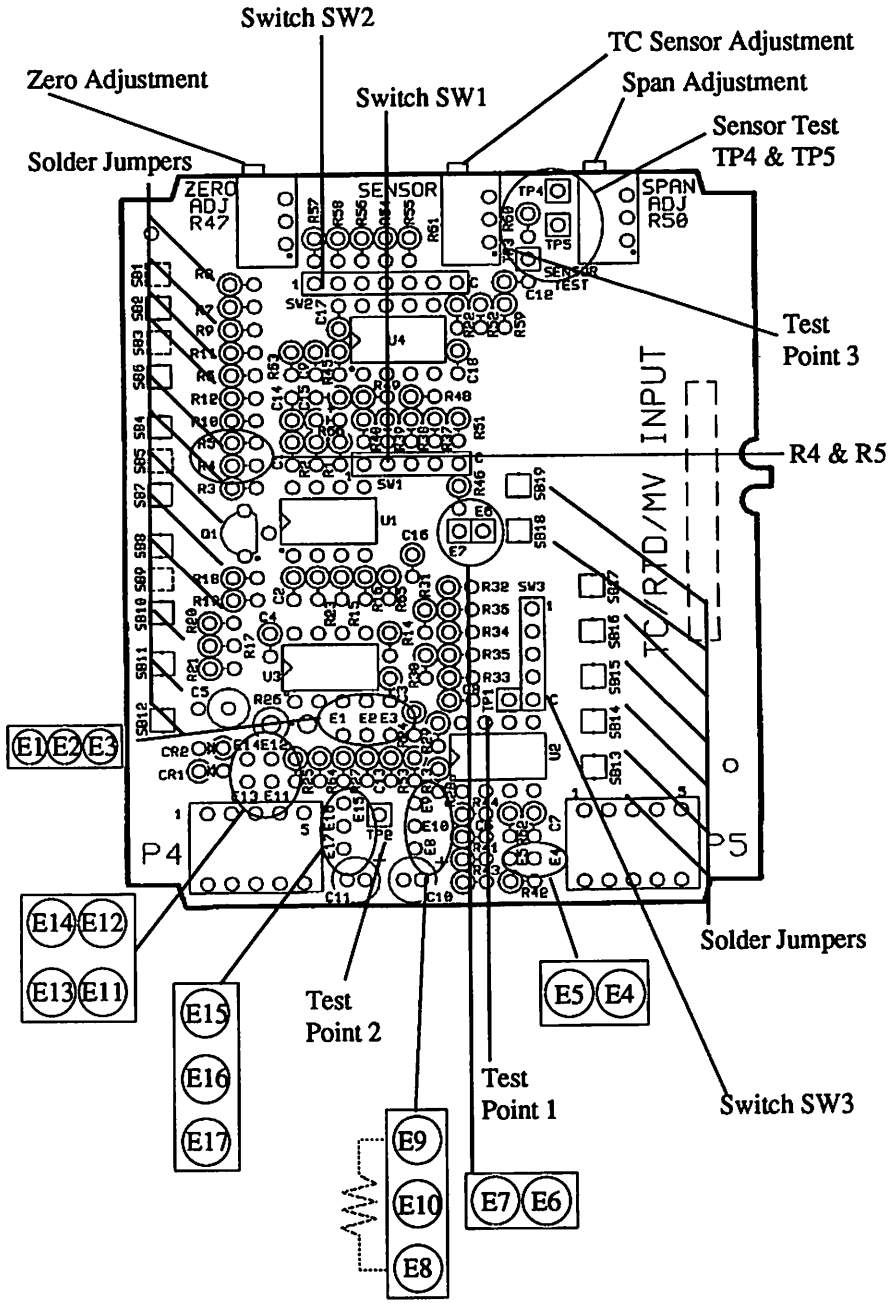
TC/RTD/mV Input Board Part Locations



Purpose

This board provides a compensated voltage output proportional to a sensor input from either a TC or an RTD. DC millivolt inputs are also provided for on this board.

Note: Should you need linearization of sensor characteristics, use the Linearization Board in conjunction with this input board.

