INSTRUCTION MANUAL

BA389
Buffer Amplifier
Signal Conditioner
Module

Validyne
ENGINEERING CORP.

8626 Wilbur Avenue
Northridge, California 91324-4498
(818) 886-2057 • Telex 65-1303
TOLL FREE (800) 423-5851 (AK/CA use (818) number)
AUTOMATIC FAX (818) 886-6512

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1.0 GENERAL INFORMATION

1.1 INTRODUCTION

This technical manual contains instructions for installing and operating the **Model BA389 Buffer Amplifier Signal Conditioner**, a plug-in module for use in several multi-channeled instrumentation cases manufactured by Validyne Engineering Corporation in Northridge, California.

1.2 DESCRIPTION

1.2.1 Capabilities This module is a true 2-wire differential amplifier with galvanic isolation between input and output circuits. The design offers a 1, 2, 5-ratio step gain range selection from 1 to 100, plus a vernier adjustment of 0.35 to 1.1 times the selected gain range. An output suppression adjustment allows up to ±10 VDC to be summed into the output signal. Refer, as necessary, to these figures:

Figure 1-1. Front Panel
Figure 1-2. Assembly With Shield In Place
Figure 1-3. Assembly Without Shield
Figure 3-1. Schematic Diagram of BA389

Users may specify a 2-pole low pass active filter with cutoff frequency located from 5.7 Hz. to 1 KHz. in approximately binary steps. 1KHz. is standard.

1.2.2 Input Input connections to the standard BA389 are through the module case internal wiring; this limits the isolation potential rating to a maximum of ±100 VDC. An available option makes input connections through a front panel bushing and terminal block on the card. This option bypasses the module case wiring, and increases the input voltage rating to ±200 VDC. Input circuitry is protected against input voltages, differential or common mode, up to ±200 VDC.

1.2.3 Output At ±2mA, the module provides ±10 VDC at the output. It is short circuit proof, and unaffected by load capacitance. The module case power supply provides the operating power: +15V/8mA and -15V/3.2mA.

1.2.4 Shielding An insulated shielded cover encloses the potentially high voltage input circuitry, including the gain range jumper. This shield also prevents circuit sensitivity to the insertion of neighboring cards.

1.2.5 Access The front panel permits access to the gain vernier, the suppression in/out switch and vernier control adjustment, and the output signal test point. The ground return test point is located on the front panel, or power supply.

1.3 TECHNICAL CHARACTERISTICS

Table 1-1, below, contains the technical characteristics of the BA389 module.

Table 1-1. BA389 TECHNICAL CHARACTERISTICS

Item No.	Item	Technical Data
1	INPUT:	
	Diff. Input Resistance	600k Ohms
	Diff. Input Voltage Range	±0.1V to ±28V for ±10V FS output
2	ISOLATION:	
	Input-Output Isolation	100 Meg Ohms min at 100VDC
	Isolated Excitation	±7.5VDC @ ±0.4mA, in series with 10k Ohms resistors.
3	GAIN	Jumper plug selected 1, 2, 5, 10, 20, 50, or 100V/V
4	GAIN VERNIER	35% to 110% of selected gain range, 20 turn pot.
5	OUTPUT	±10V @ ±2mA, short circuit proof, unaffected by load capacitance
6	OUTPUT RESISTANCE	10 Ohms maximum
7	FREQUENCY RESPONSE	0-1,000Hz (-3db) standard; optional band width of 5.7, 12, 27, 57, 120, 270, or 570Hz(-3db)
8	NOISE	0.6mV rms @ maximum gain
9	NON-LINEARITY	0.05% maximum
10	COMMON MODE REJECTION RATIO	120 db typical, @ 100 Ohm balanced source resistance, 100X gain range
11	SUPPRESSION	Output suppression, 0 to ±10VDC, suppression IN/OUT switch on front panel
12	TEMPERATURE EFFECTS	Span 0.005%/oF typical Zero 60u V/oF RTI, maximum.
13	POWER CONSUMPTION	+15V @ 8mA, -15V @ 3.2mA

2.0 INSTALLATION AND OPERATION

2.1 INSTALLATION

Insert or remove the BA389 from any available channel position of the module case while power is ON. This will not damage the module or affect adjacent module case channels. If you are using an extender card, take special care to avoid upside down connections which can damage the BA389 severely. Also, since certain applications of this plug-in can have large common mode potentials on the signal input wires, make sure not to contact or fault these input potentials during installation and use.

