FEATURES
- **Complete Sensor-to-Digital Signal Conditioning and Data Conversion**
- **Multiple Input Ranges**
  Thermocouples: J, K, T, E, R, S, and B
  RTDs: 100 Ω Platinum (α = 385 and 392)
  Voltage: Ten Ranges from ±10 mV to ±10 V
  Two Custom Ranges (User Defined)
- **High Resolution: ±0.15°C (Typical, Temperature Input) or ±0.0015% (Typical, Voltage Input)**
- **High Accuracy: ±0.2°C (Typical, RTD Input) or ±0.005% (Typical, Voltage Input)**
- **Cold Junction Compensation for Thermocouples**
- **Open Thermocouple Detection**
- **RTD Excitation**
- **Lead Resistance Compensation for RTDs**
- **Autozeroing, Data Scaling, and Linearization**
- **Data Output in Engineering Units**
- **2-Wire Asynchronous Communication I/O Port**
- **High Speed Synchronous Data Output Port**
- **Eight Integration Times: 2 ms to 200 ms**
- **Internal EEPROM Stores Calibration and Configuration Parameters**

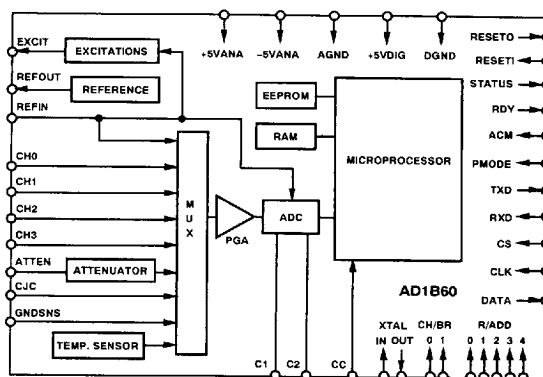# APPLICATIONS
Industrial Temperature Measurement Systems
Process Control Systems
Multichannel Thermocouple/RTD Systems
Analytical Instruments

GENERAL DESCRIPTION
The AD1B60 is an intelligent, microcontroller-based device that performs signal conditioning, excitation, compensation, linearization, and analog-to-digital conversion for a variety of low bandwidth industrial and analytical signals. Due to its highly integrated, mixed-signal design, the AD1B60 is small and inexpensive, offering designers increased flexibility and performance.

The AD1B60 is suited primarily for use with thermocouples and resistance temperature detectors (RTDs), but also accepts a broad range of low and high level voltage inputs. The AD1B60 converts sensor inputs to compensated, linearized, scaled, and autozeroed outputs represented in engineering units: degrees Celsius or volts.

FUNCTIONAL BLOCK DIAGRAM

Four modes of cold junction compensation (CJC) are supported for thermocouple applications. The AD1B60 also provides lead resistance compensation for 3-wire or 4-wire RTD connections.

Data is transmitted serially to simplify use of external optical and/or magnetic isolation devices. The AD1B60 has a bidirectional asynchronous communications port for control and for data output. Data is also available via a high-speed synchronous data output port.

Configuration parameters such as the input range and integration time of the AD1B60 can be programmed, both prior to installation and in the application. The AD1B60 incorporates EEPROM to store default and user-specified configuration and calibration values. No battery backups, potentiometers, or user-developed calibration software routines are required and no recalibration is necessary when the input range is changed.

AD1B60—SPECIFICATIONS (@ T_A = −25°C to +85°C and power supplies of ±5 V ± 5% unless otherwise noted)

Parameter	Min	Typ	Max	Unit	Notes
		AD1B60BS, AD1B60BJ			
	Min	**Typ**	**Max**	**Unit**	**Notes**
ACCURACY (ERROR)					Notes 1 and 2 (All Ranges); at +25°C
Range 0 (±10 mV)		±0.06	±0.11	% FSR	
Range 1 (±20 mV)		±0.03	±0.06	% FSR	
Range 2 (±50 mV)		±0.015	±0.03	% FSR	
Range 3 (±100 mV)		±0.008	±0.015	% FSR	
Range 4 (±200 mV)		±0.005	±0.008	% FSR	
Range 5 (±500 mV)		±0.005	±0.007	% FSR	
Range 6 (±1 V)		±0.005	±0.007	% FSR	
Range 7 (±2 V)		±0.005	±0.007	% FSR	
Range 8 (±5 V)		±0.007	±0.010	% FSR	
Range 9 (±10 V)		±0.005	±0.010	% FSR	
Range A (Type J, 0°C to 760°C)		±0.25	±0.45	°C	Note 3 (Temperature Ranges)
Range B (Type K, 0°C to 1000°C)		±0.55	±0.75	°C	
Range C (Type T, −100°C to +400°C)		±0.25	±0.45	°C	
Range D (Type E, 0°C to 1000°C)		±0.20	±0.35	°C	
Range E (Type R, 500°C to 1750°C)		±1.00	±1.75	°C	
Range F (Type S, 500°C to 1750°C)		±1.15	±2.05	°C	
Range 10 (Type B, 500°C to 1800°C)		±1.15	±2.15	°C	
Range 11 (Pt 385, −200°C to 800°C)		±0.20	±0.40	°C	
Range 12 (Pt 392, −200°C to 800°C)		±0.20	±0.40	°C	
ACCURACY (ERROR) DRIFT					Notes 4 and 5 (All Ranges)
Range 0 (±10 mV)		−40	−100	ppm/°C	
Range 1 (±20 mV)		−20		ppm/°C	
Range 2 (±50 mV)		−10		ppm/°C	
Range 3 (±100 mV)		−5		ppm/°C	
Range 4 (±200 mV)		−5		ppm/°C	
Range 5 (±500 mV)		−5		ppm/°C	
Range 6 (±1 V)		−5		ppm/°C	
Range 7 (±2 V)		−5		ppm/°C	
Range 8 (±5 V)		−5		ppm/°C	
Range 9 (±10 V)		−5		ppm/°C	
Range A (Type J, 0°C to 760°C)		−10		ppm/°C	
Range B (Type K, 0°C to 1000°C)		−10		ppm/°C	
Range C (Type T, −100°C to +400°C)		−20		ppm/°C	
Range D (Type E, 0°C to 1000°C)		−10		ppm/°C	
Range E (Type R, 500°C to 1750°C)		−20		ppm/°C	
Range F (Type S, 500°C to 1750°C)		−40		ppm/°C	
Range 10 (Type B, 500°C to 1800°C)		−40		ppm/°C	
Range 11 (Pt 385, −200°C to 800°C)		±10	±25	ppm/°C	Note 6 (RTD Ranges)
Range 12 (Pt 392, −200°C to 800°C)		±10	±25	ppm/°C	
RESOLUTION					Notes 2 and 5 (All Ranges)
Range 0 (±10 mV)		±0.035		% FSR	
Range 1 (±20 mV)		±0.02		% FSR	
Range 2 (±50 mV)		±0.01		% FSR	
Range 3 (±100 mV)		±0.004		% FSR	
Range 4 (±200 mV)		±0.002		% FSR	
Range 5 (±500 mV)		±0.0015		% FSR	
Range 6 (±1 V)		±0.0015		% FSR	
Range 7 (±2 V)		±0.0015		% FSR	
Range 8 (±5 V)		±0.0015		% FSR	
Range 9 (±10 V)		±0.0015		% FSR	
Range A (Type J, 0°C to 760°C)		±0.15		°C	
Range B (Type K, 0°C to 1000°C)		±0.2		°C	
Range C (Type T, −100°C to +400°C)		±0.15		°C	
Range D (Type E, 0°C to 1000°C)		±0.1		°C	
Range E (Type R, 500°C to 1750°C)		±0.55		°C	
Range F (Type S, 500°C to 1750°C)		±0.6		°C	
Range 10 (Type B, 500°C to 1800°C)		±0.7		°C	
Range 11 (Pt 385, −200°C to +800°C)		±0.15		°C	
Range 12 (Pt 392, −200°C to +800°C)		±0.15		°C	

