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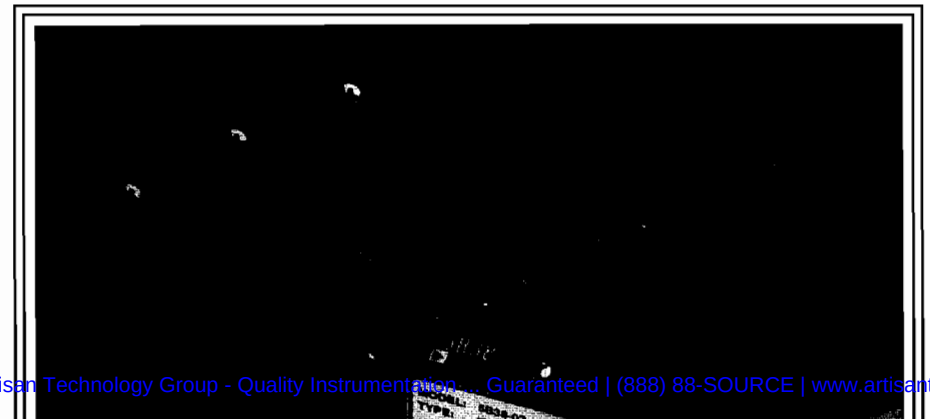
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ANALOG DEVICES

THE 5B SERIES



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The 5B Series
User's Manual

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June, 98

5B Series
New Product Information

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

5B08/5B08-MUX
8-Channel Backplanes

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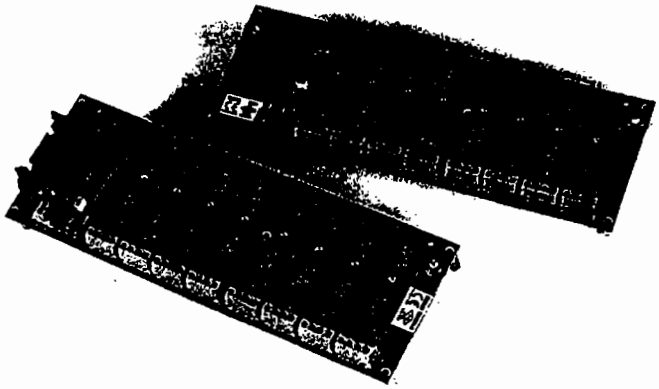
ANALOG DEVICES

5B Series 8-Channel Backplanes

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
- FM Approved
  - Approved for Use in Class I, Division 2, Groups A, B, C and D Locations
- CE Approved
  - EMC Directive In Heavy Industrial Applications



APPLICATIONS

- Front-End Data Acquisition Systems
- Process Control and Monitoring
- Product Test

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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	 * * 40 mA

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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

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	0 to 1
	J8 HI	J9 LO	to	8 to 1
J2	J9 LO	J10 LO	Channel 1	1 to 2
	J9 HI	J10 LO	to	9 to 2
J3	J10 LO	J11 LO	Channel 2	2 to 3
	J10 HI	J11 LO	to	10 to 3
J4	J11 LO	J12 LO	Channel 3	3 to 4
	J11 HI	J12 LO	to	11 to 4
J5	J12 LO	J13 LO	Channel 4	4 to 5
	J12 HI	J13 LO	to	12 to 5
J6	J13 LO	J14 LO	Channel 5	5 to 6
	J13 HI	J14 LO	to	13 to 6
J7	J14 LO	J15 LO	Channel 6	6 to 7
	J14 HI	J15 LO	to	14 to 7

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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.

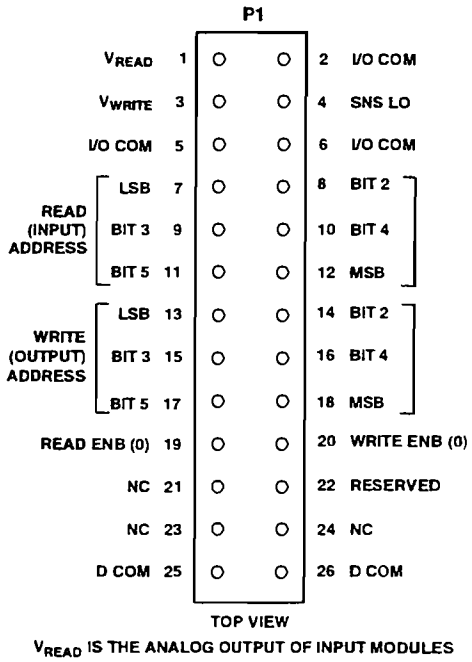


Figure 4. 5B08-MUX System Connector Pinout

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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

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5B08/5B08-MUX GROUND STUDS

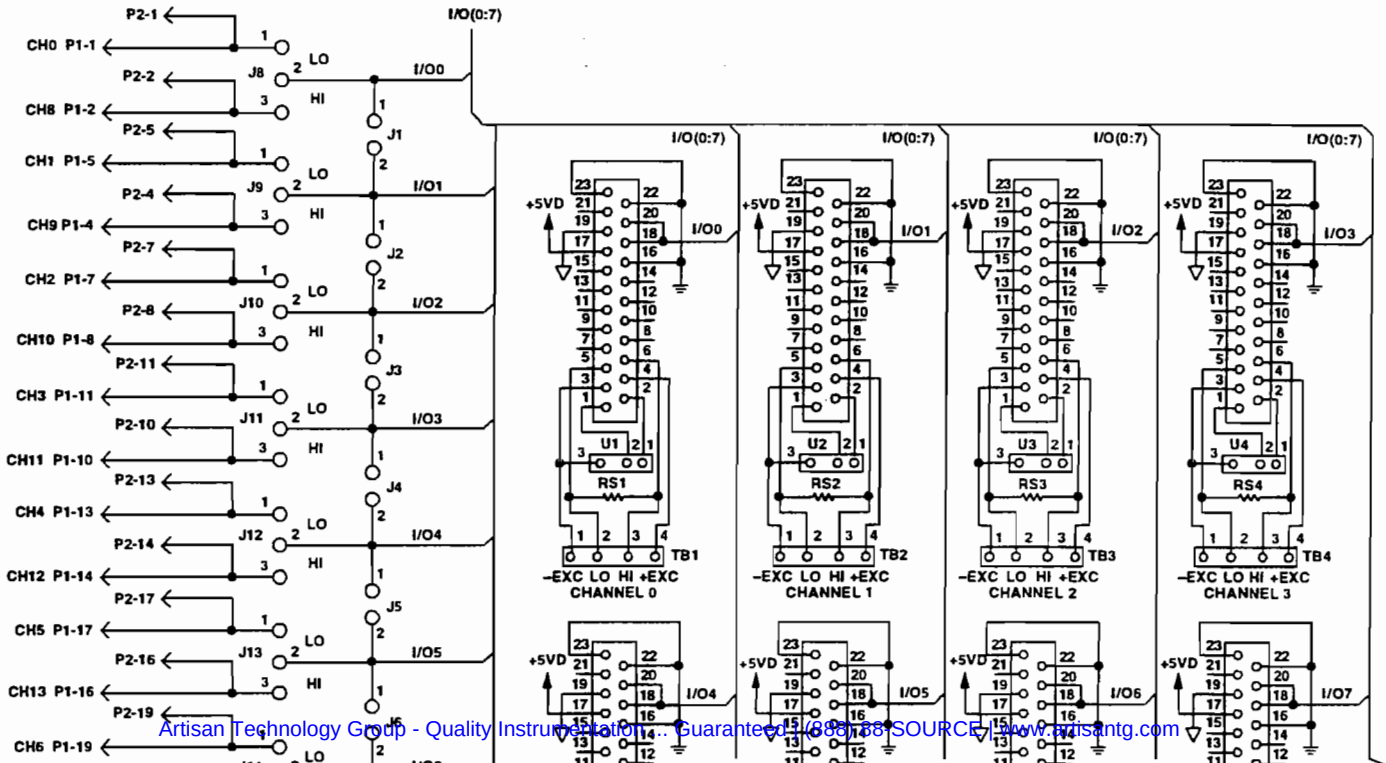
The 5B Series modules meet transient voltage protection standard ANSI/IEEE C37.90.1-1989.

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.

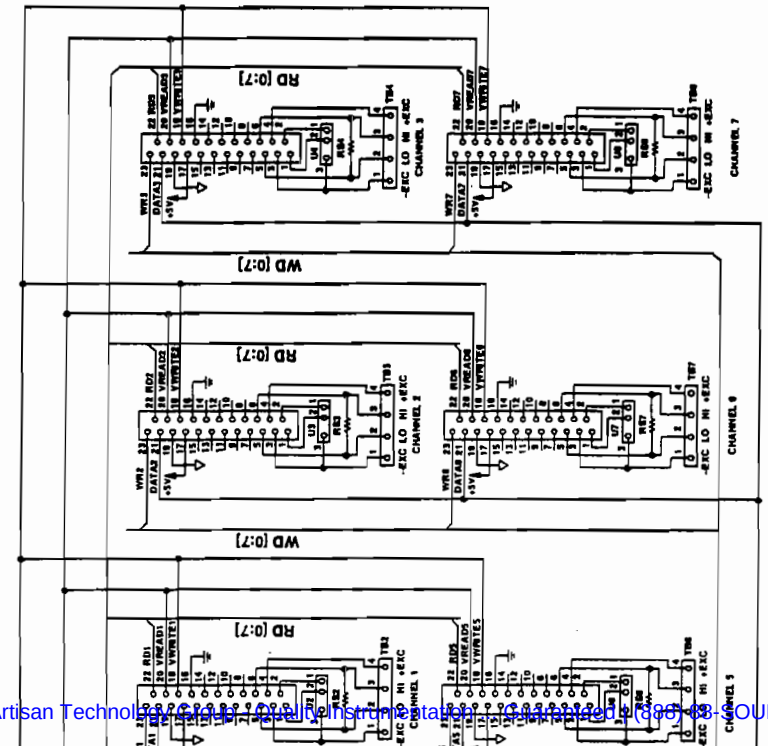
The surge withstand capability can be tested with not less than fifty 2.5 kV bursts per second. A test duration of two seconds is widely accepted. A rise time of 20 kV/µs is specified and each module could see a surge current on the order of 1 ampere.

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



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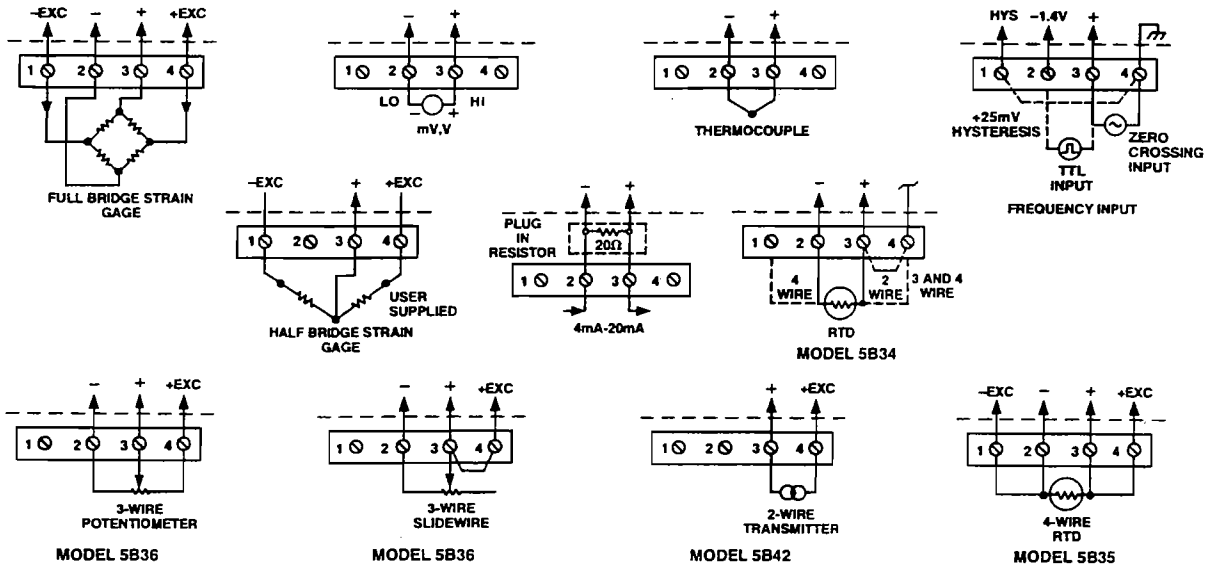