Specifications

Accuracy: Linearity, zero drift, gain drift, offset for TC/RTD (see Input Span tables on pages 04-4 and 04-6); mVDC: 0.25%FS
Response Time: <100ms *Repeatability:* ±0.1% FS
Break Detection: (up or down) < 100nA *Stability:* 0.025%/°C
Span Adjustment: See Input Span tables *Zero adjustment:* ±12.5%

Thermocouple

Input: Selectable Thermocouples: J, K, T, E, R, S, B (single or differential)
Break Detect: Upscale, downscale, or none
Cold Junction Compensation: 0.05 degree/degree; over 0-60°C ambient
Impedance: >1MΩ
Overload Protection: 50VDC or VAC peak

TC Ranges-Full-Scale Accuracy

Type	Range	Accuracy >0°C
J	0 to 750°C	2°C
K	0 to 1370°C	2°C
T	-160 to 350°C	2°C
E	-200 to 900 °C	2°C
R	0 to 1450°C	6°C
S	0 to 1450°C	6°C
B	350 to 1700°C	9°C

RTD

Input: Selectable (2-wire, 3-wire, or differential)
Pt 100Ω; Ni 120Ω; Cu 10Ω (any alpha)
Excitation Current: 0.5, 1.0, 2.0, 5.0, 10mA ±2%; Compliance Limit: 2V
Impedance: 1MΩ
Overload Protection: 5V
Lead Wire Error: (0.5mA excitation current)
0.02 Ohm per Ohm, for balanced leads

RTD Differential Minimum Spans

Type	Minimum Span	Accuracy
Pt 100	15°C	0.15°C
Ni 120	12°C	0.15°C
Cu 10	25°C	0.25°C

RTD Ranges-Full-Scale Accuracy

RTD Type	Range	Accuracy	Excitation
Pt 100	-200 to +600°C	2°C	1mA
Pt 100	0 to 600°C	1.5°C	1mA
Ni 120	0 to 320°C	1°C	1mA
Cu 10	0 to 260°C	2°C	10mA

Lead Wire Resistance

Maximum Ohm/Lead	Excitation (mA)
40	0.5
40	1.0
40	2.0
30	5.0
20	10.0

Millivolt

Input: Ranges (spans): VDC
Minimum: 0-8mV; Maximum: 0-100mV
Bipolar: ±4mV to ±50mV

For general specifications, see the Series 8000 operator's manual, which provides general information for the entire series.

Setup Procedure

I. Disassemble the Series 8000 unit as described on page 6 of the main manual.
II. Remove the TC/RTD/mV Input Board.
III. Set the unit for TC/mV or RTD as described at the beginning of Setup Instructions on page 04-2. Follow the appropriate setup instructions beginning on page 04-3 for TC/mV mode, or on page 04-5 for RTD mode.
IV. Reassemble the unit as described in the main manual, pages 4 to 6.
V. If you have selected TC mode, and require cold junction compensation, you must first calibrate the cold junction sensor as described on page 04-7. If you do not require cold junction compensation (using external ice bath reference or differential TC setup), or you are using RTD, calibrate the unit as described in Calibration (TC/mV and RTD) on page 04-7.

Note: If you have an unused pin jumper, "park" it on one pin so it will not be lost. After closing indicated solder jumpers, ensure that all others are open.

Setup Instructions

Select Input Type (TC or mV mode)

TC or mV Mode

Make the following jumper pin connections (see page 04-8 for locations):
Close: E1-E2, E6-E7, E13-E14, E8-E10(socket jumper)
Open: E4, E5

RTD Mode

Make the following jumper pin connections (see page 04-8 for locations):
Close: E2-E3, E4-E5, E9-E10, E11-E13, E12-E14
Open: E6, E7, E15, E16, E17

RTD Offset

Offset	SB18	SB19
+12.5%	open	close
-12.5%	close	open

Other RTD Types and Temperature Offsets

Find the resistance at the needed minimum temperature. Select R4* for this resistance (±12.5% of span). R5 is in parallel with R4, and can be used if you need a resistor value you do not have. Use a 1% metal film, 50PPM resistor or better.

Differential Option

For a differential option, close SB8. Select the current excitation from the Excitation Current Selection table on page 04-6. Use the formula on page 04-6 to determine the input voltage span needed (see manual for hookup instructions).
* For Differential RTD, select E10 to E9 resistor instead of R4 and R5 – see drawing on page 04-8.