Figure 2-1 shows a typical hook-up of the module for module cases whose wiring access is through a terminal block at the rear of the case. **[Figure 2-1: Typical Hook-Up of BA389-R Input Signal]** The simplicity of this true 2-wire differential connection means that a simple twisted pair input is often sufficient to provide low-noise amplifier operation. For noisy industrial environments, however, it is advisable to use a shielded twisted pair input, and tie the shield to either the module case chassis ground (earth) or to the signal ground, as preferred. Refer to individual module case instruction manuals for additional information.

2.2 OPERATION

To identify the BA389 components and locate its controls, refer to the following figures:

Figure 1-1. Front Panel
Figure 1-2. Assembly With Shield In Place
Figure 1-3. Assembly Without Shield

2.2.1 Differential Amplifier Fundamentals

a. The primary reason for using a differential amplifier is to acquire a signal, located at a distance from the user, which may contain common mode voltage incompatible with the user's system. Many data acquisition systems use differential amplifiers to reject common mode error sources. Typically, these amplifiers are not galvanically isolated between input and output. This restricts the input signal common mode voltage range, frequently limiting the voltage to a maximum of 10 to 20 volts.

b. These direct connected amplifiers have bias currents at their input leads which require a third-wire connection to the signal source to form a return path to the amplifier. By contrast, a galvanically isolated difference amplifier is a true 2-wire input, limited by system wiring and connector dielectric ratings for the common mode potential ratings.

c. The key to effective operation is a high rejection of common mode voltage at the difference amplifier output. The BA389 design has input circuitry shielding and a stray capacitance balance adjustment (See Section 3.2.) which can give high quality differential amplification in the presence of power line common mode noise.

d. Figure 2-2 shows the simplest configuration served by this form of amplifier. **[Figure 2-2: Differential Amplifier Rejection]** A galvanically isolated design is necessary when the common mode voltage exceeds 10 or 20 volts. For example, assume the differential gain is set at 100, and the 60Hz. CMRR is about 115db. Although higher values are achievable, this value is readily obtainable on the X100 gain range. Assuming the amplifier low pass filter band width exceeds 60Hz., this means that a 75 volt AC 60Hz. common mode signal will result in approximately 13.3 mV AC at the signal conditioner output.

2.2.2 Suppression Applications

a. One common suppression application involves the signal conditioning for a 4 to 20 mA current loop. Figure 2-3 shows a configuration in which a remote current transmitter produces a signal ranging from 4 to 20 mA. **[Figure 2-3: Current Loop Application]** In this application, the current may be sensed by measuring the voltage drop across resistor R_A or R_B. A single-ended input to the data acquisition system will sense the signal across R_B ground connection and the data system ground. If it is necessary to use the signal across R_A, then the common mode rejection of the BA389 is appropriate.

b. Offset scaling is another easily obtained suppression application. As Figure 2-3 shows, the 4 to 20 mA current through R_B results in a 1 to 5 VDC signal to be input to the BA389. In this figure, the voltage gain is 4.00 and the output is 0.00 when the input is set at 3.0 VDC.

2.3 GAIN JUMPER SELECTION AND VERNIER GAIN CONTROL

The gain jumper for setting the overall gain range is visible just behind the front panel. This jumper, part of the isolated input section of the amplifier, has the same input common mode voltage as the input signal lines. To prevent accidental user contact with a possible high potential signal, the insulated shield cover protects the jumper.

Table 2-1 below shows the overall voltage gain ranges possible by using the gain range jumper in combination with the gain vernier control, R10. Since the ranges overlap, the same gain can be obtained on two different gain range jumper positions. For example, jumper positions 5x or 10x can both produce a gain of 4.0. However, it is usually best to use the lower gain range jumper position, and adjust the gain vernier R10 to an upper side position. This results in a better gain stability (insensitivity to R10 movements).

