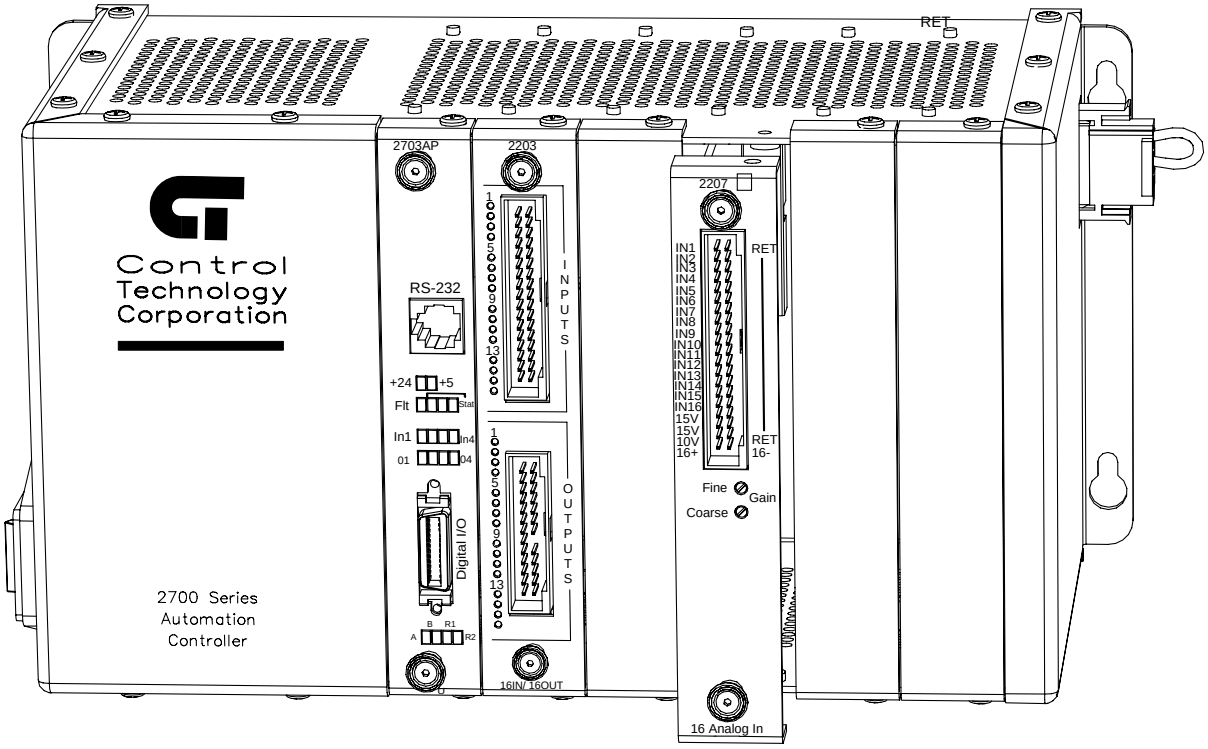
Model 2207 16-Channel Analog Input Module Installation Guide



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Notes to Readers

The *Model 2207 Installation Guide* provides the following information:

- System Overview -- describes the 2207's basic features.
- Description and Connection Diagrams -- an overview of the 2207's basic functions; pinout diagram for its analog input connector.
- Specifications -- general specifications; hardware and firmware revision levels.
- Board Handling Precautions-- contains general guidelines on handling printed circuit boards with ESD devices.
- Installation -- describes how to install the 2207 module in a CTC controller.
- Jumper Configuration -- shows the jumper locations and their function.
- Applications Guide -- contains technical information on the 2207's analog input features; describes how to use the differential amplifier; discusses how to interface with the 4-20 mA current loop signal; shows connection diagrams for various types of signals.

