PT174
Resistance Temperature Detector Conditioner

INDEX

1.0 GENERAL

1.1 Description

The PT174 is a plug-in signal conditioning module of the Validyne MC170 High Density Multi-Channel Modular Transducer Control System. The PT174 furnishes excitation to remote Platinum or Nickel RTD's, using separate supply and sense leads to avoid lead resistance errors.

The PT174 amplifies and filters the output to indicate probe temperature with a scale factor of +1V output for a ΔT of +100°F over a range of -300°F to +1000°F.

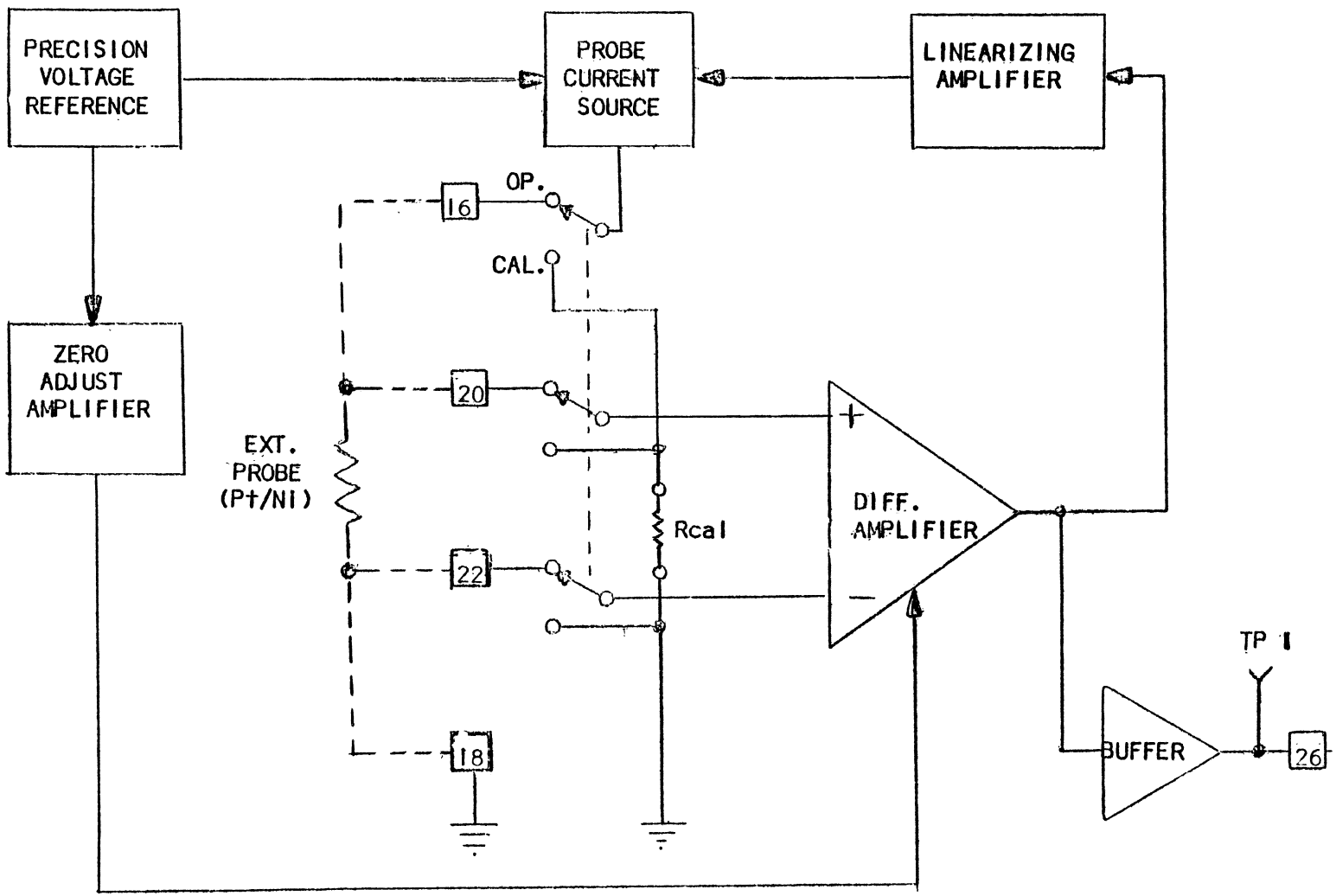
The high density packaging of the MC170 intends it for system use where the PT174 would be dedicated to a single probe. A front panel switch allows single-point calibration at a simulated temperature by the use of a user-installed resistor.