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Parameter	AD1B60BS, AD1B60BJ			Unit	Notes
	Min	Typ	Max		
INPUT CHARACTERISTICS					
Normal Mode Rejection (@ 50 Hz or 60 Hz)		66		dB	At Integration Time ≥ 100 ms
		50		dB	Note 2
Input Bias Current		−0.5	−3	nA	At T_A = +25°C
		−0.5		nA	At −25°C ≤ T_A ≤ +85°C
Input Impedance					
Channel 0-3		10		MΩ	
Attenuator Input	35	50	65	kΩ	
RTD & THERMOCOUPLE CHANNELS					
RTD Excitation Current Output (EXCIT)	−150	−200	−250	μA	Note 7; at T_A = +25°C
vs. Temperature		±75	±300	ppm/°C	Note 6
Open Thermocouple Detection Current (EXCIT)		−10		nA	
CJC Excitation Current Output (CJC)	−15	−20	−25	μA	Note 8; at T_A = +25°C
REFERENCE					
Internal Reference Output Voltage	2.360	2.500	2.640	V	
vs. Temperature		±25	±50	ppm/°C	
Internal Reference Voltage Noise		0.01		% p-p	
Ref In Current		350		μA	
TIMING					
Conversion Throughput Rate	2.5		100	conv/sec	Note 9
Integration Time (User Configurable)	2		200	ms	See Table IV
Integration Capacitor	1	2.2	3	nF	Note 10
Oscillator Frequency		11.0592		MHz	Notes 10 and 11
Integration Latency			100	μs	See Figure 2B
CLK-to-DATA Delay, Synchronous Port		30		ns	See Figure 4
Minimum CS High Time	400			μs	See Figure 4
Reset Input Pulse Width (RESETI)	5			μs	
DIGITAL LEVELS					At +25°C
Inputs					
Logic 0 Voltage			0.8	V	
Logic 1 Voltage (Except RESETI)	2.0			V	
Logic 1 Voltage (RESETI)	0.7* (+5VDIG) + 0.1			V	
Outputs					
Logic 0 Voltage (I_{SINK} = 1.6 mA)			0.45	V	
Logic 1 Voltage (I_{SOURCE} = −60 μA)	2.4			V	
Input Current (CC, RXD, CH/BR0-1, ACM, PMODE)					
Logic 0			−75	μA	At V_{IN} = 0.45 V
Logic 1-to-0 Transition			−750	μA	At V_{IN} = 2.0 V
Input Current (R/ADD0-4, CLK, CS)			±10	μA	At 0.45 ≤ V_{In} ≤ +5VDIG
Input Pulldown Resistor (RESETI)	50		150	kΩ	
POWER REQUIREMENTS					At +25°C
+V Analog (+5VANA)	4.75	5.00	5.25	V	
		7	15	mA	At +5VANA = 5.0 V
−V Analog (−5VANA)	−5.25	−5.00	−4.75	V	
		−7	−15	mA	At −5VANA = −5.0 V
+V Digital (+5VDIG)	4.75	5.00	5.25	V	Note 12
		10	30	mA	At +5VDIG = 5.0 V
Power Supply Rejection Ratio		−70		dB	
BROWNOUT DETECTOR					
±V Analog Threshold		±3.9		V	
+V Digital Threshold		3.5		V	
TEMPERATURE RANGE					
Rated Performance	−25		+85	°C	
Operating	−40		+85	°C	
Storage	−40		+85	°C	

AD1B60—SPECIFICATIONS

[1]Accuracy specifications include factory calibration errors but do not include reference noise. Also, accuracy specifications for thermocouple ranges do not include CJC calculation errors, which depend on the calculation method chosen. To calculate total measurement error, add reference noise expressed as a percentage of the reference voltage to the specified accuracy error. Because reference noise results in a gain error, its effect is a percentage of reading. For example, a measurement made using the ±1 V input range and a reference with ±0.01% maximum noise would have a maximum error of ±0.007% FSR ± 0.01% of reading. FSR = Full-Scale Range, i.e., span of input values. For thermocouple ranges, also add to the measurement error the values in Table A corresponding to the selected CJC type. For example, a measurement made with a Type J thermocouple, downloaded CJC temperature, and a reference with ±0.01% maximum noise would have a maximum error of ±0.456 °C ± 0.01 % of reading.

[2]At integration time ≥ 33.3 ms and equal to an integral number of power-line cycles.

[3]Temperature ranges use the International Practical Temperature Scale of 1968 (IPTS-68). Thermocouple accuracy specifies conformance to NIST Monograph 125. RTD accuracy specifies conformance to JIS C 1604, DIN 43760, and IEC 751.

[4]Errors expressed as ppm (parts per million) of reading.

[5]Excluding reference noise and drift.

[6]RTD measurement drift is digitally compensated to 25 ppm/°C of reading (maximum), including effects of reference, excitation current, and gain drift.

[7]RTD measurement accuracy is digitally compensated to values shown on first page of specification table.

[8]CJC excitation current is enabled only when the "Thermistor" CJC mode is selected; see Table V.

[9]Minimum throughput occurs at T_{INT} = 200 ms for any range selection. Maximum throughput occurs at T_{INT} = 2 ms for voltage ranges (ranges 0 through 9) only; see Table IV.

[10]User-supplied.

[11]Specified performance obtained with frequency of 11.0592 MHz ± 0.1%.

[12]−0.2 V < (+5VANA − +5VDIG) < 0.5 V for specified performance.

[13]Typical values are not tested or guaranteed. Operation which is specified without explicit reference to variation in operating conditions may differ as these conditions are altered.

Table A. Maximum Thermocouple CJC Calculation Error

CJC Calculation	Thermistor		1 mV/K		Downloaded	Disabled
CJC Mode	00		01		10	11
Thermocouple Type	Ambient Temperature of AD1B60					
	−25°C to +85°C	25°C	−25°C to +85°C	25°C	−25°C to +85°C	−25°C to +85°C
J	0.6°C	0.1°C	0.4°C	0.3°C	0.006°C	0°C
K	0.6°C	0.1°C	0.4°C	0.3°C	0.012°C	0°C
T	0.8°C	0.2°C	0.6°C	0.4°C	0.028°C	0°C
E	0.6°C	0.1°C	0.4°C	0.3°C	0.024°C	0°C
R	0.4°C	0.1°C	0.3°C	0.2°C	0.007°C	0°C
S	0.4°C	0.1°C	0.3°C	0.2°C	0.007°C	0°C
B	0.3°C	0.3°C	0.3°C	0.3°C	0.250°C	0°C

ABSOLUTE MAXIMUM RATINGS*
(T_A = +25°C unless otherwise stated)

+5VDIG to DGND	−0.3 V to +6 V
+5VANA to AGND	−0.3 V to +6 V
−5VANA to AGND	−6 V to +0.3 V
+5VDIG to +5VANA	−6 V to +0.3 V
+5VANA to −5VANA	0 V to 12 V
AGND to DGND	±0.3 V
Analog Inputs to AGND (Exc. ATTEN)	±5VANA ± 0.3 V
ATTEN Input to AGND	±15 V
REFOUT, EXCIT to AGND	−0.3 V to +5VANA + 0.3 V
Digital Inputs to DGND	−0.3 V to +5VDIG + 0.3 V
Digital Outputs to DGND	−0.3 V to +5VDIG + 0.3 V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C
Power Dissipation to 75°C	1,000 mW
Derate Above +75°C by	10 mW/°C

*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Absolute Maximum Ratings apply individually only, not in combination.

