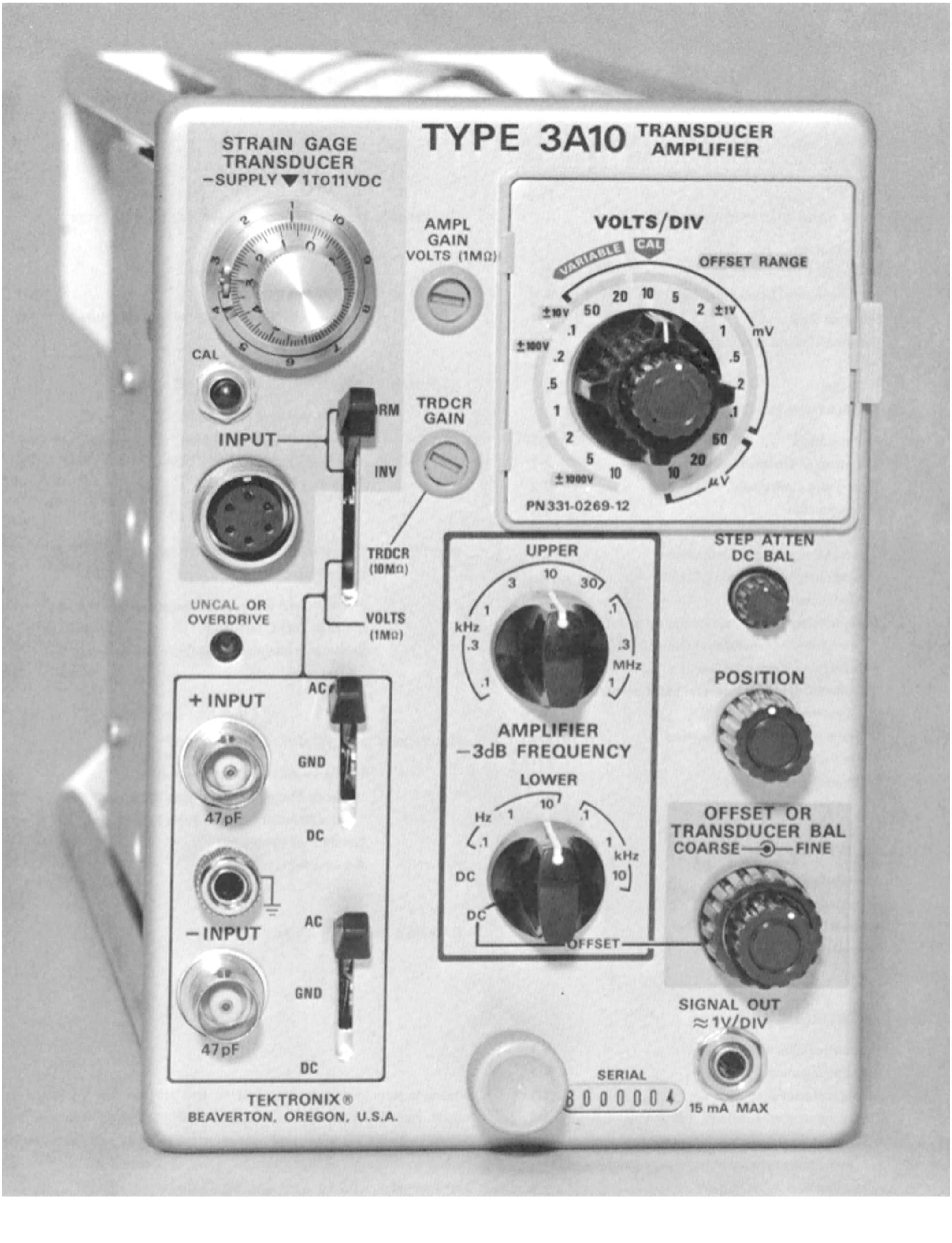
INSTRUCTION MANUAL

TYPE 3A10 TRANSDUCER AMPLIFIER

Tektronix, Inc. ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix
070-1062-00 **970**


TYPE 3A10 TRANSDUCER AMPLIFIER
STRAIN GAGE TRANSDUCER
-SUPPLY ▼ 1 TO 11 VDC
CAL
INPUT
NORM
INV
AMPL GAIN VOLTS (1MΩ)
TRDCR GAIN
TRDCR (10MΩ)
VOLTS (1MΩ)
UNCAL OR OVERDRIVE
VOLTS/DIV
VARIABLE
CAL
OFFSET RANGE
±10V
±1V
±100V
±1000V
mV
μV
PN 331-0269-12
STEP ATTEN DC BAL
UPPER
kHz
MHz
AMPLIFIER
-3dB FREQUENCY
LOWER
Hz
kHz
DC
OFFSET
POSITION
OFFSET OR TRANSDUCER BAL
COARSE FINE
+ INPUT
47pF
AC
GND
DC
- INPUT
47pF
SIGNAL OUT
≈1V/DIV
15 mA MAX
SERIAL
B000004
TEKTRONIX®
BEAVERTON, OREGON, U.S.A.

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 MΩ input is incorporated in addition to the one MΩ 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 µV/div to 10 V/div; 19 steps in a 1-2-5 sequence.
Accuracy	
20 mV/div to 10 V/div	Within 3%.
10 µV/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 MΩ Mode	1.6 Hz, within 5%.
10 MΩ Mode	0.16 Hz, within 5%.

TABLE 1-1 (cont)

Characteristic	Performance
Overdrive Recovery	10 μs 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 μV/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 μV/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		
10 μV/div to 10 mV/div	±15 V.	
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 MΩ, within 1% (1 MΩ Mode); 10 MΩ, within 1% (10 MΩ Mode)	
Nominal Capacitance	47 pF.	
Time Constant	47 μs, within 4% (in VOLTS position).	
Maximum Input Offset Current	+20°C to +30°C	+50°C
10 μV/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 μV/div (AC Coupled)		
1 MΩ Mode	±2 div	±10 div
10 MΩ Mode	±20 div	±100 div
Displayed Noise (Tangentially Measured)	12 μV (6 μV RMS) or 0.1 div or less, whichever is greater at 1 MHz bandwidth, and source resistance of 25 Ω or less. 2.5 μV (1.25 μV RMS) or 0.1 div or less, whichever is greater at 100 Hz bandwidth, and source resistance of 25 Ω or less.	

