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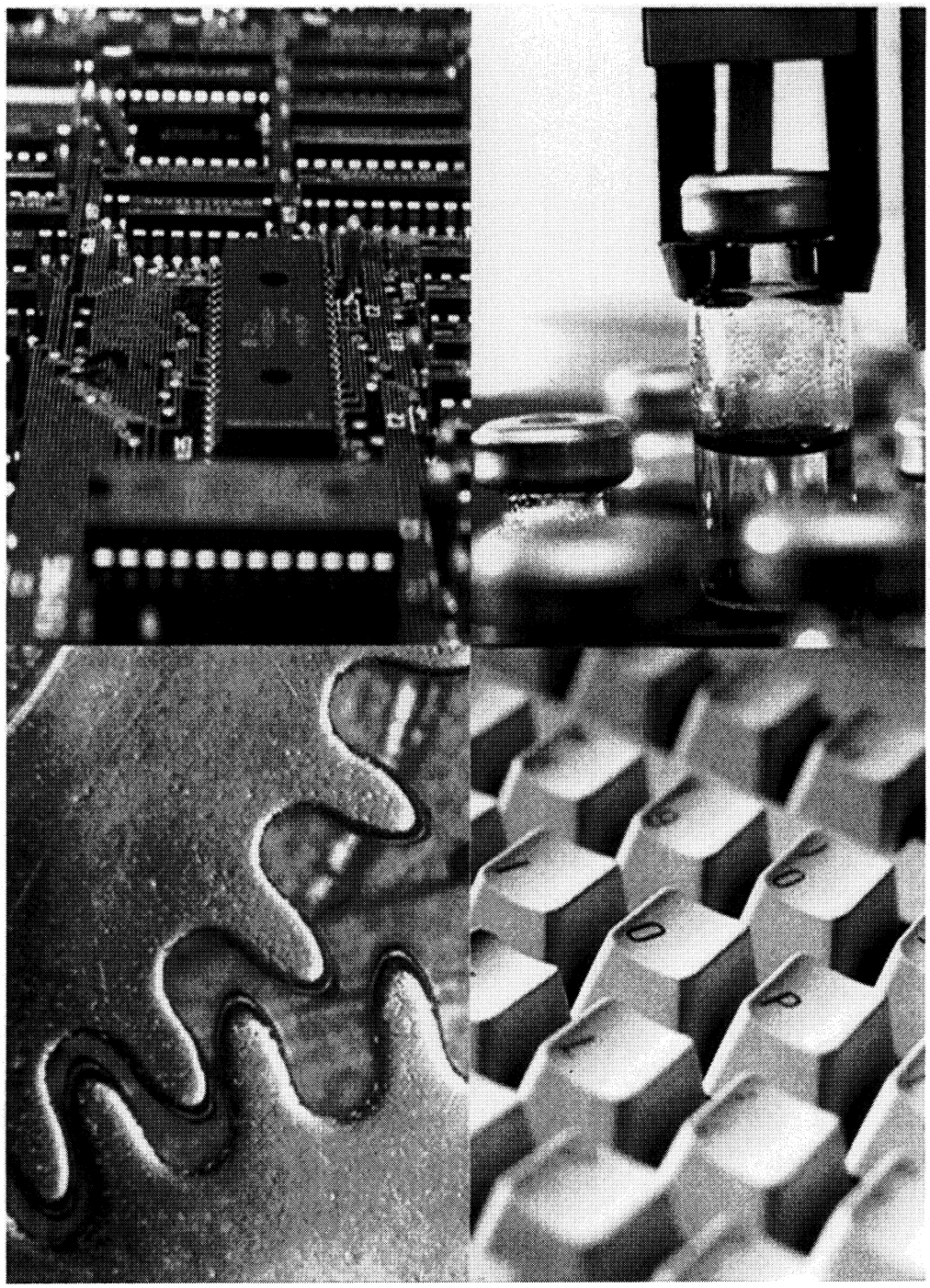
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800 Series Analog I/O Modules
User Guide

GM-ANLG-800 Rev. B



GROUPE SCHNEIDER

■ Modicon ■ Square D ■ Telemecanique

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Modicon
800 Series Analog I/O Modules
User Guide

GM–ANLG–800 Rev. B

August, 1995

AEG SCHNEIDER AUTOMATION
Modicon • Square D • Telemecanique

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Chapter 1
800 Series I/O Modules

- ☐ Overview
- ☐ System Interface
- ☐ I/O Map
- ☐ Grounding Guidelines
- ☐ Installation
- ☐ Quick Start Test
- ☐ Generic Specifications

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1.1 Overview

- ☐ Status indicators
- ☐ Front accessible fuses
- ☐ A module handle permits easy installation and removal
- ☐ Safe, non−conductive module front permits easy access of test probes
- ☐ Designed for harsh, plant−floor environments
- ☐ Each point is electrically isolated from logic
- ☐ Removable without disturbing rigid field wiring system
- ☐ Satisfies SWC requirements of IEEE and ANSI guides

Each I/O point is electrically isolated from the controller by an optical coupler. The I/O signals can withstand the severe voltage transients normally encountered in industrial environments without damage to the I/O module or controller. Moreover, the modules satisfy surge withstand capability (SWC) of both IEEE and ANSI guides. All I/O points shut OFF in the event of a communication failure between a Modicon controller and the I/O module. This occurs within 300 ms of the signal loss. The module's ACTIVE indicator will also shut OFF.

The I/O modules can be inserted into any I/O location in the 800 series I/O structure. The module slides easily into the module housing and does not interfere with any other module's operation.

The module's protective case shields the logic circuitry from any electrical interference and minimizes the possibility of any noise being coupled from the user side of the circuitry to adjacent modules. A ground is automatically established when the module is inserted into the housing. This low impedance earth ground originates from the housing's backplane.

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1.2 System Interface

When used with a Modicon PLC in a remote configuration, the appropriate RIO Adapter module or RIO Adapter module with ASCII, must be present in the I/O rack. (See instructions shipped with the Modicon adapter modules.)

1.2.1 Indicators

The applicable indicators on the front of the module shows the status as listed below.

Indicator	Color	Meaning when ON or Blinking
Active	Green	The module has passed its power diagnostics without error—it remains ON until background diagnostics detect an error condition, loss of internal voltage, or loss of communication with PLC
Discrete I/O	Red	Power is available at the output of the module for use by field devices
Blown Fuse	Red	A fuse is blown
Over Range	Red	One or more inputs have exceeded the valid input range
Under Range	Red	One or more inputs have dropped below the valid input range
Field Power	Red	Field power is supplied, and OK

☞ **Note:** The active indicator does not represent the condition of the I/O points. The indicator may be lit with one or more of the I/O points not working properly.

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1.3 I/O Map

The I/O Map is used to direct the flow of data between the various I/O modules and the logic program. It is the tie between the references used in the logic program and the I/O module connection points.

1.3.1 800 Series Configuration

The 800 Series I/O Map lets you match the 984 controller I/O addresses with what will be installed or with what actually exists in the field. The I/O Map also tells the controller how to use an input signal in user logic, and, where to send an output signal. The format of register data (BCD – binary coded decimal or BIN binary) is specified on this screen. The screen objective is to load the card selections and reference number selections to complete the I/O configuration.

In the Configuration Overview, you must specify the number of I/O drops and I/O modules. These numbers are checked when entries to the I/O Map are made. The Modsoft Runtime files contain descriptions of the different kinds of modules. GCNFTCOP.SYS includes the description of "B8" modules, with module number, number of inputs, outputs descriptor and identifier. Refer to your Modsoft software.

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1.4 Grounding Guidelines

- To have proper case ground, the housing must be connected to earth ground
- When using shielded field circuit wires, do not ground the shield at both ends of the circuit (i.e., the module and the field device)
- Single point grounding should be used where possible
- Priority for shield grounding:
  - Field side device case, if metal
  - Earth ground, as close to the field side device or module as possible
  - From shield to frame

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1.5 Installation

Procedure **How to Install an 800 Series I/O Module**

Installation of your 800 Series module involves: unpacking the module, wiring the field connector, installing key pins in the housing, and mounting the module in the housing.

Step 1 Remove the module from its shipping box and check for damage. If damaged, contact your salesman or distributor for correct replacement procedure.

Step 2 Ensure power to housing is OFF.

