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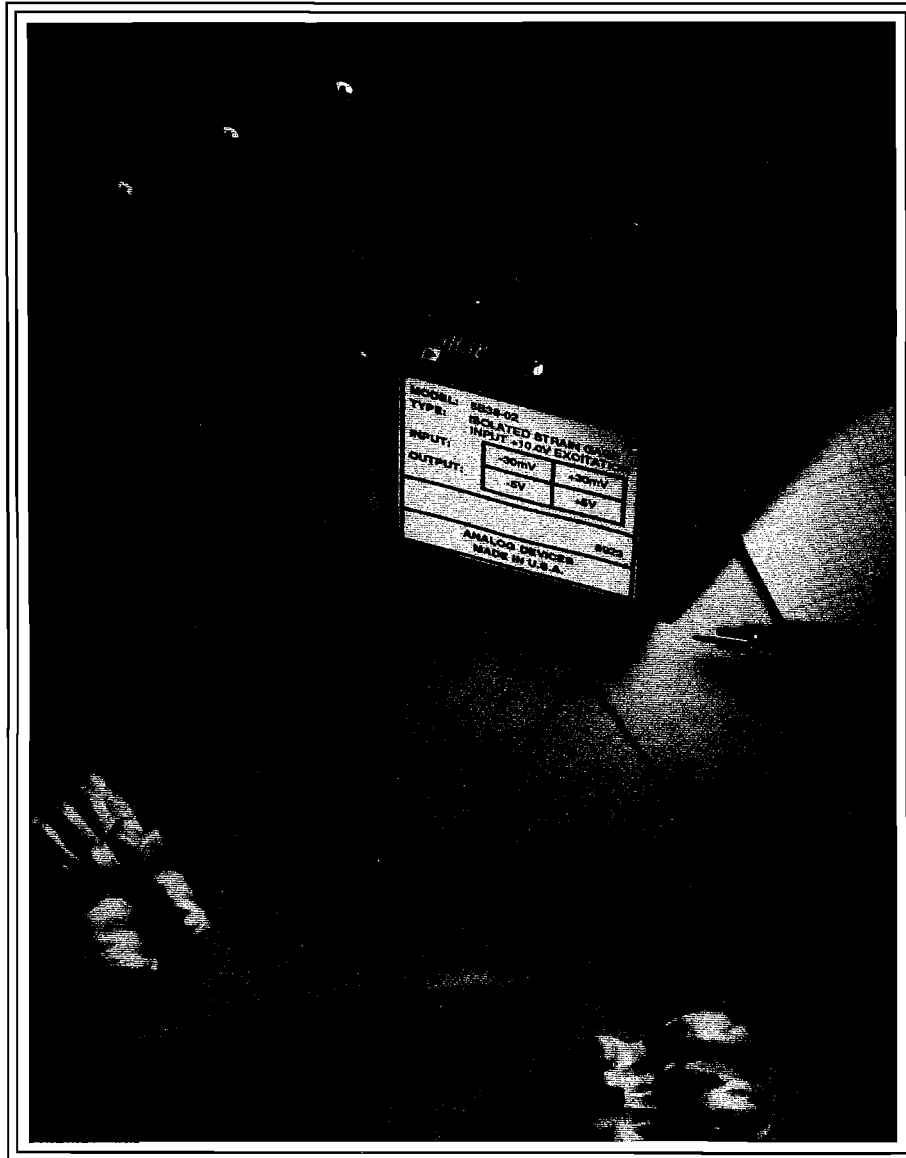
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THE 5B SERIES



USER'S MANUAL

Errata

Agency Certification

5B series products

Effective 7/1/2009

ADI will no longer carry the Factory Mutual (FM) approval Certification for the 5B series of products. All other certifications for the 5B series products will remain in place.

The decision to remove the FM approval Certification is an effort to control rising costs. Our decision to remove the FM approval Certification is not a result of any changes to these products.

The 5B Series User's Manual

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5B Series

New Product Information

**Data Sheets for the following New
5B Series products are attached:**

5B08/5B08-MUX
8-Channel Backplanes

5B35
4-Wire RTD input module

5B36
Potentiometer/Resistor input module

5B42
4-to-20 mA Process Current input module

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- **The Latest Data Sheets**
- **Technical Support (including answers to Frequently Asked Questions)**
- **Alternate Source Product Cross Reference**
- **Sales Offices - Addresses/Phone/Fax**
- **New 3-Year Warranty Statement**
- **and More!!!**

5B08/5B08-MUX

FEATURES

8-Channel, Industry Standard 5B Series Compatibility
Two Backplane Selections

5B08: Eight Independent I/O Channels

5B08-MUX: Eight I/O Channels Multiplexed onto One Bus

Mix and Match 5B Series I/O Module Capability

Thermocouple, RTD, mV, V, Frequency, mA, Strain

Gage, Loop-Powered mA, Potentiometer, Slidewire

-25°C to +85°C Temperature Range

1500 V rms Chan/Chan and Input/Output Isolation

CE Approved

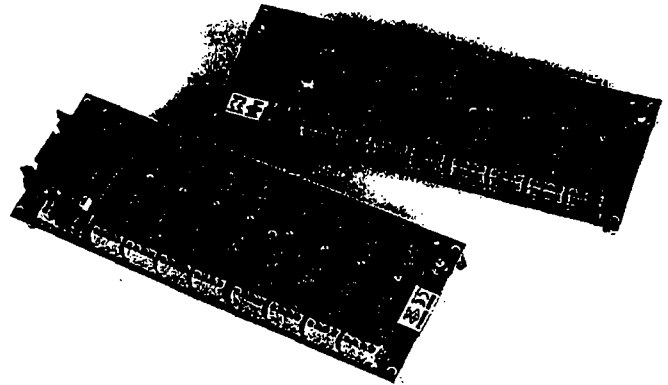
EMC Directive In Heavy Industrial Applications

APPLICATIONS

Front-End Data Acquisition Systems

Process Control and Monitoring

Product Test



GENERAL DESCRIPTION

The 5B08 and 5B08-MUX backplanes accept up to eight 5B Series input/output modules, providing direct screw terminal interfacing to sensors and transducers, as well as a 26-pin connector I/O interface to a measurement and control system (refer to Figures 2 and 3 for functional block diagrams). Model 5B08 backplane I/O signals are independently available, while Model 5B08-MUX I/O signals are controlled via an on-board multiplexer providing a bus for input signals and a separate bus for output signals. 5B Series modules can be mixed or matched and may be changed without disturbing field wiring. Each channel has a cold junction temperature sensor (Model AC1361) to accommodate thermocouple modules (5B37 or 5B47). Both backplanes require an external +5 V dc regulated power supply. Reverse power supply protection is provided as well as a replaceable 4-ampere fuse and a power ON green LED indicator.

5B08 SYSTEM CONNECTORS

Signal connections between the 5B08 and the associated measurement and control system are made with two identical 26-pin connectors (P1 and P2), similar to the 16-channel model 5B01 backplane. Reference to these connectors is electrically identical and may be useful if a 5B08 is used for both analog input and analog output and the data acquisition system has separate input or output connectors. Figure 1 illustrates the pin assignments for P1 and P2.

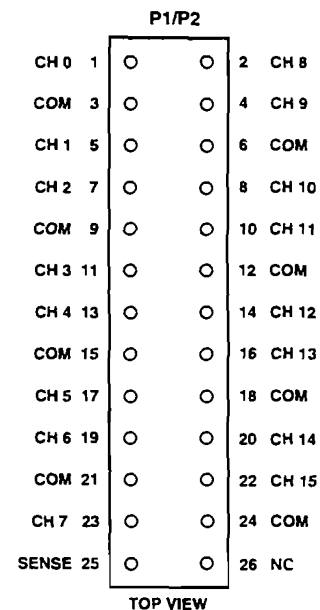


Figure 1. 5B08 System Connector Pinout

REV. A

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5B08/5B08-MUX-SPECIFICATIONS (typical @ +25°C and +5 V dc unless otherwise noted)

Model	5B08	5B08-MUX
CHANNELS	8	*
DIMENSION—WITH 5B SERIES MODULES	3.5" × 10.0" × 3.2" (88.9 mm × 254.0 mm × 81.3 mm)	* *
WEIGHT	7 oz (200 g)	*
MOUNTING STANDOFFS	5	*
COLD JUNCTION TEMPERATURE SENSORS (Provided On Backplane) Accuracy @ +25°C Over +5°C to +45°C	8, Model AC1361 ±0.25°C (±0.75°C max) ±0.5°C (±0.0125°C/°C)	* * *
SYSTEM CONNECTOR 26-Pin Male Mating	Amp 746290-6	*
ADDRESS SELECTION INPUTS Max Logic "0" Min Logic "1" Max Logic "1"	N/A N/A N/A	+0.8 V +2.0 V +7.0 V
POWER SUPPLY Voltage: Operating Voltage: Max Safe Limit—With Modules Current—Without Modules Fuse (F1)	+5 V dc ± 5% +6.0 V dc max 13 mA 4 Ampere Littelfuse® Type 252 004	* * 40 mA *
TEMPERATURE RANGE Rated Performance Storage Relative Humidity	-25°C to +85°C -40°C to +85°C 0 to 95% @ +60°C Noncondensing	* * *

*Specifications same as Model 5B08.

