

INSTRUCTION MANUAL

TYPE 3A10 TRANSDUCER AMPLIFIER

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TABLE OF CONTENTS

	Page		Page
SECTION 1 TYPE 3A10 SPECIFICATION		SECTION 5 PERFORMANCE CHECK/CALIBRATION	
Introduction	1-1	Introduction	5-1
Electrical Characteristics	1-1	Test Equipment Required	5-1
Environmental Characteristics	1-4	Short-Form Procedure	5-2
Physical Data	1-4	Performance Check/Calibration Procedure	5-3
Optional Transducer Characteristics	1-5		
SECTION 2 OPERATING INSTRUCTIONS		SECTION 6 ELECTRICAL PARTS LIST	
Introduction	2-1	Abbreviations and Symbols	
Function of Controls and Connectors	2-1	Parts Ordering Information	
First Time Operation	2-2	Index of Electrical Parts List	
Preparation	2-2	Electrical Parts List	
Operational Adjustments	2-3		
General Operating Information	2-4	SECTION 7 DIAGRAMS and CIRCUIT BOARD	
(High Impedance Input, Bandwidth		ILLUSTRATIONS	
Selection, etc.)		Symbols and Reference Designators	
Basic Mechanical Measurement Applications	2-8	Voltage Test Conditions	
Transducer Measurement Concepts	2-9	Schematic Diagrams and Component Board	
Deflection Factor Scales	2-9	Locations	
Calibrating the Mechanical Measurement			
System	2-10	SECTION 8 MECHANICAL PARTS LIST	
General Calibration Equation	2-11	Mechanical Parts List Information	
Fittings	2-12	Index of Mechanical and Repackaging	
Optional Accessories	2-12	Parts Illustrations and Parts Lists	
		Mechanical Parts List	
SECTION 3 CIRCUIT DESCRIPTION		Accessories	
Introduction	3-1		
Input Preamplifier	3-1	CHANGE INFORMATION	
Output Amplifier	3-4		
Transducer Power Supply	3-5		
SECTION 4 MAINTENANCE			
Preventive Maintenance	4-1		
Troubleshooting	4-1		
Replacement Parts	4-3		
Component Replacement	4-4		
(Circuit Board, Switch, Transistor			
and Fuse replacement)			
Recalibration After Repair	4-4		

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

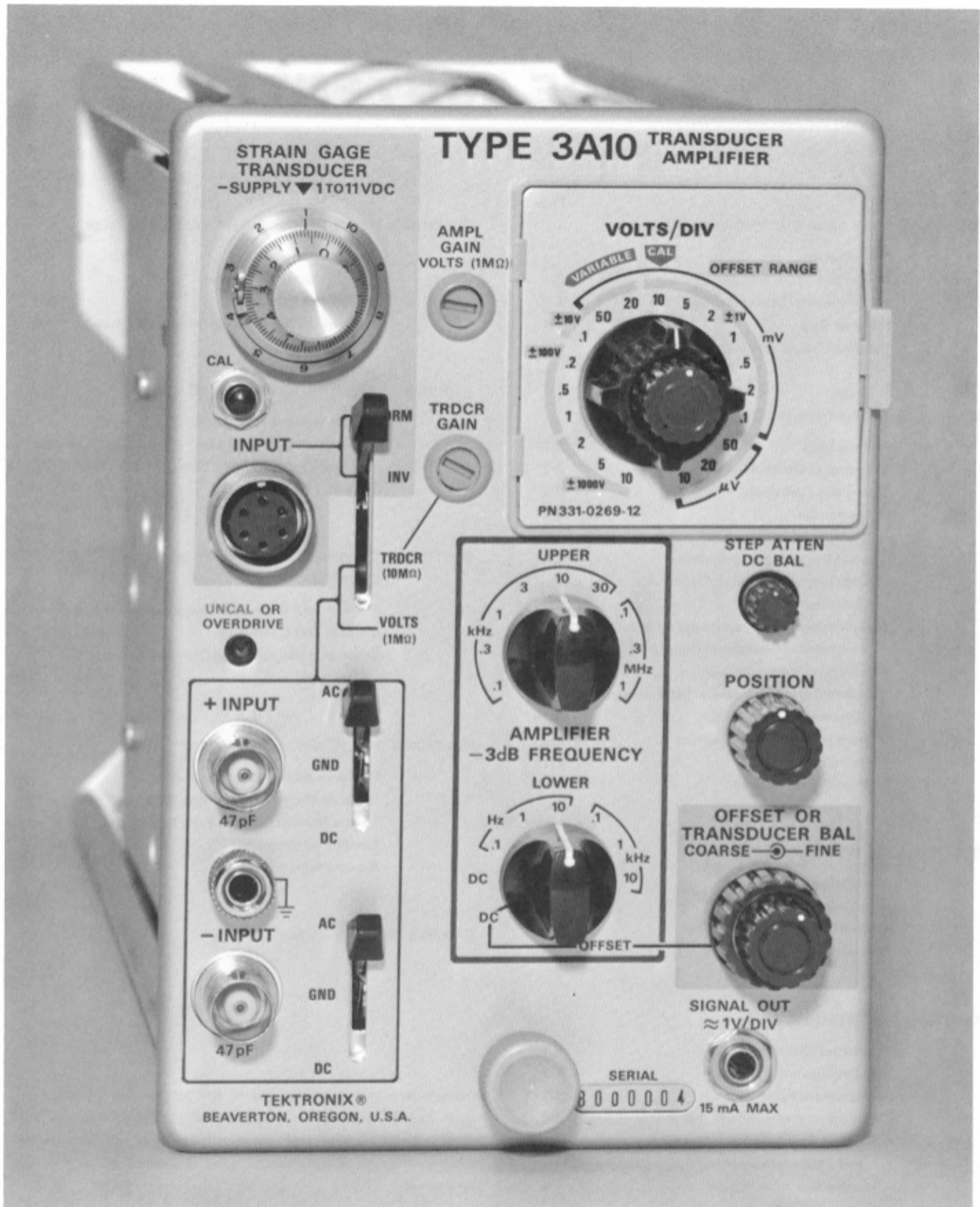


Fig. 1-1. Type 3A10 Transducer Amplifier.

SECTION 1

TYPE 3A10 SPECIFICATION

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

Introduction

The Type 3A10 Transducer Amplifier Plug-In is designed for use in combination with an appropriate oscilloscope and transducer, forming a Mechanical Measurement System to check physical quantities such as pressure, force, displacement, vibration, shock, temperature, strain, etc.

The Type 3A10 is a DC coupled differential amplifier with excellent common-mode rejection and high gain characteristics. It features selectable upper and lower frequency cutoff, and has a DC offset provision. A 10 M Ω input is incorporated in addition to the one M Ω input to accommodate high-impedance self-generating transducers. A variable, calibrated DC-voltage source is provided for powering a strain gage bridge or other passive transducer. The instrument uses snap-on panel inserts to denote the deflection-factor scale for the quantity being measured (in both U.S. and metric units). Calibration features for each of the three input modes allows switching between two transducers and VOLTS without recalibration.

The instrument will perform as stated under the Performance heading in Table 1-1, within an ambient temperature range of 0°C to +50°C, provided that it has been calibrated within an ambient temperature range of +20°C to +30°C, and is operated within a calibrated oscilloscope mainframe. Warmup time for rated accuracies is 20 minutes.

Characteristics for the recommended optional transducers are given in Table 1-2. Where applicable, transducer accuracy is a combination of linearity (L), hysteresis (H), repeatability (R) and calibration error. Accuracies are rated at +25°C, and do not include the entire Type 3A10/oscilloscope system.

TABLE 1-1

ELECTRICAL CHARACTERISTICS

Characteristic	Performance
Deflection Factor	
Calibrated Range	10 μ V/div to 10 V/div; 19 steps in a 1-2-5 sequence.

Characteristic	Performance
Accuracy	
20 mV/div to 10 V/div	Within 3%.
10 μ V/div to 10 mV/div	Within 2%.
Uncalibrated (Variable)	Continuously variable; extends deflection factor to at least 25 V/div.
Frequency Response	
Upper Bandwidth Limit (8 Div Reference)	
DC (Direct) Coupled	
1 MHz	1 MHz, within +30%, -0%.
100 Hz to 300 kHz	Within 12% of value indicated by UPPER AMP -3 dB FREQ switch setting. Nine steps in a 10-3-1 sequence.
Lower Bandwidth Limit	
DC (Direct) Coupled	From DC.
0.1 Hz to 10 kHz	Within 12% of value indicated by LOWER AMP -3 dB freq switch setting. Six steps in a 100-10-1 sequence.
AC (Capacitive) Coupled	
1 M Ω Mode	1.6 Hz, within 5%.
10 M Ω Mode	0.16 Hz, within 5%.

TABLE 1-1 (cont)

Characteristic	Performance
Overdrive Recovery	10 μ s or less to recover to within 0.5% of zero level after the removal of a + or – test input applied for at least 1 s. Test signal not to exceed Differential Dynamic Range. Specified aberration (0.5%) based on test signal amplitude.
Differential Dynamic Range (DC OFFSET off)	
10 μ V/div to 10 mV/div	± 1 V.
20 mV/div to 0.1 V/div	± 10 V.
0.2 V/div to 1 V/div	± 100 V.
2 V/div to 10 V/div	± 1000 V (500 V maximum each input).
Common Mode Dynamic Range	
10 μ V/div to 10 mV/div	± 10 V.
20 mV/div to 0.1 V/div	± 100 V.
0.2 V/div to 10 V/div	± 500 V.
Common-Mode Rejection Ratio	
DC (Direct) Coupled	See Fig. 1-2, CMRR vs. Frequency graph.
AC (Capacitive) Coupled	See Fig. 1-2, CMRR vs. Frequency graph.

Characteristic	Performance	
Maximum Input Voltage		
DC (Direct) Coupled, DC + Peak AC	± 15 V.	
10 μ V/div to 10 mV/div		
20 mV/div to 10 V/div	± 500 V.	
AC (Capacitive) Coupled, Input DC Voltage	± 500 V, each input.	
Input R and C		
Resistance	1 M Ω , within 1% (1 M Ω Mode); 10 M Ω , within 1% (10 M Ω Mode)	
Nominal Capacitance	47 pF.	
Time Constant	47 μ s, within 4% (in VOLTS position).	
Maximum Input Offset Current	+20°C to +30°C	+50°C
10 μ V/div to 10 mV/div	each input ± 20 pA	± 100 pA
20 mV/div to 10 V/div	each input ± 10 pA	± 10 pA
Display Shift At 10 μ V/div (AC Coupled)		
1 M Ω Mode	± 2 div	± 10 div
10 M Ω Mode	± 20 div	± 100 div
Displayed Noise (Tangentially Measured)	12 μ V (6 μ V RMS) or 0.1 div or less, whichever is greater at 1 MHz bandwidth, and source resistance of 25 Ω or less.	
	2.5 μ V (1.25 μ V RMS) or 0.1 div or less, whichever is greater at 100 Hz bandwidth, and source resistance of 25 Ω or less.	

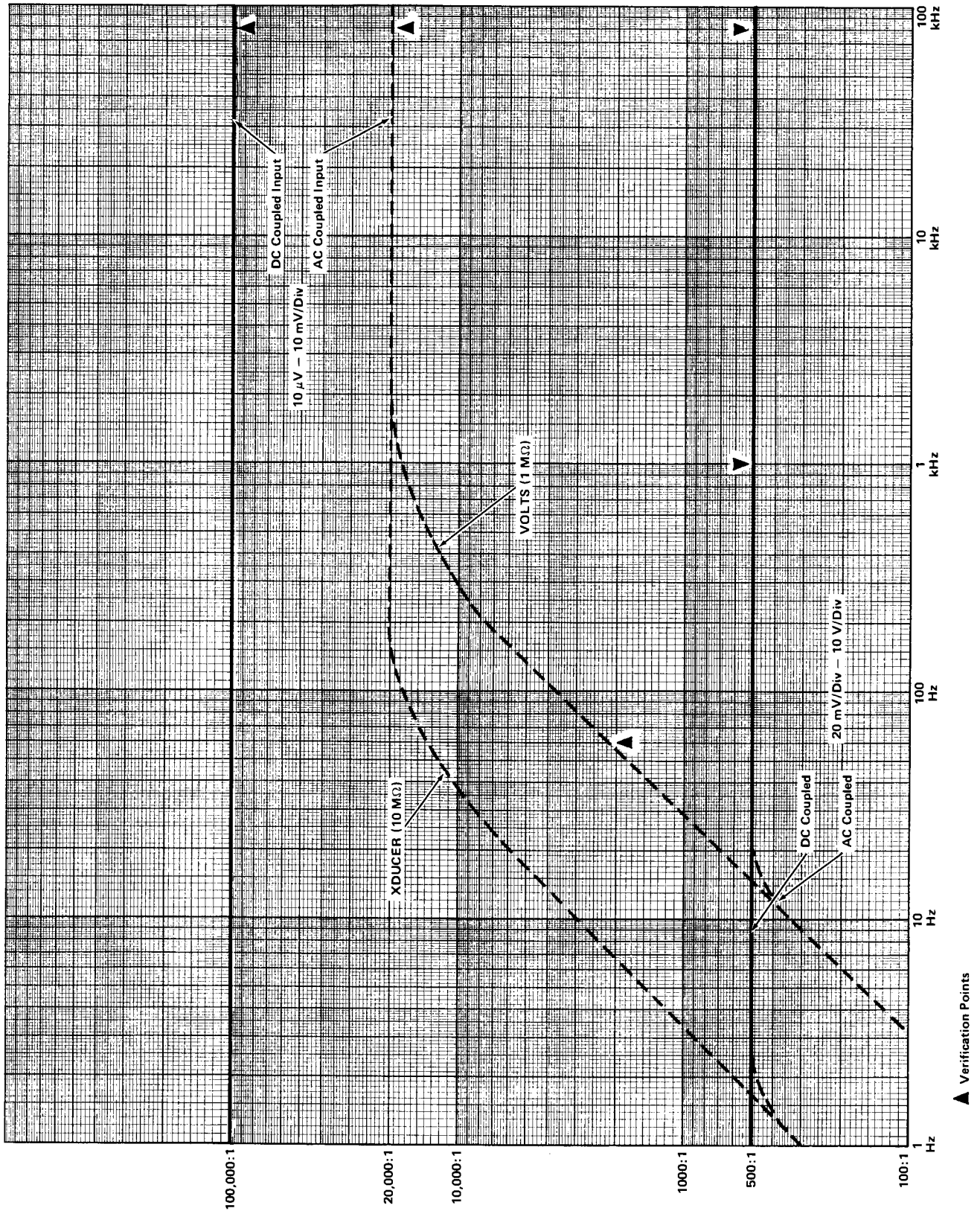


Fig. 1-2. CMRR vs. Frequency, for signals not exceeding Common-Mode Dynamic Range.

TABLE 1-1 (cont)

Characteristic	Performance
Trace Stability	
DC Drift With Time (Ambient Temperature and Line Voltage Constant)	
Short Term	5 $\mu\text{V}/\text{minute}$ (P-P) or 0.1 div (whichever is greater) after 1 hour warmup.
Long Term	10 $\mu\text{V}/\text{hour}$ (P-P) or 0.1 div (whichever is greater) after 1 hour warmup
Drift with Ambient Temperature (Line Voltage Constant)	50 $\mu\text{V}/^\circ\text{C}$, or less.
Isolation Between + and - Inputs (+INPUT to an Open -INPUT, -INPUT to an Open +INPUT)	
10 $\mu\text{V}/\text{div}$ to 10 to 10 V/div	At least 200:1, DC to 1 MHz.
Signal Output	
Dynamic Range	At least +5 V to -5 V.
Amplitude	1 V/displayed div, within 20%.
Maximum Current	15 mA.
Load Impedance	At least 400 Ω for ± 5 div of displayed signal.
Amplitude Change Over Dynamic Range	Within 2%.
Bandwidth	DC to at least 500 kHz.
Output Resistance	50 Ω or less.

Characteristic	Performance
DC OFFSET/ TRANSDUCER BALANCE	
COARSE Range from Electrical zero	
10 $\mu\text{V}/\text{div}$ to 10 mV/div	+1 V to -1 V (within 10%).
20 mV/div to 0.1 V/div	+10 V to -10 V (within 10%).
0.2 V/div to 1 V/div	+100 V to -100 V (within 10%).
2 V/div to 10 V/div	+1000 V to -1000 V (within 10%).
STRAIN GAGE TRANSDUCER Power Supply	
Voltage Range	-1 V to -11 V.
Accuracy	1%.
Current Range	0 to at least 60 mA.
Maximum (Short Circuit) Current	90 mA.

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance
Temperature	
Non-operating	-40°C to +65°C.
Operating	0°C to +50°C.
Altitude	
Non-operating	To 50,000 feet.
Operating	To 15,000 feet.

PHYSICAL DATA

Finish	Anodized aluminum front panel.
Weight	4.75 pounds.

TABLE 1-2
OPTIONAL TRANSDUCER CHARACTERISTICS

Transducer	Range	Accuracy (at 25°C)	Element Type	Voltage Out (Nominal)
Pressure (see page 2-10)	3000 psig	2% (1% L & H, 0.25% R)	Bonded Strain-Gage, 350 Ω	30 mV Full Scale
Pressure (see page 2-10)	300 psig	2% (1% L & H, 0.25% R)	Bonded Strain-Gage, 350 Ω	30 mV Full Scale
Force (see page 2-10)	3000 lbs f	1% (0.5% L, H & R)	Bonded Strain-Gage, 350 Ω	30 mV Full Scale
Force (see page 2-10)	50 lbs f/ 50 grams f	2% (0.5% L, H & R)	Unbonded Strain-Gage 350 Ω	50 mV Full Scale
Acceleration (see page 2-10)	10,000 g's	5% (2% L)	Piezo f = 30 kHz	12 mV/g
Vibration, Vert & Horiz (see page 2-10)	±0.025 inch	5%	Inductive Self Generating	550 mV/inch/sec, plus 10 mV/0.001 inch
Displacement (see page 2-10)	±0.1 inch (calibrated and usable within ±0.2 inch)	2% (1% L)	DC to DC LVDT	20 mV/0.001 inch
Strain Gage (see page 2-10)	30,000 μ strain	1%	Bonded Foil Strain Gage, 120 Ω with leads	GF≈2
Thermocouple (see page 2-10)	-28°C to +105°C	5% (+10°C to +105°C)	PVC Ripcord Iron Constantan	54 μV/°C
Thermocouple (see page 2-10)	-180°C to +480°C	5% (+10°C to +480°C)	Fiberglass insulated Iron Constantan	54 μV/°C

SECTION 2

OPERATING INSTRUCTIONS

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

Introduction

An understanding of the Type 3A10 operation and capabilities is essential for obtaining optimum results. This section of the manual gives a brief functional description of the front-panel controls and connectors, a familiarization procedure, general operating information and operation with transducers as a Mechanical Measurement System.

FUNCTION OF CONTROLS AND CONNECTORS

(See Fig. 2-1)

STRAIN GAGE/ TRANSDUCER SUPPLY VOLTS Control	Continuously variable 10-turn dial provides calibrated DC-operating voltages from -1 to -11 V. Allows calibration of optional strain gage transducers to appropriate interchangeable deflection factor scales. A brake is incorporated to lock the dial when desired output level is established.
CAL Button	Momentary-contact pushbutton switch connects shunt resistor in the strain gage bridge; provides calibration check of strain-gage transducers.
INPUT Connector (Strain Gage/ Transducer)	A 6-pin connector provides the facility for strain gage transducer-signal input and operating voltage to the strain gage transducer. Two extra pins are provided for calibration of the strain gage bridge.
Deflection Factor (VOLTS/DIV) Switch	Selects calibrated deflection factors from $10 \mu\text{V}/\text{DIV}$ to $10 \text{ V}/\text{DIV}$, 19 steps in a 1-2-5 sequence. Interchangeable deflection factor scales are used to match the units measured by optional transducers.
VARIABLE (VOLTS/DIV) Control	Provides uncalibrated continuously variable deflection factor between steps; extends range to $25 \text{ V}/\text{DIV}$.

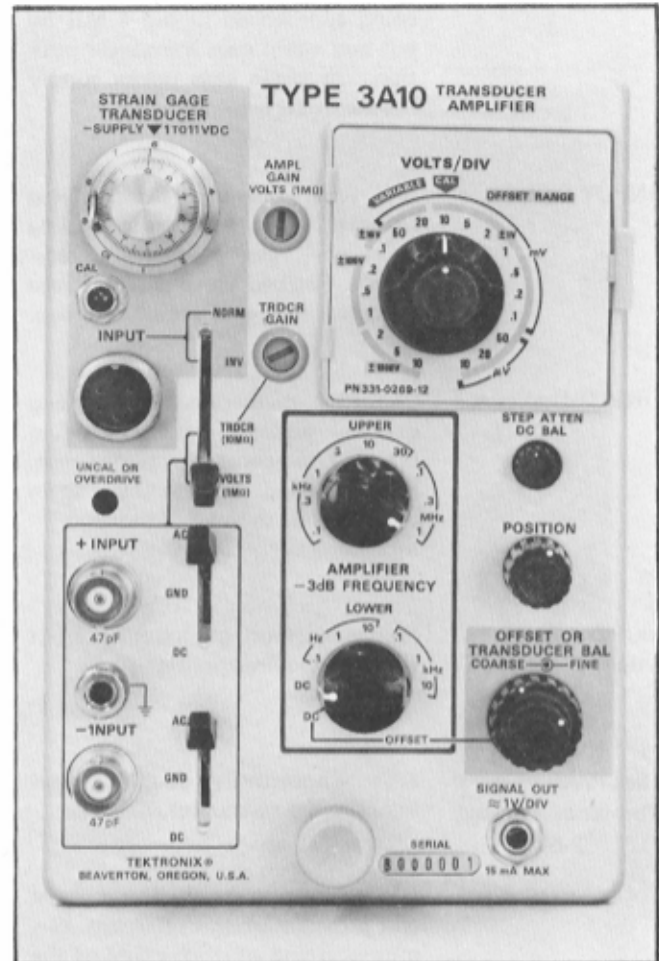


Fig. 2-1. Type 3A10 front-panel controls and connectors.

AMPLIFIER GAIN Control (Volts, $1 \text{ M}\Omega$ Input)	Screwdriver adjustment allows calibration of vertical deflection factor of the Type 3A10 to the oscilloscope.
TRANSDUCER GAIN Control (Transducer, $10 \text{ M}\Omega$ Input)	Screwdriver adjustment allows calibration of optional self-generating transducers to appropriate interchangeable vertical deflection factor scale.

Operating Instructions—Type 3A10

Input Selector Switch	Four-position lever switch selects NORMAL or INVERTED strain gage input, and TRANSDUCER (10 M Ω or VOLTS (1 M Ω) input to differential + and – INPUT connectors.	decade steps. If the input is AC coupled, the lower –3 dB point will be limited by the coupling capacitor.												
UNCAL or OVER-DRIVE Indicator	Indicates deflection factor is uncalibrated, differential overload is being approached in the 1 M Ω input and strain gage transducer positions, or strain gage power supply has a current overload.	STEP ATTEN DC BAL Control Permits balancing of trace in DC position of LOWER –3 dB FREQUENCY switch, when switching VOLTS/DIV.												
+ INPUT Connector	BNC-type connector for applying external voltage signals including optional, self-generating transducers. Positive signal deflects trace up or to the right in the X-Y mode.	POSITION Control Positions the display vertically.												
– INPUT Connector	BNC-type connector for applying external voltage signals including optional, self-generating transducers. Positive signal deflects trace down or to the left in the X-Y mode.	OFFSET OR TRANSDUCER BAL Controls COARSE and FINE controls allow on-screen display of small signal variations on relatively large signal levels. They also serve as balance controls for strain gage transducers.												
Input Coupling Switch	Selects method of coupling input signal to the Preamplifier.	SIGNAL OUT Connector Mini-phone type connector for monitoring the displayed signal or driving recorders. Output is about 1 V/displayed division, up to 15 mA.												
FIRST TIME OPERATION														
Preparation														
<p>The following procedure is intended to prepare the Type 3A10 for immediate use. Also, this procedure is referred to under Basic Mechanical Measurement Applications as the basis for operating the optional transducers. Be sure that the associated oscilloscope (for example, Tektronix Type 560-series) and time-base unit are correctly calibrated (refer to those instruction manuals), and that the calibrator output voltage is correct.</p>														
<ol style="list-style-type: none"> 1. Insert the Type 3A10 into the oscilloscope plug-in compartment. Tighten the securing latch. 2. Select the VOLTS/DIV deflection factor scale (Part No. 331-0269-12) and snap it into the scale retainer on the front panel. 3. Set the Type 3A10 controls as follows: 														
UPPER –3 dB Switch	Selects upper bandwidth frequencies from 100 Hz to 1 MHz, nine steps in a 1-3-10 sequence.	<table border="0"> <tbody> <tr> <td>VOLTS/DIV</td> <td>10 mV</td> </tr> <tr> <td>VARIABLE</td> <td>CAL</td> </tr> <tr> <td>Input Selector</td> <td>VOLTS (1 MΩ)</td> </tr> <tr> <td>Input Coupling (both + and –)</td> <td>GND</td> </tr> <tr> <td>STEP ATTEN DC BAL</td> <td>Midrange</td> </tr> <tr> <td>POSITION</td> <td>Midrange</td> </tr> </tbody> </table>	VOLTS/DIV	10 mV	VARIABLE	CAL	Input Selector	VOLTS (1 M Ω)	Input Coupling (both + and –)	GND	STEP ATTEN DC BAL	Midrange	POSITION	Midrange
VOLTS/DIV	10 mV													
VARIABLE	CAL													
Input Selector	VOLTS (1 M Ω)													
Input Coupling (both + and –)	GND													
STEP ATTEN DC BAL	Midrange													
POSITION	Midrange													
LOWER –3 dB Switch	Eight positions select DC, DC OFFSET, and lower bandwidth frequencies from 0.1 Hz to 10 kHz in													

AMPLIFIER —3 dB	
FREQUENCY	
UPPER	10 kHz
LOWER	DC
OFFSET OR	
TRANSDUCER BAL	
(both knobs)	Midrange
STRAIN GAGE/ TRANSDUCER	
—SUPPLY	1.00

4. Turn the oscilloscope Intensity control fully counter-clockwise and turn on the oscilloscope power. Preset the time base and triggering controls for a 1 ms/division sweep rate and automatic triggering.

5. Wait about 20 minutes for the Type 3A10 and oscilloscope to warm up.

NOTE

About 20 minutes is sufficient warmup time when using the Type 3A10 for short term DC applications. For long term DC applications using the lower deflection factors, allow at least one hour warmup time.

6. Adjust the oscilloscope Intensity control for normal viewing of the display. The trace should appear near the graticule center.

7. Apply a 40 mV (or 50 mV) peak-to-peak calibrator signal through a coaxial cable to the + INPUT connector.

8. Position the trace two divisions below the graticule center line, then set the + Input Coupling switch to DC. The display should be square waves 4 divisions in amplitude (5 divisions if a 50 mV calibrator signal is applied), with the bottom of the display two divisions below the center line.

9. Adjust the front-panel AMPL GAIN— VOLTS (1 MΩ) control to calibrate the display for exactly 4 graticule divisions (5 divisions for 50 mV).

10. Set the Input Selector to TRDCR (10 MΩ) and adjust the front-panel TRDCR GAIN control to calibrate the display.

11. Remove the calibrator signal, set the + Input Coupling switch to GND and position the trace to the graticule center line.

NOTE

At this point, the overall amplifier gain is adjusted to provide a calibrated display. Adjust transducer calibration as outlined later in this section under Basic Mechanical Measurement Applications.

Operational Adjustments

Before measurements are made or recorded, some operational adjustments may be made to ensure optimum instrument performance. These adjustments include step attenuator DC balancing, bandwidth limiting, AC stabilization and setting the DC zero reference of the signal output connector.

1. STEP ATTEN DC BAL. If this control is not properly adjusted, the CRT zero reference point (trace or spot) will shift vertically due to differential DC imbalance in the amplifier as the deflection factor (Measurand unit/DIV) switch is rotated through its range. The shift is more noticeable on the most sensitive positions.

a. Note the positions of the Type 3A10 front-panel controls so that they can be returned to these positions after the adjustment, then set the controls as follows:

Deflection Factor	Midrange (10 mV on the VOLTS/DIV scale)
VARIABLE	CAL
Input Selector	VOLTS (1 MΩ)
Input Coupling (both + and —)	GND
STEP ATTEN DC BAL POSITION	Midrange
AMPLIFIER —3 dB FREQUENCY	Midrange
UPPER	0.1 kHz
LOWER	DC

b. Adjust the POSITION control to move the CRT trace or spot to the graticule horizontal center line.

c. Set the Deflection Factor switch to its most clockwise position (10 μV on the VOLTS/DIV scale).

d. Return the trace or spot to graticule center by adjusting 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 3A10 is used DC coupled,

Operating Instructions—Type 3A10

or in significantly varying ambient temperatures in the 10 $\mu\text{V}/\text{DIV}$ to .1 mV/DIV ranges, the STEP ATTEN DC BAL should be checked quite frequently. It is good practice to check this control and readjust, if necessary, before any critical measurement is made under the above conditions.

2. AMPLIFIER -3 dB FREQUENCY. Extraneous variables, such as varying temperatures, pressures, mechanical resonant frequencies, etc., acting on a transducer can often interfere with dynamic measurements. Many times an undesirable signal can be attenuated by varying the bandwidth of the unit. To filter out signals varying more slowly than the desired measurand, adjust the LOWER -3 dB FREQUENCY for best results. Also, by adjusting the UPPER -3 dB FREQUENCY switch, higher-frequency noise can be considerably reduced without distorting the desired signal. Care must be taken not to overly restrict the amplifier bandwidth.

3. AC Atten Bal (internal adjustment, R405). When the LOWER -3 dB FREQUENCY switch is used to limit the low frequency response of the Type 3A10, the unit employs AC stabilization. This means that when the switch is set to any position except DC or DC OFFSET, the STEP ATTEN DC BAL and DC OFFSET controls become inoperative. VOLTS/DIV balance is then controlled with the AC Atten Bal, an internal adjustment (see Fig. 2-2). When transferring the Type 3A10 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.

NOTE

An unbalance of up to 30 μV is normal and cannot be reduced by adjusting the AC Atten Bal control.

a. Note the positions of the Type 3A10 front-panel controls so that they can be returned to these positions after the adjustment, then set the controls as follows:

Deflection Factor	10 mV (VOLTS/DIV scale)
Input Selector	VOLTS (1 $\text{M}\Omega$)
Input Coupling (both + and -)	GND
AMPLIFIER -3 dB FREQUENCY	
UPPER	.1 kHz
LOWER	10 kHz

b. Adjust the POSITION control to move the CRT trace or spot to the graticule horizontal center line.

c. Set the Deflection Factor switch to the 20 μV position (VOLTS/DIV scale).

d. Adjust the AC Atten Bal control (R405) to position the trace or spot to within 1.5 divisions of graticule center. See note preceding step a.

4. Signal Out DC Level (internal adjustment, R467). If a signal output is to be used, the Signal Out DC Level should be checked when first operating the Type 3A10 or when changing mainframes. The DC level at the SIGNAL OUT 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.

a. Note the positions of the Type 3A10 front-panel controls so that they can be returned to these positions after the adjustment, then set the controls as follows:

Deflection Factor	10 mV (VOLTS/DIV scale)
Input Selector	VOLTS (1 $\text{M}\Omega$)
Input Coupling (both + and -)	GND
AMPLIFIER -3 dB FREQUENCY	
UPPER	1 MHz
LOWER	DC

b. Adjust the POSITION control to move the trace or spot to the graticule horizontal center line.

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

d. With the left-side panel of the oscilloscope removed, adjust the Sig Out DC Level (R467) for zero volts out at the SIGNAL OUT connector (see Figs. 2-1 and 2-2).

GENERAL OPERATING INFORMATION

Trace Drift

The environment in which the Type 3A10 is operated and the inherent characteristics of the Type 3A10 influence trace drift. Therefore, to determine trace drift for a specific environment, refer to the Specification section. In an environment in which the ambient temperature does not vary much (such as an air-conditioned building), the trace drift generally will not exceed 10 μV in one hour.

To obtain accurate DC measurements at maximum sensitivity, it is necessary to ground the inputs and DC balance the amplifier just before making the measurement. This is accomplished by adjusting the STEP ATTEN DC BAL control as described earlier in this section under Operational Adjustments.

Input Gate Current

When using the .1 mV/DIV to 10 μ V/DIV ranges (VOLTS/DIV scale) for measurement with an AC coupled input, or for DC measurements where the source impedance is high (in excess of 1 M Ω), the input gate current should be checked and allowed for, or adjusted to zero. This is particularly desired at high ambient temperatures (above 40°C). Steps 8 and 9 in the Performance Check/Calibration Procedure describe the check and adjust procedures for setting the gate current to zero.

Voltage Measurement

When measuring DC voltages, use the largest deflection factor (10 V/DIV) when first connecting the Type 3A10 to an unknown voltage source. If the deflection is too small to make the measurement, switch to a lower deflection factor. If the input stage is overdriven, a large amount of current might flow into the input.

CAUTION

If the maximum input voltage rating is exceeded in the 10 μ V/DIV to 10 mV/DIV range of the deflection factor switch, the inputs are diode-clamped to fixed voltages of + and - 15 volts. If the signal source can supply more than 1/16 A, the input protective fuse(s) will open. An open input fuse is indicated by the lighting of the UNCAL OR OVER-DRIVE lamp when the input coupling switches are set to the GND position.

Precharging. Where only the AC component of a signal having both AC and DC components is to be measured, use the Input Coupling (AC-GND-DC) switches to take advantage of the precharging circuit incorporated in the unit. The pre-charging circuit permits charging the coupling capacitor to the DC source voltage when the Input Coupling switch is set to GND. The procedure for using this circuit is as follows:

- a. Before connecting the Type 3A10 to a signal containing a DC component, set the 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 display will remain on-screen and the AC component can be measured in the usual manner.

The above procedure should be followed whenever a signal having a different DC level is connected.

CAUTION

If the Type 3A10 is connected to a large DC voltage source without using the pre-charge provision, the peak charging current (into a 0.1 μ F capacitor) will be limited only by the signal source, and this source may be damaged or destroyed.

When a large DC voltage has been applied to the Type 3A10 with the input AC coupled, the input coupling capacitor(s) acquires a charge due to dielectric polarization and acts as a high impedance voltage source with a very slowly decaying output voltage. This voltage can offset subsequent AC coupled measurements at other DC voltages and drive the trace off-screen. A period of at least 10 minutes, with input set to GND, should be allowed to ensure reasonable recovery from polarization, and a longer period may be necessary for critical measurements. If the inputs are shorted to ground, the depolarization process will require less time.

Signal Input Connectors

Two types of connectors are provided for connecting signals to the Type 3A10— a 6-pin Bendix connector for connecting Wheatstone bridge and other passive circuit information (see pages 2-10 and 2-11 for additional information), and BNC connectors for coaxial cables. When connecting signals to the + and - INPUT BNC connectors, consider the method of conveying the signal. Sometimes unshielded test leads can be used to connect the Type 3A10 to a signal source, particularly when a high level, low-frequency signal is monitored at a low impedance point. However, when any of these factors is missing, it becomes increasingly important to use shielded signal cables. In all cases, the signal-transporting leads should be kept as short as practical.

When making single-ended input measurements (conventional amplifier operation), be sure to establish a common ground connection between the device under test and the Type 3A10. The shield of a coaxial cable is normally used for this purpose.

In some cases, differential measurements require no common ground connection¹, and therefore are less sus-

¹The DC plus AC voltages on the test points (with respect to the chassis potential of the Type 3A10) 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.

Operating Instructions—Type 3A10

ceptible 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 3A10. The circuit at the input connectors can normally be represented by a 1-megohm or 10-megohm resistance to ground paralleled by 50 pF, depending upon the setting of the Input Selector switch. A few feet of shielded cable (20 to 40 pF per foot) may increase the parallel capacitance to 100 pF or more. In many cases, the effects of these resistive and capacitive loads may be too great, and it may be desirable to minimize them through the use of an attenuator probe.

Attenuator probes not only decrease the resistive-capacitive loading of a signal source, but also extend the measurement range of the Type 3A10 to include substantially higher voltages. Passive attenuator probes having attenuation factors of 10X, 100X and 1000X, as well as other special-purpose types, are available through your Tektronix Field Engineer or Field Office.

Some measurement situations require a high resistance input to the Type 3A10 with very little source loading or signal attenuation. In such cases, a passive attenuator probe cannot be used. However, this problem may be solved by using an FET Probe or the high impedance input provision of the Type 3A10.

High Impedance Input

When the Input Selector is in the NORM, INV or TRDCR positions, the input resistance to the Type 3A10 is normally 10 megohms. Generally, this is adequate for use with most transducers requiring a high input impedance; however, a higher input impedance is obtainable by disconnecting the internal 10-megohm resistors.

The high input impedance provision applied to signals that are small enough to permit the use of the unattenuated positions of the Deflection Factor switch (10 mV through 10 μ V on the VOLTS/DIV scale). The attenuated positions of the switch do not permit a higher input impedance than that established by the attenuators.

In the VOLTS position of the Input Selector, the input resistance is about one megohm, established by fixed resistances to ground. This position of the switch does not permit the use of the high input impedance provision.

To obtain a very high input impedance, unsolder the wire straps (see Fig. 2-2) between the input line and the internal 10-megohm gate return resistance. Either replace the straps with a high value of resistance (such as 100 M Ω) or remove the straps and leave the circuit open. If left open, the signal source must then provide a DC path for the FET gate current.

NOTE

When the wire straps are removed from the amplifier circuit board, the + Gate Current and - Gate Current internal adjustments are disconnected. The deflection factors in the 20 mV to 10 V range (the entire range if the VOLTS position of the Input Selector is used) will be incorrect.

The uncompensated gate current is typically less than 100 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, which may result in significant error where small voltages are of concern.

The high frequency response will also depend upon the signal source impedance, since various shunt capacitances between the source and 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,

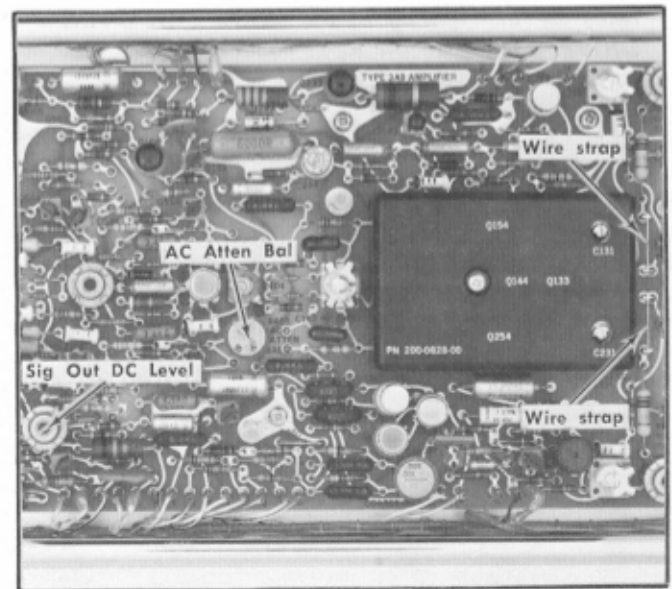


Fig. 2-2. Location of controls on Amplifier circuit board.

positive-going changes in the input signal will cause the trace to be deflected upward, and negative-going changes will cause the trace to be deflected downward. If the -INPUT is chosen, input-to-display polarity relationship will be reversed, as shown in Fig. 2-3.

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe (if any), the setting of the Deflection Factor (VOLTS/DIV) switch and the setting of the VARIABLE control. The calibrated deflection factors indicated by the deflection factor scales (12 scales are provided for different measurands, and will be discussed under Basic Mechanical Measurement Applications) apply only when the VARIABLE control is set fully clockwise into the switch detent CAL position.