Figure 7. Field Input Connections

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

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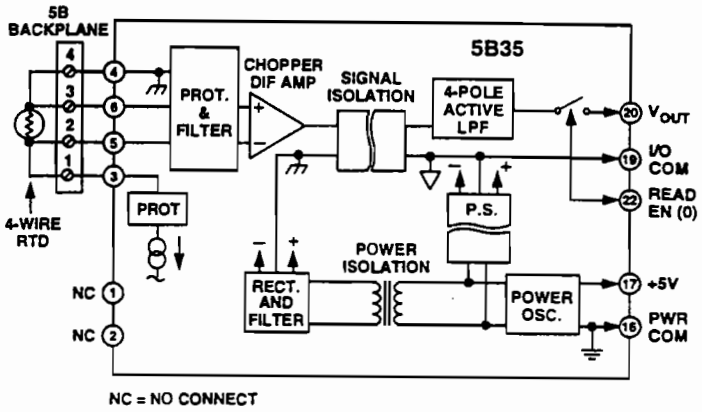
Linearized 4-Wire RTD Input Module

MODEL 5B35

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 ±0.01°C/°C
  Gain ±30 ppm/°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, FM and CE Approvals

FUNCTIONAL BLOCK DIAGRAM



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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 MΩ
Power Off	200 kΩ
Overload	200 kΩ
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	±0.00001°C/Ω
10 Ω Cu	±0.0001°C/Ω
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 Hz[2]	190 dB
ACCURACY	
Initial @ +25°C[3]	See Table I
Conformity Error	±0.05% Span
Stability vs. Temperature (-40°C to +85°C)	

Table I. Standard Model Input/Output Ranges*

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

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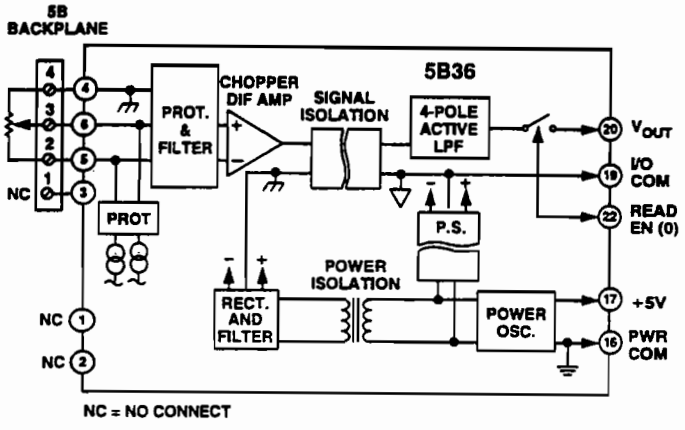
Potentiometer Input Module

MODEL 5B36

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/°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, FM and 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 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

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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 MΩ
Power Off	200 kΩ
Overload	200 kΩ
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 kΩ Sensors	0.25 mA
10 kΩ Sensor	0.1 mA
LEAD RESISTANCE EFFECT	
100 Ω, 500 Ω, 1 kΩ Sensors	±0.005 Ω/Ω
10 kΩ Sensor	±0.01 Ω/Ω
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]	±0.08% Span
Stability vs. Temperature (–40°C to +85°C)	
Input Offset	
100 Ω, 500 Ω, 1 kΩ Sensors	±0.004 Ω/°C
10 kΩ Sensor	±0.010 Ω/°C

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 kΩ	0 V to +5 V
5B36-04	0 Ω to 10 kΩ	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 kΩ + 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

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Process Current Input Module

MODEL 5B42

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: ±0.05%
Linearity: ±0.01%
240 V rms Field Wiring Protection
Protected Internal Current Sense Resistor
ANSI/IEEE C37.90.1-1989 Transient Protection
CSA, FM and 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

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°C operating temperature range. The 5B42's low drift design achieves an output offset drift of only ±5 µV/°C and gain drift of ±25 ppm/°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 25 Ω 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.

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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 Hz[3]	140 dB
ACCURACY	
Initial @ +25°C[4]	±0.05% Span ±4 μA RTI[5]
Nonlinearity	±0.01% Span
Stability vs. Temperature (-40°C to +85°C)	
Input Offset	±0.5 μV/°C
Output Offset	±5 μV/°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

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:

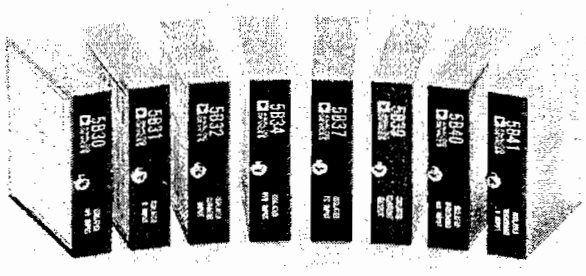
Input Range	Output Range	
Available Range	*Low Limit*	*High Limit*
0 mA to 20 mA*	0 V	10 V

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

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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

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 (±1 µV/°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

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compensation sensors for thermocouple applications. 19″ relay rack compatible backplanes that can hold up to sixteen modules are available, as well as DIN rail compatible one and two channel backplanes.

Applications

The 5B Series provides an easy and convenient solution to signal conditioning problems of both designers and end users with measurement and control applications. Typical uses include mini and microcomputer based measurement systems, standard data acquisition systems, programmable controllers, analog recorders, and dedicated control systems. These modules are ideally suited to applications where monitoring and control of temperature, pressure, flow, and other analog signals are required. A general 5B Series measurement and control application is diagrammed in Figure 1.1.

FM and CSA Approvals

The 5B Series modules and backplanes are approved by Factory Mutual (FM) and 5B Series modules by the Canadian Standards Association (CSA) for use in Class I, Division 2, Groups A, B, C, and D Hazardous Locations. These approvals certify that the 5B Series is suitable for use in locations where a hazardous concentration of

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5B Series Modules

The 5B Series includes a growing family of isolated input and output modules. All are identical in size (2.25″ x 2.25″ x 0.60″) and pinout. The choice of specific modules depends on the signals involved in a particular application. The transfer function provided by each input module is:

Input: specified sensor measurement range
Output: 0 to +5 V or –5 V to +5 V

The transfer function provided by each output module is:

Input: 0 to +5 V or –5 V to +5 V
Output: 4-20 mA or 0-20 mA

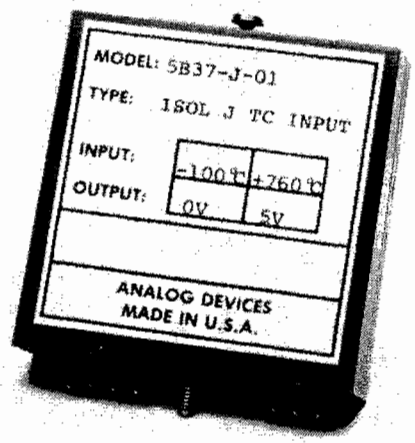
The available functions are listed in Table 1.1. Many standard configurations of each module are available and factory laser trimmed custom units can be supplied. Wide zero suppression capability allows a user to map any portion of the input signal into the full output span, permitting improved system resolution within a selected measurement range.

Existing conditioned signals can be connected into the 5B Series backplane through the AC1367 Switch Input

Chapter 2
Module Specifications

Features

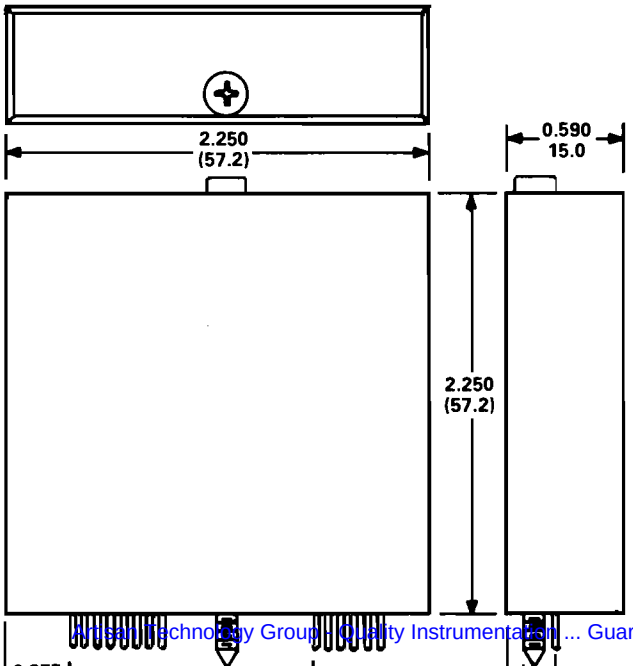
- Compact, Low Cost Signal Conditioners
- Analog Input Modules for Direct Interface to
  - Sensors: Thermocouples, RTDs, and Strain Gages
  - Millivolt and Voltage Sources
  - Process Current Inputs
- Analog Output Module
  - 4-20 mA or 0-20 mA Process Current Output
- Complete Signal Conditioning Function
  - 240 Vrms Field Wiring Protection, Filtering, Amplification, 1500 Vrms CMV Isolation, High Noise Rejection, RFI/EMI Immunity, and Wide Range Zero Suppression
- High Accuracy: ±0.05%
- Low Drift: ±1 μV/°C
- –25°C to +85°C Rated Temperature Range
- Mix and Match Module Capability
- No Potentiometer Adjustments
- Custom Ranges Available

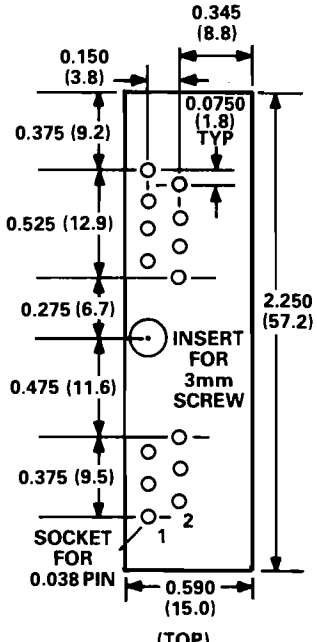


Evaluation and Test

A single channel socket, AC1360, is available for module

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Input Modules

- **Variety of Signal Source Inputs**
  - **Sensors: Thermocouples, RTDs, Tachometers, Flow Meters, and Strain Gages**
  - **Millivolt and Voltage Sources**
  - **4-20 mA or 0-20 mA Process Current Inputs**
- **Mix and Match Input Capability**
- **High Level Voltage Output: –5 V to +5 V or 0 to +5 V**
- **High Accuracy: ±0.05%**
- **Low Drift: ±1 µV/°C**
- **Reliable Transformer Isolation: 1500 Vrms CMV, 160 dB CMR, Meets IEEE-STD 472: Transient Protection (SWC)**
- **Input Protection: 240 Vrms Continuous**
- **Factory Ranged and Trimmed, Custom Ranges Available**

The 5B Series input modules are galvanically isolated, single channel, plug-in signal conditioners that provide input protection, amplification and filtering, and a high level, series-switched analog output, which can eliminate the need for external multiplexers. Key specifications include: 1500 Vrms isolation, calibrated accuracy of ±0.05%, ±0.02% span nonlinearity, and low drift of ranges to meet most applications. Special 5B Series input module ranges can be ordered from the factory. A wide zero suppression capability allows any portion of the input signal to be mapped into the full output span permitting improved system resolution within a selected measurement range.

Output Module

- **High Level Voltage Inputs: 0 to +5 V or –5 V to +5 V**
- **Process Current Output: 4-20 mA or 0-20 mA**
- **High Accuracy: ±0.05%**
- **Reliable Transformer Isolation: 1500 Vrms CMV, CMR=90 dB**
- **Meets IEEE-STD 472: Transient Protection (SWC)**
- **Output Protection: 240 Vrms continuous**
- **Internal Track and Hold Amplifier**

The 5B39 current output module accepts a high level analog signal at its input and provides a galvanically isolated 4-20 mA or 0-20 mA process current signal at its output. The module features high accuracy of ±0.05%, ±0.02% nonlinearity, and 1500 Vrms common mode voltage isolation protection.