Specifications subject to change without notice.

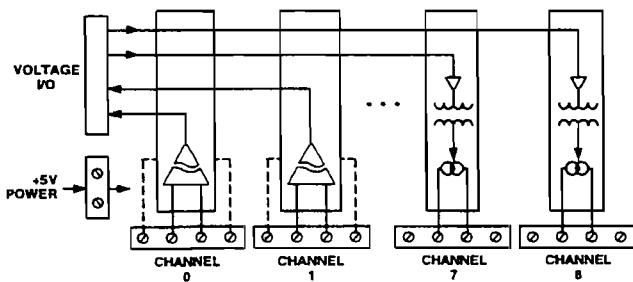


Figure 2. 5B08 Functional Block Diagram

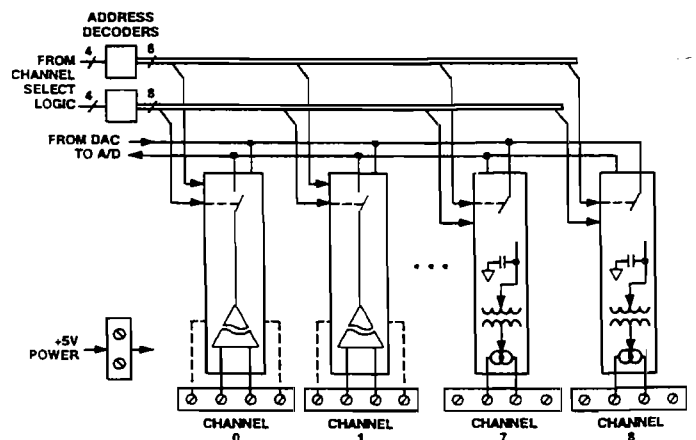


Figure 3. 5B08-MUX Functional Block Diagram

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5B08/5B08-MUX

The I/O connectors provide a signal path for each channel and, in addition, a number of grounding pins are available to provide interchannel shield conductors in the ribbon cable. In some cases, discussed below, the ground conductors will not provide an accurate signal reference, so a SENSE pin is also provided in the connectors. Several jumper and component options on the 5B08 provide optimum ground connections for various applications.

5B08 OUTPUT CHANNEL SELECTION

To configure Model 5B08 I/O for different system needs, on-board jumpers are provided. A family of eight 3-pin jumpers, J8 through J15, allows the user to assign the 5B08 I/O to either the upper eight I/O pins (CH0, CH1, CH2, CH3, CH4, CH5, CH6, CH7) or to the lower eight I/O pins (CH8, CH9, CH10, CH11, CH12, CH13, CH14, CH15). This capability allows two 8-channel 5B08 backplanes to be used in a 16-channel configuration, with all I/O assigned to the 16 unique I/O pins, CH0-CH15. Table I illustrates the channel assignments for each of the eight jumpers, J8 through J15.

Table I. 5B08 Output Channel Assignments

Jumper	Jumper Position	Connects	To V/I Channel
J8	LO	Channel 0	0
	HI		8
J9	LO	Channel 1	1
	HI		9
J10	LO	Channel 2	2
	HI		10
J11	LO	Channel 3	3
	HI		11
J12	LO	Channel 4	4
	HI		12
J13	LO	Channel 5	5
	HI		13
J14	LO	Channel 6	6
	HI		14
J15	LO	Channel 7	7
	HI		15

5B08 INTERCHANNEL JUMPERS

The 5B08 offers the user the ability to easily connect the voltage output of any 5B Series input module directly to the voltage input of an adjacent output module (e.g., Model 5B39) by placing a jumper over two pins (J1, J2, J3, J4, J5, J6 or J7). This feature can be used to provide an isolated current output from an isolated input module. This results in both isolated voltage and isolated current outputs from a single sensor input signal. A kit of ten jumpers is available as Model AC1344.

Table II shows the channel assignments when Jumpers J1-J7 are used. Additional configuration flexibility is provided when the output jumper selections (J8-J15) are combined with the inter-channel jumper selections (J1-J7). Table III provides the resulting signal assignments for each of the various jumper selections.

Table II. 5B08 Interchannel Jumpers

Jumper	Connects
J1	Channel 0 V_{OUT} to Channel 1 V_{IN}
J2	Channel 1 V_{OUT} to Channel 2 V_{IN}
J3	Channel 2 V_{OUT} to Channel 3 V_{IN}
J4	Channel 3 V_{OUT} to Channel 4 V_{IN}
J5	Channel 4 V_{OUT} to Channel 5 V_{IN}
J6	Channel 5 V_{OUT} to Channel 6 V_{IN}
J7	Channel 6 V_{OUT} to Channel 7 V_{IN}

Table III. 5B08 Channel Assignments Using Output and Interchannel Jumpers

Jumper Closed	Output Channel Jumper Setting		Connects	Connects V/I Channels
J1	J8 LO	J9 LO	Channel 0 to Channel 1	0 to 1
	J8 HI	J9 LO		8 to 1
	J8 LO	J9 HI	Channel 1	0 to 9
	J8 HI	J9 HI		8 to 9
J2	J9 LO	J10 LO	Channel 1 to Channel 2	1 to 2
	J9 HI	J10 LO		9 to 2
	J9 LO	J10 HI	Channel 2	1 to 10
	J9 HI	J10 HI		9 to 10
J3	J10 LO	J11 LO	Channel 2 to Channel 3	2 to 3
	J10 HI	J11 LO		10 to 3
	J10 LO	J11 HI	Channel 3	2 to 11
	J10 HI	J11 HI		10 to 11
J4	J11 LO	J12 LO	Channel 3 to Channel 4	3 to 4
	J11 HI	J12 LO		11 to 4
	J11 LO	J12 HI	Channel 4	3 to 12
	J11 HI	J12 HI		11 to 12
J5	J12 LO	J13 LO	Channel 4 to Channel 5	4 to 5
	J12 HI	J13 LO		12 to 5
	J12 LO	J13 HI	Channel 5	4 to 13
	J12 HI	J13 HI		12 to 13
J6	J13 HI	J14 LO	Channel 5 to Channel 6	5 to 6
	J13 LO	J14 LO		13 to 6
	J13 HI	J14 HI	Channel 6	5 to 14
	J13 LO	J14 HI		13 to 14
J7	J14 HI	J15 LO	Channel 6 to Channel 7	6 to 7
	J14 LO	J15 LO		14 to 7
	J14 HI	J15 HI	Channel 7	6 to 15
	J14 LO	J15 HI		14 to 15

5B08/5B08-MUX

5B08 GROUND JUMPERS

Model 5B08 is supplied with three grounding jumpers: W1, W3 and W4. These three jumpers are installed at the factory, but can be changed to accommodate user system configuration needs.

Jumper W1 connects the P1 and P2 shield pins (Pins 3, 6, 9, 12, 15, 18, 21 and 24) to the 5B08 I/O common (backplane measurement ground). This will usually be the primary ground connection between the 5B08 backplane and the measurement system. *This connection is required if output modules are used on the 5B08.* It is also required if there is no high impedance sense input (input LO of a differential or pseudo-differential system) available on the measurement system.

Jumper W3 connects the sense input, if available on Pin 25, to the 5B08 I/O common, so it can be read directly. W3 can be left in place at all times.

Jumper W4 connects the 5B08 I/O common to the +5 V power common. A connection between power common and I/O common is important for the 5B Series modules to function properly; however, if this connection is made elsewhere in your system (the best place is usually near the A/D or D/A converters), W4 should be cut since a ground loop could result.

5B08 ADDITIONAL INFORMATION

See the "5B08/5B08-MUX" sections of this data sheet for additional information on Model 5B08.

5B08-MUX DESCRIPTION

The 5B08-MUX incorporates input and output buses that take advantage of the internal series output switches in the 5B Series input modules as well as the track-and-hold circuit in the output modules. Designers integrating the 5B08-MUX into a measurement and control system do not need external multiplexers and can use a single digital-to-analog converter to serve numerous output channels. Refer to Figure 3 for a functional block diagram and Figure 6 for a schematic diagram of model 5B08-MUX. Digital outputs from the host data acquisition system are used to address the 5B Series modules and designate inputs and outputs. Only one analog input, one analog output and a number of digital outputs are required to address up to 64 analog input/output channels using eight 5B08-MUX backplanes.