The range of the VARIABLE control is at least 2.5:1. It provides uncalibrated deflection factors covering the full range between fixed settings of the Deflection Factor switch. The control can be set to extend the deflection factor to at least 25 volts per division (VOLTS/DIV scale).

To reduce noise and obtain a more usable display when the Deflection Factor switch is set to the most sensitive positions, use the AMPLIFIER -3 dB FREQUENCY switch settings which do not appreciably distort the desired features of the signal under observation. See Fig. 2-4.

Bandwidth Selection

In addition to the common-mode rejection of unwanted signals, many times an undesired signal can be attenuated by varying the bandwidth of the unit. The AMPLIFIER -3 dB FREQUENCY switches on the front panel of the

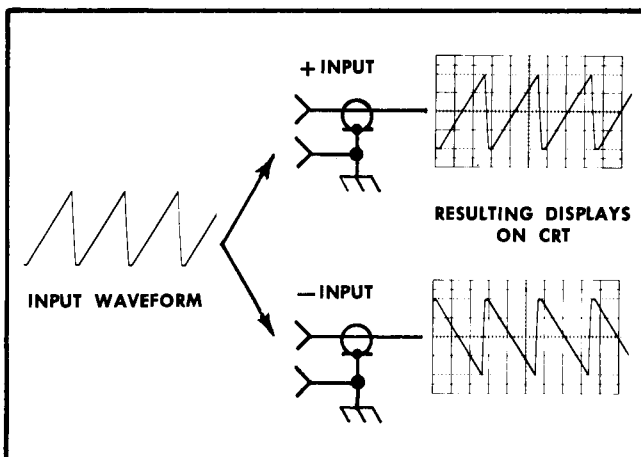


Fig. 2-3. Signals applied to the + INPUT connector produce an upright display, while signals applied to the - Input are inverted.

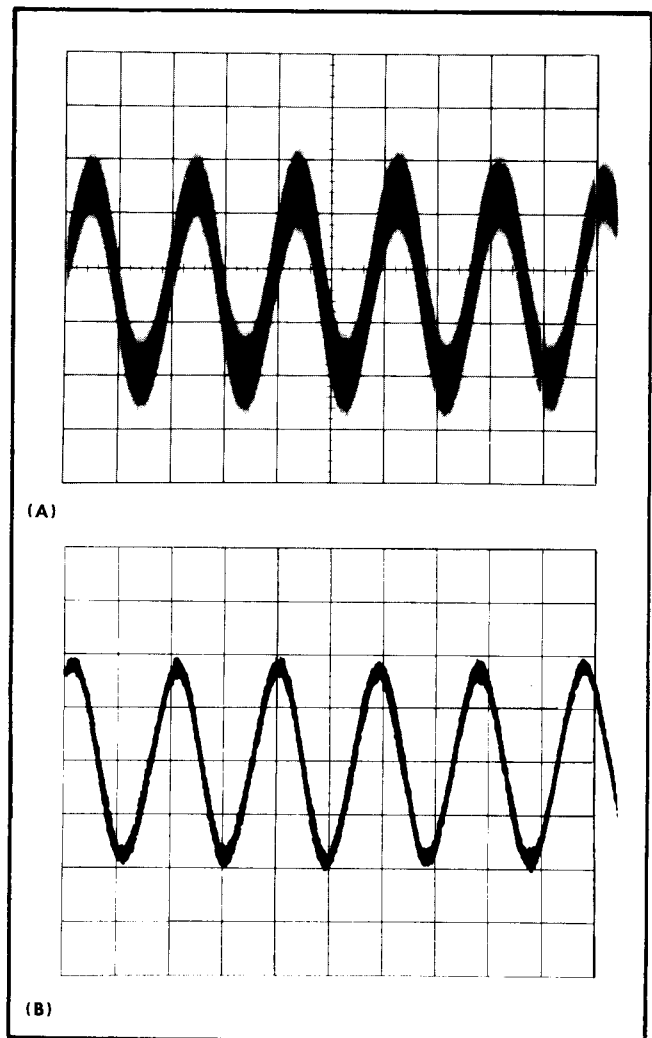


Fig. 2-4. Improving signal-to-noise ratio by setting bandwidth; (A) signal applied with UPPER -3 dB point set to 1 MHz, (B) same signal with UPPER -3 dB point set to 10 kHz.

instrument control the low-frequency and high-frequency half-power points (-3 dB points) of the amplifier when the input is DC coupled (if the input is AC coupled, the lower -3 dB point will be limited by the coupling capacitor).

Varying the bandwidth of the Type 3A10 is useful, for example, when displaying a low-frequency signal. By reducing the high-frequency response, the noise in many cases can be considerably reduced without distorting the desired signal, as is shown in Fig. 2-4. Likewise, undesired line-frequency signals can be filtered out by restricting the low-frequency response of the unit. When using the AMPLIFIER -3 dB FREQUENCY switches, care must be taken not to distort waveforms by overly restricting the amplifier bandwidth.

Voltage Comparison Measurements

Some applications require a set of deflection factors other than the fixed values provided by the Deflection

Operating Instructions—Type 3A10

Factor 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 3A10, and set the Deflection Factor switch and VARIABLE control so that the reference signal covers the desired number of graticule divisions. Do not change the setting of the VARIABLE control throughout subsequent comparisons. The settings of the Deflection Factor switch can be changed, however, to accommodate large ratios. In doing so, regard the numbers on the deflection factor scale as ratio factors, rather than deflection factors.

Differential Operation

Single-ended measurements often yield unsatisfactory results, 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 the low-frequency response.

These limitations of single-ended measurements are virtually eliminated using differential measurements. Differential measurement is made by connecting each of the inputs (+ INPUT and – INPUT) to selected points in the test circuit, or by using the multi-pin INPUT connector. If the BNC + and – INPUT connectors are used, the Input Coupling switches should be set to the same position (AC or DC), depending on the method of signal coupling required.

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

The ability of the Type 3A10 to reject common-mode signals is indicated in the common-mode rejection ratio (CMRR). CMRR is at least 100,000:1 at the input connectors for the lowest deflection factors (10 mV to 10 μ V on the VOLTS/DIV scale) when signals between DC and 100 kHz are DC coupled to the inputs. To illustrate this characteristic, assume that a single-ended input signal consists of an unwanted 60-Hz signal at 1 volt peak to peak, plus a desired signal at 1 mV peak to peak. If an attempt is made to display the described signal (single-ended measurement) at .2 mV/DIV, the 60-Hz signal will produce a deflection equivalent to 5,000 divisions and the 1 mV signal will be lost.

If the same 1 mV signal is measured differentially with the 60-Hz signal common to both inputs, no more than one part in 100,000 of the common-mode signal will appear in

the display. The desired signal will produce a display of five divisions with not more than 0.05 divisions of display produced by the common-mode signal.

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

Outside influences such as magnetic fields can also degrade the performance, particularly when low level signals are involved. Magnetic interference may be minimized by using identical signal-transporting leads to the two inputs and twisting the leads together over as much of their length as possible.

DC Offset Operation

By using the DC OFFSET controls, it is possible to use the Type 3A10 differentially in a slide-back mode to observe a small AC signal whose DC component may be considerable. The offset is continuously adjustable from +1 volts to –1 volt when the Deflection Factor switch is in the 10 μ V to 10 mV positions (VOLTS/DIV scale). In the 20 mV, 50 mV and .1 V positions, the 1 V offset is effectively multiplied by the input attenuator to a range of ± 10 V. The effective DC offset voltages internally available for all the Deflection Factor switch positions are summarized in the Specification section.

Signal Output Connector

The front-panel SIGNAL OUT mini-phone type connector (Tektronix Part No.: 134-0057-00, Black; 134-0052-00, Red) provides an output sample of the vertical deflecting signal for monitoring or driving recorders. The output DC level is proportional to the display position; the zero DC level is adjustable to the screen center. The output amplitude is about one volt per displayed division, with up to 15 mA current capability. Bandwidth of the output signal is DC to at least 500 kilohertz at the upper –3 dB point.

BASIC MECHANICAL MEASUREMENT APPLICATIONS

General

The following information describes the procedures and techniques for making basic measurements with

transducers, employing the Type 3A10 as part of the Mechanical Measurement System. In general, any mechanical quantity that can be converted to a change in resistance, capacitance, inductance, current or voltage by a transducer can be measured. While the given techniques apply to many transducers, the specific application procedures given in this section are limited to transducers available as optional accessories for use with the Type 3A10.

Transducer Measurement Concepts

A Transducer Measurement Concepts Book (Kenneth L. Arthur, Tektronix, Inc., 1970) is supplied with the Type 3A10 to augment information given in the manual. This book should be referred to for theoretical and operational concepts, detailed descriptions of transducers, appropriate instrumentation for their employment, typical application techniques, conversion tables, a glossary of terms, material characteristics and other information useful in transducer measurement applications.

Deflection Factor Scales

Twelve snap-on deflection factor scales are available for use with the Type 3A10, permitting the oscilloscope display to be calibrated in measurand units per graticule division. The measurands include pressure, force, acceleration, vibration (velocity and displacement), displacement, strain, temperature and volts. Where applicable, the scales indicate U.S. units on one side and Metric units on the other side.

To install, slip the scale over the switch knobs and lodge the left edge under the tabs on the left side of the plastic scale retainer. Apply outward pressure on the latching tab on the right side of the retainer and snap the right edge of the scale under the tab. To remove, unlatch the scale and lift it out of the retainer.

Calibrating the Mechanical Measurement System

Complete calibration instructions for using transducers provided as optional accessories to the Type 3A10 are given in Figs. 2-7 through 2-14. These instructions can be used as guidelines in setting up transducers similar to these types.

To calibrate the system using other transducers, the type of transducer must be known. Self-generating types require different calibration methods than powered ones. If doubt arises as to the specifications of a particular transducer, refer to the data sheets supplied with the transducer. Also, the Transducer Measurement Concepts Book contains information to aid in understanding various types of transducers.

A known quantity that the transducer is designed to measure (pressure, force, weight, etc.) is always the best standard to use in calibrating the system; however, the quantity can be simulated electrically using the General Calibration Equation discussed in the following paragraph. Where applicable for maximum accuracy, precise shunt calibration information for strain-gage type transducers is given on the data sheets.

General Calibration Equation For Self Generating Transducers

Many times it is necessary to simulate a quantity when calibrating the Type 3A10 for use with a self-generating transducer. This is accomplished quite easily by applying an accurate calibrator voltage to the Type 3A10 input, calculating the amplitude of vertical display that should be present, and then setting the TRDCR GAIN to provide that amplitude.

The vertical display amplitude is calculated using the General Calibration Equation where

$$\frac{\text{Calibrator Voltage (VOLTS)}}{\text{Transducer Sensitivity} \left(\frac{\text{VOLTS}}{\text{UNITS}} \right)} \times \frac{\text{Deflection Factor} \left(\frac{\text{UNITS}}{\text{DIV}} \right)}{\text{Factor}} = \text{Divisions of display}$$

EXAMPLE: For a vibration transducer whose sensitivity is 10.5 mV/.001 inch, 10.5 mV is the quantity we wish to simulate at .001 inch per division. By intuition, it appears that if the Type 3A10 is calibrated correctly, we could set the Deflection Factor switch to .001 inch/DIV, apply a 40 mV calibrator signal, and observe slightly less than 4 divisions of display. Using the General Calibration Equation, we can solve algebraically for the exact display amplitude that the 40 mV signal should produce.

$$\begin{aligned} \text{Divisions of display} &= \frac{.040 \text{ (VOLTS)}}{.0105 \text{ (VOLTS)} \times \frac{.001 \text{ (INCH)}}{\text{DIV}}} \\ &= 40 \times \frac{\text{DIV}}{10.5} \\ &= 3.8 \text{ divisions} \end{aligned}$$

To establish the correct amplitude of display for the same transducer using the Metric system, the equation is the same; however, some conversion is required.

Operating Instructions—Type 3A10

The general calibration equation now becomes:

$$\begin{array}{rcccl} \text{Divisions} & & & & \text{Conversion} \\ \text{of} & = & \text{Calibrator} & \times & \text{Factor} \\ \text{Display} & & \text{Voltage} & & \left(\frac{\text{Metric Unit}}{\text{USA Unit}} \right) \\ & & \text{(Volts)} & & \\ & & \text{Transducer} & & \text{Deflection} \\ & & \text{Sensitivity} & \times & \text{Factor} \\ & & \text{(Volts/USA} & & \left(\frac{\text{Metric Unit}}{\text{Div}} \right) \\ & & \text{Unit)} & & \end{array}$$

Using the previous example for Metric Readout:

$$\frac{0.040 \text{ (Volts)}}{10.5 \text{ (Volts/inch)}} \times \frac{25.4 \text{ (mm/inch)}}{0.020 \text{ (mm/Div)}} = 4.8 \text{ Div}$$

Calibration of Passive Transducers (Transducers that require an external power supply are passive transducers, such as strain gages)

The Tektronix strain gage transducers are provided with built in shunt calibration resistors. When pushing the CAL button a resistor is paralleled with one arm of the strain gage bridge unbalancing it by a known amount. This amount is indicated precisely on the transducer data sheets and also on the deflection scales. The calibration of each individual deflection scale is accomplished by adjusting the transducer supply voltage.

When using a transducer without the built in shunt calibration the deflection sensitivity is calculated by taking the manufacturer supplied transducer calibration data and calculating the deflection sensitivity as follows:

Typical Pressure Transducer

Range 1000 psi	Output (full scale) 3.4 mV/Volt (supply)
----------------	---

With the supply set at 10 Volts the full scale is 34 mv/1000 psi or 34 μ V/psi. Sensitivity in the 1 mV/div is

$$\frac{1 \text{ mV/div}}{34 \mu\text{V/psi}} = 29.4 \text{ psi/div}$$

In order to get a deflection factor of 25 psi/div in the 1 mV/div position reduce the supply voltage by

$$\frac{25}{29.4} \times 10 \text{ volts} = 8.5 \text{ Volts}$$

NOTE

Make use of the back of the Volts/div scale to make your own scale.

Fittings for Pressure Transducers

Fittings such as reducers and unions may be required to join a pressure transducer to a test line. Keep couplings as short as possible and use O rings to minimize pressure loss.

The pressure transducers have female fittings with an internal thread of 7/16-20 UNF-3B. This fitting is made according to Military Standard M.S. 33649 (previously AND 10049 and 10050) and connects to a flared 1/4-inch tube male fitting of the same size, as specified in M.S. 33656 (previously AND 10056). An O ring having a .351-inch inside diameter (.072-inch diameter cross section) should be used as a seal.

To connect the transducer to fittings with different male or female threads, use one of the following: a flared 1/4-inch tube union with 7/16-20 UNF male thread on either side (specified in M.S. 24392 and AN 815), a flared tube-to-pipe thread nipple (specified in AN 816), or a flared tube reducer (specified in M.S. 24399 or AN 919). Reducers (e.g., to connect the transducer 7/16-20 UNF fitting to the Tektronix Engine Analyzer System cooling adapter 1/2-20 UNF fitting) are probably available at airplane parts shops near local air fields.

Optional Accessories

Many optional accessories are available for use with the Type 3A10 to complete a mechanical measurement system. These include ten transducer packages for measuring various quantities, four interconnecting cables of various types, two 6-pin Bendix connectors, a strain gage adapter, and a strain gage cement kit. The individual components that comprise the transducer packages can also be ordered separately. Transducer specifications and operating instructions can be found in Figs. 2-7 through 2-14. Refer to the foldout sheet (Fig. 2, back of diagram 5) for ordering information.

Pressure Transducers (Fig. 2-7). Two pressure transducer packages are available; one for pressures up to 3000 PSI and one for pressures up to 300 PSI. Each package consists of a transducer and its associated deflection factor scale. A 6-conductor interconnecting cable (Tektronix Part No. 012-0209-00) is required for connection to the Type 3A10.

Force Transducers (Figs. 2-8 and 2-9). Two force transducer packages are available; a 3000-lbs. load cell and a 50 lbs./50 grams Universal transducer. The load cell package consists of a transducer, a load button, two eye bolts, and a deflection factor scale. This transducer requires

a 6-conductor interconnecting cable (Tektronix Part No. 012-0209-00) for connection to the Type 3A10. The Universal transducer package consists of a transducer connected to its cable, a 50 lbs. adapter, two deflection factor scales, various tools and a 50-gram weight.

Acceleration Transducer (Fig. 2-10). This package consists of a 10,000 g's accelerometer and its associated deflection factor scale. A low-noise microdot-to-BNC coaxial cable (Tektronix Part No. 012-0211-00), and a mating cable connector (Tektronix Part No. 131-0404-00, Amphenol 5116-92900) is required for connection to the Type 3A10.

Vibration Transducers (Fig. 2-11). Two vibration transducer packages are available; one for vertical displacement and velocity and one for horizontal displacement and velocity. Each package consists of the transducer and two deflection factor scales. Each requires a coaxial cable with BNC connectors on both ends.

Displacement Transducer (Fig. 2-12). This package consists of a transducer, a deflection factor scale, and a .040-inch feeler gage. A 6-conductor interconnecting cable (Tektronix Part No. 012-0209-00) is required for connection to the Type 3A10.

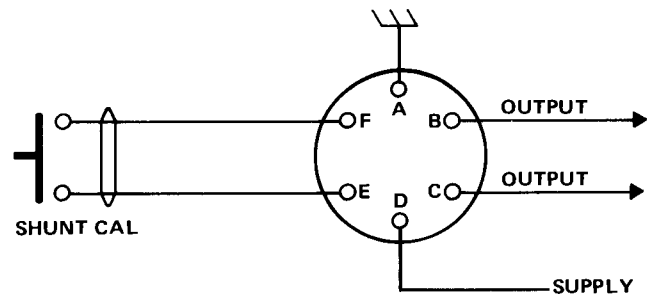
Strain Gages (Fig. 2-13). The strain gage package consists of a box of five 30,000 μ strain gages. A strain gage adapter (Tektronix Part No. 015-0169-00) is required.

Thermocouples (Fig. 2-14). This package consists of three thermocouples for a range of -20°F to $+1000^{\circ}\text{F}$, a deflection factor scale, and two binding post-to-BNC adapters.

Cables and Connectors. Four 20-foot low-noise interconnecting cable assemblies are available for connecting the transducers to the Type 3A10; a coaxial cable (Tektronix Part No. 012-0136-00) having BNC connectors on both ends, a miniature coaxial cable (Tektronix Part No. 012-0211-00) having a microdot connector on one end and a BNC on the other, a 6-conductor shielded cable having a 6-pin male Bendix connector on one end and a 6-pin female Bendix connector on the other, and a 6-conductor shielded cable (Tektronix Part No. 012-0210-00) having a 6-pin male (Tektronix Part No. 131-0618-00) Bendix connector on one end only. In addition, 6-pin male and female (Tektronix Part No. 131-0961-00) Bendix connectors are available separately, permitting any length of cable to be constructed. Table 2-1 lists the function and wire information for each lead in the 6-conductor cables. See foldout sheet, Fig. 2.

TABLE 2-1

Bendix Connector Pin	Function	Wire Color	Wire Gage
A	Ground and (+) Excitation	Red	22
B	(+) Output	Orange	26
C	(-) Output	White	26
D	(-) Excitation	Black	22
E	Shunt Calibration	Yellow	26
F	Shunt Calibration	Blue	26



CAUTION

The orange, white, yellow and blue leads have a black conductive-plastic outer sleeve, which must be stripped back in order to avoid shorting.

Strain Gage Adapter. The strain gage adapter is a unit which when connected to the 6-pin INPUT connector becomes an extension of the Type 3A10, providing an interface to which strain gages can be connected. The unit contains a modified Wheatstone Bridge made up of three internal arms and an External Arms selection switch. In the 1 EXT ARMS position, all three internal arms are used and the strain gage becomes the fourth arm. In the 2 EXT ARMS position, only two internal arms are used, requiring two strain gages to complete the bridge. In the 4 EXT ARMS position, all three internal arms are disconnected, allowing four strain gages to be connected in a bridge configuration. A built-in variable shunt calibration resistance is connected across one arm of the bridge by pushing the CAL button on the front panel of the Type 3A10. The Gage Factor control on the unit permits adjustment of the shunt calibration resistance to match the gage factor of the strain gage. While the unit is designed primarily for use with 120-ohm strain gages, gages having other resistance values can be used in the 2 and 4 EXT ARMS positions; however, in the 4 EXT ARMS configuration, the bridge calibration must be modified by the Calibration Equation printed on the unit. Refer to Fig. 2-13 for additional information. A schematic diagram is included in the Diagrams section.

Any passive transducer can be connected to the strain gage adapter if a Bendix connector is not available. If more than one strain gage is active the strain readings must be

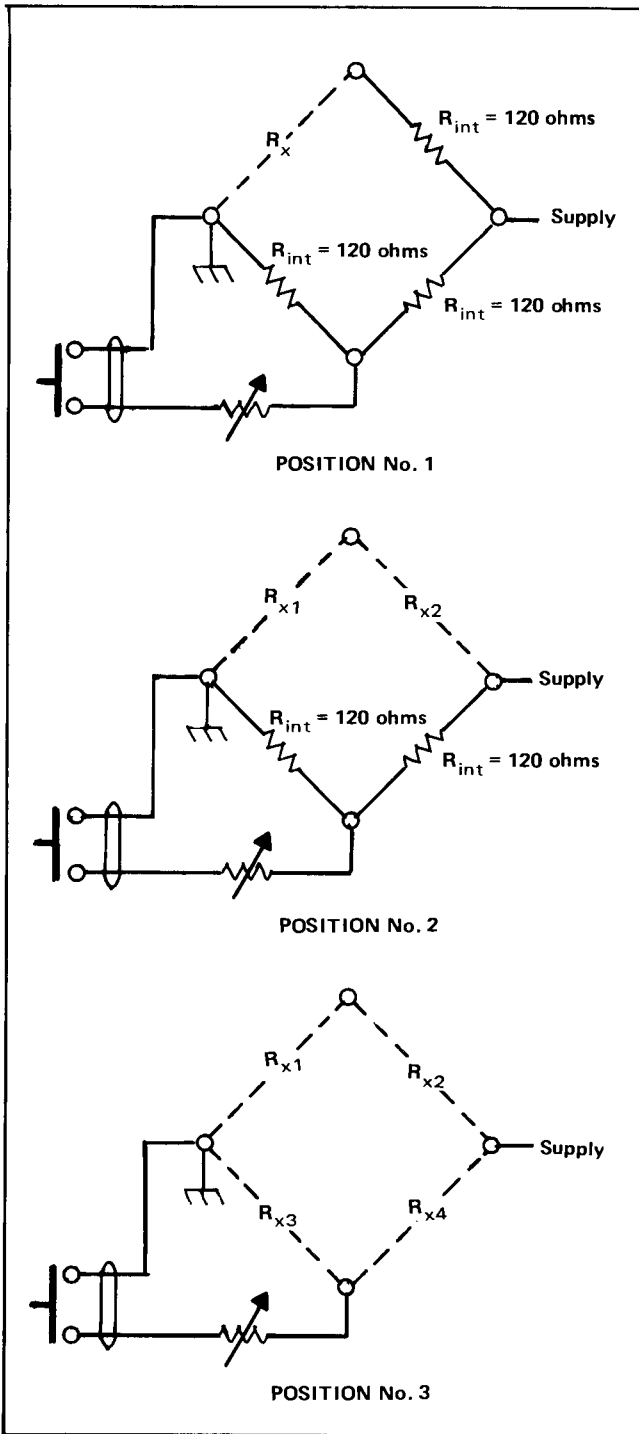


Fig. 2-5. Strain Gage Adapter Schematic Configurations.

divided by a factor greater than one. See Fig. 2-6 for example.

Gages 1 and 2 measure full strain (tension). Gages 3 and 4 measure approximately 30% of full strain (compression due to Poisson Strain). The total output of the bridge is 2.6 times the output of the single strain gage 1. If the vertical sensitivity was set up with the 1000 μ strain calibration the μ strain/div reading must be divided by 2.6.

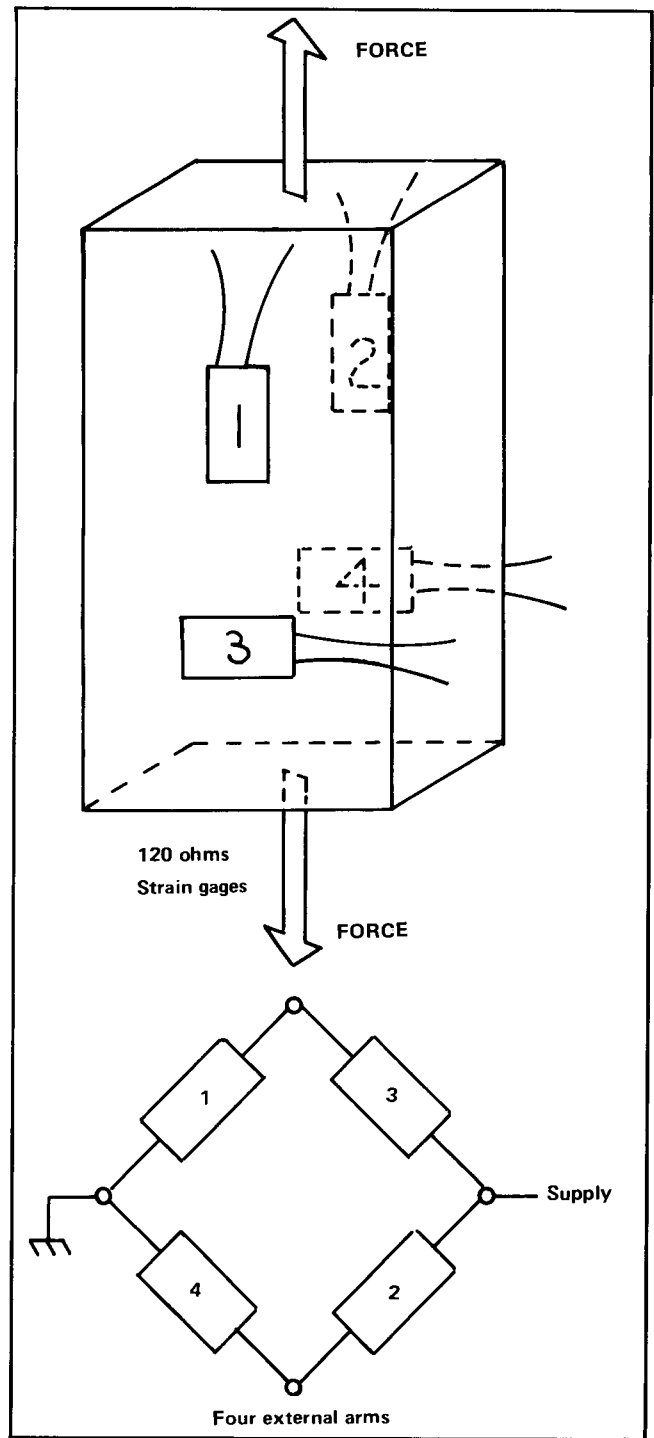
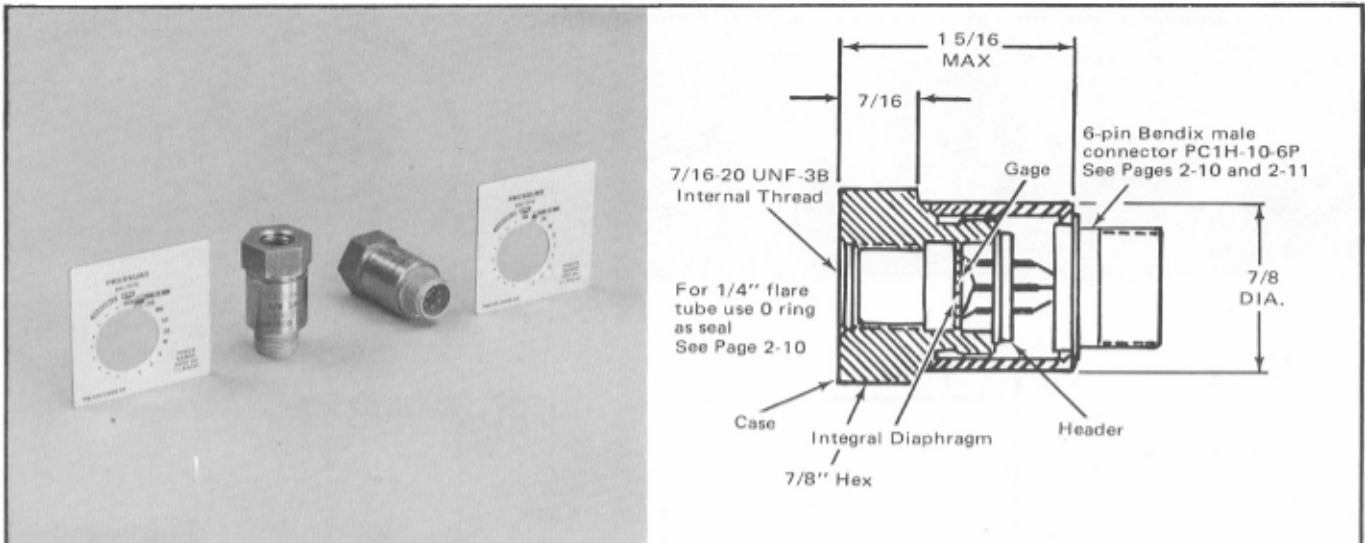


Fig. 2-6. Example: (Metal bar under tension with 4 strain gages).

Cement Kit. The strain gage cement kit contains room temperature curing epoxy cement, a tube of RTV clear silicon rubber coating, 10 neoprene pads and metal plates, 40 pairs of cementable wiring terminals and 2 rolls of clear Mylar [®] film (18 feet X 1 inch X .001 inch). Refer to the Transducer Measurement Concepts Book and Kit Manual for complete instructions for attaching a strain gage to a test member and preparing it for making measurements.



General

The 300 PSIG and 3000 PSIG pressure transducers are balanced bonded strain gage units forming four active arms of a Wheatstone Bridge, as described in Chapter 2 of the Transducer Measurement Concepts Book. Two strain gages are oriented radially on a diaphragm, and two circumferentially. As pressure is applied to one side of the diaphragm, the diaphragm deflects, straining the gages bonded to the opposite side. A shunt calibration resistor is built in to provide 1/2 FS (150 PSIG for the 300 PSIG gage, and 1500 PSIG for the 3000 PSIG gage).

Specifications

INPUT		Mechanical Resonant Frequency	
Measured Fluids	Fluids compatible with 17-4PH Stainless Steel	300 PSIG Gage	24 kHz
Pressure Range	300 and 3000 PSIG	3000 PSIG Gage	65 kHz
Excitation	Up to 15 volts	Acceleration Error	
Resistance	350 Ω nominal	300 PSIG Gage	Less than .003% FS/g
OUTPUT		3000 PSIG Gage	.001 FS/g maximum
Voltage	3.0 mV/volt (nominal) full scale	ENVIRONMENT	
Resistance	350 Ω nominal	Operating Temperature Range	-100°F to +250°F
PERFORMANCE		Compensated Temperature Range	0°F to +200°F
Combined Linearity & Hysteresis	Within 1% FSO	MECHANICAL	
Repeatability	Within 0.25% FSO	Material	17-4 PH stainless steel
Pressure Overload	1.5 X FSO	Fitting (thread size)	7/16-20 UNF-3B
Zero Balance	Within 5% of FSO	Connector	6-pin Bendix
		Weight	3 oz. max.

Operating Instructions

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

The graticule center line represents zero transducer output. Be sure that the oscilloscope trace is centered.

2. Select the correct deflection factor scale (PRESSURE; PN 331-0269-01 for 3000 psi, or PN 331-0269-02 for 300 psi) and install.
3. Set the Input Selector to NORM and set the Deflection Factor switch to the indicated calibrating position and set supply to 10 V.
4. Connect the pressure transducer to the multi-pin INPUT connector via a 6-conductor cable (Tektronix Part No. 012-0209-00). The transducer can either be free (atmospheric pressure) or connected to a static pressure.
5. Set the AMPLIFIER -3 dB FREQUENCY switch to DC OFFSET and adjust the TRANSDUCER BAL COARSE and FINE controls to position the trace to the graticule horizontal center line.

6. Push the CAL button on the Type 3A10 front panel and adjust the - SUPPLY voltage to give the indicated deflection (3 div for psi, or 5.3 div for kgf/cm²). Push and release the CAL button several times to check that the zero point has not shifted or moved (balance the zero point if necessary) and that the calibrated deflection is attained.

NOTE

It is permissible to reposition the trace to a new graticule line using the POSITION control, since this will not upset the transducer balance.

7. Connect the transducer to the line or apparatus under test, using the necessary fittings.
8. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low- and high-frequency bandwidth limiting, etc.

Fig. 2-7. Pressure Transducer (Tektronix Part No. 015-0161-00 and 015-0162-00).

Operating Instructions—Type 3A10

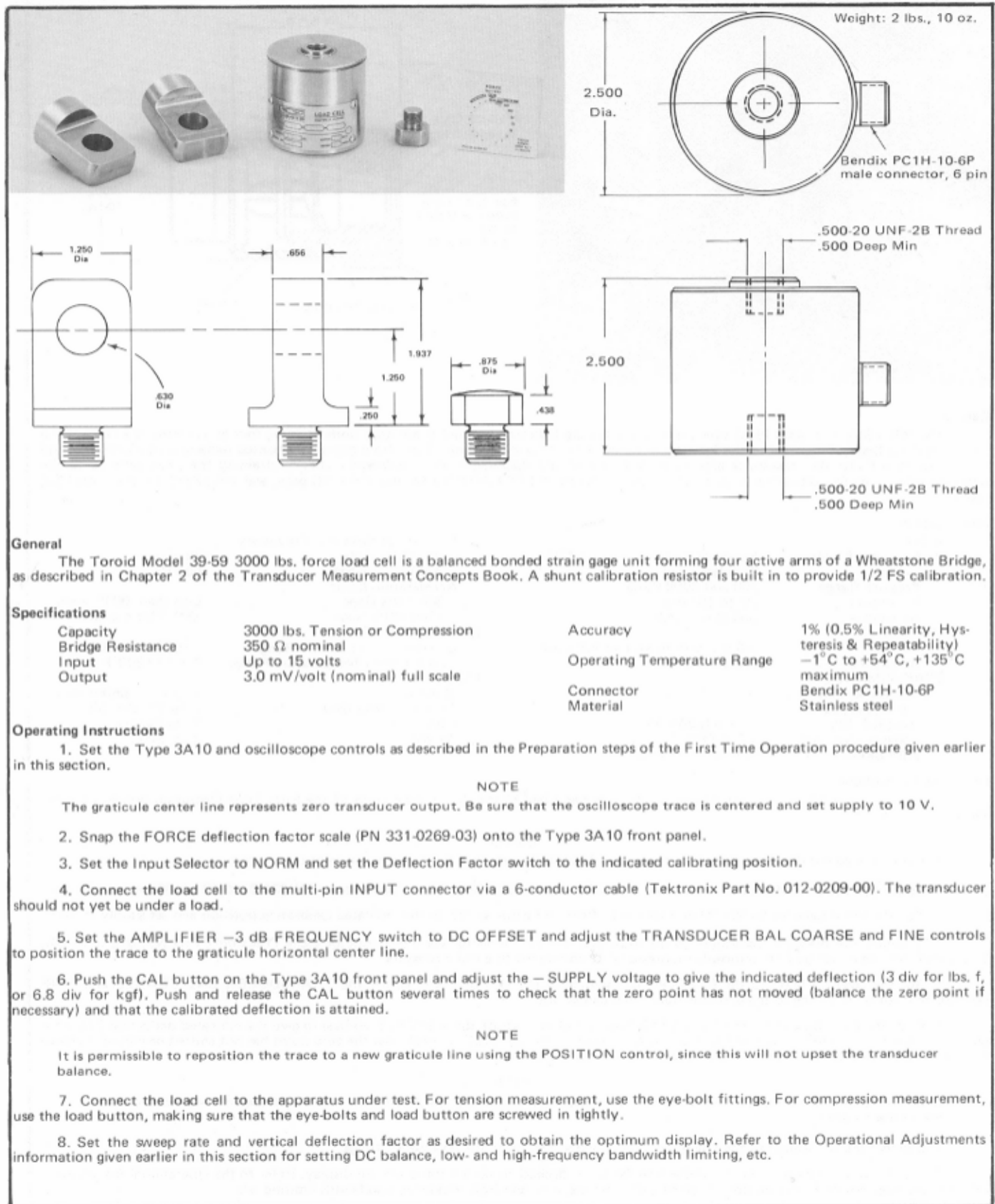
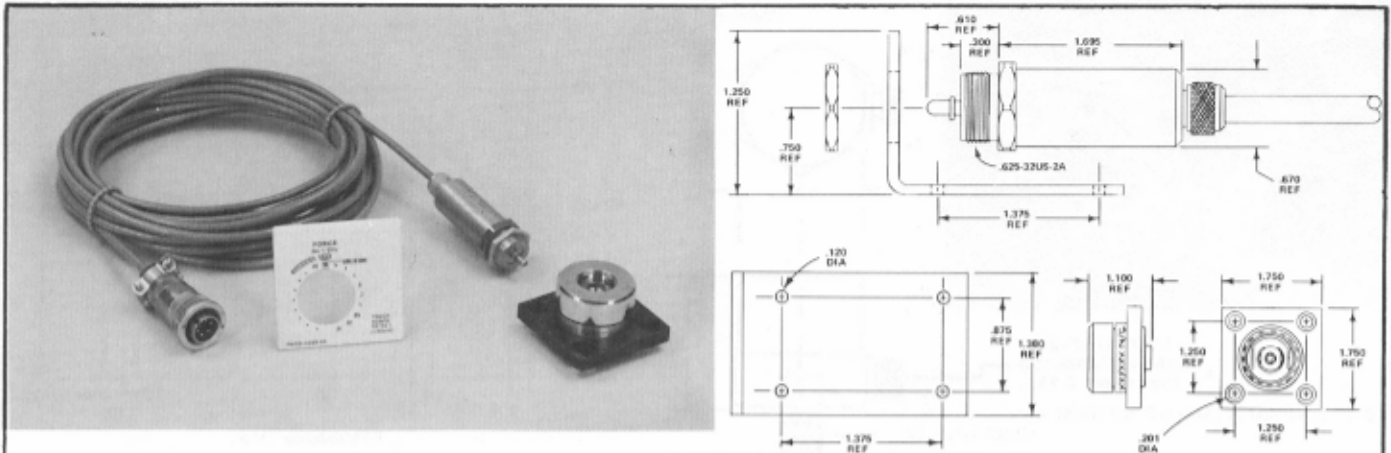


Fig. 2-8. Force Transducer (Load Cell), Tektronix Part No. 015-0163-00.



General

The Statham Model UC3 Universal Transducing Cell is basically an unbonded strain gage unit forming four active arms of a Wheatstone Bridge, as described in Chapter 2 of the Transducer Measurement Concepts Book. Without accessories, the device operates in compression only. A Statham Model UL4 50 lbs. force load cell accessory is supplied, and it has an internal adjustment screw which permits mechanical biasing of the transducer for operation in tension as well as compression. Other accessories are available from the manufacturer. A wiring diagram is shown in Section 7 of this manual.

Specifications

Force Range (UC3 only)	60 grams (compression only)	Output	16 mV/volt (nominal) full scale (12 mV/Volt with adapter)
Force Range (with UL4 accessory)	50 pounds (compression or tension)	Accuracy	2% (0.5% Linearity & Hysteresis)
Displacement Range	.12 mm	Operating Temperature Range	-54° C to +120° C
Bridge Resistance	350 Ω nominal	Electrical Connection	20 ft-conductor shielded cable with Bendix PC06A-10-6P connector
Rated Input	5 volts, 7.5 volts maximum		
Other adapters for measuring pressure, force, displacement, and blood pressure are available from Stratham Instruments, Inc.			