Related Documents

The following documents contain additional information:

- For information on Quickstep, refer to the *Quickstep™ Language and Programming Guide* or the *Quickstep™ User Guide.*
- For information on the registers in your controller, refer to the *Register Reference Guide* (available at www.ctc-control.com).
- For information on Microsoft Windows or your PC, refer to the manuals provided by the vendor.

Formatting Conventions

The following conventions are used in this book:

ALL CAPS BOLDFACE	Identifies DOS, Windows, and installation program names.
Boldface	Indicates information you must enter, an action you must perform, or a selection you can make on a dialog box or menu.
Italics	Indicates a word requiring an appropriate substitution. For example, replace *filename* with an actual file name.
Text_Connected_With_Underlines	Indicates symbolic names used in Quickstep programs. Step Names are ALL_CAPITALS. Other symbolic names can be Initial_Capitals or lower_case.
SMALL CAPS	Identifies the name of Quickstep instructions in text.
`Courier font`	Identifies step names, comments, output changes, and Quickstep instructions appearing in the Quickstep editor.
Art Code 2217F1	Identifies the file name of a particular graphic image.

Contacting Control Technology Corporation

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Your Comments

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System Overview

The Model 2207 is a 16-channel analog input module that provides a low-cost solution for applications such as data logging and statistical process control. The inputs each have a resolution of 0.1% (1 part in 1000, or 10-bit resolution). Several additional features greatly enhance the module's flexibility and allow it to accommodate current-loop devices and low-level signals without adding external components.

Opto-isolated Inputs

The inputs are opto-isolated from both the controller's logic circuitry and from the power line ground, which greatly reduces the occurrence of unintended ground loops. These loops can inject considerable noise into your readings.

Reduced System Complexity

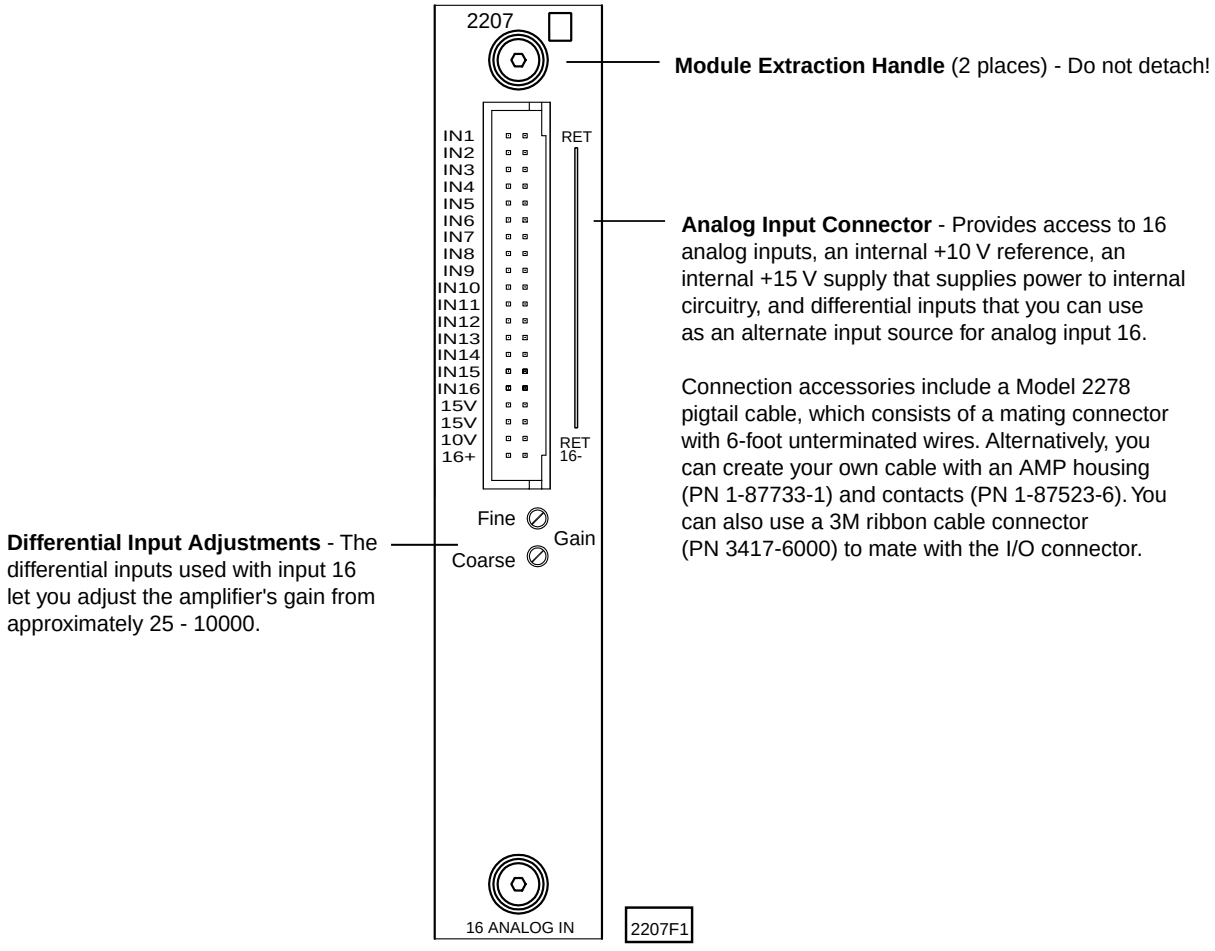
The 2207 has integral-dropping resistors that are jumper-selectable for each channel. This allows the module to interface with sensors that provide 4-20 mA current loop signals. These resistors join with the on-board 15 VDC supply in accommodating up to 5 of these sensors without requiring external circuitry.