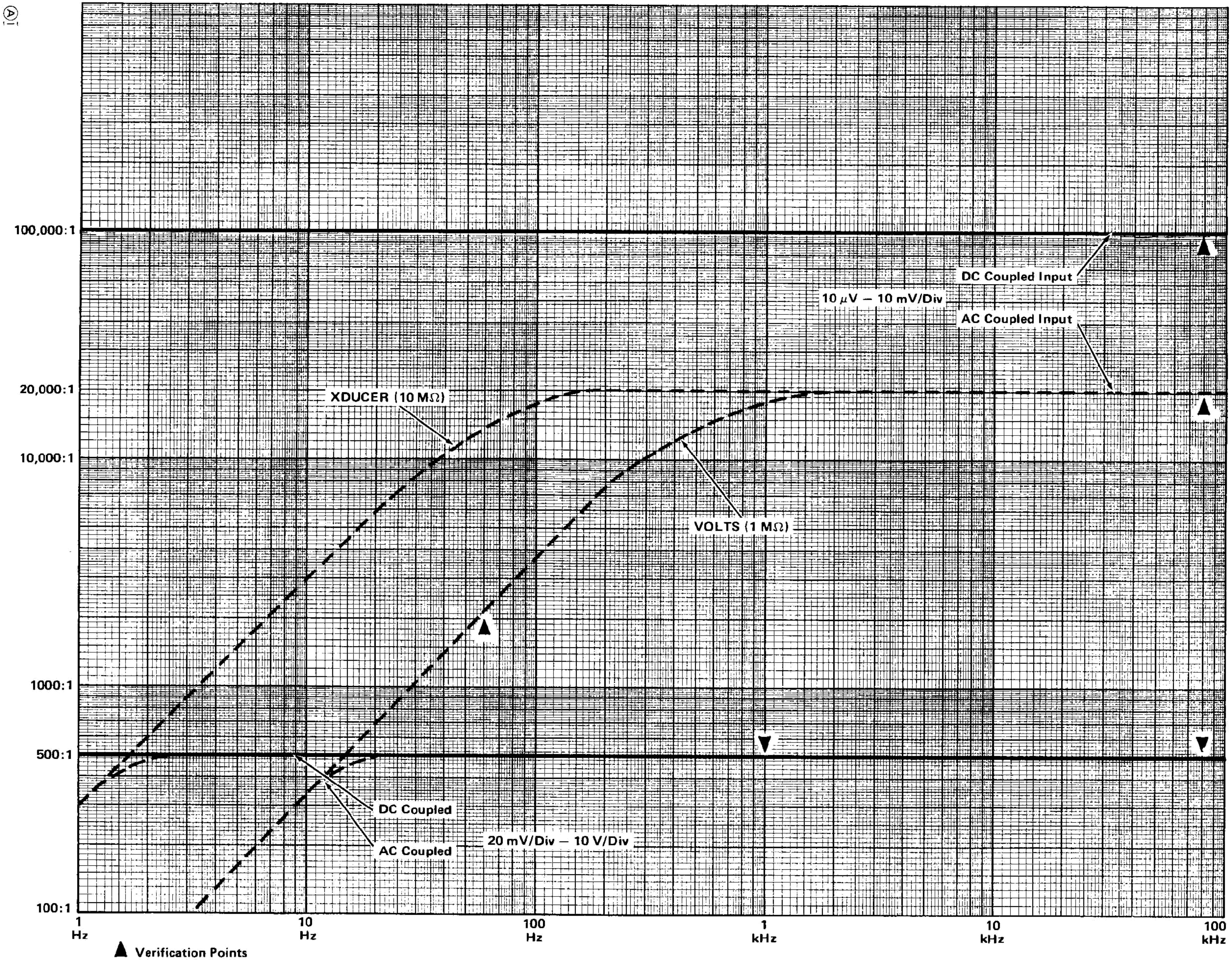


Fig. 1-2. CMRR vs. Frequency, for signals not exceeding Common-Mode Dynamic Range.

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TABLE 1-1 (cont)

Characteristic	Performance
Trace Stability	
DC Drift With Time (Ambient Temperature and Line Voltage Constant)	
Short Term	5 μV/minute (P-P) or 0.1 div (whichever is greater) after 1 hour warmup.
Long Term	10 μV/hour (P-P) or 0.1 div (whichever is greater) after 1 hour warmup
Drift with Ambient Temperature (Line Voltage Constant)	50 μV/°C, or less.
Isolation Between + and − Inputs (+INPUT to an Open −INPUT, −INPUT to an Open +INPUT)	
10 μV/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 μV/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 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 MΩ 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 MΩ or 10 MΩ input resistances) or from the Strain Gage INPUT multi-pin connector (normal or inverted, 10 MΩ 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 I^2T 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 μV, which could drive a display off-screen at the 10 μV/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.

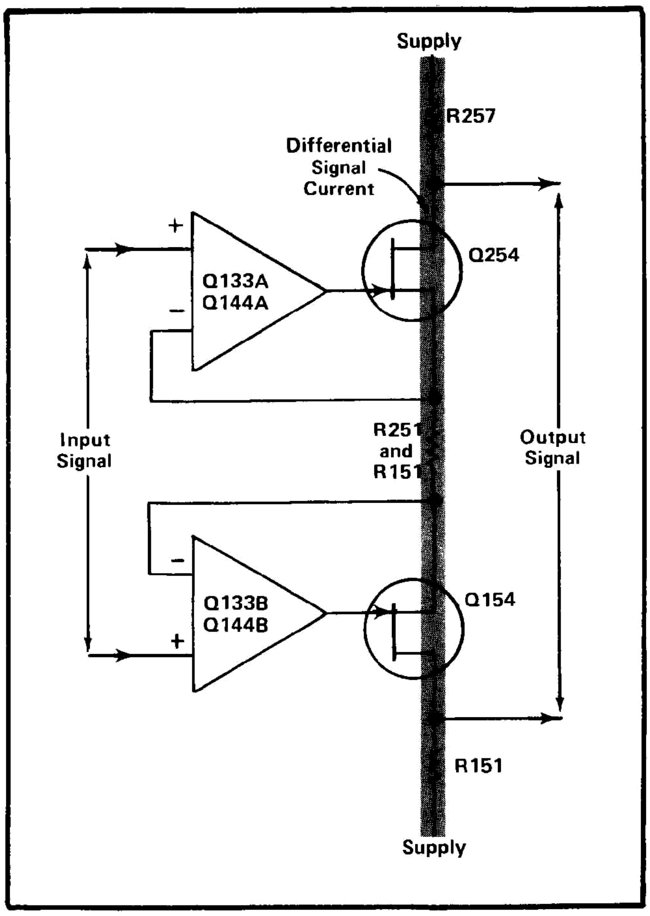


Fig. 3-1. Input Preamp detailed block diagram showing signal current path.