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5B30 and 5B31 Millivolt and Voltage Input Modules

The 5B30 millivolt input module accepts ±5 to ±500 millivolt input signals and provides either a –5 V to +5 V or 0 to +5 V output. The 5B31 voltage input module accepts ±0.5 V to ±10 V input signals and provides either a –5 V to +5 V or 0 to +5 V output.

Figure 2.2 is a functional block diagram for the 5B30 and 5B31. A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input screw terminals, and, in the 5B31, the input signal is attenuated by a factor of 20 at this point. A three-pole filter with a 4 Hz cutoff provides 60 dB of normal-mode rejection and CMR enhancement at 60 Hz. (One pole of this filter is located at the module input, while the other two poles are in the output stage for optimum noise performance.) A chopper-stabilized input amplifier provides all of the module's gain and assures low drift. This amplifier operates on the input signal after subtraction of a stable, laser-trimmed voltage, which sets the zero-scale input value. It is, therefore, possible to suppress a zero-scale input that is many times the total span to provide precise expanded scale measurements.

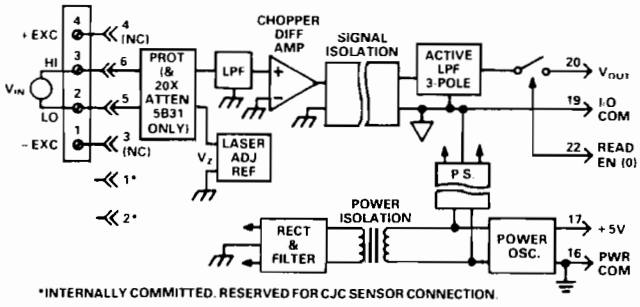


Figure 2.2. 5B30 and 5B31 Functional Block Diagram

Signal isolation is provided by transformer coupling, using a proprietary modulation technique for linear, stable performance. A demodulator on the output side of the signal transformer recovers the original signal, which is then filtered and buffered to provide a clean, low-impedance output. A series output switch is included to

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5B30 and 5B31 Specifications (typical @ 25°C and +5 V Power)

	5B30	5B31
Input Span Limits	±5 mV to ±0.5 V	±0.5 V to ±10 V
Output Ranges	–5 V to +5 V or 0 to +5 V	*
Accuracy[1]	±0.05% span ±10 µV RTI ±0.05% (Vz†)	±0.05% span ±0.2 mV RTI ±0.05%(Vz†)
Nonlinearity	±0.02% span	*
Stability vs. Ambient Temperature		
Input Offset	±1 µV/°C	±20 µV/°C
Output Offset	±20 µV/°C	*
Gain	±25 ppm of reading/°C	±50 ppm of reading/°C
Input Bias Current	±3 nA	±0.2 nA
Input Resistance		
Normal	5 MΩ	650 kΩ
Power Off	40 kΩ	650 kΩ
Overload	40 kΩ	650 kΩ
Noise		
Input, 0.1-10 Hz	0.2 µVrms RTI	2 µVrms RTI
Output, 100 kHz	200 µVrms RTO	*
Bandwidth, –3 dB	4 Hz	*
Rise Time, 10% to 90% Span	0.2 s	*
CMV, Input to Output		
Continuous	1500 Vrms max	*
Transient	meets IEEE-STD 472 (SWC)	*
CMR (50 or 60 Hz)		

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5B32 Current Input Module

The 5B32 current input module measures a 4-20 mA or 0-20 mA process current input signal by reading the voltage across a precision 20 Ω resistor. It provides a 0 to +5 V output signal.

Figure 2.3 is a functional block diagram for the 5B32. Since the resistor cannot be protected against destruction in the event of an inadvertent connection of the power line, it is provided in the form of a separate pluggable resistor carrier assembly. Extra current conversion resistors are available as accessories (model number AC1362 – see Note 2). A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input screw terminals. A three-pole filter with a 4 Hz cutoff provides 60 dB of normal-mode rejection and CMR enhancement at 60 Hz. (One pole of this filter is located at the module input, while the other two poles are in the output stage for optimum noise performance.) A chopper-stabilized input amplifier provides all of the module's gain and assures low drift. This amplifier operates on the input signal after subtraction of a stable, laser trimmed voltage, which sets the zero-scale input value for the 4-20 mA range. The laser trim process can also be used to customize units to meet special requirements.

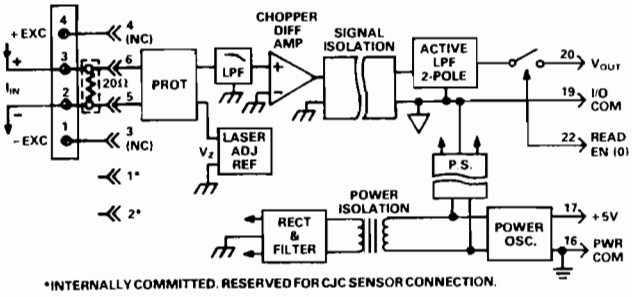


Figure 2.3. 5B32 Functional Block Diagram

The single +5 V supply powers a clock oscillator, which drives power transformers for the input and output circuits. The input circuit is, of course, fully floating. In addition, the output section acts as a third floating port, eliminating many problems that might be created by ground loops and supply noise. The common-mode range of the output circuit is limited; however, output common must be kept within ±3 V of power common.

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5B32 Specifications (typical @ 25°C and +5V Power)

Input Ranges	0 to 20 mA, 4 to 20 mA
Output Range	0 to +5 V
Accuracy[1]	±0.05% span ±0.05% (Iz†)
Input Resistor[2] Value Accuracy	 20.00 Ω ±0.1%
Nonlinearity	±0.02% span
Stability vs. Ambient Temperature Module Offset Module Gain	 ±0.0025%/°C of Iz† ±0.0025%/°C of reading/°C
Stability of Supplied Input Resistor	±0.001%/°C
Noise Input, 0.1-10 Hz Output, 100 kHz	 10 nArms RTI 200 μVrms RTO
Bandwidth, –3 dB	4 Hz
Rise Time, 10% to 90% Span	0.2 s
CMV, Input to Output Continuous Transient	 1500 Vrms max meets IEEE-STD 472 (SWC)
CMR (50 or 60 Hz) 1 kΩ in Either or Both Input Leads	 160 dB (all ranges)
NMR (50 or 60 Hz)	60 dB
Input Protection	

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5B34 RTD Input Module

The 5B34 RTD input module accepts a wide variety of RTD types as inputs and provides a linearized output of 0 to +5 V.

Figure 2.4 is a functional block diagram of the 5B34. Excitation for the RTD is provided by a current source, with an identical current taken through the third RTD lead in such a way as to cancel the effects of (equal) lead resistances. The second current also flows in Rz, which is laser-trimmed to the value of the RTD at the temperature that is to result in a module output of zero volts. Thus the input seen by the differential amplifier will be zero at that scale point. Since both current sources are connected to input screw terminals, they are protected against accidental application of voltages up to 240 Vrms. A pair of protection networks serves the same function for the amplifier, and input filtering is provided at the same points.

The differential amplifier is a chopper-stabilized design featuring exceptionally low drift. This makes possible the use of very low RTD excitation currents to minimize self-heating without incurring any loss of accuracy. A feedback linearizer is laser-trimmed along with the module's gain and zero settings. The laser trim process

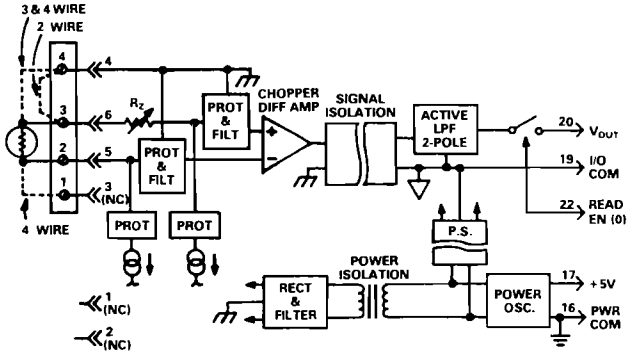


Figure 2.4. 5B34 Functional Block Diagram

applications. This switch has a low output resistance and is controlled by an active-low enable input. In cases where the output switch is not used, the enable input should be grounded to power common to turn on the switch, as it is on the 5B01 backplane.

The single +5 V supply powers a clock oscillator, which drives power transformers for the input and output

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5B34 Specifications (typical @ 25°C and +5 V Power)

Input Span Limits	25°C to 1070°C (100 Ω Pt)
Output Range	0 to +5 V
Accuracy[1]	±0.05% span ±0.04 Ω* ±0.05% (Rz†)
Conformity Error[2]	±0.05% span
Stability vs. Ambient Temperature Input Offset Output Offset Gain	 ±0.02°C/°C ±20 µV/°C ±50 ppm of reading/°C
Input Bias Current	±3 nA
Input Resistance Normal Power Off Overload	 5 MΩ 40 kΩ 40 kΩ
Noise Input, 0.1-10 Hz Output, 100 kHz	 0.2 µVrms RTI 200 µVrms RTO
Bandwidth, –3 dB	4 Hz
Rise Time, 10% to 90% Span	0.2 s
CMV, Input to Output Continuous Transient	 1500 Vrms max meets IEEE-STD 472 (SWC)
CMR (50 or 60 Hz)	

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5B37 Thermocouple Input Module

The 5B37 thermocouple input module accepts input signals from types J, K, T, E, R, S, and B thermocouples and provides a 0 to +5 V output. Figure 2.5 is a functional block diagram for the 5B37. Cold junction compensation circuitry corrects for the effects of the parasitic thermocouples formed by thermocouple wire connections to the input screw terminals. The compensator provides an accuracy of ±0.5°C over the +5°C to +45°C ambient temperature range. A bias current supplied through resistor Roc gives a predictable upscale response to an open thermocouple. (Downscale open thermocouple detection can be provided by installing a 50 MΩ resistor across screw terminals 1 and 3. This resistor could be a 0.25 W carbon composition; ±20% tolerance is suitable.)

A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input screw terminals. A three-pole filter with a 4 Hz cutoff provides 60 dB of normal-mode rejection and CMR enhancement at 60 Hz. (One pole of this filter is located at the module input, while the other two poles are in the output stage for optimum noise performance.) A chopper-stabilized input amplifier provides all of the module's gain and assures

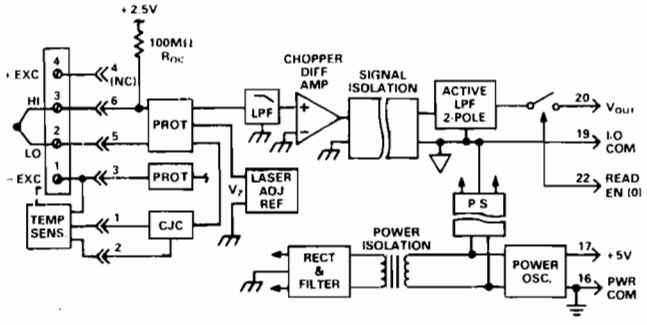


Figure 2.5. 5B37 Functional Block Diagram

where the output switch is not used, the enable input should be grounded to power common to turn on the switch, as it is on the 5B01 backplane.

The single +5 V supply powers a clock oscillator, which drives power transformers for the input and output circuits. The input circuit is, of course, fully floating. In addition, the output section acts as a third floating port, eliminating many problems that might be created by ground loops and supply noise. The common-mode range of the output circuit is limited, however, output common must be kept within ±3 V of power common.

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5B37 Specifications (typical @ 25°C and +5 V Power)

Input Span Limits	±5 mV to ±0.5 V
Output Range	0 to +5 V
Accuracy[1]	±0.05% span ±10 µV RTI ±0.05% (Vz†) + CJC Sensor, if applicable
Nonlinearity	±0.02% span
Stability vs. Ambient Temperature Input Offset Output Offset Gain	 1 µV/°C ±20 µV/°C ±25 ppm of reading/°C
Input Bias Current	–25 nA
Input Resistance Normal Power Off Overload	 5 MΩ 40 kΩ 40 kΩ
Noise Input, 0.1/10 Hz Output, 100 kHz	 0.2 µVrms RTI 200 µVrms RTO
Bandwidth, –3 dB	4 Hz
Rise Time, 10% to 90% Span	0.2 s
CMV, Input to Output Continuous Transient	 1500 Vrms max meets IEEE-STD 472 (SWC)
CMR (50 or 60 Hz) 1 kΩ in Either or Both Input Leads	 160 dB (all ranges)

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5B38 Strain Gage Input Module

The 5B38 wide bandwidth strain gage input module accepts signals from full bridge and half bridge 300 Ω to 10 kΩ transducers. The 5B38 provides +10 V excitation and produces an output of –5 V to +5 V. This module features a bandwidth of 10 kHz.