MODEL 5B08-MUX SYSTEM CONNECTOR

Signal connections between the 5B08-MUX and the associated measurement or control system are made at P1, a 26-pin connector. The pinout of P1 is shown in Figure 4.

One signal path is provided for inputs and one for outputs. Input and output modules are independently addressed by two sets of six address pins and an enable pin. In addition, a number of grounded pins are present in the connector pinout to provide shield conductors in the ribbon cable. In some cases, discussed below, the ground conductors will not provide an accurate signal reference, so a SENSE pin (SNS LO) is also provided in the pinout. Several jumper and component options in the backplane provide optimum ground connections for various circumstances.

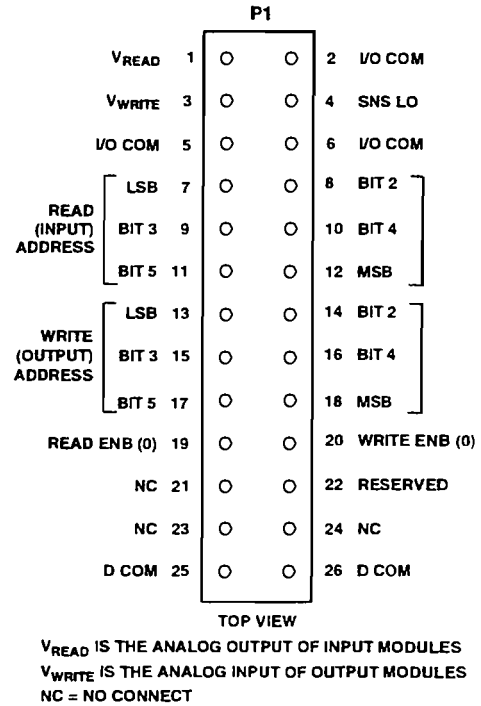


Figure 4. 5B08-MUX System Connector Pinout

5B08-MUX GROUND JUMPERS

Model 5B08-MUX is supplied with three grounding jumpers: W1, W2 and W4. These three jumpers are installed at the factory, but can be changed to accommodate user system configuration needs.

Jumper W1 connects the P1 shield pins (Pins 2, 5 and 6) to the 5B08-MUX backplane common (backplane measurement ground). This will usually be the primary ground connection between the 5B08-MUX backplane and the measurement system. *This connection is required if output modules are used on the 5B08-MUX.* It is also required if there is no high impedance sense input (input LO of a differential or pseudo-differential system) available on the measurement system.

Jumper W2 connects the sense input from the measurement system, if available on Pin 4, to the 5B08-MUX backplane common, so it can be read directly. W2 can be left in place at all times.

Jumper W4 connects the 5B08-MUX backplane common to the +5 V power common. A connection between power common and I/O common is important for the 5B Series modules to function properly; however, if this connection is made elsewhere in your system (the best place is usually near the A/D or D/A converters), W4 should be cut since a ground loop could result.

5B08-MUX ADDRESS JUMPERS

5B08-MUX backplane can hold eight 5B Series modules in any combination of inputs or outputs. Address decoders on the backplane determine which module is read (input type) or driven (output type). Separate decoders are provided for inputs and outputs. To permit system expansion, up to eight 5B08-MUX backplanes can be daisy-chained on the system I/O ribbon cable for a total of 64 channels. Jumpers on each backplane (labeled J1-J9 and J10-J18) determine the block of eight addresses assigned to each backplane. Input (read) and output (write) addressing are completely independent; in all cases, Jumpers J1-J9 control inputs and J10-J18 control outputs. Independent addressing might be used, for example, to update output modules without interrupting the monitoring of input modules.

Table IV. 5B08-MUX Address Jumpers

Input Jumper	Output Jumper	Address Range
J2	J11	56-63
J3	J12	48-55
J4	J13	40-47
J5	J14	32-39
J6	J15	24-31
J7	J16	16-23
J8	J17	8-15
J9	J18	0-7

5B08-MUX FACTORY JUMPER SETTINGS

5B08-MUX backplanes are factory configured with jumpers at positions J1 and J10. This sets up the 5B08-MUX backplane as a stand-alone 8-channel system. Moving the jumpers to any other position in the two blocks of jumpers enables decoding of the full six address bits; the exact position of the jumper determines address position for the 5B08-MUX backplane as shown in Table IV. To use multiple 5B08-MUX backplanes in this manner, connect the corresponding I/O connector pins of each backplane in parallel. Model CAB-01 cable is a ribbon cable with three 26-pin connectors designed for this purpose.

5B08/5B08-MUX FUSING AND POLARITY REVERSAL

Since reversing the polarity of the +5 V dc power source could destroy installed modules, the 5B08/5B08-MUX incorporate polarity reversal protection in the form of a shunt diode. A 4-ampere socketed fuse will open by the diode current if the supply is reversed. If the fuse is open, replacement with the proper type (Littelfuse Type 252 004) is essential.

5B08/5B08-MUX GROUND STUDS

The 5B Series modules meet transient voltage protection standard ANSI/IEEE C37.90.1-1989.

The 5B Series modules can prevent damage to the connected system even when a very large, fast transient strikes all eight field I/O lines at the same time. However, proper grounding of the backplane is essential to ensure full protection since, in such cases, currents on the order of an ampere, with rise times on the order of one microsecond, must be delivered to ground. Both the resistance and the inductance of the ground path are critical. In applications where hazards of this magnitude exist, the large (#10-32) ground stud provided at each end of the 5B08 backplane (at one end of the 5B08-MUX backplane) should be connected to system ground by the shortest practical length of large diameter wire.

The surge withstand capability can be tested with not less than fifty 2.5 kV bursts per second. A test duration of two seconds is widely accepted. A rise time of 20 kV/ μ s is specified and each module could see a surge current on the order of 1 ampere.

When a safety ground is used, the connection of backplane measurement ground to system measurement ground via the shield wires in the ribbon cable could result in a ground loop. If the application involves only input modules and a sense input is used on the measurement system, W1 should be cut to prevent a ground loop.

5B08/5B08-MUX CAUTION

W1 is required if output modules are used or there is no high impedance sense input on the measurement system. In these cases, the best defense against ground loop errors is to minimize the distance between the backplane and the associated system and to route any large currents carefully to minimize ground differences.

5B08/5B08-MUX INPUT FIELD CONNECTIONS

All field sensor and transducer connections to the 5B08 and 5B08-MUX are made to 4-screw terminal connectors associated with each channel. Figure 7 illustrates the specific field connections for each of the various 5B Series modules.

5B SERIES MODULES

The 5B Series provides a selection of over 14 module types, covering sensors signals such as mV, V, thermocouple, potentiometer, RTD, mA, frequency and strain. Both standard input/output ranges are available as well as custom ranges. The 5B-Custom program diskette, a Windows[®]-based program, is available from Analog Devices to assist the user both in selecting a standard module range and/or verifying if a custom range is available. Additionally, a 5B Series User manual is available to provide detailed specifications on all 5B Series modules and application information in using both modules and backplanes.

