Intronics Power®

High Performance, Economy Strain Gage/RTD Conditioners

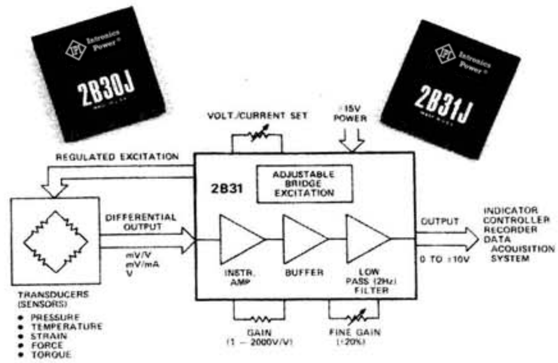
MODEL 2B30J 2B31J

FEATURES

Low Cost
Complete Signal Conditioning Function
Low Drift: 0.5μV/°C max ("L"); Low Noise: 1μV p-p max
Wide Gain Range: 1 to 2000V/V
Low Nonlinearity: 0.0025% max ("L")
High CMR: 140dB min (60Hz, G = 1000V/V)
Input Protected to 130V rms
Adjustable Low Pass Filter: 60dB/Decade Roll-Off (from 2Hz)
Programmable Transducer Excitation: Voltage (4V to 15V @ 100mA) or Current (100μA to 10mA)

APPLICATIONS

Measurement and Control of:
Pressure, Temperature, Strain/Stress, Force, Torque
Instrumentation: Indicators, Recorders, Controllers
Data Acquisition Systems
Microcomputer Analog I/O



TRANSDUCER SIGNAL CONDITIONING USING 2B31

GENERAL DESCRIPTION

Models 2B30 and 2B31 are high performance, low cost, compact signal conditioning modules designed specifically for high accuracy interface to strain gage-type transducers and RTD's (resistance temperature detectors). The 2B31 consists of three basic sections: a high quality instrumentation amplifier; a three-pole low pass filter, and an adjustable transducer excitation. The 2B30 has the same amplifier and filter as the 2B31, but no excitation capability.

Available with low offset drift of 0.5μV/°C max (RTI, G = 1000V/V) and excellent linearity of 0.0025% max, both models feature guaranteed low noise performance (1μV p-p max) and outstanding 140dB common mode rejection (60Hz, CMV = ±10V, G = 1000V/V) enabling the 2B30/2B31 to maintain total amplifier errors below 0.1% over a 20°C temperature range. The low pass filter offers 60dB/decade roll-off from 2Hz to reduce normal-mode noise bandwidth and improve system signal-to-noise ratio. The 2B31's regulated transducer excitation stage features a low output drift (0.015%/°C max) and a capability of either constant voltage or constant current operation.

Gain, filter cutoff frequency, output offset level and bridge excitation (2B31) are all adjustable, making the 2B30/2B31 the industry's most versatile high-accuracy transducer-interface modules. Both models are offered in three accuracy selections, J/K/L, differing only in maximum nonlinearity and offset drift specifications.

APPLICATIONS

The 2B30/2B31 may be easily and directly interfaced to a wide variety of transducers for precise measurement and control of pressure, temperature, stress, force and torque. For applications in harsh industrial environments, such characteristics as high CMR, input protection, low noise, and excellent temperature stability make 2B30/2B31 ideally suited for use in indicators, recorders, and controllers.

The combination of low cost, small size and high performance of the 2B30/2B31 offers also exceptional quality and value to the data acquisition system designer, allowing him to assign a conditioner to each transducer channel. The advantages of this approach over low level multiplexers include significant improvements in system noise and resolution, and elimination of crosstalk and aliasing errors.

DESIGN FEATURES AND USER BENEFITS

High Noise Rejection: The true differential input circuitry with high CMR (140dB) eliminating common-mode noise pickup errors, input filtering minimizing RFI/EMI effects, output low pass filtering (f_c=2Hz) rejecting 50/60Hz line frequency pickup and series-mode noise.

Input and Output Protection: Input protected for shorts to power lines (130V rms), output protected for shorts to ground and either supply.

Ease of Use: Direct transducer interface with minimum external parts required, convenient offset and span adjustment capability.

Programmable Transducer Excitation: User-programmable adjustable excitation source-constant voltage (4V to 15V @ 100mA) or constant current (100μA to 10mA) to optimize transducer performance.

Adjustable Low Pass Filter: The three-pole active filter (f_c=2Hz) reducing noise bandwidth and aliasing errors with provisions for external adjustment of cutoff frequency.

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SPECIFICATIONS (typical @ +25°C and V_S = ±15V unless otherwise noted)

MODEL	2B30J 2B31J	2B30K 2B31K	2B30L 2B31L
GAIN[1]			
Gain Range	1 to 2000V/V	•	•
Gain Equation	$G = (1 + 94k\Omega/R_G)\,[20k\Omega/(R_F + 16.2k\Omega)]$	•	•
Gain Equation Accuracy	±2%	•	•
Fine Gain (Span) Adjust. Range	±20%	•	•
Gain Temperature Coefficient	±25ppm/°C max (±10ppm/°C typ)	•	•
Gain Nonlinearity	±0.01% max	±0.005% max	±0.0025% max
OFFSET VOLTAGES[1]			
Total Offset Voltage, Referred to Input			
Initial, @ +25°C	Adjustable to Zero (±0.5mV typ)	•	•
Warm-Up Drift, 10 Min., G = 1000	Within ±5μV (RTI) of Final Value	•	•
vs. Temperature			
G = 1V/V	±150μV/°C max	±75μV/°C max	±50μV/°C max
G = 1000V/V	±3μV/°C max	±1μV/°C max	±0.5μV/°C max
At Other Gains	±(3 ± 150/G)μV/°C max	±(1 ± 75/G)μV/°C max	±(0.5 ± 50/G)μV/°C max
vs. Supply, G = 1000V/V[5]	±25μV/V	•	•
vs. Time, G = 1000V/V	±5μV/month	•	•
Output Offset Adjust. Range	±10V	•	•
INPUT BIAS CURRENT			
Initial @ +25°C	+200nA max (100nA typ)	•	•
vs. Temperature (0 to +70°C)	-0.6nA/°C	•	•
INPUT DIFFERENCE CURRENT			
Initial @ +25°C	±5nA	•	•
vs. Temperature (0 to +70°C)	±40pA/°C	•	•
INPUT IMPEDANCE			
Differential	100MΩ‖47pF	•	•
Common Mode	100MΩ‖47pF	•	•
INPUT VOLTAGE RANGE			
Linear Differential Input	±10V	•	•
Maximum Differential or CMV Input Without Damage	130V rms	•	•
Common Mode Voltage	±10V	•	•
CMR, 1kΩ Source Imbalance			
G = 1V/V, dc to 60Hz[1]	90dB	•	•
G = 100V/V to 2000V/V, 60Hz[1]	140dB min	•	•
dc[2]	90dB min (112 typ.)	•	•
INPUT NOISE			
Voltage, G = 1000V/V			
0.01Hz to 2Hz	1μV p-p max	•	•
10Hz to 100Hz[2]	1μV p-p	•	•
Current, G = 1000			
0.01Hz to 2Hz	70pA p-p	•	•
10Hz to 100Hz[2]	30pA rms	•	•
RATED OUTPUT[1]			
Voltage, 2kΩ Load[3]	±10V min	•	•
Current	±5mA min	•	•
Impedance, dc to 2Hz, G = 100V/V	0.1Ω	•	•
Load Capacitance	0.01μF max	•	•
DYNAMIC RESPONSE (Unfiltered)[2]			
Small Signal Bandwidth			
-3dB Gain Accuracy, G = 100V/V	30kHz	•	•
G = 1000V/V	5kHz	•	•
Slew Rate	1V/μs	•	•
Full Power	15kHz	•	•
Settling Time, G = 100, ±10V Output Step to ±0.1%	30μs	•	•
LOW PASS FILTER (Bessel)			
Number of Poles	3	•	•
Gain (Pass Band)	+1	•	•
Cutoff Frequency (-3dB Point)	2Hz	•	•
Roll-Off	60dB/decade	•	•
Offset (at 25°C)	±5mV	•	•
Settling Time, G = 100V/V, ±10V Output Step to ±0.1%	600ms	•	•
BRIDGE EXCITATION (See Table 1)			
POWER SUPPLY[4]			
Voltage, Rated Performance	±15V dc	•	•
Voltage, Operating	±(12 to 18)V dc	•	•
Current, Quiescent[6]	±15mA	•	•
TEMPERATURE RANGE			
Rated Performance	0 to +70°C	•	•
Operating	-25°C to +85°C	•	•
Storage	-55°C to +125°C	•	•
CASE SIZE	2" x 2" x 0.4" (51 x 51 x 10.2mm)	•	•

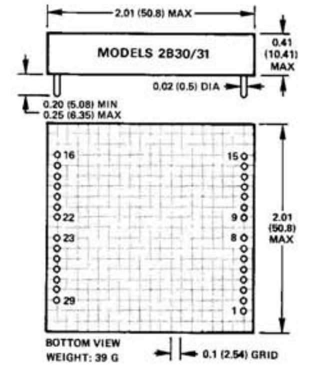
NOTES

*Specifications same as 2B30J/2B31J.
[1] Specifications referred to output at pin 7 with 3.75k, 1%, 25ppm/°C fine span resistor installed and internally set 2Hz filter cutoff frequency.
[2] Specifications referred to the unfiltered output at pin 1.
[3] Protected for shorts to ground and/or either supply voltage.
[4] Recommended power supply ADI model 902-2 or model 2B35
[5] Tracking power supplies.
[6] Does not include bridge excitation and load currents.

Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

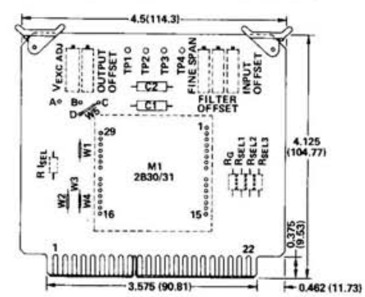


PIN DESIGNATIONS

PIN	FUNCTION	PIN	FUNCTION
1	OUTPUT 1 (UNFILTERED)	16	EXC SEL 1
2	FINE GAIN (SPAN) ADJ.	17	I SEL
3	FINE GAIN (SPAN) ADJ.	18	$V_{EXC\ OUT}$
4	FILTER OFFSET TRIM	19	$I_{EXC\ OUT}$
5	FILTER OFFSET TRIM	20	SENSE HIGH (+)
6	BANDWIDTH ADJ. 3	21	EXC SEL 2
7	OUTPUT 2 (FILTERED)	22	REF OUT
8	BANDWIDTH ADJ. 2	23	SENSE LOW (-)
9	BANDWIDTH ADJ. 1	24	REGULATOR $+V_{R\ IN}$
10	R_{GAIN}	25	REF IN
11	R_{GAIN}	26	$-V_S$
12	-INPUT	27	$+V_S$
13	INPUT OFFSET TRIM	28	COMMON
14	INPUT OFFSET TRIM	29	OUTPUT OFFSET TRIM
15	+ INPUT		

Note: Pins 16 thru 25 are not connected in Model 2B30

AC1211/AC1213 MOUNTING CARDS



AC1211/AC1213 CONNECTOR DESIGNATIONS

PIN	FUNCTION	PIN	FUNCTION
A	REGULATOR $+V_{R\ IN}$	1	EXC SEL 1
B	SENSE LOW (-)	2	I SEL
C	REF OUT	3	$V_{EXC\ OUT}$
D	REF IN	4	$I_{EXC\ OUT}$
E		5	SENSE HIGH (+)
F		6	EXC SEL 2
H		7	OUTPUT OFFSET TRIM
J		8	
K	$-V_S$	9	$-V_S$
L	$+V_S$	10	$+V_S$
M		11	
N	COMMON	12	COMMON
P		13	
R	FINE GAIN ADJ.	14	
S	FINE GAIN ADJ.	15	
T	FILTER OFFSET TRIM	16	
U	FILTER OFFSET TRIM	17	R_{GAIN}
V	OUTPUT 2 (FILTERED)	18	R_{GAIN}
W	- INPUT	19	OUTPUT 1 (UNFILTERED)
X	INPUT OFFSET TRIM	20	BANDWIDTH ADJ. 1
Y	INPUT OFFSET TRIM	21	BANDWIDTH ADJ. 3
Z	+ INPUT	22	BANDWIDTH ADJ. 2

The AC1211/AC1213 mounting card is available for the 2B30/2B31. The AC1211/AC1213 is an edge connector card with pin receptacles for plugging in the 2B30/2B31. In addition, it has provisions for installing the gain resistors and the bridge excitation, offset adjustment and filter cutoff programming components. The AC1211/AC1213 is provided with a Cinch 251-22-30-160 (or equivalent) edge connector. The AC1213 includes the adjustment pots; no pots are provided with the AC1211.

FUNCTIONAL DESCRIPTION

Models 2B30 and 2B31 accept inputs from a variety of full bridge strain gage-type transducers or RTD sensors and convert the inputs to conditioned high level analog outputs. The primary transducers providing direct inputs may be 60Ω to 1000Ω strain gage bridges, four-wire RTD's or two- or three-wire RTD's in the bridge configuration.

The 2B30 and 2B31 employ a multi-stage design, shown in Figure 1, to provide excellent performance and maximum versatility. The input stage is a high input impedance (10^8 Ω), low offset and drift, low noise differential instrumentation amplifier. The design is optimized to accurately amplify low level (mV) transducer signals riding on high common mode voltages (±10V), with wide (1-2000V/V), single resistor (R_G), programmable gain to accommodate 0.5mV/V to 36mV/V transducer spans and 5Ω to 2000Ω RTD spans. The input stage contains protection circuitry for accidental shorts to power line voltage (130V rms) and RFI filtering circuitry.

The inverting buffer amplifier stage provides a convenient means of fine gain trim (0.8 to 1.2) by using a 10kΩ potentiometer (R_F); the buffer also allows the output to be offset by up to ±10V by applying a voltage to the noninverting input (pin 29). For dynamic, high bandwidth measurements—the buffer output (pin 1) should be used.

The three-pole active filter uses a unity-gain configuration and provides low-pass Bessel-type characteristics-minimum overshoot response to step inputs and a fast rise time. The cutoff frequency (-3dB) is factory set at 2Hz, but may be increased up to 5kHz by addition of three external resistors (R_{SEL_1} - R_{SEL_3}).

INTERCONNECTION DIAGRAM AND SHIELDING TECHNIQUES

Figure 1 illustrates the 2B31 wiring configuration when used in a typical bridge transducer signal conditioning application. A recommended shielding and grounding technique for preserving the excellent performance characteristics of the 2B30/2B31 is shown.

Because models 2B30/2B31 are direct coupled, a ground return path for amplifier bias currents must be provided either by direct connection (as shown) or by an implicit ground path having up to 1MΩ resistance between signal ground and conditioner common (pin 28). The sensitive input and gain setting terminals should be shielded from noise sources for best performance, especially at high gains. To avoid ground loops, signal return or cable shield should never be grounded at more than one point.

The power supplies should be decoupled with 1μF tantalum and 1000pF ceramic capacitors as close to the amplifier as possible.

TYPICAL APPLICATION AND ERROR BUDGET ANALYSIS

Models 2B30/2B31 have been conservatively specified using min-max values as well as typicals to allow the designer to develop accurate error budgets for predictable performance. The error calculations for a typical transducer application, shown in Figure 1 (350Ω bridge, 1mV/V F.S., 10V excitation), are illustrated below.

Assumptions: 2B31L is used, G = 1000, ΔT = ±10°C, source imbalance is 100Ω, common mode noise is 0.25V (60Hz) on the ground return.

Absolute gain and offset errors can be trimmed to zero. The remaining error sources and their effect on system accuracy (worst case) as a % of Full Scale (10V) are listed:

Error Source	Effect on Absolute Accuracy % of F.S.	Effect on Resolution % of F.S.
Gain Nonlinearity	±0.0025	±0.0025
Gain Drift	±0.025	
Voltage Offset Drift	±0.05	
Offset Current Drift	±0.004	
CMR	±0.00025	±0.00025
Noise (0.01 to 2Hz)	±0.01	±0.01
Total Amplifier Error	±0.09175 max	±0.01275 max
Excitation Drift	±0.15 (±0.03 typ)	
Total Output Error (Worst Case)	±0.24175 max (±0.1 typ)	±0.0127 max

The total worst case effect on absolute accuracy over ±10°C is less than ±0.25% and the 2B31 is capable of 1/2 LSB resolution in a 12 bit, low input level system. Since the 2B31 is conservatively specified, a typical overall accuracy error would be lower than ±0.1% of F.S.

In a computer or microprocessor based system, automatic recalibration can nullify gain and offset drifts leaving noise, nonlinearity and CMR as the only error sources. A transducer excitation drift error is frequently eliminated by a ratiometric operation with the system's A/D converter.

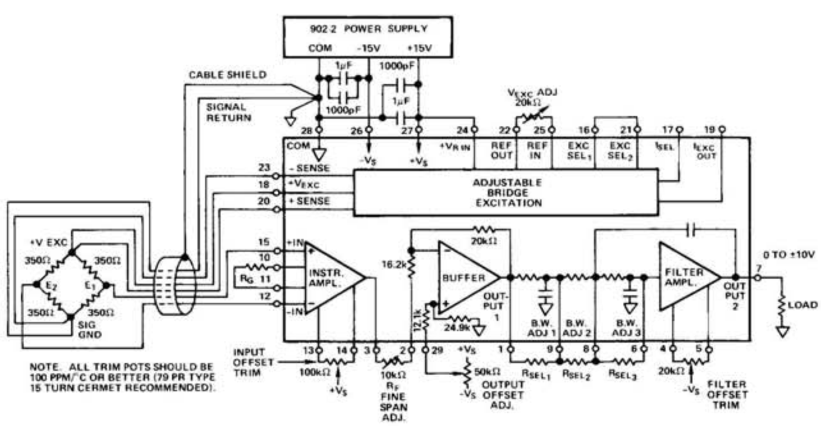


Figure 1. Typical Bridge Transducer Application Using 2B31

BRIDGE EXCITATION (2B31)

The bridge excitation stage of the model 2B31 is an adjustable output, short circuit protected, regulated supply with internally provided reference voltage (+7.15V). The remote sensing inputs are used in the voltage output mode to compensate for the voltage drop variations in long leads to the transducer. The regulator circuitry input (pin 24) may be connected to $+V_S$ or some other positive dc voltage (pin 28 referenced) within specified voltage level and load current range. User-programmable constant voltage or constant current excitation mode may be used. Specifications are listed below in Table I.