A wide-range Zero circuit is provided so that the PT174 can be made to read '0' volts out at any temperature in the operating range. Linearization is applied to both the Pt and Ni circuits for optimum accuracy over the operating range.

Power to operate the PT174 is obtained from the MC170 Module Case P.C. Board Connector (bussed from PS176 Power Supply Module).

1.2 Functional Block Diagram

A Functional Block Diagram of the PT174 appears in Fig. 1.1.



MC170 P.C. Board Connections:

FIG 1.1 PT-174 FUNCTIONAL BLOCK DIAGRAM

2.0 SPECIFICATIONS

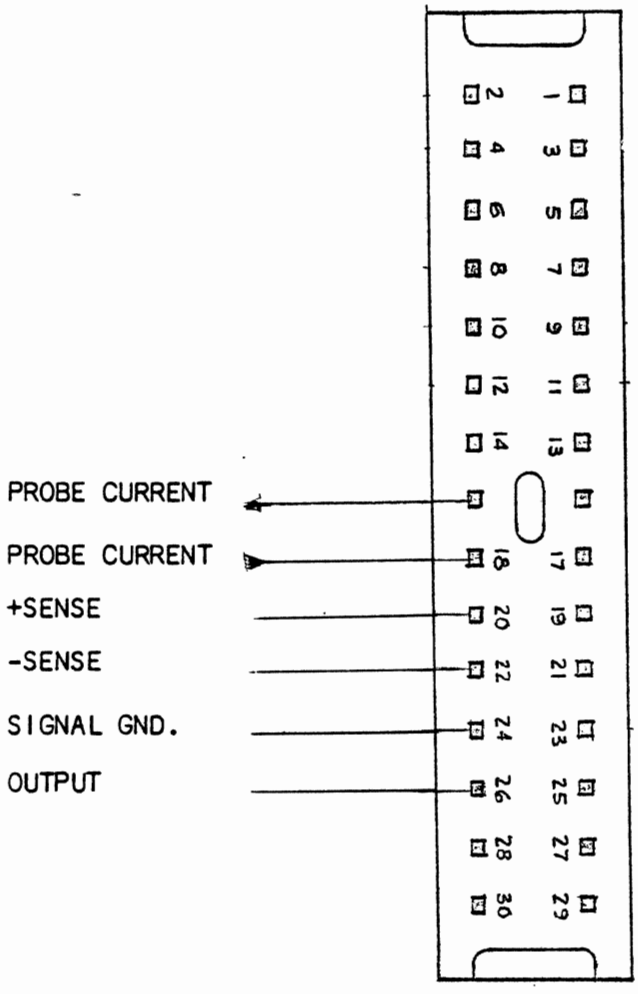
2.1 Electrical

Sensitivity:	+1V per +100°F
Range:	-300°F to +1000°F for -3V to +10V Output
Zero Range:	+10°F Minimum, May be extended to -300°F to +1000°F by Internal Modifications
Current Output:	2mA Maximum
Probe Material:	Platinum or Nickel Alloy
Probe Connections:	Std. 4-Wire Connections
Probe Resistance:	100 ohms, Standard. Any Value Between 50 and 2500 ohms May be Used by Changing One Internal Resistor.
Probe Current:	1mA with 100 ohm Probe. For Other Probe Resistances: $I = \frac{0.1}{R(Probe)}$ (mA) for Platinum Probes; $I = \frac{0.11}{R(Probe)}$ (mA) for Nickel Probes
Calibration:	Internal Resistor, Front Panel Selected
Linearity: (V out vs. Temp.)	Better than ±0.1% FS USING STANDARD RTD Curves (IPTS 1968)
Frequency Response:	10Hz (t_R = 35m Sec.)
Temperature:	Operating Range 0° to +150°F
Zero/T(°F)	0.02°F/°F
Range/T(°F)	0.01°F/°F
Power Required:	+15V DC, Supplied by PS176 Power Supply Module

2.2 Mechanical

Size:	2.76"H X 0.45"W X 7.5"D (7cmH X 1.13cmW X 19cmD)
Weight:	6 oz. (AVDP) (168 grams)

Input and Output Connections: (Accessible through Printed Circuit Board Connector at Rear of MC170 Module Case.)



Printed Circuit Board Connector

As Viewed from Rear of MC170 Module Case

(WIRE-WRAP TERMINAL VERSION)

Pin Assignments, PT174

Figure 3.2.1

3.0 INSTALLATION & OPERATION

3.1 Installation

The PT174 may be installed in any one of the 25 card slots in the MC170 Module Case. The ±15V DC power and grounds are bussed to all MC170 P.C. Board connectors and require no further connections by the customer (user).

3.2 Input/Output Connections

The 30-pin rear connector is shown in Fig. 3.2.1. Since the p.c. card has connections on both sides, only the terminals indicated should be used.

The power supply and grounds are bussed at the factory. NOTE: SIGNAL AND POWER GROUND ARE CONNECTED AT THE POWER SUPPLY, AND SHOULD NOT BE CONNECTED AT THE P.C. CONNECTOR.

All probe current is carried separate from sense leads, and should be connected accordingly. For example:

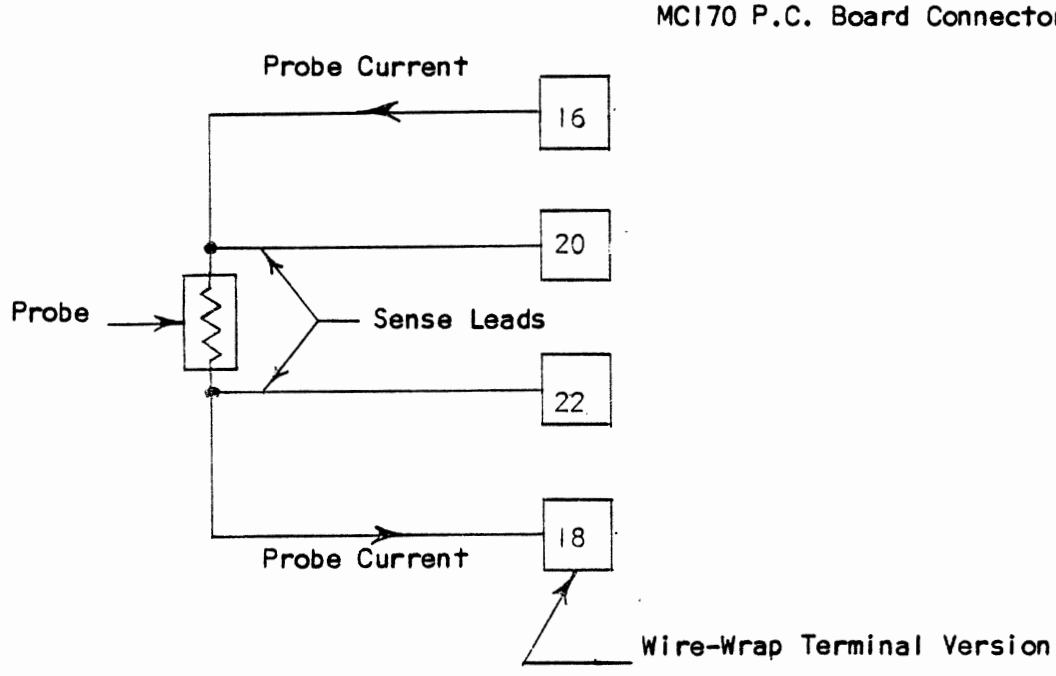


Figure 3.2.2 - Probe Connections

3.3 Platinum/Nickel Probes

The PT174 is shipped from the factory adjusted for use with 100 ohm platinum probes. (Nickel probes and/or other probe resistances may be specified at time of order and manufacturer's curve should be supplied).

Fig. 3.3.1 shows the location of R7. When R7 is connected to the "A" terminal, the PT174 is set for Pt. probes. When R7 is