Step 3 Designate the housing slot for this module.

Step 4 Locate the required connector assembly. (Modicon Part number AS–8534–000 or AS–8535–000). This assembly consists of one or two 20–pin connectors.

☞ **Note:** Remove the keying tabs on the connector prior to installing the module.

Step 5 Remove the old duct, if a different connector/cabling duct assembly is already present in the designated housing slot.

Step 6 (Optional Step) If there is a module to the immediate left of the slot designated for the module's installation, temporarily remove it.

Step 6 Mount the new field connector/duct assembly to the left of the module's designated housing slot and secure it to the housing top and bottom using the two Phillips head machine screws provided.

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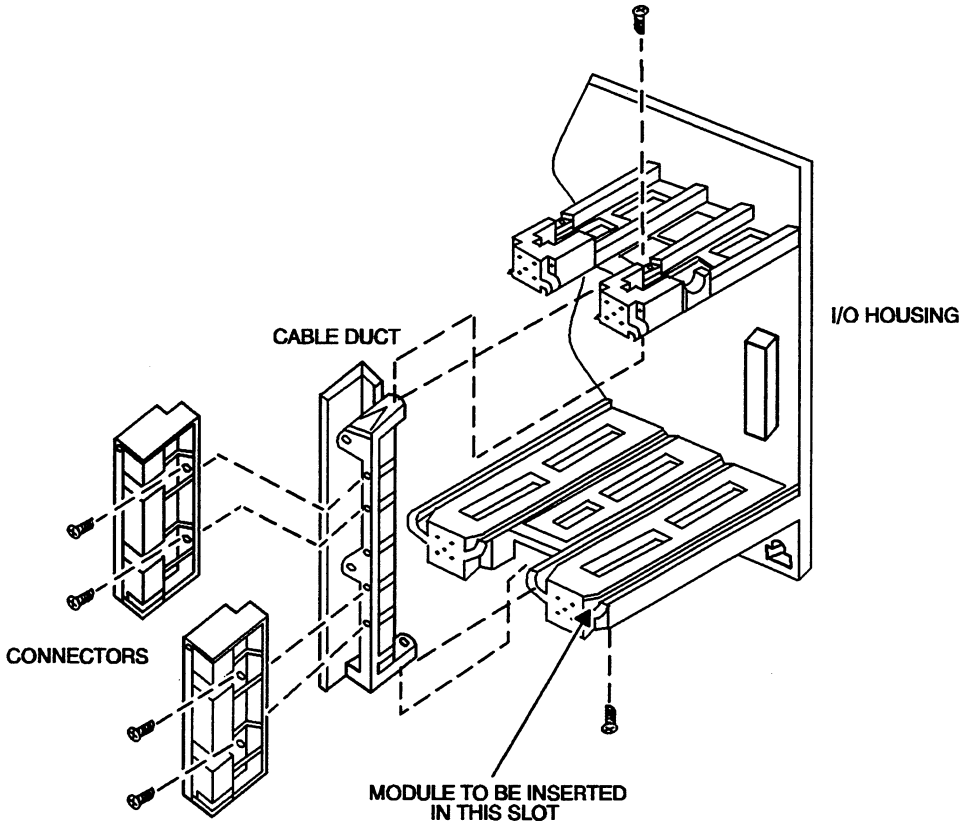


Figure 1 Cabling Duct/Field Connector Assembly

1.5.1 Field Connection

☞ **Note:** When performing this step, refer to the appropriate chapter in this manual of the 800 Series module you are installing for the appropriate connector type.

Step 7 Connect field side wiring to proper pins on the field connector.

☞ **Note:** Terminals accept either two 141 AWG size wires or one 12 AWG size wire/point.

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Caution: Neat and proper workmanship methods by qualified personnel must be employed when making connections to this module. Take extra precautions if you are using stranded wire. Ensure that loose or projecting strands do not short circuit or ground the other terminals. We recommend that you use solid wire.

Step 8 Re–install any module temporarily removed.

Note: When performing this step, refer to Appendix A for illustrations of optional key pin patterns for the 800 Series module you are installing. This Appendix contains key pin patterns for all 800 series I/O modules.

Step 9 When using key pins (provided with housing shipment), install them above and below the housing slot selected for this module's installation.

Figure 2 shows this optional mechanical keying system used to match the module type with a particular slot in the housing to ensure proper module replacement.

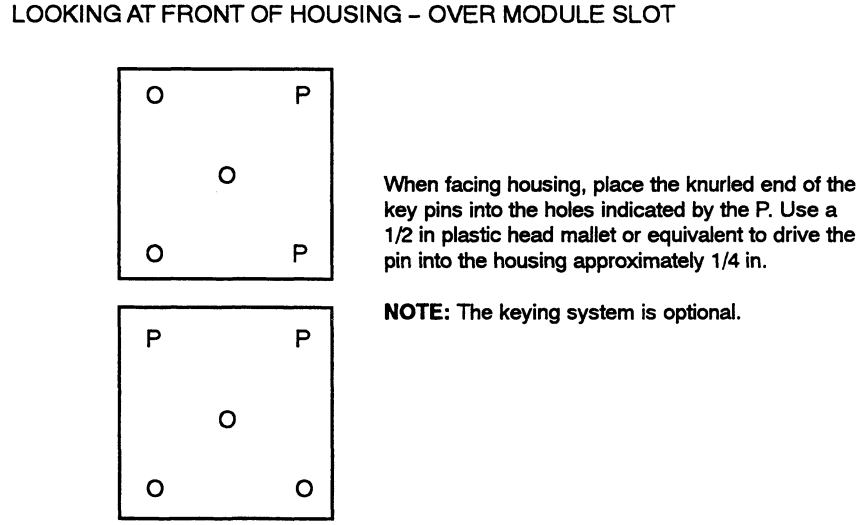


Figure 2 Example of Key Pin Location

Step 10 Insert module into housing, firmly but carefully, seating the edge connector in the backplane.

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☞ **Note:** First time installation of a module may be tight.

Step 11 Secure the module to housing using captive slotted mounting screws at the top and bottom of the module front panel.

Step 12 After confirming all modules are properly installed, apply applicable field power and re−apply power to the programmable controller.

Step 13 I/O Map the module.

Step 14 Start the controller.

Step 15 Confirm that the module's active light is illuminated.

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1.6 Quick Start Test

Step 1 Determine which channel and slot location are being used for this module.

Step 2 Wire field device to the appropriate terminals (refer to the individual wiring diagrams/field connector drawings for that particular I/O module) on either the AS–8534–000 low density connector, or AS–8535–000 high density connector, (refer to the Specification section for your particular I/O module to determine which connector is required.)

Step 3 Stop the PLC.

Step 4 Install the I/O module.

Step 5 I/O Map the module, reference at the desired discrete or register reference.

Step 6 Start the PLC.

Step 7 Confirm that the modules active light is illuminated (may require Step 8 wiring first).

Step 8 To turn an input ON, apply the required power to the appropriate terminals (refer to the individual wiring diagrams/field connector drawings for your particular I/O module), and confirm that the red I/O light is illuminated after turning I/O point ON.

To turn an output ON enter the programming screen (P230 or equivalent) and call up the reference and disable this reference ON.

☞ **Note:** Refer to 984 System Manual for specifics on disabling coils.

See individual chapters for module specific Quick Starts.

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1.7 Generic Specifications

Generic Environmental Specifications

Operating	Temperature	0 ... 60°C (32 ... 140°F)
	Humidity	0 ... 95% (non-condensing) @ 60°C
Operating	Temperature	-40 ... 85°C (32 ... 140°F)
	Humidity	0 ... 95% (non-condensing) @ 60°C
Isolation	Field to System	2000 VAC steady state maximum @ 60 Hz for 1 min
	Between Groups	2500 VDC for 60 s without breakdown. Leakage current shall not exceed 1.5 mA
Shock	Operating	±15 G peak, 11 ms, half-sine wave
	Non-operating	±15 G peak, 11 ms, half-sine wave
Vibration	Operating	0.005 in D.A. Sine, from 10 to crossover frequency (57 ... 62 Hz)
		1.0 G from crossover frequency to 50 Hz
	Non-operating	0.029 G sq/Hz, 10 ... 50 Hz rolloff @ -8dB/octave from 50 ... 500 Hz
EMI		MIL-STD 461B
RFI		FCC Class A
Surge Withstand Capability		IEEE 472-1974 and ANSI C37.90A-1974

Generic Mechanical Specifications

Dimensions (W x H x D)	2.0 x 10.5 x 8.0 in
	50.8 x 266.7 x 203.2 mm
Weight	2.4 lbs. (1.1 kg)
Space Required	1 I/O slot

See individual chapters for module specific Specifications.