Operating Instructions

NOTE

This procedure applies to all three operating modes of the Universal cell. The 50-lb. load cell can be attached.

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

The graticule center line represents zero transducer output. Be sure that the oscilloscope trace is centered.

2. Select the correct deflection factor scale (FORCE, DISPLACEMENT; PN 331-0269-04 for 50 lbs. f, or PN 331-0269-09 for 50 grams f) and install on the Type 3A10 front panel.

3. Set the Input Selector to NORM, the Deflection Factor switch to the indicated calibrating position, and the supply voltage to 4 volts.

4. Connect the Universal transducer to the multi-pin INPUT connector. The transducer should not yet be under load.

5. Set the AMPLIFIER -3 dB FREQUENCY switch to DC OFFSET and adjust the TRANSDUCER BAL COARSE and FINE controls to position the trace to the graticule center line.

6. Push the CAL button on the Type 3A10 front panel and adjust the - SUPPLY voltage to give one of the following:

a. Deflection indicated on scale (3 div nominal for lbs. f, or 5.5 div nominal for kgf).

b. Number of divisions correlating to force given on Tektronix calibration data sheet for precise calibration (EXAMPLE: if 28 grams is given on the sheet, adjust the voltage to provide 2.8 divisions at 10 grams f/DIV).

c. Number of divisions correlating to a known force or weight applied to the transducer (such as using the supplied 50-gram weight). Optimum accuracy is achieved by this method.

Push and release the CAL button several times to check that the zero point has not moved (balance the zero point if necessary) and that the calibration deflection is attained.

NOTE

It is permissible to reposition the trace to a new graticule line using the POSITION control, since this will not upset the transducer balance.

7. Connect the transducer to the apparatus under test. If the 50 lbs f load cell is used, adjust the internal mechanical biasing screw to center the transducer no-load zero point as desired within the compression/tension range. Readjust the Type 3A10 POSITION as necessary. Compression results in upward deflection on the CRT screen, tension results in downward deflection (either condition can be inverted by placing the Input Selector in the INV position).

8. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low- and high-frequency bandwidth limiting, etc.

Fig. 2-9. Low-Force Transducer (Tektronix Part No. 015-0164-00).

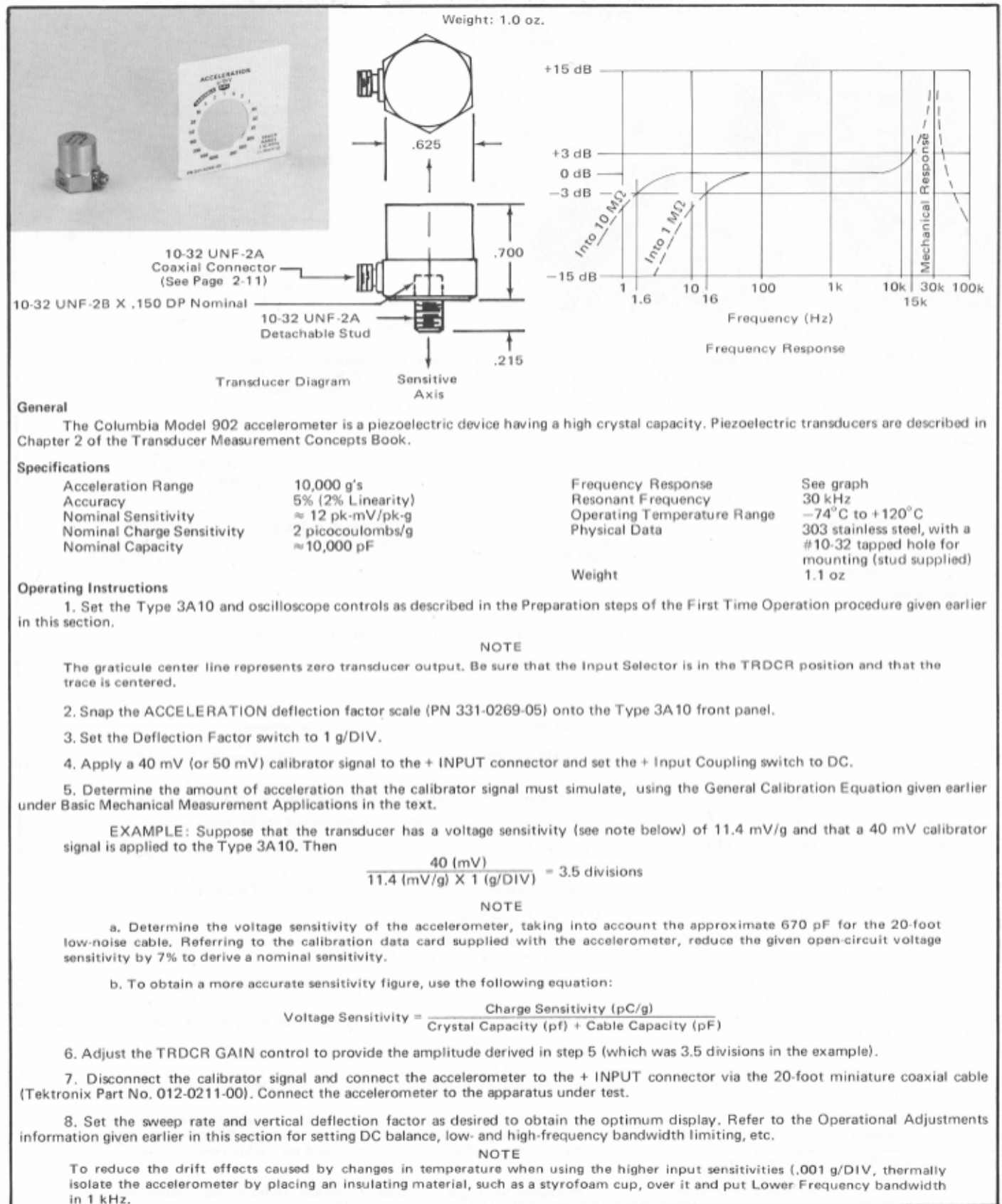
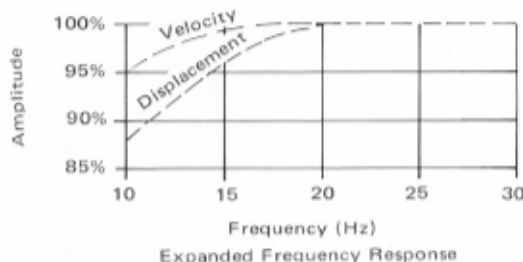
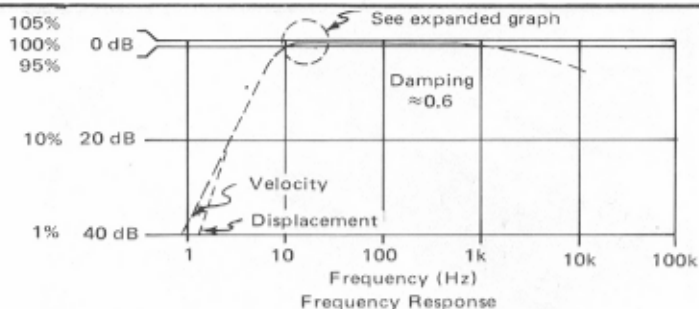


Fig. 2-10. Acceleration Transducer (Tektronix Part No. 015-0165-00).



General

The vertical and horizontal vibration transducers are inductive, self-generating devices as described in Chapter 2 of the Transducer Measurement Concepts Book. These units employ Mark Products L-11A Dual-Coil Geophones as the vibration-detecting elements, and contain discrete circuit components which electrically integrate the velocity output to provide an output proportional to displacement. Schematic diagrams are shown in Section 7, Diagrams. The relationship between acceleration, velocity and displacement is discussed in Chapter 3 of the Transducer Measurement Concepts Book.

Specifications

Coil Resistance	840 ohms	Frequency Response	See graph
Coil Inductance	0.125 Henry	Displacement Range	± 0.025 inch
Voltage Output (Nominal)	550 mV/inch/sec, and 10 mV/.001 inch	Accuracy	5%
		Operating Temperature Range	-40°C to $+71^{\circ}\text{C}$
		Weight	5.8 oz

Operating Instructions

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

The graticule center line represents zero transducer output. Be sure that the Input Selector is in the TRDCR position and that the trace is centered.

2. Select the correct deflection factor scale (VIBRATION: PN 331-0269-06 for displacement, or PN 331-0269-07 for velocity) and install on the Type 3A10.

3. Set the Deflection Factor switch to the top position (e.g., 1×10^{-3} inch/DIV on the displacement scale).

4. Apply a 40 mV (or 50 mV) calibrator signal to the + INPUT connector and set the + Input Coupling switch to DC.

5. Determine the amount of vibration that the calibrator signal must simulate, using the General Calibration Equation given earlier under Basic Mechanical Measurement Applications in the text. The voltage sensitivity of the transducer is stamped on the transducer body.

EXAMPLE (Inch Scale): Suppose that the voltage sensitivity of the transducer is 10.5 mV/.001 inch and that a 40 mV calibrator signal is applied to the Type 3A10. Then

$$\frac{40 \text{ (mV)}}{10.5 \text{ (mV/.001 inch)} \times 1 \text{ (.001 inch/DIV)}} = 3.8 \text{ divisions}$$

EXAMPLE (Metric Scale): The same position on the metric side of the scale is at 20×10^{-3} . If the conditions given in the Inch Scale example exist, then

$$\frac{\text{CAL VOLTS (V)} \times 25.4 \text{ (mm/inch)}}{\text{Transducer Sens (V/inch)} \times \text{Deflection Factor (mm/div)}} = \frac{0.040 \times 25.4}{10.5 \times 0.020} = 4.8 \text{ Div}$$

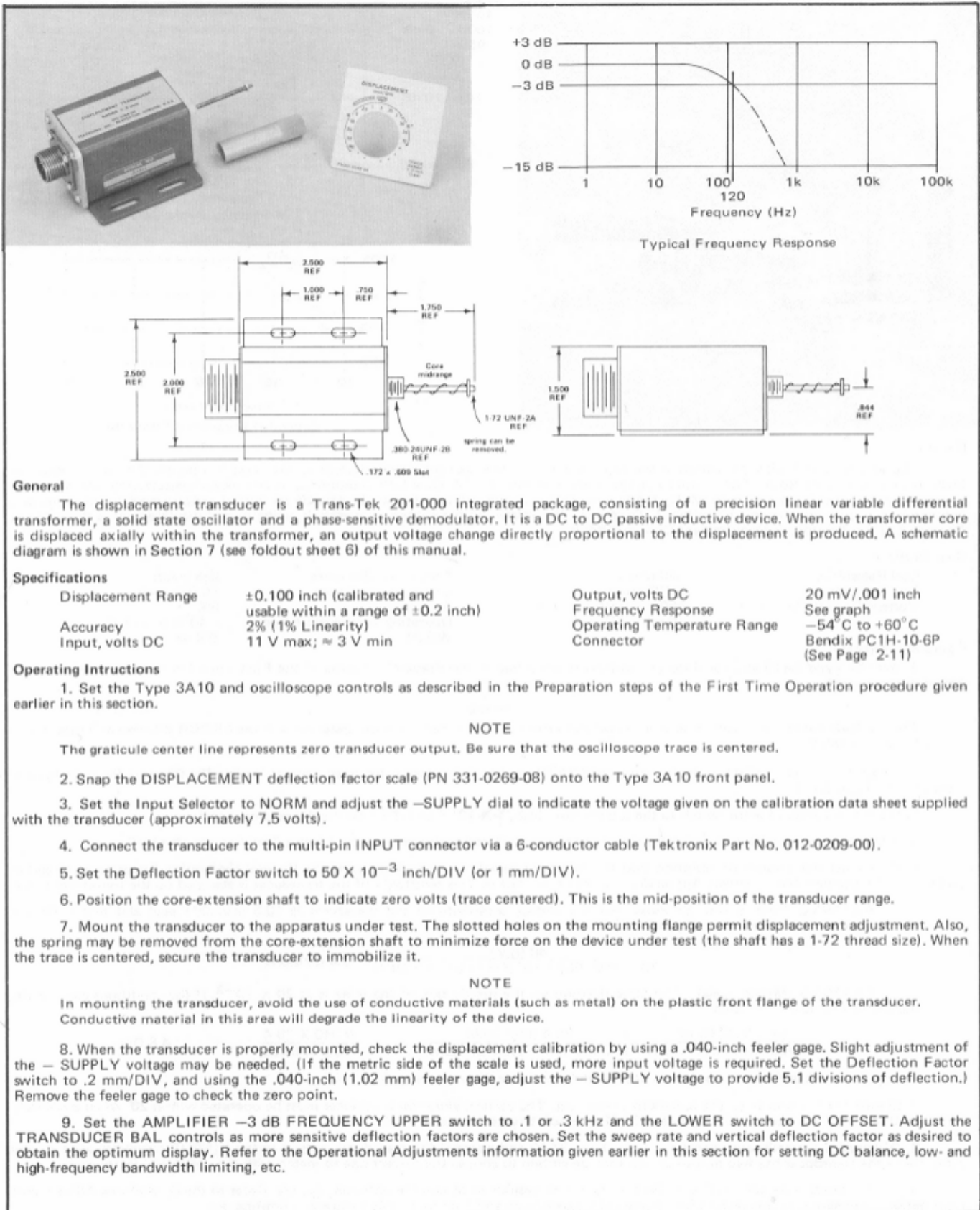
6. Adjust the TRDCR GAIN control to provide the amplitude derived in step 5.

7. Mount the transducer to the apparatus under test. The vertical vibration transducer must be operated within 20° of an absolutely vertical attitude, and the horizontal unit within 5° of an absolutely horizontal attitude.

8. Disconnect the calibrator signal from the Type 3A10 and connect the transducer output to the + INPUT connector via a coaxial cable. Since the transducer has two output connectors, be certain to choose the correct one to match with the deflection factor scale.

9. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low- and high-frequency bandwidth limiting, etc.

Fig. 2-11. Vibration Transducers (Tektronix Part No. 015-0166-00 and 015-0167-00).



General

The displacement transducer is a Trans-Tek 201-000 integrated package, consisting of a precision linear variable differential transformer, a solid state oscillator and a phase-sensitive demodulator. It is a DC to DC passive inductive device. When the transformer core is displaced axially within the transformer, an output voltage change directly proportional to the displacement is produced. A schematic diagram is shown in Section 7 (see foldout sheet 6) of this manual.

Specifications

Displacement Range	± 0.100 inch (calibrated and usable within a range of ± 0.2 inch)	Output, volts DC	20 mV/.001 inch
Accuracy	2% (1% Linearity)	Frequency Response	See graph
Input, volts DC	11 V max; ≈ 3 V min	Operating Temperature Range	-54°C to $+60^{\circ}\text{C}$
		Connector	Bendix PC1H-10-6P (See Page 2-11)

Operating Instructions

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

The graticule center line represents zero transducer output. Be sure that the oscilloscope trace is centered.

2. Snap the DISPLACEMENT deflection factor scale (PN 331-0269-08) onto the Type 3A10 front panel.

3. Set the Input Selector to NORM and adjust the -SUPPLY dial to indicate the voltage given on the calibration data sheet supplied with the transducer (approximately 7.5 volts).

4. Connect the transducer to the multi-pin INPUT connector via a 6-conductor cable (Tektronix Part No. 012-0209-00).

5. Set the Deflection Factor switch to 50×10^{-3} inch/DIV (or 1 mm/DIV).

6. Position the core-extension shaft to indicate zero volts (trace centered). This is the mid-position of the transducer range.

7. Mount the transducer to the apparatus under test. The slotted holes on the mounting flange permit displacement adjustment. Also, the spring may be removed from the core-extension shaft to minimize force on the device under test (the shaft has a 1-72 thread size). When the trace is centered, secure the transducer to immobilize it.

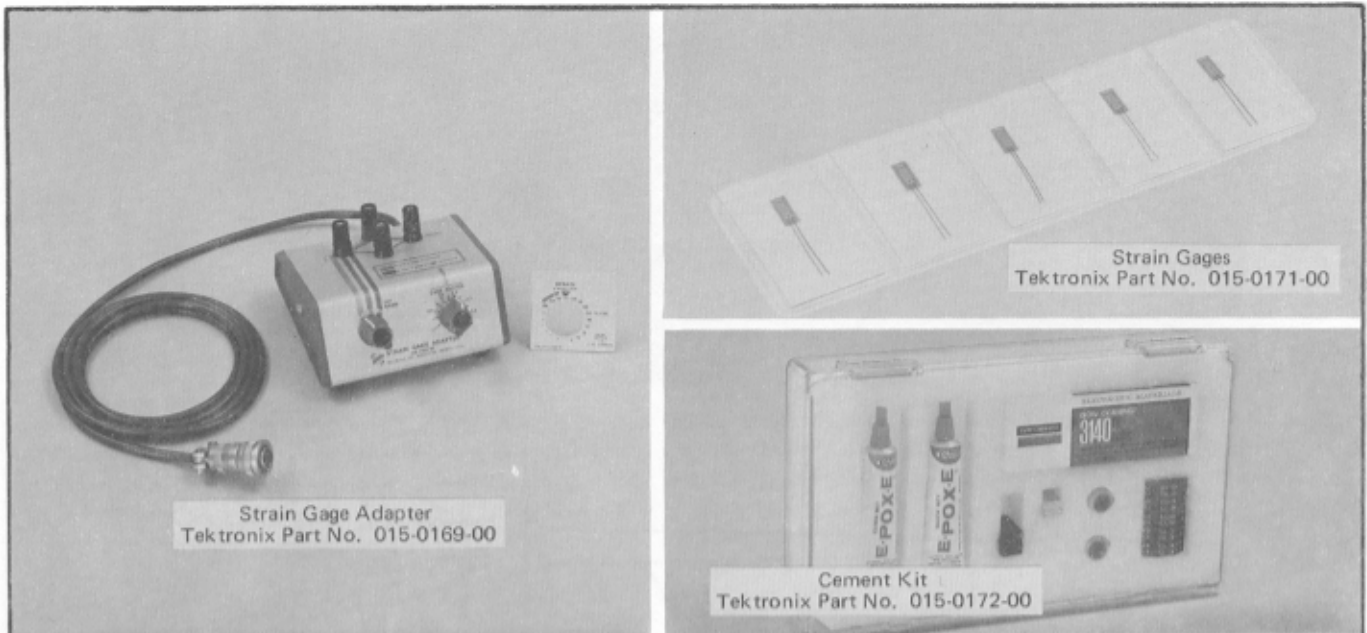
NOTE

In mounting the transducer, avoid the use of conductive materials (such as metal) on the plastic front flange of the transducer. Conductive material in this area will degrade the linearity of the device.

8. When the transducer is properly mounted, check the displacement calibration by using a .040-inch feeler gage. Slight adjustment of the - SUPPLY voltage may be needed. (If the metric side of the scale is used, more input voltage is required. Set the Deflection Factor switch to .2 mm/DIV, and using the .040-inch (1.02 mm) feeler gage, adjust the - SUPPLY voltage to provide 5.1 divisions of deflection.) Remove the feeler gage to check the zero point.

9. Set the AMPLIFIER -3 dB FREQUENCY UPPER switch to .1 or .3 kHz and the LOWER switch to DC OFFSET. Adjust the TRANSDUCER BAL controls as more sensitive deflection factors are chosen. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low- and high-frequency bandwidth limiting, etc.

Fig. 2-12. Displacement Transducers (Tektronix Part No. 015-0168-00).



Strain Gage Adapter
Tektronix Part No. 015-0169-00

Strain Gages
Tektronix Part No. 015-0171-00

Cement Kit
Tektronix Part No. 015-0172-00

General

The strain gages are bonded foil 120-ohm gages with leads. The Strain Gage Adapter is required as an interface between the strain gages and the Type 3A10. Refer to the Transducer Measurement Concepts Book for stress and strain theory, Wheatstone bridge theory, instructions for cementing strain gages to the test member, selecting external bridge arms, and additional information. A schematic diagram of the Strain Gage Adapter is shown in Section 7 of this manual. See pages 2-11 and 2-12 for description of adapter and cement kit.

Strain Gage Specifications

Range	30,000 μ strain	Element Size	1/8 inch X 1/16 inch
Accuracy	1% at calibrated temp	Operating Temp Range	-40°C to +120°C with RTC cement. Cryogenic to +400°F with high temp cement (see Transducer Measurement Concept book).
Resistance	120 Ω		
Backing Material	Polyimide		
Gage Factor	≈ 2.1		

Operating Instructions

NOTE

The strain gage(s) should already be installed on the test member. Refer to the Transducer Measurement Concepts Book for complete installation instructions.

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

The graticule center line represents zero transducer output. Be sure that the oscilloscope trace is centered.

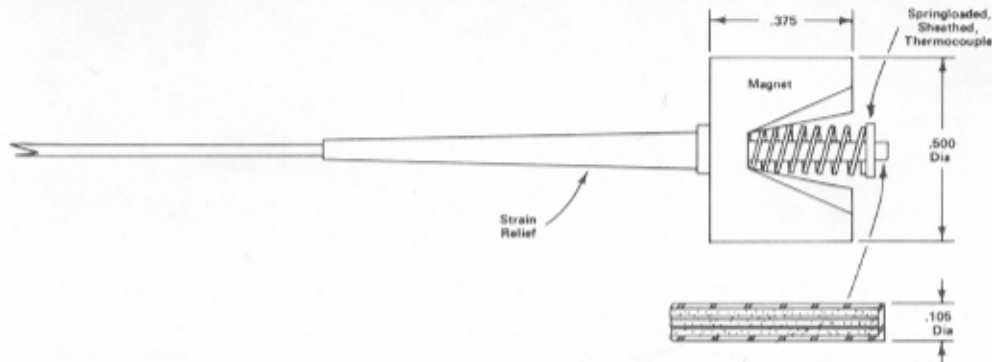
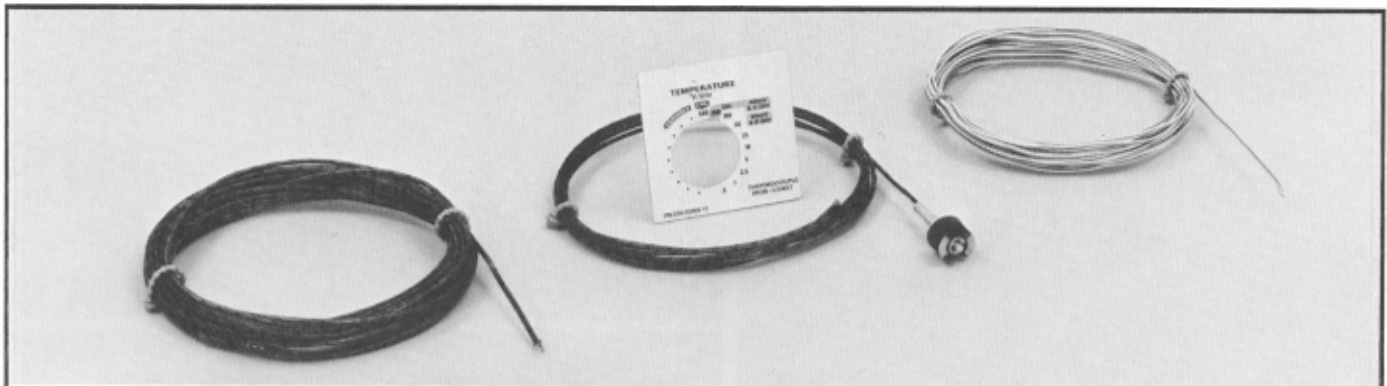
2. Snap the STRAIN deflection factor scale (PN 331-0269-10) onto the Type 3A10 front panel.
3. Set the input Selector to NORM and the Deflection Factor switch to 250 μ strain/DIV (calibrating position). Set the - SUPPLY voltage to 4.00.
4. Connect the Strain Gage Adapter to the multi-pin INPUT connector and set the External Arms switch for the appropriate bridge configuration.
5. Connect the strain gage leads to the Adapter. Connect the Adapter ground to the member under test to reduce extraneous pickup.
6. Set the Deflection Factor switch to 5K μ strain/DIV. Set the AMPLIFIER -3 dB FREQUENCY LOWER switch to DC OFFSET and adjust the TRANSDUCER BAL controls to move the trace to the screen center.
7. Set the Deflection Factor switch back to 250 μ strain/DIV and readjust the TRANSDUCER BAL FINE control.
8. Set the GAGE FACTOR control on the Adapter to the figure given on the strain gage data sheet and push the CAL button. While holding the CAL button in, adjust the - SUPPLY voltage to provide 4 divisions of display. Push and release the CAL button several times to check that the zero point has not moved (balance the zero point if necessary) and that the calibrated deflection is attained.

NOTE

The above procedure is valid when using 120 Ω strain gages in the 1 and 4 EXT ARMS positions, and any value of R in the 2 EXT ARMS position. The more departure from 120 Ω in the 1 EXT ARM position, the more error is introduced, although the bridge may be balanced by using the TRANSDUCER BAL controls. For other values of R in the 4 EXT ARMS position, modify the bridge calibration by the equation printed on the Strain Gage Adapter.

9. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low- and high-frequency bandwidth limiting, etc.

Fig. 2-13. Strain Gages.



General

The thermocouples are spot-welded iron-constantan junctions. The opposite ends of the wires are free, and can be connected differentially to the Type 3A10. The voltage developed across the free ends is proportional to the temperature difference between the junction and the free (cold reference) ends.

Specifications

PVC Ripcord Insulated Iron-Constantan Thermocouple
 Temperature Range -28°C to $+105^{\circ}\text{C}$
 Accuracy 5% ($+10^{\circ}\text{C}$ to $+105^{\circ}\text{C}$)
 Voltage Output (Nominal) $54\ \mu\text{V}/^{\circ}\text{C}$
 Physical Data 20 feet of #30 wire
 Two BNC to binding post adapters included (not shown)

Fiberglass Insulated Iron-Constantan Thermocouple
 Temperature Range -180°C to $+480^{\circ}\text{C}$
 Accuracy 5% ($+10^{\circ}\text{C}$ to $+480^{\circ}\text{C}$)
 Voltage Output (Nominal) $54\ \mu\text{V}/^{\circ}\text{C}$
 Physical Data 20 feet of #30 wire;
 6 feet of #24 wire with magnet mounting for surface temperature measurements

Operating Instructions

1. Set the Type 3A10 and oscilloscope controls as described in the Preparation steps of the First Time Operation procedure given earlier in this section.

NOTE

Be sure that the Input Selector is in the TRDCR position.

2. Select the correct deflection factor scale (TEMPERATURE; PN 331-0269-11, F° on one side and C° on the other) and install on the Type 3A10.

3. Set the Deflection Factor switch to the indicated calibrating position ($250^{\circ}\text{F}/\text{DIV}$ or $200^{\circ}\text{C}/\text{DIV}$).

4. Apply a 40 mV (or 50 mV) calibrator signal to the + INPUT connector. Set the + Input Coupling switch to DC, adjust the TRDCR GAIN control to provide the amplitude indicated on the deflection factor scale, then set the + Input Coupling switch back to GND.

5. Remove the calibrator signal and connect the binding post-to-BNC adapters (Tektronix Part No. 103-0033-00) to the + and - INPUT connectors.

6. Strip the free ends of the wires (opposite the thermocouples end) and connect the leads to the binding post-to-BNC adapters. The adapters form the cold reference junction of the thermocouples. To make a new junction, strip and clean wire ends and spot-weld or twist and solder the ends together.

NOTE

For absolute measurement of temperatures, use a different cold reference junction. For cold reference junction information, refer to the Transducer Measurement Concepts Book.

7. Attach the thermocouple to the device under test.

8. Set both the + and - Input Coupling switches to DC and the UPPER -3 dB FREQUENCY switch to .1 kHz.

9. Set the sweep rate and vertical deflection factor as desired to obtain the optimum display. Refer to the Operational Adjustments information given earlier in this section for setting DC balance, low-frequency bandwidth limiting, etc.

Fig. 2-14. Thermocouples (Tektronix Part No. 015-0173-00).

SECTION 3

CIRCUIT DESCRIPTION

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

Introduction

This section of the manual contains an electrical description of the circuits in the Type 3A10 Transducer Amplifier unit. It is suggested that the schematics provided at the rear of the manual be referred to while studying this circuit description.

INPUT PREAMPLIFIER

Input Coupling

Signals applied to the front-panel + and – INPUT connectors may be capacitive coupled (AC), direct coupled (DC), or internally disconnected (GND). Input coupling is selected by means of a three-position lever switch at each input, SW201 for the + input and SW101 for the – input.

For AC coupling, capacitors C102 and C202 couple signals of about 1.6 Hz (–3 dB point, 1 M Ω input resistance) and higher to the attenuators. Any DC component of the signal is blocked. In the GND position of the switches, a ground reference is provided to the input of the amplifier without the need to remove the applied signal from the input connector.

NOTE

When DC levels are to be blocked by AC coupling, the Input Coupling switch should be set to GND while input connections are made or broken, or when voltage levels are changed. This will allow the coupling capacitor to charge without blowing the input fuses or overdriving the amplifier.

Strain Gage Input

Strain gage signals are applied to the Type 3A10 via a 6-pin connector, J203. Pins A and D permit power to be applied to the strain gage bridge or transducer (for example, across a modified Wheatstone Bridge as in the optional Strain Gage Adapter), and pins B and C receive the differential input signal (pin B becomes the + input when the Input Selector is in the NORM position, pin C becomes the + input in the INV position). SW103, CAL, which connects pins E and F together, permits a shunt calibration check of the transducer from the front panel.

Input Selector

The Input Selector switch, SW203, permits selection of the input signal from either the INPUT BNC connectors (1 M Ω or 10 M Ω input resistances) or from the Strain Gage INPUT multi-pin connector (normal or inverted, 10 M Ω input resistance). In the VOLTS position, R103 and R203 are connected in parallel with the input FET gate-to-ground resistances to provide a one-megohm input resistance for the + and – INPUT connectors. In the TRDCR position, these resistors are removed to provide a ten-megohm input resistance for transducer operation. Also, the TRDCR position permits –12 volts to be applied via one set of switch contacts to relay K260, which when energized connects an adjustable transducer gain resistor across the output of the Input Preamplifier. The NORM and INV positions of SW203 permit normal or inverted strain gage data to be selected as the signal source, and in either of these positions, the input resistance to ground is ten megohms.

Input Attenuators

The input attenuators are conventional frequency-compensated voltage dividers, and the correct attenuation ratio is selected by the Deflection Factor (VOLTS/DIV) switch. At DC and for low-frequency signals, the dividers are essentially resistive (attenuation ratio determined by the resistance ratio). At higher frequencies, at which the capacitive reactance becomes affective, the attenuation ratio is determined by the impedance ratio of the capacitors.

Besides providing constant attenuation at all frequencies within the bandwidth capabilities of the instrument, the input attenuators maintain a constant input RC characteristic (either one or ten megohms, depending on the Input Selector switch setting, paralleled by 47 picofarads) for all settings of the Deflection Factor switch.

Input Protection

Input protection consists of fuses F131 and F231, and diodes D132, D133, D232 and D233. If the signal should reach a level sufficient to forward bias one of the protection diodes (a potential greater than about 15.5 volts), current will be conducted through that diode, protecting the input FET's. If that current should exceed the I²T rating of the fuse, the protective fuse(s) will open. If the signal source is not able to supply enough current to open the fuse, damage to the signal source may result.

Gate Current Compensation

The leakage current associated with the gates of the input FET's may be as high as 100 pA. This leakage current will produce an offset voltage which at the higher input sensitivities is not acceptable (for example, 100 pA through a one-megohm input resistance to ground produces an offset voltage of 100 μ V, which could drive a display off-screen at the 10 μ V/DIV sensitivity). To compensate this effect, the gates of the input FET's may be adjusted to zero volts by returning R113 and R213 through potentiometers R115 and R215 to a slightly negative supply voltage.

Leakage current associated with the gate of the input FET's and the overload protection diodes increases rapidly with temperature, approximately doubling for every 10°C. To compensate this increase, a temperature-sensitive input current balancing network is included, using thermistors RT122 and RT124 as the sensing elements.

As the voltage across R113 and R213 increases due to increase of temperature of the active devices, an equal voltage change is produced in the thermistor compensating circuit, maintaining the FET gate level at zero volts. The gate current compensation becomes inoperative if the straps are removed.

Preamp

The Preamp stage consists of two identical non-inverting operational amplifiers, connected in a differential configuration, and provides an approximate 16 times amplification of the voltage differences between the two inputs. See Fig. 3-1.

The operational amplifiers are composed of Q133A, Q144A and Q254 on one side, and Q133B, Q144B and Q154 on the other side. Q133A and Q133B provide a voltage follower input to the series-pass elements Q254 and Q154. Total gain of the stage is about X16, determined by the ratio of R251-R151 to the total Q254-Q154 drain-load resistances.

Quiescently, the two sides of the amplifier are balanced (conduct equally). When a difference signal is applied to the gates of Q133A and Q133B, the signal voltage is developed across R251 and R151. This causes the balance of current through the two sides to shift, changing the conduction of Q254 and Q154, and developing the output signal across R257 and R157. The output is a push-pull signal, opposite in polarity to the signal applied to the inputs. The constant-current high-impedance source (floating power supply) will be described in subsequent paragraphs under Common Mode Rejection.

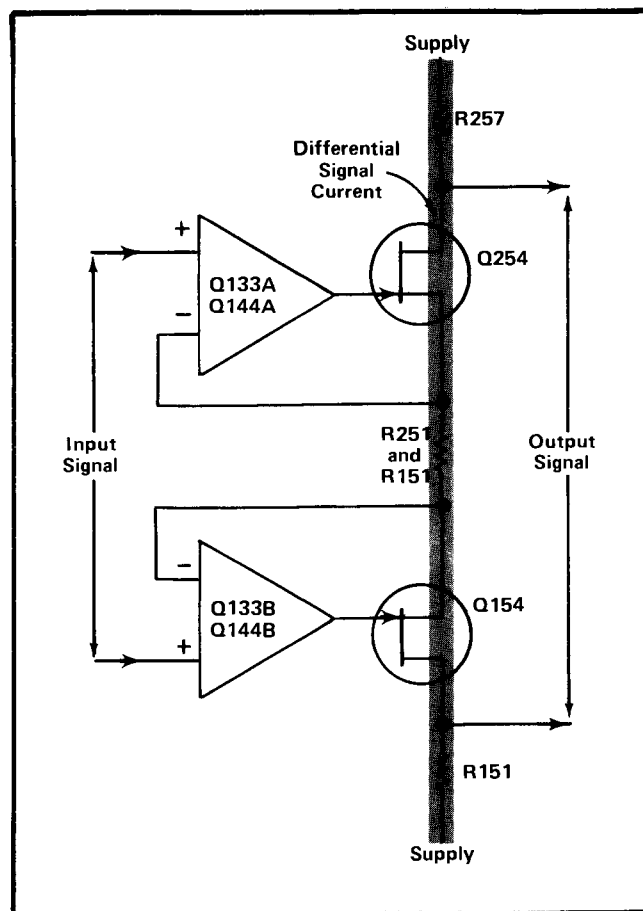


Fig. 3-1. Input Preamp detailed block diagram showing signal current path.

To minimize trace shift as vertical deflection factors are selected, the outputs at Q254 and Q154 drains are DC balanced at equal potentials so that the voltage across the gain-setting resistors in the next stage is zero at all settings of the Deflection Factor (VOLTS/DIV) switch. The DC balance is achieved by adjusting R259, STEP ATTEN DC BAL, with the gates of Q133A and Q133B effectively tied together.

While an amplifier gain control (to be described in the Output Stage) is provided to match the Type 3A10 to the oscilloscope deflection system, and thus ensure a calibrated deflection factor, an additional gain control, R260, TRDCR GAIN, is provided in the Preamp to compensate the effects of differences in transducers, cable losses, etc. This front-panel control is effective only when the Input Selector, SW203, is set to the TRDCR (10 M Ω) position, energizing relay K260 and connecting R260 and R265 into the Q254-Q154 drain circuit.

Common-Mode Rejection

One of the primary functions of the Preamp is to reject any common-mode component of the input signal and amplify only the difference.

Assume that the inputs are tied together and a voltage is applied to the common input. The amplifier differential output is ideally zero, and would actually be zero provided that the characteristics of all corresponding elements on the two sides of the amplifier were matched (e.g., Q133A and Q133B transconductance and μ , Q144A and Q144B beta, current sources, etc.). In practice, any mismatch will cause a differential output.

Floating Power Supply. A floating power supply made up of Q283, Q284, Q294, and Zener diodes D275, D285 and D295 minimizes inherent common-mode difficulties and therefore improves the common-mode rejection (refer to Fig. 3-2). Q284 is a constant-current high-impedance source for the Preamp stage, and Q294 is the current return.

The input to the bootstrap (X1 gain) amplifier is connected to the junction of R251 and R151. The bootstrap amplifier portion of the supply consists of emitter-follower Q283 and Zener diode shunt regulators D275, D285 and D295. The collector impedance of Q284 and Q294 presents minimum loading to the Q283 output and maintains the gain of the amplifier (bootstrap efficiency) very close to one.

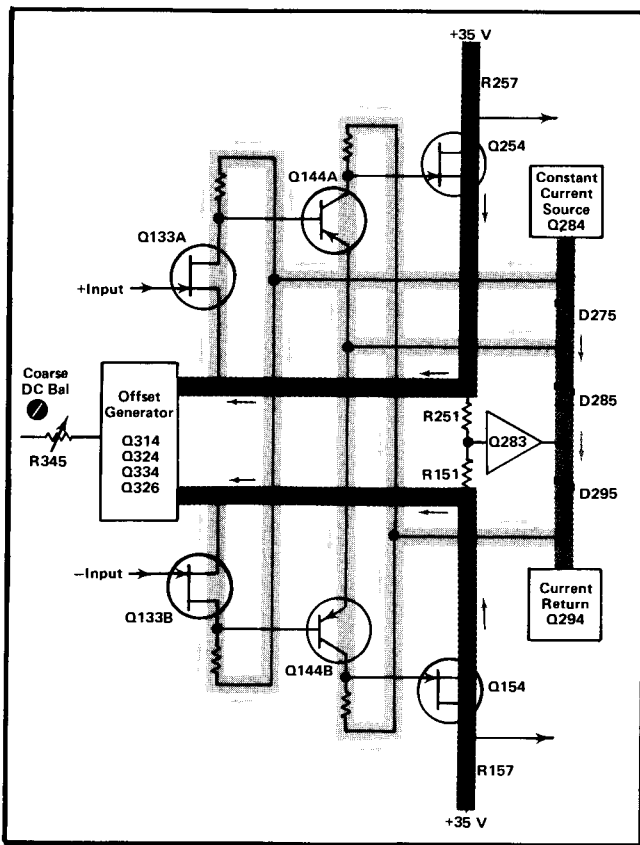


Fig. 3-2. Floating Power Supply and Offset Generator detailed block diagram showing standing current paths through the Preamp.

The entire power supply and amplifier voltages move an amount equal to the common-mode voltage, maintaining a constant operating characteristic of the elements in the Preamp. This results in an unchanged output at the drains of Q254 and Q154; that is, the common-mode signal is rejected.

High Frequency CMRR. At higher frequencies, stray capacitance to ground at various points in the Preamp begins to inject significant current into the amplifier as a result of common-mode signals. Differential capacitor C162, connected from the floating power supply to the output lines, injects adjustable current into the output to equalize the net output current resulting from high-frequency common-mode signals, and extends the frequency range over which good CMRR can be obtained to over 100 kHz.

Input Cross-Neutralization

The use of a common bootstrap supply results in undesirable capacitive coupling between the two inputs. Consider the effect of applying +1 volt to the gate of Q133A while keeping the gate of Q133B at zero volts (grounded). This results in a shift of all floating supply voltages by 0.5 volt, due to the divider action of R251-R151. The drain of Q133B also rises and injects a current through the drain-to-gate capacitance and into the Q133B input. If there is any impedance between Q133B gate and ground, this current will develop a voltage which will appear as an input signal at Q133B gate; thus, an erroneous output results.