connected to the "B" terminal, the PT174 is set for Nickel probes.

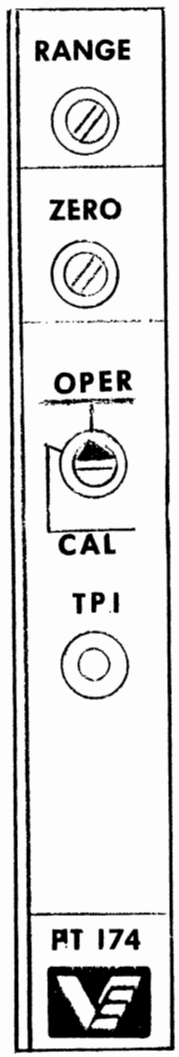
Resistor R1 as indicated in Fig. 3.3.1 also must be changed when Micro Measurement Nickel probes are used. (Values shown are for Ni. probes of 50 ohms at 75°F).

The table below indicates values:

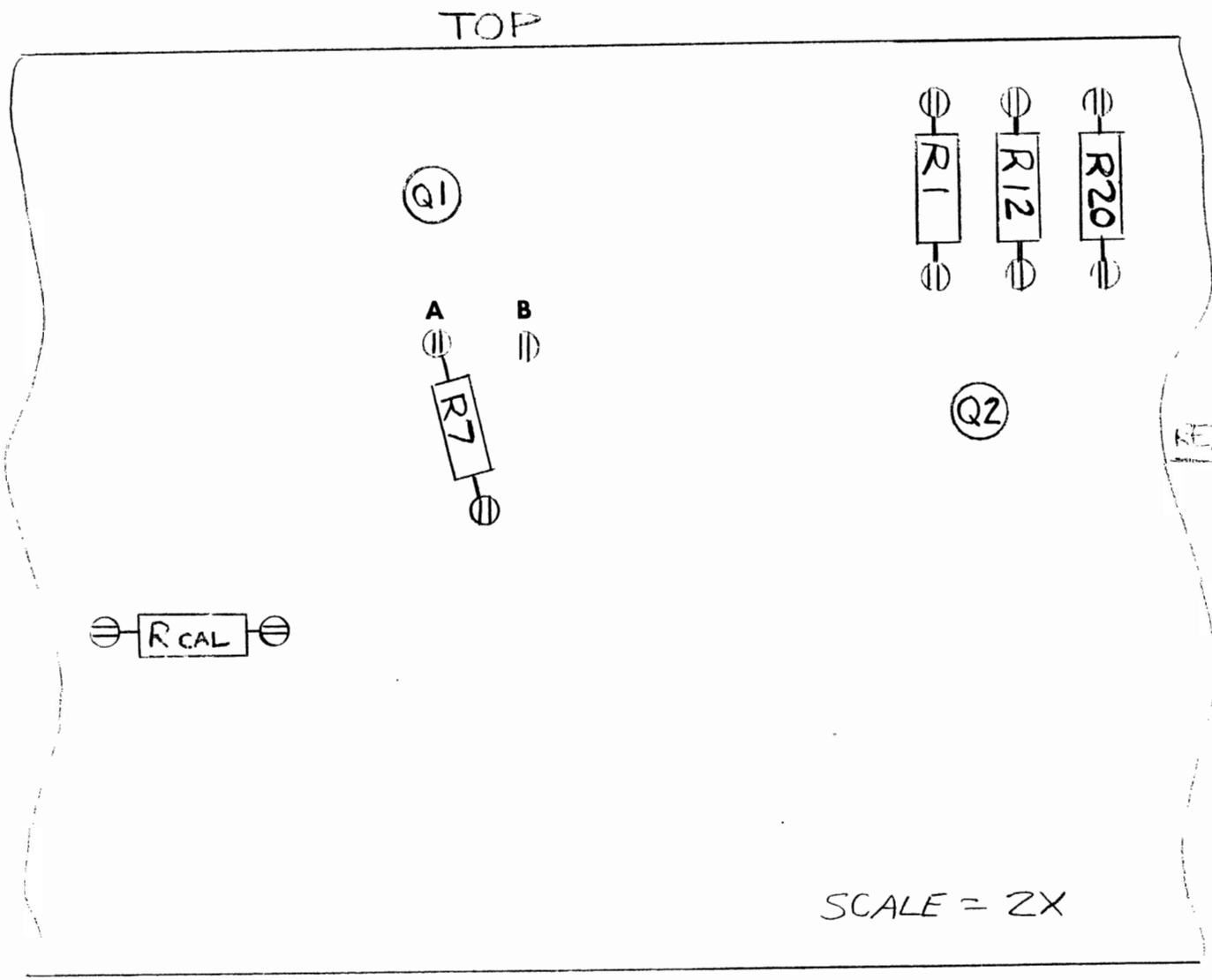
R# / PROBE	Pt. (R7 to "A")	Ni. (R7 to "B")
R1	4.99K ohms	2.21K ohms
R7	332K ohms	40.2K ohms