Calibration (TC/mV and RTD)

1. If you require cold junction compensation (TC only), you must first calibrate the cold junction as described separately below. Or if you are using RTD, continue at step 2.
2. Set switches and jumpers for desired input and output.
3. Connect correct TC or RTD type from voltage calibrator to unit.
4. Turn on unit.
5. Set input to minimum*.
6. Adjust input zero until LED lights.
7. Adjust output zero for minimum output.
8. Set input to maximum.
9. Adjust span for maximum output.
10. If you cannot adjust output low enough, set SW1 switch 4*.

* For TC, use mV corrected for ambient temp or TC wire with ice point reference.

Cold Junction Sensor Calibration (TC inputs only)

1. Turn on unit.
2. Turn on and allow 15-20 min. for warm up. Calibrate sensor according to table.
3. Attach volt meter to test points (TP4 & TP5) and measure ambient temp (°F).
4. Look up temperature on the chart below*.
5. Adjust sensor potentiometer to the appropriate mV setting.

* For temperatures not shown, mV values may be interpolated.

Cold Junction Adjustment Table

C°	F°	Input mV	C°	F°	Input mV
15	59	612.43	23	73.4	594.54
15.5	59.9	611.32	23.5	74.3	593.42
16	60.8	610.20	24	75.2	592.30
16.5	61.7	609.08	24.5	76.1	591.17
17	62.6	607.96	25	77	590.05
17.5	63.5	606.85	25.5	77.9	588.93
18	64.4	605.73	26	78.8	587.81
18.5	65.3	604.61	26.5	79.7	586.69
19	66.2	603.49	27	80.6	585.57
19.5	67.1	602.37	27.5	81.5	584.45
20	68	601.25	28	82.4	583.32
20.5	68.9	600.14	28.5	83.3	582.20
21	69.8	599.02	29	84.2	581.08
21.5	70.7	597.90	29.5	85.1	579.95
22	71.6	596.78	30	86	578.83
22.5	72.5	595.66			

Other Ranges
For ranges not listed above, determine the input voltage needed using this equation:

$$(I_{Exc}) \times (R_{High} - R_{Low}) = \text{Input Voltage Span (must be less than 340mV)}$$

I_{Exc} = excitation current (Amps), R_{High} = resistance of the RTD at the maximun input in Ohms, and R_{Low} = resistance of the RTD at the minimum input in Ohms. Select the excitation current from the following table and set the corresponding solder jumper:

Excitation Current Selection

Excitation Current	Solder Jumper
0.5mA	None
1.0mA	SB9
2.0mA	SB10
5.0mA	SB11
10.0mA	SB12

Find the span in the following table and set SW1–SW3 switches accordingly.

RTD Input Span

Input Span V_{IN} (mV)	SW1	SW2	SW3	Input Span V_{IN} (mV)	SW1	SW2	SW3
21.2355-23.7141	3	6	None	96.27-108.01	1	6	3
23.7141-26.6133	2	6	None	108.01-121.163	None	6	3
26.6133-29.8585	1	6	None	119.72-132.764	3	6	4
29.8585-33.4944	None	6	None	132.764-150.043	2	6	4
32.8782-36.7158	3	6	1	150.043-168.339	1	6	4
36.7158-41.2044	2	6	1	168.339-188.84	None	6	4
41.2044-46.228	1	6	1	175.305-195.767	3	6	4,3
46.228-51.8583	None	6	1	195.767-219.699	2	6	4,3
51.8583-56.9137	3	6	2	219.699-246.491	1	6	4,3
56.9137-63.8716	2	6	2	246.491-276.507	None	6	4,3
63.8716-71.6602	1	6	2	216.678-241.968	3	6	4,3,2,1
71.6022-80.3865	None	6	2	241.968-271.549	2	6	4,3,2,1
76.8171-85.7829	3	6	3	271.549-304.663	1	6	4,3,2,1
85.7829-96.27	2	6	3	304.663-341.76	None	6	4,3,2,1

The Zero Reference Point
The zero reference point can be configured for either 0°C or 0°F for a selected RTD, by closing the SB1-SB7 solder jumpers as follows:

RTD Common Offset

Type	0°C	0°F
Pt 100	SB3,SB5	SB1,SB3,SB5
Ni 120	SB2,SB4	SB1,SB2,SB4
Cu 10	SB6,SB7	SB1,SB6,SB7

Calculate the offset using the following formula:

$$\text{Offset} = \left(\frac{V_{Low}}{V_{High} - V_{Low}} \right) \times 100\%$$