MODEL	2B31J	2B31K	2B31L
Constant Voltage Output Mode			
Regulator Input Voltage Range	+9.5V to +28V	•	•
Output Voltage Range	+4V to +15V	•	•
Regulator Input/Output Voltage Differential	3V to 24V	•	•
Output Current[1]	0 to 100mA max	•	•
Regulation, Output Voltage vs. Supply	0.05%/V	•	•
Load Regulation, I_L = 1mA to I_L = 50mA	0.1%	•	
Output Voltage vs. Temperature	0.015%/°C max	•	•
(0 to +70°C)	0.003%/°C typ	•	•
Output Noise	1mV rms	•	•
Reference Voltage (Internal)	7.15V ±3%	•	•
Constant Current Output Mode			
Regulator Input Voltage Range	+9.5V to +28V	•	•
Output Current Range	100µA to 10mA	•	•
Compliance Voltage	0 to 10V	•	•
Load Regulation	0.1%	•	•
Temperature Coefficient (0 to +70°C)	0.003%/°C	•	•
Output Noise	1µA rms	•	•

[1] Output Current derated to 33mA max for 24V regulator input/output voltage differential.

Table I. Bridge Excitation Specifications

OPERATING INSTRUCTIONS

Gain Setting: The differential gain, G, is determined according to the equation:

$$G = (1 + 94k\Omega/R_G)\,[20k\Omega/(R_F + 16.2k\Omega)]$$

where R_G is the input stage resistor shown in Figure 1 and R_F is the variable 10kΩ resistor in the output stage. For best performance, the input stage gain should be made as large as possible, using a low temperature coefficient (10ppm/°C) R_G, and the output stage gain can then be used to make a ±20% linear gain adjustment by varying R_F.

Input Offset Adjustment: To null input offset voltage, an optional 100kΩ potentiometer connected between pins 13 and 14 (Figure 1) can be used. With gain set at the desired value, connect both inputs (pins 12 and 15) to the system common (pin 28), and adjust the 100kΩ potentiometer for zero volts at pin 3. The purpose of this adjustment is to null the internal amplifier offset and it is not intended to compensate for the transducer bridge unbalance.

Output Offset Adjustment: The output of the 2B30/2B31 can be intentionally offset from zero over the ±10V range by applying a voltage to pin 29, e.g., by using an external potentiometer or a fixed resistor. Pin 29 is normally grounded if output offsetting is not desired. The optional filter amplifier offset null capability is also provided as illustrated in Figure 1.

Filter Cutoff Frequency Programming: The low pass filter cutoff frequency may be increased from the internally set 2Hz by the addition of three external resistors connected as shown in Figure 1. The values of resistors required for a desired cutoff frequency, f_c, above 5Hz are obtained by the equation below:

$$R_{SEL_1} = 11.6 \times 10^6/(2.67f_c - 4.34);$$

$$R_{SEL_2} = 27.6 \times 10^6/(4.12f_c - 7)$$

$$R_{SEL_3} = 1.05 \times 10^6/(0.806f_c - 1.3)$$

where R_{SEL} is in ohms and f_c in Hz. Table II gives the nearest 1% R_{SEL} for several common filter cutoff (–3dB) frequencies.

f_c (Hz)	R_{SEL1} (kΩ) (Pin 1 to 9)	R_{SEL2} (kΩ) (Pin 9 to 8)	R_{SEL3} (kΩ) (Pin 8 to 6)
2	Open	Open	Open
5	1270.000	2050.00	383.000
10	523.000	806.00	154.000
50	90.000	137.00	26.700
100	44.200	68.10	13.300
500	8.660	13.30	2.610
1000	4.320	6.65	1.300
5000	0.866	1.33	0.261

Table II. Filter Cutoff Frequency vs. R_{SEL}

Voltage Excitation Programming: Pin connections for a constant voltage output operation are shown in Figure 2. The bridge excitation voltage, V_{EXC}, is adjusted between +4V to +15V by the 20kΩ (50ppm/°C) R_{VSEL} potentiometer. For ratiometric operation, the bridge excitation can be adjusted by applying an external positive reference to pin 25 of the 2B31. The output voltage is given by: $V_{EXC\ OUT} = 3.265V_{REF\ IN}$. The remote sensing leads should be externally connected to the excitation leads at the transducer or jumpered as shown in Figure 2 if sensing is not required.

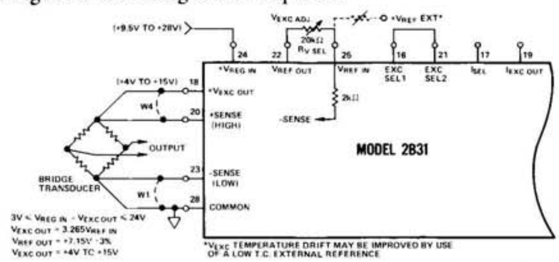


Figure 2. Constant Voltage Excitation Connections

Current Excitation Programming: The constant current excitation output can be adjusted between 100µA to 10mA by two methods with the 2B31. Figure 3 shows circuit configuration for a current output with the maximum voltage developed across the sensor (compliance voltage) constrained to +5V. The value of programming resistor R_{ISEL} may be calculated from the relationship: $R_{ISEL} = (V_{REG\ IN} - V_{REF\ IN})/I_{EXC\ OUT}$. This application requires a stable power supply because any variation of the input supply voltage will result in a change in the excitation current output.

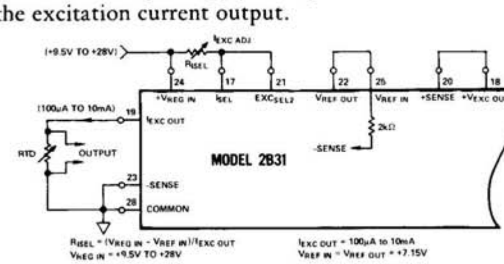


Figure 3. Constant Current Excitation Connections (V_{COMPL} = 0 to +5V)

A compliance voltage range of 0 to +10V can be obtained by connecting the 2B31 as shown in Figure 4. The 2kΩ potentiometer R_{ISEL} is adjusted for desired constant current excitation output.

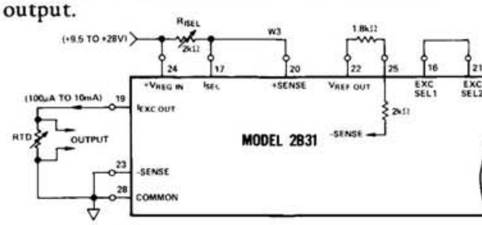


Figure 4. Constant Current Excitation Connections (V_{COMPL} = 0 to +10V)

APPLICATIONS

Strain Measurement: The 2B30 is shown in Figure 5 in a strain measurement system. A single active gage (120Ω, GF = 2) is used in a bridge configuration to detect small changes in gage resistance caused by strain. The temperature compensation is provided by an equivalent dummy gage and two high precision 120Ω resistors complete the bridge. The 2B35 adjustable power supply is set to a low +3V excitation voltage to avoid the self-heating error effects of the gage and bridge elements. System calibration produces a 1V output for an input of 1000 microstrains. The filter cutoff frequency is set at 100Hz.

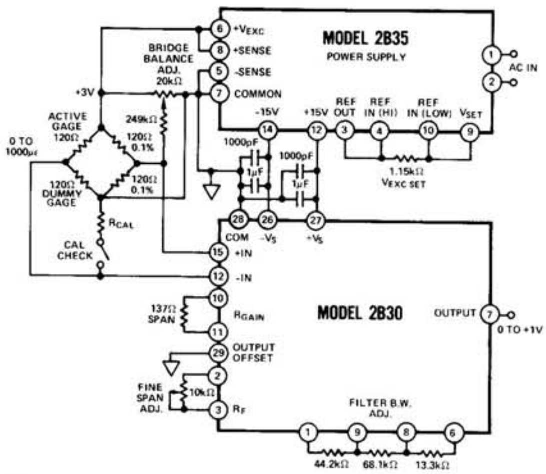


Figure 5. Interfacing Half-Bridge Strain Gage Circuit

Pressure Transducer Interface: A strain gage type pressure transducer (BLH Electronics, DHF Series) is interfaced by the 2B31 in Figure 6. The 2B31 supplies regulated excitation (+10V) to the transducer and operates at a gain of 333.3 to achieve 0-10V output for 0-10,000 p.s.i. at the pressure transducer. Bridge Balance potentiometer is used to cancel out any offset which may be present and the Fine Span potentiometer adjustment accurately sets the full scale output. Depressing the calibration check pushbutton switch shunts a system calibration resistor (R_{CAL}) across the transducer bridge to give an instant check on system calibration.

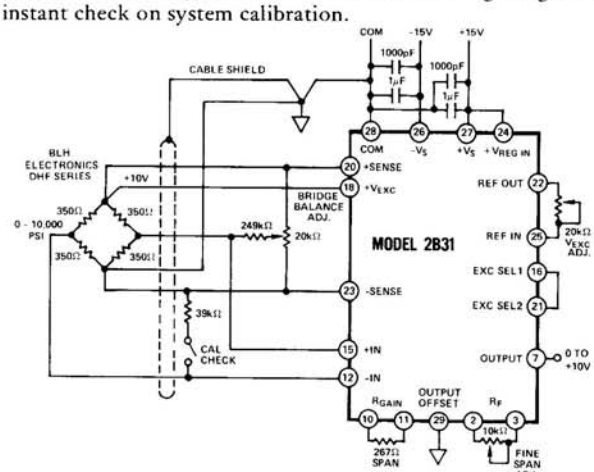


Figure 6. Pressure Transducer Interface Application

Platinum RTD Temperature Measurement: In Figure 7 model 2B31 provides complete convenient signal conditioning in a wide range (−100°C to +600°C) RTD temperature measurement system. YSI - Sostman four-wire, 100Ω platinum RTD (PT139AX) is used. The four wire sensor configuration, combined with a constant current excitation and a high input impedance offered by the 2B31, eliminates measurement errors resulting from voltage drops in the lead wires. Offsetting may be provided via the 2B31's offset terminal. The gain is set by the gain resistor for a +10V output at +600°C. This application requires a stable power supply.