Figure 2.6 is a functional block diagram of the 5B38. A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input screw terminals. The excitation section provides +10 V. Since the excitation lines are not sensed at the strain gage, care should be taken to minimize any IR loss in these wires. This can be accomplished by the use of heavy gage wires or the shortest length of wire possible. A one pole anti-aliasing filter is located at the module's input, while a three pole low pass filter in the output stage sets the bandwidth and yields optimum noise performance. A low drift amplifier provides the module's gain.

Signal isolation is provided by transformer coupling, using a proprietary modulation technique for linear, stable performance. A demodulator on the output side of the signal transformer recovers the original signal, which is then filtered and buffered to provide a clean, low-

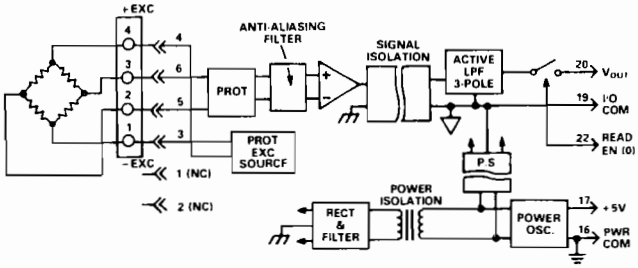


Figure 2.6. 5B38 Functional Block Diagram

many problems that might be created by ground loops and supply noise. The common-mode range of the output circuit is limited; however, output common must be kept within ±3 V of power common.

The 5B38 can be used with half-bridge transducers since the module contains bridge completion circuitry. The module can be factory configured for wide input ranges to accommodate the DC offset created by mismatches in the transducer. There is no provision for use with quarter or three-quarter-bridge strain gages. However, the user may

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5B38 Specifications (typical @ 25°C and +5 V Power)

	Full Bridge	Half Bridge
Models	5B38-02, 5B38-05	5B38-04
Input Span Limits	±30 mV @ 3 mV/V Sensitivity ±20 mV @ 2 mV/V Sensitivity	±30 mV @ 3 mV/V Sensitivity
Output Range	–5 V to +5 V	*
Accuracy[1]	±0.08% span ±10 µV RTI	±0.08% span ± 1 mV RTI
Nonlinearity	±0.02% span	*
Excitation Output[2]	+10 V ± 3 mV	*
Excitation Load Regulation	±5 ppm/mA	*
Half Bridge Voltage Level	N/A	(Excitation Voltage/2) ±1 mV
Stability vs. Ambient Temperature		
Input Offset	1 µV/°C	*
Output Offset	±40 µV/°C	*
Gain	±25 ppm of reading/°C	*
Excitation Voltage	±15 ppm/°C	*
Half Bridge	N/A	±15 ppm/°C
Input Bias Current	±3 nA	*
Input Resistance		
Normal	20 MΩ minimum	*
Power Off	40 kΩ minimum	*
Overload	40 kΩ minimum	*
Noise		
Input, bandwidth = 10 Hz	0.4 µVrms RTI	±2 µVrms RTI
Input, bandwidth = 10 kHz	±70 nV/√Hz RTI	±250 nV/√Hz RTI

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5B39 Current Output Module

The 5B39 current output module accepts a high level analog signal at its input and provides a galvanically isolated 4-20 mA or 0-20 mA process current signal at its output. The module features high accuracy of ±0.05%, ±0.02% nonlinearity and 1500 Vrms common mode voltage isolation protection.

Figure 2.7 is a functional block diagram of the 5B39 current output module. The voltage input, usually from a digital-to-analog converter, is buffered and a quarter scale offset is added if a 4-20 mA output is specified.

The signal is latched in a track and hold circuit. This track-and-hold allows one DAC to serve numerous output channels. The output droop rate is 80 µA/s, which corresponds to a refresh interval of 25 ms for 0.01% FS droop. The track-and-hold is controlled by an active-low enable input. On power-up, the output of the 5B39 remains at 0 mA for approximately 100 ms, allowing the user to initialize the track-and-hold.

In conventional applications where one DAC is used per channel and the track-and-hold is not used, the enable input should be grounded to power common, as it is on the 5B01 backplane. This keeps the module in tracking

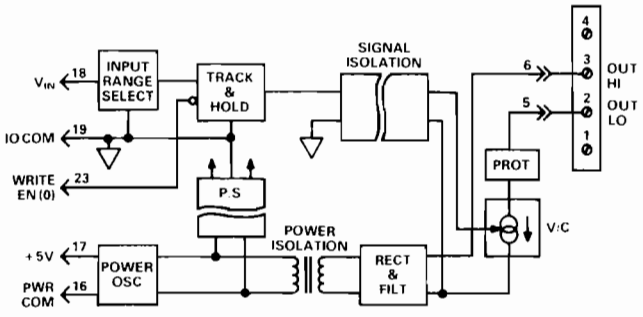


Figure 2.7. 5B39 Functional Block Diagram

A single +5 V supply powers a clock oscillator, which drives power transformers for the input circuit and the output's high-compliance, current loop supply. The output current loop is, of course, fully floating. In addition, the input section acts as a third floating port, eliminating many problems that might be created by ground loops and supply noise. The common-mode range of the input circuit is limited; however, input common must be kept within ±1 V of power common.

Notes:

(1) A current path must exist between input common and

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5B39 Specifications (typical @25°C and +5 V Power)

Standard Input Ranges	0 to +5 V or –5 V to +5 V
Standard Output Ranges	4-20 mA or 0-20 mA
Load Resistance Range[1]	0 to 650 Ω
Accuracy[2]	±0.05% span
Nonlinearity	±0.02% span
Stability vs. Ambient Temperature Zero Span	 ±0.5 µA/°C ±20 ppm of reading/°C
Output Ripple, 100 Hz bandwidth	30 µA peak-peak
Common Mode Voltage Output to Input and Power Supply	 1500 Vrms continuous
Common Mode Rejection	90 dB
Normal Mode Output Protection	240 Vrms continuous
Output Transient Protection	Meets IEEE-STD 472 (SWC)
Sample & Hold: Output Droop Rate Acquisition Time	 80 µA/s 50 µs
Overrange Capability	10%
Maximum Output Under Fault	26 mA
Input Resistance	10 MΩ
Bandwidth, –3 dB	400 Hz
Rise Time, 10% to 90% Span	2 ms

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5B40 and 5B41 Wide Bandwidth Millivolt and Voltage Input Modules

The 5B40 wide bandwidth millivolt input module accepts ±5 to ±500 millivolt input signals and provides either a –5 V to +5 V or 0 to +5 V output. The 5B41 wide bandwidth voltage input module accepts ±0.5 V to ±10 V input signals and provides either a –5 V to +5 V or 0 to +5 V output. Both modules feature a 10 kHz bandwidth.

Figure 2.8 is a functional block diagram of the 5B40 and 5B41. A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input , and, in the 5B41, the signal is attenuated by a factor of 20 at this point. A one pole anti-aliasing filter is located at the module's input, while a thre- pole, low-pass filter in the output stage sets the bandwidth and yields optimum noise performance. A low drift input amplifier provides all of the module's gain. This amplifier operates on the input signal after subtraction of a stable, laser-trimmed voltage, which sets the zero-scale input value. It is, therefore, possible to suppress a zero-scale input that is many times the total span to provide precise expanded scale measurements.

Signal isolation is provided by transformer coupling,

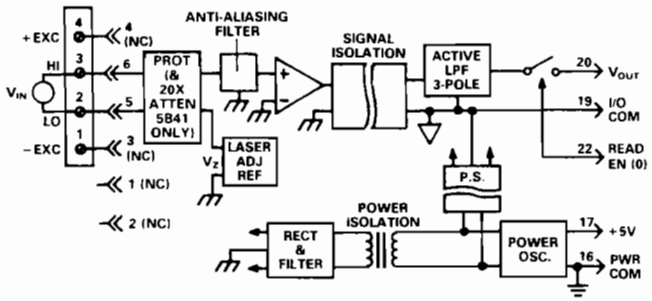


Figure 2.8. 5B40 and 5B41 Functional Block Diagram

where the output switch is not used, the enable input should be grounded to power common to turn on the switch, as it is on the 5B01 backplane.

A single +5 V supply powers a clock oscillator which drives power transformers for the input and output circuits. The input circuit is, of course, fully floating. In addition, the output section acts as a third floating port, eliminating many problems that might be created by ground loops and supply noise. The common-mode range

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5B40 and 5B41 Specifications (typical @ 25°C)

	5B40	5B41
Input Span Limits	±5 mV to ±0.5 V	±0.5 V to ±10 V
Output Ranges	–5 V to +5 V or 0 to +5 V	*
Accuracy[1]	±0.05% span ±10 µV RTI ±0.05% (Vz†)	±0.05% span ±0.05% (Vz†)
Nonlinearity	±0.02% span	*
Stability vs. Ambient Temperature		
Input Offset	±1 µV/°C	±20 µV/°C
Output Offset	±40 µV/°C	*
Gain	±25 ppm of reading/°C	±50 ppm of reading/°C
Input Bias Current	±3 nA	±0.2 nA
Input Resistance		
Normal	200 MΩ	650 kΩ
Power Off	40 kΩ	650 kΩ
Overload	40 kΩ	650 kΩ
Noise		
Input, 0.1/10 Hz	0.4 µVrms RTI	2 µVrms RTI
Output		
Vi=±FS	20 mV, peak-peak	*
Vi=0	10 mV, peak-peak	*
Bandwidth, –3 dB	10 kHz	*
Rise Time, 10% - 90% span	35 µs	*
CMV, Input to Output		
Continuous	1500 Vrms	*

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5B45 and 5B46 Frequency Input Modules

The 5B45 is an isolated frequency input module that accepts full scale input frequency signals ranging from 500 Hz to 20 kHz. Model 5B46 is an isolated frequency input module that accepts full scale input signals ranging from 20 kHz to 275 kHz. Both modules have a user selectable threshold of either 0 V or +1.4 V, and a user selectable hysteresis of either ±25 mV or ±400 mV.

Circuit Description: Figure 2.9 shows a functional block diagram for models 5B45 and 5B46. Input protection of up to 240 Vrms is provided on the four input screw terminals. The input signal is compared to the selected threshold (V_T) and hysteresis (V_H). Signals of virtually any waveshape which exceed the combined threshold and hysteresis levels ($V_T \pm V_H$), will trigger the comparator. The comparator's output frequency is transmitted across a proprietary isolation barrier and converted into a high level analog signal. The signal is then filtered by a two-pole low pass butterworth filter and buffered to provide a clean, low impedance output signal.