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 MΩ) 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.

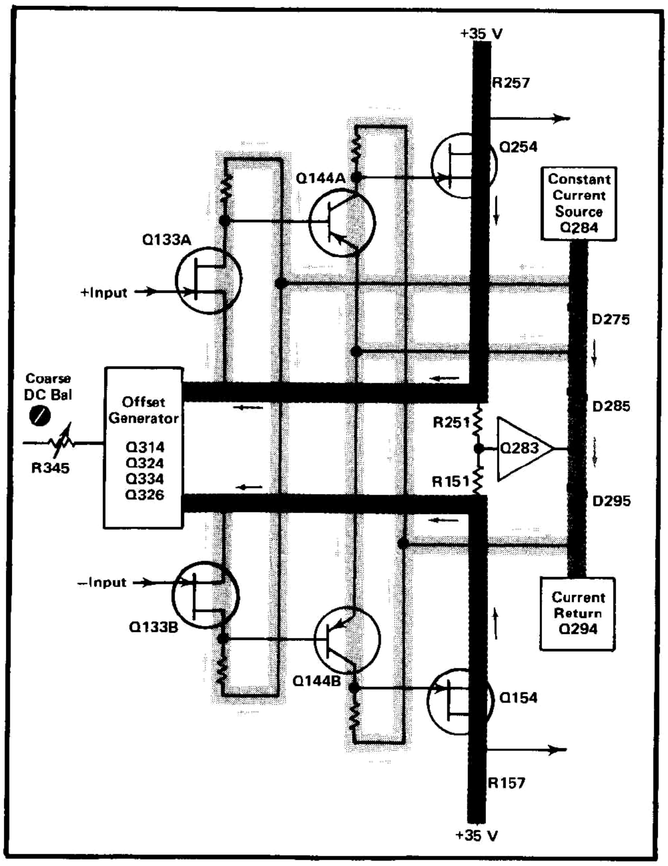


Fig. 3-2. Floating Power Supply and Offset Generator detailed block diagram showing standing current paths through the Preamp.

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 ± one volt. Due to the wide range of the Offset Generator (200,000 div at 10 μV per div), stable components are used and circuit techniques which minimize drift and noise are employed.

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 MΩ) 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.

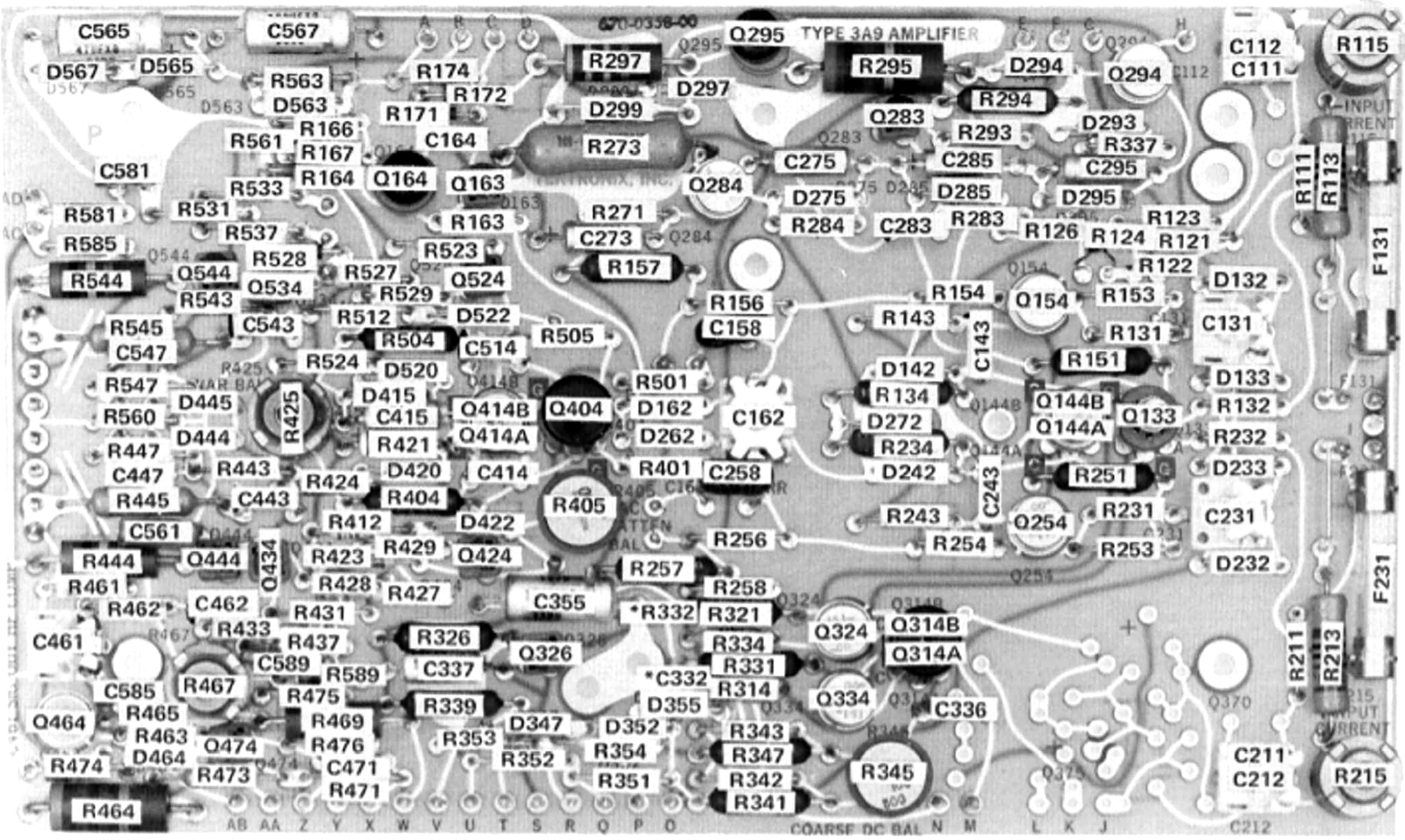
Voltage Follower Stage

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.