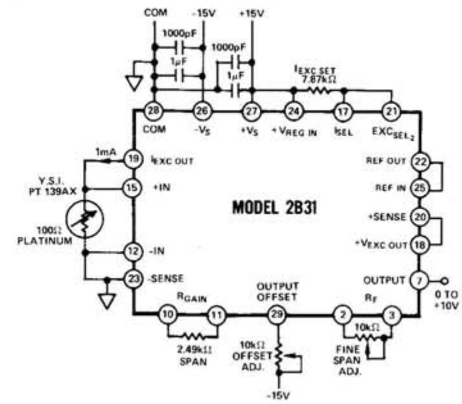


Figure 7. Platinum RTD Temperature Measurement

Interfacing Three-Wire Sensors: A bridge configuration is particularly useful to provide offset in interfacing to a platinum RTD and to detect small, fractional sensor resistance changes. Lead compensation is employed, as shown in Figure 8, to maintain high measurement accuracy when the lead lengths are so long that thermal gradients along the RTD leg may cause changes in line resistance. The two completion resistors (R1, R2) in the bridge should have a good ratio tracking (±5ppm/°C) to eliminate bridge error due to drift. The single resistor (R3) in series with the platinum sensor must, however, be of very high absolute stability. The adjustable excitation in the 2B31 controls the power dissipated by the RTD itself to avoid self-heating errors.

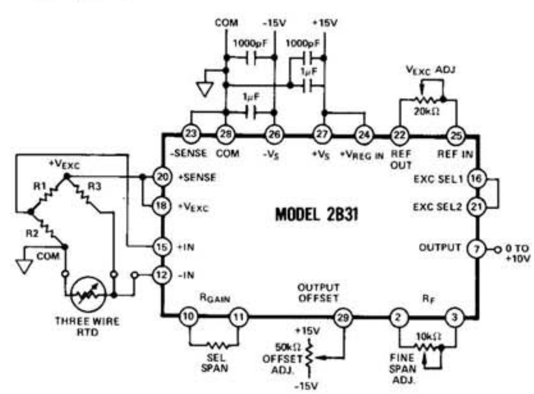


Figure 8. Three-Wire RTD Interface

Linearizing Transducer Output: To maximize overall system linearity and accuracy, some strain gage-type and RTD transducer analog outputs may require linearization. A simple circuit may be used with the 2B31 to correct for the curvature in the input signal as shown in Figure 9. The addition of feedback in the excitation stage will allow for the correction of nonlinearity by the addition of two components. The sense of the feedback is determined by whether the nonlinearity is concave upward or concave downward (jumper A to pin 21, or to pin 25). The magnitude of the correction is determined by the resistor, R_{SEL}, and the *linearity adjust* pot provides a fine trim.

If an RTD is to be used, the adjustment can be made efficiently, without actually changing the temperature, by simulating the RTD with a precision resistance decade. The offset is adjusted at the low end of the resistance range, the fine span is adjusted at about one third of the range, and the linearity is adjusted at a resistance corresponding to full-scale temperature. One or two iterations of the adjustments will probably be found necessary because of the interaction of linearity error and scale-factor error. This circuit's applications are not restricted to RTD's; it will work in most cases where bridges are used – e.g., load cells and pressure transducers.

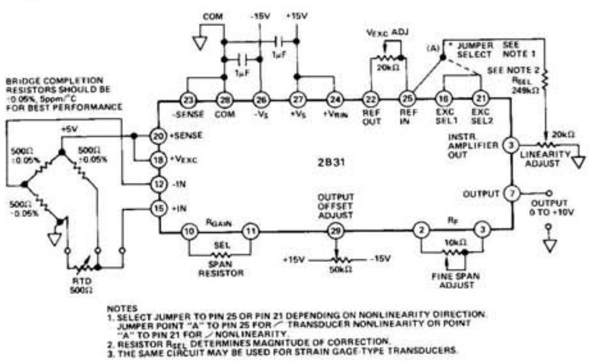


Figure 9. Transducer Nonlinearity Correction

PERFORMANCE CHARACTERISTICS

Input Offset Voltage Drift: Models 2B30/2B31 are available in three drift selections: ±0.5, ±1 and ±3μV/°C (max, RTI, G = 1000V/V). Total input drift is composed of two sources (input and output stage drifts) and is gain dependent. Figure 10 is a graph of the worst case total voltage offset drift vs. gain for all versions.

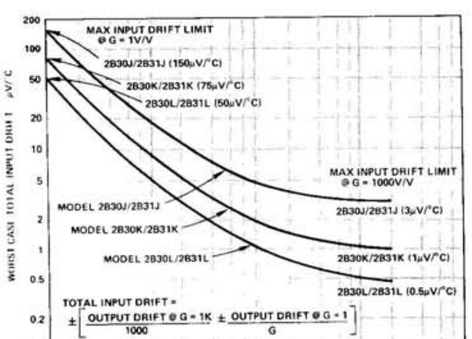


Figure 10. Total Input Offset Drift (Worst Case) vs. Gain

Gain Nonlinearity and Noise: Nonlinearity is specified as a percent of full scale (10V), e.g. 0.25mV RTO for 0.0025%. Three maximum nonlinearity selections offered are: ±0.0025%, ±0.005% and ±0.01% (G = 1 to 2000V/V). Models 2B30/2B31 offer also an excellent voltage noise performance by guaranteeing maximum RTI noise of 1μV p-p (G = 1000V/V, $R_S \leqslant 5k\Omega$) with noise bandwidth reduced to 2Hz by the LPF.

Common Mode Rejection: CMR is rated at ±10V CMV and 1kΩ source imbalance. The CMR improves with increasing gain. As a function of frequency, the CMR performance is enhanced by the incorporation of low pass filtering, adding to the 90dB minimum rejection ratio of the instrumentation amplifier. The effective CMR at 60Hz at the output of the filter (f_c = 2Hz) is 140dB min. Figure 11 illustrates a typical CMR vs. Frequency and Gain.

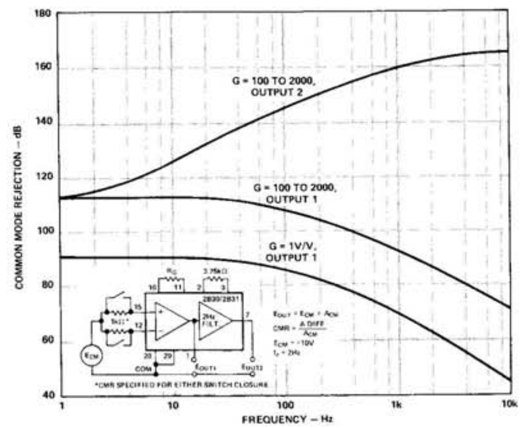


Figure 11. Common-Mode Rejection vs. Frequency and Gain

Low Pass Filter: The three pole Bessel-type active filter attenuates unwanted high-frequency components of the input signal above its cutoff frequency (–3dB) with 60dB/decade rolloff. With a 2Hz filter, attenuation of 70dB at 60Hz is obtained, settling time is 600ms to 0.1% of final value with less than 1% overshoot response to step inputs. Figure 12 shows the filter response.

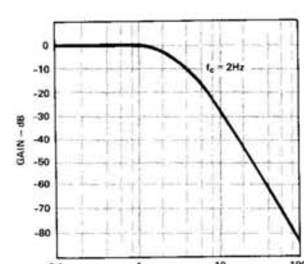


Figure 12. Filter Amplitude Response vs. Frequency

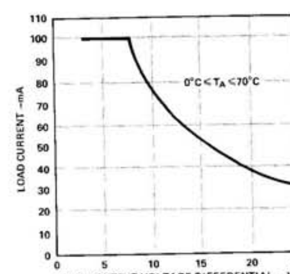


Figure 13. Maximum Load Current vs. Regulator Input-Output Voltage Differential

Bridge Excitation (2B31): The adjustable bridge excitation is specified to operate over a wide regulator input voltage range (+9.5V to +28V). However, the maximum load current is a function of the regulator circuit input-output differential voltage, as shown in Figure 13. Voltage output is short circuit protected and its temperature coefficient is ±0.015% V_{OUT}/°C max (±0.003%/°C typ). Output temperature stability is directly dependent on a temperature coefficient of a reference and for higher stability requirements, a precision external reference may be used.