Output Switch: A series output switch is included to eliminate the need for external multiplexing in many

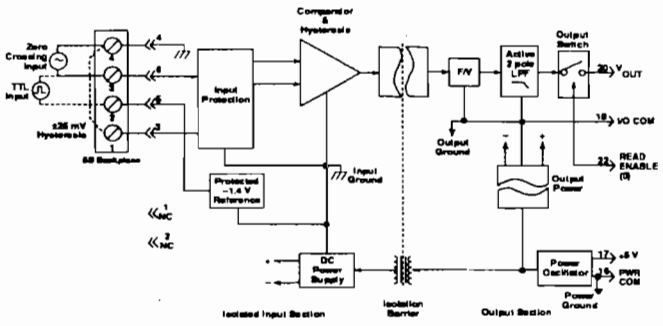


Figure 2.9 5B45 and 5B46 Functional Block Diagram

5B45 and 5B46 Response Time

Model	Rise/Fall Time 10% to 90% ms	Step Response to ±0.1% ms
5B45-01	80	150
5B45-02	60	140
5B45-03	50	130
5B45-04	50	130
5B45-05	50	130
5B46-01	15	44
5B46-02	7	22

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5B45 and 5B46 Specifications (typical @ +25°C and Vs = +5 V dc)

MODEL	5B45	5B46
FREQUENCY INPUT		
Frequency Ranges - Standard Ranges	*See Ordering Guide*	*See Ordering Guide*
Span Limits - Custom Input Ranges[1]	500 Hz, min - 20 kHz, max	20 kHz, min - 275 kHz, max
Overrange	20% of span	*
Voltage Range	70 mV rms, min - 240 V rms, max	*
Waveforms	Sine, Square, Triangle, Pulse Train	*
Pulse Width (Pulse Train Inputs)	2 µsec, min	*
Protection		
Continuous	240 V rms, max continuous	*
Threshold Options	0 V or +1.4 V	*
TTL Input, Low (–40°C to +85°C)	0.8 V, max	*
TTL Input, High (–40°C to +85°C)	2.0 V, min	*
Hysteresis Options[2]	±25 mV or ±400 mV	*
Impedance		
Small Signal, Vin <5 V, p-p	5 M Ω	*
Large Signal, Vin >5 V, p-p	40 k Ω ‖330 pF	*
Power Off	40 k Ω ‖330 pF	*
Bias Current, Vin <5 V, p-p	±100 µA	*
COMMON-MODE VOLTAGE (CMV)		
Input-to-Output, Continuous	1500 V rms, min	*
Transient	Meets IEEE STD 472 (SWC)	*
COMMON-MODE REJECTION (CMR)		
1 k Ω source imbalance, 50/60 Hz	120 dB	*
ACCURACY		
Initial @ +25°C[3]	±0.05% span (±0.1% span max)	*
Nonlinearity	±0.005% span (±0.015% span max)	*
Gain vs Temperature (–40°C to +85°C)	±20 ppm/°C	*
Offset vs. Temperature (–40°C to +85°C)	±20 µV/°C	*

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5B47 Linearized Thermocouple Input Module

The 5B47 thermocouple input module accepts input signals from types J, K, T, E, R, S, and B thermocouples and provides a 0 to +5 V output. The input signal is internally linearized to provide an output that is linear with temperature.

Figure 2.10 is a functional block diagram for the 5B47. Cold junction compensation circuitry corrects for the effects of the parasitic thermocouples formed by thermocouple wire connections to the input screw terminals. The compensator provides an accuracy of ±0.5°C over the +5°C to +45°C ambient temperature range. A bias current supplied through resistor Roc gives a predictable upscale response to an open thermocouple. (Downscale open thermocouple detection can be provided by installing a 50 MΩ resistor across screw terminals 1 and 3. This resistor could be a 0.25 W carbon composition; ±20% tolerance is suitable.)

A protection circuit assures safe operation even if a 240 Vrms power line is connected to the input screw terminals. A three-pole filter with a 4 Hz cutoff provides 60 dB of normal-mode rejection and CMR enhancement

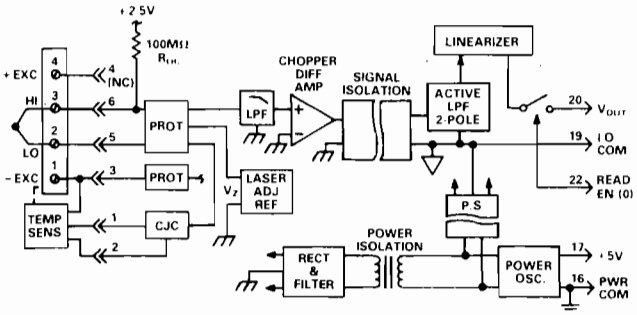


Figure 2.10. 5B47 Functional Block Diagram

then filtered and buffered to provide a clean, low-impedance output. 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. In cases where the output switch is not used, the enable input should be grounded to power common to turn on the switch, as it is on the 5B01 backplane.

The single +5 V supply powers a clock oscillator, which drives power transformers for the input and output circuits. The input circuit is, of course, fully floating. In addition, the output section acts as a third floating port,

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5B47 Specifications (typical @ 25°C and +5 V Power)

Input Span Limits	±5 mV to ±0.5 V
Output Range	0 to +5 V
Accuracy[1]	See Ordering Information
Stability vs. Ambient Temperature Input Offset[2] Gain	 ±1 µV/°C ±25 ppm of reading/°C
Input Bias Current	–25 nA
Input Resistance Normal Power Off Overload	 5 MΩ 40 kΩ 40 kΩ
Output Noise, 100 kHz	500 µVrms RTO
Bandwidth, –3 dB	4 Hz
Rise Time, 10% to 90% Span	0.2 s
CMV, Input to Output Continuous Transient	 1500 Vrms max meets IEEE-STD 472 (SWC)
CMR (50 or 60 Hz) 1 kΩ in Either or Both Input Leads	 160 dB (all ranges)
NMR (50 or 60 Hz)	60 dB
Input Protection Continuous	 240 Vrms max continuous
Output Resistance[3]	50 Ω

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AC1367 Voltage Switch Input Module

The AC1367 voltage switch input module allows the 5B user to connect an existing, conditioned signal into the 5B Series backplane. This module accepts a –5 V to +5 V input and provides a –5 V to +5 V output. The module is not isolated and there is no gain or attenuation of the signal.

Figure 2.11 is a functional block diagram of the AC1367. This module is protected for continuous inputs of ±10 V and will withstand ±20 V for 10 seconds. Above these limits, a nonreplaceable fuse within the module may blow. The resistance between the input and the output is 250 Ω when the module is enabled. As with all 5B Series modules, 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. In cases where the output switch is not used, the enable input should be grounded to power common to turn on the switch, as it is on the 5B01 backplane.

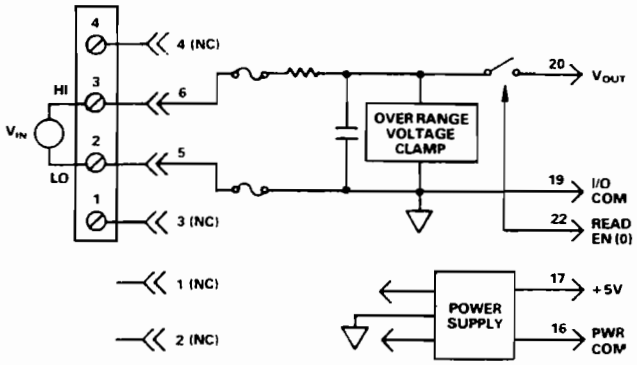


Figure 2.11. AC1367 Functional Block Diagram

AC1367 Specifications (typical @ 25°C and +5 V Power)

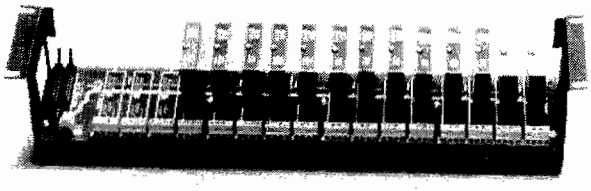
Input Span Limits	–5 V to +5 V
Output Range	–5 V to +5 V
Input-to-Output Resistance, when enabled	250 Ω
Input Resistance	

Note:
Input voltages above those specified may cause permanent damage to the module.

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Chapter 3
5B Series Subsystem Solutions

The 5B Series includes a number of backplanes which provide a complete signal conditioning solution. The two 5B Series 16-channel backplanes currently available, the 5B01 and 5B02, provide different system configuration options. The 5B03 and 5B04, one and two channel backplanes, allow an economical means to handle a few remote signals. A single-channel socket, AC1360, is available for module evaluation. It is discussed in Chapter 4.

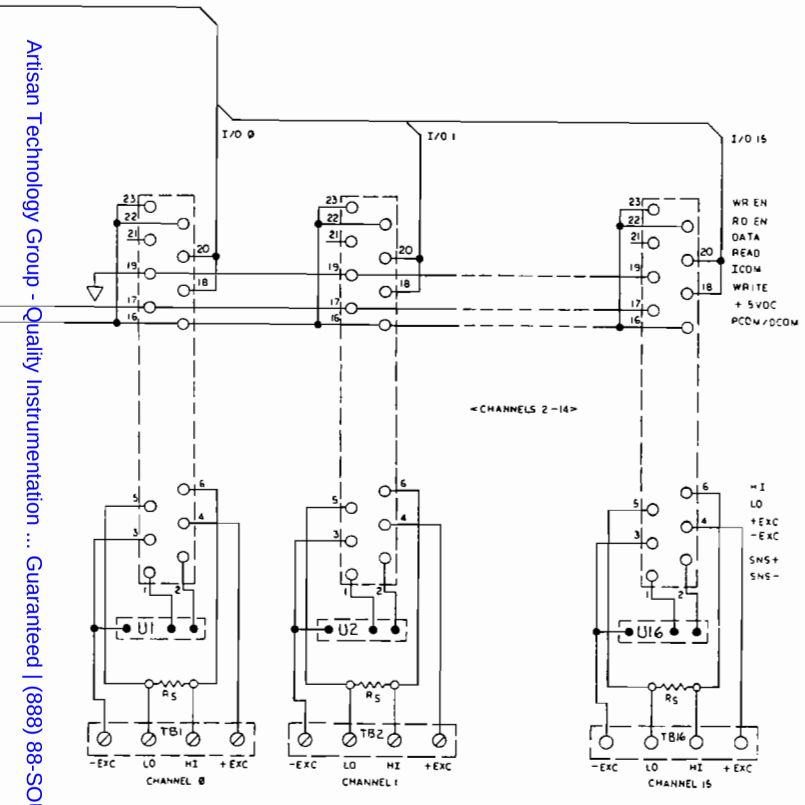


Both 16 channel 5B Series backplanes can be mounted in a 19″ x 3.5″ panel space. The one and two channel backplanes are DIN rail compatible. Each channel has four screw terminals for field connections. These connections satisfy all transducer inputs and process current outputs and provide sensor excitation when necessary. A cold junction sensor is supplied on each channel to accommodate thermocouple modules. All backplanes require an external +5 V power supply.

Connector Pin Usage

Signal connections between the 5B01 backplane and the associated measurement and control system are made at P1 and P2. These connectors are identical electrically.

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U1-U16 ARE CJC TEMPERATURE SENSORS (AC1361).
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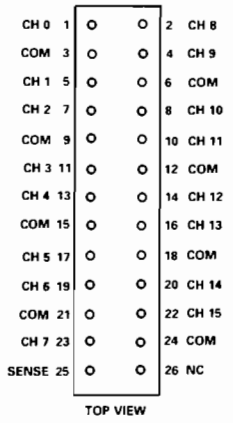


Figure 3.3. 5B01 System Connector Pinout

Grounding

Each 5B01 backplane is factory configured with jumpers W1, W3, and W4 installed.

Jumper W1 grounds the shield wires in the ribbon cable (pins 3, 6, 12, 15, 18, 21, and 24) at the 5B01 backplane. This will usually be the primary ground connection between the 5B01 and the measurement system. This connection is required if output modules will be used on

The surge withstand capability can be tested with not less than 50 2.5 kV bursts per second. A test duration of 2 seconds is widely accepted. A rise time of 20 kV/µs is specified, and each module could see a surge current on the order of 1 A.

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. 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 so as to minimize ground differences.