NOTE: All resistors are Metal Film type, 1/8 Watt, ±1% Tolerance, Type RN55 or equal.

Many probe types (including Balco) can be used with the PT174. The factory should be consulted for selection of resistance values to adjust probe current, overall gain, and linearization. DO NOT attempt these changes without factory advice.



Front Panel



Component Locations, p.c. board.

FIG. 3.3.1 PT174 Controls and Key Component Locations

Validyne ENGINEERING CORPORATION

3.4 Probe Resistance Changes

In order to maintain a probe current which develops a sense voltage within the dynamic range of the amplifier, RI, the probe current resistor, must be varied. A simple equation indicates the resistor value.

EQ.1 For Pt. Probes:

R_I = Rprobe X 50

EQ.2 For Ni. Probes:

R_I = Rprobe X 44

Example: For a Pt. 100 ohm probe,

R_I = 100 X 50 = 5000 ohms

Selecting the nearest 1% value from the RN55 Chart indicates a value of 4.99K ohms.

3.5 Range Set Control

The 20 turn Range Set control is accessible at the top of the panel. This control offers a ±5% range adjustment at the amplifier output, and allows upscale calibration of the PTI74 and the RTD. See Sec. 3.7, Calibration Procedure for details.

3.6 Zero Set Control

The 20-turn Zero Set control is accessible below the Range control on the front panel. This control offers a ±4% zero adjustment, and provides zero output for 0°F resistance of the probe. The Zero Set Control range can be increased by reducing the value of R_{12} and other circuit changes.

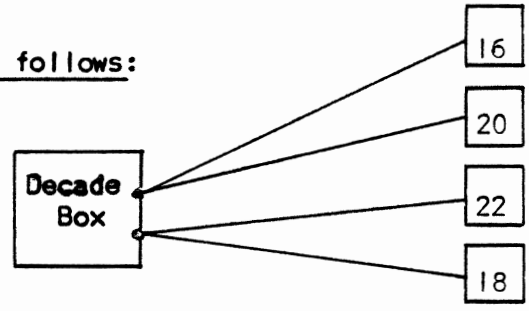
Consult the factory for exact values to fit the application. See Sec. 3.7 for details on calibration.