ORDERING GUIDE

Model	Temperature Range	Package Option*
AD1B60BS	−40°C to +85°C	S-64
AD1B60BJ	−40°C to +85°C	J-44
AD1B60/EB	−40°C to +85°C	Printed Circuit Board

NOTES
*S = Plastic Quad Flat Pack (PQFP), J = J-leaded Ceramic Chip Carrier, /EB = Evaluation Board with AD1B60BJ & Software. Consult factory for availability. For outline information see Package Information section.

CAUTION
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD1B60 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

WARNING!
ESD SENSITIVE DEVICE

Table I. Pin Functions

BS #	BJ #	Name	Connection
4	18	RESETI	Reset input; active high. Initializes the AD1B60 to the pin-strapped and EEPROM default values. Connect to RESETO.
5	19	RXD	Receive data input for asynchronous port.
6	20	TXD	Transmit data output for asynchronous port.
7	21	CC	Continuous Conversion input. Enables synchronous signal integration or continuous conversion. While low, the AD1B60 waits in "idle mode." When CC goes high, the AD1B60 starts converting. While held high, the AD1B60 continuously converts input data.
8	22	DGND	Digital ground.
12	23	+5VANA	+5 V, ± 5% analog power supply.
13	24	REFOUT	Output from internal reference (+2.5 V).
14	25	REFIN	Reference input; may be connected directly to REFOUT.
15	26	−5VANA	−5 V, ± 5% analog power supply.
16	27	AGND	Analog ground.
17	28	ATTEN	5:1 attenuator input for ±5 V and ±10 V input voltages.
21	29	C2	External integration capacitor (nominally 2.2 nF).
22	30	C1	External integration capacitor.
23	31	NC	Make no connection (factory test).
24	32	CJC	External CJC sensor input. Also outputs 20 μA excitation current in thermistor CJC mode.
25	33	EXCIT	Excitation Output: provides 10 nA for open thermocouple detection if a thermocouple range is selected, or 200 μA excitation if an RTD range is selected.
26	34	GNDSNS	Sense input for ground potential. Connect to AGND (typical).
27	35	CH3	Channel 3 signal input.
28	36	CH2	Channel 2 signal input.
29	37	CH1	Channel 1 signal input.
30	38	CH0	Channel 0 signal input.
31	39	NC	Make no connection (factory test).
34	40	RESETO	Output from the power-on reset/brownout detect/watchdog timer circuit; active high. Connect to RESETI.
35	41	+5VDIG	+5 V, ± 5% digital power supply; connect also to other +5 VDIG pins.
36	42	CS	Chip select input (low to select). Connect to DGND if not used.
37	43	CLK	Synchronous serial shift clock input. Connect to DGND if not used.
38	44	DATA	Synchronous serial data output.

| BS #	BJ #	Name	Connection
39	1	XTLOUT	External crystal (11.0592 MHz).
40	2	XTLIN	External crystal (11.0592 MHz) or external logic-level clock input.
41	3	+5VANA	+5 V, ± 5% analog power supply.
45, 46	4, 5	CH/BR0-1	Channel select inputs when PMODE is low at reset. Baud rate select inputs when PMODE is high at reset.
47	6	+5VDIG	+5 V, ± 5% digital power supply; connect also to other +5 VDIG pins.
53–57	7–11	R/ADD4-0	Range select inputs if PMODE is low at reset. Address select inputs if PMODE and ACM are high at reset. External pull-ups are required.
58	12	+5VDIG	+5 V, ± 5% digital power supply; connect also to other +5 VDIG pins.
59	13	STATUS	Computation status output. If Status is high, results from the previous signal integration are being computed; if STATUS is low, results are available.
60	14	PMODE	Mode select input for CH/BR and R/ADDR pins; high or low state sensed at power-up and reset. Specifies whether input range, input channel, device address, and baud rate are determined by external pins or by values in EEPROM.
61	15	ACM	Addressed Communication Mode input. When ACM is high, address and CRC are enabled.
62	16	RDY	Ready (integration status) output. If RDY is high, the AD1B60 is integrating the signal; if RDY is low, the AD1B60 is integrating a background input.
63	17	NC	Make no connection (factory test).

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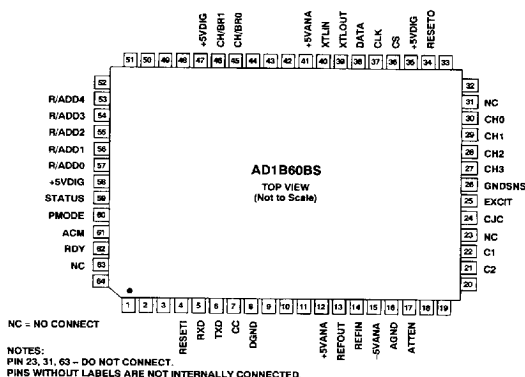
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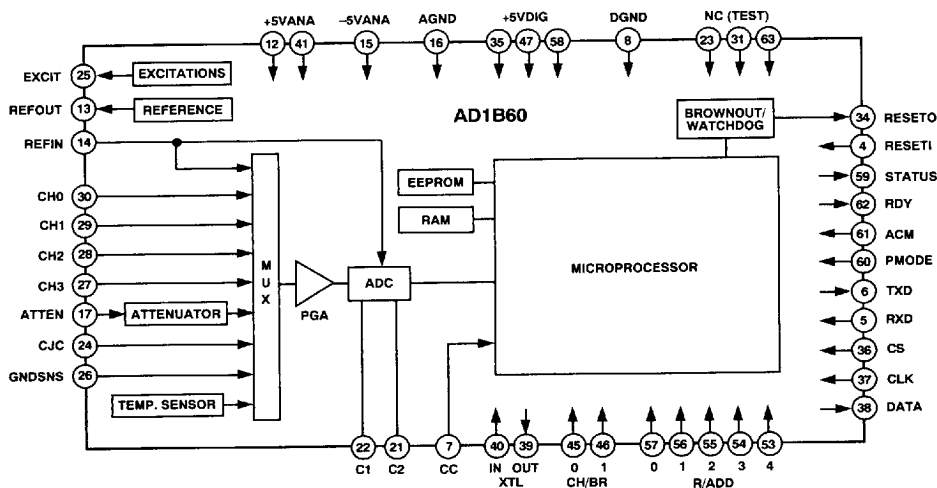
AD1B60

Figure 1. Functional Block Diagram

FUNCTIONAL DESCRIPTION

The AD1B60 is a complete data acquisition subsystem in a single package which interfaces directly to a sensor and a host processor (see Figure 1). The sensor is applied to one or more of the multiplexer inputs and amplified by the programmable gain amplifier. Excitation currents for RTDs, open thermocouple input detection, and cold junction compensation sensors are provided.

The AD1B60 has an input multiplexer with four channels for low level input signals and one channel with an attenuator for high level inputs. There are also reference and zero inputs, a cold junction compensation channel, and an internal temperature sense channel on the multiplexer. Voltage input ranges are ±10 mV full scale to ±10 V full scale.

The multiplexer feeds a programmable gain amplifier (PGA), which has a gain range of 1 to 128. The output of the PGA is applied to an integrating voltage-to-frequency converter, which is resolved by the microprocessor. The microprocessor controls the input multiplexer and PGA alternately selecting an input channel, voltage reference, ground, or other signal channel necessary for an accurate measurement.

For a voltage measurement, the AD1B60 will measure the input voltage, measurement ground and reference voltage, and will calculate the value of the input voltage ratiometrically to the reference and then generate an output value in volts.

For thermocouple measurements, the AD1B60 will also read a cold junction sensor, calculate the required CJC correction voltage, apply it to the voltage reading of the thermocouple, and generate an output in degrees Celsius.