However, C131 and R131 are connected between the Q133B gate and the Q154 source to neutralize the effect of the drain-to-gate capacitance. Capacitor C131 is adjustable to divert the correct amount of current away from the Q133B gate.

C231 and R231 perform a similar function for the Q133A input.

DC Offset

To amplify varying signals having other than a ground reference and still maintain the amplifier differential capabilities, the Offset Generator is designed to cancel out small DC components of the input signal. This is achieved by producing a current to offset the current developed by the DC voltage. The result is that the Q154 and Q254 drain currents remain balanced and unchanged; hence, no output is produced. In this manner, the DC component of the signal may be offset up to \pm one volt. Due to the wide range of the Offset Generator (200,000 div at 10 μ V per div), stable components are used and circuit techniques which minimize drift and noise are employed.

Circuit Description—Type 3A10

The Offset Generator is essentially a voltage comparator, composed of Q314A-Q334 on one side and Q314B-Q324 on the other. Q326 serves as a constant current return. When the LOWER AMPLIFIER -3 dB FREQUENCY switch, SW175, is in the DC OFFSET position, the OFFSET OR TRANSDUCER BAL COARSE and FINE potentiometers, R355A and R355B, tap an adjustable portion of voltage across Zener diode D352 and apply it to the emitter of Q314B. Divider R341-R345-R347 supplies a reference voltage for the emitter of Q314A. Any difference in the applied voltage is reproduced across resistors R331-R321, producing an offset current which is conducted through Q324 and Q334 to the Preamp.

When the offset is not in use, the emitter of Q314B is switched to a fixed divider, R342-R343, by the LOWER AMPLIFIER -3 dB FREQUENCY switch. Q314A emitter voltage is adjustable over a small range with respect to the Q314B emitter by R345, Coarse DC Bal, whose purpose is to adjust out any initial DC unbalance in the Preamp, and to bring its output to zero when the input FET gates are grounded.

In the event of failure of the $+125$ -volt supply (the current source for the Preamp) the Offset Generator is turned off to prevent current being forced to conduct through the Type 3A10 input via the Q133A-Q133B gate circuit. As the $+125$ -volt output drops, Q295 is biased into conduction to provide a low-impedance current path to R294 and R326. As Q295 saturates, the emitters of Q294 and Q326 are driven positive, turning these transistors off.

Overdrive or Uncalibrated Indicator

The OVERDRIVE OR UNCAL lamp illuminates to indicate any of the following conditions: that the Preamp is approaching the limits of its differential dynamic range in the VOLTS ($1\text{ M}\Omega$) mode, that the deflection factor is uncalibrated, or that the Transducer Power Supply is overloaded.

When the amplifier is operating normally (no overdrive condition), D162 and D262 are reverse biased, Q163 is biased off and Q164 is saturated. The Q164 saturation current through R172 sets the voltage across B174 below the firing potential.

If the voltage on either of the output lines is sufficient to forward bias D162 or D262 and Q163, Q164 turns off, allowing the voltage across B174 to reach the firing point. C164 and R164 allow the lamp to indicate on overdrive pulses of short duty cycle. C164 charges through Q163, R171 and R172. When Q163 turns off, C164 discharges slowly through Q164, holding B174 on long enough to be seen, or until the next pulse. R171 and R174 equalize firing

transients on the two leads of the neon, B174, reducing radiation into the physically close input circuit.

When the Input Selector is set to the TRDCR position, $+50$ volts is applied via the contacts of K260 and R175 to render neon R174 insensitive to overdrive information; however, in the event of uncalibrated deflection factor or Transducer Power Supply overload, voltage applied from D641 (Transducer Power Supply circuit) would be sufficient to fire the neon.

LOWER -3 dB Frequency Selector

The LOWER AMPLIFIER -3 dB FREQUENCY switch, SW175, permits the lower half-power point of the amplifier bandwidth to be selected from a range of 0.1 hertz to 10 kilohertz. Selection is accomplished by switching the resistor and capacitor of a pair of AC couplings, one on each side of the amplifier, between the Preamp and Gain Switching Amplifier. For ranges 100 Hz to 10 kHz, coupling capacitors C158 and C258 are used in conjunction with the resistors on the switch to set the half-power point. For ranges 0.1 Hz to 10 Hz, C176 and C276 are connected in parallel with C158 and C258 respectively. For the DC and DC OFFSET positions of the switch, the capacitors are shorted out to provide DC coupling.

OUTPUT AMPLIFIER

Gain Switching Amplifier

The Gain Switching Amplifier is a balanced differential configuration very similar to the Preamp. Since the common-mode signals are rejected in the earlier stage, a fixed power supply is used. The active components are Q404A, Q414A and Q424 on one side, and Q404B, Q414B and Q524 on the other. Gain is changed by means of the Deflection Factor (VOLTS/DIV) switch, SW205, which connects different values of R408 between the two sides of the amplifier.

R405, AC Atten Bal, in series with the source of Q404A, is adjusted to set the voltage across gain-setting resistors R407 and R408 to zero when the Q404 gate-to-gate voltage is zero. The Var Bal control, R425, is also adjusted to balance the collectors of Q424 and Q524 when the inputs to the Preamp are grounded, setting the quiescent voltage across the VAR control to zero, and preventing trace deflection as the VAR control is rotated throughout its range.

UPPER -3 dB Frequency Selector

Switch SW445, the UPPER AMPLIFIER -3 dB FREQUENCY selector, switches capacitors across the Q424-Q524 output to set the high frequency response characteristics.

Position and Variable Stage

This stage consists of push-pull amplifier Q434-Q534. R431 and R531 establish the basic operating currents in the amplifier. POSITION control R440 provides an adjustable current through R437 and R537, which either adds to or subtracts from the Q434-Q534 emitter currents to alter the quiescent vertical position of the CRT beam.

With a signal applied, variable control (VAR) R535 provides emitter degeneration, the gain being determined by the total emitter feedback resistance. Gain is adjustable over a 2.5 to 1 ratio, and R535 provides a fine control to interpolate between the steps of the Deflection Factor switch. When SW535 is turned to the uncalibrated position, a voltage is applied from the Transducer Power Supply circuit to illuminate the front-panel OVERDRIVE OR UNCAL neon.

When SW535 is in the calibrated detent position, the variable control is removed from the circuit and the input signal is developed across R433-R533 only.

Output Stage

The last stage of signal amplification is provided by Q444-Q454 and Q544-Q554, which are connected as a push-pull amplifier with feedback from the output collectors to the input bases. R450, GAIN, provides a variable current-diverting path in the feedback divider, permitting the Type 3A10 overall gain to be matched to the oscilloscope mainframe in which it is used. Fast overdrive recovery of this stage is ensured, by diodes D444 and D445.

Trigger and Signal Out Amplifiers

A signal is picked off at Q454 collector and applied to FET source follower Q464. The FET source provides a low impedance point from which a triggering signal is sent to the associated time-base unit. The triggering signal amplitude at Q464 source is about 3.75 volts per displayed division.

A sample of the output signal is also applied via two emitter follower stages, Q474 and Q650, to provide signal access at the front-panel SIGNAL OUT connector, J475, with an output current capability up to 15 milliamperes. The output signal is about 1 volt per division of display. R467, Sig Out DC Level, sets the DC level at J475 to zero volts. C461, Sig Out HF Comp, compensates voltage divider R461-R465-R467 to provide good frequency response at J475.

Zener Regulators

Supply voltage of +300 volts, +125 volts and -100 volts are applied to the Type 3A10 via the plug-in connector,

P11, from the mainframe power supply. Zener diodes D347, D352, D355, D563, D565 and D567 supply operating voltages to various points throughout the instrument.

TRANSDUCER POWER SUPPLY

General

The Transducer Power Supply provides a calibrated DC-voltage source for powering a strain gage bridge or other passive transducer. This voltage, variable from -1 to -11 volts, is available at pin D of the Strain Gage INPUT connector, J203. The circuit includes an overload-sensing circuit that limits the output current and causes the front-panel OVERDRIVE neon to light.

Voltage Follower Stage

Integrated Circuit U610 and current-pass transistor Q620 are operated as a voltage follower stage. Input voltage is tapped from a reference divider consisting of R603 through R607, and the output of the supply is taken from the emitter of Q620.

D601 provides Zener regulation of the reference divider. R604 is adjustable to provide exactly -1 volt at the supply output when the wiper arm of R605, SUPPLY, is at the positive extreme (counterclockwise); R606 is adjusted to provide a supply output of exactly -11 volts when the wiper arm of R605 is at the negative extreme (clockwise). As pin 2 of U610 seeks to balance pin 3 through voltage follower action, the reference-divider voltage is developed across R622. The current forced through R622 is passed through R620, Q620 and R631 to the negative supply. The voltage dropped across R620 is added to the voltage dropped across R622 to establish the output voltage. Q620 absorbs current variations from the load to maintain a steady output voltage.

Current-Limiting Stage

Current limiting of the supply output and overload indication are controlled by a comparator, Q630A and Q630B. If an excessive load forces increased conduction of pass transistor Q620, R631 "senses" the overload by developing a larger voltage drop. This results in increased bias of Q630B and an imbalance of conduction in the two halves of the comparator. With reduced Q630A collector current, D614 and Q620 are held in a state of limited conduction as they attempt to turn off, thus limiting current to the load. Simultaneously, the increased Q630B collector current forces Q640 base negative, switching Q640 off. D641, whose anode was held at ground potential by the saturated Q640, connects B174, OVERDRIVE OR UNCAL lamp (Preamp Circuit), through R640 to the positive supply, lighting the lamp.

SECTION 4

MAINTENANCE

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

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, lubrication, etc., performed on a regular basis, will improve the reliability of this instrument. Periodic checks on the semiconductor devices used in the unit are not recommended as a preventive maintenance measure. See semiconductor-checking information given under troubleshooting.

Cleaning



Avoid the use of chemical cleaning agents which might damage the plastics in this instrument. Avoid chemicals containing benzene, toluene, xylene, acetone or similar solvents.

Front Panel. Loose dust may be removed with a soft cloth or a dry paint brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of the unit should precede calibration, since the cleaning process could alter the settings of the calibration adjustments. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a soft, dry paint brush, cotton-tipped swab or cloth dampened with a water and mild detergent solution.

Lubrication

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 Tektronix Part Number 003-0342-00.

Recalibration

To ensure accurate measurements, the Type 3A10 should be checked after each 1000 hours of operation or

every six months if used infrequently. Complete calibration instructions are given 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.

TROUBLESHOOTING

General

The following is provided to augment information contained in other sections of this manual when troubleshooting the Type 3A10. The schematic diagrams, Circuit Description and Performance Check sections should be used to full advantage. The Circuit Description section gives detailed information on circuit behavior and output requirements.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 7. The circuit number and electrical value of each component in this instrument are shown on the diagrams. Important voltages are also shown.

Circuit Boards. The circuit boards used in the Type 3A10 are outlined on the schematic diagrams, and a photograph of each board is shown to the left of the diagrams. Each board-mounted electrical component is identified on the photograph by its circuit number.

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

Table 4-1 shows the wiring color code for the power-supply voltages using insulated wires for interconnection in the Type 3A10.

The remainder of the wiring in the Type 3A10 is color coded with two or less stripes, or is a solid color with no

TABLE 4-1

Supply	Back-ground Color	1st Stripe	2nd Stripe	3rd Stripe
+300 V	White	Orange	Brown	Brown
+125 V	White	Brown	Red	Brown
-100 V	Tan	Brown	Black	Brown

stripes. The color code helps to trace a wire from one point to another in the unit.

Semiconductor Lead Configuration. Fig. 4-1 shows the lead configuration of the semiconductor devices used in this instrument.

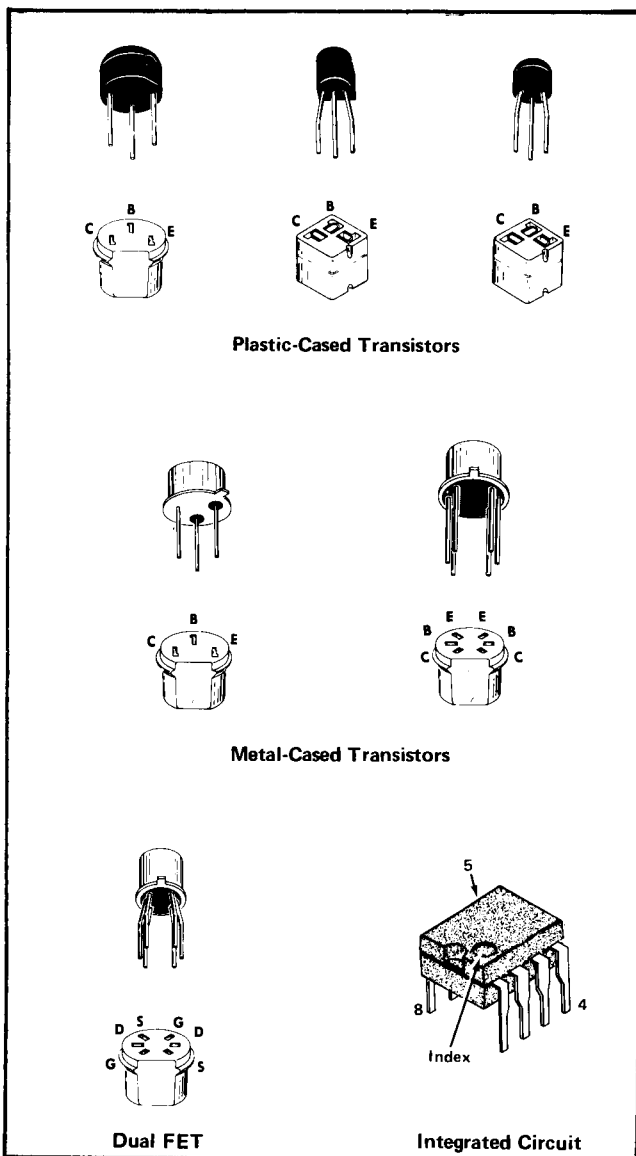


Fig. 4-1. Electrode configuration data of semiconductor devices.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type 3A10:

1. **Semiconductor Tester**—Some means of testing the transistors, diodes and FET's used in this instrument is helpful. A transistor-curve tracer such as the Tektronix Type 576 will give the most complete information.

2. **DC Voltmeter and Ohmmeter**—A voltmeter for checking voltages within the circuit and an ohmmeter for checking resistors and diodes are required. For most applications a 20,000 ohm/volt VOM can be used to check voltages and resistances, if allowances are made for the circuit loading of a VOM when making voltage measurements at high-impedance points.

3. **Test Oscilloscope**—A test oscilloscope is required to view waveforms at different points in the circuit. An oscilloscope with DC to 10 MHz frequency response and 1 mV to 10 V/division vertical deflection factor is suggested. A 10X probe should be used when circuit loading is critical.

Troubleshooting Procedure

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting.

1. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of this manual.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type 3A10, check that the equipment used with this instrument is operating correctly. If possible, substitute a vertical amplifier plug-in unit known to be operating correctly into the indicator unit and see if the problem persists. Check that the signal is properly connected and that the interconnecting cables are not defective.

3. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. 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 this 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 Section 5.

5. Check Voltages and Waveforms. Often the defective component or stage can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the diagrams; however, these are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the instructions in the schematics section.

Waveforms are not given on the diagrams; however, the amplifier circuits can be checked for correct operation by applying a test signal to the input of the unit and checking the inputs and outputs of various stages with a test oscilloscope.

6. Check Individual Components. The following methods are provided for checking the individual components in the Type 3A10. Components which are soldered in place are best checked by disconnecting one end, isolating the measurement from the effects of surrounding circuitry.

A. TRANSISTORS and INTEGRATED CIRCUITS. The best check of transistor and integrated circuit operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a component known to be good; 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 576). Static-type testers may be used, but since they do not check operation under simulated operating conditions, some defects may go unnoticed. Fig. 4-1 shows base pin and socket arrangements of semiconductor devices. Be sure power is off before attempting to remove or replace any transistor or integrated circuit.

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 leads are reversed.



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. Resistor tolerance is given in the Electrical Parts

List. 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 be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will 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 whether the capacitor passes AC signals.

7. Repair and Readjust the Circuit. Special techniques required to replace components in this unit are given under corrective maintenance. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced. Recalibration of the affected circuit may be necessary.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical part replacements for the Type 3A10 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. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the 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 special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes

Maintenance—Type 3A10

and Symbols on the page immediately preceding the Electrical Parts List section. Include the following information:

1. Instrument Type (3A10)
2. Instrument Serial Number
3. A description of the part (if electrical, include the circuit number)
4. Tektronix Part Number

COMPONENT REPLACEMENT

General

The exploded-view drawing associated with the Mechanical Parts List (Fig. 1, pullout page) may be helpful when disassembling or re-assembling individual components or sub-assemblies.

Circuit Board Replacement

In general, the circuit boards used in the Type 3A10 need never be removed unless they must be replaced. Electrical connections to the boards are made by two methods: soldered lead connections and solderless pin connections.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board.
2. Remove all the screws holding the board to the chassis or other mounting surface.
3. Lift the circuit board out of the unit. Do not force or bend the board.
4. To replace the board, reverse the order of removal. Replace the pin connectors carefully so they mate correctly with the pins. If forced into place incorrectly positioned, the pin connectors may be damaged. As a guide, correct connections of the wires are given in the diagram section. For soldered connections, use ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron.

Switch Replacement

If any of the front-panel lever-type switches 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 shields). The switches can be replaced without removing the front panel. Remove the knob from the actuating lever, and the nuts and lock-washers from the back of the switch. To replace, reverse the order of removal.

Single wafers on the rotary switches, are not normally replaced. If any of these switches is defective, the entire switch should be replaced. The switches can be ordered through your Tektronix Field Engineer either wired or unwired.

CAUTION

When disconnecting or connecting leads to a wafer-type rotary 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.

Transistor and Integrated Circuit Replacement

Transistors and IC's should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Special care should be given to integrated circuit leads, because they can easily be damaged in removal from sockets. Unnecessary replacement or switching of components may affect the calibration of the instrument. When a transistor is replaced, check the operation of that part of the instrument that may be affected.

Fuse Replacement

The fuses in the + and – inputs are located on the amplifier circuit board and are 1/16 A fast blow. Spare fuses are located on the chassis behind the front-panel POSITION control.

CAUTION

The particular types and makes of fuses listed in the Parts List have been selected for performance under conditions not normally specified by fuse manufacturers. Other apparently equivalent types may not perform satisfactorily.

RECALIBRATION AFTER REPAIR

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check instructions outlined in Section 5 provide a quick and convenient means of checking the instrument operation.

SECTION 5

PERFORMANCE CHECK/CALIBRATION

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

Introduction

This combined performance check and calibration procedure provides both a method of comparing the instrument to performance requirements given in the Specification section, and a method of adjusting any instrument characteristics that do not meet this specification. A performance check and calibration record is included for use as an index to locate steps within the complete procedure, or as a guide for quick calibration by an experienced technician.

To ensure instrument accuracy, check the calibration of the Type 3A10 every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

The step by step instructions in the procedure furnish an orderly approach to the isolation of possible malfunctions, and thus serve as an aid in troubleshooting the instrument. Any maintenance that is known to be needed should be performed before starting the calibration procedure. If any troubles become apparent during calibration, these also should be corrected before proceeding. Repair and servicing information is given in the Maintenance section. Calibration of optional transducers is normally not required, and Section 2 should be referred to for correct operation of these units.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, is required for complete calibration of the Type 3A10. Specifications given are the minimum necessary for accurate calibration. Therefore, some of the recommended equipment may have specifications which exceed those given. 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, special Tektronix calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. 560-Series oscilloscope (except for Type 560), referred to as the Indicator oscilloscope in this procedure. For example, a Type 561B with a Type 3B4 Time Base plug-in is used in this procedure.

2. Plug-in extension for the 560-Series oscilloscope (for calibration only). Tektronix Part No. 013-0034-00.

3. Standard amplitude calibrator. Frequency, about one kilohertz; square wave and DC output amplitude, 0.2 millivolt to 100 volts, within 0.25%. Tektronix Calibration Fixture 067-0502-01 recommended.

4. Constant amplitude sine-wave generator. Frequency, 2 hertz to about 1.5 megahertz; output amplitude, from about 0.5 volt to 40 volts peak to peak into 50 ohms. For example, General Radio 1310-A Oscillator (use a General Radio Type 2740BJ Adapter to provide BNC output).

5. Test oscilloscope. Bandwidth, DC to 1 MHz; minimum deflection factor, 0.2 volt per division, within 3%. Must be capable of supplying a positive voltage gate. Tektronix Type 547 with a Type W plug-in is recommended.

6. Coaxial Cable (2 needed). Impedance, 50 ohms; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

7. Dual-input cable. Provides matched signal paths to the + and - inputs; BNC connectors. Tektronix Part No. 067-0525-00.

8. T connector, BNC. Tektronix Part No. 103-0030-00.

9. In-line termination. Impedance, 50 ohms; accuracy, $\pm 2\%$, connectors, BNC. Tektronix Part No. 011-0049-01.

10. 10X attenuator (2 needed). Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, BNC. Tektronix Part No. 011-0059-01.

11. Input RC normalizer. RC time constant 47 μs ($1\text{ M}\Omega - 47\text{ pF}$); connectors, BNC. Tektronix Part No. 067-0541-00.

Performance Check/Calibration—Type 3A10

12. 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 connects to the attenuator output. Tektronix Calibration Fixture 067-0511-00 recommended.

13. Adapter, GR to BNC female. Tektronix Part No. 017-0063-00.

14. Adapter, GR to BNC male. Tektronix Part No. 017-0064-00.

15. Adapter, BNC to banana terminal (binding post). For example, Pomona #1269 (Tektronix Part No. 103-0090-00).

16. Either a mini-phone plug-to-BNC adapter, or a 1X probe for monitoring the Signal Out facility.

17. 1000:1 divider. Tektronix Part No. 067-0529-00.

4. Check/Adjust Amplifier Gain page 5-6

CHECK—For a 5 mV signal at 1 mV/DIV, display amplitude is 5 divisions, $\pm 2\%$.

ADJUST—AMPL GAIN-VOLTS (1 M Ω) and TRDCR GAIN.

5. Check VOLTS/DIV Switch Accuracy page 5-6

CHECK—Volts/Division accuracy is within 3% for positions 10 V to 20 mV; within 2%, 10 mV to 50 μ V; within 4%, 20 μ V and 10 μ V.

6. Check VARIABLE Volts/Div Control Range page 5-6

CHECK—Range is at least 2.5:1.

7. Check POSITION Control Range page 5-7

CHECK—Range of control is at least + and – 10 divisions from graticule center.

8 and 9. Check/Adjust + and – Input Gate Current Zero page 5-7

CHECK—Q133 gate current is ≤ 20 pA.

ADJUST—R215, + Input Current; R115, – Input Current.

SHORT-FORM PROCEDURE

Type 3A10, Serial No. _____

___ Performance Check/ ___ Calibration Date _____

___ Checked/ ___ Calibrated by _____

1. Check/Adjust AC Atten Bal page 5-5

CHECK—Trace shift is ≤ 1.5 divisions as VOLTS/DIV switch is rotated between 10 mV and 20 μ V.

ADJUST—R405, AC Atten Bal.

2. Check/Adjust Variable Balance page 5-5

CHECK—Trace shift is ≤ 0.2 division as the VARIABLE Volts/Div control is rotated throughout its range.

ADJUST—R425, Var Bal.

3. Check/Adjust Coarse DC Balance page 5-6

CHECK—Trace is within 0.1 division of graticule center at 10 mV/DIV, on-screen at 50 μ V/DIV.

ADJUST—R345, Coarse DC Bal.

10. Check DC Offset Range page 5-8

CHECK—Trace returns within calibrated graticule area with 1 volt of offset applied to the input.

11 and 12. Check/Adjust Cross Neutralization pages 5-8 & 9

CHECK—Minimum capacitive coupling between the two inputs (isolation ratio is 200:1).

ADJUST—C131 and C231.

13 and 14. Check/Adjust X1 + and – Input Attenuator Time Constant page 5-9

CHECK—Optimum square corner at leading edge of display.

ADJUST—C212 for + input; C112 for – input.

- | | |
|---|--|
| <p>15. Check/Adjust Input Attenuator Differential Balance page 5-9
CHECK—Optimum differential balance (minimum deflection amplitude).
ADJUST—R105E, R107E and R109E as indicated in Table 5-2.</p> | <p>23. Check Amplifier Frequency Response page 5-13
CHECK—Bandwidth upper -3 dB point is between 1 and 1.3 MHz.</p> |
| <p>16. Check Differential Dynamic Range page 5-10
CHECK—No change in sine wave amplitude when applying a DC level to the opposite input.</p> | <p>24. Check Upper and Lower -3 dB Frequency Switches page 5-14
CHECK—Frequency at -3 dB point is within 12% of the frequency indicated by the -3 dB FREQUENCY switches.</p> |
| <p>17. Check/Adjust + Input Attenuator Compensation page 5-10
CHECK—Optimum square wave response.
ADJUST—C205B, C205C, C207B, C207C, C209B and C209C as indicated in Tables 5-3 and 5-4.</p> | <p>25. Check Overall Noise Level Tangentially page 5-14
CHECK—Noise is 12 μV or less.</p> |
| <p>18. Check/Adjust $-$ Input Attenuator Series Compensation page 5-11
CHECK—The $-$ input is matched to the $+$ input to provide optimum differential balance.
ADJUST—C105C, C107C and C109C.</p> | <p>26. Check Overdrive Recovery Time page 5-15
CHECK—With an overdriving signal of 1 volt applied for at least 1 second, time to recover to within 0.5% of zero level is ≤ 10 microseconds.</p> |
| <p>19. Check/Adjust $-$ Input Attenuator Shunt Compensation page 5-11
CHECK—Optimum square wave response.
ADJUST—C105B, C107B and C109B.</p> | <p>27. Check/Adjust Signal Output page 5-16
CHECK—DC level is adjusted to zero; dynamic range is at least $+$ and -5 volts; amplitude is within 20% of 1 V/divided division; frequency response is at least 500 kHz.
ADJUST—R467, Sig Out DC Level; C461, Sig Out HF Comp.</p> |
| <p>20. Check 100-Hertz CMRR page 5-12
CHECK—Vertical tilt of X-Y display must not exceed 2 divisions (CMRR is 100,000:1 or greater).</p> | <p>28. Check/Adjust Transducer Power Supply page 5-17
CHECK—Output voltage is within 1% of dial indication.
ADJUST—R606, -11 V Cal; R604, -1 V Cal.</p> |
| <p>21. Check AC-Coupled CMRR (at 60 Hz for 1 MΩ input; at 6 Hz for 10 MΩ input) page 5-13
CHECK—Vertical deflection of display must not exceed 1 division (CMRR is 2,000:1 or greater).</p> | <p>29. Check DC Drift with Time (Check after specified warmup. Ambient temperature and line voltage must be held constant.) page 5-17
CHECK—After one hour warmup, 5 μV/minute or less; after 2.5 hours warmup, 10 μV/hour or less.</p> |
| <p>22. Check/Adjust High Frequency (1 kHz, 100 kHz) CMRR page 5-13
CHECK—CMRR at 1 kHz and 100 kHz is at least as indicated in Fig. 1-2.
ADJUST—C162, HF CMRR.</p> | |

PERFORMANCE CHECK/CALIBRATION PROCEDURE

General

The following procedure is arranged so that the Type 3A10 can be calibrated with the least interaction of adjustments and reconnection of equipment. Control titles which are printed on the front panel of the Type 3A10 are capitalized in this procedure (e.g., VOLTS/DIV). Internal adjust-

Performance Check/Calibration—Type 3A10

ments or control titles of associated equipment are initial capitalized only (e.g., Sig Out DC Level).

Instrument performance is checked in the "CHECK" part of a step before an adjustment is made. The "ADJUST" part of a step is that point at which the actual adjustment is made.

When conducting a complete calibration, the best overall performance will be obtained if each adjustment is made to the exact setting, even if the observed performance is within tolerance. Do not preset any internal controls unless they are known to be significantly out of adjustment, or unless repairs have been made to the circuit. In these instances, the particular controls can be set to midrange.

NOTE

All waveforms shown in this procedure were taken with a Tektronix Oscilloscope Camera System. Limits, tolerances, and waveforms are given as calibration guides and should not be interpreted as instrument specifications except as listed in Section 1.

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 needed for the test. Detailed operating instructions for the test equipment are not given in this manual. If in doubt as to correct operation of associated equipment, refer to the instruction manual for that unit.

NOTE

The tolerances given in this procedure are for temperature ranges as follows: Calibration should be conducted at +25°C, ±5°C, and Performance checked within 0°C to +50°C.

Preliminary Procedure

1. Snap the VOLTS/DIV deflection factor scale (331-0269-12) into the scale retainer on the front panel.

2. PERFORMANCE CHECK: Place the Type 3A10 all the way into the plug-in compartment.

CALIBRATION: Place the Type 3A10 on a plug-in extender and insert the extender into the compartment.

3. Connect the indicator oscilloscope to the power source for which it is wired and turn on the power. Allow at least 20 minutes warmup for checking the Type 3A10 to the given accuracy.

4. Set the front-panel controls as given under Preliminary Control Settings.

5. Internal controls and test points are shown in Fig. 5-1.

Preliminary Control Settings

Type 3A10	
VOLTS/DIV	10 mV
VARIABLE	CAL
Input Selector	VOLTS (1 MΩ)
+ Input Coupling (AC-GND-DC)	GND
– Input Coupling (AC-GND–DC)	GND
STEP ATTEN DC BAL	Midrange
POSITION	Midrange
OFFSET OR TRANSDUCER BAL	
COARSE (small knob)	Midrange (5 turns from either extreme)
FINE (large knob)	Midrange
AMPLIFIER –3 dB FREQUENCY	
UPPER	.1 kHz
LOWER	10 kHz
STRAIN GAGE/TRANSDUCER	1.00
– SUPPLY	

Indicator Oscilloscope

Intensity	Normal display brightness
Focus and Astigmatism	Adjust for well-defined trace
Calibrator	Off

Time Base Unit

Time/Div	1 ms
Variable	Calib
Slope	+
Coupling	AC
Source	Int
Trigger Mode	Free Run

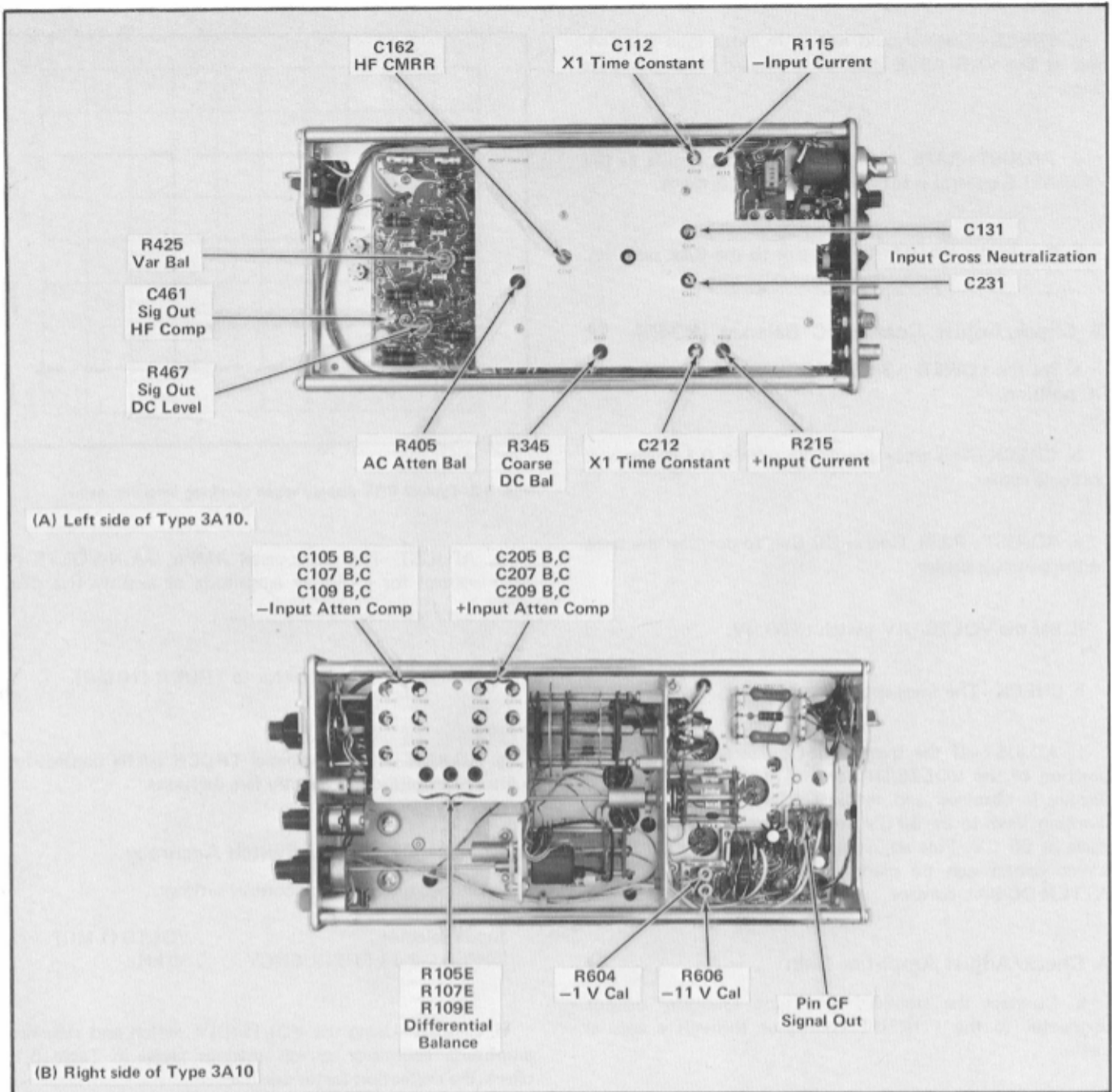


Fig. 5-1. Location of internal controls and test points in the Type 3A10.

1. Check/Adjust AC Atten Bal (R405) ❶

a. With the POSITION control, move the trace to the graticule center horizontal line.

b. CHECK—Rotate the VOLTS/DIV switch between 10 mV and 20 μ V. The trace should not move more than 1.5 divisions vertically.

c. ADJUST—R405, AC Atten Bal, for minimum trace shift as the VOLTS/DIV switch is rotated between the 10

mV and 20 μ V positions. Adjustment of the POSITION control may be required to center the trace.

2. Check/Adjust Variable Balance (R425) ❶

a. Set the VOLTS/DIV switch to 10 mV and center the trace.

b. Rotate the VARIABLE Volts/Div control counterclockwise. Note that the front-panel UNCAL neon illuminates to indicate the uncalibrated deflection factor.

Performance Check/Calibration—Type 3A10

c. CHECK—Trace should not shift more than 0.2 division as the VARIABLE control is rotated throughout its range.

d. ADJUST—R425, Var Bal, for no trace shift as the VARIABLE control is rotated throughout its range.

e. Return the VARIABLE control to the CAL position.

3. Check/Adjust Coarse DC Balance (R345) ①

a. Set the LOWER -3 dB FREQUENCY selector to the DC position.

b. CHECK—The trace should be within 0.1 division of graticule center.

c. ADJUST—R345, Coarse DC Bal, to position the trace to the graticule center.

d. Set the VOLTS/DIV switch to $50 \mu\text{V}$.

e. CHECK—The trace should be on screen.

f. ADJUST—If the trace is not on screen, start at the position of the VOLTS/DIV switch at which an on-screen display is obtained and readjust R345 (Coarse DC Bal), working down to the $50 \mu\text{V}$ position to obtain an on-screen trace at $50 \mu\text{V}$. Fine adjustment to bring the trace to the screen center can be made with the front-panel STEP ATTEN DC BAL control.

4. Check/Adjust Amplifier Gain ①

a. Connect the standard amplitude calibrator output connector to the + INPUT connector through a coaxial cable.

b. Set the standard amplitude calibrator for a 5-millivolt square-wave output.

c. Change the following control settings:

VOLTS/DIV	1 mV
UPPER -3 dB FREQUENCY	1 MHz
+ Input Coupling	DC
Trigger Mode	Auto
(Time Base unit)	

d. CHECK—Display amplitude is five divisions, $\pm 2\%$ (see Fig. 5-2). Adjust positioning as required.

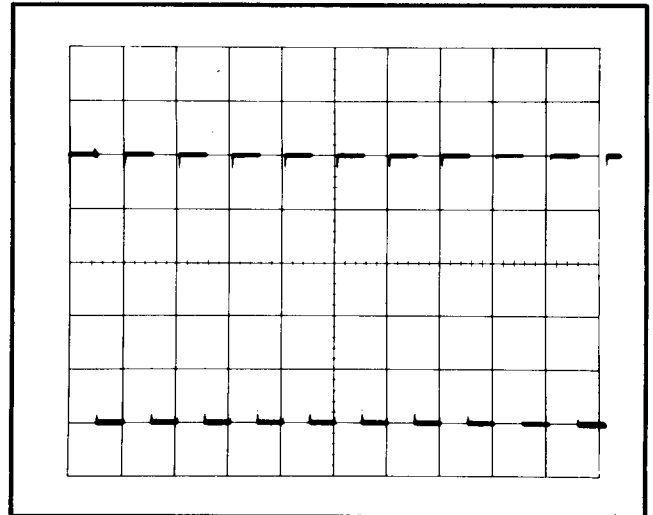


Fig. 5-2. Typical CRT display when checking amplifier gain.

e. ADJUST—The front-panel AMPL GAIN-VOLTS ($1 \text{ M}\Omega$) control for a display amplitude of exactly five divisions.

f. Change the Input Selector to TRDCR ($10 \text{ M}\Omega$).

g. ADJUST—The front-panel TRDCR GAIN control for a display amplitude of exactly five divisions.

5. Check VOLTS/DIV Switch Accuracy

a. Change the following control settings:

Input Selector	VOLTS ($1 \text{ M}\Omega$)
UPPER -3 dB FREQUENCY	30 kHz

b. CHECK—Using the VOLTS/DIV switch and standard amplitude calibrator switch settings given in Table 5-1, check the deflection factor accuracy.

c. Remove the 1000:1 divider, set the VOLTS/DIV switch to 1 mV and set the standard amplitude calibrator for a 5-millivolt square-wave output.

6. Check VARIABLE Volts/Div Control Range

a. Observe a 5-division display, then turn the VARIABLE Volts/Div control fully counterclockwise.

b. CHECK—Display amplitude is 2 divisions or less when the VARIABLE control is in the full counterclockwise position. This indicates a control ratio of at least 2.5:1.

TABLE 5-1

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output	CRT Display (Vertical Deflection)
10 V	50 volts	5 div, $\pm 3\%$
5 V	20 volts	4 div, $\pm 3\%$
2 V	10 volts	5 div, $\pm 3\%$
1 V	5 volts	5 div, $\pm 3\%$
500 mV	2 volts	4 div, $\pm 3\%$
200 mV	1 volt	5 div, $\pm 3\%$
100 mV	.5 volt	5 div, $\pm 3\%$
50 mV	.2 volt	4 div, $\pm 3\%$
20 mV	.1 volt	5 div, $\pm 3\%$
10 mV	50 mV	5 div, $\pm 2\%$
5 mV	20 mV	4 div, $\pm 2\%$
2 mV	10 mV	5 div, $\pm 2\%$
1 mV	5 mV	5 div, $\pm 2\%$
500 μ V	2 mV	4 div, $\pm 2\%$
200 μ V	1 mV	5 div, $\pm 2\%$
100 μ V	.5 mV	5 div, $\pm 2\%$
50 μ V	.2 mV	4 div, $\pm 2\%$

Connect a 1000:1 divider between the calibrator output and the + INPUT connector to check the 20 μ V and 10 μ V settings.