5B08/5B08-MUX

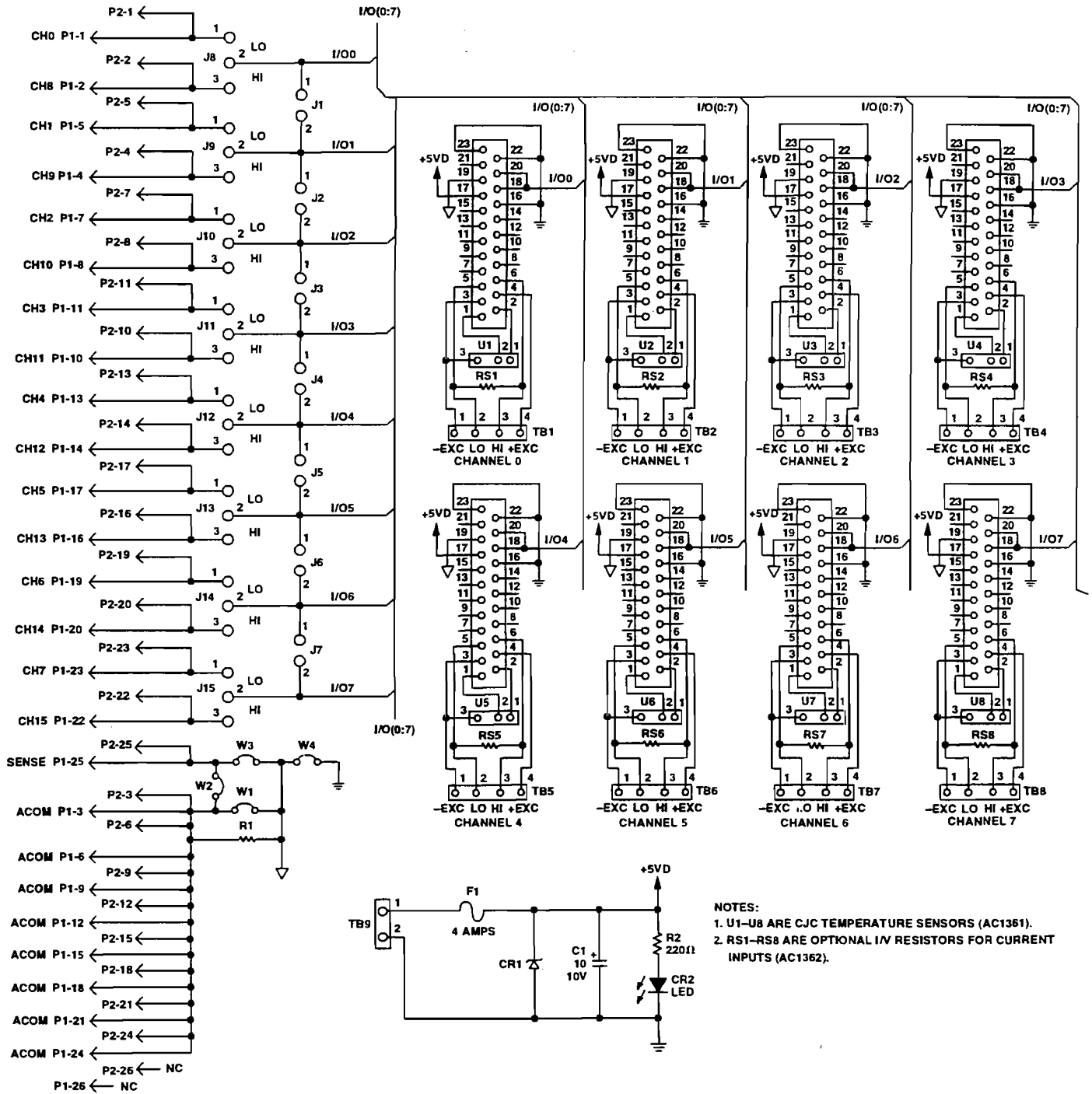
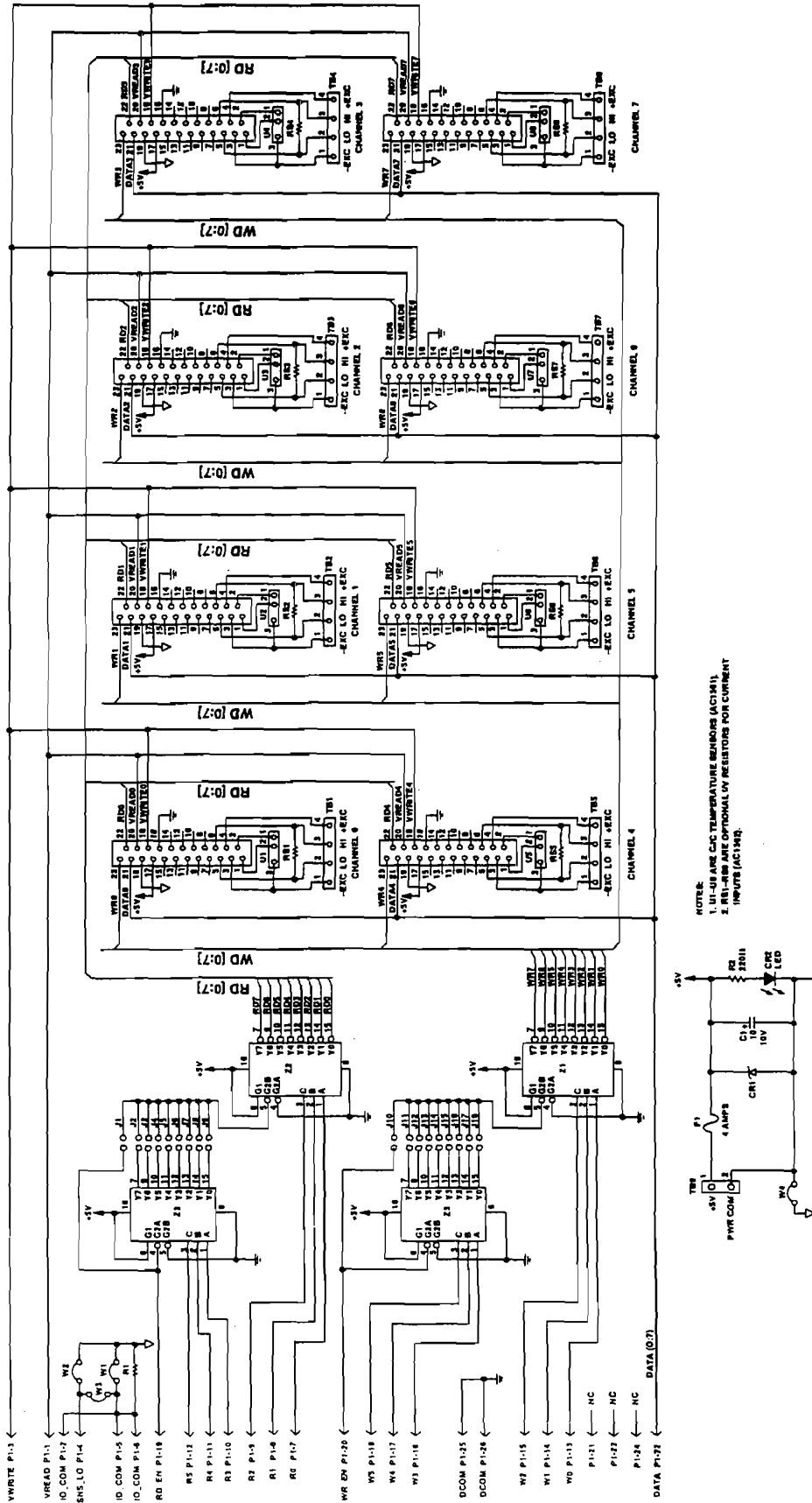


Figure 5. 5B08 Schematic Diagram



NOTE:
 1. U1-U8 ARE C/C TEMPERATURE SENSORS (ACT1-8).
 2. R81-R88 ARE OPTIONAL BY RESISTORS FOR CURRENT INPUTS (ACT1-8).