Intronics Power®

Four Channel RTD/Strain Gage Conditioner

2B34

FEATURES
Low Input Offset Drift: ±1.0μV/°C
Low Gain Drift: ±25ppm/°C
Low Nonlinearity: ±0.01% max (±0.005% typ)
Differential Input Protection: ±130V rms
Channel Multiplexing: 3000 chan/sec Scanning Speed
Solid State Reliability
Internal RTD Excitation/Lead Wire Compensation

APPLICATIONS
Multichannel Signal Conditioning
Data Acquisition
Industrial Process Monitoring

FUNCTIONAL BLOCK DIAGRAM

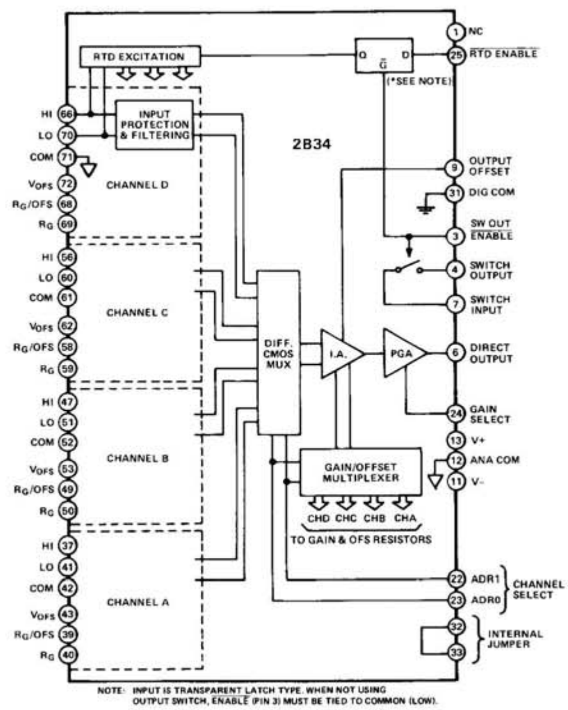


Figure 1.

GENERAL DESCRIPTION
The model 2B34 is a four channel signal conditioner providing input protection, multiplexing, and amplification in a single, low cost package. A multi-purpose device, the 2B34 is designed to effectively condition low level signals (±30mV to ±100mV) such as those produced by RTD and strain gage sensors. The superior design of the 2B34 provides low input drift (±1.0μV/°C), high common mode rejection (94dB @ 60Hz), and extremely stable gain (±25ppm/°C). Other features include low nonlinearity (±0.01% max), excitation and lead wire compensation for RTD inputs, and a wide operating temperature range (−25°C to +85°C).

APPLICATIONS
The 2B34 is a superior alternative to the relay multiplexing technique used in multichannel data acquisition systems, computer interface systems, and measurement and control instrumentation. Advantages over relay circuits include functional versatility, superior signal conditioning, and solid state speed and reliability.

DESIGN FEATURES AND USER BENEFITS
Solid State Design: Complete solid state construction offers both high performance and reliability.

Ease of Use: The multichannel, functionally complete design in a compact (2″ × 4″ × 0.4″) module, conserves board space and eliminates the need for a number of discrete components that would otherwise be required.

Low Cost: The 2B34 offers the lowest cost per channel for solid state, low level sensor signal conditioning.

Wide Operating Temperature Range: The 2B34 has been designed to operate over −25°C to +85°C ambient temperature range.

FUNCTIONAL DESCRIPTION
The internal structure of the 2B34 is shown in Figure 1. Four individual input channels are multiplexed into a single, low

(continued on page 3)

REV. A

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PHONE: 781-551-5500 FAX: 781-551-5555

2B34 — SPECIFICATIONS (typical @ +25°C, V_S = ±15V, unless otherwise noted)

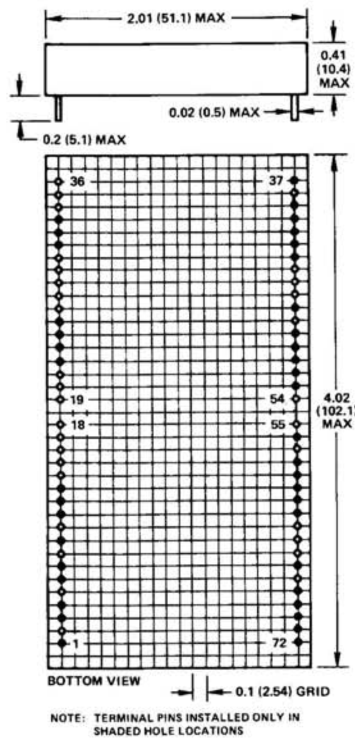
Model	2B34J Strain Gage Mode	RTD Mode
ANALOG INPUT		
Number of Channels	4	•
Input Range	±30mV & ±100mV	25–175Ω & 0–350Ω
Gain Range (R_G =945Ω)	166.6V/V & 50V/V	•
Expanded[1]	50V/V to 1000V/V	•
Transfer Function	N/A	V_{OUT} = [0.4 × 10^{-3} × (R_{RTD}) –0.04] G
Gain Error	±0.6% max (G = 50)	•
	±0.8% max (G = 166.6)	•
Gain Temperature Coefficient[2]	±25ppm/°C	•
Gain Nonlinearity	±0.01% of Span, max	•
Offset Voltage		
Input Offset, Initial[3] (Adj. to Zero)	±150µV	•
vs. Temperature	±1µV/°C	±0.015 deg/deg
Channel to Channel Offset	±25µV	•
Total Offset Drift (RTI)	±1µV/°C	•
Input Noise Voltage		
0.01Hz–100Hz, R_S = 1kΩ	1.5µV p-p	•
Common Mode Voltage	±6V	N/A
Common Mode Rejection		
R_S = 100Ω, f = 60Hz	94dB (@ G = 166.6)	N/A
R_S = 1kΩ, f = 60Hz	86dB (@ G = 166.6)	
Maximum Safe Differential Input (10 min)	130V rms	•
Normal Mode Rejection @ 60Hz	24dB	•
Input Resistance	20MΩ	•
Input Bias Current	10nA max	•
Lead Resistance Effect	N/A	±0.03 deg/Ω
ANALOG OUTPUT		
Output Voltage Swing	±5V @ 1mA	•
Output Resistance		
Direct Output	0.1Ω	•
Switched Output	35Ω, +0.5%/°C	•
Maximum Switched Voltage	±9V, no load	•
SENSOR EXCITATION		
Excitation Level (per channel)	NA	0.4mA ±1% (±1.7% max)
vs. Temperature	NA	±10ppm/°C
CHANNEL SELECTION		
Channel Selection Time to ±0.01% F.S.	300µs	•
Channel Scanning Speed	>3000 chan/sec	•
DYNAMIC RESPONSE		
Input Settling Time to ±0.01% F.S.	0.4 sec	•
Bandwidth	4Hz	•
POWER SUPPLY		
Voltage, ±V_S, Rated Performance	±15V dc ±5%	•
Current	+35mA, –15mA, max	•
Supply Effect on Offset	±0.003%/%	±0.02%/%
ENVIRONMENTAL		
Temperature		
Rated Performance	0 to +70°C	•
Operating	–25°C to +85°C	•
Storage	–55°C to +85°C	•
CASE SIZE	2″ × 4″ × 0.4″	

NOTES
[1] Gain range may be expanded by use of external amplifier as shown in Figure 3.
[2] Does not include effects of sensor excitation drift.
[3] With no induced offset, using circuit shown in Figure 2 (pots centered).
•Specifications same as Strain Gage Mode.

Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



2B34 PIN DESIGNATIONS

PIN	FUNCTION	PIN	FUNCTION	
1	NC	37	HI	
2		38		
3	SW'D OUTPUT ENABLE	39	R_G/OFS	
4	SW'D OUTPUT	40	R_G	CHANNEL A
5		41	LO	
6	DIRECT OUTPUT	42	COM	
7	SW'D INPUT	43	V_{OFS} (+10V)	
8		44		
9	OUTPUT OFFSET	45		
10		46		
11	–15V	47	HI	
12	ANA COM	48		
13	+15V	49	R_G/OFS	
14		50	R_G	CHANNEL B
15		51	LO	
16		52	COM	
17		53	V_{OFS} (+10V)	
18		54		
19		55		
20		56	HI	
21		57		
22	ADR1 } CHANNEL	58	R_G/OFS	
23	ADR0 } SELECT	59	R_G	CHANNEL C
24	GAIN SELECT	60	LO	
25	RTD ENABLE	61	COM	
26		62	V_{OFS} (+10V)	
27		63		
28		64		
29		65		
30		66	HI	
31	DIG COM	67		
32	SYNC IN } *	68	R_G/OFS	
33	SYNC OUT } *	69	R_G	CHANNEL D
34		70	LO	
35		71	COM	
36		72	V_{OFS} (+10V)	

*SHORTED INTERNALLY FOR FEEDTHROUGH FOR USE WITH 2B54/55 MODELS.

(continued from page 1)

drift differential instrumentation amplifier, with the desired channel specified by the two digital channel select inputs. This signal is then fed to a digitally controlled programmable gain amplifier (PGA). The appropriate gain for a particular sensor type is selected by the gain select input.

User selectable direct or switched output permits direct output connection of several modules, should more than four channels be required.

An internally selectable constant current excitation source provides direct connection of 2 or 3 wire RTDs, thus eliminating the need for external excitation sources. Each channel contains an input protection and filtering network to preserve signal integrity in the presence of series mode 50/60Hz noise.

OPERATING INSTRUCTIONS

Connection of the 2B34 with three wire RTD inputs is shown in Figure 2 and will be all that is needed in most cases. The following sections describe the basic application, as well as detail some optional connections that enhance the module's performance in more complex applications. All unused inputs should be shorted to common.