3.7 Calibration Procedure

3.7.1 Laboratory Calibration

In place of the probe, connect a precision decade box using the P.C. Board Connector on the rear of the MC170 Module Case for the channel to be used;

Connections as follows:



Minitor the DC output of the PT174 either through the rear connector ("Output" and "Signal Ground"), or the Test Point on the front panel of the PT174 and the "Gnd." jack on the PS176 Power Supply module. From the standard table of values for the probe material to be used, adjust the decade box to the resistance value corresponding to 0°F. Adjust the ZERO control until the DVM reads 0.00 V.

Next, a temperature/resistance value near the maximum operating temperature of the probe is applied to the decade box and the RANGE control adjusted to produce the appropriate DVM reading (for ease of calibration a resistance value corresponding to a multiple of 100°F can be used, e.g. 200°, 300°, etc., as the output scale factor to be maintained in 1V/100°F).

Example: For a 100 ohm Platinum probe, the probe resistance corresponding to 0°F is 92.89 ohms, and for 500°F, 199.61 ohms.

Zero--Set the decade box to 92.89 ohms; adjust the Zero control until the DVM reads 0.00V.

Range--Set the decade box to 199.61 ohms; adjust the Range control until the DVM reads 5.00V.

NOTE: The Zero and Range controls are not interactive and should not require further adjustment.

3.7.2 Field Calibration

The PT174 provides for single-point field calibration by a front panel OPER-CAL screwdriver actuated switch. Bifurcated terminals are provided for monitoring a user-supplied calibration resistor on the printed circuit board (R_{CAL} on Figure 3.1).

3.7.2 Field Calibration (Cont.)

Again from the Temperature/Resistance tables for the probe material to be used, a fixed resistor corresponding to a known temperature in the operating temperature range is selected and installed in the R_{CAL} terminals provided.

With the OPER-CAL switch in the CAL position the output of the PT174 is measured and recorded for use in subsequent periodic field performance checks.

CAUTION--The OPER-CAL switch is a 6-position, detented rotary device without internal limit stops. Switch position is indicated by a black arrow on the adjustment screw face, and by indexing lines on the front panel of the PT174. If the switch is placed in any unmarked position an open-circuit condition will exist, resulting in no output from the module.

4.0 PRINCIPLES OF OPERATION

The PT174 utilizes the instrumentation amplifier circuit to measure the exact voltage developed across a precious metal RTD when a constant current is passed through the probe.