For RTD measurements, the AD1B60 will perform 3- or 4-wire lead resistance compensation, compensate for internal excitation and gain drifts and generate an output in degrees Celsius.

The AD1B60's standard input ranges include the seven NIST thermocouple standards, two platinum RTD ranges, and ten voltage ranges.

In addition, the AD1B60 can use two ranges stored in internal EEPROM. These "custom" ranges are easily created by the user through use of the AD1B60 Custom Range Generation Software included with every Evaluation Board. Several example files, such as a Type N thermocouple range, are also included with the software.

With each conversion, the AD1B60 reports status information, input channel, and an overflow flag. The AD1B60 communicates via one or both of its serial ports: a 2-wire asynchronous I/O port up to 19.2 kbaud, and a 3-wire synchronous data output port up to 5 Mbps.

The AD1B60 contains a brownout detector and watchdog monitor circuit. If any of the power supplies falls below a threshold, or if the internal microprocessor fails to trigger the watchdog timer, this circuit will generate a reset output.

CONFIGURABLE PARAMETERS

You can set the following parameters of the AD1B60:

- Device Address
- Baud Rate
- Channel Selection
- Input Range
- Integration Time
- Cold Junction Compensation Mode
- RTD Connection Mode

Depending on the parameter, you can change values in the following ways:

- Execute AD1B60 commands to change values in EEPROM.
- Set specified pins on the AD1B60.
- Execute AD1B60 commands to change values in RAM.

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The factory-programmed default values of the configurable parameters are listed in Table II.

If the default values for the device address and baud rate do not match those in your application, you must reset the AD1B60 with the PMODE pin high and the desired device address and baud rate set by AD1B60 pins. Using AD1B60 commands, you can change the EEPROM-based defaults, and then power up the AD1B60 with PMODE low to use the new default values from EEPROM.

The following section describes the configurable parameters. The COMMAND SET section describes the commands used to change parameter settings.

Table II. Configurable Parameters and their Default Values

Configurable Parameter	Factory Default Value	For Details, See
Device Address	0	Table I
Baud Rate	9600	Table VII
Channel Selection	0	Figure 5
Input Range	Type J Thermocouple	Table III
Integration Time	100 ms	Table IV
Cold Junction Compensation Mode	Direct Connection of a Thermistor	Table V
RTD Connection Mode	3-Wire	Figure 6

CONFIGURATION PARAMETER DESCRIPTIONS

Device Address

In Addressed Communication Mode (ACM pin high), you can connect a cluster of up to 32 AD1B60s to a single communication port. Each AD1B60 in a cluster must have a unique address from 0 to 31 (0 to 1F hex).

When the AD1B60 is reset with PMODE high, the address is read from R/ADD 4–0 pins. Refer to Table I for more information on using the pins of the AD1B60.

When the AD1B60 is reset with PMODE low, the address is read from EEPROM. You can change the default address stored in EEPROM by executing the WR_EPM_PARS command.

Baud Rate

You can set one of the following baud rates for the AD1B60: 2400, 4800, 9600 (the factory default), or 19200.

When the AD1B60 is reset with PMODE low, the baud rate is read from EEPROM. You can change the default baud rate stored in EEPROM by executing the WR_EPM_PARS command.

When the AD1B60 is reset with PMODE high, the baud rate is read from the CH/BR 0–1 pins.

Channel Selection

Although the AD1B60 is optimized for single-channel applications, you can use up to five input channels on one device. The AD1B60 checks the input channel selection before each conversion. Note that selecting an RTD or high voltage input range also determines the channel(s).

If the AD1B60 is powered up with PMODE high, Channel 0 is selected. For thermocouple and low level voltage ranges, you can select an input channel using the SEL_CH command. Check the channel address in the ADSTAT byte returned with the data to ensure that the data represents the correct channel. Also

check ADSTAT's Valid Data flag after changing channels. You may have to wait up to two integration times for valid data when changing channels on the same input range. Refer to the COMMAND SET section for more information on SEL_CH.

If the AD1B60 is reset with PMODE low, the input channel is determined by the CH/BR 0–1 pins.

Input Ranges

The AD1B60 supports the input ranges listed in Table III.

If the standard input ranges (numbered 00 through 12 hex) do not meet the requirements of your application, you can download up to two additional user defined custom input ranges into the AD1B60. Custom ranges are generated by the user with the Custom Range Generation Software. Refer to the following subsection for more information on downloading input ranges.

The input range is determined by the R/ADD 4–0 pins when the AD1B60 is reset with PMODE low.

Table III. Input Ranges

Input Range	Range Code (In Hex)
±10 mV	00
±20 mV	01
±50 mV	02
±100 mV	03
±200 mV	04
±500 mV	05
±1 V	06
±2 V	07
±5 V (ATTEN Input)	08
±10 V (ATTEN Input)	09
Type J Thermocouple, 0°C to 760°C*	0A*
Type K Thermocouple, 0°C to 1000°C	0B
Type T Thermocouple, −100°C to +400°C	0C
Type E Thermocouple, 0°C to 1000°C	0D
Type R Thermocouple, 500°C to 1750°C	0E
Type S Thermocouple, 500°C to 1750°C	0F
Type B Thermocouple, 500°C to 1800°C	10
Platinum RTD, 100 Ω, α = 0.00385, −200°C to +800°C	11
Platinum RTD, 100 Ω, α = 0.00392, −200°C to +800°C	12
Not Used	13 to 1D
User Range 1	1E
User Range 2	1F

NOTE
*Default Configuration

The input range is read from EEPROM when the AD1B60 is reset with PMODE high. To change the input range stored in EEPROM, execute the WR_EPM_PARS command. You can also change the input range by using the WR_RAM_PARS command. This command changes the range immediately and does not affect values in EEPROM. You can issue the RD_RAM_PARS command to read the current configuration.

You can use only one input range at a time. When you change the input range, you may have to wait up to 13 integration times to ensure that the output data is valid, as indicated by the Valid Data flag in the ADSTAT byte. Therefore, you should only change the input range in applications having very low bandwidth.

0816800 0044019 345

AD1B60

Downloading User Input Ranges

You can choose up to two additional user defined input ranges to download into the AD1B60's EEPROM at any time. A range is typically generated by a user in order to accept a sensor or input signal not supported by the standard AD1B60 internal ranges or to provide a range that optimizes the output data for easier calculations or other considerations.

Ranges can be simply made by using the IBM PC compatible, Windows version "AD1B60 Custom Range Generation Software." All AD1B60 software is included free of charge with each Evaluation Board.

To download an input range to EEPROM, execute the LOAD_RNG command. You must execute LOAD_RNG eight times to download the entire input range to EEPROM. Refer to the COMMAND SET section for more information on this command.

Reading User-Downloaded Input Ranges

To verify a user-downloaded input range, execute the GET_RNG command. You must execute GET_RNG eight times to read the entire input range from EEPROM.

Integration Time

You can set the integration time used by the AD1B60's A/D converter. The integration time and the input range affect the overall conversion rate. Table IV shows available integration times and the range of corresponding conversion rates, as well as line frequencies that have high normal mode rejection (NMR). Voltage ranges have the fastest conversion rates. Because of the extensive calculation required for linearization and compensation, the conversion rate for Type K thermocouples is the slowest of the AD1B60's standard ranges.

Setting the integration time equal in duration to an integral number of power line cycles will cause high normal mode rejection at the line frequency. The fastest available integration times for 50 Hz and 60 Hz are 40 ms and 33.3 ms, respectively; each time is equal to two power line cycles. The default integration time, 100 ms, is an integral multiple of both power line periods.

You can change the default integration time stored in EEPROM by executing the WR_EPM_PARS command. You can change the integration time without changing values in EEPROM by executing

the WR_RAM_PARS command. You can use the RD_RAM_PARS command to read back the current configuration.