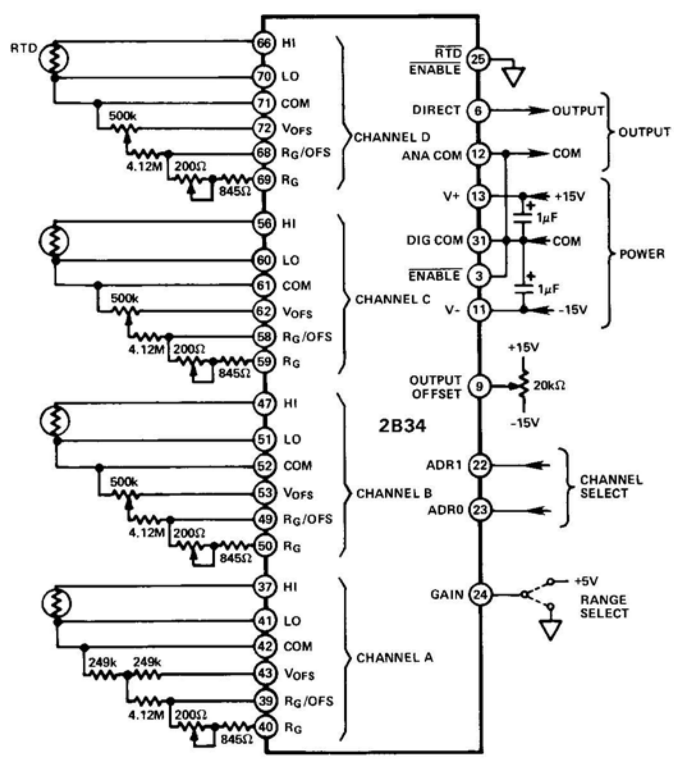


Figure 2. Basic RTD Application

Channel Selection: Each channnel of the 2B34 is turned on and off by applying the proper binary code to channel select inputs (ADR0, ADR1). Channels may be selected in any order and there are no restrictions on rate other than the 300µs settling time for access to a channel (Table I, channel select truth table).

Gain Selection: The 2B34 is designed to provide signal conditioning of both RTD and strain gage sensor inputs. To accommodate both of these sensor types, the 2B34 is precalibrated to provide gains of 50 and 166.6, with gain components shown in Figure 2. This provides proper amplification of input signals over the span of ±30mV to ±100mV. Selection of the desired gain and sensor input mode is achieved by applying the appropriate binary codes shown in Table II. A 200Ω pot provides ±3% full scale span adjustment.

AD1	AD0	Channel
0	0	A
0	1	B
1	0	C
1	1	D

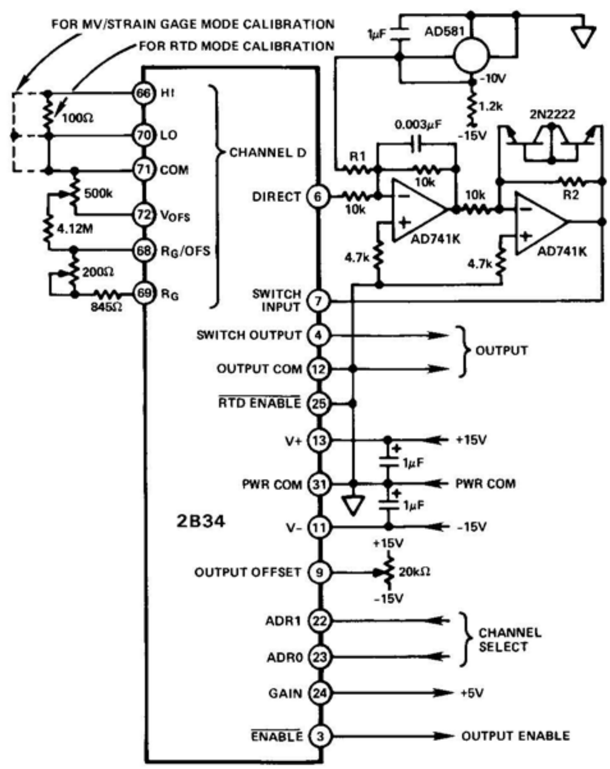
Table I. Channel Selection

(Pin 24) Gain Select Input	Selected Gain
0	166.6
1	50

(Pin 25) $\overline{\text{RTD ENABLE}}$	Selected Mode
0	RTD
1	Strain Gage

Table II. Gain and Mode Selection

Zero Suppression & Gain: In most instances, the gain capability of the 2B34 will be sufficient. However, in the case of input signals that may require gains greater than 166, the



$$V_O = \left[\left[\left(0.4 \times 10^{-3}\,(R_{RTD}) - 0.04\right) 50 \right] - \frac{100k}{R1} \right] \frac{R2}{10k}$$

Figure 3. Zero Suppressed Switched Output RTD Application

gain range of the 2B34 may be supplemented by use of an external amplifier (Figure 3). A low drift, operational amplifier (such as the AD741K) should be used to maintain signal integrity.

Optional Offset Adjustment: All channels of the 2B34 are typically within ±150μV (RTI) offset. For use in more demanding applications, the module has provisions for fine adjustment of the input offset (RTI) of each input as well as the output offset (RTO) of the entire module. None of the offset adjustments will affect drift performance.

In some applications, where ±25μV channel-to-channel offset voltage can be tolerated, adjustment of only the output offset will be sufficient. The offset circuit shown in Figure 2 (for channel "A") is required when a potentiometer is not used to adjust input offset. The output offset adjustment may then be used to null the 150μV (RTI) offset, leaving an offset difference between channels of ±25μV. If input offset adjustment is desired, the input offset circuitry shown in Figure 3 should be used. This provides approximately ±140mV (RTO) of adjustment, and should be adequate, in most cases, for elimination of sensor offset errors.

To calibrate in the mV (strain gage) mode, (Figure 3), short the signal inputs (for example, pins 66, 70 for channel "D") to common and center the input offset adjustment potentiometer. Adjust the output offset potentiometer until the output is nulled for that channel at the appropriate gain. The input offset pots on each channel may then be used to eliminate any errors on subsequent channels that are selected.

To calibrate in the RTD mode, follow the same procedure, but replace the short with a 100Ω resistance standard.

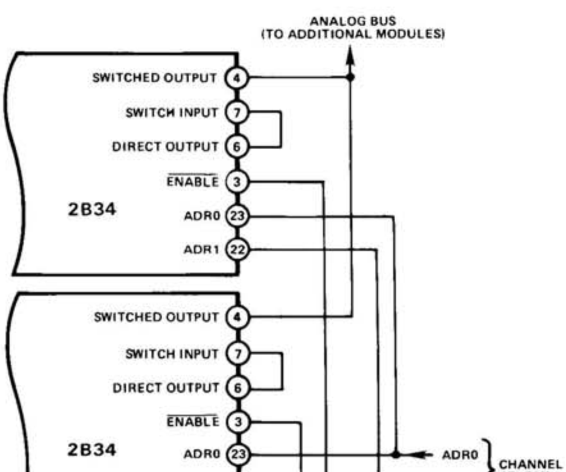


Figure 4. Channel Expansion

Channel Expansion: The 2B34 has provisions for directly interconnecting several modules when more than four channels are required. The series switched outputs of the modules are connected together, the channel select inputs are driven in parallel, and the switched output of the desired module is selected using the $\overline{\text{ENABLE}}$ pin. This technique is shown in Figure 4. Channel address and $\overline{\text{ENABLE}}$ (active low) inputs are CMOS/TTL compatible with an input current of 100μA each.

2B34 Strain Gage Application: Figure 5 shows a four channel strain gage input system utilizing the multiplexing feature of the 2B34. Input offset and gain adjustments are used to eliminate inherent sensor errors. The model 2B35 triple output supply may be used to provide power for the 2B34 as well as excitation for the strain gage sensors.

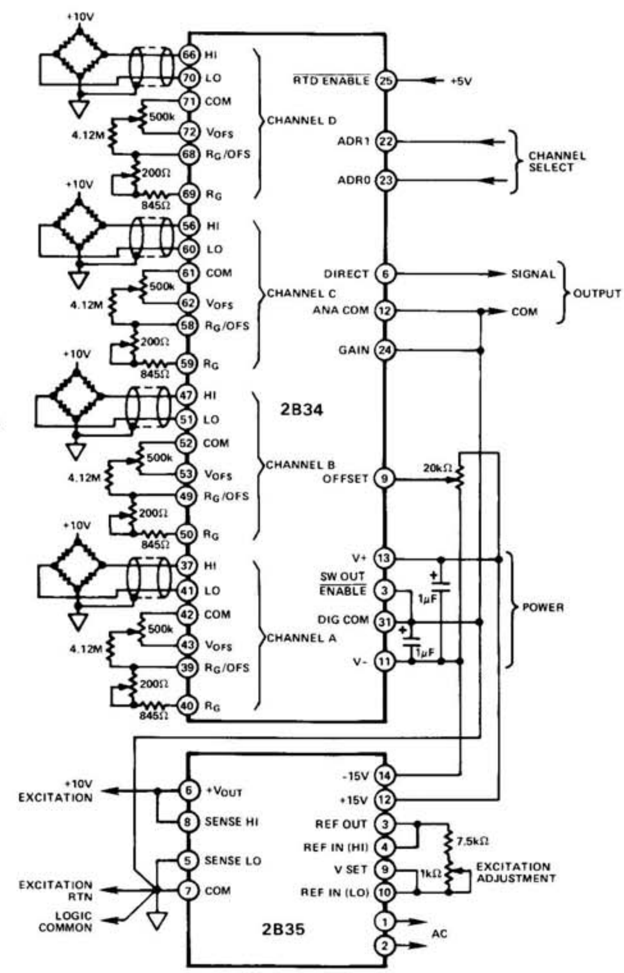


Figure 5. 2B34 Strain Gage Application

Intronics Power ®

Isolated, Thermocouple Signal Conditioner

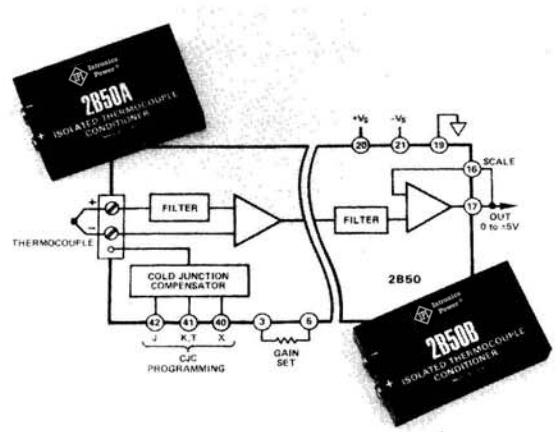
Model 2B50

FEATURES

Accepts J, K, T, E, R, S or B Thermocouple Types
Internally Provided Cold Junction Compensation
High CMV Isolation: ±1500V pk
High CMR: 160dB min @ 60Hz
Low Drift: ±1μV/°C max (2B50B)
High Linearity: ±0.01% max (2B50B)
Input Protection and Filtering
Screw Terminal Input Connections