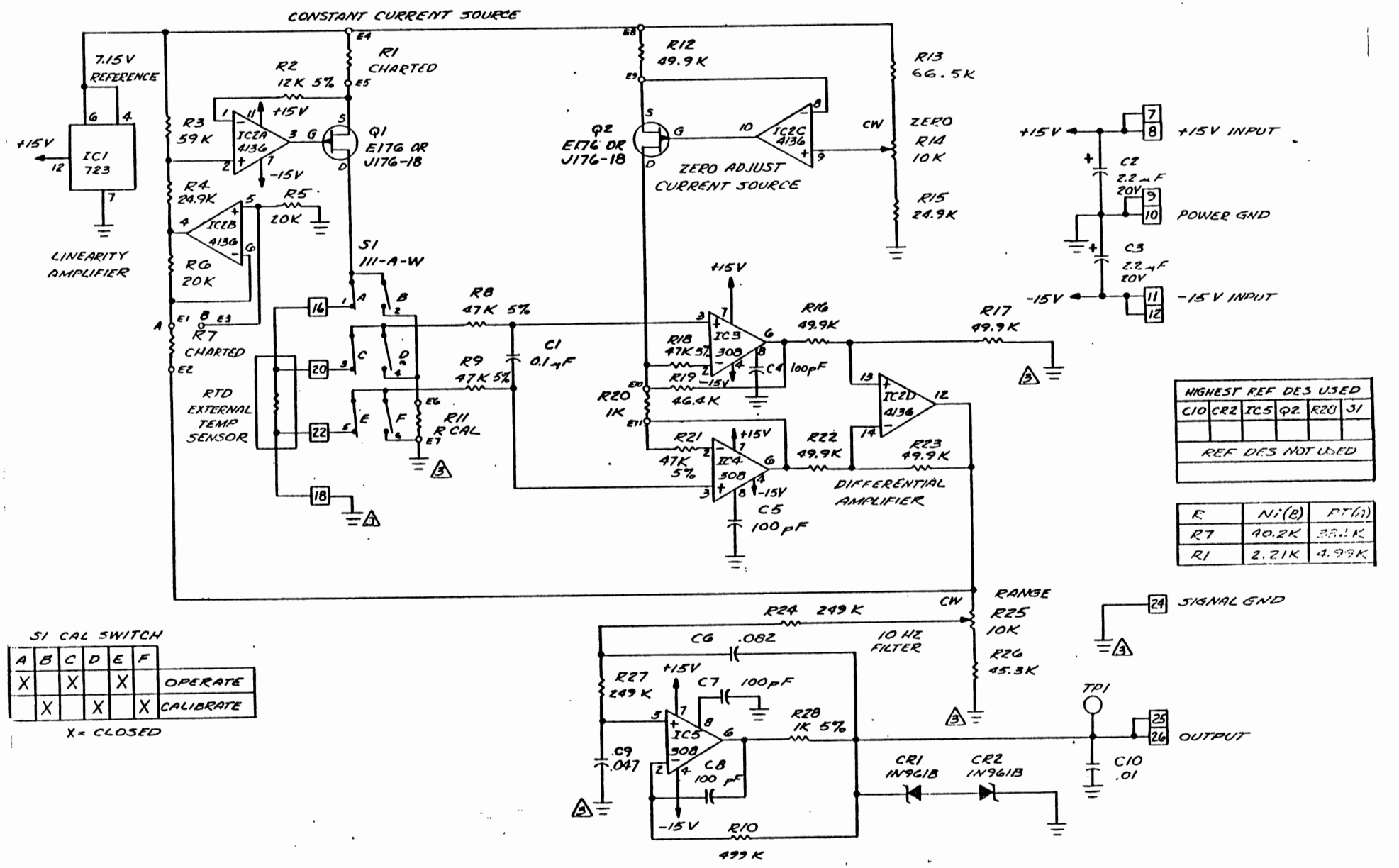
A 4-wire probe circuit is used to prevent line resistance effects on the temperature measurements. The sense leads are connected through a simple filter network to the high impedance inputs of the instrumentation amplifier.

Probe current is controlled by an amplifier driving a current set resistor, R_1. Linearization of the Platinum RTD is achieved by returning a small part of the output to a second amplifier which drives the reference. For Nickel probes, the sense of the returning signal is reversed to match the Positive Temperature coefficient of Nickel Probes. (R_7 connected to Point B) The normal Pt. RTD linearity of 2.2% has been improved to better than 0.5% by this technique.

The ZERO control is achieved by adding a current to the input of the instrumentation amplifier. Since the zero and probe current generators use the same precision reference, zero drift is minimized.

The output buffer amplifier uses both positive and negative feedback to produce a sharp cutoff low pass filter at 10 Hz.

The output is limited to ±10 volts by zener diodes. This prevents overload and possible damage to following data acquisition system inputs.



R	Ni(Ω)	PT(Ω)
R7	40.2K	39.2K
R1	2.21K	4.99K

S1 CAL SWITCH

A	B	C	D	E	F	
X		X		X		OPERATE
	X		X		X	CALIBRATE

X = CLOSED

3. SIGNAL GROUND.
2. CAPACITOR VALUES ARE IN MICROFARADS.
1. RESISTOR VALUES ARE IN OHMS ± 1%, 1/8 WATT.

NOTES: UNLESS OTHERWISE SPECIFIED