Fusing and Polarity Reversal

Since reversing the polarity of the connected +5 V power source could destroy installed modules, the 5B01 incorporates polarity reversal protection in the form of a shunt diode. A series fuse will be blown by the diode current if

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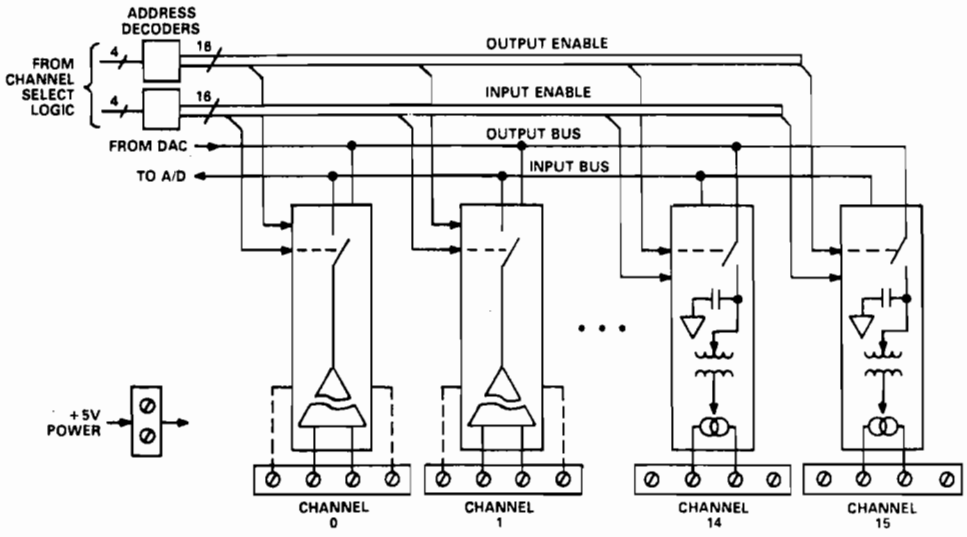


Figure 3.4. 5B02 Diagram

Connector Pin Usage

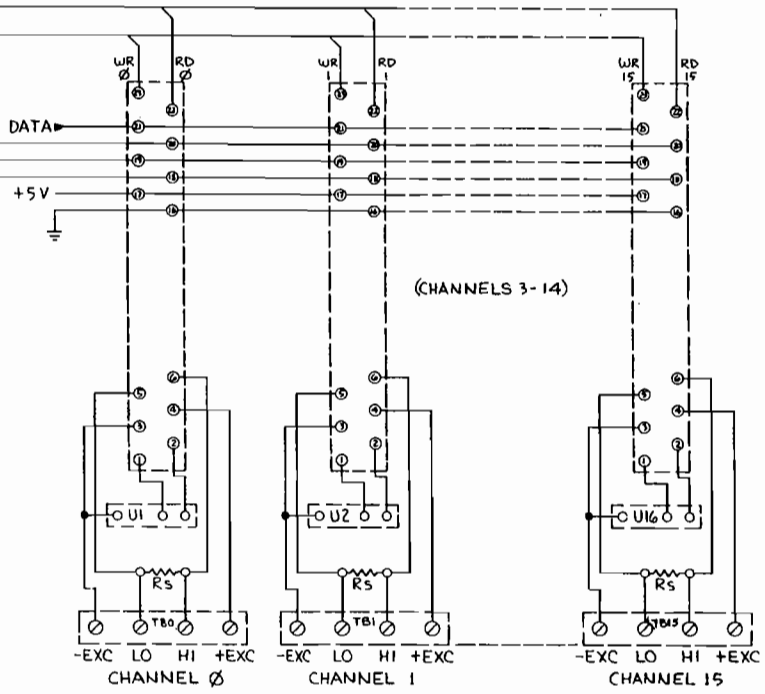
Signal connections between the 5B02 backplane and the associated measurement or control system are made at P1. The pinout of this connector is illustrated in Figure 3.5.

Grounding

Each 5B02 backplane is factory configured with jumpers W1, W2, and W4 installed.

Jumper W1 grounds the shield wires in the ribbon cable (pins 2, 5, and 6) at the 5B02 backplane. This will

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The surge withstand capability can be tested with not less than 50 2.5 kV bursts per second. A test duration of 2 seconds is widely accepted. A rise time of 20 kV/µs is specified, and each module could see a surge current on the order of 1 A.

When such 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. 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 so as to minimize ground differences.

Address Selection Jumpers

The 5B02 backplane can hold 16 modules in any combination of inputs or outputs. Address decoders on the backplane (separate decoders are provided for inputs and outputs) determine which module is read (inputs) or

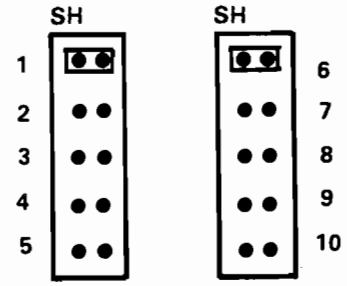


Figure 3.7. Address Selection Pins Default Jumpers

highest-order address bits in the read and write addresses are ignored. Moving the jumpers to any other position in the two blocks enables decoding of the full six address bits; the exact position of the jumper determines address position for the backplane as shown in Table 3.1. To use multiple backplanes in this manner, connect the corresponding I/O connector pins of each backplane in parallel. CAB-01 is a ribbon cable with three 26 pin connectors designed for this purpose.

Table 3.1. Address Selection Jumpers

Input	Output	Address

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5B03 and 5B04 Backplanes

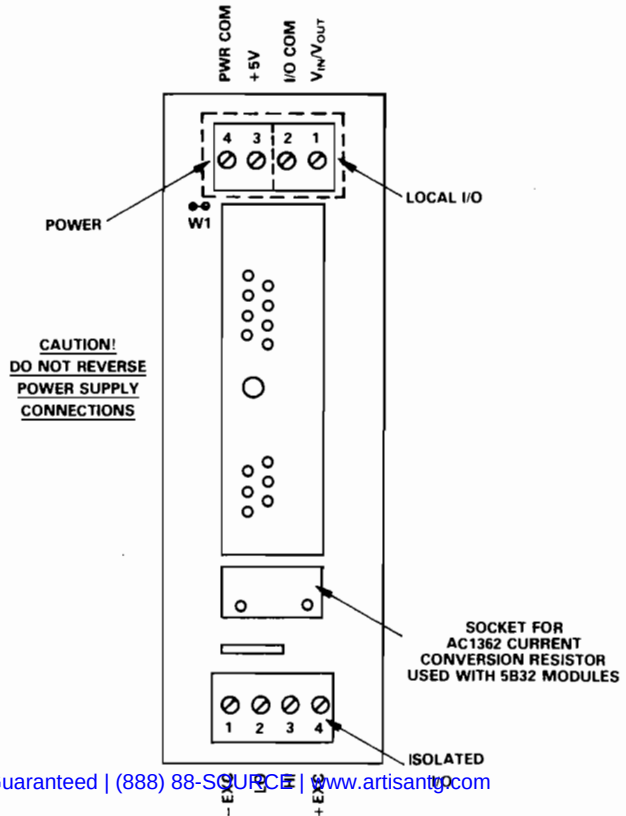
The 5B03 backplane holds one 5B Series module, the 5B04 holds two modules. These backplanes may be clustered for larger groups of modules.

Figures 3.8 and 3.9 are the wiring diagrams for the 5B03 and 5B04. CAUTION! The 5B03 and 5B04 are not protected against reversed power supply connections. A reversal may destroy the installed modules.

Jumper W1 connects +5 V power common to input/output common (backplane measurement ground). A connection between power common and input/output 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 D/A or A/D converters), W1 should be cut since a ground loop could result.

Individual backplanes are DIN rail compatible using Phoenix Universal Mounting UM modules. Two or more backplanes can be mounted in wider UM assemblies.

Mounting a single 5B03 or 5B04 would require the following Phoenix parts:



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Power Requirements

All 5B Series backplanes require external +5 V power. This is connected to TB17 on the 5B01 and TB16 on the 5B02.

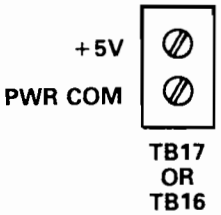


Figure 3.10. Power Connection – Terminal Block 17 (5B01), Terminal Block 16 (5B02)

The power supply is bused to all signal conditioners on the backplane. The total subsystem power requirement is a function of the modules that are used. Module power requirements are listed in Table 3.2. A chassis mounting 1 A (model 955) +5 V power supply is available.

Table 3.2. Module Power Requirements

Model	Current
5B30	30 mA
5B31	30 mA
5B32	30 mA
5B34	30 mA
5B37	30 mA
5B38	200 mA
5B39	170 mA*
5B40	30 mA
5B41	30 mA
5B45	70 mA
5B46	70 mA
5B47	30 mA

*Maximum output load resistance is 750 Ω.

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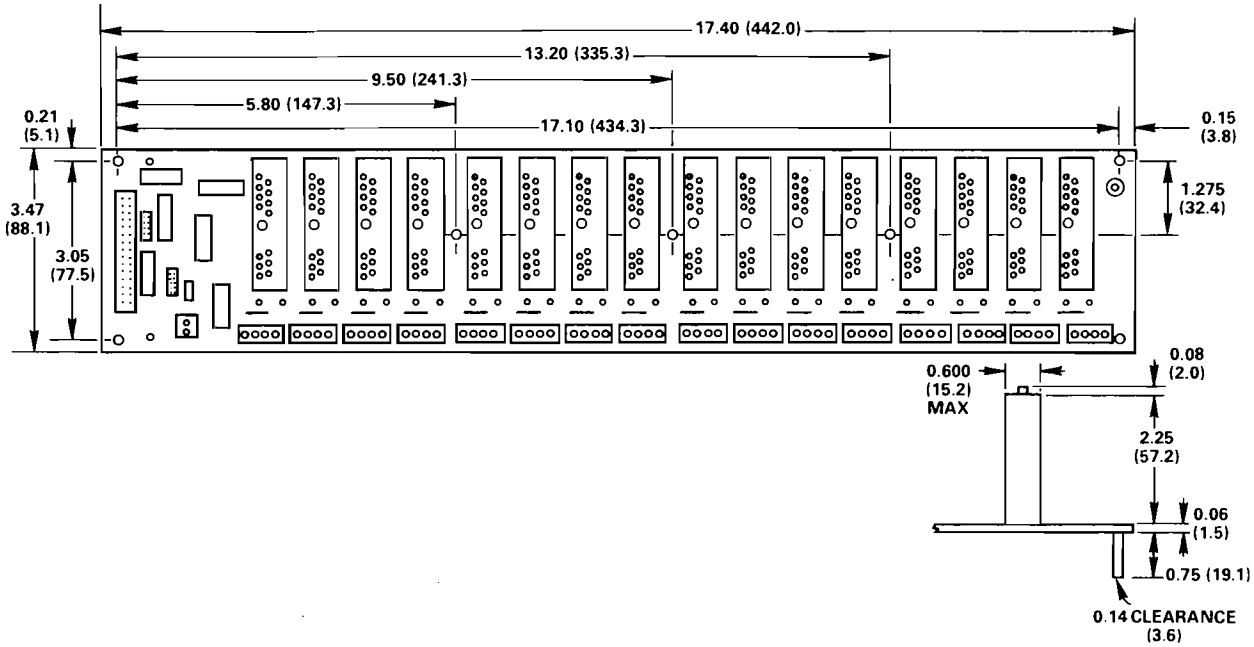
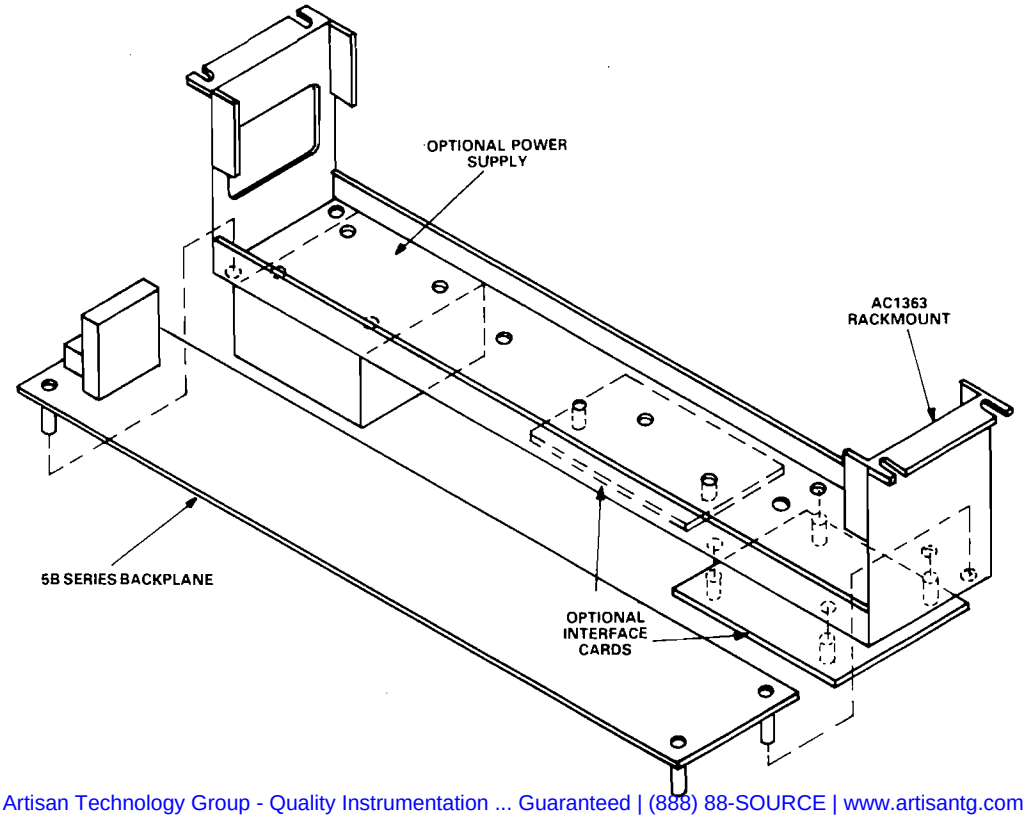


Figure 3.12. 5B01 and 5B02 Backplane Mounting Dimensions in Inches and (mm)

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Figure 3.14. Rack Mount Assembly Drawing

Each 5B Series 16-channel backplane has seven standoffs – one at each corner and three along the centerline – and is supplied with seven 3 mm screws for mounting purposes. Figure 3.10 is a diagram of the mounting dimensions for these backplanes. A drill template is included in Appendix B.