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Chapter 2
B846–001 and B846–002 Multiplexers

- ☐ Overview
- ☐ Field Connections
- ☐ Specifications

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2.1 Overview

The B846−002 (4 ... 20 mA) and the B846−001 (0 ... 5 V, 1 ... 5 V, 0 ... ±10 V) Input Multiplexer (MUX) Modules accept 16 analog input signals and connect one multiplexed input signal to the output terminals of the module at a time. The only differences between the two modules are their input ranges and their key pin patterns.

The value of a 16-bit discrete output (coil) or register assigned to the module determines which input signal is connected to the output. The B846 output is intended to be connected to an analog input module, such as the B875. One possible installation would use eight B846 modules and one B875 module to multiplex a total of 128 analog inputs into eight input registers.

Each channel of the B846 has a high reliability DPST mercury wetted reed relay with a life rating of 50,000,000,000 operations. The module is updated with every scan of the programmable controller and the switched output is stable within ten milliseconds. The relay contacts are guaranteed to go break before make.

With the B846−002, each individual input channel may be wired with built−in, precision 250 Ω resistors. This allows continuous 4 ... 20 mA current loop operation when the B846 output is connected to a 1 ... 5 V analog input.

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2.2 Field Connections

User connections are made to a standard screw terminal strip and the rigid wiring system permits module insertion or removal without disturbing the wiring.

2.2.1 Terminal Numbering and Input Connections

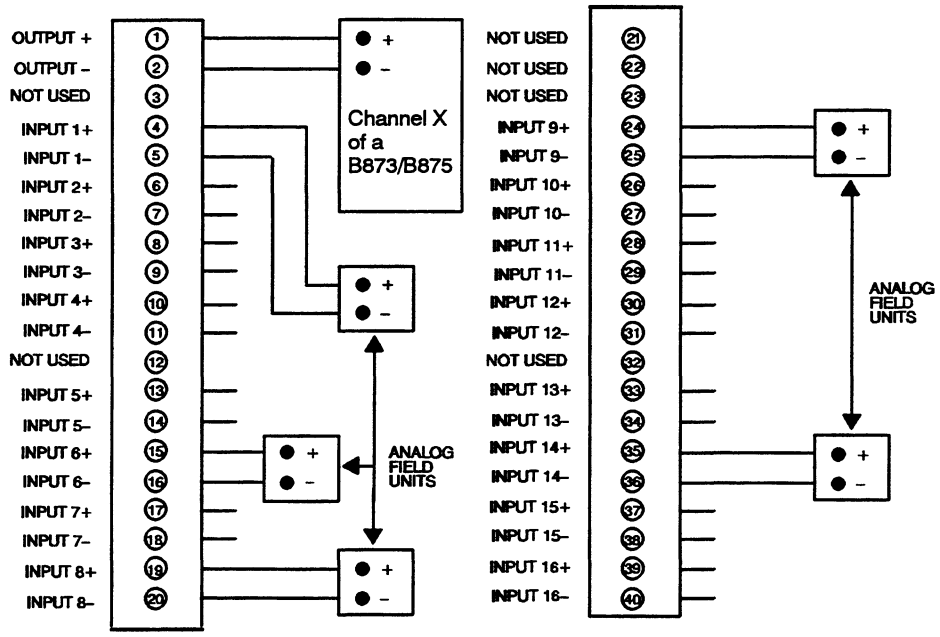


Figure 3 B846–001 Terminal Numbering and Input Connections

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2.3 Specifications

B846–001 and B846–002 Specifications

Description	B846–001	Voltage Input Multiplexer
	B846–002	Current Input Multiplexer
Number of Input Points		16, potential isolated from each other
Address Capacity		1 register data out (Bin data type)
Ranges	B846–001	0 ... 5 V, 1 ... 5 V, ±10 V
	B846–002	4 ... 20 mA
Input Impedance	B846–001	Equal to B873 or B875
	B846–002	250 Ω
Relay Response Time		10 ms including break before make
Power Required	+5 Vdc	65 mA
	+4.3 Vdc	1 mA
	–5 Vdc	0 mA
Update Time	B846 MUX only	3 ms
	with B875	>780 ms
	with B873	>470 ms
Terminal Connector		AS-8535-000

☞ **Note:** An over-range condition on any B873/B875 channel will add approximately 200 ms per over-range channel to the update time of the remaining channels.

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Chapter 3
B872–100 Analog Output

- ☐ Overview
- ☐ Data Value to Output Conversion
- ☐ Field Connections
- ☐ Switch Settings
- ☐ Quick Start Test
- ☐ Calibration
- ☐ Specifications

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3.1 Overview

The B872–100 Four–channel Analog (D/A) Output Module converts numerical data in the range 0000 ... 4095 into current in the range 4 ... 20 mA (12–bit resolution).

The module is designed to allow you to control the state of each output channel when the programmable controller is reset or stopped. The output of the channel can either remain at the last value (HOLD) or go to 0.0 mA—i.e., return–to–zero (RTZ). You can select this option for each of the four isolated outputs using a four–position DIP switch.

A switch is associated with each output (switch 1 for output 1, etc.). The HOLD or RTZ function is selected by you to meet your specific application. The RTZ function allows you to bring the outputs to zero as a safety feature. The HOLD function allows you to maintain the last valid output value after the loss of Ourbus communication.



Caution: RTZ disables the output of the module so that output current goes to zero, not to zero scale (4 mA). Monitor voltage goes below 1V to indicate an output current loss of less than 4 mA.

The module has four isolated analog outputs and is capable of updates to all four channels every 1 ms. The 12–bit resolution and the absolute accuracy of ±0.1% @ 25°C provides precise control of your application.

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3.1.1 Simplified Schematic

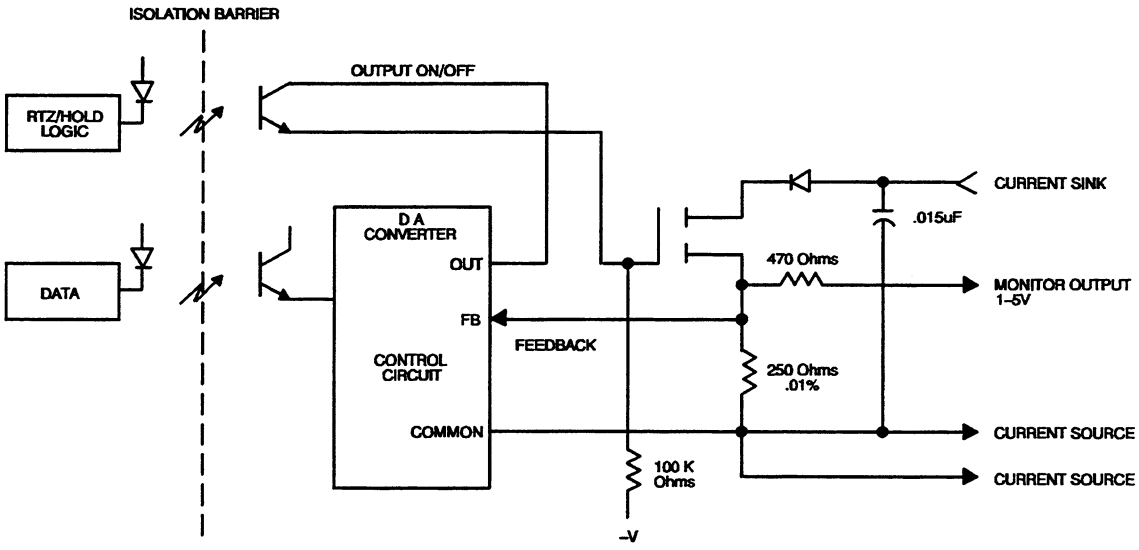


Figure 4 Simplified Schematic

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3.2 Data Value to Output Conversion

The B872 accepts data values ranging from 0000 ... 4095 and converts them into output currents of 4 ... 20 mA. The output current is directly proportional to the data value plus 4 mA.