Figure 6. 5B08-MUX Schematic Diagram

5B08/5B08-MUX

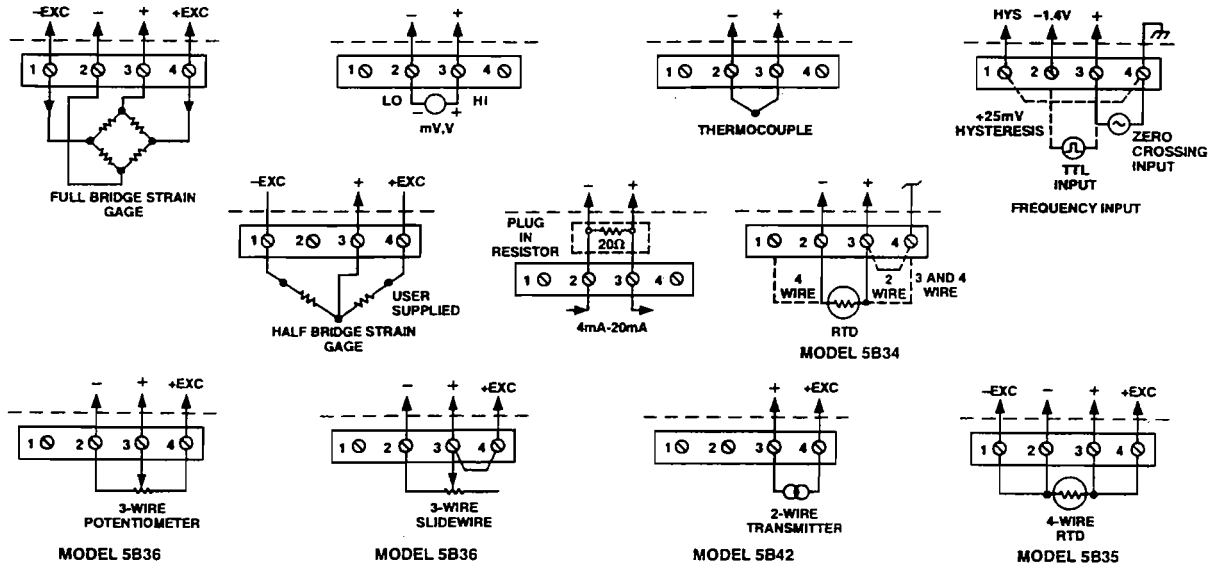
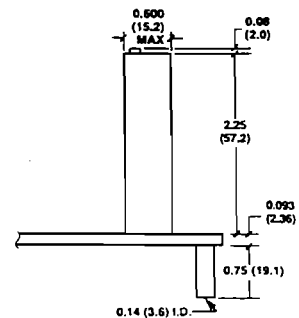
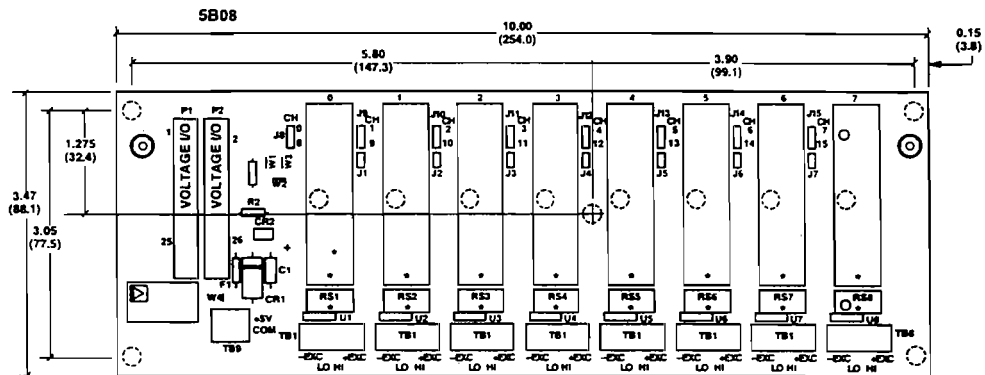
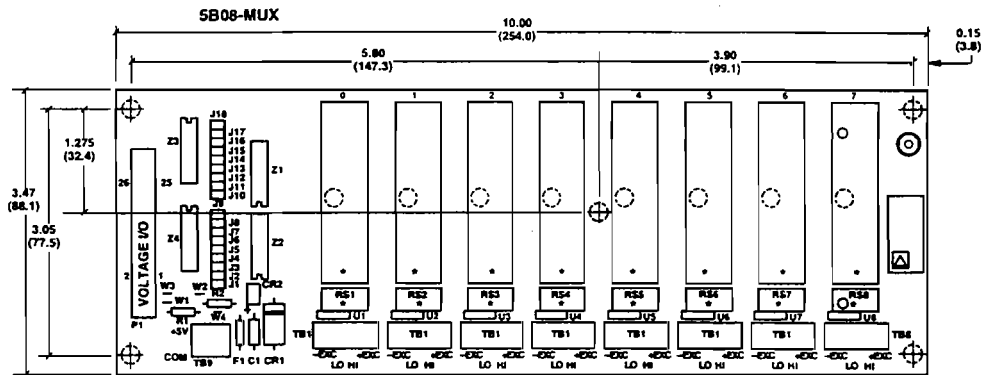


Figure 7. Field Input Connections

OUTLINE DIMENSIONS

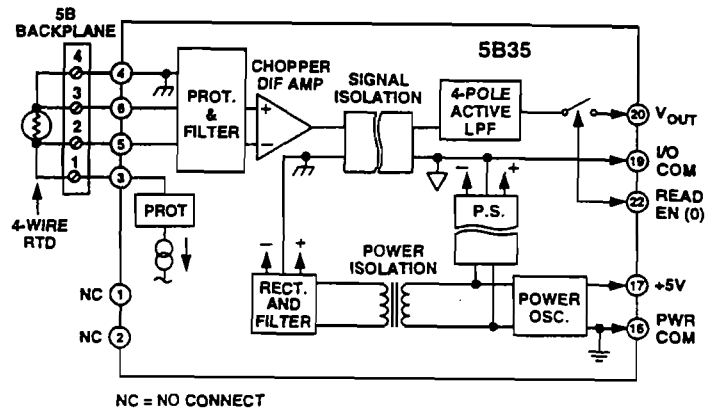
Dimensions shown in inches and (mm).



FEATURES

- Accepts a Variety of RTD Types
 - 100 Ω Platinum, 10 Ω Copper, 120 Ω Nickel
- Linearizes RTD Signal
- 1500 V rms Input/Output and Input/Power Isolation
- 250 V rms Output/Power Isolation
- 240 V rms Field Wiring Protection
- 4-Wire Lead Resistance Compensation
- 190 dB CMRR
- 116 dB NMR @ 60 Hz, 108 dB @ 50 Hz
- Low Drift:
 - Input Offset $\pm 0.01^{\circ}\text{C}/^{\circ}\text{C}$
 - Gain ± 30 ppm/ $^{\circ}\text{C}$
- Low Output Noise:
 - 0.3 mV p-p @ 100 kHz BW
 - 6 mV p-p @ 5 MHz BW
- Low Power Consumption: +5 V dc @ 15 mA
- ANSI/IEEE C37.90.1-1989 Transient Protection
- CSA, CE Approvals

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

Model 5B35 converts the input from a wide variety of RTD types to a linearized, high accuracy output of 0 V to +5 V. The module provides transformer isolation, RTD excitation, RTD lead-resistance compensation, signal filtering and input protection against line voltage connection. A series output switch eliminates the need for external multiplexing. The industry standard 5B Series encapsulated plug-in modular package is compatible with all 5B backplanes. Modules are powered by +5 V dc, $\pm 5\%$.

Signal isolation is provided by transformer coupling using a proprietary technique for linear, stable performance. A demodulator on the output side of the signal transformer recovers the input signal, which is filtered and buffered to provide an accurate, low impedance, low noise output.

True three-port isolation includes common-mode voltage of: 1500 V rms between input and output, and between input and power; 250 V rms between output and power.

The modules provide RTD excitation from a precision current source. A low drift, chopper stabilized, differential amplifier design allows for the use of very low RTD excitation currents to minimize accuracy losses from self-heating of the RTD. The low input offset drift of $\pm 0.01^{\circ}\text{C}/^{\circ}\text{C}$ and gain drift of ± 30 ppm/ $^{\circ}\text{C}$ assure that accuracy is maintained over a wide operating temperature range.

The four-wire configuration of the 5B35 supplies the RTD excitation current through two leads that are not the signal input leads. Because there is no excitation current in the signal input leads, the lead lengths or resistances have no effect on the RTD measurement.

An optimized five-pole Butterworth filter (with 4 Hz bandwidth) provides 116 dB of normal-mode rejection at 60 Hz and 108 dB at 50 Hz. Output noise is an exceptionally low 0.3 mV p-p at 100 kHz bandwidth and 6 mV p-p at 5 MHz bandwidth.

The input circuit is protected against accidental application of voltages, such as an ac power line, up to 240 V rms continuous.

A series output switch is included to eliminate the need for external multiplexing in many applications. This switch has a low output resistance and is controlled by an active-low enable input. When the output switch is not used, ground the enable input to I/O common to turn on the switch.

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MODEL 5B35—SPECIFICATIONS (typical @ +25°C and $V_S = +5$ V dc)