The module also contains a differential amplifier on input 16 that you can use for low-level, strain-gauge signals. This amplifier has an adjustable gain of approximately 25 - 10000 and can directly connect to many types of pressure transducers and load cells. Coarse and fine gain adjustments are made with the two potentiometers located on the module's front panel. These adjustments let you tailor the amplifier to a specific transducer. In addition, you can use the on-board 10V reference supply as the excitation source for the transducer, which eliminates the need for external interfacing components.

2207 Description

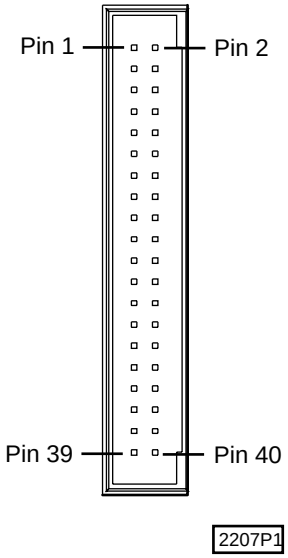
Figure 1 shows the 2207's faceplate and describes its different features.

Figure 1. 2207 Faceplate and Features



2207 Connection Diagram

Table 1. Connection Diagram - Analog Input Connector

Analog I/O Connector	Pin #	Signal	Pin #	Signal
	1	Input 1	2	Return
	3	Input 2	4	Return
	5	Input 3	6	Return
	7	Input 4	8	Return
	9	Input 5	10	Return
	11	Input 6	12	Return
	13	Input 7	14	Return
	15	Input 8	16	Return
	17	Input 9	18	Return
	19	Input 10	20	Return
	21	Input 11	22	Return
	23	Input 12	24	Return
	25	Input 13	26	Return
	27	Input 14	28	Return
	29	Input 15	30	Return
	31	Input 16	32	Return
	33	+15 VDC	34	Return
	35	+15 VDC	36	Return
	37	+15 VDC	38	Return
	39	Diff (+)	40	Diff (-)