The zero offset adjustment is ±12.5%. For fixed ±12.5% offset (with a maximum of ±25%, zero adjustment, and fixed offsets), set the SB18 and SB19 solder jumpers as follows:

Range Selection

TC/mV

Determine the thermocouple type in use and the temperature range needed. For common settings, you can use the following quick setup guide (then proceed to break detection setup on page 04-5). Set SW1-SW3 switches ("Off" means all switches on that switch are in the off position) and close the solder jumpers as described:

TC Quick Setup Guide

Type	Range	Switch Settings SW1	SW2	SW3	Solder Jumpers	+Offset R28
K	0-1200°F	Off	1	2	None	None
K	0-400°F	2	1	Off		
K	0-1370°C	1	1	4		
K	0-500°F	Off	1	Off		
K	0-1500°F	2	1	3		
K	0-500°C	3	1	2		
K	0-1000°C	Off	1	3		
J	800-1200°F	3	2	1	SB13	84.5k
J	500-1000°F	1	2	1		140k
J	0-300°F	2	2	Off	None	
J	0-750°C	Off	2	3		
J	0-1000°F	3	2	3		
J	0-500°C	Off	2	2		
T	-160-350°C	2	3	2	SB14,SB15	None
T	-250-250°C	Off	3	1	SB16	
T	0-250°C	3	3	1		
E	0-300°F	1	5	Off	None	None
E	0-500°F	3	5	2		
E	0-1000°F	Off	5	3		
E	0-125°C	3	5	Off		
E	0-200°C	3	5	1		
R	0-1000°C	1	4	Off	None	None
R	0-2000°F	Off	4	Off		
R	0-2500°F	1	4	1		
S	0-2000°F	1	4	Off	None	None
S	0-1000°C	2	4	Off		

Other TC/mV Ranges

If you require settings not listed in the quick setup guide, select the thermocouple type (or mV range) that you are using and set SW2 according to the following table:

TC Selection

TC Type	SW2
K	1
J	2
T	3
R or S	4
E	5
B or mV	6

Determining Input Range Settings

After you have selected the thermocouple or millivolt setting, determine the needed range for your application by the following formula:

$$V_{High} - V_{Low} = \text{Input Span}$$

where V_{High} = TC voltage at desired maximum temperature and V_{Low} = TC voltage

at desired minimum temperature (refer to standard NBS mV versus temperature charts to determine V_{High} and V_{Low} (these steps also apply to DC mV inputs). Find the range in the table below and set SW1 and SW3 switches accordingly:

TC/mV Input Span Table

Input Span V_{IN} (mV)	SW3	SW1	Input Span V_{IN} (mV)	SW3	SW1
7.66-8.553	Off	3	34.72-38.96	3	1
8.553-9.598	Off	2	38.96-43.702	3	Off
9.598-10.77	Off	1	43.1825-48.223	4	3
10.77-12.08	Off	Off	48.223-54.116	4	2
11.8587-13.26	1	3	54.116-60.720	4	1
13.26-14.88	1	2	60.720-68.111	4	Off
14.88-16.70	1	1	63.23-70.61	4,3	3
16.70-18.733	1	Off	70.61-79.24	4,3	2
18.3824-20.53	2	3	79.24-88.91	4,3	1
20.53-23.036	2	2	88.91-99.73	4,3	Off
23.036-25.85	2	1	73.953-82.58	4,3,2,1	3
25.85-28.974	2	Off	82.58-92.677	4,3,2,1	2
27.7067-30.94	3	3	92.677-103.99	4,3,2,1	1
30.94-34.72	3	2	103.99-116.645	4,3,2,1	Off

Calculating Offset and Offset Adjustment

The standard reference setting is 0°C based signal (minimum input value, V_{Start} = 0mV). You can calculate the percentage offset from standard with the following:

$$\text{Offset} = \left(\frac{V_{Low} - V_{Start}}{V_{High} - V_{Low}} \right) \times 100\%$$

The zero (minimum input) potentiometer will adjust ±12.5% of the selected range. For a fixed positive 12.5% offset, close SB19. For a fixed negative 12.5% offset, close SB18. (For a maximum of ±25% with zero adjustment.)