20 μ V	.1 volt	5 div, $\pm 4\%$
10 μ V	50 mV	5 div, $\pm 4\%$

c. Return the VARIABLE control to the CAL (fully clockwise) position.

7. Check POSITION Control Range

a. Change the following control settings:

VOLTS/DIV	.5 V
+ Input Coupling	AC

b. Set the standard amplitude calibrator for a 2-volt square-wave output. Observe four divisions of display amplitude.

c. Set the VOLTS/DIV switch to .1 V (this will produce a 20-division display, or 10 divisions each way from graticule center).

d. Rotate the POSITION control to both extremes of its range.

e. CHECK—When POSITION control is fully clockwise, the bottom of the display positions to graticule center or above; when fully counterclockwise, the top of the display

positions to graticule center or below. This indicates a POSITION control range of at least + and – 10 divisions.

f. Disconnect the standard amplitude calibrator.

8. Check/Adjust + Input Gate Current Zero (R215)

a. Position the trace to the graticule centerline.

b. Change the following control settings:

VOLTS/DIV	10 μ V
UPPER –3 dB FREQUENCY	.1 kHz
+ Input Coupling	GND

c. Connect a 50-ohm termination to the + INPUT connector.

d. Using the STEP ATTEN DC BAL control, position the trace to the graticule centerline.

e. Set the + Input Coupling switch to AC.

f. CHECK—Maximum trace shift is less than ± 1 division.

g. ADJUST—R215, + Input Current, to return the trace to horizontal centerline.

h. RECHECK (only if an adjustment has been made)—There should be no trace shift while alternately switching the + Input Coupling switch between GND and AC.

i. Set the + Input Coupling switch to GND.

9. Check/Adjust – Input Gate Current Zero (R115)

a. Move the 50-ohm termination from the + INPUT connector to the – INPUT connector.

b. With the trace at graticule center, set the – Input Coupling switch to AC.

c. CHECK—Maximum trace shift is less than ± 1 division.

d. ADJUST—R115, – Input Current, to return the trace to the horizontal centerline.

Performance Check/Calibration—Type 3A10

e. RECHECK (only if an adjustment has been made)—There should be no trace shift while alternately switching the — Input Coupling switch between GND and AC.

f. Set the — Input Coupling switch to GND and remove the 50-ohm termination.

10. Check DC Offset Range

a. Connect the standard amplitude calibrator output to the + INPUT connector through a coaxial cable.

b. Set the standard amplitude calibrator for a 50-millivolt +DC output.

c. Change the following control settings:

VOLTS/DIV	10 mV
VARIABLE	Counterclockwise
UPPER –3 dB FREQUENCY	1 MHz
Time/Div (Time Base unit)	.2 μ s
Trigger Mode (Time Base unit)	Free Run

d. Set the trace to the graticule center line using the POSITION control.

e. Set the + Input Coupling switch to DC.

f. With the VARIABLE Volts/Div control, position the trace to the second major graticule line above the center line.

g. Switch the + Input Coupling switch between DC and GND and check for exactly two divisions of deflection (deflection factor calibrated to 25 mV/DIV). Do not change the position of the VARIABLE control until the DC offset range has been checked.

h. Set the + Input Coupling switch to GND.

i. Rotate the OFFSET OR TRANSDUCER BAL COARSE and FINE controls fully counterclockwise.

j. Set the standard amplitude calibrator for a 1-volt +DC output.

k. Simultaneously switch the + Input Coupling switch to DC and the LOWER –3 dB FREQUENCY selector to DC OFFSET.

l. CHECK—The trace should return within the calibrated graticule area. The DC Offset Range is + and – 1 volt, within 10% (+4 divisions at 25 mV/DIV = 100 mV, or 10% of 1 volt).

m. Simultaneously switch the + Input Coupling switch to GND and the LOWER –3 dB FREQUENCY selector to DC.

n. Set the standard amplitude calibrator for a 1-volt –DC output and rotate the OFFSET OR TRANSDUCER BAL COARSE and FINE controls fully clockwise.

o. Simultaneously switch the + Input Coupling switch to DC and the LOWER –3 dB FREQUENCY selector to DC OFFSET.

p. CHECK—The trace should return to within the graticule area.

q. Simultaneously switch the + Input Coupling switch to GND and the LOWER –3 dB FREQUENCY selector to DC.

11. Check/Adjust Cross Neutralization (C131)

a. Insert the 1000:1 divider between the calibrator output and the coaxial cable, and set the standard amplitude calibrator for a 100-volt square-wave output.

b. Change the following control settings:

VOLTS/DIV	1 mV
VARIABLE Volts/Div	CAL
+ Input Coupling	DC
LOWER –3 dB FREQUENCY	DC OFFSET
Time/Div (Time Base unit)	.5 ms
Trigger Mode (Time Base unit)	Auto

c. Adjust the OFFSET OR TRANSDUCER BAL COARSE and FINE controls to position the top of the square-wave display to the graticule center line, and switch the — Input Coupling to DC.

d. CHECK—Observe the upper leading corner of the waveform and note any change that occurs as the — Input Coupling is switched from GND to DC. Change should not exceed 0.5 division (isolation ratio of 200:1).

e. ADJUST—With the — Input Coupling set to DC, adjust C131 for minimum change on the upper leading corner of the waveform.

f. INTERACTION—C131 affects the X1 input capacitance and all other input attenuator adjustments. If C131 is adjusted out of sequence, steps 13, 14, 17 and 19 must also be performed.

12. Check/Adjust Cross Neutralization (C231) ①

a. Set both the + and – Input Coupling switches to GND.

b. Move the calibrator signal from the + INPUT to the – INPUT.

c. Set the – Input Coupling switch to DC.

d. Adjust the OFFSET OR TRANSDUCER BAL COARSE and FINE controls to bring the bottom of the waveform to the graticule centerline.

e. Set the + Input Coupling switch to DC.

f. CHECK—Observe the lower leading corner of the waveform, and note any change that occurs as the + Input Coupling is switched from GND to DC. Change should not exceed 0.5 division (isolation ratio of 200:1).

g. ADJUST—With the + Input Coupling set to DC, adjust C231 for minimum change on the lower leading corner of the waveform.

h. INTERACTION—C231 affects the X1 input capacitance and all other input attenuator adjustments. If C231 is adjusted out of sequence, steps 13, 14, 17 and 19 must also be performed.

13. Check/Adjust X1 + Input Attenuator Time Constant (C212) ①

NOTE

It is important that C131 and C231 be properly adjusted before performing this step. If steps 11 and 12 have not been performed, do so at this point.

a. Change the following control settings:

VOLTS/DIV	10 mV
LOWER –3 dB FREQUENCY	DC
+ Input Coupling	GND
– Input Coupling	GND

b. Connect a 47 pF input RC normalizer to the + INPUT. Move the calibrator signal from the – INPUT to the RC normalizer.

c. Set the + Input Coupling switch to DC. Observe five divisions of display amplitude.

d. Position the display so that it is centered in the graticule area.

e. CHECK—Optimum square leading corner of the square-wave display.

f. ADJUST—C212 for minimum roll-off or overshoot.

g. INTERACTION—If C212 is adjusted out of sequence, steps 11, 15, 16 and 17 must also be performed.

14. Check/Adjust X1 – Input Attenuator Time Constant (C112) ①

a. Move the RC normalizer and calibrator signal from the + INPUT to the – INPUT.

b. Set the + Input Coupling switch to GND and the – Input Coupling switch to DC.

c. Position the display to the center of the graticule area.

d. CHECK—Optimum square leading corner of square-wave display.

e. ADJUST—C112 for minimum roll-off or overshoot.

f. INTERACTION—If C112 is adjusted out of sequence, steps 12, 15, 16 and 17 must also be performed.

g. Remove the 1000:1 divider, coaxial cable and RC normalizer from the standard amplitude calibrator output and the Type 3A10 – INPUT connectors.

15. Check/Adjust Input Attenuator Differential Balance (R105E, R107E, R109E) ①

a. Change the following control settings:

VOLTS/DIV	50 mV
+ Input Coupling	DC
– Input Coupling	DC
Trigger Source (Time Base)	Ext

Performance Check/Calibration—Type 3A10

b. Connect the standard amplitude calibrator output connector to both the + and – INPUT connectors through a T connector, a coaxial cable and a dual input cable. Connect another coaxial cable from the T connector to the Ext Trig In connector on the Time Base unit.

c. Set the standard amplitude calibrator for a 50-volt square-wave output.

d. CHECK—For optimum differential balance (minimum display amplitude), using the switch settings and signals listed in Table 5-2 (disregard any spikes on the waveform).

e. ADJUST—R105E, R107E and R109E for optimum differential balance, using the switch settings and signals listed in Table 5-2.

c. Connect the sine wave generator output connector to the –INPUT connector through a coaxial cable.

d. Set the – Input Coupling switch to DC.

e. Set the standard amplitude calibrator for a 1-volt +DC output. Adjust the sine-wave generator to give 5 divisions of one-kilohertz display (if the sine-wave generator minimum amplitude is too large, insert an attenuator between the cable and the – INPUT connector).

f. Switch the + Input Coupling switch to DC.

g. CHECK—Sine-wave display amplitude should not change when DC level from standard amplitude calibrator is applied.

h. Set the + Input Coupling switch to GND.

i. Set the standard amplitude calibrator for a 1-volt –DC output.

j. Switch the + Input Coupling switch to DC.

k. CHECK—Sine-wave display amplitude should not change when DC level from standard amplitude calibrator is applied.

l. Set both the + and – Input Coupling switches to GND.

m. Disconnect the sine-wave generator signal from the – INPUT connector, leaving the standard amplitude calibrator signal connected to the + INPUT connector.

TABLE 5-2

VOLTS/DIV	Standard Amplitude Calibrator Output	Check or Adjust For Null
50 mV	50 V	R105E
20 mV	50 V	Check
.1 V	50 V	Check
.5 V	100 V	R107E
.2 V	100 V	Check
1 V	100 V	Check
5 V	100 V	R109E
2 V	100 V	Check
10 V	100 V	Check

f. Set the standard amplitude calibrator for a .2-volt square-wave output.

g. Disconnect all signal connections between the standard amplitude calibrator, Type 3A10 and Time Base unit.

16. Check Differential Dynamic Range

a. Change the following control settings:

VOLTS/DIV	1 mV
LOWER –3 dB FREQUENCY	10 Hz
+ Input Coupling	GND
– Input Coupling	GND
Time/Div (Time Base unit)	1 ms
Source (Time Base unit)	Int

b. Connect the standard amplitude calibrator output connector to the + INPUT connector through a coaxial cable.

17. Check/Adjust + Input Attenuator Compensation (C205B, C, C207B, C, C209B, C)

a. Set the standard amplitude calibrator for a .2-volt square-wave output.

b. Change the following control settings:

VOLTS/DIV	50 mV
LOWER –3 dB FREQUENCY	DC
+ Input Coupling	DC
Time/Div (Time Base unit)	.5 ms

c. CHECK—The displayed square wave for optimum flat top and leading edge corner, using the switch settings and signals listed in Table 5-3.

d. ADJUST—C205C, C207C and C209C as indicated in Table 5-3 to give optimum flat top and leading edge corner.

TABLE 5-3

VOLTS/DIV	Standard Amplitude Calibrator Output	Check or Adjust For Optimum Leading Corner
50 mV	.2 V	C205C
20 mV	.1 V	Check
.1 V	.5 V	Check
.5 V	2 V	C207C
.2 V	1 V	Check
1 V	5 V	Check
5 V	20 V	C209C
2 V	10 V	Check
10 V	50 V	Check

e. Insert the 47 pF input RC normalizer between the signal cable and the + INPUT connector.

f. CHECK—The displayed square wave for optimum flat top and leading-edge corner, using the switch settings and signals listed in Table 5-4.

g. ADJUST—C205B, C207B and C209B as indicated in Table 5-4 to give optimum flat top and leading-edge corner.

TABLE 5-4

VOLTS/DIV	Standard Amplitude Calibrator Output	Check or Adjust For Optimum Leading Corner
5 V	50 V	C209B
2 V	20 V	Check
10 V	100 V	Check
.5 V	5 V	C207B
.2 V	2 V	Check
1 V	10 V	Check
50 mV	.5 V	C205B
20 mV	.2 V	Check
.1 V	1 V	Check

h. INTERACTION—If this step is performed out of sequence, steps 13 and 14 must also be performed.

i. Disconnect the RC normalizer and coaxial cable from the + INPUT connector and the standard amplitude calibrator.

18. Check/Adjust — Input Attenuator Series Compensation (C105C, C107C, C109C) ①

a. Connect the standard amplitude calibrator output connector to both the + and – INPUT connectors through a T connector, a coaxial cable and a dual input cable. Connect another coaxial cable from the T connector to the Ext Trig In connector on the Time Base unit.

b. Change the following control settings:

VOLTS/DIV	50 mV
+ Input Coupling	DC
– Input Coupling	DC
Trigger Source (Time Base unit)	Ext

c. Set the standard amplitude calibrator for a 50-volt square-wave output.

d. CHECK—For optimum common-mode signal rejection (a straight line), for each of the switch positions listed in Table 5-5.

e. ADJUST—The series compensation capacitors, C105C, C107C and C109C, for optimum differential balance (straight line), using the switch settings and signals listed in Table 5-5.

TABLE 5-5

VOLTS/DIV	Standard Amplitude Calibrator Output	Check or Adjust For Optimum Differential Balance
50 mV	50 V	C105C
20 mV	50 V	Check
.1 V	50 V	Check
.5 V	100 V	C107C
.2 V	100 V	Check
1 V	100 V	Check
5 V	100 V	C109C
2 V	100 V	Check
10 V	100 V	Check

f. Set the standard amplitude calibrator for a .5-volt square-wave output.

g. Disconnect all signal connections between the standard amplitude calibrator, Type 3A10 and Time Base unit.

19. Check/Adjust — Input Attenuator Shunt Compensation (C105B, C107B, C109B) ①

a. Connect the standard amplitude calibrator output connector to the – INPUT connector through a coaxial cable and an input RC normalizer.

Performance Check/Calibration—Type 3A10

b. Change the following control settings:

+ Input Coupling GND
 Source (Time Base unit) Int

c. CHECK—The displayed square wave for optimum flat top and leading-edge corner, using the switch settings and signals listed in Table 5-6.

d. ADJUST—C105B, C107B and C109B as indicated in Table 5-6 to give optimum flat top and leading-edge corner.

TABLE 5-6

VOLTS/DIV	Standard Amplitude Calibrator Output	Check or Adjust For Optimum Leading Corner
50 mV	.5 V	C105B
20 mV	.2 V	Check
.1 V	1 V	Check
.5 V	5 V	C107B
.2 V	2 V	Check
1 V	10 V	Check
5 V	50 V	C109B
2 V	20 V	Check
10 V	100 V	Check

e. Disconnect the RC normalizer and coaxial cable from the – INPUT connector and the standard amplitude calibrator output connector.

20. Check 100-Hertz CMRR

a. Connect the standard amplitude calibrator output connector to the Time Base Ext Horiz In. Set the standard amplitude calibrator for a 20-volt square-wave output.

b. Change the following control settings:

VOLTS/DIV .1 mV
 – Input Coupling GND
 Time/Div (Time Base unit) Ext Horiz In
 Horiz Volts/Div 2 (pull to unlock)

c. Adjust the Time Base Horizontal Volts/Div Variable for exactly ten divisions of horizontal deflection (two dots). Leave the Variable control in this position for the balance of the test. Horizontal deflection factor is now calibrated for 2 volts per division (see Fig. 5-3).

d. Connect the sine-wave generator output connector to both the + and – INPUT connectors through a T con-

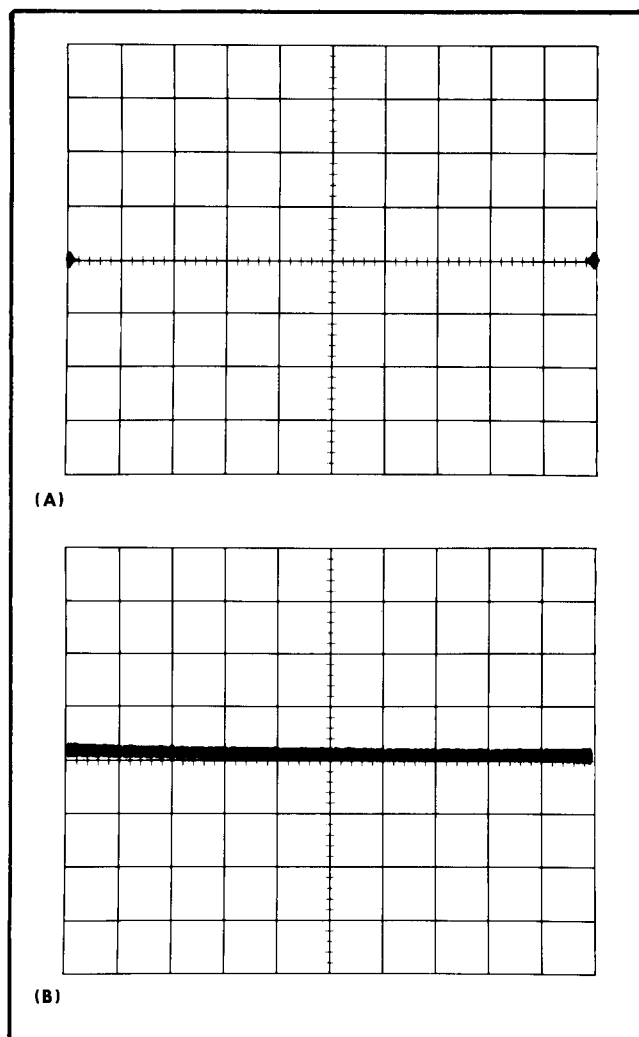


Fig. 5-3. Typical CRT displays when checking common-mode rejection ratio.

ector, a coaxial cable and a dual input cable. Disconnect the cable from the standard amplitude calibrator output and connect it to the other side of the T connector.

e. Set the sine-wave generator for a 100-hertz signal, and adjust the amplitude to provide 10 divisions of horizontal display.

f. Set both the + and – Input Coupling switches to DC.

g. CHECK—The horizontal display for vertical tilt. Vertical deflection of the tilt should not exceed two divisions (see Fig. 5-3B). (Two divisions at .1 mV/DIV = .2 millivolt; .0002 part in 20 = a CMRR ratio of 100,000:1.)

21. Check AC-Coupled CMRR (at 60 Hz for 1 MΩ input; at 6 Hz for 10 MΩ input)

- a. Set both the + and – Input Coupling switches to GND.
- b. Set the sine-wave generator frequency to 60 hertz and adjust the amplitude to provide exactly 10 divisions of horizontal deflection.
- c. Set the VOLTS/DIV switch to 10 mV and set both the + and – Input Coupling switches to AC.
- d. CHECK—The vertical deflection of the display is one division or less (CMRR = 2,000:1 or higher).
- e. Set the sine-wave generator frequency to 6 Hz and the Type 3A10 Input Selector to TRDCR (10 MΩ).
- f. CHECK—The CMRR is 2,000:1 or higher as in step d.
- g. Set the Input Selector to VOLTS (1 MΩ) and both the + and – Input Coupling switches to GND.

22. Check/Adjust High Frequency (1 kHz, 100 kHz) CMRR

- a. Set the VOLTS/DIV switch to .1 mV, and simultaneously set both the + and – Input Coupling switches to DC.
- b. Set the sine-wave generator frequency to 100 kilohertz and adjust the amplitude to provide exactly 10 divisions of horizontal deflection.
- c. CHECK—The vertical deflection of the resulting display should not exceed two divisions.
- d. ADJUST—C162, HF CMRR, for minimum vertical deflection.
- e. Set both the + and – Input Coupling switches to GND, set the VOLTS/DIV switch to .5 mV, then set the + and – Input Coupling switches to AC.
- f. CHECK—The vertical deflection of the display should not exceed two divisions.
- g. Set both the + and – Input Coupling switches to GND, set the VOLTS/DIV switch to 20 mV, then set the + and – Input Coupling switches to AC.

- h. CHECK—The vertical deflection of the display should not exceed two divisions.
- i. Set both the + and – Input Coupling switches to GND, then simultaneously set them to DC.
- j. CHECK—The vertical deflection of the display should not exceed two divisions.
- k. Set both the + and – Input Coupling switches to GND.
- l. Change the sine-wave generator frequency to one kilohertz.
- m. Set both the + and – Input Coupling switches to AC.
- n. CHECK—The vertical deflection of the display should not exceed two divisions.
- o. Set both the + and – Input Coupling switches to DC.
- p. CHECK—The vertical deflection of the display should not exceed two divisions.

NOTE

If CMRR is not within tolerance at 100 kHz and 1 kHz, C105C may be slightly adjusted at 100 kHz and R105E at 1 kHz for minimum vertical deflection.

- q. Disconnect all cables from the sine-wave generator, Type 3A10 and Time Base unit.

23. Check Amplifier Frequency Response

NOTE

Remove the plug-in extender and plug the Type 3A10 all the way into the plug-in compartment for steps 23 through 25.

- a. Change the following control settings:

VOLTS/DIV	1 mV
– Input Coupling	GND
Time/Div (Time Base unit)	1 ms

Performance Check/Calibration—Type 3A10

b. Connect the constant-amplitude sine-wave generator output to the + INPUT connector through a coaxial cable (and 10X attenuator, if needed).

c. Set the constant-amplitude sine-wave generator for eight vertical divisions of 200-kilohertz display as a reference. Then slowly increase the frequency until the display amplitude is 5.66 divisions (see Fig. 5-4). This is the upper -3 dB point.

d. CHECK—Frequency at upper -3 dB point is between 1.0 and 1.3 megahertz.

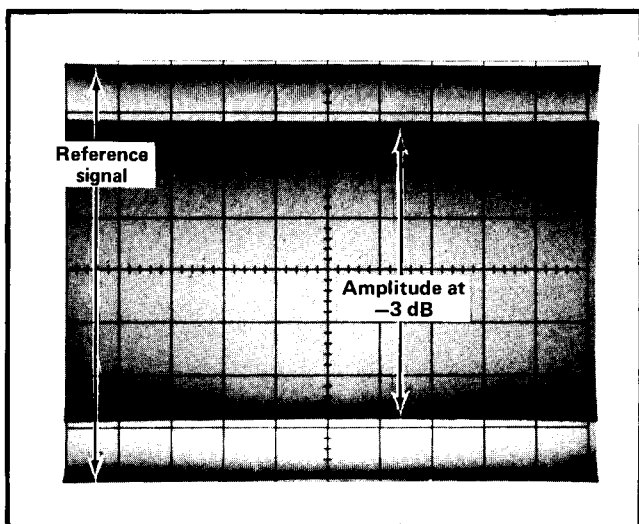


Fig. 5-4. Typical CRT displays (double exposure) when checking amplifier frequency response.

24. Check Upper and Lower -3 dB Frequency Switches

a. Following the basic procedure outlined in step 23, check the bandwidth limit accuracy of each position listed in Table 5-7. Set the constant-amplitude sine-wave generator for eight divisions of vertical display at the listed reference frequency, then slowly increase or decrease the frequency until the -3 dB point is located.

b. CHECK—Frequency at bandwidth limit in each case is within 12% of the frequency indicated by the UPPER and LOWER -3 dB FREQUENCY switches, using the switch settings and signals listed in Table 5-7.

NOTE

The components used in the 0.1 Hz and the 1 Hz positions of the LOWER -3 dB FREQUENCY selector are also used in other positions; therefore, the tolerances of these positions are checked.

TABLE 5-7

Time/Div	AMPLIFIER -3 dB FREQUENCY		Reference Frequency (8 divisions)	Frequency at -3 dB point		
	UPPER	LOWER				
1 ms	.3 MHz	DC	50 kHz	264 kHz	336 kHz	
	.1 MHz		10 kHz	88 kHz	112 kHz	
	30 kHz		5 kHz	26.4 kHz	33.6 kHz	
	10 kHz		1 kHz	8.8 kHz	11.2 kHz	
	3 kHz		200 Hz	2.64 kHz	3.36 kHz	
10 ms	1 kHz	DC	100 Hz	880 Hz	1.12 kHz	
	.3 kHz		20 Hz	264 Hz	336 Hz	
	.1 kHz		10 Hz	88 Hz	112 Hz	
	1 MHz		10 Hz	100 Hz	8.8 Hz	11.2 Hz
	.1 kHz		1 kHz	88 Hz	112 Hz	
1 ms	1 kHz	DC	10 kHz	880 Hz	1.12 kHz	
	10 kHz		100 kHz	8.8 kHz	11.2 kHz	

c. Disconnect the cable between the sine-wave generator and the + INPUT connector.

25. Check Overall Noise Level Tangentially

a. Connect the standard amplitude calibrator output connector to the + INPUT connector through a BNC-to-GR adapter, a variable attenuator (arrow pointing away from the calibrator output), a GR-to-BNC female adapter, a coaxial cable, two 10X attenuators and a 50-ohm termination.

b. Set the standard amplitude calibrator for a 50-millivolt square-wave output and turn the variable attenuator control fully clockwise.

c. Change the following control settings:

VOLTS/DIV	10 μV
UPPER -3 dB FREQUENCY	1 MHz
LOWER -3 dB FREQUENCY	DC
Time/Div (Time Base unit)	50 μs
Trigger Mode	Free Run

d. Observe two noise bands displayed on the CRT (noise and free running square wave). See Fig. 5-5A.

e. Turn the variable attenuator control slowly counter-clockwise until the two noise bands merge (just to the point at which the dark band between the two noise bands disappears). See Fig. 5-5B.

f. Remove the two 10X attenuators and connect the coaxial cable to the 50-ohm termination.

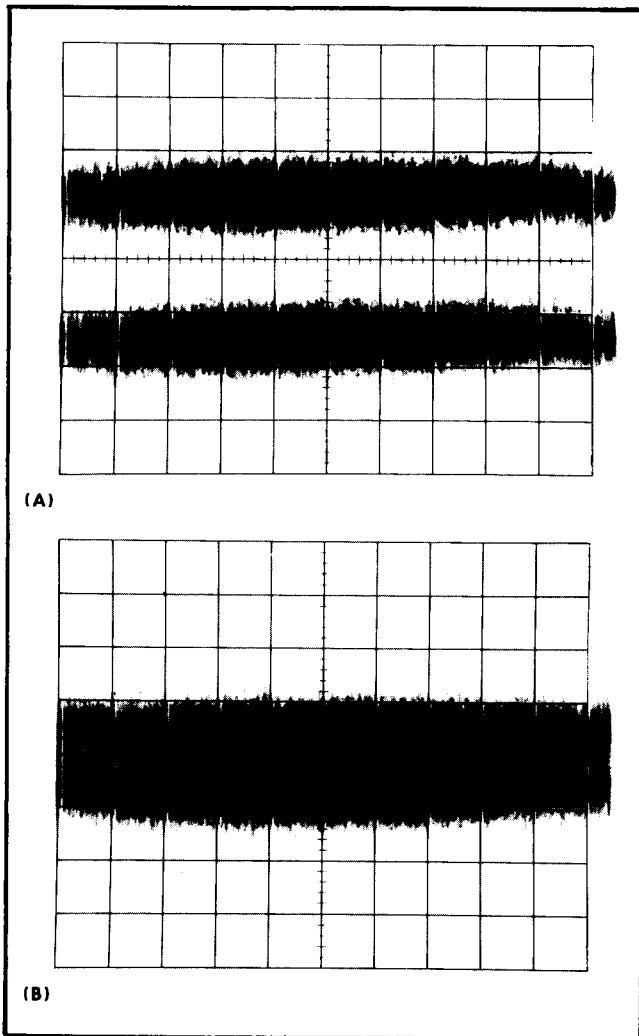


Fig. 5-5. Typical CRT displays showing (A) two noise bands and (B) merging noise bands.

g. Switch the VOLTS/DIV switch to any position which will give a convenient display (two traces).

h. CHECK—The vertical amplitude of the display. Calculate the tangentially measured noise by dividing the measured display by 100. For example, two divisions of display at .5 mV per division is equal to one millivolt. One millivolt divided by 100 is equal to 10 microvolts of tangentially measured noise. Maximum noise, 12 μ V.

i. Disconnect all test equipment.

26. Check Overdrive Recovery Time

NOTE

Re-install the plug-in extender removed prior to step 23.

a. Change the following control settings:

VOLTS/DIV	.5 V
+ Input Coupling	GND
Time/Div (Time Base unit)	1 ms
Slope (Time Base unit)	—
Triggering Mode (Time Base unit)	Auto

b. Connect the test oscilloscope (Type 547) + Gate B binding post to the Type 3A10 + INPUT connector through a binding post-to-BNC adapter, a BNC male-to-GR adapter, a variable attenuator, a GR-to-BNC female adapter and a coaxial cable.

c. Set the test oscilloscope Time Base B controls as follows:

Time/Div	50 μ s Calibrated
Triggering Slope	+
Triggering Coupling	AC
Trigger Source	Int
Triggering Mode	Auto

d. Set the + Input Coupling switch to DC and adjust the variable attenuator to provide exactly two divisions (1 volt) of display amplitude on the indicator oscilloscope. Position the display as required.

e. Set the test oscilloscope Sweep Mode to Single Sweep and Time/Div to .1 s.

f. Change the following control settings:

VOLTS/DIV	5 mV
Time/Div (Time Base unit)	50 μ s
Trigger Mode (Time Base unit)	Free Run
Triggering Level	Slightly negative

g. Position the indicator oscilloscope trace to the graticule center line, then set the Time Base unit Trigger Mode switch to Single Sweep.

h. Push the Time Base unit Reset button, then set the test oscilloscope Sweep Mode switch to Reset. Observe a single sweep on the indicator oscilloscope following the one-second, one-volt overdrive signal applied from the test oscilloscope. (It may be necessary to increase the indicator oscilloscope intensity to see the single sweep.)

i. Repeatedly reset and initiate single sweeps of both oscilloscopes while adjusting the indicator oscilloscope

Performance Check/Calibration—Type 3A10

Time Base unit Triggering Level control for stable triggering.

Time/cm	.5 ms
Triggering Mode	Auto
Sweep Mode	Normal

j. Set the Time Base unit Time/Div switch to 5 μ s.

k. CHECK—The time (on the indicator oscilloscope graticule) required for the trace to return to within one division (0.5% of one volt = 5 mV) of graticule center on each sweep. The recovery time should not be more than ten microseconds (see Fig. 5-6).

l. Disconnect the cable from the + INPUT connector and the test oscilloscope + Gate B binding post.

c. Connect a cable from the front panel SIGNAL OUT mini-phone jack (or connect a 1X probe from pin CF on the power supply board; see Fig. 5-1) to the test oscilloscope input connector.

d. CHECK—The test oscilloscope trace should remain centered.

e. ADJUST—R467, Sig Out DC Level, to return the test oscilloscope trace to graticule center (zero volts).

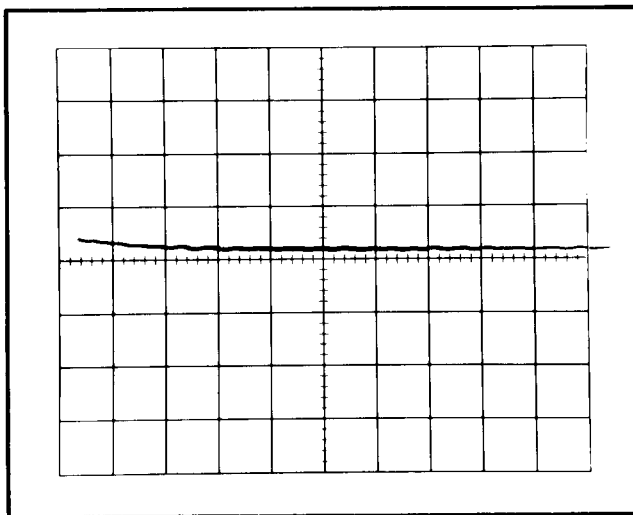


Fig. 5-6. Typical CRT display when checking overdrive recovery time.

DYNAMIC RANGE

f. Change the following control settings:

VOLTS/DIV	.2 V
+ Input Coupling	AC
Trigger Mode	Auto
Test Oscilloscope Input Atten	100
Test Oscilloscope Millivolts/cm	50

g. Set the standard amplitude calibrator for a 10-volt square-wave signal and connect a cable from its output connector to the Type 3A10 + INPUT connector.

h. CHECK—The test oscilloscope display for at least 10 volts of square wave (one division above and one division below graticule center).

AMPLITUDE

i. Set the standard amplitude calibrator for a 50-millivolt square-wave output.

j. Set the Type 3A10 VOLTS/DIV switch to 10 mV and the test oscilloscope Millivolts/cm switch to 10.

k. CHECK—The square wave displayed on the test oscilloscope should have an amplitude of 5 volts (5 divisions), \pm one volt (\pm 20%).

DIVIDER COMPENSATION

l. Set the Type 3A10 VOLTS/DIV switch to .2 V.

m. Set the standard amplitude calibrator for a one-volt square-wave output.

27. Check/Adjust Signal Out



DC LEVEL

a. Change the following control settings:

VOLTS/DIV	10 mV
+ Input Coupling	GND
Time/Div (Time Base unit)	.5 ms
Triggering Slope	+
Triggering Mode	Free Run

b. Set the test oscilloscope controls as follows:

V _C Range	0
Millivolts/cm	20
Display	A-V _C
Input Atten	10
Input Coupling	DC

n. CHECK—The leading-edge corner on the test oscilloscope square-wave display for overshoot or roll-off.

o. ADJUST—C461, Sig Out HF Comp, for optimum square-wave response.

p. Disconnect the standard amplitude calibrator.

FREQUENCY RESPONSE

q. Set the constant-amplitude sine-wave generator for a 50-kilohertz, minimum-amplitude output and connect its output connector to the Type 3A10 + INPUT connector through a coaxial cable and a 10X attenuator.

r. Adjust the sine-wave generator amplitude to provide exactly six vertical divisions of 50-kilohertz display on the test oscilloscope.

s. Slowly increase the constant-amplitude sine-wave generator frequency until the test oscilloscope display amplitude is reduced to 4.2 divisions. This is the -3 dB point of the signal output facility.

t. CHECK—The frequency at the -3 dB point must be 500 kilohertz or greater.

28. Check/Adjust Transducer Power Supply ①

a. Move the 1X probe from the Signal Out facility and connect it to pin D of the multi-pin INPUT connector on the front panel.

b. Set the test oscilloscope controls as follows:

V _C Range	-1.1
Comparison Voltage	1.000 (Outer ring 10, dial 00)
Input Atten	1
Millivolts/cm	10

c. Position the test oscilloscope trace to the graticule horizontal center line.

d. CHECK—With the STRAIN GAGE TRANSDUCER -SUPPLY dial set to 1.00, the test oscilloscope trace must be within one division of the graticule center line (1.00 volt, ±1%).

e. ADJUST—R604, -1 V Cal, for an indication of exactly 1.00 volt (trace centered on test oscilloscope).

f. Change the test oscilloscope controls as follows:

V _C Range	-11
Comparison Voltage	11.00 (Outer ring 10, dial 10.0)
Millivolts/cm	50

g. Set the STRAIN GAGE TRANSDUCER -SUPPLY dial to 11.00 volts.

h. CHECK—The test oscilloscope trace must be within 2.2 divisions of graticule center (11.00 volts, ±1%).

i. ADJUST—R606, -11 V Cal, for an indication of exactly 11.00 volts (trace centered on the test oscilloscope).

j. INTERACTION—R604 and R606 interact and may need to be readjusted to obtain the correct reading. Repeat steps b through i to recheck the supply accuracy.

k. Disconnect all test equipment.

29. Check DC Drift With Time (Check after specified warmup. Ambient temperature and line voltage must be held constant)

a. Change the following control settings:

VOLTS/DIV	10 μV
+ and - Input Coupling	GND

b. Position the trace to the graticule center line.

c. CHECK—Trace drift for one minute (after instrument has warmed up for one hour). Drift must be 0.5 division or less.

d. CHECK—The trace drift for one hour (after the instrument has warmed up for 2.5 hours). Drift must be 1.0 division or less.

This completes the performance check/calibration procedure for the Type 3A10 Transducer Amplifier.

PARTS LIST ABBREVIATIONS

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

INDEX OF ELECTRICAL PARTS LIST

Title	Page No.
CHASSIS	6-1
A1 AMPLIFIER Circuit Board Assembly	6-3
A2 ATTENUATOR Circuit Board Assembly	6-8
A3 10 MΩ GAIN Circuit Board Assembly	6-9
A4 TRANSDUCER POWER Circuit Board Assembly	6-10

SECTION 6

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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CHASSIS

Bulb

B174	150-0035-00			Neon, A1D T2
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Capacitors

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

C101	281-0518-00			47 pF	Cer	500 V	
C102 ¹	*295-0081-00			0.1 μ F	MT	600 V	10%
C105A	281-0505-00			12 pF	Cer	500 V	10%
C176	285-0815-00			1 μ F	Plastic	100 V	5%
C201	281-0518-00			47 pF	Cer	500 V	
C202 ¹	*295-0081-00			0.1 μ F	MT	600 V	10%
C203	283-0177-00			1 μ F	Cer	25 V	+10%—20%
C205A	281-0505-00			12 pF	Cer	500 V	10%
C276	285-0815-00			1 μ F	Plastic	100 V	5%
C444	281-0604-00			2.2 pF	Cer	500 V	± 0.25 pF
C445A	285-0703-00			0.1 μ F	PTM	100 V	5%
C445B	285-0702-00			0.033 μ F	PTM	100 V	5%
C445C	285-0598-00			0.01 μ F	PTM	100 V	5%
C445D	285-0627-00			0.0033 μ F	PTM	100 V	5%
C445E	285-0862-00			0.001 μ F	Plastic	100 V	10%
C445F	281-0546-00			330 pF	Cer	500 V	10%
C445H	283-0599-00			98 pF	Mica	500 V	5%
C445J	281-0515-00			27 pF	Cer	500 V	

Semiconductor Device, Diode

D174	*152-0061-00			Silicon	Tek Spec
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Fuse

F131, F231	159-0024-00			$\frac{1}{16}$ A	3AG Fast-Blo
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¹C102 and C202 furnished as a matched pair.