Cold Junction Compensation Mode

The AD1B60 provides four different CJC modes for thermocouple ranges, described in Table V.

You can change the default CJC mode stored in EEPROM by executing the WR_EPM_PARS command.

You can change the CJC mode without changing the EEPROM default by executing the WR_RAM_PARS command. To read the current CJC mode from RAM, execute the RD_RAM_PARS command. To read the current value of the CJC temperature from RAM, execute the RD_CJC command.

RTD Connection Mode

The AD1B60 supports 3-wire and 4-wire RTD connection modes (see Figures 10, 11, and 12); 3-wire is the default configuration.

You can change the default RTD connection mode stored in EEPROM by executing the WR_EPM_PARS command.

You can change the RTD connection mode without changing the EEPROM default by executing the WR_RAM_PARS command. To read back the current configuration stored in RAM, execute the RD_RAM_PARS command.

Table IV. Integration Times

Integration Time	Conversion Rate	High NMR Frequency	AUX Byte Bits B2–B0
200 ms	2.5 per second	50 or 60 Hz	000
100*	5*	50 or 60	001*
60	8.3	50	010
50	9.9	60	011
40	12.3	50	100
33.3	14.8	60	101
5	44† to 87.5‡		110
2	48† to 100‡		111

NOTES
*Default Configuration
†Type K thermocouple with thermistor CJC (mode 00)
‡Voltage range with CJC disabled (Mode 11)

Table V. Cold Junction Compensation Modes

CJC Sensor Type	CJC Mode Description	CJC Excitation Current	Cold Junction Temperature Range	AUX Byte Code, Bits B6–B5
Thermistor*	Direct connection of a 10K3A1 thermistor made by Betatherm (Shrewsbury, Massachusetts, and Galway, Ireland). At +25°C, this thermistor's R = 10 kΩ, alpha = −4.4%/°C, and beta = 3892.	Enabled	−25°C to +70°C	00*
1 mV/K	A 1 mV/K external sensor is connected at the input. This mode allows the use of silicon sensors, such as the Analog Devices AD592 with a 1 kΩ resistor (see Figure 9).	Disabled	−25°C to +85°C	01
Downloaded	A user-defined value of an externally derived cold junction temperature is downloaded over the asynchronous communication port using the WR CJC command.	Disabled	−25°C to +85°C	10
CJC Calculation Disabled	No CJC calculations are performed by the AD1B60. An analog CJC, such as the Analog Devices AC1226, is connected at the input. This type of sensor must be externally configured for the specific thermocouple type.	Disabled	User-defined; must be in −25°C to +85°C range	11

NOTE
*Default Configuration

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REV. A

CONVERSION TIMING AND CONTROL

In normal operation, the Continuous Conversion (CC) Pin is high, and the AD1B60 performs continuous conversions, alternating between signal conversions and background conversions, such as autozero or cold junction compensation (see Figure 2a).

The RDY pin and the Ready flag in the ADSTAT byte are high while the AD1B60 integrates the input signal. The STATUS pin and Status flag in the ADSTAT byte are high while the AD1B60 computes the result of the signal integration. When STATUS goes low, the data is available at the Asynchronous Communication Port. When RDY goes high again for the next signal integration, the data from the prior conversion is available at the Synchronous Data Output Port.

When CC is low, signal conversions are suspended. After CC goes high, a signal conversion will start. This allows synchronizing the conversions to external events, or synchronizing multiple AD1B60s (see Figure 2b). If you communicate with the AD1B60 using the Asynchronous Communications Port, the time spent in communications service may increase the latency between the trigger and the signal conversion.
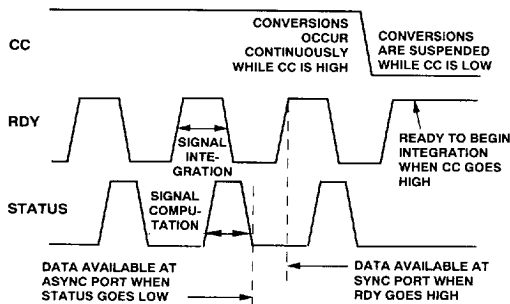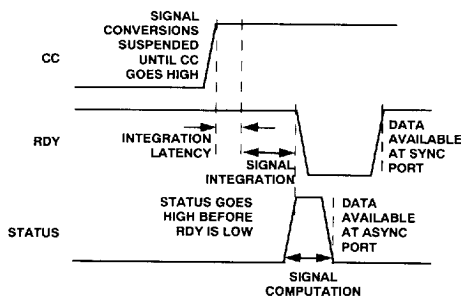

Figure 2a. Continuous Conversion

Figure 2b. Synchronizing Conversion

SERIAL COMMUNICATION PORTS

Asynchronous Communication Port

The asynchronous communication port is a two-wire, half-duplex, input/output port. You can connect the asynchronous port to host systems either at +5 V logic levels or by using external level translation to communication standards such as RS-232 and RS-422. The AD1B60 responds to the commands listed in the COMMAND SET section.

The asynchronous port operates at 2400, 4800, 9600, or 19200 baud using eight data bits, no parity, and one stop bit. Bytes are transmitted least significant bit first.

In Addressed Communications Mode (ACM), the asynchronous port supports device addressing and CRC error checking. Device addressing enables clusters of up to 32 AD1B60s to share a single communication line (see Figure 3). Cyclic Redundancy Codes (CRC) improve communication reliability in noisy environments. The AD1B60 uses CRC-16 ($x^{16} + x^{15} + x^2 + 1$) as a generator polynomial.

ACM is active when the ACM pin is high. When ACM is active, the address and CRC are required to accompany commands to the AD1B60, which will include address and CRC in its response. See the COMMAND PARAMETERS section for details on the format of address and CRC. The address and baud rate are read from either EEPROM or external pins at reset, depending on the state of the PMODE pin.

When the PMODE pin is low at reset, device address and async port baud rate are read from EEPROM, and input range and channel are read from R/ADD and CH/BR pins at reset. When PMODE is high at reset, address and baud rate are read from these pins, input range is read from EEPROM, and input channel is set to 0.
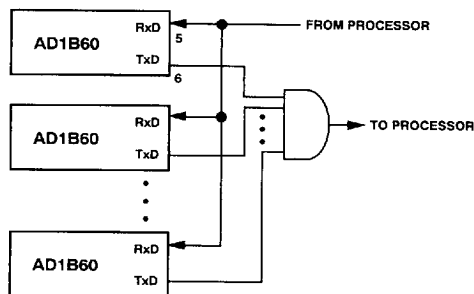
Figure 3. Connecting a Cluster of AD1B60s to a Communication Port

If you intend to use the AD1B60 with a device address or baud rate different from the values in EEPROM, reset the device with PMODE high and the desired address and baud rate selected through the R/ADD and CH/BR pins. You may then load the desired values of device address and baud rate into EEPROM to free these pins for selecting input range and channel.

If a message with an invalid address, command code, or CRC is received by an AD1B60, it will not respond to that message. The host may use a time-out to detect an AD1B60 that does not respond. If the host detects an error from an AD1B60, whether by invalid response or lack of response, it may issue a Break and retry the command.

The AD1B60 will detect Breaks to allow recovery from communications errors. The AD1B60 recognizes a Break when it receives a character with a zero (space) where the stop bit should be. The AD1B60 then resets its communications processes, and is ready to receive the next command. All AD1B60s on a line will recognize a Break.

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AD1B60

Asynchronous communications with the AD1B60 are half-duplex. If a character is sent to an AD1B60 while it is transmitting, it ignores the character and continues transmitting. After its transmission is complete, the AD1B60 is ready to receive the next character.