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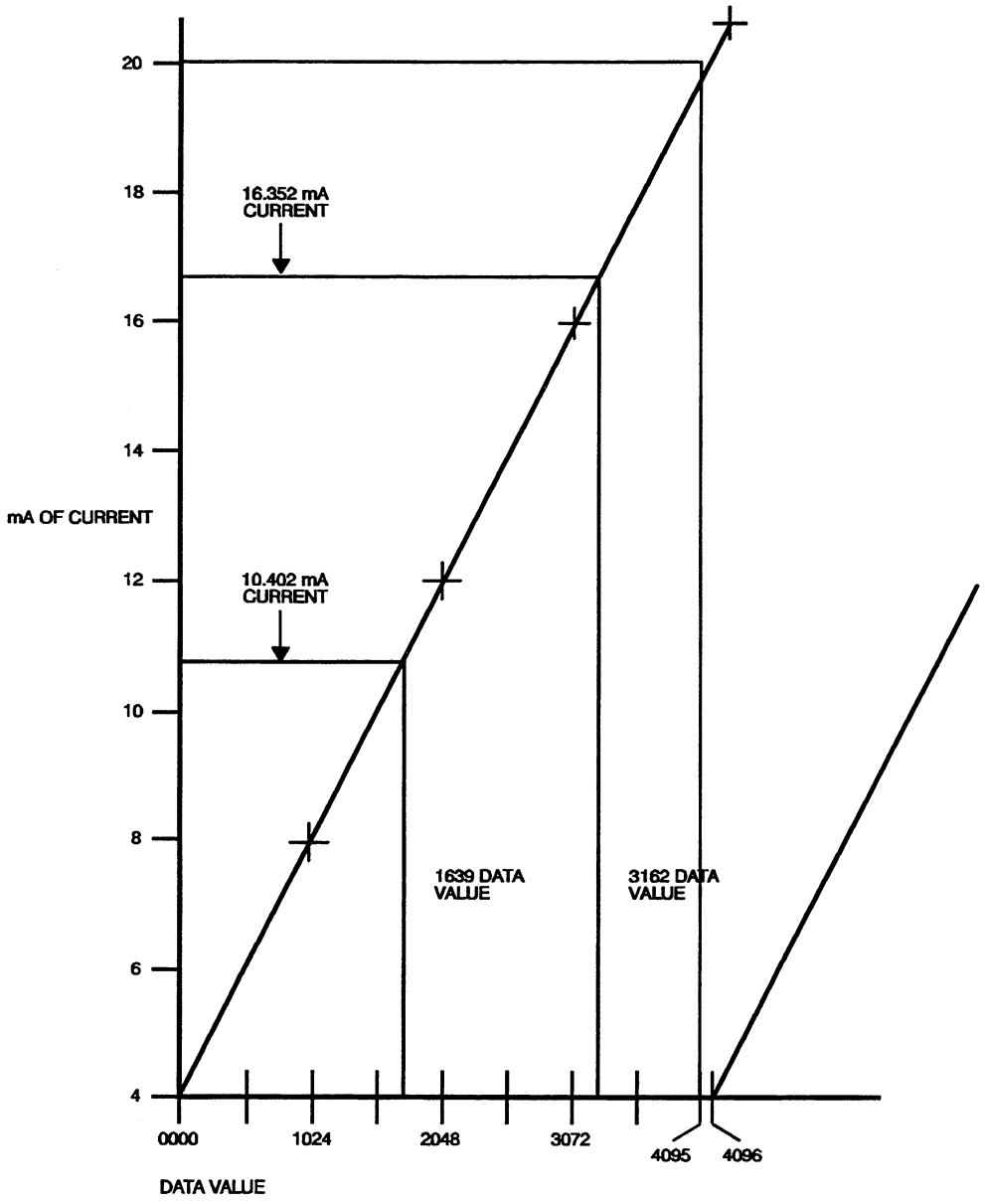


Figure 5 Data Value to Output Conversion Chart

To determine either the data value or the output current, use the following calculations:

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To solve for output current:

$$Current = (Data\ Value / 256) + 4$$

For example:

$$Current = (3162 / 256) + 4$$
$$Current = (12.35156) + 4$$
$$Current = 16.35156$$
$$Current = 16.352$$

To solve for data value:

$$Data\ Value = (Current - 4) \times 256$$

For example:

$$Data\ Value = (10.402 - 4) \times 256$$
$$Data\ Value = (6.402) \times 256$$
$$Data\ Value = 1638.912$$
$$Data\ Value = 1639$$

☞ **Note:** Data values larger than 4095 will result in currents less than 20 mA. Refer to Figure 8. The equations above are valid for data values of 0 ... 4095 only. The module can output values in the range of 4096 ... 8191 in a offset scale. If you use this offset range, be sure to subtract 4096 from the calculations provided above.

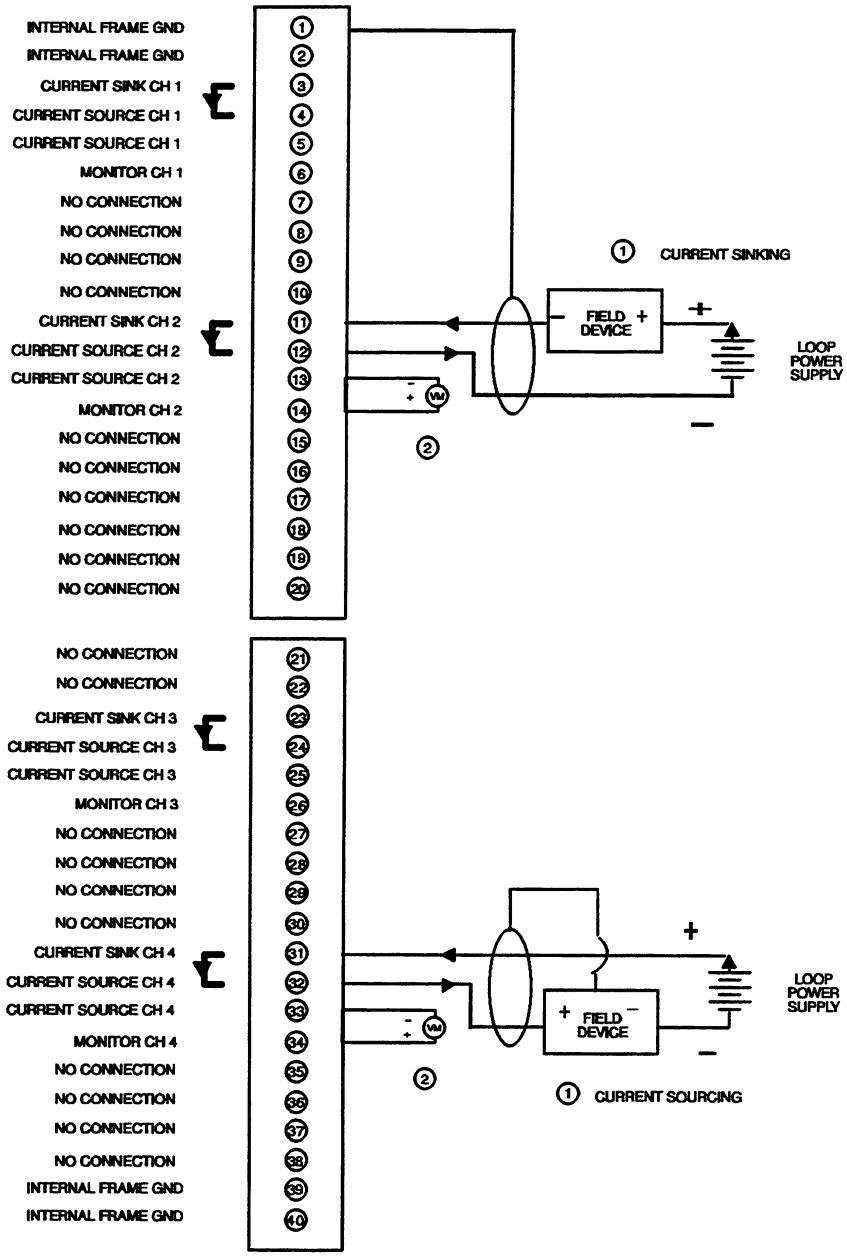
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3.3 Field Connections

User connections are made to a standard screw terminal strip; the rigid wiring system permits insertion and removal without disturbing the wiring.