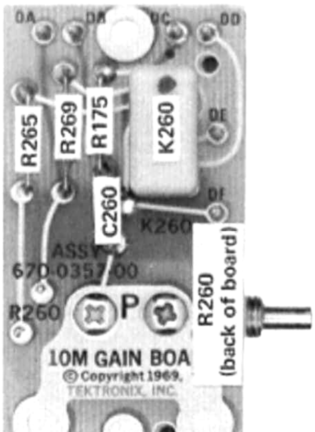


A-1 Amplifier Board

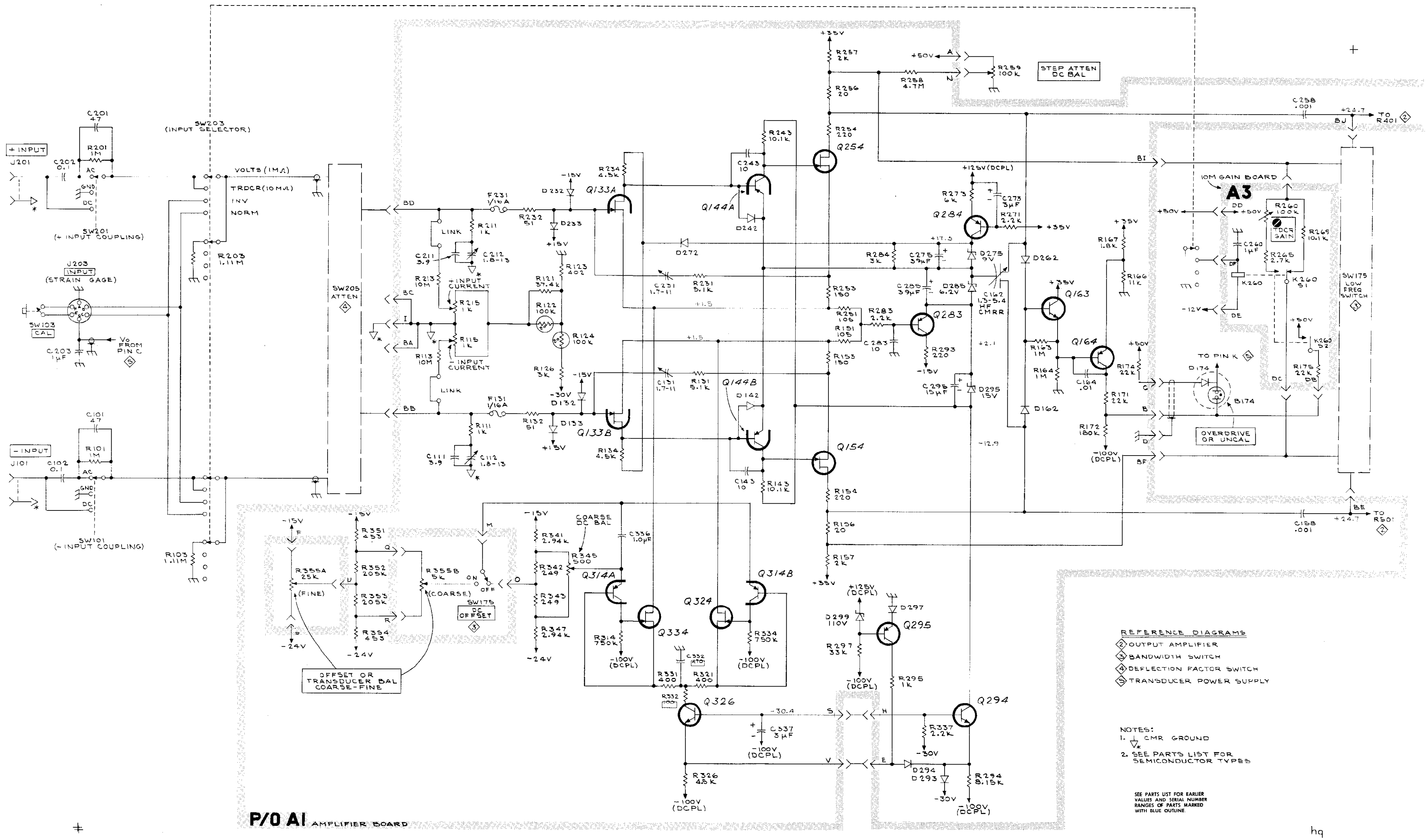
*Added SN B030000

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


+ INPUT
J201
- INPUT
J101
SW203
(INPUT SELECTOR)
VOLTS (1MΩ)
TRDCR (10MΩ)
INV
NORM
SW201
(+ INPUT COUPLING)
SW101
(- INPUT COUPLING)
J203
INPUT
(STRAIN GAGE)
SW103
CAL
SW205
ATTEN
Q133A
Q133B
Q144A
Q144B
Q254
Q154
Q284
Q283
Q163
Q164
Q314A
Q314B
Q324
Q334
Q326
Q295
Q294
STEP ATTEN
DC BAL
10M GAIN BOARD
A3
TDCR GAIN
SW175
LOW FREQ SWITCH
OVERDRIVE OR UNCAL
COARSE DC BAL
OFFSET OR TRANSDUCER BAL COARSE-FINE
SW175
DC OFFSET
P/O A1 AMPLIFIER BOARD
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.