Table 2-1. GAIN RANGE

Gain Jumper Position	Gain Vernier R10 Range Limits
1	0.35 - 1.1
2	0.70 - 2.2
5	1.75 - 5.5
10	3.5 - 11
20	7.0 - 22
50	25 - 55
100	35 - 110

2.4 SUPPRESSION CONTROLS

The output voltage can be offset up to ±10 volts by placing the SUPPR switch (Figure 1-2: SW1) in the IN position, and adjusting the SUPPR potentiometer R21. Both controls are accessible at the front panel.

The procedure sequence given below has minimal interaction between gain and suppression adjustments. Keep in mind that the gain control changes the slope of the transfer function about a pivot point at zero input volts. The suppression control translates the curve left and right on the input voltage axis, but does not change the slope (gain) of the line.

Figure 2-3 offers an example of a workable procedure for setting the SUPPR controls; the desired gain is 16V out for 4V in, or 4V/V:

a. Disable the SUPPRR by placing S1 at the OUT position.

b. Remove the shield cover (shown in Figure 1-2) to change the gain jumper position.

c. Place the gain jumper in the X5 position. (See Section 2.3 and Figures 1-1, and 1-3.)

d. After changing the gain jumper position, replace the shield cover and all 5 screws.

e. With the input voltage at zero, note the output voltage. If this voltage is greater than 0.05 VDC, perform the zero calibration procedure described in Section 3.

f. Apply a known input differential voltage such as +2.00 VDC, and adjust the gain vernier control at the front panel to obtain +8.00 VDC above the value noted with zero signal at the input. This will set the gain at 4V/V.

g. Enable the SUPPR by placing SW2 at the IN position.

h. Apply +3 VDC at the input, and adjust the SUPPR control R21 to obtain an output voltage of 0 VDC. Verify that the output is +8 VDC with +5 VDC at the input.

i. Check the calibration by applying known input voltages over the range of interest, and by verifying correct output response. Current loop receiver is the same except that this will compensate for shunt resistor tolerance.

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3.0 INTERNAL ADJUSTMENTS

Three controls not accessible through the front panel are normally factory-set, but may need attention after aging or accidental mis-adjustment in the field: INPUT ZERO R4, OUTPUT ZERO R26, and CMRR ADJ R13. All of these are shown in Figure 1-3.

3.1 ZERO CONTROLS

These adjustments are made as follows: shield cover removed, card on an extender, SW1 SUPPR at the OUT position, and the signal input leads shorted together:

a. With the gain jumper in the X1 position, adjust the OUTPUT ZERO R26 for minimum output voltage.

b. With the gain jumper in the X100 position, adjust the INPUT ZERO R4 for minimum output voltage.

c. Repeat 'a' and 'b' until the output signal is 0 $\pm$25 mVDC in either extreme position of the gain jumper. Install the gain jumper and replace the shield and the 5 screws.

3.2 CMRR ADJUSTMENT

Because of potentially great hazards in testing the common mode rejection capability of this amplifier, this procedure should be referred back to Validyne, if required.

At the factory, 115VAC at 60Hz. is applied to both input signal pins, and the CMRR ADJ R13 is set for minimum 60Hz. amplitude at the output. This test is performed with the gain jumper at X100 and the shield installed.