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3.3.1 Terminal Numbering and Output Functions



1 FIELD DEVICES MAY BE LOCATED IN EITHER SINK OR SOURCE LEADS AS SHOWN
2 VM IS AN OPTIONAL VOLTMETER THAT READS A VOLTAGE PROPORTIONAL TO THE CURRENT

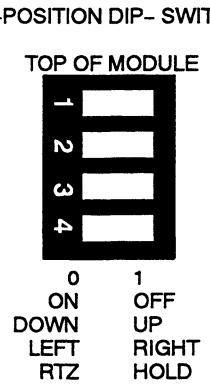
Figure 6 Terminal Numbering and Output Connections

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3.4 Switch Settings

The four-position DIP switch is located on the rear of the module. This switch controls the state of each channel when the system is reset or stopped. The output to the channel can either remain at the last value (Hold) or go to 0.0 mA Return–To–Zero (RTZ).

Set the switch for either hold or RTZ prior to installation of the module. Each of the four switches control the mode of operation for its associated output (i.e., switch 1 for output 1, etc.). Refer to Figure 7 for switch settings. Also, refer to the label located on the left side of the module itself.



SWITCHES	FUNCTIONS
1,2,3,4–Channel	STATE OF OUTPUT WHEN PC RESETS OR STOPS
	FOR RTZ: SW=L
	FOR HOLD: SW=R

Figure 7 DIP–Switch Settings

Set the switch to the left to select return–to–zero or to the right to select hold (viewing the rear of the module when held vertically). Channels are set independently.

☞ **Note:** The output state after power–up initialization is dependent on the position of DIP–switch. An open circuit results in current 0 mA.

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Relationship Between Power–up and DIP–Switch Settings

Possible Event During Power–up	Switch = RTZ	Switch = HOLD
At Power–up	Open Circuit	Open Circuit
After Receiving Valid Data	Data	Data
PC Stop (After Run)	Open Circuit	Last Data
Loss of +5 V	Open Circuit	Open Circuit
Loss of +4.3 VIO	Open Circuit	Last Data
Loss of +5 V & +4.3 VIO	Open Circuit	Open Circuit

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3.5 Quick Start Test

This test configures the module as follows: B872 (analog 4 channel output), and output state set to RTZ.

3.5.1 Required Parts

Before starting make sure you have the following items:

- ☐ A loop power supply (24 Vdc, ±10% @ 1, 2 A
- ☐ A resistance decade box or two 510 Ω resistors at $^1/_4$ W 5%
- ☐ An AS−8535−000 high density connector

3.5.2 Configuration Switch

Step 1 Set the 4 position DIP−Switch as follows: (viewing the rear of the module when held vertically)

SW1,2,3,&4 Left RTZ

Step 2 With a resistance decade box, or two paralleled 510 Ω resistors, wire the output module as shown in Figure 8 for current sinking, or Figure 9 for current sourcing on a AS−8535−000 high density connector.

☞ **Note:** The resistance decade box should be set for 249 Ω

☞ **Note:** Remove the keying tabs on the AS−8535−000 high density connector prior to installing module.

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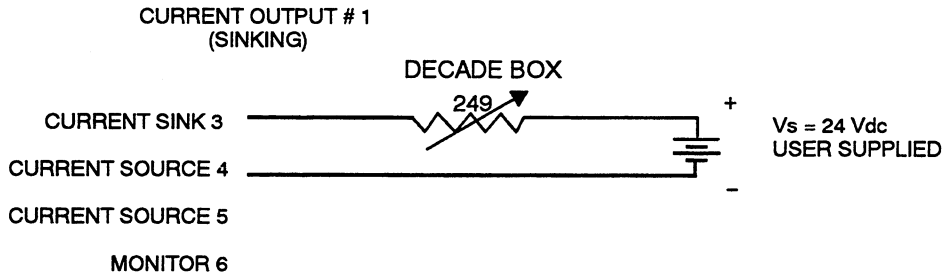


Figure 8 Current Sinking – Wiring

Step 3 Determine which channel and slot location are being used for this module.

Step 4 Stop the PLC, and remove ac power.

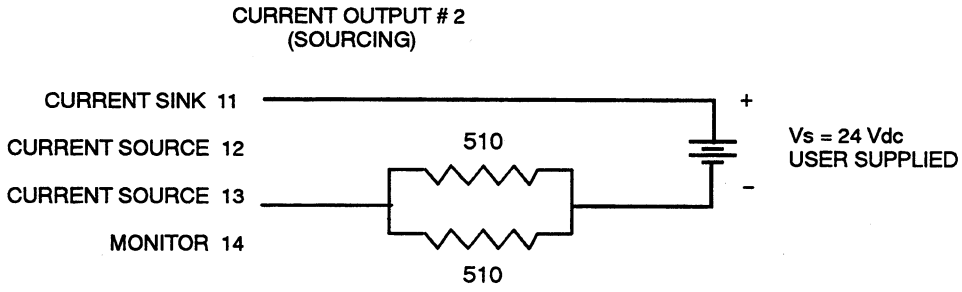


Figure 9 Current Sourcing – Wiring

Step 5 Insert the module into the rack.

Step 6 Re–apply ac power, attach programmer, and access the traffic cop.

Step 7 I/O map the module as a B872, registers 40001 ... 40004 binary.

Step 8 Start the PLC.

Step 9 Confirm that the module's active light is illuminated.

☞ **Note:** Active on steady = OK.

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Step 10 Access the programming software. Enter a value of 2048 in any or all of the declared 4*x* registers of your traffic cop assigned to the module.

Step 11 Using the monitor terminals for each output, measure what should be 3 Vdc. This value is equivalent to 12 mA of current in the loop. (See table below.)

☞ **Note:** Monitor voltage measurement is made with respect to each outputs current source terminal.

Relationship Between Current and Monitor Voltage

Register Value	Loop Current	Monitor Voltage
4x=0001	4 mA	1.0 V
4x=1024	8 mA	2.0 V
4x=2048	12 mA	3.0 V
4x=3071	16 mA	4.0 V
4x=4095	20 mA–1 LSB	5.0 V–1 LSB

Step 12 Continue to provide your output registers with values from the table. This assures each output is capable of a span of 4 ... 20 mA.

☞ **Note:** When using the two resistors in lieu of a decade box, your voltage monitor readings may vary slightly, because of the value and tolerance of the component.

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3.6 Calibration

The Analog Output module is calibrated at the factory prior to shipment. To ensure the module's accuracy you should calibrate the trim−pots for each output regularly. Calibration is recommended at 12 month intervals for operation between 25 ... 45 °C and at 6 month intervals between 0 ... 60 °C.

3.6.1 Calibration Tools

The following tools are needed to calibrate an Analog Output module:

- ☐ A programming panel,
- ☐ A precision voltmeter, with an accuracy of ±0.0001 volts on a 10 V scale
- ☐ A 1/4 in Phillips screwdriver
- ☐ A 1/8 in standard screwdriver

3.6.2 Calibration Adjustments

To make the adjustments, a load and loop supply must be connected to the channel being calibrated. There are two ways to make the adjustments. One procedure requires a load and loop supply to be assembled using voltage and resistance (Method 1). Refer to the Calibration Voltage/Resistance Procedure and NO TAG. The second procedure uses the existing field side circuit (Method 2). Refer to the Calibration Procedure, NO TAG, and NO TAG.

3.6.2.1 Calibration Voltage/Resistance Procedure (Method 1)

Step 1 Use a close tolerance 250 Ω resistor (±0.01%) and a voltage supply of between 12 ... 35 Vdc. The voltage readings will be taken across the resistor. Connect as indicated in the upper part of Figure 11.

Step 2 Remove the two screws and the label located on the front panel of the Analog Output module. This allows you access to the trim−pots. There are two trim−pots per output. The first two trim−pots are for output number one, the second set is for output two, etc. Refer to Figure 10.