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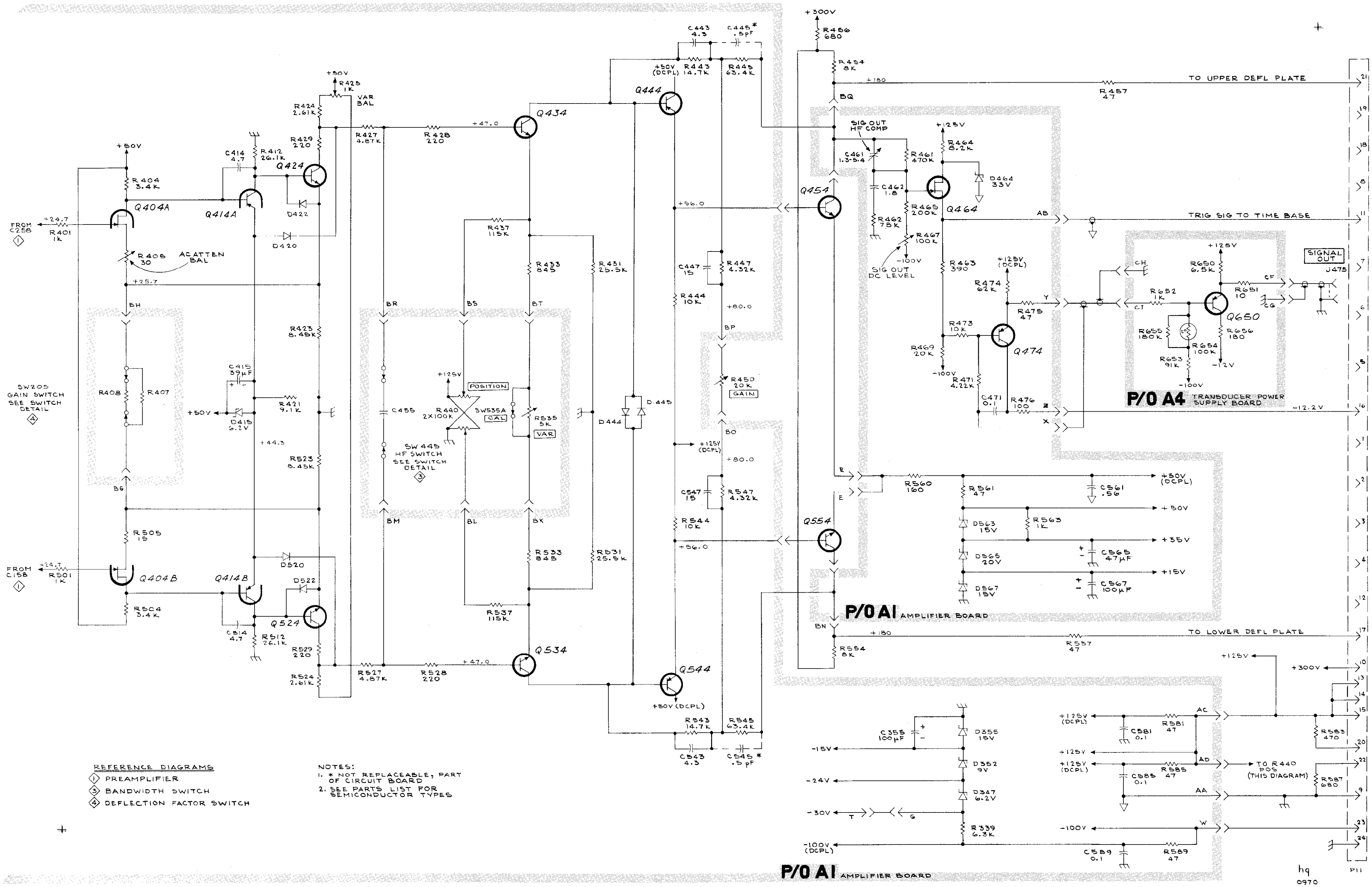

REFERENCE DIAGRAMS
1. PREAMPLIFIER
3. BANDWIDTH SWITCH
4. DEFLECTION FACTOR SWITCH

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

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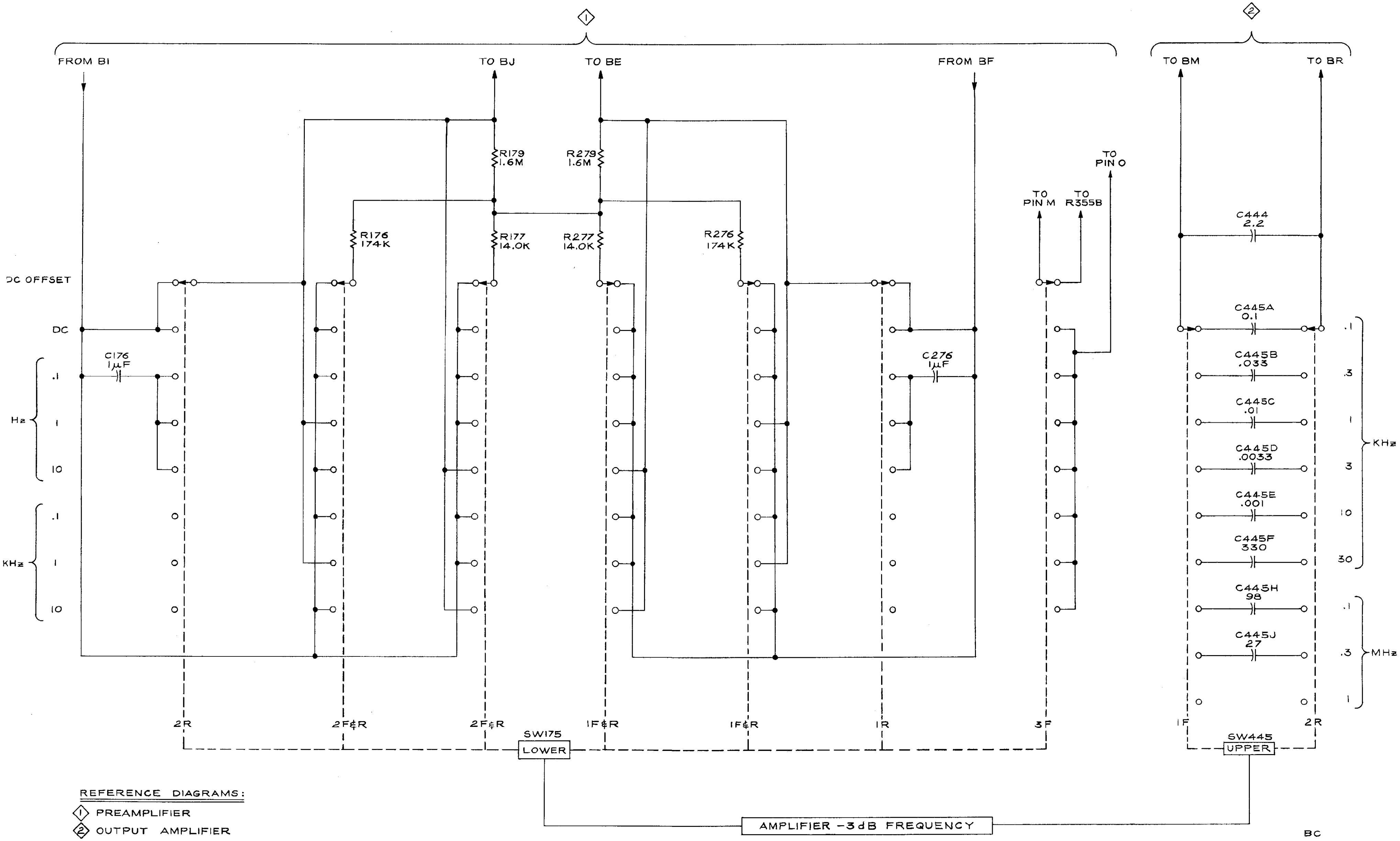

REFERENCE DIAGRAMS:

1 PREAMPLIFIER

2 OUTPUT AMPLIFIER

TYPE 3A10

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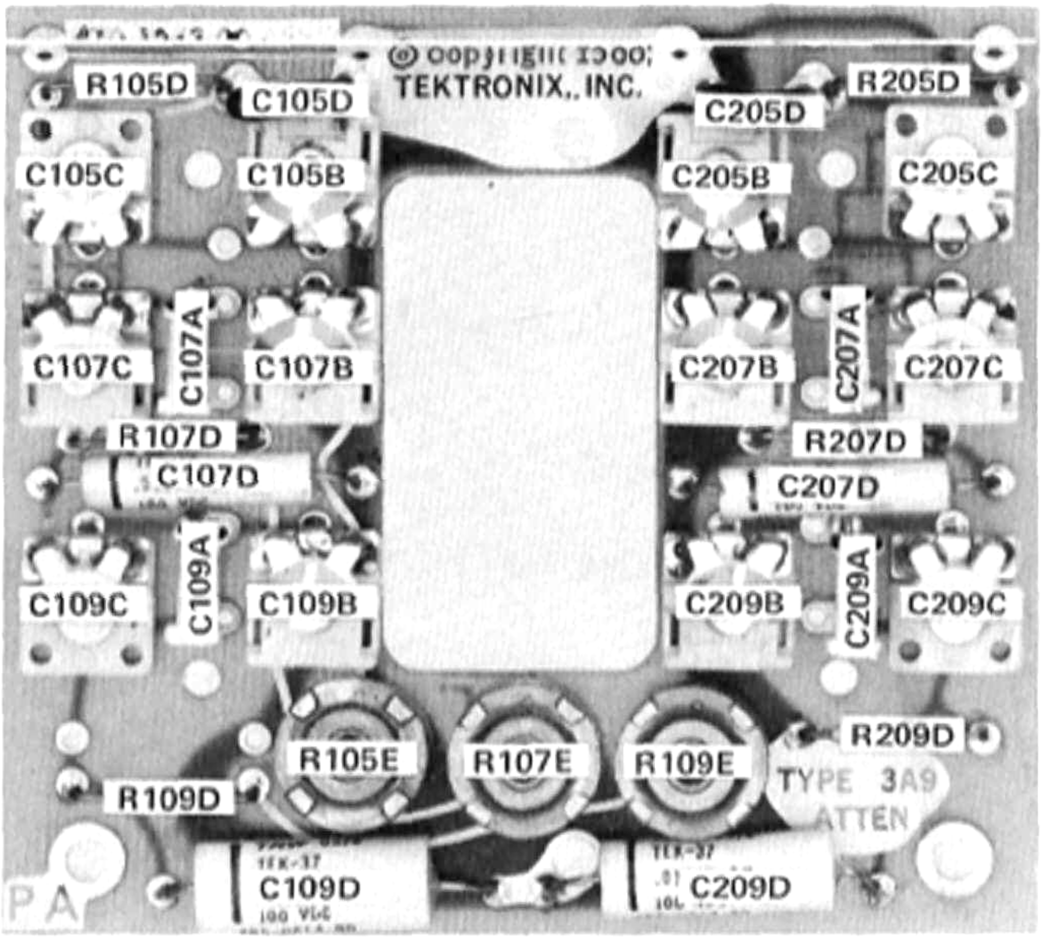
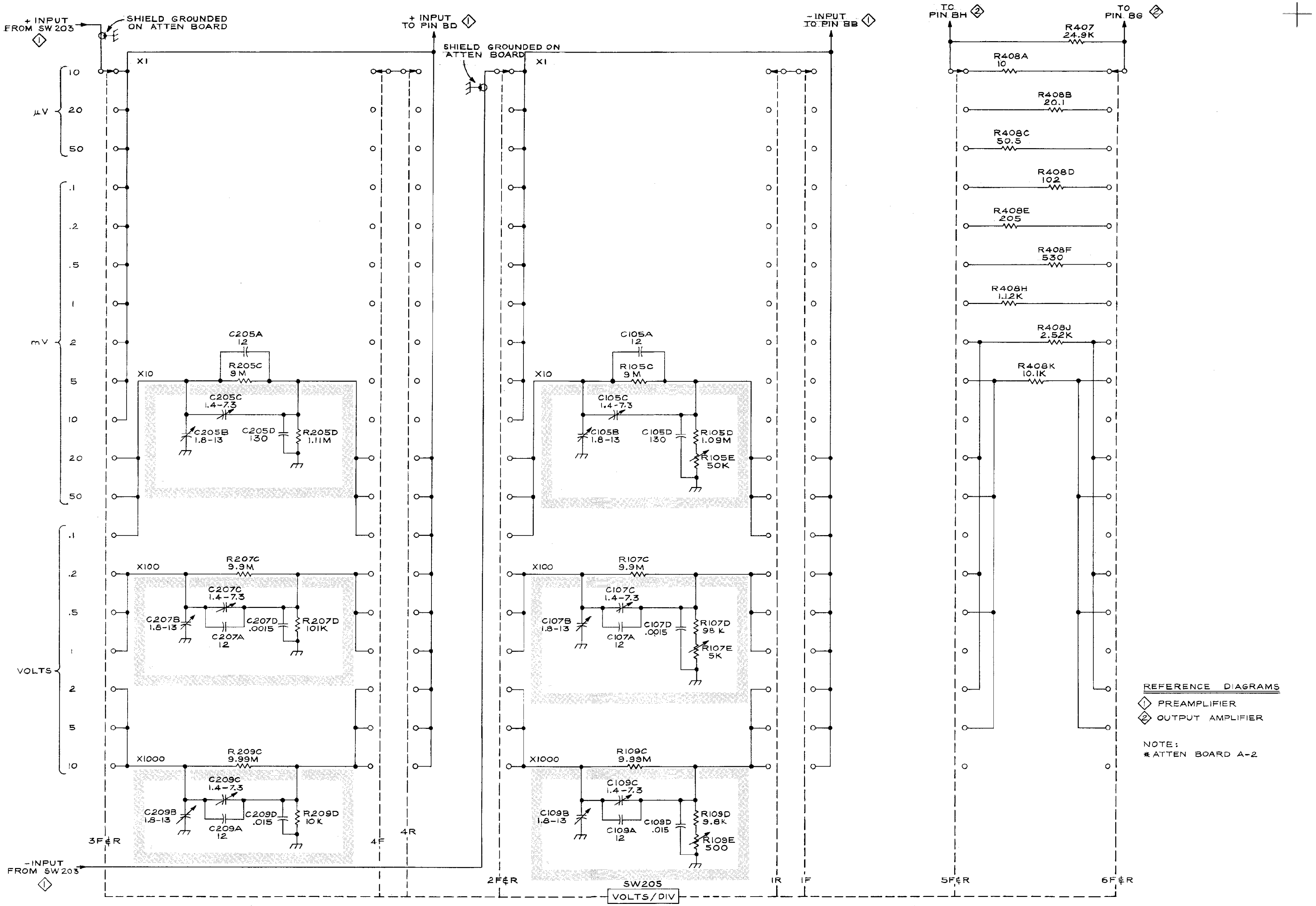
BANDWIDTH SWITCH 3



A-2 Attenuator board.