Specifications

Table 2. General Specifications

Description	Min.	Typical	Max.	Units
Power Supply Requirements				
Logic Supply (5 V)		240.0	300.0	mA
Auxiliary Supply (24 V)		25.0	150.0	mA
Absolute Maximum Ratings				
Ambient Temperature				
Operating	0		+50	°C
Storage	-20		+80	°C
Applied Input Voltage	0 [1]		35	VDC
Output Current				
+10 V Reference			15	mA DC
+15 V Supply			100	mA DC
Operating Characteristics				
Input Characteristics - Normal Mode				
Nominal Sensing Range	0 [1]		10	VDC
Resolution		0.01		VDC
Accuracy		± 0.01	± 0.03	VDC
Input Current		0.01	1.0	µA DC
Input Characteristics - Differential Mode				
Common Mode Voltage Range		0	6	VDC
Nominal Gain Adjustment Range	25		10000	
Input Impedance		20		kΩ
+10 V Reference Accuracy		± 5	± 10	mVDC

1. Do not apply a negative voltage or erroneous readings may result.
2. The specifications listed above are at 25°C, unless otherwise specified.

Table 3. Hardware / Firmware Revision Levels

Model Numbers	Hardware Revision Level	Firmware Revision Level [1] [2]
2207	B	2.2
2200 Series	0	6.0
2600 Series	C	1.0
2700 Series	C	2.10

1. You can confirm firmware revision levels by doing a register read in Quickstep's monitor program. Use register 13003 to confirm the firmware revision in a 2600/2700 series controller.
2. Firmware revision levels are not equivalent to standard decimal numbers. For example, firmware revision level 2.10 translates to:

   Major Revision Level 2
   Major Revision Level 10

   If this value changes to 2.20, it translates to
   :
   Major Revision Level 2
   Major Revision Level 20 (not revision level 2)

Board Handling Precautions

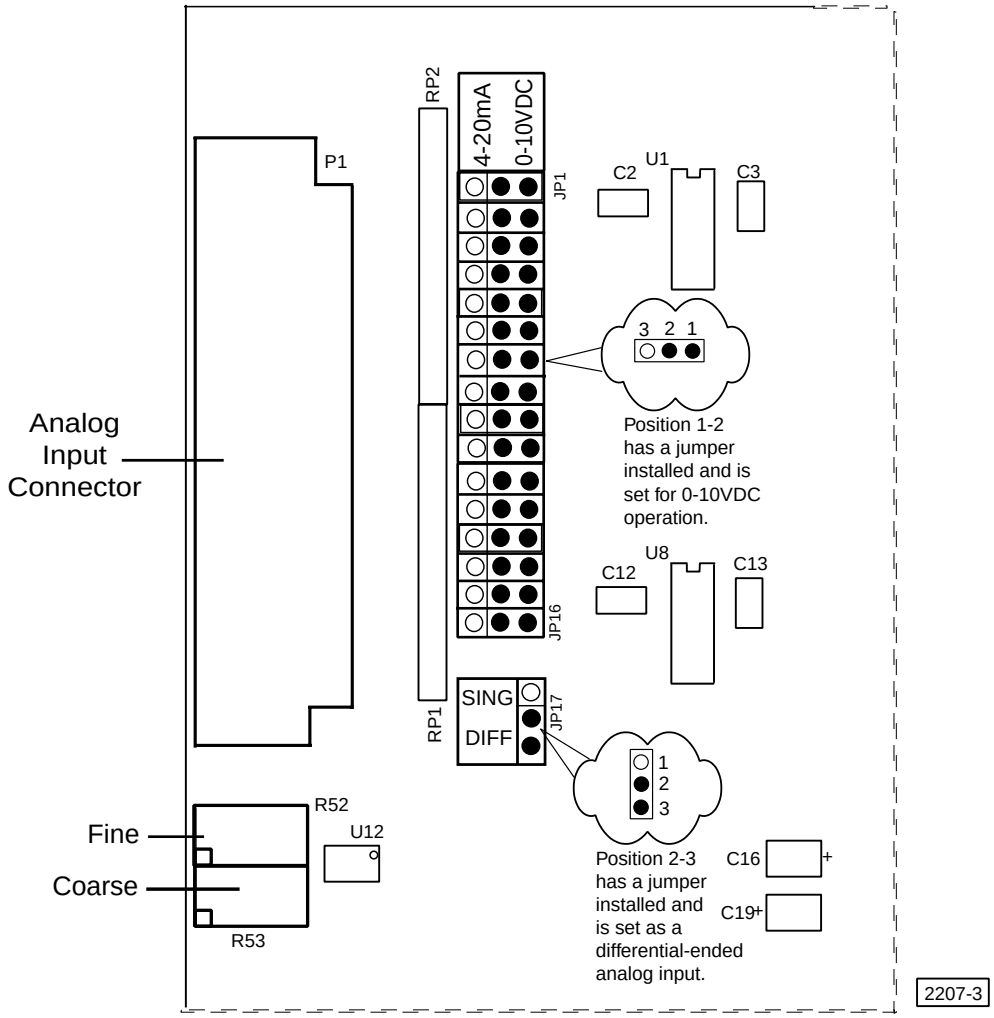
The module's printed circuit board contains electrostatic discharge sensitive (ESD) devices. Improper board handling could result in damage to the board. The following precautions are recommended when handling the board or before inserting it into the controller:

- Make sure you are grounded electrically by using a wrist strap connected to an electrically grounded workstation or by physically touching the controller case or something electrically connected to the controller case.
- Avoid touching the leads or contacts of the circuit board and handle the board by its edges only.
- Transport circuit boards in protective, anti-static bags, bins, or totes. Do not insert boards into materials such as plastic, polystyrene foam, clear plastic bags, bubble wrap, or plastic trays.

2207 Jumper Configuration

Figure 2 shows the jumper locations on the 2207 board. Additional information on these jumpers is listed in Table 4. Table 5 lists the various versions of the 2207 module and the resistor that is installed with each version.

Figure 2. 2207 Jumper Configuration Diagram



NOTE: This drawing only shows a partial view of the board and is not drawn to scale. Several components are included to help identify jumper locations.

Table 4. 2207 Jumpers - Position and Function

Jumper Number	Position		Function
JP1-JP16	1-2 (Right)		0-10 VDC analog input
	2-3 (Left)		4-20 mA analog input [1]
JP17	1-2 (Up)		Single-ended analog input
	2-3 (Down)		Differential-ended analog input

1. The 2207 module uses a resistor to convert 4-20 mA signals into voltages you can read. Refer to Table 5 for the voltage ranges you will see with different model numbers.

Table 5. 2207 Model Numbers and Resistor Values for 4-20 mA Inputs

Model Number	Resistor Value	Analog Input Reading
2207	100 Ω	400 - 2000 mV
2207A	470 Ω	1880 - 9400 mV
2207B	220 Ω	880 - 4400 mV

Installing the 2207 Module

The module fits into one of the slots of your automation controller (Figure 3). You can insert any combination of modules into the controller (subject to system limits) and can install them in any order. This is possible because the controller's CPU dynamically assigns such items as motor numbers, input numbers, and output numbers each time power is re-applied to the controller. These numbers are assigned from left-to-right across the controller. To install a module into the automation controller:

Note

Retain all hardware removed during this procedure.