Select the desired minimum input starting point for your specific thermocouple from the following table and close the specified solder jumpers.

TC Offset Table

Type	-200°C	-100°C	-50°C	0°C
K	SB16	SB15	SB14	None
T	SB16	SB15	SB14	None
E	SB15, SB16	SB16	SB15	None

For non-standard offsets and DC mV inputs, select the needed offset from the following table and close the indicated solder jumpers (only).

Voltage at Minimum V_{Start}

Offset	0mV	-2mV	-3mV	-5.06mV	-5.8mV	-8.84mV	-10.75mV
Solder Jumper	None	SB14	SB15	SB14 SB15	SB16	SB15 SB16	SB14 SB15 SB16

Other Offsets (positive or negative)

If you require a reference point other than these, this can be calculated using the following formula:

$$\frac{2000}{V_{Low}} = \text{R28 or R32 in Ohms (see text)}$$

V_{Low} = voltage of the thermocouple (minimum temperature) in Volts, or low mV input, and R = resistance in Ohms. Use an R28 resistor and close SB13 for positive reference,or an R32 resistor and close SB17 for negative reference. Use a 1% metal film, 50PPM resistor or better. Use a resistor value that is within 12.5% of R.

Break Detection Setup for TC

Three break detection options are available: upscale, downscale, or no break detection. To select an upscale break detection option, connect the E17-E16 jumper pins. To select downscale, connect the E16-E15 jumper pins. To select the no break detection option, leave pin jumpers E15 through E17 unset.

Differential Option for TC

Thermocouples used in the defferential mode do not need cold junction compensation . Set SW2 switch 6 (mV) to on. Find differential V_{max} and V_{min}. Span = V_{max} - V_{min}. V_{min}/Span =offset. Select span and offset switches as shown on page 04-4.

Proceed to Calibration on page 04-7.

RTD

To compensate for the resistance in wires, input to this device is 3-wire. When wiring this unit, input wires should be the same length and gage.

Determine the type of RTD that you are using and the range and the current excitation that you require. For common settings, use the Quick Setup Guide below.

RTD Quick Setup Guide

Type	Range	Switch Settings SW1	SW2	SW3	Solder Jumpers	Offset R4; R5	Excitation Current
Pt	0-500°F	1	6	3	SB1,SB3,SB5,SB9		1mA
Pt	0-100°F	3	6	N	SB1,SB3,SB5,SB9		1mA
Pt	0-250°F	3	6	2	SB1,SB3,SB5,SB9		1mA
Pt	0-1000°F	1	6	3	SB1,SB3,SB5		0.5mA
Pt	0-100°C	2	6	1	SB3,SB5,SB9		1mA
Pt	0-250°C	2	6	3	SB3,SB5,SB9		1mA
Pt	0-500°C	2	6	4	SB3,SB5		0.5mA
Pt	-100-100°C	N	6	2	SB9	60.4Ω 1%	1mA
Pt	-50-50°C	2	6	1	SB9	80.6Ω 1%	1mA
Ni	0-100°C	3	6	3	SB4,SB2,SB9		1mA
Ni	0-250°C	3	6	4	SB4,SB2		0.5mA
Ni	0-300°C	1	6	4	SB4,SB2		0.5mA
Ni	0-100°F	2	6	1	SB4,SB2,SB1,SB9		1mA
Ni	0-500°F	2	6	4	SB4,SB2,SB1		0.5mA
Cu	0-100°F	3	6	N	SB6,SB7,SB1,SB12		10mA
Cu	0-200°F	3	6	1	SB6,SB7,SB1,SB12		10mA
Cu	0-100°C	2	6	1	SB6,SB7,SB12		10mA

Differential RTD Quick Setup Guide

Type	Operating Range	Range	Switch Settings SW1	SW2	SW3	Solder Jumpers	Offset E10 to E9	Excitation Current
ΔPt	0-100°F	0-20°F	1	6	1	SB8,SB12		10mA
ΔPt	0-250°F	±50°F	2	6	4	SB8, SB12	11.82Ω 1%	10mA
ΔPt	0-1000°F	0-100°F	1	6	4	SB8,SB12		10mA
ΔPt	0-60°C	±10°C	Off	6	2	SB8, SB12	3.88Ω 1%	10mA
ΔPt	0-100°C	0-25°C	2	6	3	SB8,SB12		10mA