The AC1363 is a single piece metal chassis for mounting a 5B01 or 5B02 backplane in a 19″ rack. It has seven 3 mm threaded inserts for mounting a 5B01 or 5B02, six additional threaded inserts to allow mounting of an adaptor board on the back of the rack mount kit, and holes that allow a 955 or 976 power supply to be mounted on the back of the rack. Screws are also included. The backplane fits readily in the rack by sliding it in from the side under the end flanges. The AC1363 weighs 1.70 lb (775 g). Figure 3.13 is a diagram of the AC1363 rack-mount kit, and Figure 3.14 is a rack mount assembly drawing.

Interface Accessories

A number of accessories are available, which complete the 5B Series Signal Conditioning Subsystem solution by providing an interface to a host system. The AC1315 is a 2′ (60 cm) 26-pin cable with two connectors that can be chaining 5B02 backplanes. The number of CAB-01 cables needed is equal to the total number of 5B02 backplanes minus one.

The AC1324 accepts the AC1315 or CAB-01 from a 5B Series backplane and provides 26 screw terminals for interconnecting to any analog I/O subsystem. This interface board might be used with programmable controllers, for example, and is diagrammed in Figure 3.15. It can be mounted in snap track, if desired, or may be mounted to the AC1363 Rack-Mount Kit. Standoffs are included with the AC1324 and should be used if it is to be mounted on the back of the AC1363.

The AC1366 is an interface board that will convert high-level logic control signals into the TTL levels necessary for the 5B02 backplane. An application requiring this board can occur with programmable controllers that may use up to 24 V logic.

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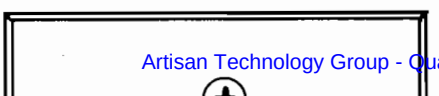
Chapter 4
System Design Considerations

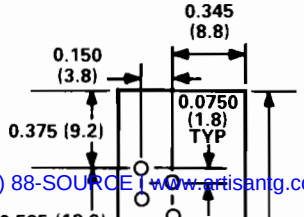
It is simple to incorporate the functionally complete 5B Series modules in your own circuit board or backplane. This chapter discusses some of the important considerations in integrating the 5B Series into your design. Physical, process side, and system side design issues are presented in turn. Miscellaneous topics are grouped at the end of the chapter.

Physical Design Issues

The 5B Series modules are identical in size and pinout. This makes designing a system with a variety of sensor inputs and/or process outputs very simple. Figure 4.1 shows the module outline and pinout. Figure 4.2 shows a single channel of a 5B01 backplane as an example of the factors to consider in a design. You may want to refer to this figure throughout this chapter.

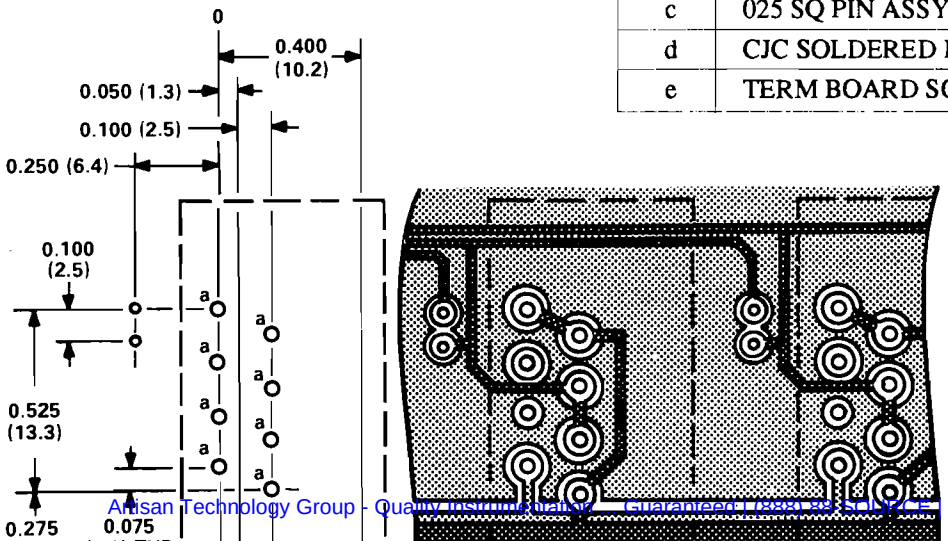
The modules' 40 mil pins fit into widely available sockets such as AMP Inc.'s 645502-1, and the modules are secured with self-contained, metric mounting screws and 3 mm inserts, such as PEM's (Penn Engineering and Manufacturing Corp.) KFS2-M3.





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HOLE	INSTALL
a	AMP SOCKET – P/N 645500-1
b	3MM SWAGE INSERT – PEM KFS2-M3
c	025 SQ PIN ASSY – SAMTEK
d	CJC SOLDERED IN
e	TERM BOARD SOLDERED IN



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Process Side Issues

This section addresses board design issues related to the process side of the isolation barrier.

Field Terminations

Screw terminals will usually be required for connecting field wiring to the modules. Each module will use a minimum of two terminals and a maximum of four (2 signal, 2 excitation).

AC1361 Cold Junction Temperature Sensor

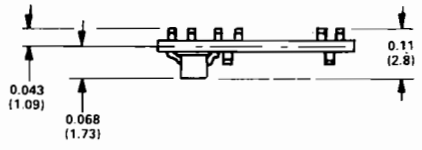
Where thermocouple wires connect to copper terminals, a correction for the thermoelectric potential of that junction must be made. In the 5B Series modules, this is accomplished by measuring the temperature at the screw terminals and applying a correction signal in the module. The AC1361 temperature sensor was designed specifically for this purpose. It is a cold junction temperature sensor optimized for operation in the temperature range from +5°C to +45°C and is intended to be used exclusively with 5B Series thermocouple input modules.

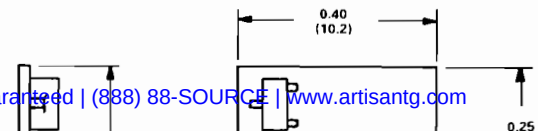
Installing sensors in every channel provides maximum system flexibility. When a system is configured in this

Thus there is no need to keep a sensor associated with a specific module or to dedicate channels exclusively for thermocouple use.

Figure 4.4 shows the limits of the outline of the AC1361 sensor package. This sensor should be placed as close to the field wiring terminations as possible. It is not necessary for the body of the sensor to touch the terminal block – the thermal path to the sensor is primarily through its leads. It is important , whenever thermocouples are connected to a system, to minimize thermal gradients in the neighborhood of the field terminals. Heat sources should be placed as far from the screw terminals as possible.

Electrical specifications of the sensor (Table 4.1) are





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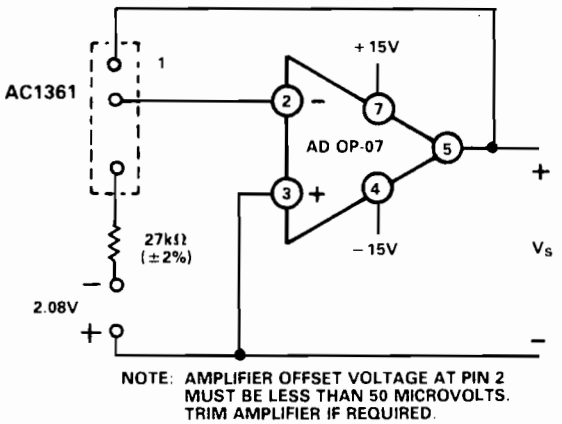


Figure 4.5. AC1361 Test Circuit

Current Conversion Resistor

The 5B32 current input module measures process current signals by reading the voltage developed across a precision 20 Ω resistor. This resistor is supplied in the form of a separate pluggable resistor carrier assembly since it can not be protected against destruction in the event of an inadvertent connection of the power line. (Extra current conversion resistors are available as accessories, model number AC1362.)

Protection

The 5B Series modules can withstand application of 240 V to any combination of I/O field terminations. To protect your board from being harmed by such an occurrence, a 50 mil spacing should be maintained between conductors associated with the field wiring screw terminals. For spacing purposes, track from pins 1 and 2 of the AC1361 can be taken as equivalent to IN LO.

The 5B Series modules can also prevent harm to the connected system when a very large, fast transient strikes all field I/O lines at the same time. However, proper grounding of your board is essential to get full protection since, in some cases, currents on the order of an ampere, with rise times on the order of one microsecond must be diverted to ground. Both the resistance and the inductance of the ground path are critical. On our 5B Series backplanes, large ground studs are provided and, when hazards of this magnitude exist, are connected to ground by the shortest practical length of large diameter wire.

The surge withstand capability can be tested with not less than 50 2.5 kV bursts per second. A test duration of 2 seconds is widely accepted. A rise time of 20 kV/μs is specified, and each module could see a surge current on

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Board design issues related to the system side of the isolation barrier are discussed in this section.

Grounding

A current path must exist between power common and output common (input common and power common in output modules) at some point for proper operation of the module. This path can be resistive; anything less than 10 kΩ is sufficient. The connection does not need to be near the module; distances up to 6 feet are acceptable.

Using the Input Modules' Output Switch

The low-resistance (<50 Ω) series output switch (active-low) in each input module can provide a self-multiplexed output controlled by an enable input that is compatible with MOS and LSTTL levels. Turning on a channel results in a settled output to a 1000 pf bus load (equivalent to roughly 30 modules) in less than 5 microseconds.

If you do not wish to use the output switch present in each 5B Series input module, simply ground the read enable input to power common.

Effects of the Output Switch

The output switch has a typical resistance of 50 Ω and a

Miscellaneous Topics

Other system design considerations are grouped in this section.

AC1360 Evaluation Socket

The AC1360 is a test or evaluation socket for 5B Series modules. Screw terminals are provided for all of the module's input, output, control, and power connections. In addition, an AC1361 cold junction temperature sensor is installed for thermocouple applications, and a pair of sockets permits installation of the AC1362 current sensing resistor used with the 5B32 current input module.

The AC1360 is DIN rail compatible using Phoenix Universal Module UM elements. To mount a single AC1360 would require the following Phoenix parts:

Model	Description	Qty.
UM - BEFE	Base Element with Snap Foot	2
UM - SE	Side Element	2
UM - VS	Connection Pins	4

The snap foot elements will fit DIN EN 50022, DIN EN 50035, and DIN EN 50045 rails.

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The first, labeled W1, provides a convenient point for providing the required current return path from I/O common on the nonisolated (system side) of the modules to the +5 V supply common. In general, this is not the best place to have such a connection. In most applications, there will already be a suitable path resulting from a connection at another point so that W1 will result in a ground loop. Virtually any contact between supply common and analog measurement common in the surrounding system is sufficient; the two grounds can be several volts apart and can have a resistance of up to 10 KΩ between them without affecting 5B Series module operation. W1 should be cut if such a contact exists.