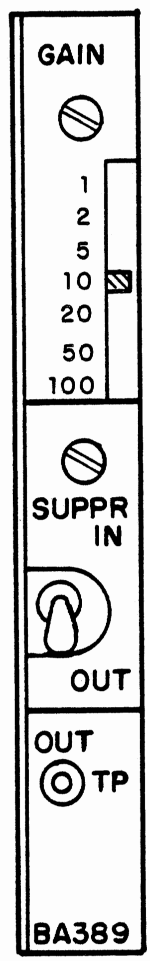


Figure 1-1. Front Panel

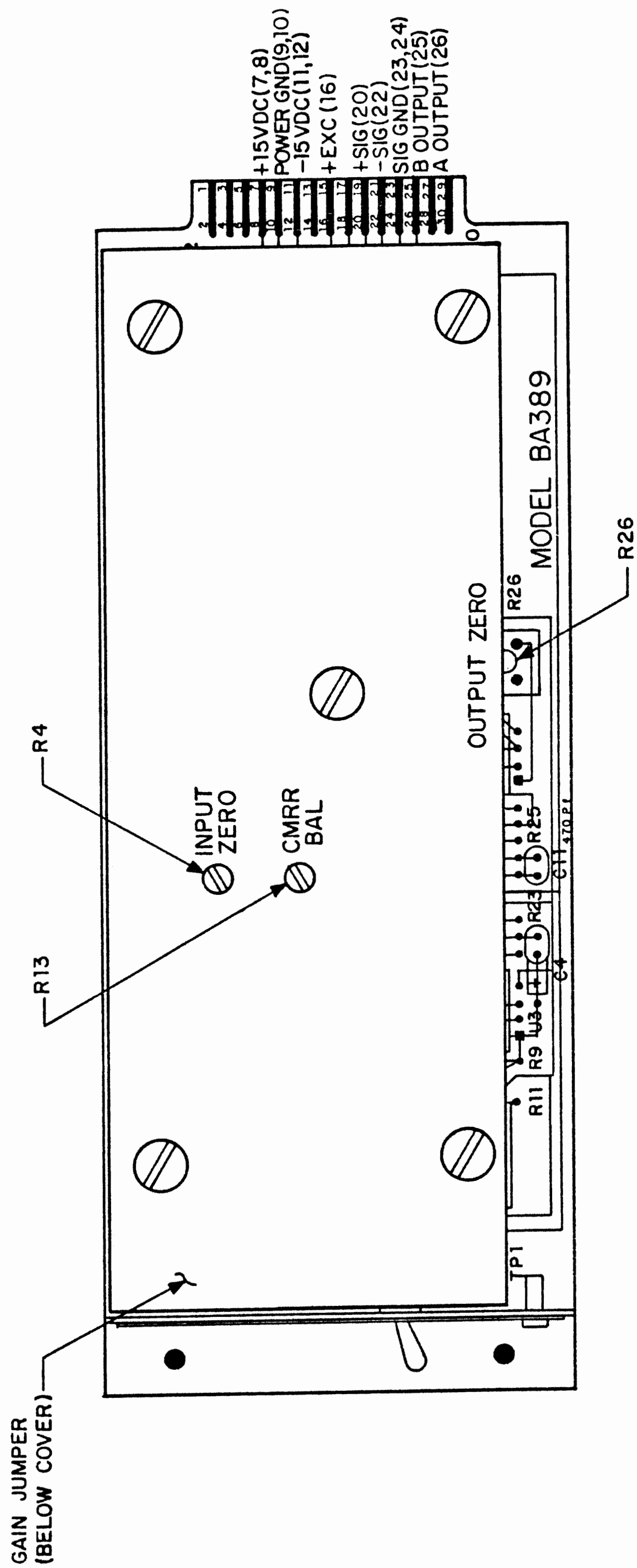