1. Remove all AC and DC power, including any external supplies connected to the controller.

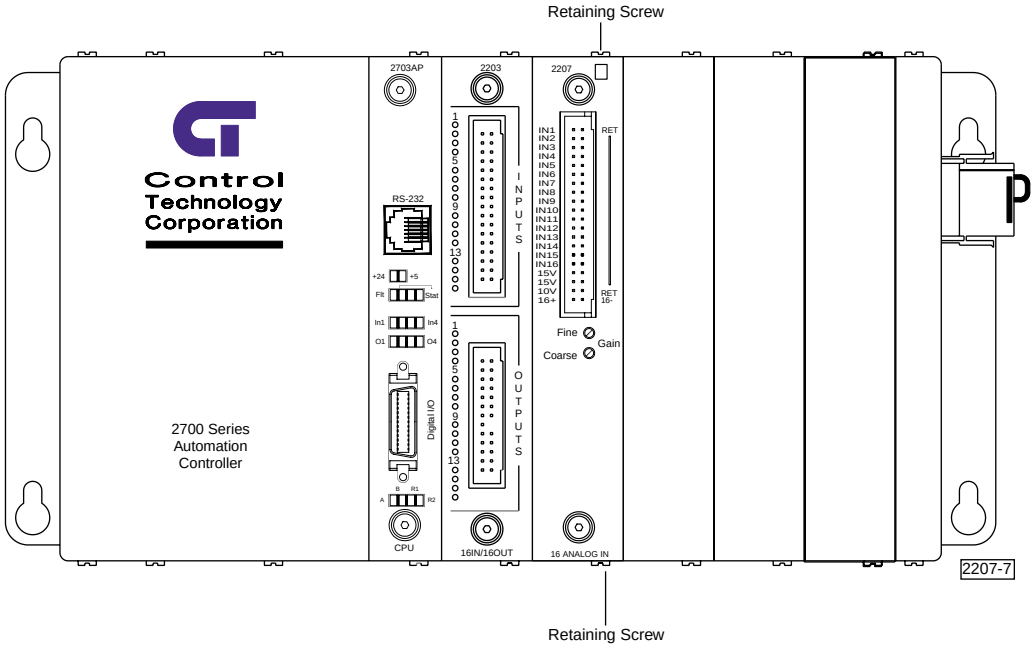
2. Locate an unused slot and remove two retaining screws from the top and bottom of its cover plate.

3. Slide the module into the slot and make sure that the circuit board slides into the nylon guides at the top and bottom of the controller case. Make sure that the card is oriented properly so that its labels are right-side-up.

4. Press the module firmly into the controller. Make sure that the module's faceplate is flush with the adjacent sheet metal surface.

5. Re-install two retaining screws in the top and bottom of the new module.

Figure 3. 2700AP Series Controller with the 2207 module installed in the right-hand slot



Applications Guide

This section describes how to take full advantage of the 2207's capabilities. If your application is unusual or you need help in connecting a specific type of sensor, please contact CTC Technical Support for assistance.

Overview

Analog sensing presents a difficult challenge in an industrial environment. Analog inputs add a valuable extension to a controller's sensing capabilities when they are used properly. If they are applied correctly, they allow you to make accurate and repeatable measurements of physical variables. However, improper use can lead to grossly erroneous readings caused by ground currents, electrical noise, and resolution-induced errors.

Types of Analog Signals

Analog signals carry information that typically represent a physical variable such as temperature or pressure. This information is represented by a voltage or current level that is proportional to the physical variable being measured.

There are a wide variety of transducers that produce analog output signals. These include such items as pressure transducers, load cells, thermocouples, potentiometers, and potentiometric sensors. Unfortunately, these sensors have output signals that differ greatly from one another. In many cases, you have to pre-condition or amplify the signals before connecting to the 2207 module.

How Resolution Affects Sensing

Any system that accepts an analog signal and converts it into digital information has fundamental resolution, which is the smallest change that the system (2207) can sense. The 2207 is able to sense a 10 millivolt (0.01V) nominal change in an input signal over a range of 0-10 volts. Therefore, the 2207's resolution is 1 part in 1000, or 0.1%.

Note

If your transducer makes full use of the 2207's 0-10 V range, you have a better chance of sensing small changes in the physical variable being measured. Keep this in mind when you select a transducer.

Certain types of transducers, such as thermocouples and LVDTs, produce extremely low-level signals. Since their full-scale range is on the order of 1-10 millivolts, it is impossible to directly read their signals with the 2207's conventional inputs. In this situation, you must amplify these low-level signals to a reasonable sensing level. Various external modules are available to perform this function:

- Analog Devices of Norwood, MA (www.analog.com)
- Omega of Stamford, CT (www.omega.com)

Some transducer manufacturers are able to provide suitable amplification for their products. In any case, you will achieve better results if you can closely match the 2207's full 0-10V range.