Jumper W2 is factory installed and only affects the operation of thermocouple input modules. W2 connects the AC1361 temperature sensor in its normal manner when a thermocouple input module is installed in the module socket. For applications involving connection of thermocouple wire to the HI and LO screw terminals, this results in normal correction in the module for the thermal effects of the connections.

If, however, a 5B37 or 5B47 thermocouple module is to be operated without thermocouple wire at the screw terminals—as, for example, in a test fixture using a

In these applications, a CJC voltage of 510.0 mV will simulate sensor operation at a terminal temperature of +25°C. Since there are no parasitic thermocouples at the screw terminals to correct, all output readings will appear to be 25°C higher than would be implied by the input voltage. With the 25°C shift taken into account, however, module operation is close to normal conditions for test or evaluation purposes. Alternatively, a CJC voltage of 572.5 mV can be applied, simulating operation at a terminal temperature of 0°C. Millivolt inputs can then be read directly from thermocouple tables without any temperature shift. At 572.5 mV, however, since the module's cold junction correction circuitry is operating far from its design center, its errors will be larger than would be the case in normal operation.

Power Connection.

Caution: The AC 1360 is not protected against reversed power supply connections. A reversal may destroy the installed module.

Double Isolation Protection

A board using the 5B Series modules can be configured to provide a double isolation barrier, as shown in Figure 4.8.

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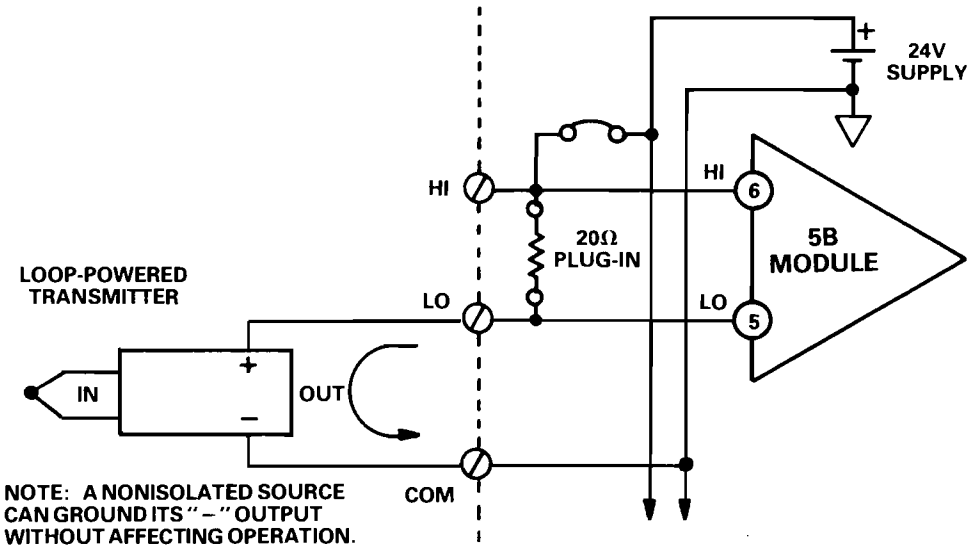


Figure 4.9. Current Loop Input from Loop-Powered Transmitter (2-Wire)

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Appendix A
Accessories

To ease the board design process and to complete the 5B Series subsystem solution, the following accessories are available.

AC1315

The AC1315 is a 2′ (60 cm) 26-pin cable with 2 connectors

AC1324

The AC1324 is a universal interface board with a 26-pin connector in and 26 screw terminals out. A diagram of the AC1324 is included in the Interface Accessories section of Chapter 3, page 3-11.

AC1344

The AC1344 is a package of 10 jumpers for providing two levels of isolation protection on the 5B01 backplane or replacing the address selection jumpers on the 5B02

AC1364

The AC1364 is this *5B Series User's Manual*.

AC1365

The AC1365 is a module case and mounting screw.

AC1366

The AC1366 is an interface board used to convert high-level control signals to the TTL logic levels used on the 5B02 backplane. This board can be mounted on the backside of the metal chassis (AC1363).

AC1367

The AC1367 voltage switch input is a nonisolated, unity

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Appendix B
Drill Template

Figure B.1 is a drill template for mounting a 5B01 or 5B02 backplane.

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Appendix C
5B02 Jumper Configurations

The 5B02 backplane was designed to address multiple backplane configurations with a minimum of external circuitry. This is accomplished by implementing analog input and output buses and taking advantage of output enable and track-and-hold circuits built into the modules. Using the address and control lines on the 5B02, up to 64 analog input/output channels can be accessed.

The following tables describe the jumper configurations required on the 5B02 backplanes for one, two, three, or four 5B02 combinations.

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5B02 Logic Table – Dual-Board Application

In this appliction, the first board will be called "A" and the second board will be called "B."

Board A will have the jumpers in positions 5 and 10.
Board B will have the jumpers in positions 4 and 9.

RD EN	R5	R4	R3	R2	R1	R0	READ/ CHANNEL	WR EN	W5	W4	W3	W2	W1	W0	WRITE/ CHANNEL
1	X	X	X	X	X	X	N.C.	1	X	X	X	X	X	X	N.C.
X	1	X	X	X	X	X	N.C.	X	1	X	X	X	X	X	N.C.
0	0	0	0	0	0	0	CH0/A	0	0	0	0	0	0	0	CH0/A
0	0	0	0	0	0	1	CH1/A	0	0	0	0	0	0	1	CH1/A
0	0	0	0	0	1	0	CH2/A	0	0	0	0	0	1	0	CH2/A
0	0	0	0	0	1	1	CH3/A	0	0	0	0	0	1	1	CH3/A
0	0	0	0	1	0	0	CH4/A	0	0	0	0	1	0	0	CH4/A
0	0	0	0	1	0	1	CH5/A	0	0	0	0	1	0	1	CH5/A
0	0	0	0	1	1	0	CH6/A	0	0	0	0	1	1	0	CH6/A
0	0	0	0	1	1	1	CH7/A	0	0	0	0	1	1	1	CH7/A
0	0	0	1	0	0	0	CH8/A	0	0	0	1	0	0	0	CH8/A
0	0	0	1	0	0	1	CH9/A	0	0	0	1	0	0	1	CH9/A
0	0	0	1	0	1	0	CH10/A	0	0	0	1	0	1	0	CH10/A
0	0	0	1	0	1	1	CH11/A	0	0	0	1	0	1	1	CH11/A
0	0	0	1	1	1	0	CH12/A	0	0	0	1	1	1	0	CH12/A

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5B02 Logic Table – Triple-Board Application

A third board can be added to a dual application, and this will be called board "C." This board will have jumpers in location 3 and 8.

RD EN	R5	R4	R3	R2	R1	R0	READ/ CHANNEL	WR EN	W5	W4	W3	W2	W1	W0	WRITE/ CHANNEL
1	X	X	X	X	X	X	N.C.	1	X	X	X	X	X	X	N.C.
X	1	1	X	X	X	X	N.C.	X	1	1	X	X	X	X	N.C.
0	1	0	0	0	0	0	CH0/C	0	1	0	0	0	0	0	CH0/C
0	1	0	0	0	0	1	CH1/C	0	1	0	0	0	0	1	CH1/C
0	1	0	0	0	1	0	CH2/C	0	1	0	0	0	1	0	CH2/C
0	1	0	0	0	1	1	CH3/C	0	1	0	0	0	1	1	CH3/C
0	1	0	0	1	0	0	CH4/C	0	1	0	0	1	0	0	CH4/C
0	1	0	0	1	0	1	CH5/C	0	1	0	0	1	0	1	CH5/C
0	1	0	0	1	1	0	CH6/C	0	1	0	0	1	1	0	CH6/C
0	1	0	0	1	1	1	CH7/C	0	1	0	0	1	1	1	CH7/C
0	1	0	1	0	0	0	CH8/C	0	1	0	1	0	0	0	CH8/C
0	1	0	1	0	0	1	CH9/C	0	1	0	1	0	0	1	CH9/C
0	1	0	1	0	1	0	CH10/C	0	1	0	1	0	1	0	CH10/C
0	1	0	1	0	1	1	CH11/C	0	1	0	1	0	1	1	CH11/C
0	1	0	1	1	0	0	CH12/C	0	1	0	1	1	0	0	CH12/C
0	1	0	1	1	0	1	CH13/C	0	1	0	1	1	0	1	CH13/C
0	1	0	1	1	1	0	CH14/C	0	1	0	1	1	1	0	CH14/C
0	1	0	1	1	1	1	CH15/C	0	1	0	1	1	1	1	CH15/C

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Appendix D
5B37 Transfer Function

Calculating the Output Voltage of a 5B37

The output voltage of a 5B37 thermocouple signal conditioner can be calculated by knowing: (a) the thermocouple input voltage at the measurement temperature; (b) the thermocouple input signal at the minimum point of the 5B37 module temperature range; and (c) the 5B37 gain.

Transfer Equation for 5B37

To determine the output voltage from a 5B37 module, use the following equation:

$$V_{OUT} = [\text{ T.C. Output} - V_{ZERO}\text{ }] * \text{GAIN}$$

where,

1 – V_{OUT} is the 5B37 module output (in volts)

The table show below provides the thermocouple output voltage at the minimum temperature span of each 5B37 module (V_{ZERO}) and the 5B37 gain.

Sensors Software Program

For assistance in determining a specific thermocouple output voltage at any temperature, you may contact the Analog Devices, Inc. Technical Support Group and request a copy of the SENSORS software program. This Windows software program provides a convenient reference to lookup tables of temperature sensing devices, including thermocouples, RTD's (Platinum, Nickel, and Copper), as well as thermistors. Functions are implemented in both directions (i.e., temperature to mV and mV to temperature), as well as in both °C and °F.

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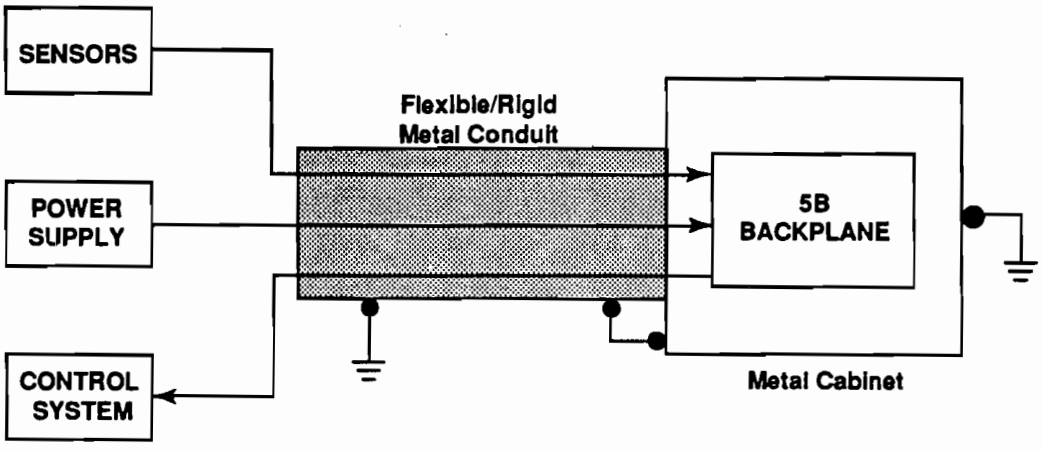
Addendum to the 5B Series User's Manual

Important Information

for use of the
5B Series Signal Conditioning Subsystems
in RFI/EMI fields.

The 5B Series Signal Conditioning Subsystem has been tested and passed the stringent "heavy industrial" requirements of the European Union's electromagnetic compatibility (EMC) directive. The 5B Series modules have the CE (Communité Européenne) mark on their label indicating their approval. Only products that comply with these directives can have the CE mark affixed. Only CE marked products can be sold in the EU starting on January 1, 1996.

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General Wiring Configuration

CE CERTIFICATION TESTS

The 5B Series modules have been tested and certified according to the rigorous electromagnetic constrains of the EN50082-2 and EN50081-2

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Statement of Warranty

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Upon request by Analog Devices, the product or part claimed to be defective shall immediately be returned at the Customer's expense to Analog Devices. Replaced or repaired products or parts will be shipped to

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the Customer at the expense of Analog Devices.

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