Figure 1-2. Assembly With Shield

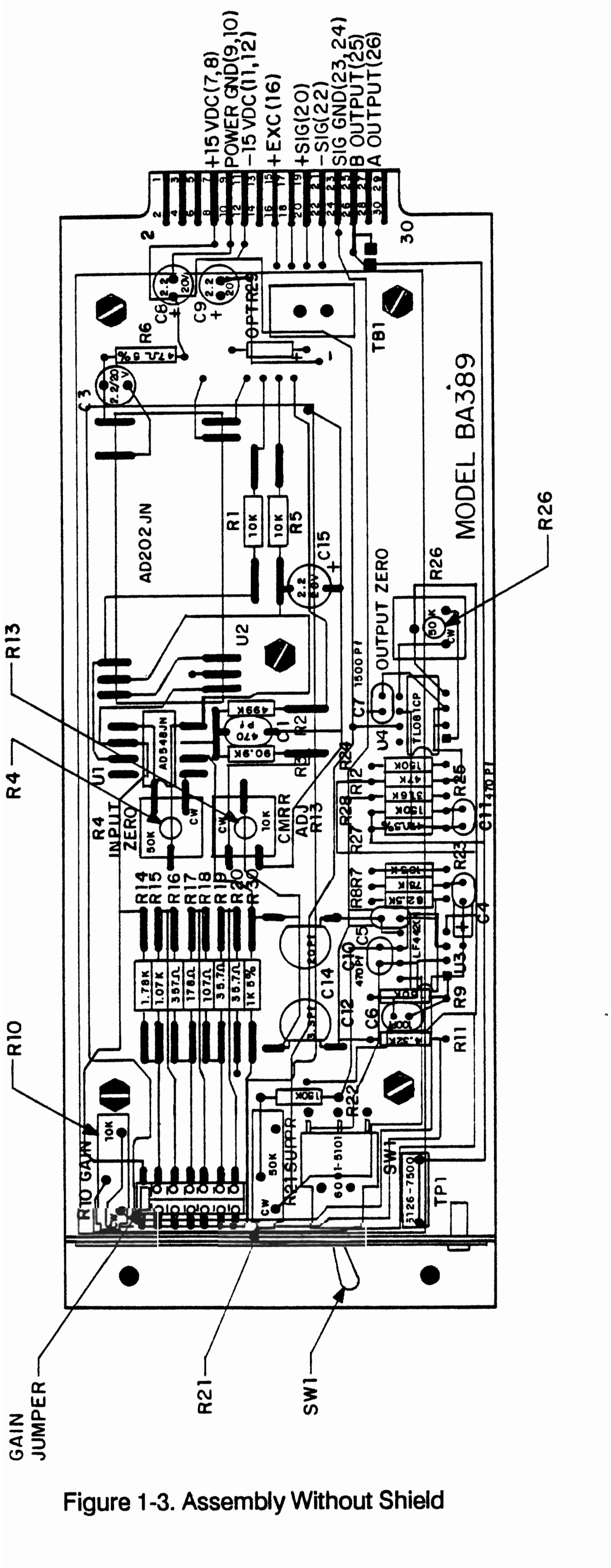


Figure 1-3. Assembly