Synchronous Data Output Port

The synchronous port is a 3-wire data output port. It is independent of the asynchronous port, and both can be accessed simultaneously, if desired.

Using the CS (chip select), CLK (clock input), and DATA (data output) pins of the AD1B60, you can read data at speeds up to 5 Mbps (see Figure 4). When RDY goes high at the beginning of a conversion cycle, the MSB of the previous data word appears at the DATA output (see Figures 2a and 2b). Bringing CS low freezes the data in the synchronous port buffer. Results of other conversions won't be transferred to the synchronous port buffer while CS is low. 15 CLK pulses will read out the remaining bits of the word in the synchronous port buffer. Further CLK pulses will continue to read out the same data bits from this circular buffer.

After all 16 bits are read, CS must be brought high and then low again to read the next word. CS must stay high for a minimum of 400 µs to allow the data buffer to be updated.

The synchronous port sends integer data only, in 16-bit twos complement or offset binary format, depending on the input range (see Table VI).

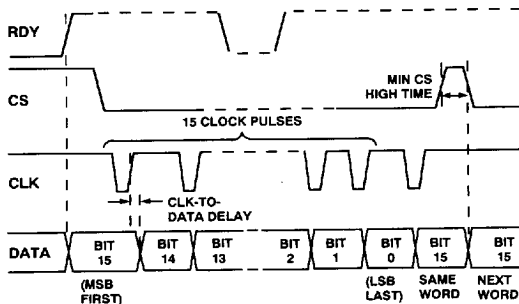If you don't use the synchronous output port, ground the CS and CLK pins to minimize digital noise.

Figure 4. Reading Data from the Synchronous Port

Table VI. Integer Data Output Formats

Voltage Ranges (Twos Complement, in Hex)		Temperature Ranges (Offset Binary, in Hex)	
+Full Scale	7FFF	Top of Span	FFFF
Zero	0000		
Zero −1 LSB	FFFF		
−Full Scale	8000	Bottom of Span	0000

COMMAND PARAMETERS

This section describes the parameters of the AD1B60 commands, which are described in the next section. All values in <angle brackets> and [square brackets] are 8-bit bytes; values in [square brackets] are used only when ACM is active. Numbers followed by H are expressed in hexadecimal (hex) notation.

[Addr] represents the address of the AD1B60. It is required in the command and generated in the response only if ACM is active. Values for [addr] range from 00H to 1FH (0 to 31 decimal). The factory default value is 00H.

<ADSTAT>, shown in Figure 5, represents the status of the AD1B60. Values of ADSTAT range from 00H to FFH. ADSTAT's Valid Data flag and Input Channel should be checked on every measurement reading.

<Aux>, shown in Figure 6, represents the RTD connection mode, CJC mode, and integration time of the AD1B60. Values of <aux> range from 00H to FFH and may be read via the RD_RAM_PARS command.
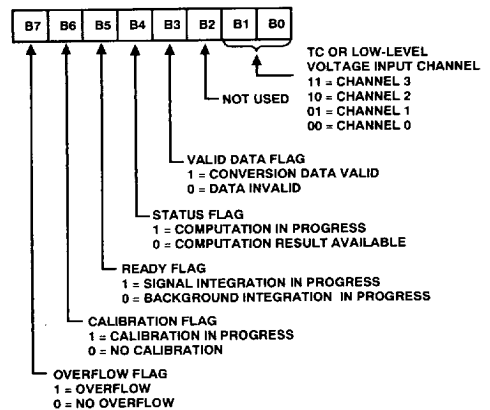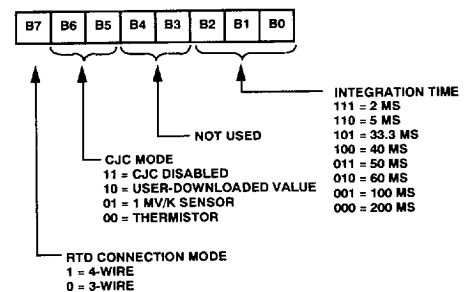

Figure 5. The ADSTAT Byte

Figure 6. The Aux Byte

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Table VII. Baud Rate Codes

Baud Rate	Baud Code (in Hex)
2400	00
4800	01
9600*	02*
19200	03

NOTE
*Default Configuration

<Baud> represents the baud rate code of the AD1B60. Table VII lists the codes associated the available baud rates.

<C0> through <C3> are four bytes that represent the CJC temperature, in ANSI/IEEE 754-single-precision floating-point format, and in degrees C. Values ranges from −25°C to +85°C. For example, in this format, a 25°C is expressed as 41 C8 00 00 (hexadecimal). <C0> contains the least significant byte of the mantissa, or 00H in this example; <C3> contains the sign bit and the 7 most significant bits of the exponent, or 41H in this example.

[CRC1] and [CRC2] represent the CRC-16 error checking value. These arguments are required in the command and generated in the response only if ACM is active. [CRC1] is the LSB; [CRC2] is the MSB.

<Device_addr> represents the new default address for the AD1B60. Values for <device_addr> range from 00H to 1FH (0 to 31 decimal).

<D0> through <D7> comprise an 8-byte segment of the user-selected input range in EEPROM. <D0> is the low order byte; <D7> is the high order byte.

<F0> through <F3> are four bytes that represent the floating-point data, in IEEE 754 standard format. See the description of <C0> through <C3>, above, for information on this format.

<INT_LO> and <INT_HI> represent the lower and upper eight bits, respectively, of the 16-bit integer representation of the data. Values range from 00H to FFH; see Table VI for data formats.

<Range> represents the input range code. Refer to Table III for a list of the available input range codes. The current range may be read via the RD_RAM_PARS command.

<Range_addr> represents the address of the 8-byte segment of the 64-byte input range in EEPROM. Range addresses 00H to 07H correspond to the eight, 8-byte segments of User Range 1 (code 1EH); range addresses 08H to 0FH correspond to the eight, 8-byte segments of User Range 2 (code 1FH).

COMMAND SET
The AD1B60 commands allow you to configure the AD1B60, read converted data and status information, and calibrate input ranges over the asynchronous port. This section describes the commands in detail.

Configuration Commands
The AD1B60 Command Set provides the configuration commands listed below. Note that the data written into RAM by WR_RAM_PARS, WR_CJC, and SEL_CH will be cleared at power-up and reset.

● **RD_RAM_PARS**
Reads back the current value of the configuration parameters from RAM.

Command Syntax
[addr] <02H> [CRC1] [CRC2]

Response Syntax
[addr] <02H> <range> <aux> [CRC1] [CRC2]

● **WR_RAM_PARS**
Writes new values of the configuration parameters in RAM. These values take effect immediately and do not change the default values in EEPROM.

Command Syntax
[addr] <04H> <range> <aux> [CRC1] [CRC2]

Response Syntax
[addr] <04H> [CRC1] [CRC2]

● **WR_EPM_PARS**
Writes new values of the configuration parameters in EEPROM. The new values do not change currently selected values in RAM and only take effect when the AD1B60 is powered up or reset.

Command Syntax
[addr] <05H> <range> <aux> <device-addr> <baud> [CRC1] [CRC2]

Response Syntax
[addr] <05H> [CRC1] [CRC2]

● **GET_RNG**
Reads an 8-byte segment of a downloadable input range from EEPROM. See LOAD_RNG, below.

Command Syntax
[addr] <07H> <range-addr> [CRC1] [CRC2]

Response Syntax
[addr] <07H> <D0> <D1> <D2> <D3> <D4> <D5> <D6> <D7> [CRC1] [CRC2]

● **LOAD_RNG**
Writes an 8-byte segment of a downloadable input range into EEPROM. LOAD_RNG and GET_RNG must be executed 8 times to write or read an entire 64-byte range. Each successive time, <range-addr> must increment by 1 to address the next segment.