The Importance of External Ground Paths

One of the most common errors made in analog measurements is an inappropriate ground path that creates current flow through the wires carrying an analog signal. This current flow creates a voltage drop as it passes through the resistance of the wire and this drop appears as an error voltage that is superimposed on the analog signal.

The 2207's input circuit has been carefully designed with a high input impedance. This drastically reduces the current that flows through the circuit (< 0.01 µA) and any error that is introduced is very slight. The benefit of having such a high impedance will be lost if the "grounds" are mismatched because it can cause current to flow in the "return" wire that carries the common reference point for the analog signal.

The 2207's analog inputs are isolated from ground, so it is relatively easy to avoid problems. You should completely isolate your analog transducer from ground to prevent ground currents from affecting your analog reading. This isolation should also avoid any DC (resistive) or AC (capacitive) coupling to either electrical ground or to other system components. If you connect to ground, you should connect in one place only and make the connection as close to the transducer as possible. These measures will help prevent ground currents from flowing through the same wires that carry the analog signal.

Note

Use shields carefully and only terminate them at one end of a cable. Terminating the shield on both ends may cause ground currents to flow through the shield and could also result in the coupling of noise currents to the conductors within the shield.

Using the Differential Amplifier

Input 16 has an integral amplifier that you can activate with a jumper, which is useful when you require signal amplification. This amplifier provides differential inputs for sensing strain-gauge type signals and has an adjustable gain ranging from approximately 25-10000. This is suitable for devices whose output is 25-30 mV full scale.

You can use the differential amplifier by moving a jumper (JP17) on the 2207's circuit board. This jumper switches the source for input 16 from pin 31 of the analog input connector to the differential amplifier's output. Change the jumper position as follows:

1. Remove the module by reversing the assembly instructions outlined in *Installing the 2207 Module*. Handle the board carefully and use the suggestions listed under *Board Handling Precautions*.
2. Locate JP17 as shown in Figure 2.
3. Move the jumper to the position marked **DIFF** on the board.
4. Re-install the module as instructed in *Installing the 2207 Module*.

Note

Once the module is configured as a differential amplifier, you cannot use pin 31 for input signal connections because this pin has no internal connections to the analog input.

Adjusting the Gain

The amplifier's adjustable gain provides a way of matching your transducer's operating range to the 2207's full-scale input range (0-10 V). Use this feature to take advantage of the module's full resolution and accuracy. Try to adjust the gain when your transducer's output is full-scale. Since this is not always possible, you may have to settle for a proportionately lower signal level.

Note

The gain adjustment controls are located on the 2207's front panel.

Set the **FINE** adjustment to approximately half-scale and the **COARSE** adjustment as close to the desired gain value as possible. You can then use the **FINE** adjustment control to fine-tune your gain.

In summary, you should adjust the gain to produce an analog reading (as seen with Quickstep's diagnostic provisions) of the desired magnitude with a full-scale transducer signal applied. You can then verify any intermediate signal levels with Quickstep.

Interfacing a 4-20 mA Current Loop Signal

Some sensors produce an output signal as variable current instead of variable voltage. A 4-20 mA current signal is an industry standard and many transducers are available that produce signals in this range.

You can sense these signals by creating a current loop. This type of circuit contains a power source, a current regulator (the transducer), and a way to sense the current (the analog input). Most transducers of this type also draw their power (for their own internal circuitry) from the current that flows through the signal loop. They accomplish this by creating a voltage drop that is large enough to power the transducer.

You can configure the 2207's analog inputs to interface with such a current loop by changing jumper settings (JP1-JP16). Jumpers JP1-JP16 are shown in Figure 2. They are arranged from top to bottom and represent analog inputs 1-16 respectively.

Note

You can use the 2207's internal power supply to provide power to the current loop circuitry.