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Connectors				
J101, J201	131-0955-00			Receptacle, electrical, BNC, female
J203	131-0609-01			Receptacle, electrical, 6-contact, female
J475	136-0094-00			Socket, Tini-Jax
P11	131-0149-00			Chassis mtd., 24-contact, male
Transistors				
Q454, Q554	151-0150-00		Silicon	NPN TO-5 Selected from 2N3440
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R101	315-0105-00		1 M Ω	$\frac{1}{4}$ W 5%
R103	323-1485-08		1.11 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R105C	325-0096-00		9 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R107C	325-0097-00		9.9 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R109C	325-0098-00		9.99 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R176	321-0408-00		174 k Ω	$\frac{1}{8}$ W Prec 1%
R177	321-0303-00		14 k Ω	$\frac{1}{8}$ W Prec 1%
R179	301-0165-00		1.6 M Ω	$\frac{1}{2}$ W 5%
R201	315-0105-00		1 M Ω	$\frac{1}{4}$ W 5%
R203	323-1485-08		1.11 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R205C	325-0096-00		9 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R207C	325-0097-00		9.9 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R209C	325-0098-00		9.99 M Ω	$\frac{1}{2}$ W Prec $\frac{1}{2}\%$
R259	311-0467-00		100 k Ω , Var	
R276	321-0408-00		174 k Ω	$\frac{1}{8}$ W Prec 1%
R277	321-0303-00		14 k Ω	$\frac{1}{8}$ W Prec 1%
R279	301-0165-00		1.6 M Ω	$\frac{1}{2}$ W 5%
R355A	311-1097-00		25 k Ω , Var	
R355B	311-0360-01		5 k Ω , Var	
R407	321-0689-00		24.9 k Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408A	321-0001-01		10 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408B	321-0762-01		20.1 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408C	321-1068-01		50.5 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408D	321-0098-01		102 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408E	321-0127-01		205 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408F	321-1166-01		530 Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408H	321-0763-07		1.12 k Ω	$\frac{1}{8}$ W Prec 1/10%
R408J	321-1231-01		2.52 k Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R408K	321-1289-01		10.1 k Ω	$\frac{1}{8}$ W Prec $\frac{1}{2}\%$
R440	311-1098-00		2 x 100 k Ω , Var	
R450	311-0642-00		20 k Ω , Var	
R454	308-0053-00		8 k Ω	5 W WW 5%
R456	304-0681-00		680 Ω	1 W
R457	316-0470-00		47 Ω	$\frac{1}{4}$ W
R535	311-0417-00		5 k Ω , Var	

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R554	308-0053-00			8 k Ω	5 W	WW 5%
R557	316-0470-00			47 Ω	1/4 W	
R583	308-0426-00			470 Ω	3 W	WW 5%
R587	308-0314-00			680 Ω	3 W	WW 5%
R605	311-0360-03			5 k Ω , Var		

Switches

Wired or Unwired						
SW101	260-0665-00	B010100	B019999	Lever		AC-GND-DC
SW101	260-1168-00	B020000		Lever		AC-GND-DC
SW103	260-0247-00			Pushbutton		CAL
SW175	Wired *262-0908-00			Rotary		AMPLIFIER 3 dB FREQUENCY (LOWER)
SW175	260-1045-00			Rotary		AMPLIFIER 3 dB FREQUENCY (LOWER)
SW201	260-0665-00	B010100	B019999	Lever		AC-GND-DC
SW201	260-1168-00	B020000		Lever		AC-GND-DC
SW203	260-1167-00			Lever		INPUT
SW205	Wired *262-0906-00			Rotary		VOLTS/DIV
SW205	260-1044-00			Rotary		VOLTS/DIV
SW445	Wired *262-0907-00			Rotary		AMPLIFIER 3 dB FREQUENCY (UPPER)
SW445	260-1047-00			Rotary		AMPLIFIER 3 dB FREQUENCY (UPPER)
SW535 ²						

A1 AMPLIFIER Circuit Board Assembly

*670-0358-00

Complete Board

Capacitors

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

C111	281-0593-00			3.9 pF	Cer	500 V	10%
C112	281-0081-00			1.8-13 pF, Var	Air		
C131	281-0080-00			1.7-11 pF, Var	Air		
C143	281-0504-00			10 pF	Cer	500 V	10%
C158	283-0594-00			0.001 μ F	Mica	100 V	1%
C162	281-0077-00			1.3-5.4 pF, Var	Air		
C164	283-0003-00			0.01 μ F	Cer	150 V	
C211	281-0593-00			3.9 pF	Cer	500 V	10%
C212	281-0081-00			1.8-13 pF, Var	Air		
C231	281-0080-00			1.7-11 pF, Var	Air		
C243	281-0504-00			10 pF	Cer	500 V	10%
C258	283-0594-00			0.001 μ F	Mica	100 V	1%
C273	290-0305-00			3 μ F	Elect.	150 V	
C275	290-0297-00			39 μ F	Elect.	10 V	10%
C283	281-0504-00			10 pF	Cer	500 V	10%

²Furnished as a unit with R535.

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors (cont)						
C285	290-0297-00		39 μ F	Elect.	10 V	10%
C295	290-0135-00		15 μ F	Elect.	20 V	
C332	281-0525 00	XB030000	470 pF	Cer	500 V	
C336	283-0059-00		1 μ F	Cer	25 V	+ 80%—20%
C337	290-0305-00		3 μ F	Elect.	150 V	
C355	290-0309-00		100 μ F	Elect.	25 V	
C414	281-0592-00		4.7 pF	Cer	200 V	\pm 0.5 pF
C415	290-0297-00	39 μ F	Elect.	10 V	10%	
C443	281-0659-00	4.3 pF	Cer	500 V	\pm 0.25 pF	
C445 ³						
C447	281-0509-00	15 pF	Cer	500 V	10%	
C461	281-0114-00	1.3-5.4 pF, Var	Air			
C462	281-0557-00	1.8 pF	Cer	500 V		
C471	283-0111-00	0.1 μ F	Cer	50 V		
C514	281-0592-00	4.7 pF	Cer	200 V	\pm 0.5 pF	
C543	281-0659-00	4.3 pF	Cer	500 V	\pm 0.25 pF	
C545 ³						
C547	281-0509-00	15 pF	Cer	500 V	10%	
C561	283-0129-00	0.56 μ F	Cer	100 V		
C565	290-0272-00	47 μ F	Elect.	50 V		
C567	290-0309-00	100 μ F	lect.	25 V		
C581-C589	283-0211-00	0.1 μ F	Cer	200 V	10%	

Semiconductor Device, Diodes

D132, D133	*152-0323-00	Silicon	Tek Spec
D142, D162	*152-0185-00	Silicon	Replaceable by 1N4152
D232, D233	*152-0323-00	Silicon	Tek Spec
D242-D272	*152-0185-00	Silicon	Replaceable by 1N4152
D275	152-0212-00	Zener	1N936 500 mW, 9 V, 5%
D285	152-0280-00	Zener	1N753A 400 mW, 6.2 V, 5%
D293	*152-0185-00	Silicon	Replaceable by 1N4152
D294	*152-0061-00	Silicon	Tek Spec
D295	152-0243-00	Zener	1N965B 400 mW, 15 V, 5%
D297	*152-0185-00	Silicon	Replaceable by 1N4152
D299	152-0305-00	Zener	1N3045B 1 W, 110 V, 5%
D347	152-0280-00	Zener	1N753A 400 mW, 6.2 V, 5%
D352	152-0212-00	Zener	1N936 500 mW, 9 V, 5%
D355	152-0405-00	Zener	1 W, 15 V, 5%
D415	152-0280-00	Zener	1N753A 400 mW, 6.2 V, 5%
D420-D445	*152-0185-00	Silicon	Replaceable by 1N4152
D464	152-0241-00	Zener	1N973B 400 mW, 33 V, 5%
D520, D522	*152-0185-00	Silicon	Replaceable by 1N4152
D563	152-0243-00	Zener	1N965B 400 mW, 15 V, 5%
D565	152-0304-00	Zener	1N968B 400 mW, 20 V, 5%
D567	152-0405-00	Zener	1 W, 15 V, 5%

³Part of Circuit Board.

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Transistors						
Q133A, B	*151-1027-00			Silicon	FET	TO-18 Dual, Tek Spec
Q144A, B	*151-0261-00			Silicon	PNP	TO-18 Dual, Tek Spec
Q154	*151-1028-00			Silicon	FET	TO-5 Tek Spec
Q163	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS 6521
Q164	*151-0228-00			Silicon	PNP	TO-5 Tek Spec
Q254	*151-1028-00			Silicon	FET	TO-5 Tek Spec
Q283	151-0220-00			Silicon	PNP	TO-18 2N4122
Q284	151-0208-00			Silicon	PNP	TO-5 2N4036
Q294	*151-0136-00			Silicon	NPN	TO-5 Replaceable by 2N3053
Q295	*151-0228-00			Silicon	PNP	TO-5 Tek Spec
Q314A, B	*151-0261-00			Silicon	PNP	TO-78 Dual, Tek Spec
Q324	*151-1028-00			Silicon	FET	TO-5 Tek Spec
Q326	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS 6521
Q334	*151-1028-00			Silicon	FET	TO-5 Tek Spec
Q404A, B	*151-1027-00	B010100	B019999	Silicon	FET	TO-18 Dual, Tek Spec
Q404A, B	151-1046-00	B020000		Silicon	FET	TO-71 N channel, dual
Q414A, B	*151-0261-00			Silicon	PNP	TO-78 Dual, Tek Spec
Q424	151-0190-00			Silicon	NPN	TO-92 2N3904
Q434	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS 6521
Q444	151-0188-00			Silicon	PNP	TO-92 2N3906
Q464	*151-1028-00			Silicon	FET	TO-5 Tek Spec
Q474	151-0188-00			Silicon	PNP	TO-92 2N3906
Q524	151-0190-00			Silicon	NPN	TO-92 2N3904
Q534	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS 6521
Q544	151-0188-00			Silicon	PNP	TO-92 2N3906

Resistors

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

R111	315-0102-00			1 k Ω	1/4 W		5%
R113	325-0071-00			10 M Ω	1 W	Prec	1/2%
R115	311-0462-00	B010100	B029999	1 k Ω , Var			
R115	311-1225-00	B030000		1 k Ω , Var			
R115	311-0462-00			1 k Ω , Var			
R121	321-0344-00			37.4 k Ω	1/8 W	Prec	1%
R122	307-0181-00			100 k Ω	Thermal		
R123	321-0155-00			402 Ω	1/8 W	Prec	1%
R124	307-0181-00			100 k Ω	Thermal		
R126	315-0302-00			3 k Ω	1/4 W		5%
R131	315-0512-00			5.1 k Ω	1/4 W		5%
R132	315-0510-00			51 Ω	1/4 W		5%
R134	308-0495-00			4.5 k Ω	2.5 W	WW	1/10%
R143	321-0614-00			10.1 k Ω	1/4 W	Prec	1%
R151	308-0497-00			105 Ω	2.5 W	WW	1%
R153	321-0114-00			150 Ω	1/8 W	Prec	1%
R154	316-0221-00			220 Ω	1/4 W		
R156	321-0030-00			20 Ω	1/8 W	Prec	1%
R157	308-0436-00			2 k Ω	3 W	WW	1/10%
R163, R164	316-0105-00			1 M Ω	1/4 W		
R166	315-0113-00			11 k Ω	1/4 W		5%
R167	315-0182-00			1.8 k Ω	1/4 W		5%

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Resistors (cont)						
R171	315-0223-00			22 k Ω	1/4 W	5%
R172	315-0184-00			180 k Ω	1/4 W	5%
R174	316-0223-00			22 k Ω	1/4 W	
R211	315-0102-00			1 k Ω	1/4 W	5%
R213	325-0071-00			10 M Ω	1 W	Prec 1/2%
R215	311-0462-00	B010100	B029999	1 k Ω , Var		
R215	311-1225-00	B030000		1 k Ω , Var		
R231	315-0512-00			5.1 k Ω	1/4 W	5%
R232	315-0510-00			51 Ω	1/4 W	5%
R234	308-0495-00			4.5 k Ω	2.5 W	WW 1/10%
R243	321-0614-00			10.1 k Ω	1/4 W	Prec 1%
R251	308-0497-00			105 Ω	2.5 W	WW 1%
R253	321-0114-00			150 Ω	1/8 W	Prec 1%
R254	316-0221-00			220 Ω	1/4 W	
R256	321-0030-00			20 Ω	1/8 W	Prec 1%
R257	308-0436-00			2 k Ω	3 W	WW 1/10%
R258	315-0475-00			4.7 M Ω	1/4 W	5%
R271	316-0222-00			2.2 k Ω	1/4 W	
R273	308-0112-00			6 k Ω	5 W	WW 1%
R283	315-0222-00			2.2 k Ω	1/4 W	5%
R284	315-0302-00			3 k Ω	1/4 W	5%
R293	316-0221-00			220 Ω	1/4 W	
R294	308-0492-00			8.15 k Ω	3 W	WW 1%
R295	306-0102-00			1 k Ω	2 W	
R297	303-0333-00			33 k Ω	1 W	5%
R314	322-0469-00			750 k Ω	1/4 W	Prec 1%
R321	308-0550-00			400 Ω	2.5 W	WW 1/10%
R326	308-0319-00			4.5 k Ω	3 W	WW 1%
R331	308-0550-00			400 Ω	2.5 W	WW 1/10%
R332	316-0101-00	XB030000		100 Ω	1/4 W	
R334	322-0469-00			750 k Ω	1/4 W	Prec 1%
R337	316-0222-00			2.2 k Ω	1/4 W	
R339	308-0549-00			6.3 k Ω	3 W	WW 1%
R341	308-0498-00			2.94 k Ω	2.5 W	WW %
R342, R343	321-0135-00			249 Ω	1/8 W	Prec 1%
R345	311-0658-00			500 Ω , Var		
R347	308-0498-00			2.94 k Ω	2.5 W	WW 1%
R351	321-0160-00			453 Ω	1/8 W	Prec 1%
R352, R353	321-0415-00			205 k Ω	1/8 W	Prec 1%
R354	321-0160-00			453 Ω	1/8 W	Prec 1%
R401	315-0102-00			1 k Ω	1/4 W	5%
R404	308-0366-00			3.4 k Ω	3 W	WW 1%

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R405	311-0867-00			30 Ω , Var		
R412	321-0329-00			26.1 k Ω	1/8 W	Prec 1%
R421	301-0912-00			9.1 k Ω	1/2 W	5%
R423	321-0282-00			8.45 k Ω	1/8 W	Prec 1%
R424	321-0233-00			2.61 k Ω	1/8 W	Prec 1%
R425	311-0462-00	B010100	B029999	1 k Ω , Var		
R425	311-1225-00	B030000		1 k Ω , Var		
R427	321-0259-00			4.87 k Ω	1/8 W	Prec 1%
R428	316-0221-00			220 Ω	1/4 W	
R429	316-0221-00			220 Ω	1/4 W	
R431	321-0328-00			25.5 k Ω	1/8 W	Prec 1%
R433	321-0186-00			845 Ω	1/8 W	Prec 1%
R437	321-0391-00			115 k Ω	1/8 W	Prec 1%
R443	321-0305-00			14.7 k Ω	1/8 W	Prec 1%
R444	303-0103-00			10 k Ω	1 W	5%
R445	323-0366-00			63.4 k Ω	1/2 W	Prec 1%
R447	321-0254-00			4.32 k Ω	1/8 W	Prec 1%
R461	315-0474-00			470 k Ω	1/4 W	5%
R462	315-0753-00			75 k Ω	1/4 W	5%
R463	316-0391-00			390 Ω	1/4 W	
R464	305-0822-00			8.2 k Ω	2 W	5%
R465	315-0204-00			200 k Ω	1/4 W	5%
R467	311-0465-00	B010100	B029999	100 k Ω , Var		
R467	311-1235-00	B030000		100 k Ω , Var		
R467	311-0465-00			100 k Ω , Var		
R469	303-0203-00			20 k Ω	1 W	5%
R471	321-0253-00			4.22 k Ω	1/8 W	Prec 1%
R473	322-0289-00			10 k Ω	1/4 W	Prec 1%
R474	301-0623-00			62 k Ω	1/2 W	5%
R475	316-0470-00			47 Ω	1/4 W	
R476	316-0101-00			100 Ω	1/4 W	
R501	315-0102-00			1 k Ω	1/4 W	5%
R504	308-0366-00			3.4 k Ω	3 W	WW 1%
R505	321-0018-00			15 Ω	1/8 W	Prec 1%
R512	321-0329-00			26.1 k Ω	1/8 W	Prec 1%
R523	321-0282-00			8.45 k Ω	1/8 W	Prec 1%
R524	321-0233-00			2.61 k Ω	1/8 W	Prec 1%
R527	321-0259-00			4.87 k Ω	1/8 W	Prec 1%
R528, R529	316-0221-00			220 Ω	1/4 W	
R531	321-0328-00			25.5 k Ω	1/8 W	Prec 1%
R533	321-0186-00			845 Ω	1/8 W	Prec 1%
R537	321-0391-00			115 k Ω	1/8 W	Prec 1%
R543	321-0305-00			14.7 k Ω	1/8 W	Prec 1%

Electrical Parts List—3A10

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Resistors (cont)						
R544	303-0103-00			10 k Ω	1 W	
R545	323-0366-00			63.4 k Ω	1/2 W	Prec 1%
R547	321-0254-00			4.32 k Ω	1/8 W	Prec 1%
R560	315-0161-00			160 Ω	1/4 W	5%
R561	316-0470-00			47 Ω	1/4 W	
R563	301-0102-00			1 k Ω	1/2 W	5%
R581-R589	316-0470-00			47 Ω	1/4 W	

A2 ATTENUATOR Circuit Board Assembly

*670-1243-00

Complete Board

Capacitors

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

C105B	281-0081-00			1.8-13 pF, Var	Air	
C105C	281-0078-00			1.4-7.3 pF, Var	Air	
C105D	283-0628-00			130 pF	Mica	100 V 1%
C107A	281-0505-00			12 pF	Cer	500 V 10%
C107B	281-0081-00			1.8-13 pF, Var	Air	
C107C	281-0078-00			1.4-7.3 pF, Var	Air	
C107D	285-0813-00			0.0015 μ F	Plastic	100 V 5%
C109A	281-0505-00			12 pF	Cer	500 V 10%
C109B	281-0081-00			1.8-13 pF, Var	Air	
C109C	281-0078-00			1.4-7.3 pF, Var	Air	
C109D	285-0814-00			0.015 μ F	Plastic	100 V 5%
C205B	281-0081-00			1.8-13 pF, Var	Air	
C205C	281-0078-00			1.4-7.3 pF	Air	
C205D	283-0638-00			130 pF	Mica	100 V 1%
C207A	281-0505-00			12 pF	Cer	500 V 10%
C207B	281-0081-00			1.8-13 pF, Var	Air	
C207C	281-0078-00			1.4-7.3 pF, Var	Air	
C207D	285-0813-00			0.0015 μ F	Plastic	100 V 5%
C209A	281-0505-00			12 pF	Cer	500 V 10%
C209B	281-0081-00			1.8-13 pF, Var	Air	
C209C	281-0078-00			1.4-7.3 pF, Var	Air	
C209D	285-0814-00			0.015 μ F	Plastic	100 V 5%

A2 ATTENUATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description			
Resistors							
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.							
R105D	321-1484-03			1.09 M Ω	1/8 W	Prec	1/4%
R105E	311-0942-00	B010100	B029999	50 k Ω , Var			
R105E	311-1233-00	B030000		50 k Ω , Var			
R107D	321-0897-03			98 k Ω	1/8 W	Prec	1/4%
R107E	311-0463-00	B010100	B029999	5 k Ω , Var			
R107E	311-1227-00	B030000		5 k Ω , Var			
R109D	321-0896-03			9.8 k Ω	1/8 W	Prec	1/4%
R109E	311-0480-00	B010100	B029999	500 Ω , Var			
R109E	311-1224-00	B030000		500 Ω , Var			
R205D	321-1485-03			1.11 M Ω	1/8 W	Prec	1/4%
R207D	321-1385-03			101 k Ω	1/8 W	Prec	1/4%
R209D	321-0289-03			10 k Ω	1/8 W	Prec	1/4%

A3 10 M Ω GAIN Circuit Board Assembly

*670-0357-00

Complete Board

Capacitor

C260	283-0177-00			1 μ F	Cer	25 V	+80%—20%
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Relay

K260	*148-0044-00			Armature, sens, dpdt, 12 V DC			
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Resistors

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

R175	315-0223-00			22 k Ω	1/4 W		5%
R260	311-1099-00			100 k Ω , Var			
R265	315-0272-00			2.7 k Ω	1/4 W		5%
R269	321-0614-00			10.1 k Ω	1/8 W	Prec	1%

Electrical Parts List—3A10

A4 TRANSDUCER POWER Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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*670-0356-00 Complete Board

Capacitors

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

C611	283-0177-00		1 μ F	Cer	25 V	+ 80%—20%
C620, C649	290-0134-00		22 μ F	Elect.	15 V	

Semiconductor Device, Diodes

D601	152-0212-00		Zener	1N936	500 mW, 9 V, 5%
D610	152-0326-00		Zener	1N755A	400 mW, 7.5 V, 5%
D614	*152-0185-00		Silicon	Replaceable by 1N4152	
D641	*152-0107-00		Silicon	Replaceable by 1N647	

Transistors

Q620	*151-0134-00		Silicon	PNP	TO-5	Replaceable by 2N2905
Q630A, B	151-0232-00		Silicon	NPN	TO-77	Dual
Q640	151-0292-00		Silicon	NPN	TO-92	TIS 100
Q650	*151-0134-00		Silicon	PNP	TO-5	Replaceable by 2N2905

Resistors

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

R603	321-0160-00			453 Ω	1/8 W	Prec	1%
R604	311-0884-00	B010100	B029999	100 Ω , Var			
R604	311-1259-00	B030000		100 Ω , Var			
R606	311-0732-00	B010100	B029999	1 k Ω , Var			
R606	311-1263-00	B030000		1 k Ω , Var			
R607	321-0150-00			357 Ω	1/8 W	Prec	1%
R610	305-0163-00			16 k Ω	2 W		5%
R611	315-0512-00			5.1 k Ω	1/4 W		5%
R613	316-0102-00			1 k Ω	1/4 W		
R614	301-0473-00			47 k Ω	1/2 W		5%
R620	321-0210-00			1.5 k Ω	1/8 W	Prec	1%
R621	315-0332-00			3.3 k Ω	1/4 W		5%
R622	321-0251-00			4.02 k Ω	1/8 W	Prec	1%
R630	301-0333-00			33 k Ω	1/2 W		5%
R631	307-0110-00			3 Ω	1/4 W		5%
R632	321-0234-00			2.67 k Ω	1/8 W	Prec	1%
R633	321-0232-00			2.55 k Ω	1/8 W	Prec	1%

A4 TRANSDUCER POWER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R634	321-0101-00	110 Ω	$\frac{1}{8}$ W Prec 1%
R635	315-0133-00	13 k Ω	$\frac{1}{4}$ W 5%
R640	315-0224-00	220 k Ω	$\frac{1}{4}$ W 5%
R641	315-0244-00	240 k Ω	$\frac{1}{4}$ W 5%
R650	308-0273-00	6.5 k Ω	5 W WW 2%
R651	315-0100-00	10 Ω	$\frac{1}{4}$ W 5%
R652	316-0102-00	1 k Ω	$\frac{1}{4}$ W 5%
R653	315-0913-00	91 k Ω	$\frac{1}{4}$ W 5%
R654	307-0181-00	100 k Ω	Thermal
R655	315-0184-00	180 k Ω	$\frac{1}{4}$ W 5%
R656	301-0181-00	180 Ω	$\frac{1}{2}$ W 5%
Integrated Circuit			
U610	156-0067-00	Op ampl.	Replaceable by Fairchild μ A741C

SECTION 7

DIAGRAMS, CIRCUIT BOARDS, MECHANICAL and REPACKAGING PARTS ILLUSTRATIONS

Symbols and Reference Designators

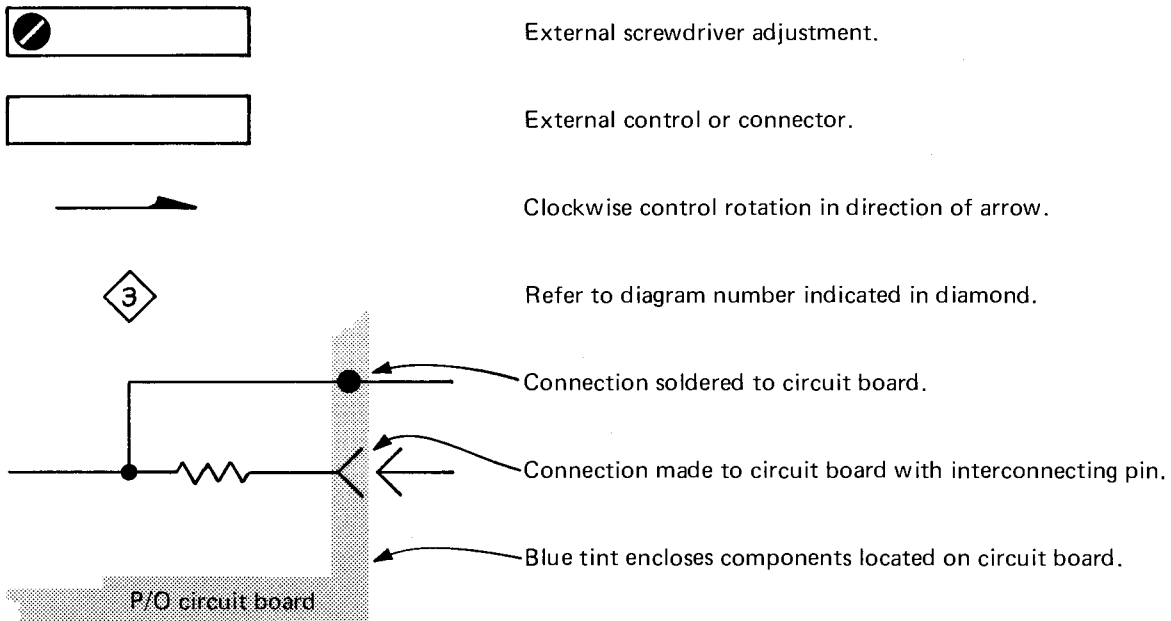
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF). Values less than one are in microfarads (μ F).
Resistors =	Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



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

A	Assembly, separable or repairable (circuit board, etc.)	LR	Inductor/resistor combination
AT	Attenuator, fixed or variable	M	Meter
B	Bulb (lamp)	Q	Transistor or silicon-controlled rectifier
BT	Battery	P	Connector, movable portion
C	Capacitor, Fixed or variable	R	Resistor, fixed or variable
D	Diode, signal or rectifier	RT	Thermistor
DL	Delay line	SW	Switch
F	Fuse	T	Transformer
FL	Filter	TP	Test point
H	Heat dissipating device (heat sink, heat radiator, etc.)	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
HR	Heater	V	Electron tube
J	Connector, stationary portion	VR	Voltage regulator
K	Relay	Y	Crystal
L	Inductor, fixed or variable		

IMPORTANT

Circuit voltages measured with an electronic voltmeter, having an input resistance of $100\text{ M}\Omega \pm 5\%$, and a meter accuracy of $\pm 2\%$. Voltages are measured with respect to chassis ground unless otherwise noted. If a $20,000\ \Omega/\text{volt}$ VOM is used, the effects of circuit loading at high impedance points must be taken into consideration.

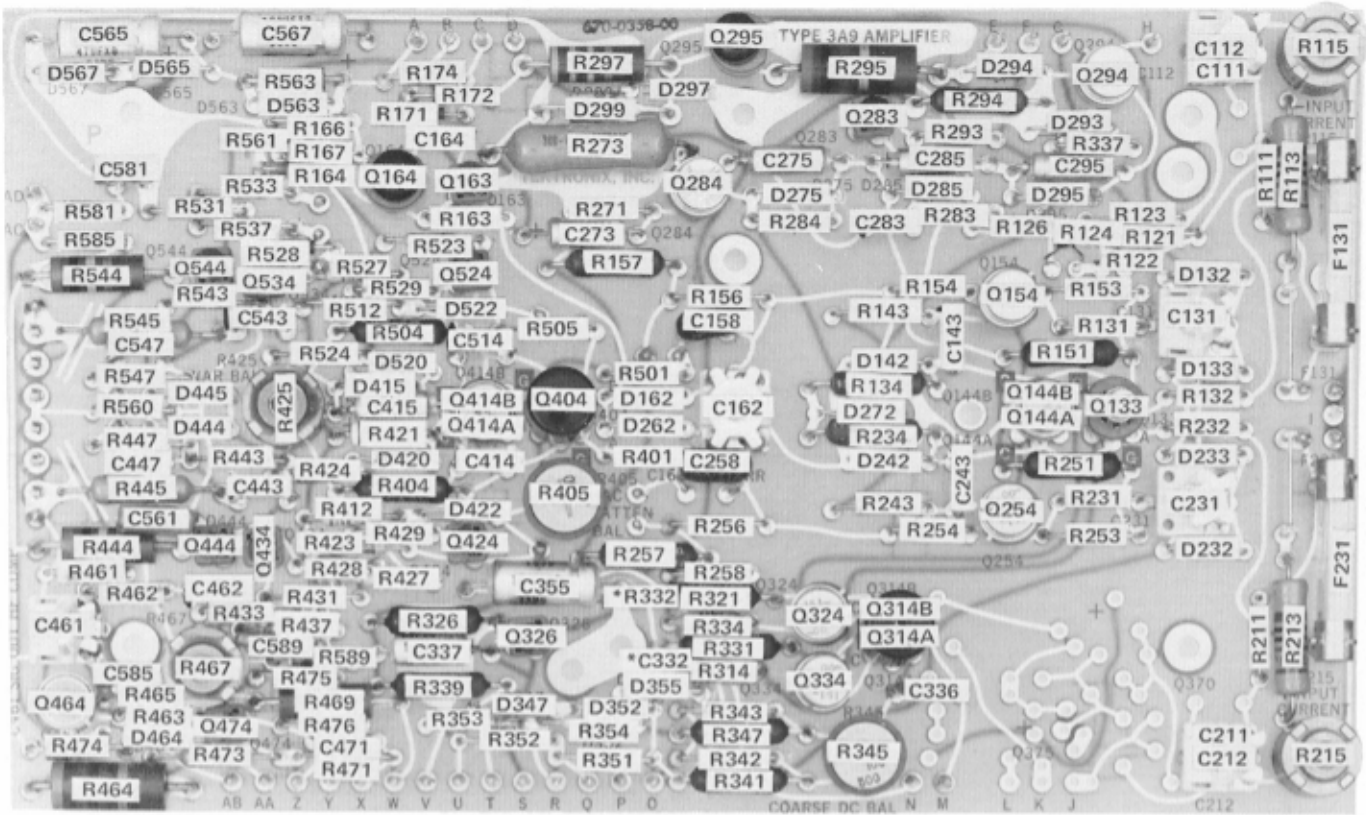
Voltages on the schematics (shown in blue) are not absolute and may vary between instruments because of component tolerances.

The Type 3A10 controls are set as follows:

POSITION	Midrange
VOLTS/DIV	10 mV
VARIABLE	CAL
-3 dB FREQUENCY UPPER	1 MHz
-3 dB FREQUENCY LOWER	DC
AC-GND-DC + INPUT	GND
AC-GND-DC - INPUT	GND
STEP ATTEN DC BAL	Midrange
DC OFFSET COARSE	Midrange
DC OFFSET FINE	Midrange

The time-base controls were set as follows:

Time/Div	.5 ms
Variable	Calib
Slope	+
Coupling	AC
Source	Int
Trigger Mode	Free Run

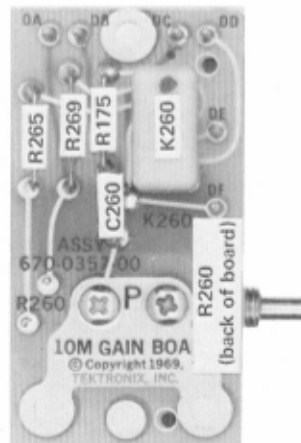


A-1 Amplifier Board

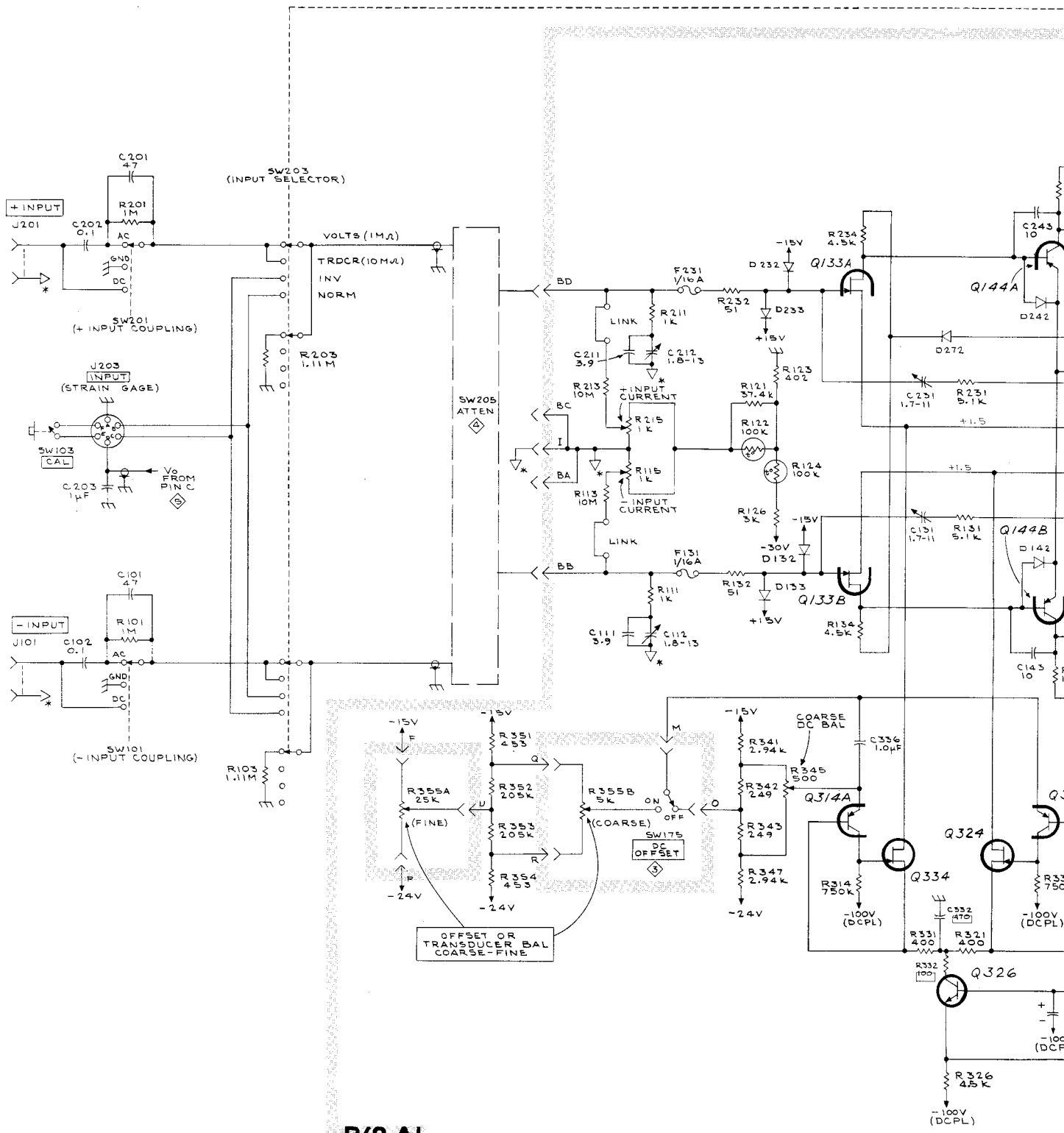
*Added SN B030000

NOTE

For color code of interconnecting wires, refer to the table to the left of Diagram 2, Output Amp.

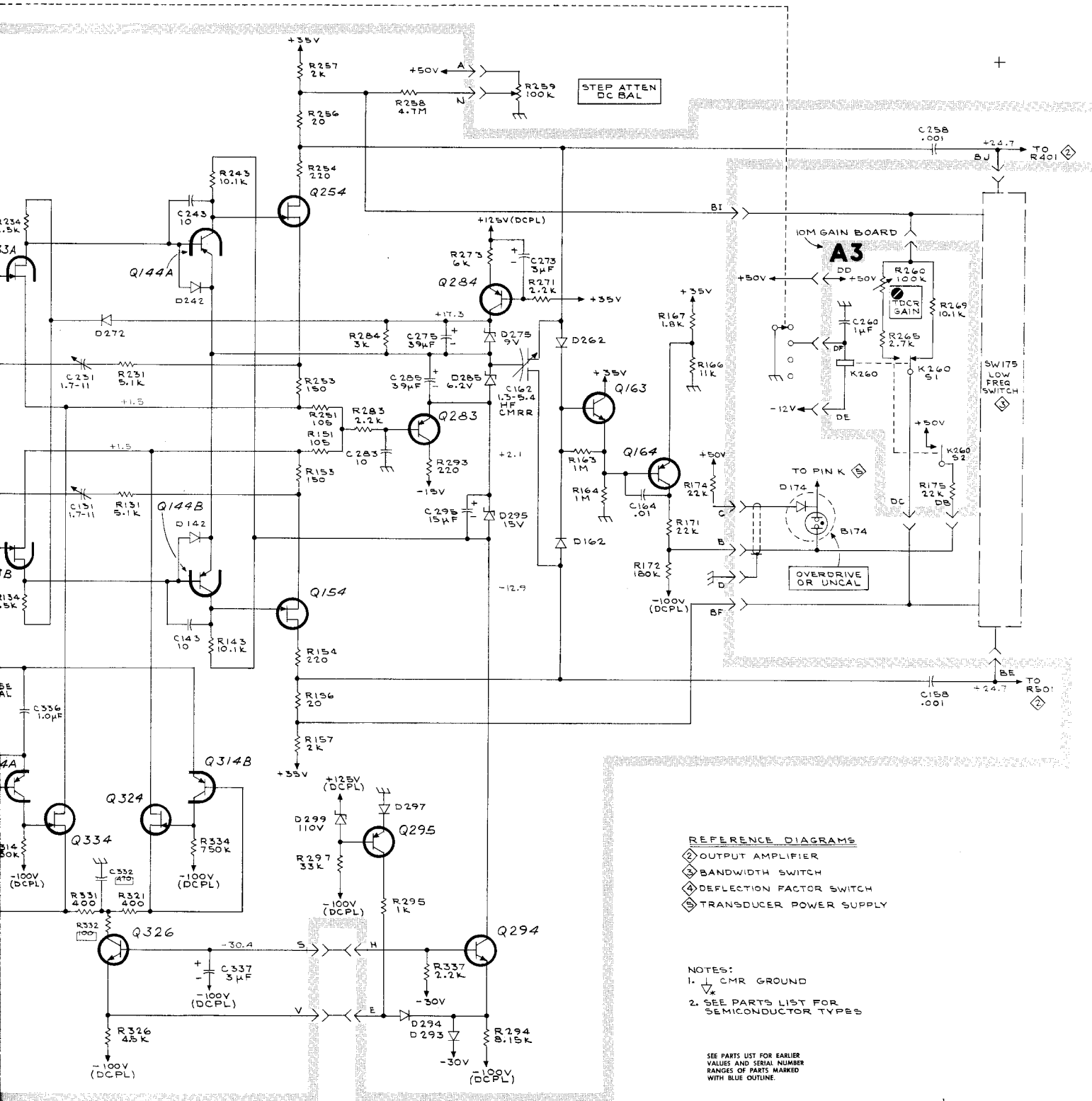


A-3 10 M Gain Board



P/O AI AMPLIFIER BOARD

TYPE 3A10



- REFERENCE DIAGRAMS**
- ② OUTPUT AMPLIFIER
 - ③ BANDWIDTH SWITCH
 - ④ DEFLECTION FACTOR SWITCH
 - ⑤ TRANSDUCER POWER SUPPLY

NOTES:

1. ∇ CMR GROUND
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

Color code for interconnecting wires of the Amplifier board and 10M Gain board
(board pictures are shown to the left of Diagram 1, Preamp).