Model	5B35
INPUT	
Standard Ranges	See Table I
Custom Range Limits	(See Table II for More Information)
100 Ω Pt	-200°C to +850°C
120 Ω Ni	-80°C to +320°C
10 Ω Cu	-100°C to +260°C
Impedance	
Normal (Power On)	>1000 M Ω
Power Off	200 k Ω
Overload	200 k Ω
Normal-Mode Rejection (NMR)	116 dB (60 Hz); 108 dB (50 Hz)
Protection	
Continuous	240 V rms max
Transient	ANSI/IEEE C37.90.1-1989
SENSOR EXCITATION CURRENT	
100 Ω Pt, 120 Ω Ni	0.25 mA
10 Ω Cu	1.0 mA
LEAD RESISTANCE EFFECT	
100 Ω Pt, 120 Ω Ni	$\pm 0.00001^\circ\text{C}/\Omega$
10 Ω Cu	$\pm 0.0001^\circ\text{C}/\Omega$
COMMON-MODE VOLTAGE (CMV)	
Input-to-Output, Continuous	1500 V rms, max
Input-to-Power, Continuous	1500 V rms, max
Power-to-Output, Continuous ¹	250 V rms, max
COMMON-MODE REJECTION (CMR), 50/60 Hz²	190 dB
ACCURACY	
Initial @ +25°C ³	See Table I
Conformity Error	$\pm 0.05\%$ Span
Stability vs. Temperature (-40°C to +85°C)	
Input Offset	$\pm 0.01^\circ\text{C}/^\circ\text{C}$
Output Offset	$\pm 20 \mu\text{V}/^\circ\text{C}$
Gain	± 30 ppm of Reading/ $^\circ\text{C}$
OUTPUT	
Range	0 V to +5 V
Resistance	25 Ω
Bandwidth	4 Hz
Step Response Time (10% to 90% range)	100 ms
Noise	
Input, 0.1 Hz to 10 Hz	0.2 μV rms
Output, 100 kHz Bandwidth	100 μV rms
Output, 1 MHz Bandwidth	0.3 mV p-p
Output, 5 MHz Bandwidth	1.5 mV p-p
Protection	6 mV p-p
Current Limit	Continuous Short to Ground
Enable Time (C Load = 0 pF to 2000 pF)	± 9 mA
Enable Control	6 μs to ± 1 mV of V_{OUT}
Max Logic "0"	+0.8 V
Min Logic "1"	+2.4 V
Max Logic "1"	+100 V
Input Current "0," "1"	0.5 μA
POWER SUPPLY	
Voltage, Rated Performance	+5 V dc $\pm 5\%$
Current	15 mA
Sensitivity (100 Ω Pt, 120 Ω Ni, 10 Ω Cu)	$\pm 0.2^\circ\text{C}/\text{V}$
CASE SIZE, Maximum	2.275" x 2.325" x 0.595" (57.8 mm x 59.1 mm x 15.1 mm)
WEIGHT	70 grams
ENVIRONMENTAL	
Temperature Range, Rated Performance	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Relative Humidity	0% to 93% @ +40°C, Noncondensing
RFI Susceptibility	$\pm 0.5\%$ Span Error @ 400 MHz, 5 W, 3'

Table I. Standard Model Input/Output Ranges*

Model	Input Range	Accuracy
100 Ω Platinum, $\alpha = 0.00385^*$		
5B35-01	-100°C to +100°C (-148°F to +212°F)	$\pm 0.26^\circ\text{C}$
5B35-02	0°C to +100°C (+32°F to +212°F)	$\pm 0.13^\circ\text{C}$
5B35-03	0°C to +200°C (+32°F to +392°F)	$\pm 0.26^\circ\text{C}$
5B35-04	0°C to +600°C (+32°F to +1112°F)	$\pm 0.78^\circ\text{C}$
5B35-05	-100°C to +200°C (-148°F to +392°F)	$\pm 0.60^\circ\text{C}$
10 Ω Copper, $\alpha = 0.004274$		
5B35-C-01	0°C to +120°C (10 Ω at 0°C) (+32°F to +248°F)	$\pm 0.23^\circ\text{C}$
5B35-C-02	0°C to +120°C (10 Ω at +25°C) (+32°F to +248°F)	$\pm 0.23^\circ\text{C}$
120 Ω Nickel, $\alpha = 0.00672$		
5B35-N-01	0°C to +300°C (+32°F to +572°F)	$\pm 0.40^\circ\text{C}$

*Standard output range for all models is 0 V to +5 V. Custom input/output ranges are available, including versions for the 100 Ω Platinum ($\alpha = 0.003916$) RTD. See Table II.

Table II. Custom Model Ordering Guide

Order Model: **5B35-CUSTOM*** plus Customer Specified Information

Customer Specified Information:				
Sensor Type	Input Range		Output Range	
Available Sensor Types	Low Limit	High Limit	Low Limit	High Limit
100 Ω Pt $\alpha = 0.00385$	-200°C	+850°C	0 V	+5 V
100 Ω Pt $\alpha = 0.003916$	-200°C	+850°C	0 V	+5 V
10 Ω Cu $\alpha = 0.004274$	Consult Factory		0 V	+5 V
120 Ω Ni $\alpha = 0.00672$	Consult Factory		0 V	+5 V

*For copper (Cu) RTD sensor inputs, order 5B35-C-CUSTOM.
For nickel (Ni) RTD sensor inputs, order 5B35-N-CUSTOM.

NOTES

¹The user's board layout must separate Power Ground from I/O Common and when the 5B35 output switch is not used, ground the enable input to I/O Common. Power-to-Output CMV is not available when the 5B35 is installed on a 5 B Series backplane.

²CMR for Model 5B35-04 is 180 dB

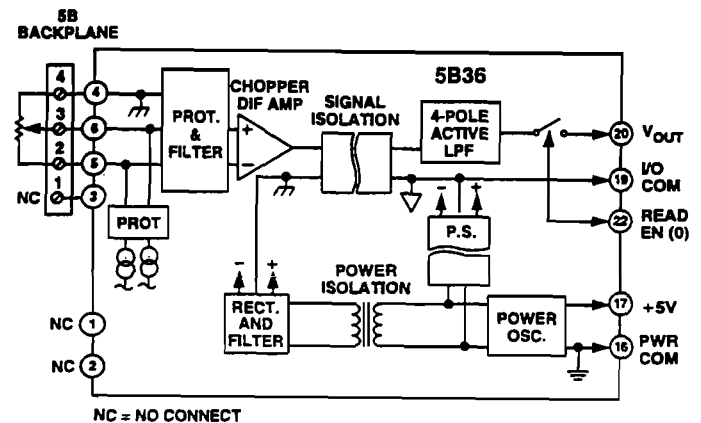
³Includes the combined effects of repeatability, hysteresis and conformity.

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FEATURES

- Accepts Potentiometers up to 10,000 Ω
- High Level 0 V to +5 V Output
- 1500 V rms Input/Output and Input/Power Isolation
- 250 V rms Output/Power Isolation
- 240 V rms Field Wiring Protection
- 170 dB CMRR
- 116 dB NMR @ 60 Hz, 108 dB @ 50 Hz
- Low Gain Drift: ± 30 ppm/ $^{\circ}$ C
- Low Output Noise:
 - 0.3 mV p-p @ 100 kHz BW
 - 6 mV p-p @ 5 MHz BW
- Low Power Consumption: +5 V dc @ 15 mA
- ANSI/IEEE C37.90.1-1989 Transient Protection
- CSA, CE Approvals

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

Model 5B36 converts the input from a variety of potentiometers and variable resistors to a high level output of 0 V to +5 V. The module provides transformer isolation, potentiometer excitation, signal filtering and input protection against line voltage connection. The series output switch eliminates the need for external multiplexing. The industry standard 5B Series encapsulated plug-in modular package is compatible with all 5B backplanes. Modules are powered by +5 V dc, $\pm 5\%$.

Signal isolation is provided by transformer coupling using a proprietary technique for linear, stable performance. A demodulator on the output side of the signal transformer recovers the input signal, which is filtered and buffered to provide an accurate, low impedance, low noise output.

True three-port isolation includes common-mode voltage of: 1500 V rms between input and output, and between input and power; 250 V rms between output and power.

The modules provide potentiometer excitation from a precision current source. A low drift, chopper stabilized, differential amplifier design allows for the use of very low excitation currents to minimize accuracy losses from self-heating of the potentiometer. The low gain drift of ± 30 ppm/ $^{\circ}$ C and low offset drift assure that accuracy is maintained over a wide operating temperature range.

The 5B36 supplies equal excitation currents to three-wire potentiometers to cancel the effects of lead resistance.

An optimized five-pole Butterworth filter (with 4 Hz bandwidth) provides 116 dB of normal-mode rejection at 60 Hz and 108 dB

at 50 Hz. Output noise is an exceptionally low 0.3 mV p-p at 100 kHz bandwidth and 6 mV p-p at 5 MHz bandwidth.

The input circuit is protected against accidental application of voltages, such as an ac power line, up to 240 V rms continuous.

A series output switch is included to eliminate the need for external multiplexing in many applications. This switch has a low output resistance and is controlled by an active-low enable input. When the output switch is not used, ground the enable input to I/O common to turn on the switch.