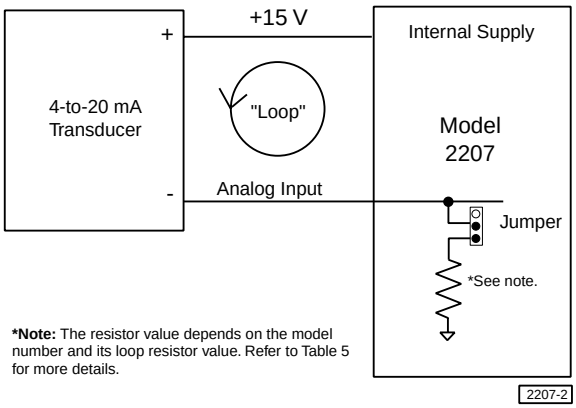
Select a specific output for current loop operation by moving its jumper to the left. This inserts a loop resistor between the analog input and the internal analog "return". The loop resistor's ohm value is determined by the version of the 2207 module used in your application. Refer to Table 5 for model numbers and resistor values.

Once this is accomplished, you can then connect a current-loop sensor to the analog input. This sensor is powered by the 2207's 15 V supply (+ connection on the sensor), which is accessed through pins 33 and 35. The return for the sensor (- connection) is connected directly to the analog input. Figure 4 outlines this setup. As the sensor measures a controlled amount of current through the current loop, the resulting voltage drop across the internal resistor will vary.

Note

Make sure that the transducer's specifications are compatible with the 2207.

Figure 4. 4-20 mA Current Loop Signal Setup



Connecting and Programming Analog Inputs

The 2207's analog inputs are opto-isolated from the controller's CPU logic circuitry. This reduces ground-looping and increases noise immunity. Figures 5 through 7 show wiring configurations for a differential signal, a single-ended signal, and a potentiometer.

Figure 5. Connecting a Differential Signal

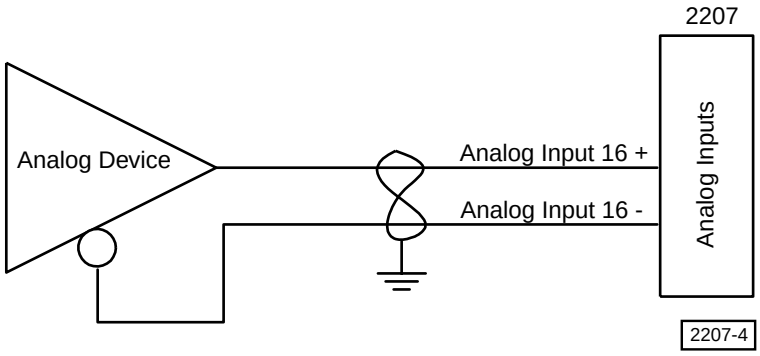


Figure 6. Connecting a Single-Ended Signal

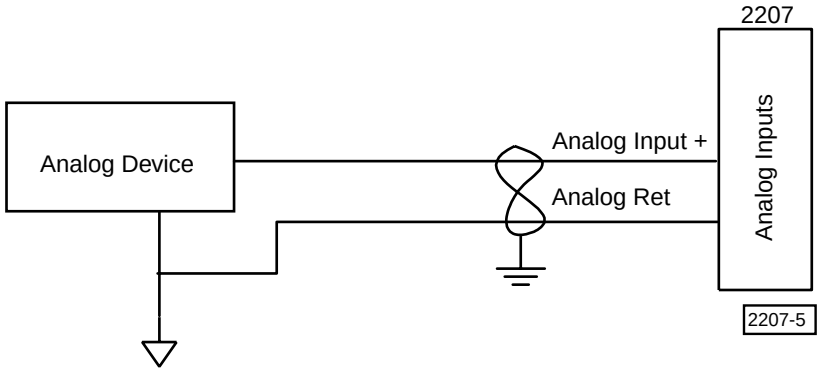


Figure 7. Connecting to a Potentiometer