APPLICATIONS

Precision Thermocouple Signal Conditioning For:
- **Process Control and Monitoring**
- **Industrial Automation**
- **Energy Management**
- **Data Acquisition Systems**



GENERAL DESCRIPTION

The model 2B50 is a high performance thermocouple signal conditioner providing input protection, isolation and common mode rejection, amplification, filtering and integral cold junction compensation in a single, compact package.

The 2B50 has been designed to condition low level analog signals, such as those produced by thermocouples, in the presence of high common mode voltages. Featuring direct thermocouple connection via screw terminals and internally provided reference junction temperature sensor, the 2B50 may be jumper programmed to provide cold junction compensation for thermocouple types J, K, T, and B, or resistor programmed for types E, R, and S.

The high performance of the 2B50 is accomplished by the use of reliable transformer isolation techniques. This assures complete input to output galvanic isolation (±1500V pk) and excellent common mode rejection (160dB @ 60Hz).

Other key features include: input protection (220V rms), filtering (NMR of 70dB @ 60Hz), low drift amplification (±1μV/°C max – 2B50B), and high linearity (±0.01% max – 2B50B).

APPLICATIONS

The 2B50 has been designed to provide thermocouple signal conditioning in data acquisition systems, computer interface systems, and temperature measurement and control instrumentation.

In thermocouple temperature measurement applications, outstanding features such as low drift, high noise rejection, and 1500V isolation make the 2B50 an ideal choice for systems used in harsh industrial environments.

DESIGN FEATURES AND USER BENEFITS

High Reliability: To assure high reliability and provide isolation protection to electronic instrumentation, the 2B50 has been conservatively designed to meet the IEEE Standard for transient voltage protection (472-1974: SWC) and provide 220V rms differential input protection.

High Noise Rejection: The 2B50 features internal filtering circuitry for elimination of errors caused by RFI/EMI, series mode noise, and 50Hz/60Hz pickup.

Ease of Use: Internal compensation enables the 2B50 to be used with seven different thermocouple types. Unique circuitry offers a choice of internal or remote reference junction temperature sensing. Thermocouple connections may be made either by screw terminals or, in applications requiring PC Board connections, by terminal pins.

Small Package: 1.5" X 2.5" X 0.6" size conserves board space

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SPECIFICATIONS (typical @ +25°C and V_S = ±15V unless otherwise noted)

MODEL	2B50A	2B50B
INPUT SPECIFICATIONS		
Thermocouple Types		
Jumper Configurable Compensation	J, K, T, or B	*
Resistor Configurable Compensation	R, S, or E	*
Input Span Range	±5mV to ±100mV	*
Gain Range	50V/V to 1000V/V	*
Gain Equation	$1 + (200k\Omega/R_G)$	*
Gain Error	±0.25%	*
Gain Temperature Coefficient	±35ppm/°C max	±25ppm/°C max
Gain Nonlinearity[1]	±0.025% max	±0.01% max
Offset Voltage		
Input Offset (Adjustable to Zero)	±50μV	*
vs. Temperature	±2.5μV/°C max	±1μV/°C max
vs. Time	±1.5μV/month	*
Output Offset (Adjustable to Zero)	±10mV	*
vs. Temperature	±30μV/°C	*
Total Offset Drift	$\pm\left(2.5 + \frac{30}{G}\right)$ μV/°C	$\pm\left(1 + \frac{30}{G}\right)$ μV/°C
Input Noise Voltage		
0.01Hz to 100Hz, $R_S = 1k\Omega$	1μV p-p	*
Maximum Safe Differential Input Voltage	220V rms, Continuous	*
CMV, Input to Output		
Continuous, ac or dc	±1500V pk max	*
Common Mode Rejection		
@ 60Hz, 1kΩ Source Unbalance	160dB min	*
Normal Mode Rejection @ 60Hz	70dB min	*
Bandwidth	dc to 2.5Hz (-3dB)	*
Input Impedance	100MΩ	*
Input Bias Current[2]	±5nA	*
Open Input Detection	Downscale	*
Response Time[3], G = 250	1.4sec	*
Cold Junction Compensation		
Initial Accuracy[4]	±0.5°C	*
vs. Temperature[5] (+5°C to +45°C)	±0.01°C/°C	*
OUTPUT SPECIFICATIONS		
Output Voltage Range[6]	±5V @ ±2mA	*
Output Resistance	0.1Ω	*
Output Protection	Continuous Short to Ground	*
POWER SUPPLY		
Voltage		
Output $\pm V_S$ (Rated Performance)	±15V dc ±10% @ ±0.5mA	*
(Operating)	±12V to ±18V dc max	*
Oscillator $+V_{OSC}$ (Rated Performance)	+13V to +18V @ 15mA	*
ENVIRONMENTAL		
Temperature Range, Rated Performance	0 to +70°C	*
Operating	-25°C to +85°C	*
Storage Temperature Range	-55°C to +85°C	*
RFI Effect (5W @ 470MHz @ 3ft)		
Error	±0.5% of Span	*
PHYSICAL		
Case Size	1.5" X 2.5" X 0.6"	*

NOTES

*Specifications same as 2B50A.

[1] Gain nonlinearity is specified as a percentage of output signal span representing peak deviation from the best straight line; e.g., nonlinearity at an output span of 10V pk-pk (±5V) is ±0.01% or ±1mV.

[2] Does not include open circuit detection current of 20nA (optional by jumper connection).

[3] Open input response time is dependent upon gain.

[4] When used with internally provided CJC sensor.

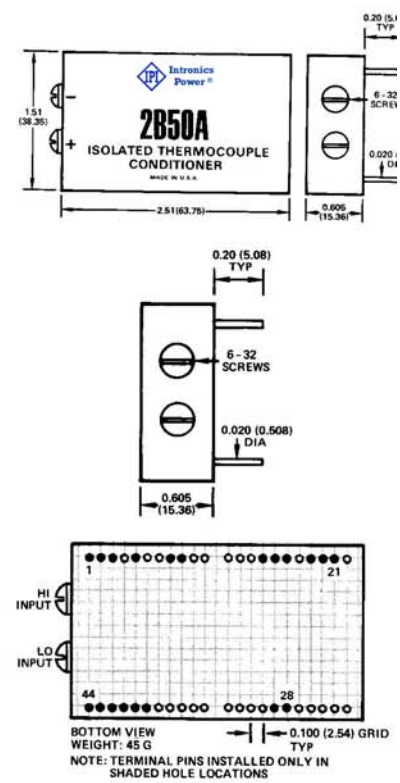
[5] Compensation error contributed by ambient temperature changes at the module.

[6] Output swing of ±10V may be obtained through output scaling (Figure 5).

Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



PIN DESIGNATIONS

PIN	FUNCTION	PIN	FUNCTION
1	INPUT LO	23	
2	INPUT HI	24	
3	R_G	25	
4		26	
5	R_G/COM	27	
6		28	+V OSC
7		29	OSC COM
8	+V ISO OUT	30	
9	-V ISO OUT	31	
10		32	
11		33	
12		34	
13		35	
14		36	
15	OUTPUT OFFSET ADJUST	37	
		38	
16	OUTPUT SCALE	39	OPEN INPUT DET.
17	OUTPUT	40	X } T TYPE PROGRAMMING
18		41	K, T } T TYPE PROGRAMMING
19	OUTPUT COM	42	J } T TYPE PROGRAMMING
20	$+V_S$	43	CJC SENSOR IN
21	$-V_S$	44	CJC SENSOR OUT
22			

MATING SOCKET: AC1218

FUNCTIONAL DESCRIPTION

The internal structure of the 2B50 is shown in Figure 1. An input filtering and protection network precedes a low drift, high performance amplifier whose gain is set by a user supplied resistor (R_G) for gains of 50 to 1000V/V. Isolated power is brought out to permit convenient adjustment of the input offset voltage, if desired.