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MODEL 5B36—SPECIFICATIONS (typical @ +25°C and $V_S = +5$ V dc)

Model	5B36
INPUT	
Standard Ranges	See Table I
Custom Range Limits	See Table II
Impedance	
Normal (Power On)	>1000 M Ω
Power Off	200 k Ω
Overload	200 k Ω
Normal Mode Rejection (NMR)	116 dB (60 Hz); 108 dB (50 Hz)
Protection	
Continuous	240 V rms max
Transient	ANSI/IEEE C37.90.1-1989
SENSOR EXCITATION CURRENT	
100 Ω , 500 Ω , 1 k Ω Sensors	0.25 mA
10 k Ω Sensor	0.1 mA
LEAD RESISTANCE EFFECT	
100 Ω , 500 Ω , 1 k Ω Sensors	$\pm 0.005 \Omega/\Omega$
10 k Ω Sensor	$\pm 0.01 \Omega/\Omega$
COMMON-MODE VOLTAGE (CMV)	
Input-to-Output, Continuous	1500 V rms, max
Input-to-Power, Continuous	1500 V rms, max
Power-to-Output, Continuous ¹	250 V rms, max
COMMON-MODE REJECTION (CMR) 50 Hz/60 Hz	170 dB
ACCURACY	
Initial @ +25°C ²	$\pm 0.08\%$ Span
Stability vs. Temperature (-40°C to +85°C)	
Input Offset	
100 Ω , 500 Ω , 1 k Ω Sensors	$\pm 0.004 \Omega/^\circ\text{C}$
10 k Ω Sensor	$\pm 0.010 \Omega/^\circ\text{C}$
Output Offset	$\pm 20 \mu\text{V}/^\circ\text{C}$
Gain	$\pm 30 \text{ ppm of Reading}/^\circ\text{C}$
OUTPUT	
Range	0 V to +5 V
Resistance	25 Ω
Bandwidth, -3 dB	4 Hz
Step Response Time (10% to 90% Range)	100 ms
Noise	
Input, 0.1 Hz to 10 Hz	0.2 $\mu\text{V rms RTI}$ ³
Output, 100 kHz Bandwidth	100 $\mu\text{V rms}$
	0.3 mV p-p
Output, 1 MHz Bandwidth	1.5 mV p-p
Output, 5 MHz Bandwidth	6 mV p-p
Protection	Continuous Short to Ground
Current Limit	$\pm 9 \text{ mA}$
Enable Time (C Load = 0 pF to 2000 pF)	6 μs to $\pm 1 \text{ mV}$ of V_{OUT}
Enable Control	
Max Logic "0"	+0.8 V
Min Logic "1"	+2.4 V
Max Logic "1"	+100 V
Input Current "0," "1"	0.5 μA
POWER SUPPLY	
Voltage, Rated Performance	+5 V dc $\pm 5\%$
Current	15 mA
Sensitivity	$\pm 2 \mu\text{V}/\% \text{ RTI}$ ³
CASE SIZE, Maximum	2.275" \times 2.325" \times 0.595" (57.8 mm \times 59.1 mm \times 15.1 mm)
WEIGHT	70 grams
ENVIRONMENTAL	
Temperature Range, Rated Performance	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Relative Humidity	0% to 93% @ +40°C, Noncondensing
RFI Susceptibility	$\pm 0.5\%$ Span Error @ 400 MHz, 5 W, 3'

Table I. Standard Model Input/Output Ranges*

Model	Input Range	Output Range
5B36-01	0 Ω to 100 Ω	0 V to +5 V
5B36-02	0 Ω to 500 Ω	0 V to +5 V
5B36-03	0 Ω to 1 k Ω	0 V to +5 V
5B36-04	0 Ω to 10 k Ω	0 V to +5 V

NOTE

*Custom input/output ranges are available. See Table II.

Table II. Custom Model Ordering Guide

Order Model: 5B36-CUSTOM

Plus Customer Specified Information

Input Range

Zero Suppression

(= Low); *specify*

 Minimum 0 Ω

 Maximum 150 Ω

High; specify

 Minimum 25 Ω + Zero Suppression

 Maximum 10 k Ω + Zero Suppression

Output Range

 Low; *fixed* 0 V

High; specify +5 V max

Examples:

Smallest Input Range with No Zero Suppression

 Specify 0 Ω to 25 Ω Input Range

Smallest Input Range with Highest Zero Suppression

 Specify 150 Ω to 175 Ω Input Range

Largest Input Range with No Zero Suppression

 Specify 0 Ω to 10 k Ω Input Range

Largest Input Range with Highest Zero Suppression

 Specify 150 Ω to 10.150 k Ω Input Range

NOTES

¹The user's board layout must separate Power Ground from I/O Common and when the 5B36 output switch is not used, ground the enable input to I/O Common. Power-to-Output CMV is not available when the 5B36 is installed on a 5B Series backplane.

²Includes the combined effects of repeatability, hysteresis and nonlinearity.

³Referenced to input.

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FEATURES

Accepts 4-to-20 mA Process Current Input Signal
Provides Isolation and Regulated 20 V DC Loop Power for Nonisolated 2-Wire Transmitters
+1 V to +5 V or +2 V to +10 V Output
1500 V rms Input/Output and Input/Power Isolation
250 V rms Output/Power Isolation
140 dB Common-Mode Rejection
100 Hz Signal Bandwidth
Accuracy: $\pm 0.05\%$
Linearity: $\pm 0.01\%$
240 V rms Field Wiring Protection
Protected Internal Current Sense Resistor
ANSI/IEEE C37.90.1-1989 Transient Protection
CSA, CE Approvals

GENERAL DESCRIPTION

Model 5B42 interfaces with 2-wire transmitters to convert their 4-to-20 mA process current signal into a high accuracy output of +1 V to +5 V or +2 V to +10 V. The module provides 1500 V isolation with 140 dB CMR, 20 V regulated loop power (at a 4-to-20 mA loop current), signal filtering, and input protection against accidental line voltage connection. The industry standard 5B Series encapsulated plug-in modular package is compatible with all 5B backplanes. Modules are powered by +5 V dc, $\pm 5\%$.

Signal isolation is provided by transformer coupling using a proprietary technique for linear, stable performance. A demodulator on the output side of the signal transformer recovers the input signal, which is filtered and buffered to provide an accurate, low impedance, low noise output.

True three-port isolation includes common-mode voltage of: 1500 V rms between input and output, and between input and power; 250 V rms between output and power.

Accurate performance is maintained over a wide -40°C to $+85^{\circ}\text{C}$ operating temperature range. The 5B42's low drift design achieves an output offset drift of only $\pm 5 \mu\text{V}/^{\circ}\text{C}$ and gain drift of $\pm 25 \text{ ppm}/^{\circ}\text{C}$.

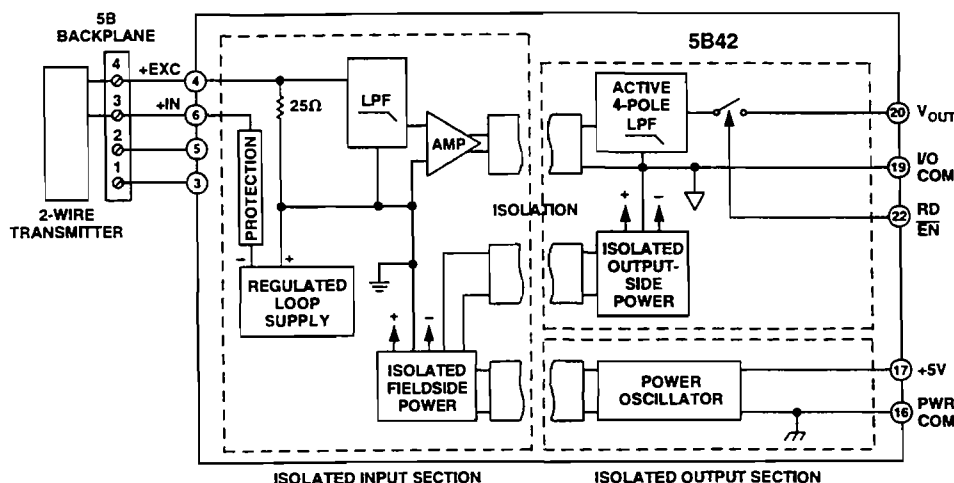
The 5B42 offers significant advantages over signal conditioners that require an external current sense resistor. An external resistor is not protected from accidental connection to ac line voltages, and its error tolerance must be added to the conditioner's specified errors.

The 5B42 is trimmed and specified including its internal 25Ω current-sense input resistor. The 5B42 signal input, loop supply and the sense resistor are all protected against accidental application of voltages, such as an ac power line, up to 240 V rms continuous. There is no need to install an external resistor on the backplane, but if one is installed, it has no effect on the 5B42 performance.

The module has a -3 dB bandwidth of 100 Hz, an optimized 5-pole signal filter with low overshoot and exceptional output noise performance of $200 \mu\text{V}$ peak-to-peak at 100 kHz bandwidth.

The 5B42 logic-controlled series output switch eliminates the need for external multiplexing in many applications. This low output resistance switch is controlled by an active low enable input. When the output switch is not used, ground the enable input to I/O common to turn on the switch.