Without Shield

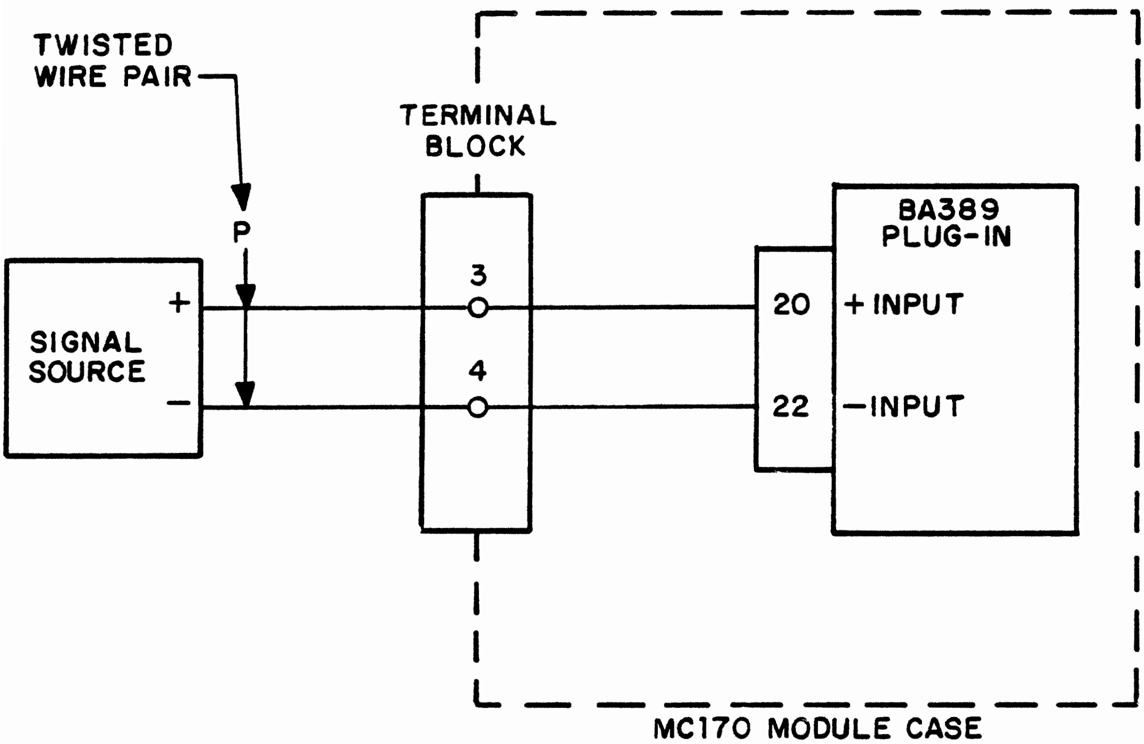
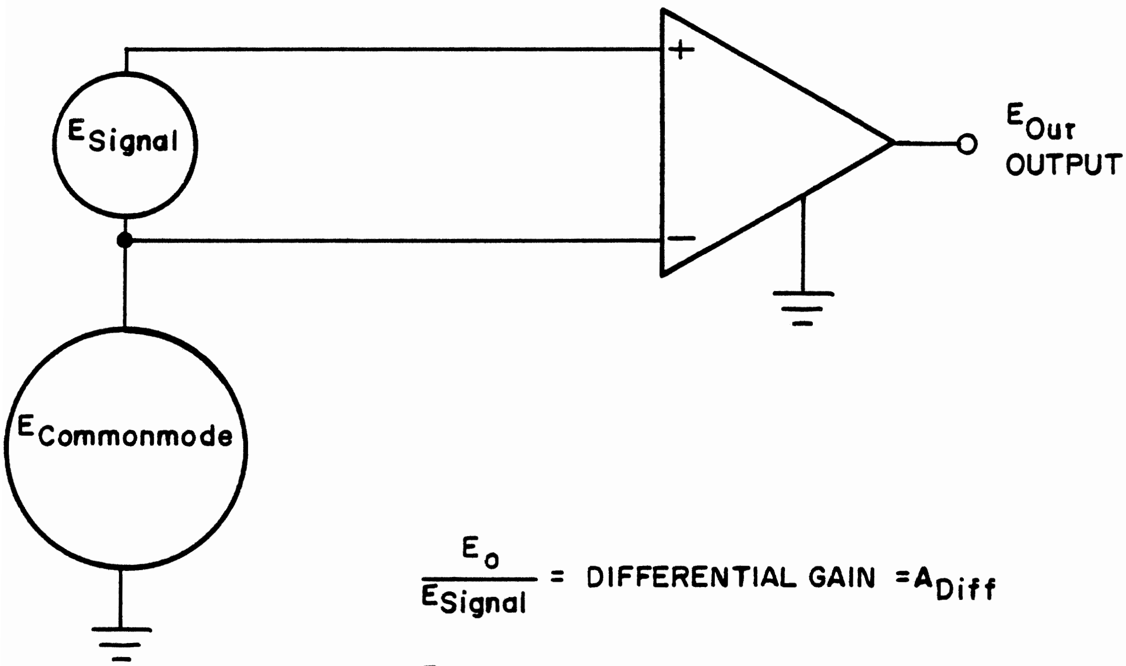