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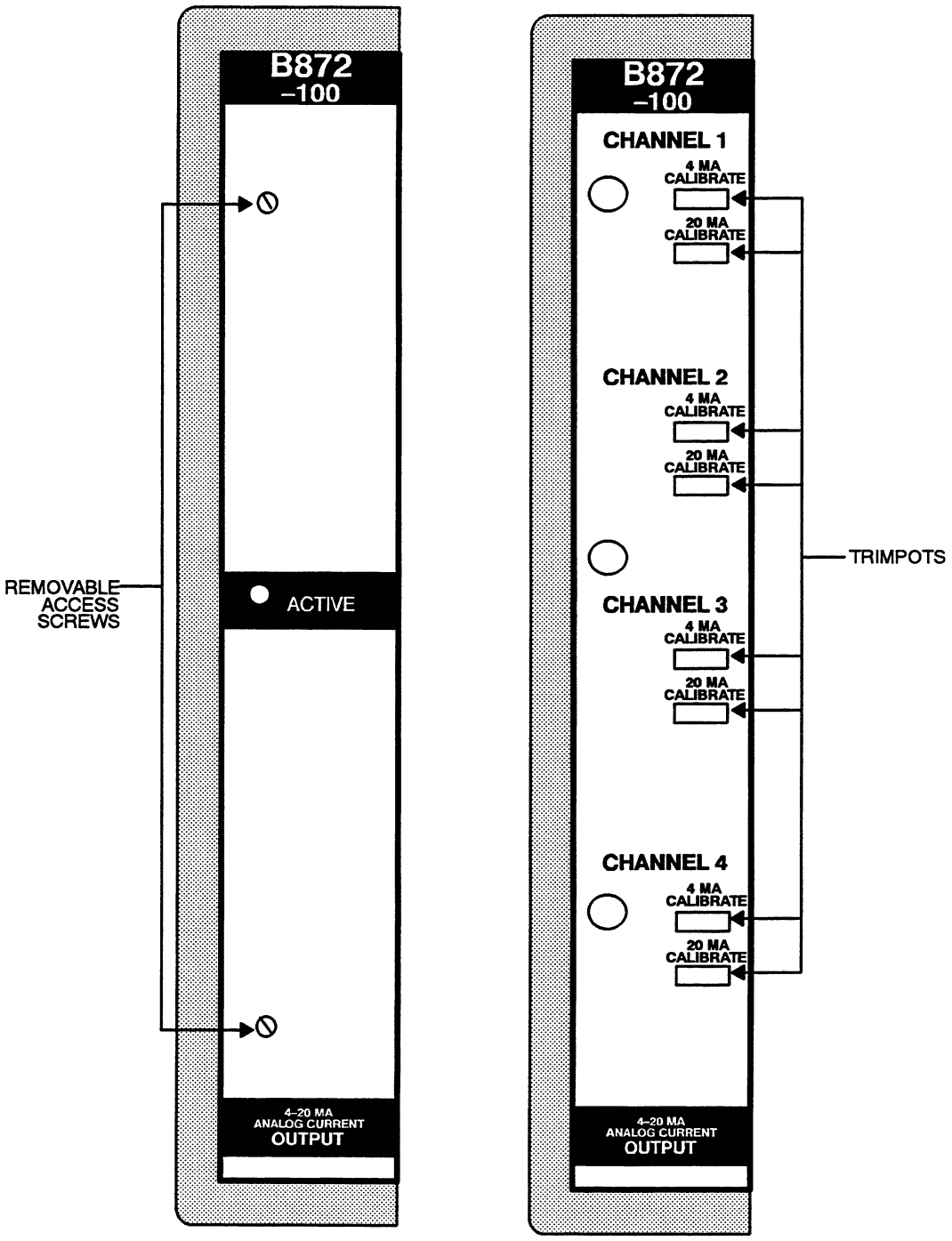


Figure 10 Location of Trim–Pots

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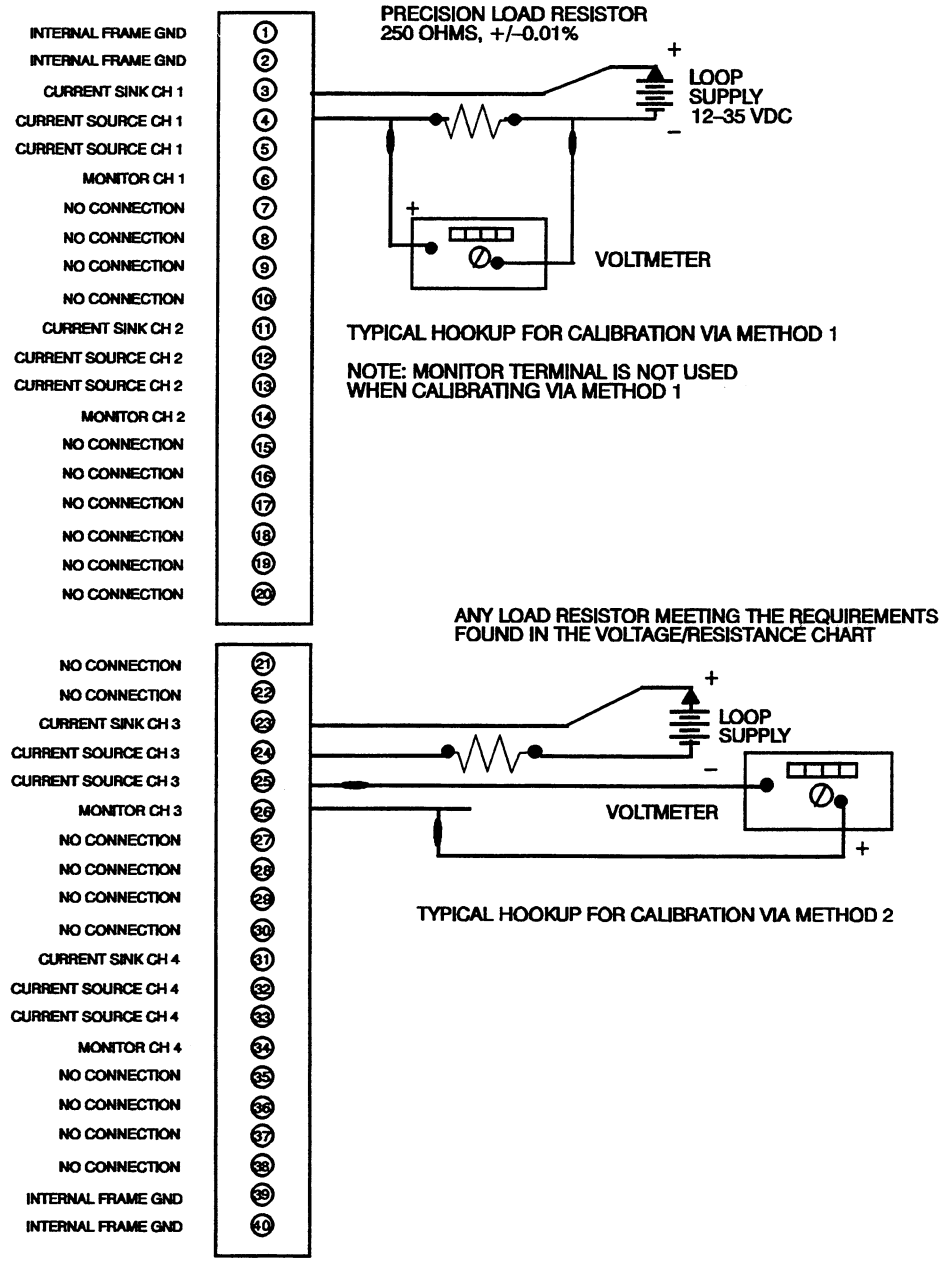


Figure 11 Voltmeter Connections Diagram

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Step 3 Open the Analog Output module handle to expose the connectors and terminals.

Step 4 Load the data value of 0000 into the output register for the channel under test.

Step 5 Adjust the top (4 mA calibrate) trim−pot of the set for a voltage of +1.0000, ±0.002 V. This calibrates to ±0.05% of full scale.

Step 6 Manually program a data value of 4095 into the output register for channel one.

Step 7 Adjust the bottom (20 mA calibrate) trim−pot of the set for a voltage reading of +4.9990, ±0.002 V. This calibrates to ±0.05% of full scale.

Step 8 Return to step 4 and repeat steps 4 ... 8 until module is within tolerance.

Step 9 Move connections to next channel to calibrate, and repeat steps 4 ... 8 for each output channel.

Step 10 After the calibration procedure is complete, disconnect the voltmeter, return connections to their original state, close module handle, and replace front label that covers the trim−pots. Pot locking paint, and other substances are not required.