AMPLIFIER BOARD

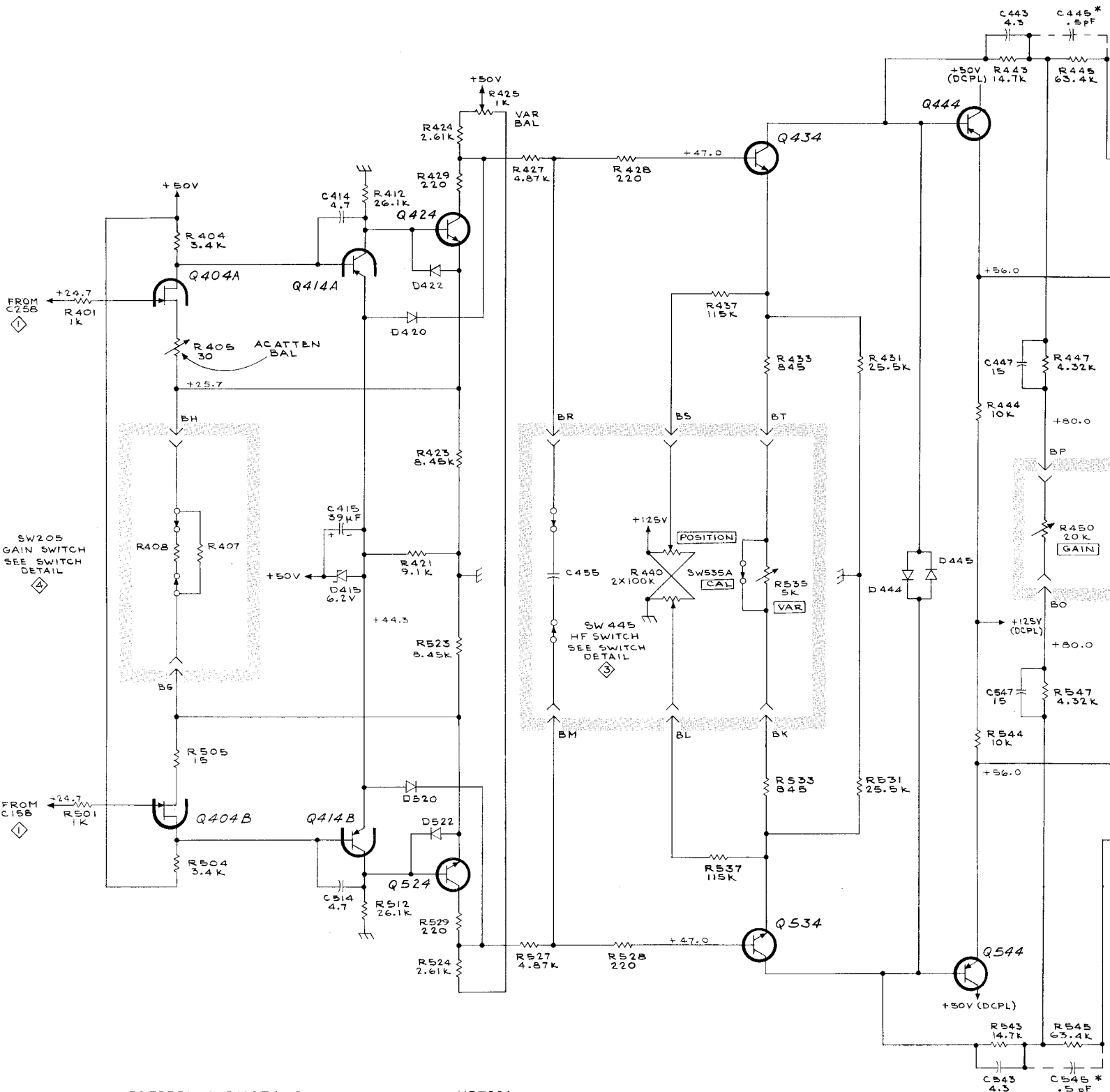
A	Black-green on white	P	Black-orange on white
B	Red	Q	Red on white
C	Black	R	Black-brown on white
D	Shield for B and C	S	Green on white
E	Blue on white	T	Black-yellow on white
F	Brown-black-green on tan	U	Brown on white
G	Black-yellow on white	V	Blue on white
H	Green on white	W	Brown-black-brown on tan
I	White	X	Shield for Y
J	} Not used	Y	Orange-orange on white (coax)
K		Z	Black-blue on white
L		AA	Shield for AB
M	Blue on white	AB	Gray on white (coax)
N	Yellow on white	AC	Black-brown-red on white
O	Violet on white	AD	Black-brown-red on white

(reverse side of Amplifier board)

BA	Shield for BB	BK	Orange-yellow on white
BB	Yellow-yellow on gray (coax)	BL	Orange-green on white
BC	Shield for BD	BM	Orange-blue on white
BD	Red-red on gray (coax)	BN	Red-violet on white
BE	Brown-yellow on white	BO	Red-green on white
BF	Brown-green on white	BP	Red-blue on white
BG	Brown-blue on white	BQ	Red-gray on white
BH	Brown-violet on white	BR	Orange-violet on white
BI	Brown-orange on white	BS	Black-red on white
BJ	Brown-red on white	BT	Orange-gray on white

10 MΩ GAIN BOARD

DA	Brown-orange on white	DD	Black-green on white
DB	Brown-red on white	DE	Violet on white (coax)
DC	Brown-green on white	DF	Brown-blue on white

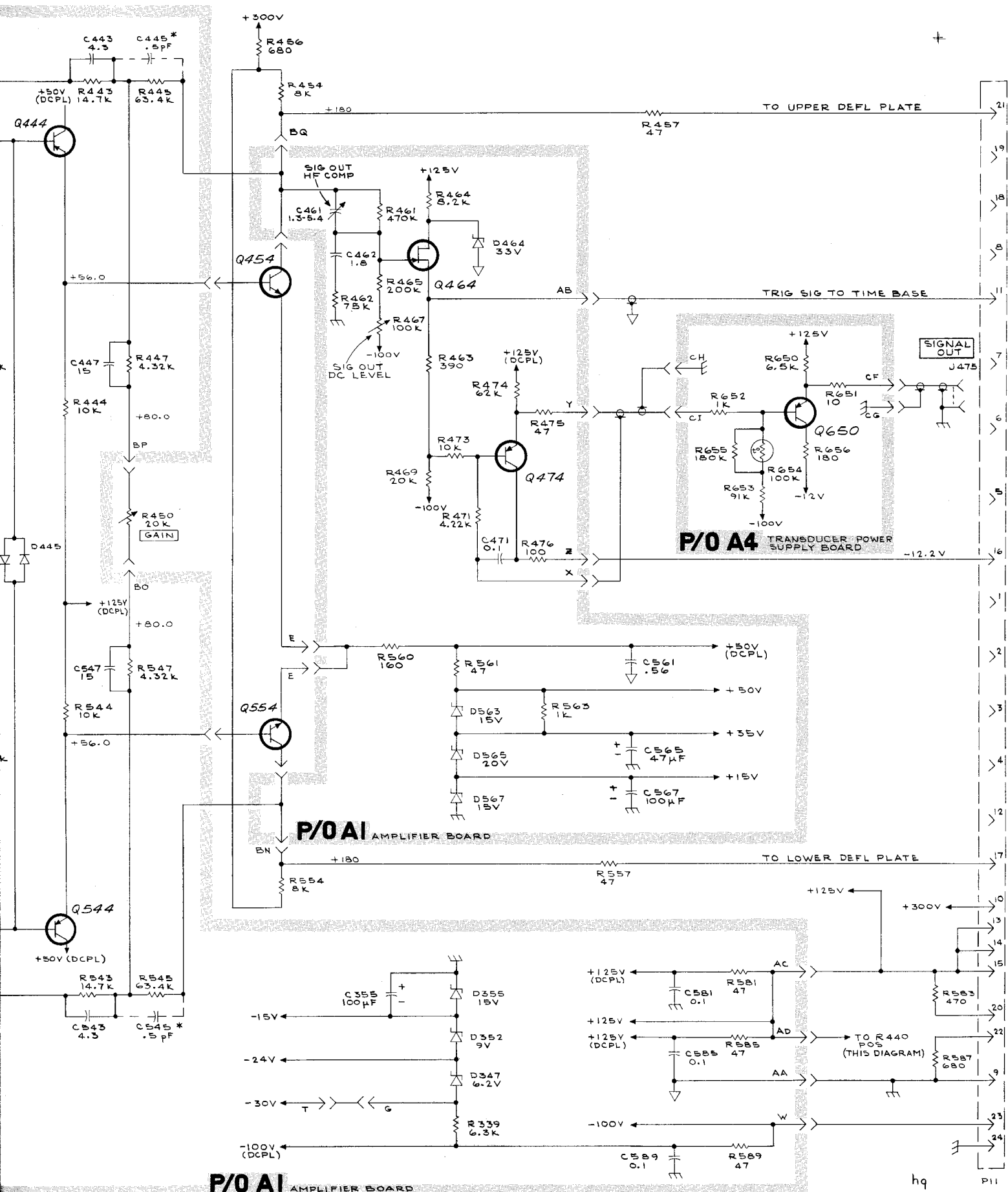


REFERENCE DIAGRAMS

- ① PREAMPLIFIER
- ② BANDWIDTH SWITCH
- ③ DEFLECTION FACTOR SWITCH

NOTES:

1. * NOT REPLACEABLE, PART OF CIRCUIT BOARD
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES



P/O AI AMPLIFIER BOARD

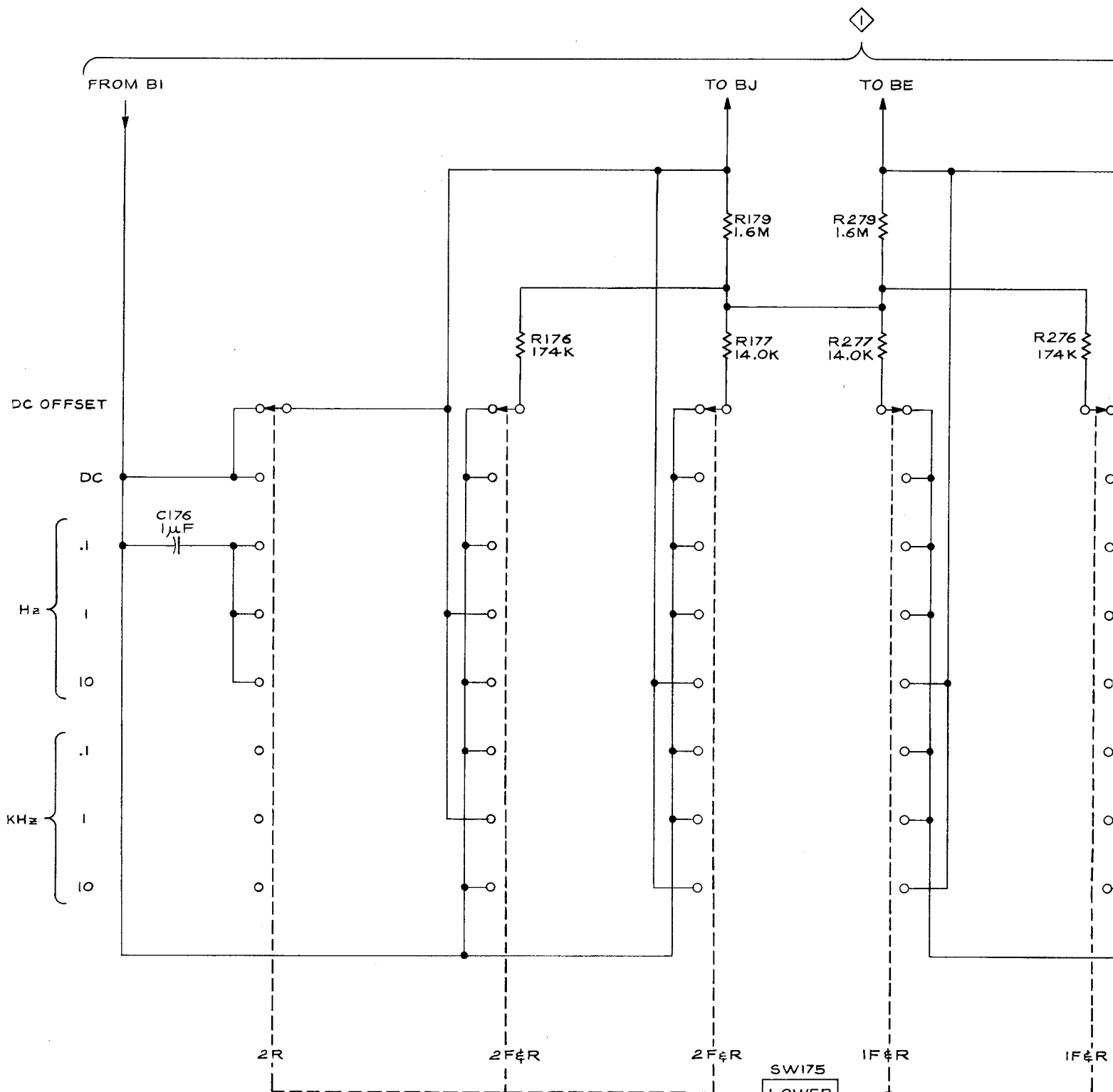
P/O A4 TRANSDUCER POWER SUPPLY BOARD

OUTPUT AMPLIFIER

hq
0970

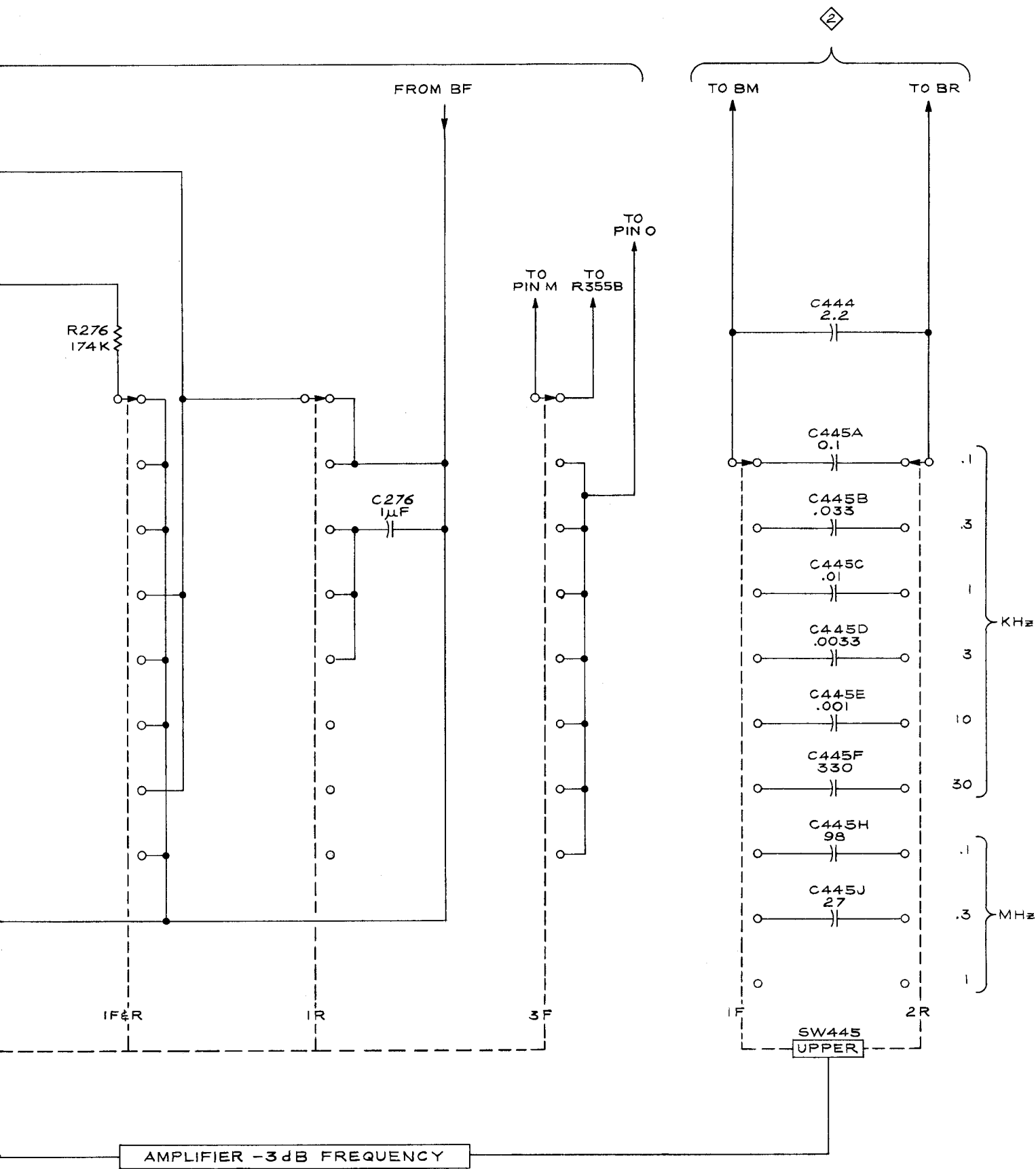
P11

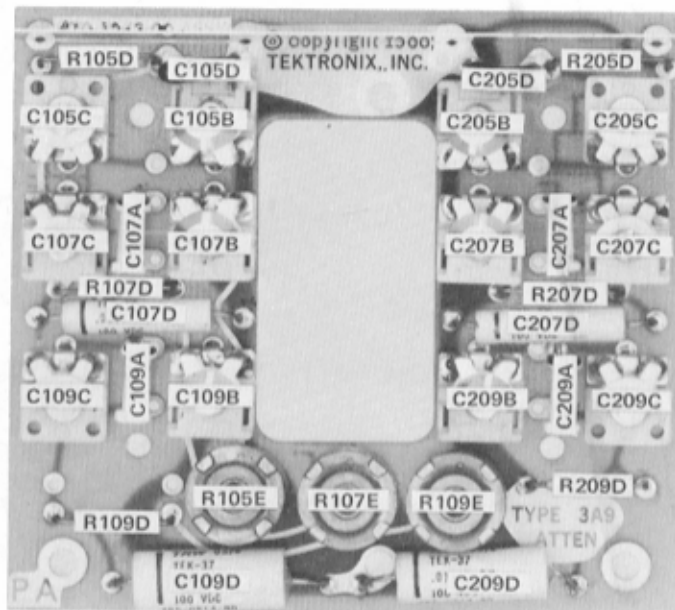
(A)



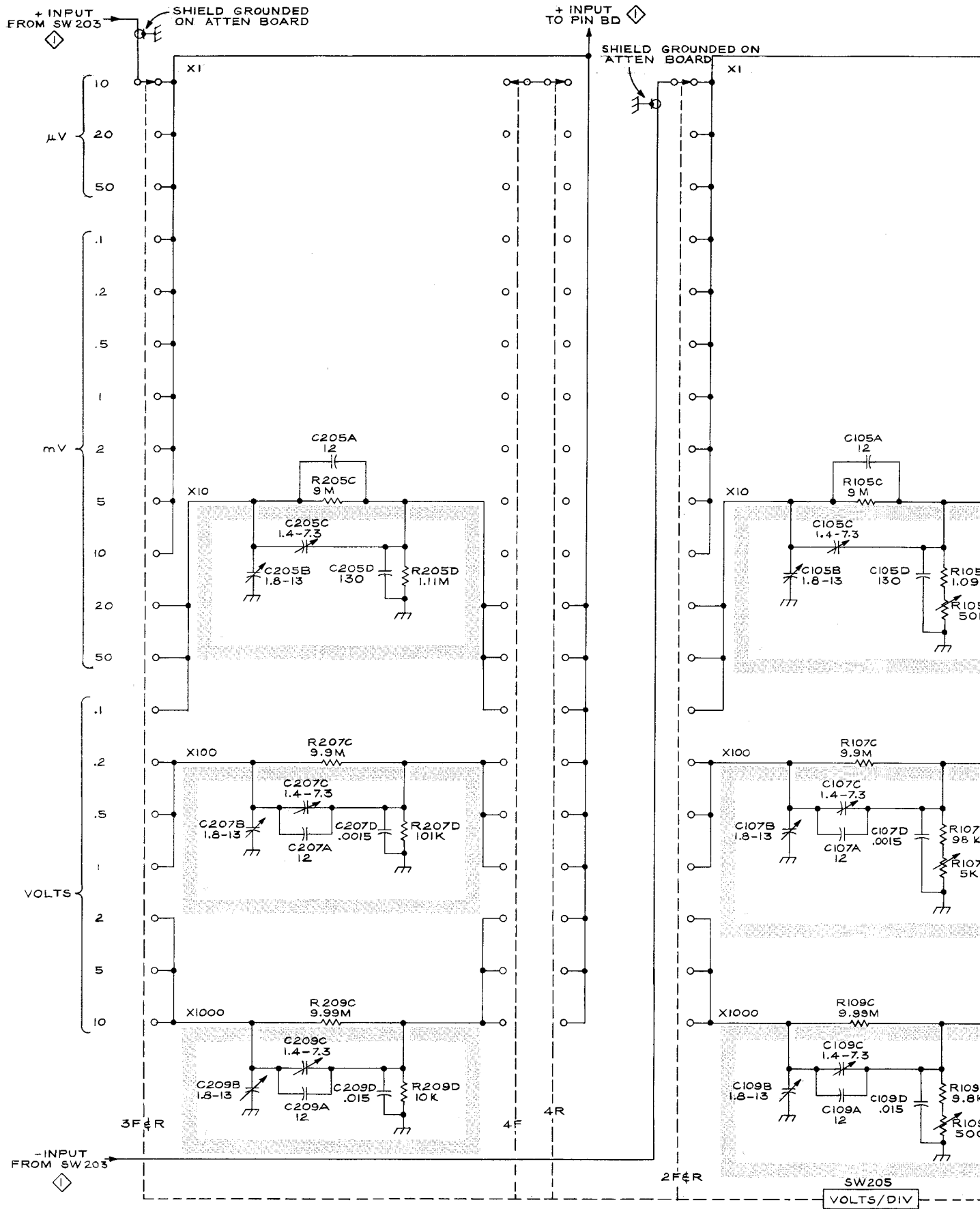
REFERENCE DIAGRAMS:

- ① PREAMPLIFIER
- ② OUTPUT AMPLIFIER



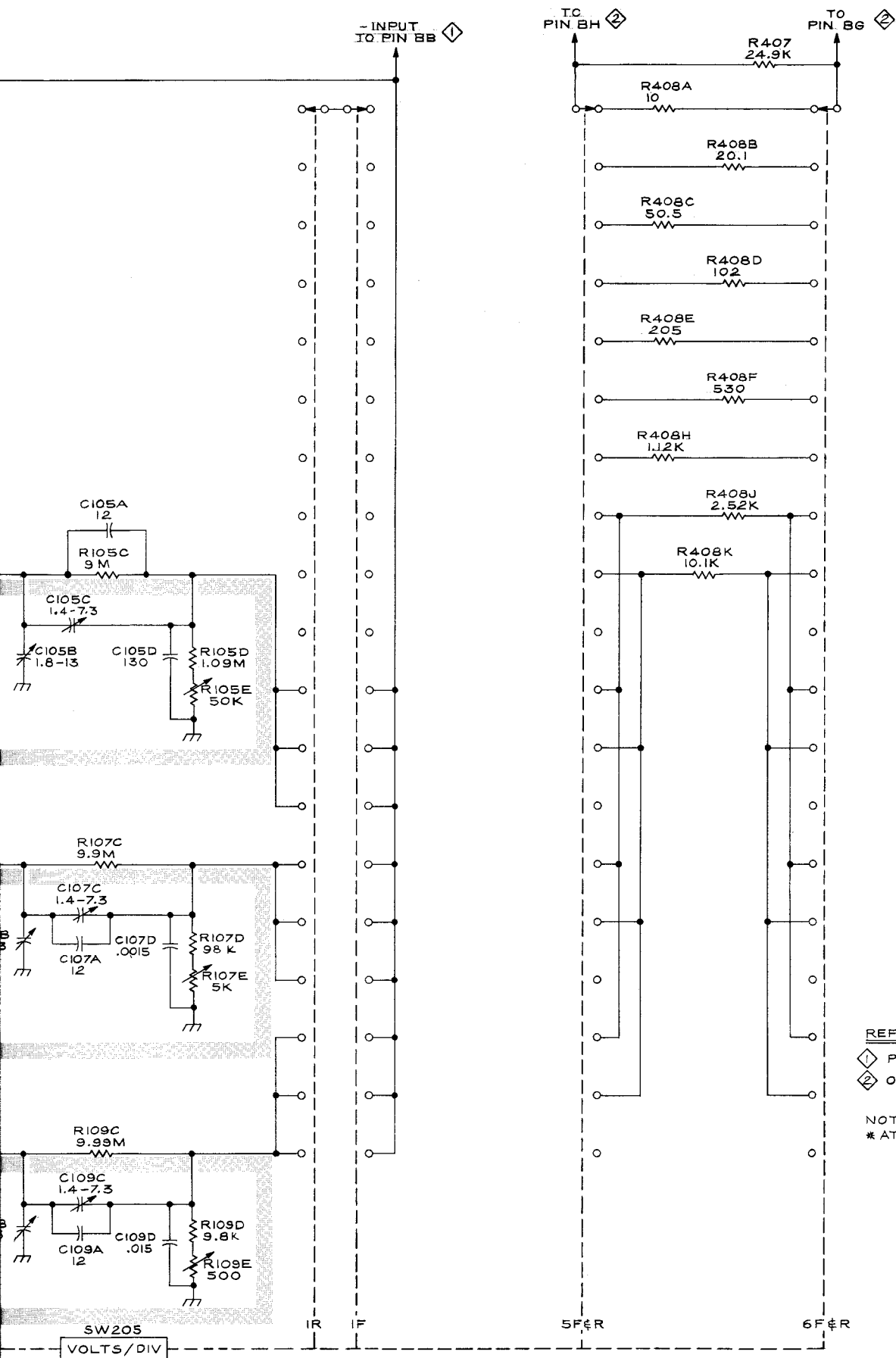


A-2 Attenuator board.



TYPE 3A10

(A)



REFERENCE DIAGRAMS

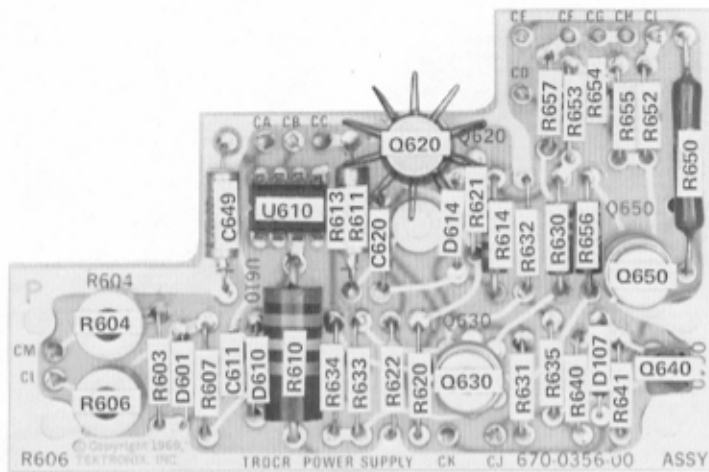
- 1 PREAMPLIFIER
- 2 OUTPUT AMPLIFIER

NOTE:
* ATTEN BOARD A-2

(A)

DEFLECTION FACTOR (VOLTS/DIV) SWITCH 4

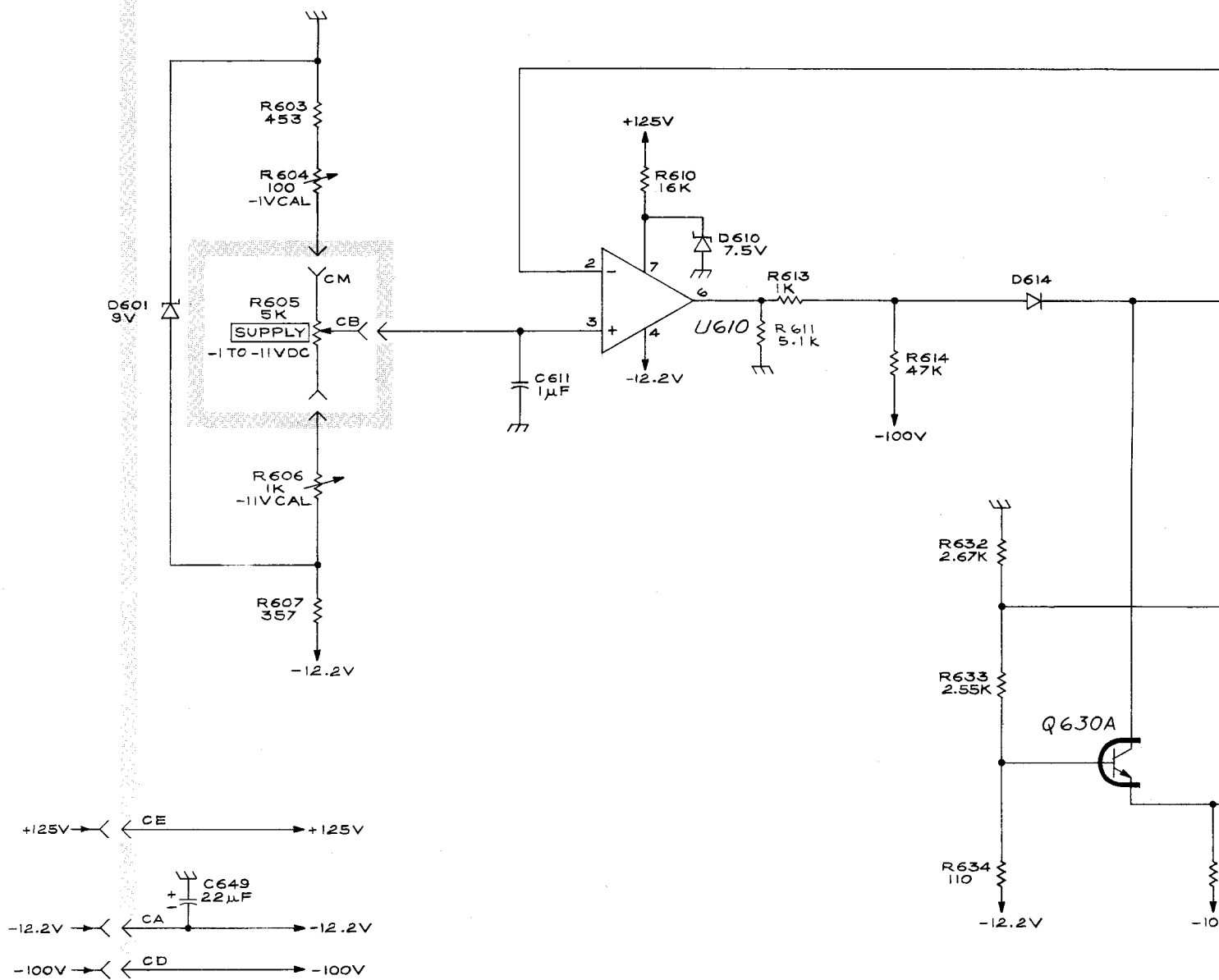
BC
0970



A-4 Transducer Power Supply board.

Color code of interconnecting wires:

- CA Black-blue on white
- CB Brown-green on white
- CC Blue on white (coax)
- CD Brown-black-brown on tan
- CE Brown-red-black on white
- CF Red on white (coax)
- CG Shield for CF
- CH Shield for CI
- CI Orange on white (coax)
- CJ Red-green on white
- CK Brown on white
- CL Brown-blue on white
- CM Brown-yellow on white



A4 TRDCR POWER SUPPLY BOARD

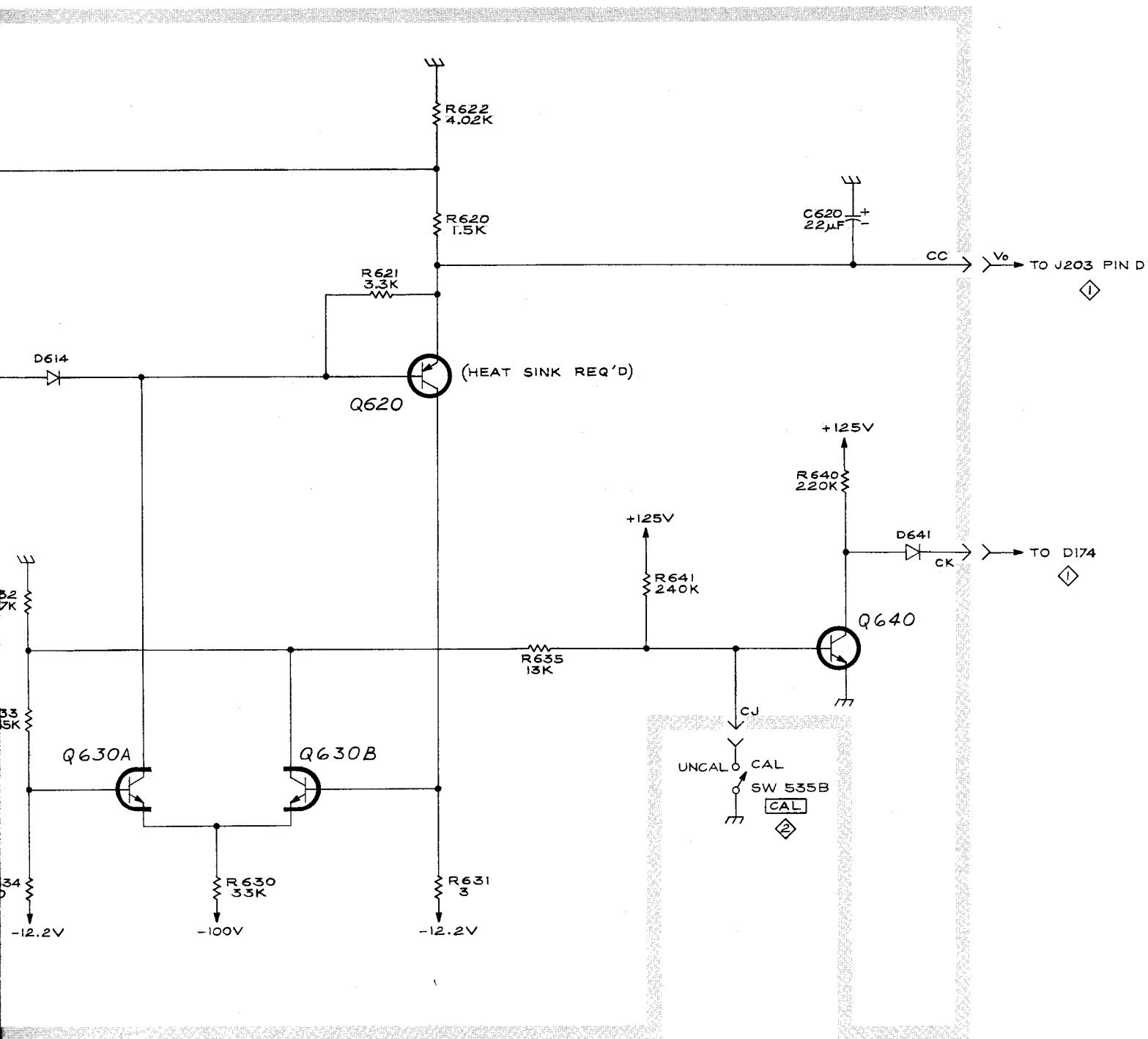
REFERENCE DIAGRAMS:

- ① PREAMPLIFIER
- ② OUTPUT AMPLIFIER

TYPE 3A10

Ⓐ₂

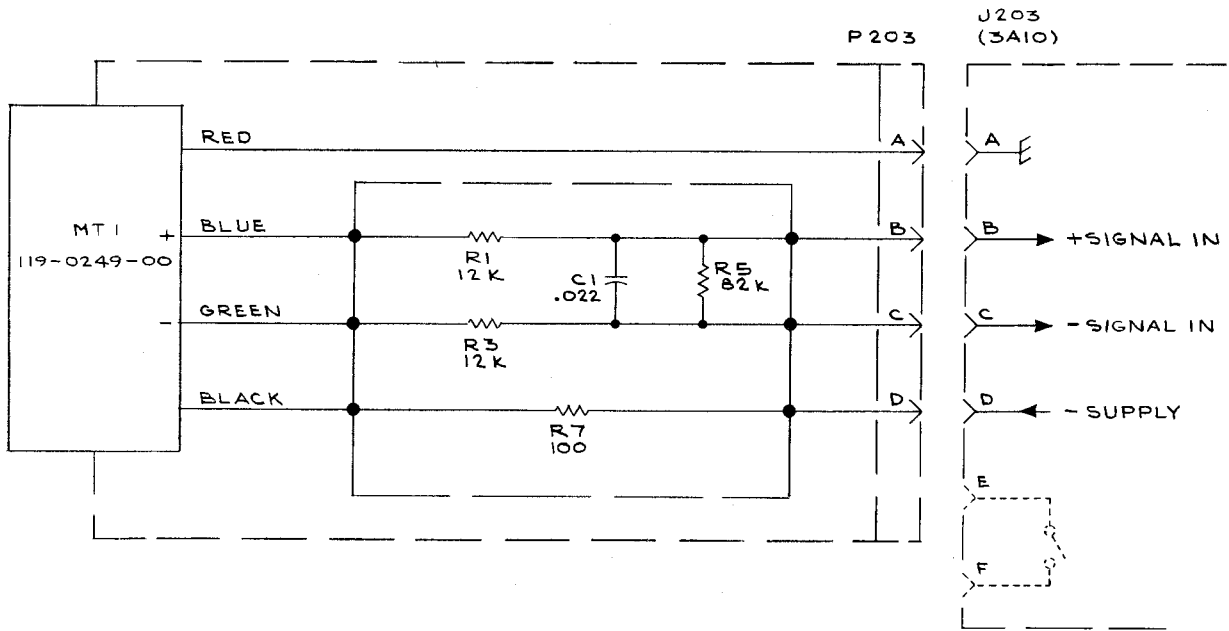
+



⊙₂

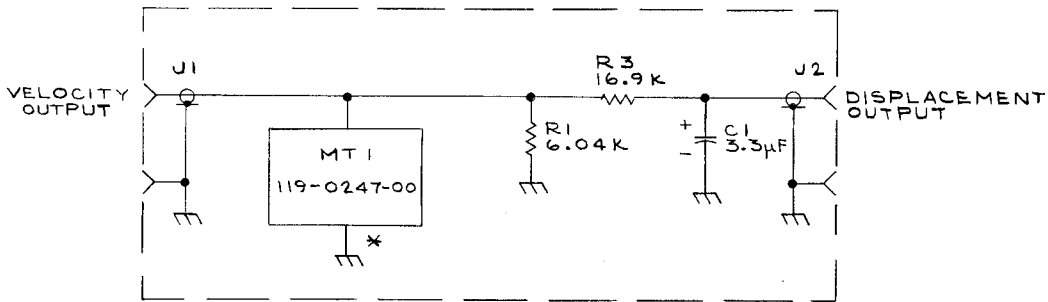
TRANSDUCER POWER SUPPLY

hq
0970
⑤



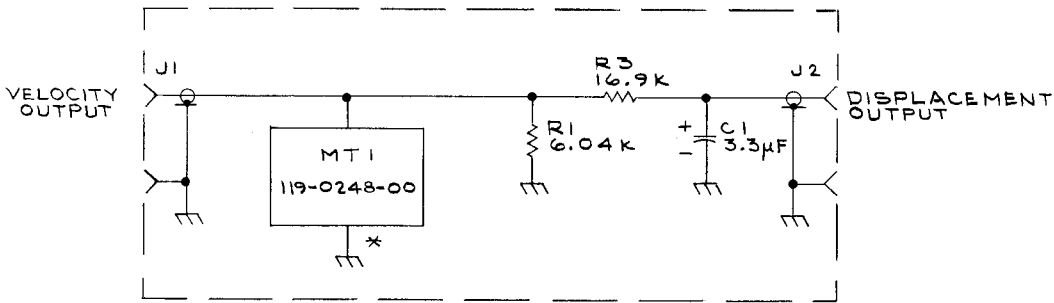
DISPLACEMENT TRANSDUCER
015-0168-00

* MARKED (RED) TERMINAL

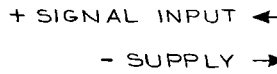
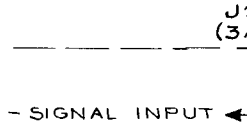


VERTICAL VIBRATION TRANSDUCER
015-0166-00

* MARKED (RED) TERMINAL

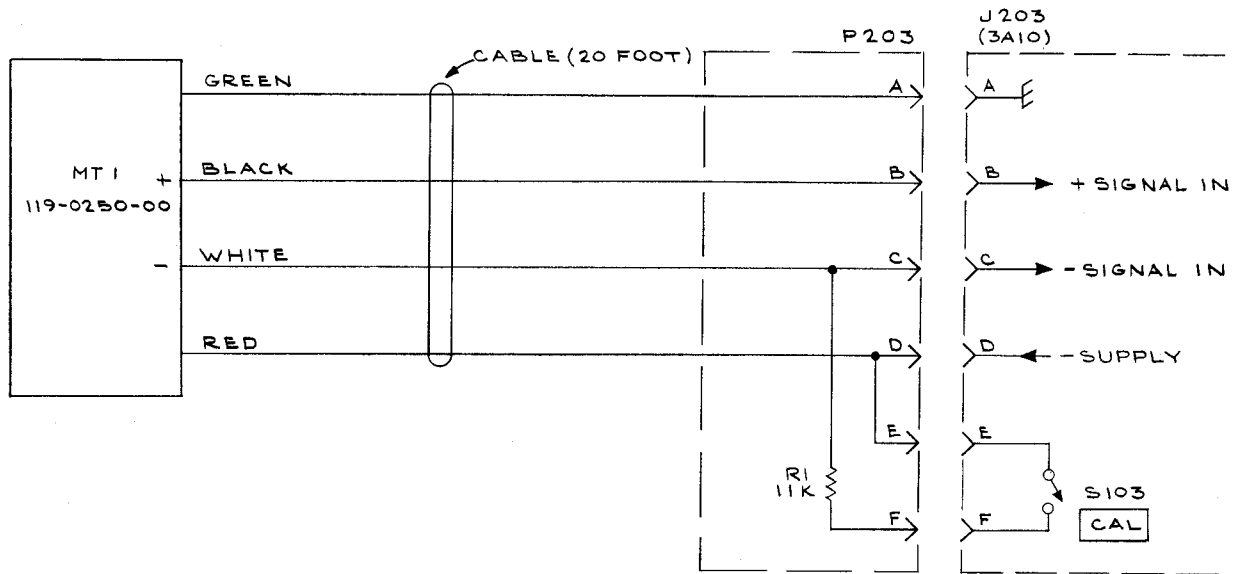


HORIZONTAL VIBRATION TRANSDUCER
015-0167-00

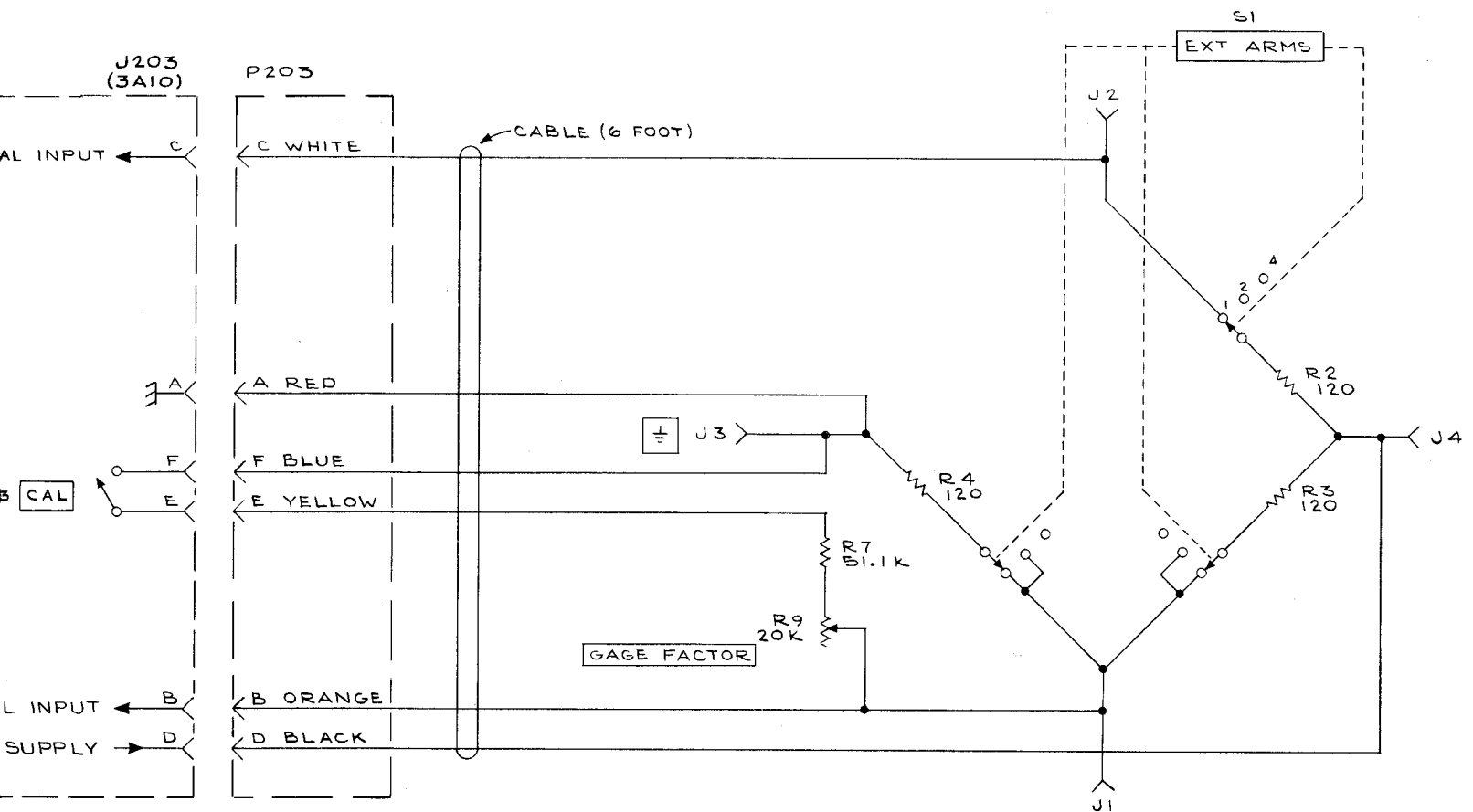


NOTE:
OPTIONAL ACCESSORIES; PARTS ARE NOT LISTED IN ELECTRICAL PARTS LIST. SEE MECHANICAL PARTS LIST FOR ORDERING INFORMATION.