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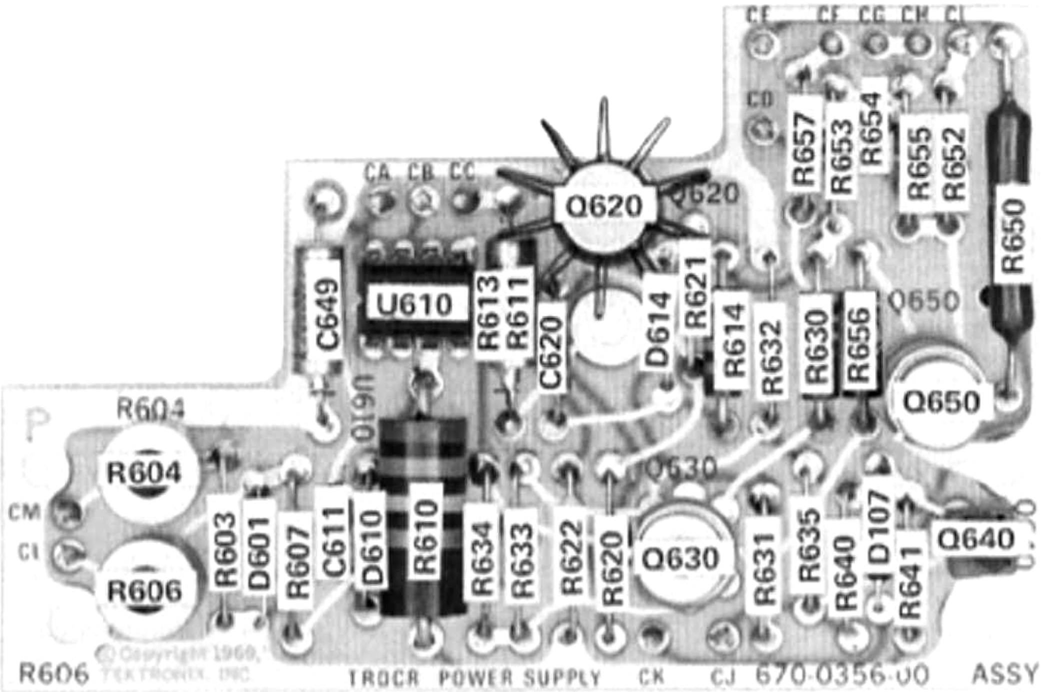
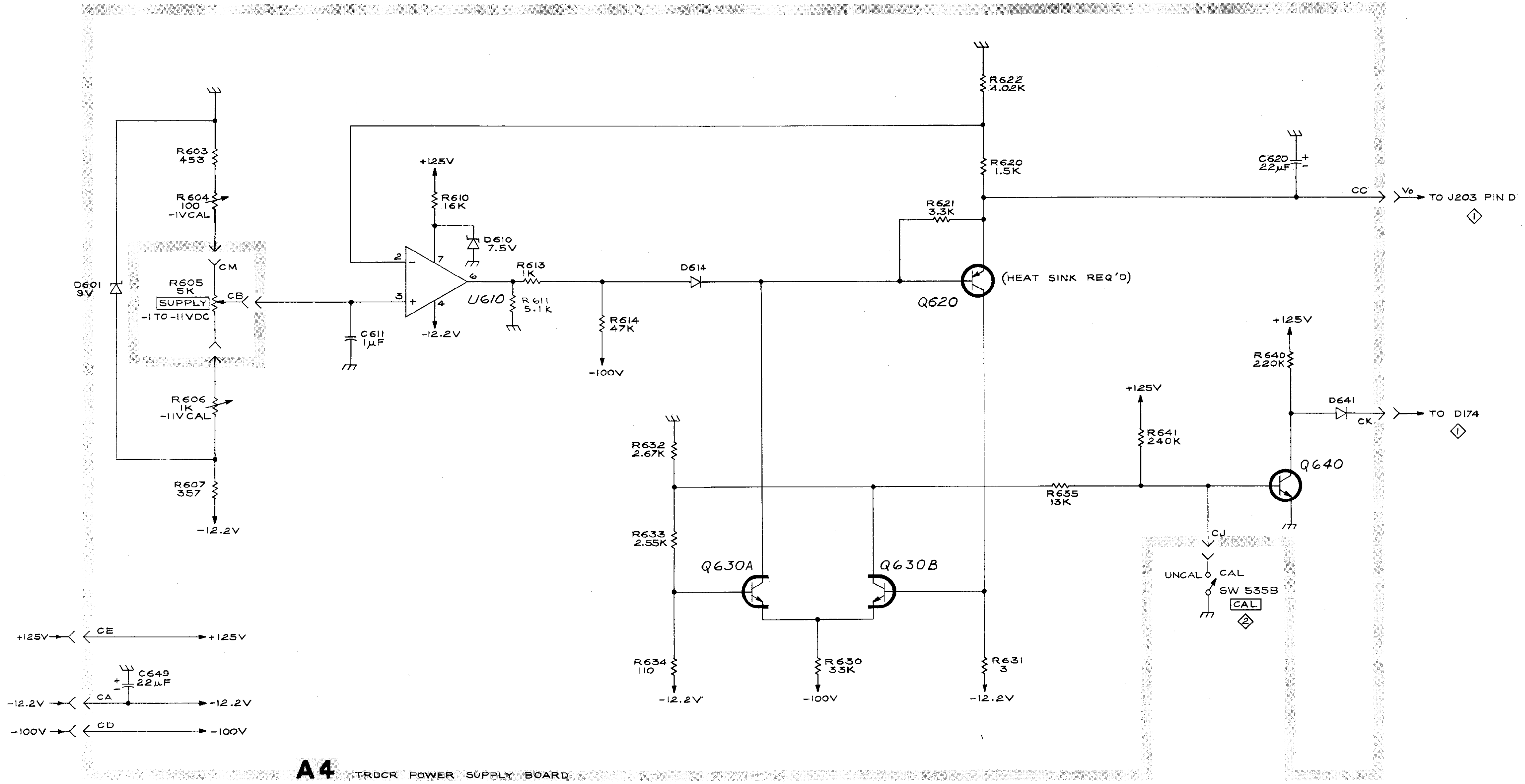
TYPE 3A10 — A — DEFLECTION FACTOR (VOLTS/DIV) SWITCH 4