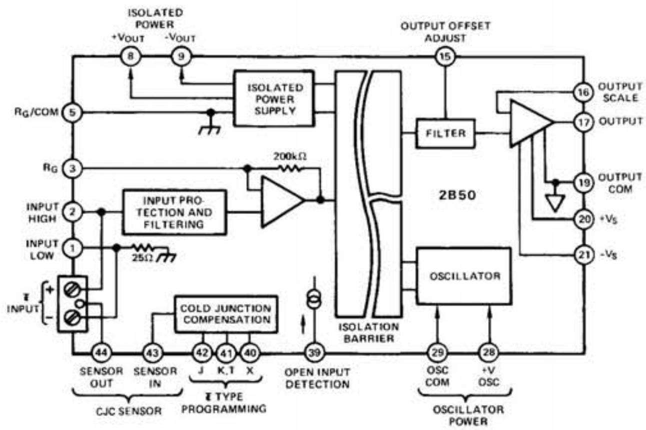


Figure 1. 2B50 Functional Block Diagram

Internal circuitry provides reference junction compensation. An integral reference junction sensor is provided for direct thermocouple connections, or an external reference sensor (2N2222 transistor) may be used in applications having remote thermocouple termination. Compensating networks for thermocouple types J, K, and T are built into the 2B50. A fourth compensation (X) may be programmed with a single resistor for any other thermocouple type. The 2B50 can be programmed for uncompensated output when used with inputs other than thermocouples.

Transformer coupling is used to achieve stable, reliable input to output galvanic isolation, as well as elimination of ground loop error effects.

Normally, the full scale output of the 2B50 is ±5V. However, with the addition of an external resistive divider, the output buffer amplifier may be scaled for a gain of up to 2, providing a full scale output swing of ±10V.

OPERATING INSTRUCTIONS

The connections shown in Figure 2 are common to most applications using the 2B50, and, in many cases, will be all that is required.

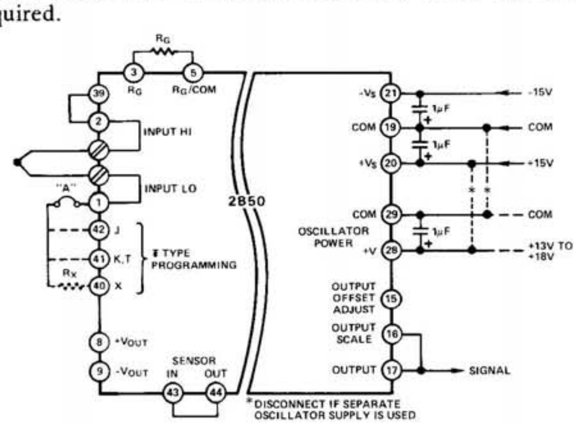


Figure 2. Basic 2B50 Application

Two sets of parallel thermocouple input connections are provided. The thermocouple input may be connected by screw terminals (Input+, Input –) or to terminal Pins 1(–) and 2(+) in cases where thermocouples are to be remotely terminated. The following sections describe a basic thermocouple application, as well as detail some optional connections to enhance performance in more demanding applications. Jumper A (Figure 2) is used to disconnect cold junction compensation circuitry during offset adjustments.

INTERCONNECTION GUIDELINES

All power supply inputs should be decoupled with 1μF capacitors as close to the unit as possible. Any jumpers installed for programming purposes should also be installed as close as possible to minimize noise pickup effects.

Since the oscillator section of the 2B50 accounts for most of the power consumption but can accept a wide range of voltage (+13V to +18V), it may be desirable to power this section from a convenient source of unregulated power.

If the same supply is to be used for both amplifier and oscillator circuitry, the power supply returns should be brought out separately so that oscillator power supply currents do not flow in the low lead of the signal output. In either case, a 1μF capacitor must be connected from $+V_{OSC}$ (Pin 28 to Oscillator COM (Pin 29).

The oscillator and amplifier sections are completely isolated; therefore, a dc power return path is not required between the two power supply commons.

GAIN SETTING

The gain of the 2B50 is set by a user-supplied resistor (R_G) connected as shown in Figure 2. Gain will normally be selected so that the maximum output of the signal source will result in a plus full scale output swing. The resistor value required is determined by the equation: $R_G = 200k\Omega/G{-}1)$.

A series trim on the gain setting resistor can be used to trim out the resistor tolerance and module gain error (Figure 3). Since addition of a series resistance will always decrease gain, the value of the gain-setting resistor should be selected to provide a gain somewhat higher than the desired trimmed gain. A good quality (e.g., 10ppm/°C), metal-film resistor should be used for R_G, since drift of R_G will add to the overall gain drift of the 2B50. A cermet pot is suitable for the trim. Note that a minimum gain of 50 is required for guaranteed operation.

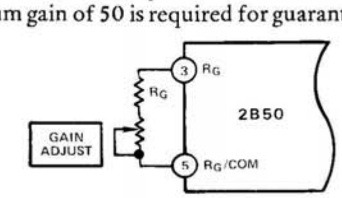


Figure 3. Gain Adjustment

INPUT AND OUTPUT OFFSET ADJUSTMENTS

The 2B50 has provisions for adjusting input and output offset errors of the module. None of the offset adjustments will affect drift performance, and adjustments need not be used unless the particular application calls for lower offsets than those specified.

Connections for offset adjustments are shown in Figure 4. Isolated supply voltages are brought out for input trimming convenience only and are not for use as a power supply for external components.

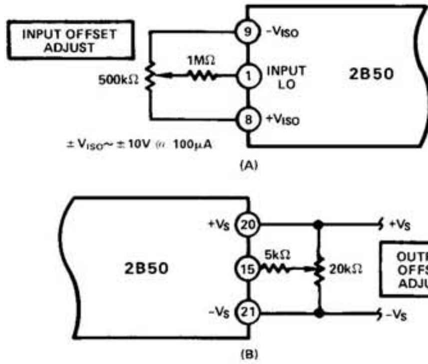


Figure 4. (A) Input and (B) Output Offset Adjustment

OFFSET CALIBRATION

1. Short Input + and Input - together.
2. Disconnect cold junction compensation circuitry by removing Jumper "A" (Figure 2).
3. Adjust input offset trim pot (±250μV range, RTI) to zero output while operating at the desired gain. In most applications, adjustment of the input offset alone will be sufficient. Output offset adjustment (±30mV range) may be performed if it is desired to adjust output offset on the nonisolated side.

OPEN INPUT DETECTION

Connecting the open input detection pin (Pin 39) to Input High (Pin 2) creates a 20nA bias current which will provide a negative overscale response if the input is opened, or in case of thermocouple "burn out". The speed at which this occurs is dependent on gain, with a typical response time of 1.4sec @ G = 250. For positive upscale response, connect a 500MΩ resistor between $+V_{ISO}$ (Pin 8) and Input Hi (Pin 2).

OUTPUT SCALING

With the output scale (Pin 16) connected to the output (Pin 17), the full scale output range is ±5V and the total gain is equal to the gain set by R_G. For applications requiring a full scale output of ±10V, a resistive divider may be connected to provide a gain of 2 at the output amplifier (see Figure 5). In this configuration, total gain will be twice the gain set by R_G. Output gains greater than 2 cannot be used.

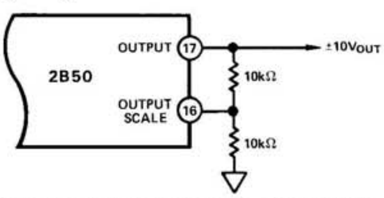


Figure 5. Output Scaling Connections

COLD JUNCTION COMPENSATION

The 2B50 may be programmed to provide cold junction compensation for types J, K and T thermocouples by connecting a jumper from Input Low (Pin 1) to the appropriate programming points (Pin 42 for J, Pin 41 for K or T). To compensate other themocouple types, a resistor (R_X) is connected from the "X" programming point (Pin 40) to Input Low (Pin 1). Table I shows the appropriate R_X values for types E, R, and S. R_X should be a 50ppm/°C, 1% tolerance resistor.

Type B thermocouples are unique, in that they have almost no output in the +5°C to +45°C range, and therefore, do not require cold junction compensation at all. To accommodate a type B thermocouple, resistor R_X must be left open. Error due to cold junction temperature will be less than ±1°C for any measurement above 260°C. In the measurement range above 1000°C (where type B thermocouples are normally used) the error will be less than ±0.3°C.

Ŧ Type	R_X (kΩ)
E	1.85
R, S	19.6
B	Open

Table I. Compensation Values for Thermocouple Types E, R, S and B

REMOTE REFERENCE SENSING

In applications requiring termination of themocouple leads at a point located remotely from the 2B50, with connections brought to the 2B50 (Pins 1, 2) by copper wires, reference temperature sensing at the remote location will be necessary. The 2B50 has provisions for connection of a 2N2222 transistor (metal can version) for use as a reference junction sensor. The connections are shown in Figure 6. The remote sensing transistor is calibrated by adjusting R_{CAL} to obtain the value of V_{CAL} as specified in Table II.

(Example: V_{CAL} = 570.0mV @ 25°C)

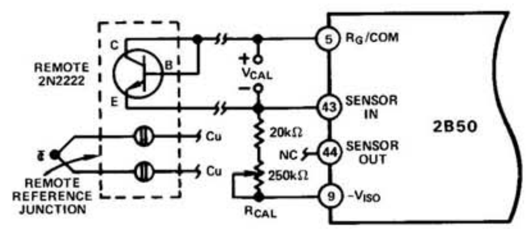


Figure 6. Remote Reference Junction Sensing

Sensor Temp (°C)	V_{CAL} (mV)
5	616.5
10	604.9
15	593.3
20	581.6
25	570.0
30	558.4
35	546.8
40	535.1
45	523.5

(Values may be interpolated)

Table II. Calibration Voltages vs. Sensor Temperature

Proper sensor placement is important. Close thermal contact of the sensor and thermocouple termination point (reference junction) is essential for accurate operation of the 2B50. The sensor may be placed any distance from the 2B50. When the sensor leads are more than ten feet long, or in the presence of strong noise signal sources, shielded cable should be used.