3.6.2.2 Calibration Procedure (Method 2)

Step 1 Connect loop supply and load resistor (if any) as indicated in the lower part of Figure 11. Verify that resistor and loop supply are within limits as defined by Figure 12.

Step 2 Connect voltmeter to monitor terminals as indicated in the lower part of Figure 11.

Step 3 Load the data value of 0000 into the output register for the channel under test.

Step 4 Adjust the top (4 mA calibrate) trim−pot of the set for a voltage of +1.0000, ±0.002 V. This calibrates to ±0.05% of full scale.

Step 5 Manually program a data value of 4095 into the output register for channel one.

Step 6 Adjust the bottom (20 mA calibrate) trim−pot of the set for a voltage reading of +4.9990, ±0.002 V. This calibrates to ±0.05% of full scale.

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Step 7 Return to step 3 and repeat steps 3 ... 6 until module is within tolerance.

Step 8 Move connections to next channel to calibrate, and repeat steps 3 ... 7 for each output channel.

Step 9 After the calibration procedure is complete, disconnect the voltmeter, return connections to their original state, close module handle, and replace front label that covers the trim−pots. Pot locking paint, and other substances are not required.

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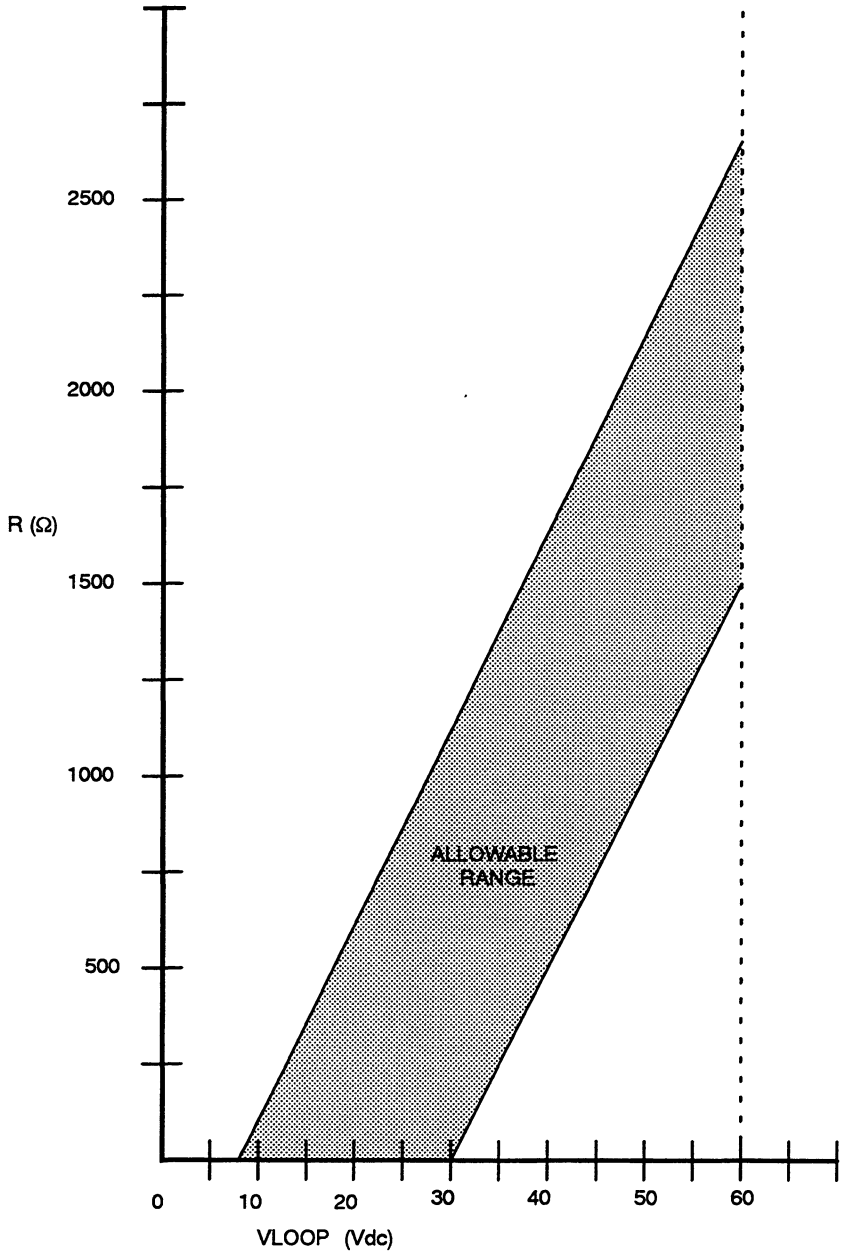


Figure 12 Voltage/Resistance Chart

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3.7 Specifications

B872-100 Specifications

Description		Analog output D/A; 4 ... 20 mA
Number of Points		4
Operating Range		4 ... 20 mA
Maximum Loop Supply Voltage		60 Vdc
Allowable Resistance Range*	Minimum	$R_{min} = \frac{VLoop^{**} - 30\ V}{0.02\ A}$
	Maximum	$R_{max} = \frac{VLoop^{**} - 7\ V}{0.02\ A}$

* Resistance is the sum of all components, including wiring, in the field side circuit.

** VLoop equals the voltage of the loop supply (not to exceed 60 Vdc). If voltage is <30 Vdc, then the minimum loop resistance is 0 Ohms. Refer to the voltage/resistance range chart.

Voltage Drop @ 20 mA	Minimum	7 Vdc
	Maximum	30 Vdc
Response Time to Within ±0.1% of Full Range		0.35 ms, all four channels
Valid Data Values		0 ... 4095 or offset 4096 ... 8191
Resolution		1 part in 4096 counts
Monitor Output Voltage	Range	1 ... 5 Vdc
	Min Load	1 MΩ
	Impedance	470 Ω, typical
Accuracy***		
Output Errors @ 25°C (77°F)	Overall	±0.1% @ 25° C absolute
	Nonlinearity	±0.024%
	Differential Nonlinearity	±0.036%
Output Errors 0 ... 60°C (32 ... 140°F)	Total	±0.17%
	Gain TC	±35 ppm/°C
	Offset TC	±20 ppm/°F
		±15 ppm/°C
		±8.3 ppm/°F
	Nonlinearity	±0.024%
	Differential Nonlinearity	±0.036%
Output Isolation	Output to OURBUS	1500 Vac or 2500 Vdc for 1 min
		500 Vac or 500 Vdc continuous operation
	Channel to Channel	1500 Vac or 2500 Vdc for 1 min
		500 Vac or 500 Vdc continuous operation

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*** All percentages are of full range.

Conversion	Resolution	12 bits (1 part in 4096)
	Update Time	Can accept new data every 1 ms for a four-channel update
	Settling Time	Within ±0.1%, < 350 µs
	Linearity	0 ... 60° C, ±1 LSB maximum
	Differential Nonlinearity	0 ... 60° C, ±1.5 LSB maximum
Load Inductance		1 H max, with no external diode suppression
Power Required	+5 V	475 mA
	+4.3 V	5 mA
	-5 V	0 mA
Terminal Connector		AS-8535-000

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Chapter 4
B872–200 Analog Output

- ☐ Overview
- ☐ Data Value to Output Conversion
- ☐ Field Connections
- ☐ Setting Module Jumpers
- ☐ Switch Settings
- ☐ Quick Start Test
- ☐ Calibration
- ☐ Specifications

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4.1 Overview

The B872–200 Four-channel Analog (D/A) Output Module converts numerical data in the range 0000 ... 4095 into output voltage ranges (12-bit resolution).

The module allows you to drive a wide array of field devices requiring different voltages based upon your unique application. You can select from four available output voltage ranges. The ranges, which are 0 ... 5 V, 0 ... 10 V, −5 ... +5 V, and −10 ... +10 V, are selected by means of four pairs of jumpers, one pair/channel. You can operate multiple ranges simultaneously.

The module is designed to allow you to control the state of each output channel when the programmable controller is reset or stopped. The output of the channel can either remain at the last value (HOLD) or go to 0.0 mV—i.e., return–to–zero (RTZ).

You can select this option for each of the four isolated outputs using a four–position DIP switch. A switch is associated with each output (switch 1 for output 1, etc.). The HOLD or RTZ function is selected by you to meet your specific application. The RTZ function allows you to bring the outputs to zero as a safety feature. The HOLD function allows you to maintain the last valid output value after the loss of Ourbus communication.