FUNCTIONAL BLOCK DIAGRAM



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MODEL 5B42—SPECIFICATIONS (typical @ +25°C and $V_s = +5$ V dc)

Model	5B42
INPUT	
Standard Ranges	4 mA to 20 mA (See Table I)
Custom Range Limits	0 mA to 20 mA (See Table II)
Input Resistor ¹	25 Ω
Loop Supply Voltage	20 V @ 4 mA to 20 mA
Normal-Mode Rejection (NMR)	
-3 dB @ 100 Hz	90 dB Per Decade Above 100 Hz
Input/Excitation/Sense Resistor Protection	
Continuous	240 V rms max
Transient	ANSI/IEEE C37.90.1-1989
COMMON-MODE VOLTAGE (CMV)	
Input-to-Output, Continuous	1500 V rms, max
Input-to-Power, Continuous	1500 V rms, max
Power-to-Output, Continuous ²	250 V rms, max
COMMON-MODE REJECTION (CMR) 50 Hz/60 Hz³	140 dB
ACCURACY	
Initial @ +25°C ⁴	$\pm 0.05\%$ Span ± 4 μ A RTI ⁵
Nonlinearity	$\pm 0.01\%$ Span
Stability vs. Temperature (-40°C to +85°C)	
Input Offset	± 0.5 μ V/°C
Output Offset	± 5 μ V/°C
Gain	± 25 ppm of Reading/°C
OUTPUT	
Range (See Tables I and II)	
5B42-01	+1 V to +5 V
5B42-02	+2 V to +10 V
Resistance	25 Ω
Bandwidth, -3 dB	100 Hz
Step Response Time (90% Span)	4 ms
Noise	
Input, 0.1 Hz to 10 Hz	10 nA rms
Output, 100 kHz	200 μ V pk-pk
Protection	Continuous Short to Ground
Current Limit	± 20 mA
Enable Time (C Load = 0 pF to 2000 pF)	6 μ s to ± 1 mV of V_{OUT}
Enable Control	
Max Logic "0"	+0.8 V
Min Logic "1"	+2.4 V
Max Logic "1"	+36 V
Input Current "0," "1"	0.5 μ A
POWER SUPPLY	
Voltage, Rated Performance	+5 V dc $\pm 5\%$
Current	
@ Transmitter Load of 20 mA	200 mA
@ Transmitter Load of 4 mA	100 mA
Sensitivity	± 1 μ V/% RTI ⁵
CASE SIZE, Maximum	2.275" \times 2.325" \times 0.595" (57.8 mm \times 59.1 mm \times 15.1 mm)
WEIGHT	70 grams
ENVIRONMENTAL	
Temperature Range, Rated Performance	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Relative Humidity	0% to 93% @ +40°C, Noncondensing
RFI Susceptibility	$\pm 0.5\%$ Span Error @ 400 MHz, 5 W, 3'

Table I. Standard Model Input/Output Ranges*

Model	Input Range	Output Range
5B42-01	4 mA to 20 mA	+1 V to +5 V
5B42-02	4 mA to 20 mA	+2 V to +10 V

*Custom input/output ranges are available. See Table II.

Table II. Custom Model Ordering Guide

Order Model: 5B42-CUSTOM plus Customer Specified Information

Customer Specified Information:

Input Range	Output Range	
	Low Limit	High Limit
Available Range 0 mA to 20 mA*	0 V	10 V

*There is no loop power supplied by the 5B42 at 0 mA input.

NOTES

¹A precision 25 Ω current-sense input resistor is internal to the 5B42.

²The user's board layout must separate Power Ground from I/O Common and when the 5B42 output switch is not used, ground the enable input to I/O Common. Power-to-Output CMV is not available when the 5B42 is installed on a 5B Series backplane.

³The use of shielded cable from the signal source to the 5B42 inputs is recommended to maintain CMR performance.

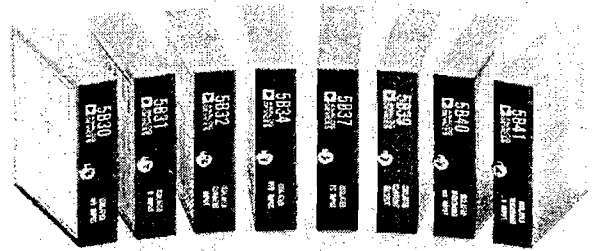
⁴Includes the combined effects of repeatability, hysteresis and nonlinearity.

⁵Referenced to Input.

Specifications subject to change without notice.

Chapter 1 Introduction

This manual serves as a guide to both designers of systems using 5B Series Modular Signal Conditioners and to users of a 5B Series Signal Conditioning Subsystem solution. Module functions and specifications are described in Chapter 2. The proper configuration and operation of the 5B Series Subsystem are discussed in Chapter 3, and system design issues are addressed in Chapter 4. Appendixes are devoted to available accessories, drill templates, and product notes.



General Description

The 5B Series modules are low cost, high performance plug-in signal conditioners. Designed for industrial applications, these modules incorporate a circuit design utilizing transformer-based isolation and automated surface mount manufacturing technology. This allows for long term stability and channel to channel isolation. They are compact, economical components whose performance exceeds that available from more expensive devices. Combining 1500 Vrms continuous CMV isolation, $\pm 0.05\%$ calibrated accuracy, small size and low cost, the 5B Series is an attractive alternative to expensive signal conditioners and in-house designs.

All modules are hard potted and identical in pinout and size ($2.25'' \times 2.25'' \times 0.60''$). They can be mixed and matched on one backplane, permitting users to address their exact needs, and may be changed without disturbing field wiring. The isolated input modules provide 0 to +5 V or -5 V to +5 V outputs (depending on model type) and accept J, K, T, E, R, S, N, and B thermocouples;

100 Ω platinum, 10 Ω copper and 120 Ω nickel RTDs; strain gages; mV, V, 4-20 mA or 0-20 mA, frequency (0 to 250 kHz), and wide bandwidth (10 kHz) mV and V signals. These modules feature complete signal conditioning functions including 240 Vrms input protection, filtering, chopper stabilized low drift ($\pm 1 \mu\text{V}/^\circ\text{C}$), amplification, 1500 Vrms isolation, linearization for RTD and thermocouple inputs, and sensor excitation when required. The output module converts a 0 to +5 V or ± 5 V input to an isolated 4-20 mA or 0-20 mA process current signal. All modules feature excellent common mode rejection and meet IEEE-STD 472 (SWC). These modules incorporate a laser trimmed resistor network, obviating the need for potentiometer adjustments and constant calibration.

The 5B Series provides system designers with an easy to use solution for analog I/O in a minimum of board space. The modules' standard pinout and easy installation simplify design. There are also a number of backplanes, which provide a complete signal conditioning solution for end users. Each backplane incorporates screw terminals for field wiring inputs and outputs and cold junction

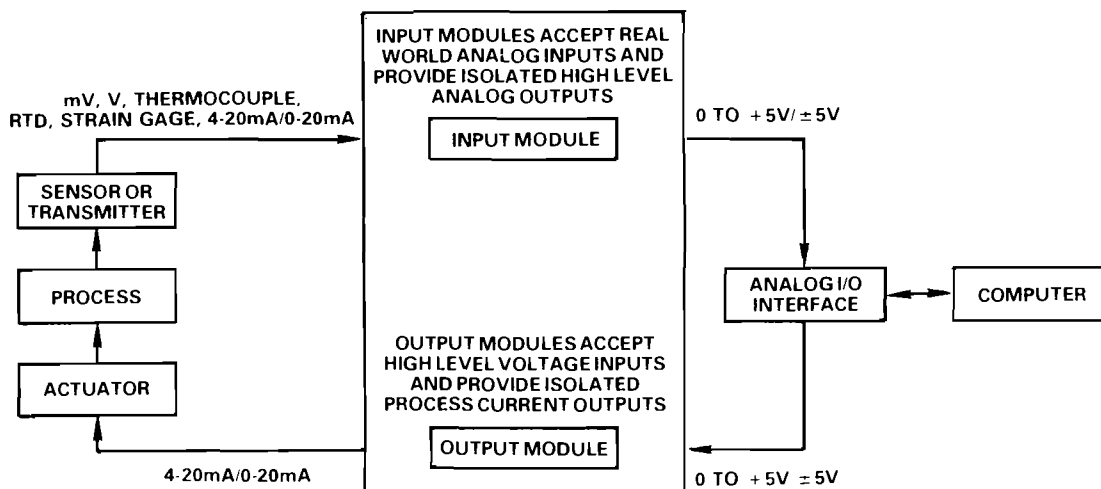


Figure 1.1. Block Diagram of a General Measurement and Control Application Using the 5B Series