Command Syntax
[addr] <08H> <range-addr> <D0> <D1> <D2> <D3> <D4> <D5> <D6> <D7> [CRC1] [CRC2]

Response Syntax
[addr] <08H> [CRC1] [CRC2]

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AD1B60

● **RD_CJC**

Reads the current value of the CJC temperature in RAM, in °C. This value may have been measured by a thermistor or mV/K sensor, or loaded via a WR_CJC command.

Command Syntax
[addr] <03H> [CRC1] [CRC2]

Response Syntax
[addr] <03H> <C0> <C1> <C2> <C3> [CRC1] [CRC2]

● **WR_CJC**

Downloads to RAM a CJC temperature in °C, obtained from an external source. Only used in Downloaded CJC mode (mode 10).

Command Syntax
[addr] <06H> <C0> <C1> <C2> <C3> [CRC1] [CRC2]

Response Syntax
[addr] <06H> [CRC1] [CRC2]

● **SEL_CH**

Selects an input channel on the AD1B60 and stores the channel address in RAM. This command is not meaningful if the PMODE pin is low, or if the input range is RTD or attenuator; for these ranges, the channel is selected automatically.

Command Syntax
[addr] <0AH> <chan> [CRC1] [CRC2]

Response Syntax
[addr] <0AH> <chan> [CRC1] [CRC2]

Read Data Commands

The AD1B60 Command Set includes the following read data commands:

● **RD_INTDATA**

Reads converted data, in 16-bit integer format (see Table VI), and the conversion status.

Command Syntax
[addr] <00H> [CRC1] [CRC2]

Response Syntax
[addr] <00H> <INT_LO> <INT_HI> <ADSTAT> [CRC1] [CRC2]

● **RD_FPDATA**

Reads converted data, in IEEE 754 floating point format and engineering units, and the conversion status.

Command Syntax
[addr] <01H> [CRC1] [CRC2]

Response Syntax
[addr] <01H> <F0> <F1> <F2> <F3> <ADSTAT> [CRC1] [CRC2]

Calibration Command

● **CAL**

Performs a calibration cycle for parameters related to the configured input range. See the Calibration section below.

Command Syntax
[addr] <09H> <09H> [CRC1] [CRC2]

Response Syntax
[addr] <09H> <09H> [CRC1] [CRC2]

CALIBRATION

The AD1B60 is calibrated with its internal reference at the factory prior to shipment. You can also calibrate the AD1B60 in your application, if desired. You should calibrate the AD1B60 if you use an external reference.

Calibrating the AD1B60 requires a precision reference excitation source for different input ranges. The accuracy of the AD1B60 depends on the accuracy of the calibration source. For best performance, calibrate the AD1B60 using the maximum integration time of 200 ms.

Note that calibrating certain input ranges, such as thermocouple ranges, depends on the prior calibration of one or more voltage ranges. Therefore, to properly calibrate all the input ranges and channels of the AD1B60, perform the following procedure for each step of the calibration sequence:

1. Using the WR_RAM_PARS command, configure the AD1B60 for the appropriate range listed in Table VIII. For example, in the first step of the calibration sequence, set the input range to ±2 V.

2. Apply the reference excitation specified for the input range, listed in Table VIII. For example, in the first step of the calibration sequence, apply a +2.00000 V excitation to channel 0.

3. Issue RD_FPDATA or RD_INTDATA commands and observe the readings. Allow the excitation source to stabilize, and check that the Valid Data flag in the ADSTAT byte is high.

4. Execute the CAL command.

5. Wait until the CAL flag in ADSTAT goes low.

6. Repeat operations 1 through 5 above, using the input ranges and reference excitations, listed in Table VIII, for the next step of the calibration sequence.

Note that you must complete Steps 1 through 8 in Table VIII. However, if your application does not require the attenuator input, you can skip Step 9. If your application does not require thermocouples, you can skip Step 10. If your application does not require RTDs, you can skip Step 11.

RESETTING THE AD1B60

The AD1B60 generates a reset signal (RESETO) at power-up, on detecting a low supply voltage (brown-out), or on missing an internal watchdog pulse. In normal operation, RESETO is tied to the reset input (RESETI). An external active-high reset signal may be used instead of, or in addition to, RESETO. Figure 7 shows how to OR internal and external signals to control RESETI.
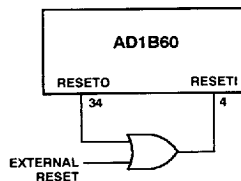

Figure 7. Resetting the AD1B60

Table VIII. Input Ranges and Reference Excitations for Each Iteration of the Calibration Sequence

Step	Input Range	Range Code	Reference Excitation	Channel to Which Reference Excitation Is Applied
1	±2 V	07	+2.00000 V	CH0 to Analog Gnd
2	±1 V	06	+1.00000 V	CH0 to Analog Gnd
3	±500 mV	05	+0.50000 V	CH0 to Analog Gnd
4	±200 mV	04	+0.20000 V	CH0 to Analog Gnd
5	±100 mV	03	+0.10000 V	CH0 to Analog Gnd
6	±50 mV	02	+50.000 mV	CH0 to Analog Gnd
7	±20 mV	01	+20.000 mV	CH0 to Analog Gnd
8	±10 mV	00	+10.000 mV	CH0 to Analog Gnd
9	±10 V	09	+10.00000 V	Attenuator Input to Analog Gnd
10	Type J Thermocouple	0A	100.000 kΩ	CJC Input to Analog Gnd
11	100 Ω Pt. RTD, $\alpha = 0.00385$	11	250.000 Ω	250 Ω Reference Resistor Substituted for 4-Wire RTD (See Figure 10)

5

TYPICAL INPUT CONNECTIONS

Thermocouple Input Connections

Figure 8 shows the AD1B60 connections required for a typical, single thermocouple input. In this example, a thermistor CJC sensor is used; the AD1B60 provides the CJC sensor excitation current. The EXCIT output can be used to source current, nominally 10 nA, for open-circuit detection.

Figure 9 shows how four thermocouples may be connected, using a 1 mV/K CJC sensor. All thermocouple inputs must share a common ground.
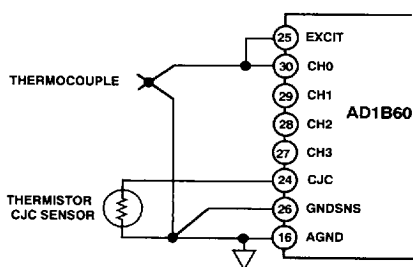

Figure 8. Typical Single-Channel Thermocouple Connection (with Thermistor CJC)
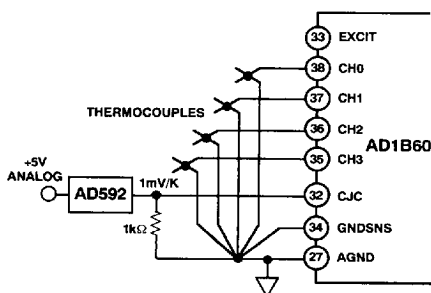
Figure 9. Typical Four-Channel Thermocouple Connection (with AD592 CJC)

Using the CJC Pin as a Digital Output

The CJC pin is normally used as an analog input for cold-junction compensation of thermocouples. When thermistor CJC mode is selected, this pin also outputs an excitation current (nominally 20 μA) for the CJC sensor. In other CJC modes, this output is switched off.

If thermocouples are not being used, the CJC pin may serve as a digital output. This may be especially useful if the AD1B60 is isolated, since providing an isolated control line by other means would be costly.

By placing a 330 kΩ resistor to AGND from this pin, a logic voltage can be generated (see Figure 11). The level can be switched from high (about +4 V) to low (AGND) by changing the CJC mode from thermistor (00) to any other, using the WR_RAM_PARS command.