TYPE 3A10 OPTIONAL ACCESSORIES



FORCE TRANSDUCER
015-0164-00



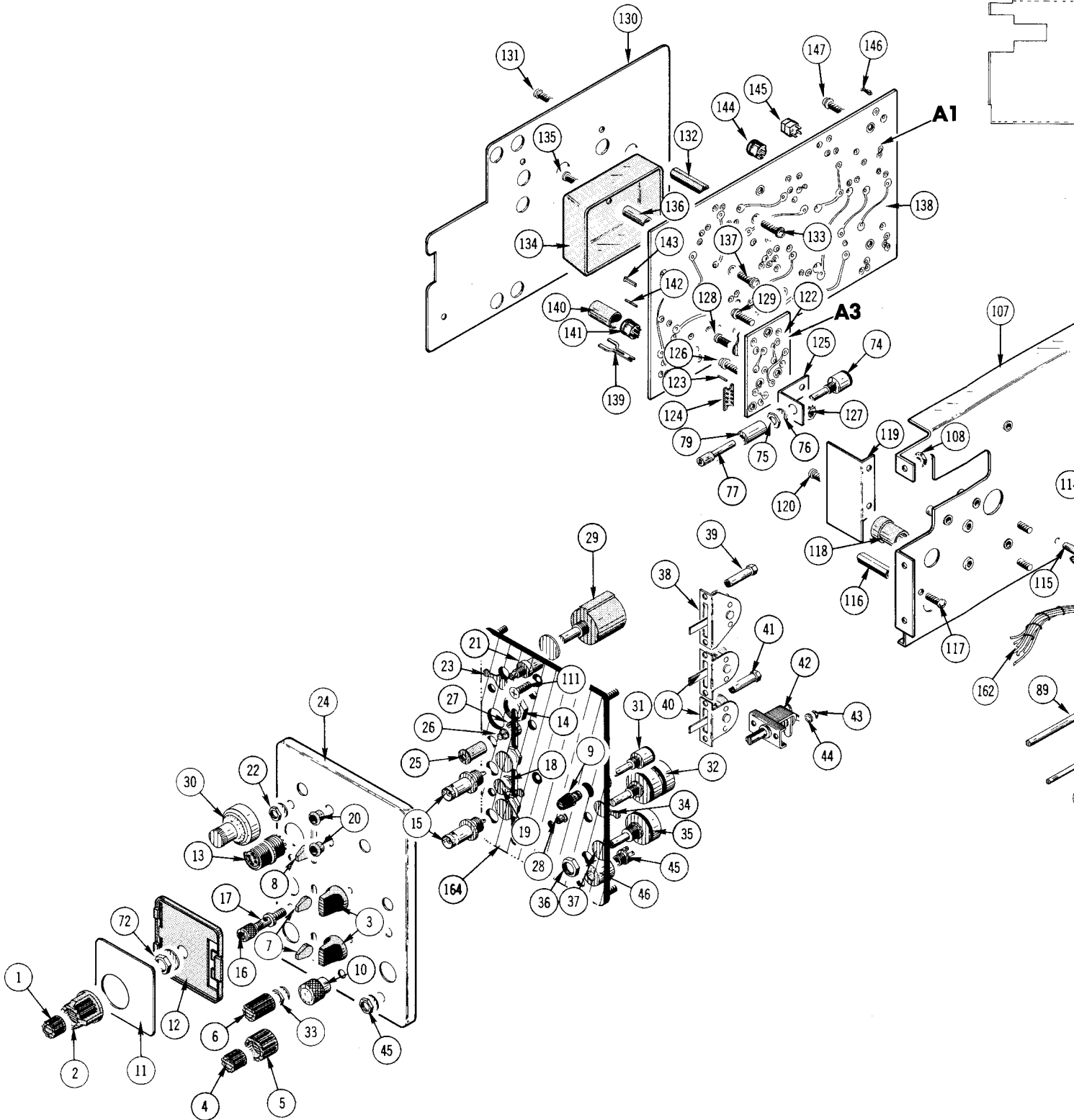
STRAIN GAGE ADAPTER
015-0169-00

STRAIN GAGE ADAPTER
& TRANSDUCERS

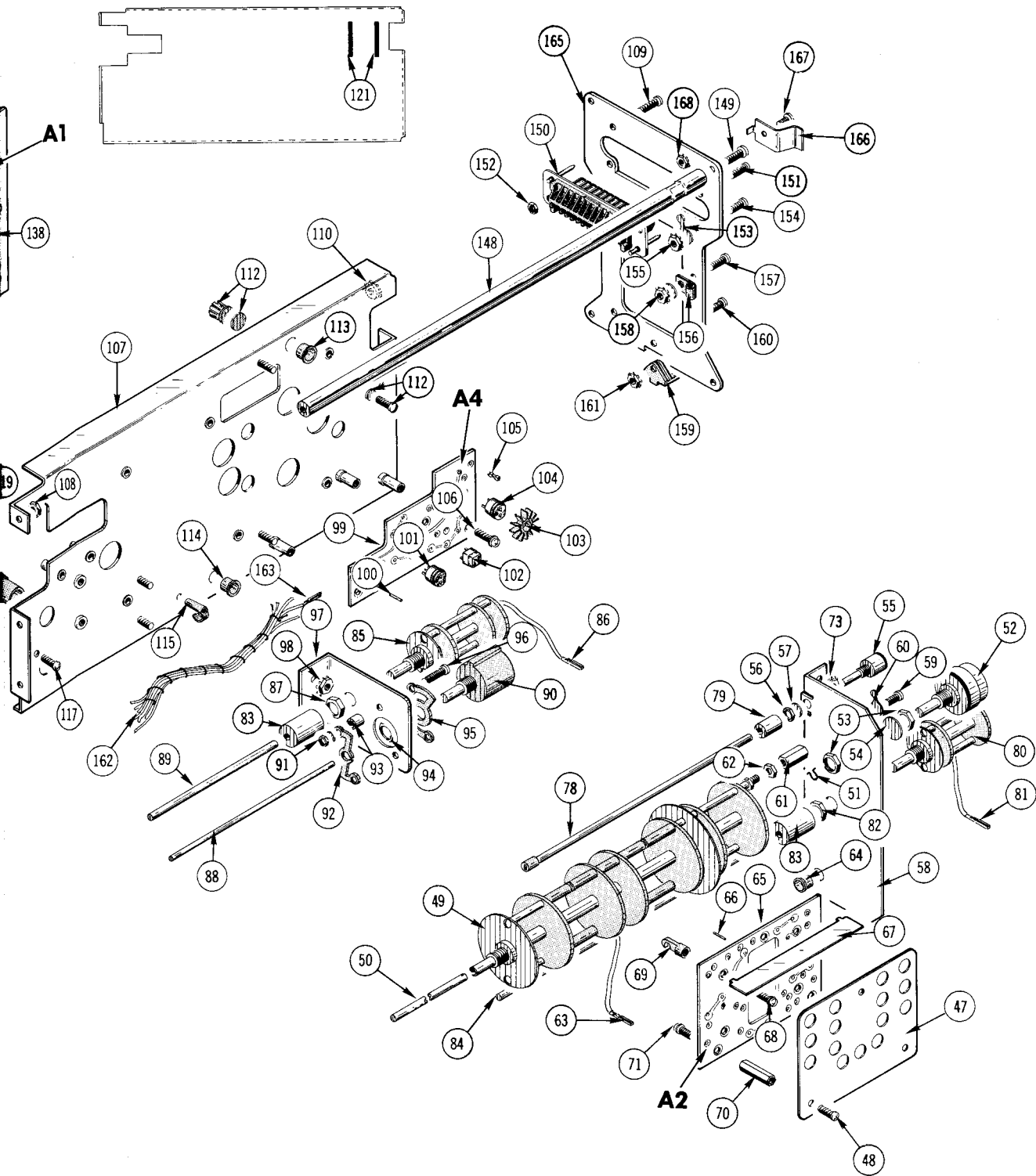
hq
0970

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3A10 TRANSDUCER AMPLIFIER



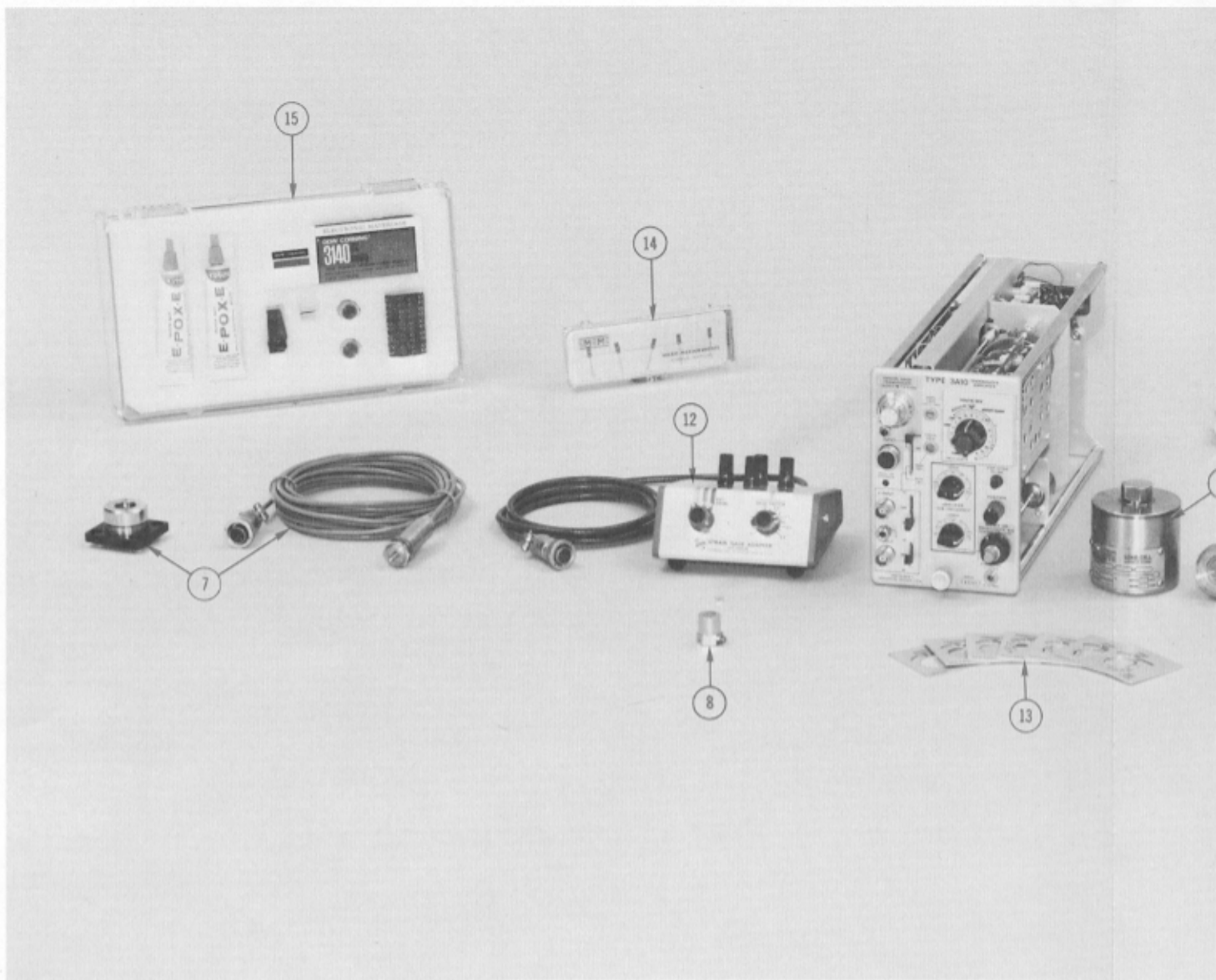
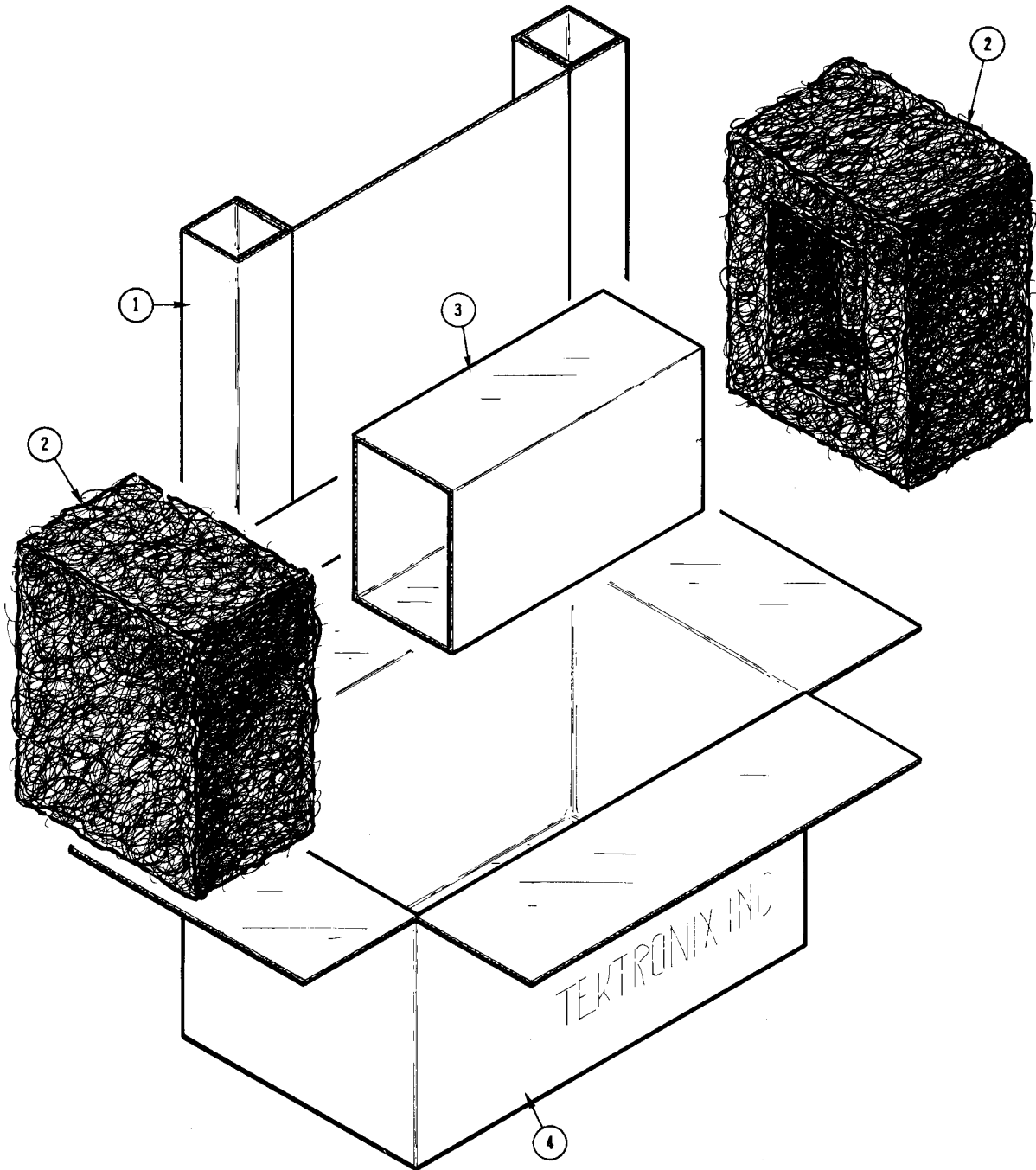


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Model No. Disc	Q						Description	Fig. & Index No.	Tektronix Part No.
					t	y	1	2	3			
2-1	012-0136-00			1						CABLE ASSEMBLY, BNC each end (20 feet)	2-10	015-0
-2	012-0209-00			1						CABLE ASSEMBLY, interconnecting (240 inches)	-11	015-0
	012-0210-00			1						CABLE ASSEMBLY, interconnecting (78 inches) (not shown)	-12	015-0
-3	012-0211-00			1						CABLE ASSEMBLY, RF (20 feet)	-13	015-0
-4	015-0161-00			1						TRANSDUCER PACKAGE (pressure 3000 psig)	-14	015-0
-5	015-0162-00			1						TRANSDUCER PACKAGE (pressure 300 psig)	-15	015-0
-6	015-0163-00			1						TRANSDUCER PACKAGE (force 3000 lbs f)	-16	015-0
-7	015-0164-00			1						TRANSDUCER PACKAGE (force 50 lbs f)		131-0
-8	015-0165-00			1						TRANSDUCER PACKAGE (acceleration)		131-0
-9	015-0166-00			1						TRANSDUCER PACKAGE (vertical vibration)		

3A10 TRANSDUCER AMPLIFIER

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CARTON ASSEMBLY
(Part No. 065-0107-00)



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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q † y	Q					Description
					1	2	3	4	5	
3-	065-0107-00			1						CARTON ASSEMBLY, for 3A10
-1	004-1028-00			-						carton assembly includes:
-2	004-0226-00			1						PAD SET, 1-piece
-3	004-0540-00			2						END CAP, molded hair
-4	004-0640-00			1						PAD SET, sleeve, 1-piece
				1						CARTON

3A10 TRANSDUCER AMPLIFIER

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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 indicated 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 AND REPACKAGING PARTS ILLUSTRATIONS

Title	Location (reverse side of)
Figure 1 Exploded	Deflection Factor (VOLTS/DIV) Switch Diagram
Figure 2 Optional Accessories	Transducer Power Supply Diagram
Figure 3 Repackaging	Strain Gage Adapter & Transducers Diagram

SECTION 8

MECHANICAL PARTS LIST

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-1	366-0140-00			1						KNOB, red—VARIABLE CAL
	213-0004-00			-						knob includes:
	213-0004-00			1						SETSCREW, 6-32 x 0.188 inch, HSS
-2	366-0322-00			1						KNOB, charcoal—VOLTS DIVISION
	213-0004-00			-						knob includes:
	213-0004-00			1						SETSCREW, 6-32 x 0.188 inch, HSS
-3	366-0427-00			2						KNOB, charcoal—AMPLIFIER, upper and lower
	213-0153-00			-						each knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.125 inch, HSS
-4	366-0270-00			1						KNOB, charcoal—OFFSET OR TRDCR BAL, coarse
	213-0004-00			-						knob includes:
	213-0004-00			1						SETSCREW, 6-32 x 0.188 inch, HSS
-5	366-1251-00			1						KNOB, charcoal—OFFSET OR TRDCR BAL, fine
	213-0153-00			-						knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.188 inch, HSS
-6	366-0153-00			1						KNOB, charcoal—POSITION
	213-0075-00			-						knob includes:
	213-0075-00			1						SETSCREW, 4-40 x 0.094 inch, HSS
-7	366-0215-01			2						KNOB, charcoal, lever switch—AC GND DC
-8	366-0215-01			1						KNOB, charcoal, lever switch—NORM INV TRDCR VOLTS
-9	366-0283-00			1						KNOB, charcoal—STEP ATTEN DC BAL
-10	366-0109-00			1						KNOB, plug-in securing
-11	331-0269-12			1						SCALE, attenuator switch—VOLTS/DIVISION
-12	352-0251-00			1						HOLDER, scale, plastic
-13	131-0609-01			1						CONNECTOR, receptacle, contact, female
	220-0504-00			-						mounting hardware: (not included w/connector)
	220-0504-00			1						NUT, hex., 0.562-24 x 0.688 inch
-15	131-0955-00			2						CONNECTOR, receptacle, female, w/hardware
	229-0053-00			1						BINDING POST ASSEMBLY
	200-0103-00			-						binding post assembly includes:
-16	200-0103-00			1						CAP, binding post
-17	355-0507-00			1						STEM, binding post
	210-0455-00			-						mounting hardware: (not included w/binding post assembly)
-18	210-0455-00			1						NUT, hex., 0.25-28 x 0.375 inch
-19	210-0223-00			1						LUG, solder, 0.25 ID x 0.437 inch OD, SE
-20	358-0216-00			2						BUSHING, plastic
-21	260-0257-00			1						SWITCH, push button—CAL
	210-0583-00			-						mounting hardware: (not included w/switch)
-22	210-0583-00			1						NUT, hex., 0.25-32 x 0.312 inch
	210-0940-00			1						WASHER, flat, 0.25 ID x 0.375 inch OD
-23	210-0223-00			1						LUG, solder, 0.25 x 0.437 inch OD, SE

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				y	1	2	3	4		5
1-24	333-1335-00			1						PANEL, front
-25	352-0084-00			1						HOLDER, neon
-26	378-0541-00			1						FILTER, lens
-27	200-0609-0			1						CAP, holder
-28	348-0031-00			2						GROMMET, plastic, 0.094 inch diameter
-29	- - - - -			1						RESISTOR, variable, w/hardware
	- - - - -			-						mounting hardware: (not included w/resistor)
-30	331-0271-00			1						DIAL, control, 10-turn
-31	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
	213-0020-00			1						SETSCREW, 6-32 x 0.125 inch, HSS
-32	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
-33	210-0583-00			1						NUT, hex., 8-32 x 0.344 inch
	210-0940-00			1						WASHER, flat, 0.25 ID x 0.375 inch OD
-34	210-0223-01			1						LUG, solder, 0.25 ID x 0.437 inch OD, SE, bent
-35	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
-36	210-0590-00			1						NUT, hex., 0.375-32 x 0.438 inch
-37	210-0012-00			1						WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-38	260-1167-00			1						SWITCH, lever—NORM INV TRDCR VOLTS
	- - - - -			-						mounting hardware: (not included w/switch)
-39	220-0413-00			2						NUT, switch mounting, 4-40 x 0.562 inch long
-40	260-1168-00			2						SWITCH, lever, —AC GND DC
	- - - - -			-						mounting hardware for each: (not included w/switch)
-41	220-0413-00			2						NUT, switch mounting, 4-40 x 0.562 inch long
-42	214-0052-00			1						FASTENER
	- - - - -			-						mounting hardware: (not included w/fastener)
-43	210-0406-00			2						NUT, hex., 4-40 x 0.188 inch
-44	210-0004-00			2						WASHER, lock, internal, #4
-45	136-0094-00			1						SOCKET, w/hardware
-46	337-1331-01			1						SHIELD, electrical, output
-47	337-1114-00			1						SHIELD, circuit board
	- - - - -			-						mounting hardware: (not included w/shield)
-48	211-0008-00			3						SCREW, 4-40 x 0.25 inch, PHS

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-49	262-0906-00			1						SWITCH, rotary—VOLTS/DIV, wired
	- - - - -			-						switch includes:
	260-1044-00			1						SWITCH, rotary, unwired
-50	384-0442-00			1						EXTENSION SHAFT, 8.452 inches long
-51	376-0014-00			1						COUPLING, variable resistor
-52	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: <i>(not included w/resistor)</i>
-53	210-0413-00			2						NUT, hex., 0.375-32 x 0.50 inch
-54	210-0012-00			1						WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-55	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: <i>(not included w/resistor)</i>
-56	210-0583-00			1						NUT, hex., 0.25-32 x 0.312 inch
-57	210-0940-00			1						WASHER, flat, 0.25 ID x 0.37 5inch OD
-58	407-0548-00			1						BRACKET, rotor switch
	- - - - -			-						mounting hardware: <i>(not included w/bracket)</i>
-59	213-0203-00			2						SCREW, 5-40 x 0.25 inch, PHS
-60	210-0202-00			1						LUG, solder, SE #6
-61	129-0185-00			2						POST, hex., 0.50 inch long
-62	210-0449-00			2						NUT, hex., 5-40 x 0.25 inch
-63	131-0371-00			7						CONNECTOR, terminal
	131-0677-00			4						CONNECTOR, terminal
-64	348-0067-00			1						GROMMET, plastic, 0.312 inch diameter
-65	670-1243-00			1						CIRCUIT BOARD ASSEMBLY—ATTENUATOR A2
	- - - - -			-						circuit board assembly includes:
	388-1178-01			1						CIRCUIT BOARD
-66	131-0633-00			2						TERMINAL, pin, 0.385 inch long
-67	337-1197-00			1						SHIELD, electrical
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-68	211-0116-00			4						SCREW, sems, 4-40 x 0.312 inch, PHB
-69	352-0071-00			4						HOLDER, circuit board, plastic
-70	129-0198-00			3						POST, hex., 0.74 inch long
	- - - - -			-						mounting hardware for each: <i>(not included w/post)</i>
-71	211-0116-00			1						SCREW, sems, 4-40 x 0.312 inch, PHB
	- - - - -			-						mounting hardware: <i>(not included w/switch)</i>
-72	210-0413-00			1						NUT, hex., 0.375-32 x 0.50 inch
	210-0012-00			1						WASHER, lock internal, 0.375 ID x 0.50 inch OD
-73	210-0457-00			3						NUT, keps, 6-32 x 0.312 inch
-74	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: <i>(not included w/resistor)</i>
-75	210-0583-00			1						NUT, hex., 0.25-32 x 0.312 inch
-76	210-0940-00			1						WASHER, flat, 0.25 ID x 0.375 inch OD

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q	Description
				† y	
1-77	384-1018-00			1	SHAFT, extension, 1.125 inch long, w/plastic end
-78	384-0454-01			1	SHAFT, extension, 7.125 inches long, w/plastic end
-79	376-0029-00			2	COUPLING, shaft, 0.50 inch long
	- - - - -			-	each coupling includes:
	213-0075-00			2	SETSCREW, 4-40 x 0.094 inch, HSS
-80	262-0907-00			1	SWITCH, rotary—AMPLIFIER, wired, upper
	- - - - -			-	switch includes:
	260-1047-00			1	SWITCH, rotary, unwired
-81	131-0371-00			1	CONNECTOR, terminal
	- - - - -			-	mounting hardware: (not included w/switch)
-82	210-0413-00			1	NUT, hex., 0.375 x 0.50 inch
-83	376-0008-00			2	COUPLING, shaft, 0.875 inch long
	- - - - -			-	each coupling includes:
	213-0005-00			2	SETSCREW, 8-32 x 0.125 inch, HSS
-84	384-0695-00			1	SHAFT, extension, 7.73 inches long
-85	262-0908-00			1	SWITCH, rotary—AMPLIFIER, wired, lower
	- - - - -			-	switch includes:
	260-1045-00			1	SWITCH, rotary, unwired
-86	131-0371-00			6	CONNECTOR, terminal
	- - - - -			-	mounting hardware: (not included w/switch)
-87	210-0413-00			1	NUT, hex., 0.375-32 x 0.50 inch
-88	384-0143-00			1	ROD, extension, 5.281 inches long
-89	384-0268-00			1	SHAFT, extension, 4.907 inches long
-90	- - - - -			1	RESISTOR, variable
	- - - - -			-	resistor includes:
	213-0075-00			1	SETSCREW, 4-40 x 0.094 inch, HSS
	- - - - -			-	mounting hardware: (not included w/resistor)
-91	210-0406-00			2	NUT, hex., 4-40 x 0.188 inch
	210-0054-00			2	WASHER, lock, split, #4
-92	354-0325-00			1	RING, brake friction
-93	166-0024-00			2	TUBE, spacer, 0.125 ID x 0.188 inch long
-94	210-0413-00			1	NUT, hex., 0.375-32 x 0.50 inch
-95	426-0289-00			1	MOUNT, plastic
-96	211-0014-00			2	SCREW, 4-40 x 0.50 inch, PHS
-97	407-0790-00			1	BRACKET, angle
	- - - - -			-	mounting hardware: (not included w/bracket)
-98	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q † y	Description				
					1	2	3	4	5
1-99	670-0356-00			1	CIRCUIT BOARD ASSEMBLY—TRDCR POWER SUPPLY A4				
	- - - - -			-	circuit board assembly includes:				
	388-1654-00			1	CIRCUIT BOARD				
-100	131-0633-00			13	TERMINAL, pin, 0.385 inch long				
-101	136-0235-00			1	SOCKET, transistor, 6 pin				
-102	136-0220-00			1	SOCKET, transistor, 3 pin, square				
-103	214-1292-00			1	HEAT SINK, transistor				
-104	136-0183-00			2	SOCKET, transistor, 3 pin				
-105	136-0399-00			8	SOCKET, terminal pin				
	- - - - -			-	mounting hardware: <i>(not included w/circuit board assembly)</i>				
-106	211-0116-00			3	SCREW, sems, 4-40 x 0.312 inch, PHB				
-107	441-0957-00			1	CHASSIS, plug-in unit				
	- - - - -			-	mounting hardware: <i>(not included w/chassis)</i>				
-108	210-0458-00			3	NUT, keps., 8-32 x 0.344 inch				
-109	211-0507-00			3	SCREW, 6-32 x 0.312 inch, PHS				
-110	210-0457-00			3	NUT, keps, 6-32 x 0.312 inch				
-111	212-0040-00			3	SCREW, 8-32 x 0.375 inch, PHS				
-112	214-0757-00			2	HEAT SINK, w/hardware				
-113	348-0056-00			2	GROMMET, plastic, 0.375 inch				
-114	348-0067-00			1	GROMMET, plastic, 0.312 inch				
-115	343-0088-00			1	CLAMP, cable, plastic, small				
-116	129-0203-00			1	POST, hex., 1.141 inches long				
	- - - - -			-	mounting hardware: <i>(not included w/post)</i>				
-117	211-0008-00			1	SCREW, 4-40 x 0.25 inch, PHS				
-118	354-0068-00			2	RING, securing, plastic, 0.50 ID x 0.562 inch OD				
-119	337-1332-00			1	SHIELD, electrical, input				
	- - - - -			-	mounting hardware: <i>(not included w/shield)</i>				
-120	211-0008-00			2	SCREW, 4-40 x 0.25 inch, PHS				
-121	124-0093-00			2	TERMINAL STRIP, ceramic, 0.438 inch h, w/5 notches				
	- - - - -			-	each terminal strip includes:				
	355-0082-00			2	STUD, plastic, tall				
	- - - - -			-	mounting hardware for each: <i>(not included w/terminal strip)</i>				
	361-0009-00			2	SPACER, plastic, 0.281 inch				
-122	670-0357-00			1	CIRCUIT BOARD ASSEMBLY—10M GAIN A3				
	- - - - -			-	circuit board assembly includes:				
	388-1687-00			1	CIRCUIT BOARD				
-123	131-0633-00			6	TERMINAL, pin, 0.385 inch long				
-124	136-0337-00			1	SOCKET, relay, 8 pin				
-125	407-0791-00			1	BRACKET, angle				
	- - - - -			-	mounting hardware: <i>(not included w/bracket)</i>				
-126	211-0116-00			2	SCREW, sems 4-40 x 0.312 inch, PHB				
-127	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch				
	- - - - -			-	mounting hardware: <i>(not included w/circuit board assembly)</i>				
-128	211-0008-00			1	SCREW, 4-40 x 0.25 inch, PHS				
	210-0201-00			2	LUG, solder, SE #4				
-129	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB				

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † Y	1 2 3 4 5					Description
					1	2	3	4	5	
1-130	337-1043-00			1						SHIELD, electrical
	- - - - -			-						mounting hardware: <i>(not included w/shield)</i>
-131	211-0008-000			4						SCREW, 4-40 x 0.25 inch, PHS
-132	129-0202-00			3						POST, hex., plastic, 0.801 inch long
	- - - - -			-						mounting hardware for each: <i>(not included w/post)</i>
-133	211-0116-00			1						SCREW, sems, 4-40 x 0.312 inch, PHB
-134	200-0828-00			1						COVER, circuit board, plastic
	- - - - -			-						mounting hardware: <i>(not included w/cover)</i>
-135	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-136	385-0149-00			1						ROD, spacer, plastic, 0.625 inch long
	- - - - -			-						mounting hardware: <i>(not included w/rod)</i>
-137	211-0116-00			1						SCREW, sems, 4-40 x 0.312 inch, PHB
-138	670-0358-00			1						CIRCUIT BOARD ASSEMBLY—AMPLIFIER A1
	- - - - -			-						circuit board assembly includes:
	388-1179-00			1						CIRCUIT BOARD
-139	344-0154-00			4						CLIP, electrical, fuse
-140	200-0687-01			2						COVER, transistor, plastic
-141	136-0235-00			5						SOCKET, transistor, 6 pin
-142	131-0633-00			47						TERMINAL, pin, 0.385 inch long
-143	214-0579-00			4						PIN, test point
-144	136-0183-00			9						SOCKET, transistor, 3 pin
-145	136-0220-00			10						SOCKET, transistor, 3 pin, square
-146	344-0119-00			6						CLIP, transistor
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-147	211-0116-00			6						SCREW, sems, 4-40 x 0.312 inch, PHB
-148	384-0615-00			4						ROD, spacer, plug-in, 12.25 inches long
	- - - - -			-						mounting hardware for each: <i>(not included w/rod)</i>
-149	212-0023-00			1						SCREW, 8-32 x 0.375 inch, PHS
-150	131-0149-00			1						CONNECTOR, 24 contact, male
	- - - - -			-						mounting hardware: <i>(not included w/connector)</i>
-151	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-152	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch
-153	210-0202-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: <i>(not included w/lug)</i>
-154	211-0504-00			1						SCREW, 6-32 x 0.25 inch, PHS
-155	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-156	343-0119-00			1						CLAMP, cable, 0.094 inch diameter
	- - - - -			-						mounting hardware: <i>(not included w/clamp)</i>
-157	211-0510-00			1						SCREW, 6-32 x 0.375 inch, PHS
	210-0803-00			1						WASHER, flat, 0.15 ID x 0.375 inch OD
-158	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-159	351-0037-00			1						GUIDE, plug-in, plastic
	- - - - -			-						mounting hardware: <i>(not included w/guide)</i>
-160	211-0012-00			1						SCREW, 4-40 x 0.375 inch, PHS
-161	210-0586-00			1						NUT, keps, 4-40 x 0.25 inch
-162	179-1586-00			1						WIRING, HARNESS, chassis
	- - - - -			-						wiring harness includes:
-163	131-0171-00			48						CONNECTOR, terminal
	131-0677-00			1						CONNECTOR, terminal
-164	386-1802-00			1						SUBPANEL, front
-165	387-0647-00			1						PANEL, rear
-166	214-0276-00			2						CONTACT, ground
	- - - - -			-						mounting hardware for each: <i>(not included w/contact)</i>
-167	211-0507-00			1						SCREW, 6-32 x 0.312 inch, PHS
-168	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch

STANDARD ACCESSORIES

070-1062-00	1	MANUAL, instruction <i>(not shown)</i>
062-1246-00	1	BOOKLET, Transducer Measurements <i>(not shown)</i>

MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

K4XL's **BAMA**

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