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



REFERENCE DIAGRAMS:
1. PREAMPLIFIER
2. OUTPUT AMPLIFIER

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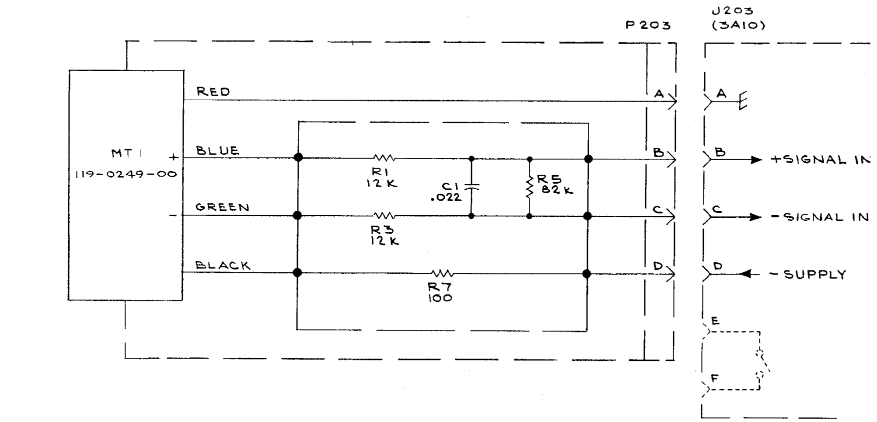
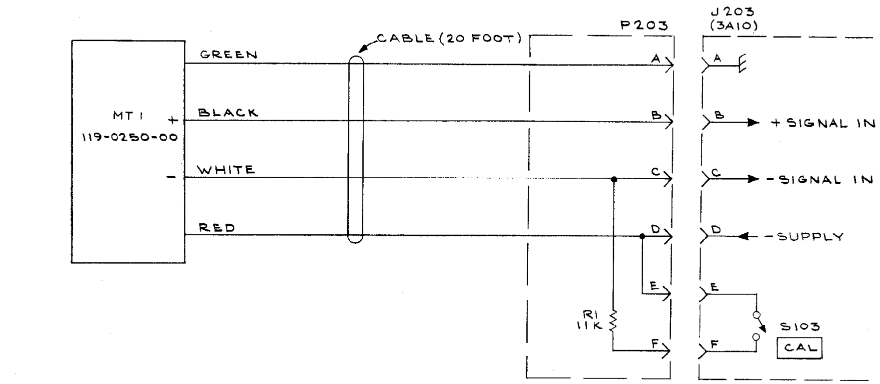
TRANSDUCER POWER SUPPLY 5

TYPE 3A10

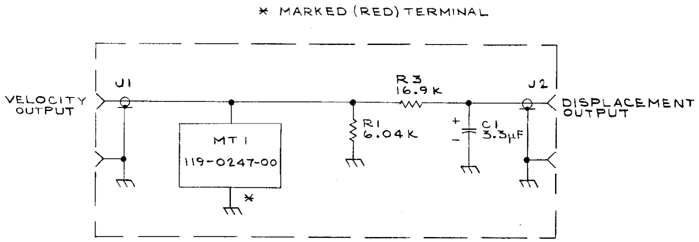
A2



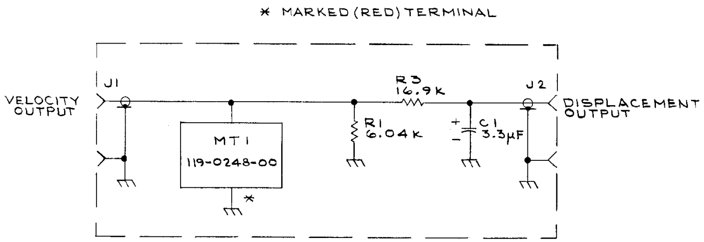
DISPLACEMENT TRANSDUCER
015-0168-00



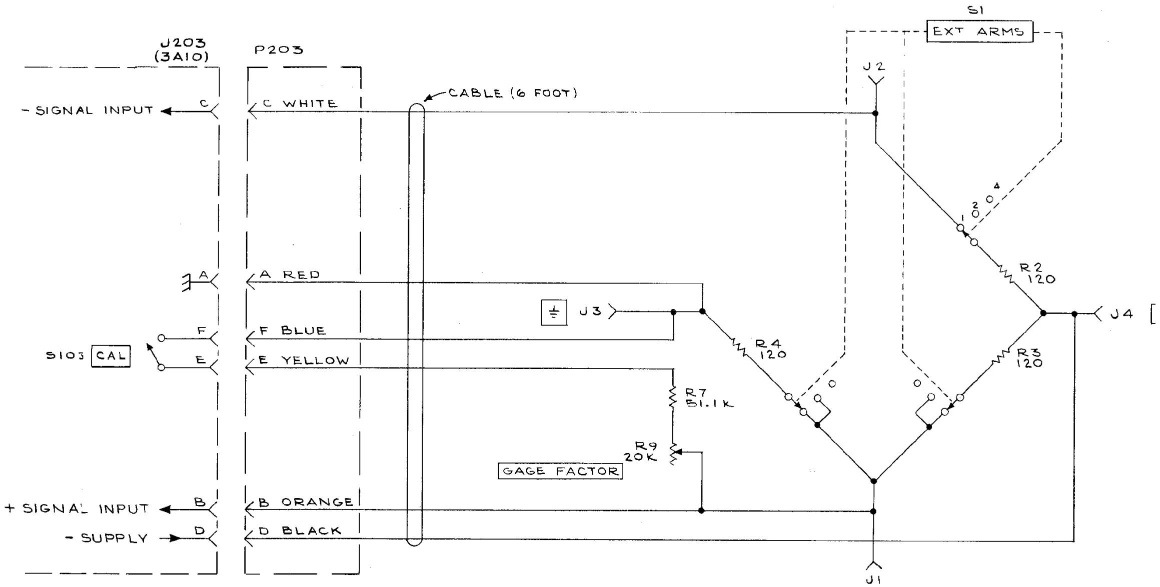
FORCE TRANSDUCER
015-0164-00



VERTICAL VIBRATION TRANSDUCER
015-0166-00



HORIZONTAL VIBRATION TRANSDUCER
015-0167-00



STRAIN GAGE ADAPTER
015-0169-00

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

TYPE 3A10 OPTIONAL ACCESSOF

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STRAIN GAGE ADAPTER ⑥
& TRANSDUCERS