RTD Input Connections

Typical 3-wire and 4-wire RTD input connections are shown in Figure 10. The EXCIT output supplies 200 μA excitation to the RTD. To maintain high accuracy, lead resistances must match and be less than 20 Ω for 3-wire RTDs, and must be less than 40 Ω for 4-wire RTDs. The 10 kΩ resistor in series with the excitation current source is not required, but will reduce power dissipation and self-heating errors in the AD1B60.

Two RTDs can be multiplexed using the CJC pin as a control line to select between them, as described in the previous subsection. Figures 11 and 12 show multiplexed 3-wire and 4-wire RTDs.

Figure 10. Typical Single-Channel RTD Connection

Figure 11. Typical Multiplexed 3-Wire RTD Connection

Figure 12. Typical Multiplexed 4-Wire RTD Connection

Figure 13. Typical Multiple-Channel Low Level Voltage Input
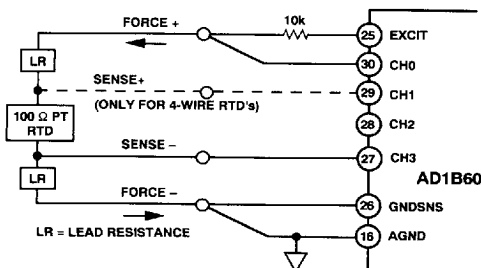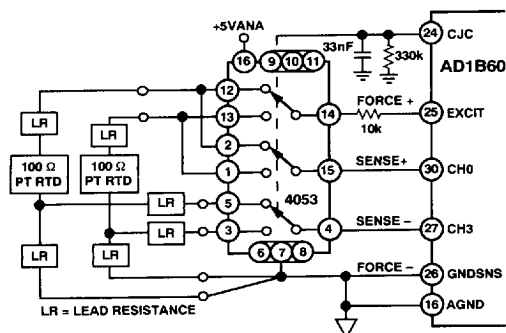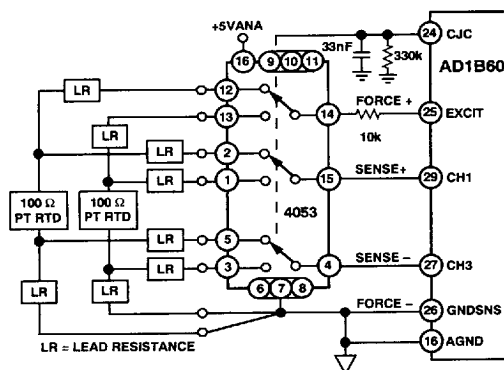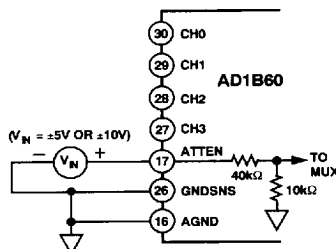

Figure 14. Typical High Level Voltage Input Connection

Low Level Voltage Input Connections

Single channel input connections for low level voltages of up to ±2 V are similar to those of thermocouple input connections, except that no CJC sensor is required. When connecting multiple-channel, low level voltage inputs, all four inputs must share a common ground, as shown in Figure 13. For fastest response when switching between channels, all inputs must share the same input range.

High Level Voltage Input Connections

High level voltages must be connected to the Attenuator pin. An internal 5:1 attenuator scales down high level voltage inputs of ±5 V or ±10 V to levels compatible with the AD1B60's front-end circuitry. Figure 14 shows a typical connection for a high level voltage input.

Input Protection

Inputs that are subject to large transient voltages require protection. For example, inputs should be protected if they connect to sensors through several hundred feet of wiring that may pick up electrical noise or if they may be connected accidentally to power lines. Such inputs should use series resistors to limit input currents and diodes to clamp transient voltages (see Figure 15).

The EXCIT, CH0-CH3, and GNDSNS pins may be subject to large transients and hence may require protection. The ATTEN

pin has an internal 40 kΩ resistor, and does not require an external resistor; however, clamp diodes may be required. Generally, the CJC, AGND, and other pins are connected only locally and don't require protection.

Any mismatch in input resistance between an input channel and GNDSNS will be multiplied by the input bias current (3 nA max) and create an apparent input offset voltage. For example, 50 kΩ, 1 % resistors may mismatch by as much as 1 kΩ, resulting in a 3 μV input offset. The resistor used to protect the EXCIT pin may be much larger, since the thermocouple open-circuit detection current is only 10 nA. A 1 MΩ resistor will cause a drop of 10 mV.

Figure 15. Typical Input Protection Circuitry

The AD1B60 side of the resistors must be clamped to suitable voltages, such as the supply rails (see the Absolute Maximum Ratings). Use low leakage, low capacitance diodes, such as diode-connected J201 JFETs. Note that the diodes' leakage current will flow through the protection resistors and create an off-set voltage.

The resistors must be able to withstand the worst-case expected fault voltage, the clamp diodes must be able to pass the worst-case fault current, and the clamp voltages (e.g., the power supplies) must be able to absorb the fault current.

For a fully protected system, you must isolate the AD1B60 from ground. You may do so by using optoisolators on the communications port (RXD and TXD pins) and a dc-to-dc converter for the power supplies.

GENERAL CIRCUIT CONSIDERATIONS
In any system including logic and low level analog signals, care

must be taken in the layout and bypassing of the components. Bypass the analog and digital supplies close to the package pins, with a 1.0 μF or 4.7 μF tantalum capacitor in parallel with a 0.1 μF ceramic capacitor. Keep analog and digital grounds separate except at a single common point. Minimize stray capacitance between digital signals and any analog signal, including analog common. All analog grounds should be connected in a star pattern to a single point.

The integrating capacitor, C_{INT}, should be ceramic and of good quality (X7R dielectric or better). If the synchronous output port is not used, connect CS and CLK to DGND to minimize digital noise.

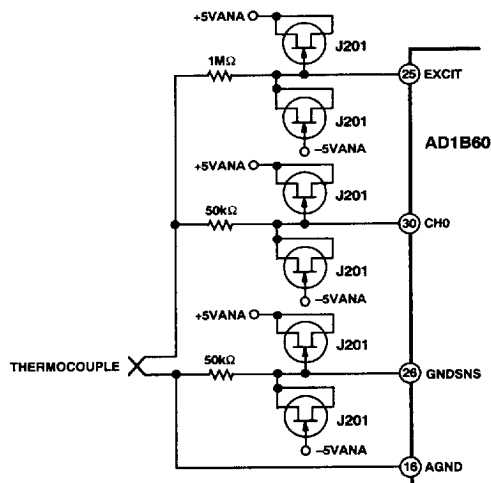Figure 16 shows a typical hookup for the default configuration parameters: Type J thermocouple with thermistor CJC and device address 0. The AD232 translates between the TTL levels of the AD1B60 and RS-232 levels for the asynchronous I/O port.

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Figure 16. Typical Input and Output Connections for Thermocouple Application

EVALUATION BOARD
The AD1B60/EB evaluation board contains an AD1B60 and support circuitry which allows you to evaluate its functionality and performance using an IBM PC via an asynchronous RS-232 communications port (COM1 or COM2 only).

Included with the evaluation board is an AD1B60BJ device, Evaluation Board User's Manual, 3.5″ diskette with the AD1B60 Demonstration Program for PC-DOS and a free copy of the AD1B60 Custom Range Generation Software for Windows.

The menu-driven Demonstration Program allows you to configure and read data from the AD1B60. The Custom Range Generation Software allows generation of user defined ranges specific to your application without additional assistance required from Analog Devices. These range files may be downloaded into the EEPROM of the AD1B60 as required to optimize its performance in your specific application.