Figure 2-1. Typical Hookup of BA389-R Input Signal



$$\frac{E_o}{E_{Signal}} = \text{DIFFERENTIAL GAIN} = A_{Diff}$$

$$\frac{E_o}{E_{Commonmode}} = \text{COMMON MODE GAIN} = A_{Commonmode}$$

$$\text{CMRR} = 20 \, \text{Log}_{10} \frac{A_{Diff}}{A_{Commonmode}}$$

Figure 2-2. Differential Amplifier Rejection

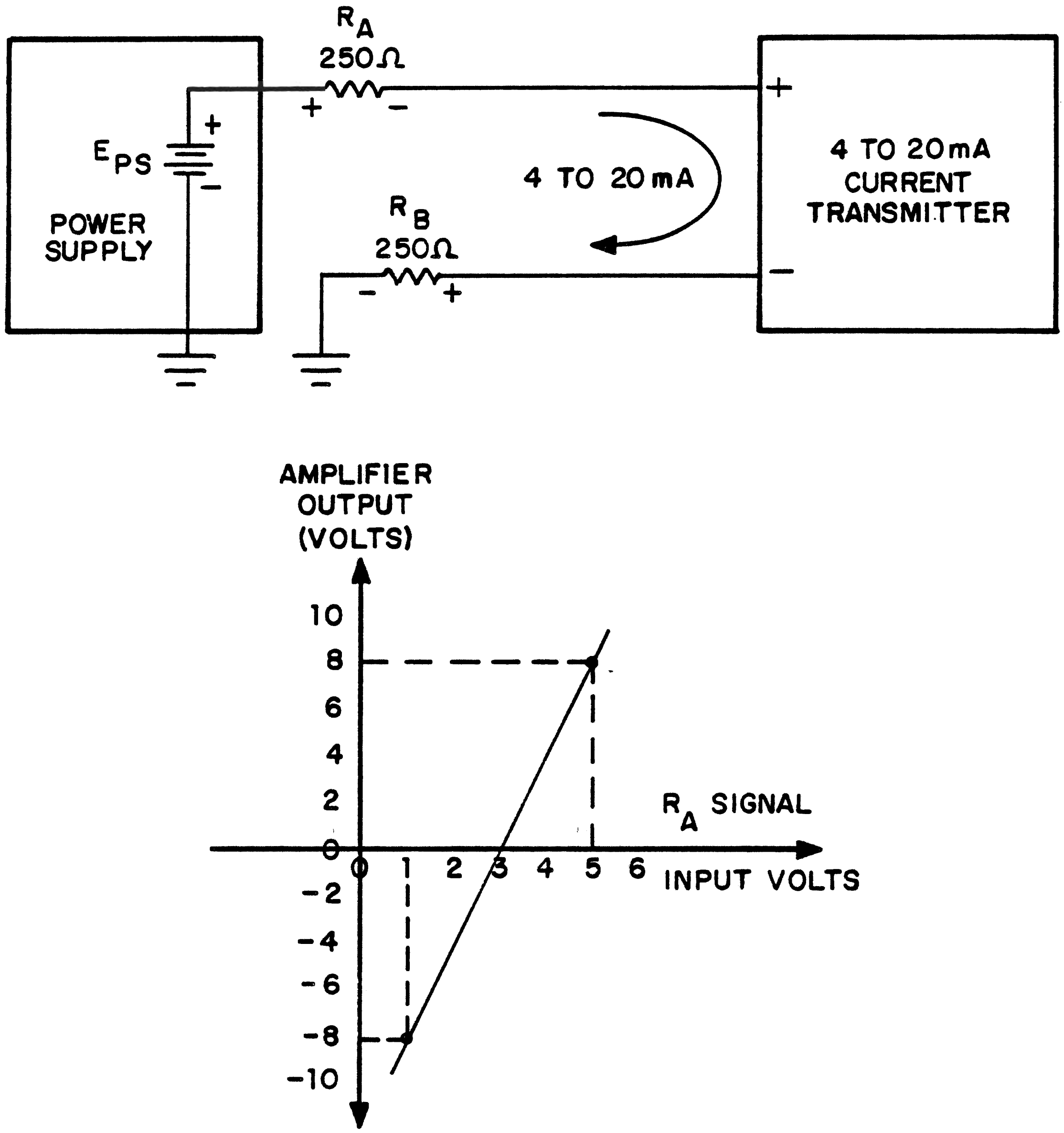
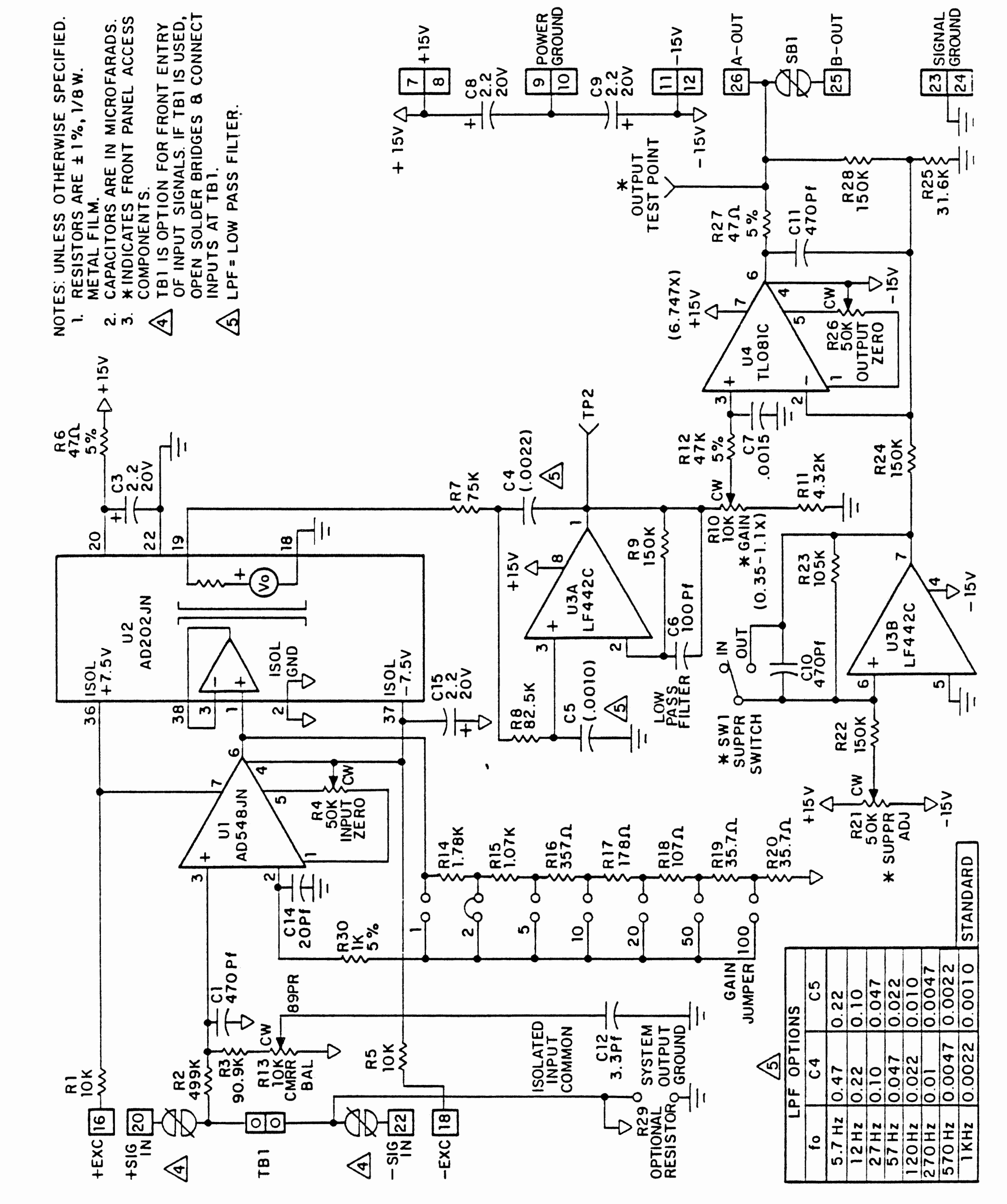


Figure 2-3. Current Loop Application



5 LPF OPTIONS

fo	C4	C5
5.7 Hz	0.47	0.22
12 Hz	0.22	0.10
27 Hz	0.10	0.047
57 Hz	0.047	0.022
120 Hz	0.022	0.010
270 Hz	0.01	0.0047
570 Hz	0.0047	0.0022
1 KHz	0.0022	0.0010 STANDARD

Figure 3-1. Schematic Diagram