Caution: RTZ disables the output of the module so that output voltage goes to zero, independent of range selected.

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4.1.1 Simplified Schematic

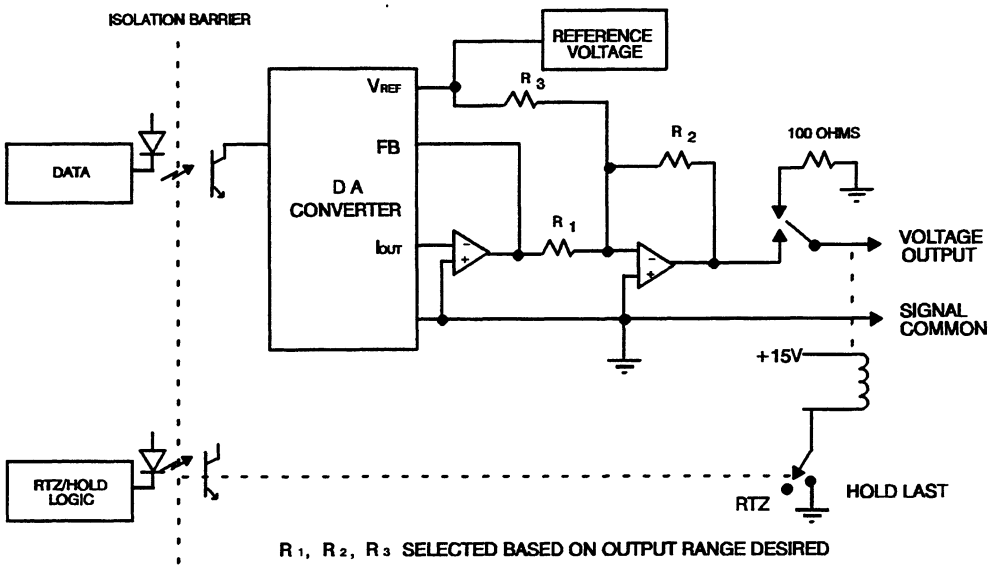


Figure 13 Simplified Schematic

The module has four isolated analog outputs and is capable of updates to all four channels every 1 ms. The 12−bit resolution and the absolute accuracy of ±0.1% at 25° C provides precise control of your application.

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4.2 Data Value to Output Conversion

The B872 accepts data values ranging from 0000 ... 4095 and converts them into output voltages for all four ranges. The output voltage is directly proportional to the data value.

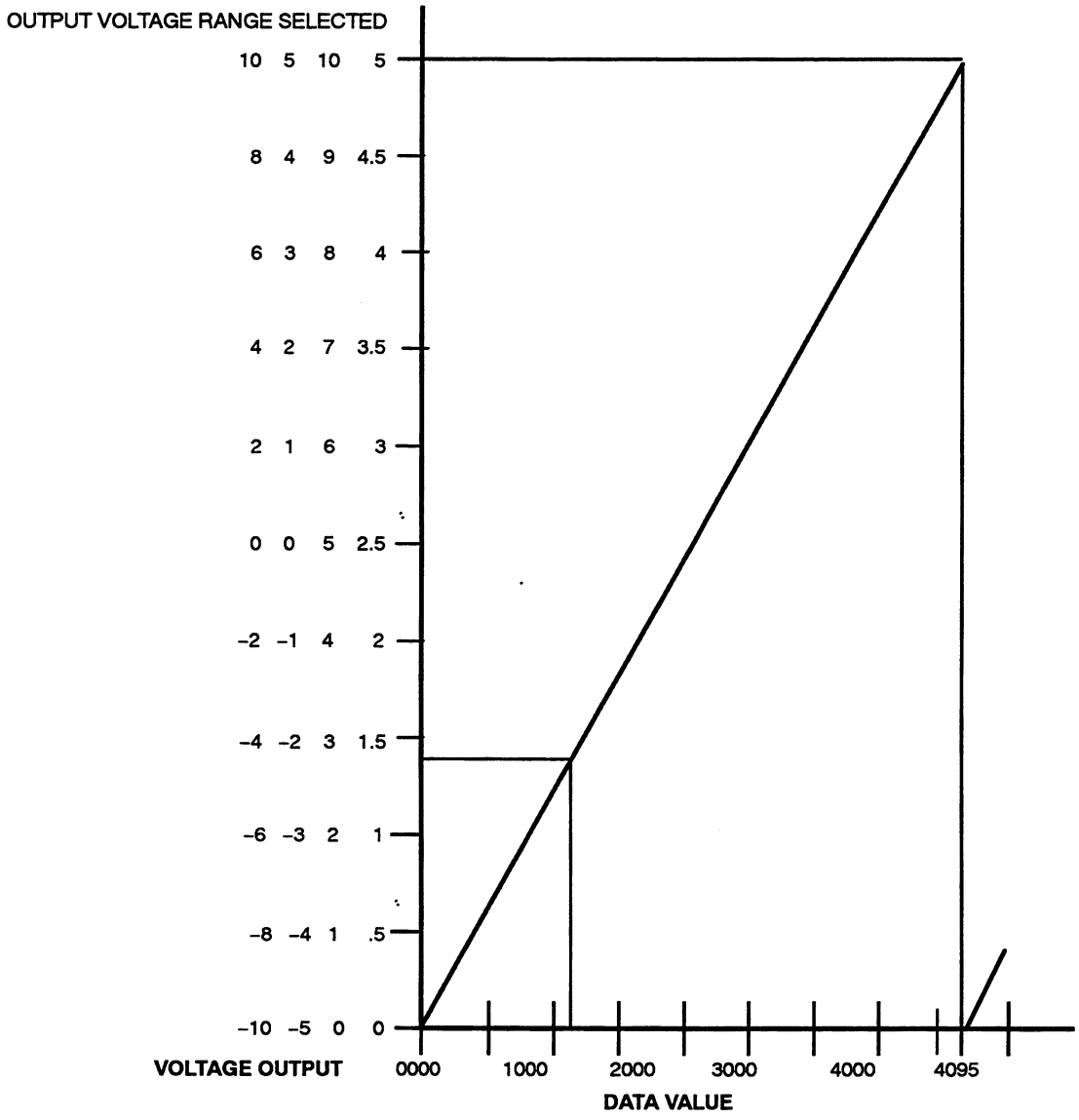


Figure 14 Data Value to Output Conversion Chart

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4.2.1 Calculating Voltage Reading for 0 ... 5 V, 0 ... 10 V Ranges

$$\text{Voltage Output} = \frac{\text{Total Voltage Span*} \times \text{Data Value}}{4096}$$

For example:

$$\text{Voltage Output} = \frac{5 \times 1024}{4096}$$

$$\text{Voltage Output} = 1.250 \text{ Vdc}$$

4.2.1.1 Calculating Data Value for 0 ... 5 V, 0 ... 10 V Ranges

$$\text{Data Value} = \frac{\text{Output Volts} \times 4096}{\text{Total Volts*}}$$

For example:

$$\text{Data Value} = \frac{3.1104 \times 4096}{5}$$

$$\text{Data Value} = 2548$$

4.2.1.2 Calculating Voltage Reading for –5 ... +5 V, –10 ... +10 V Ranges

$$\text{V Output} = \frac{\text{Total Volts*} \times \text{Data Value}}{4096} + \text{Offset Voltage**}$$

For example:

$$\text{Voltage Output} = \frac{10 \times 1024}{4096} + -5$$

$$\text{Voltage Output} = -2.500 \text{ Vdc}$$

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4.2.1.3 Calculating Data Value for –5 ... +5 V, –10 ... +10 V Ranges

$$\text{Data Value} = \frac{(\text{Voltage Output} - \text{Offset Voltage}^{**}) \times 4096}{\text{Total Volts}^{*}}$$

For example:

$$\text{Data Value} = \frac{\{\ 1.2183 - (-5)\ \} \times 4096}{10}$$

Data Value = 2547

* Total Volts Span = Voltage sum from lowest to highest voltage in range is selected.

Examples: −10 ... 10 V = 20 V
−5 ... +5 V = 10 V

** Offset Voltage = The lower number of the range is selected.

Examples: −5 ... +5 V = −5 V
−10 ... +10 V = −10 V

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4.3 Field Connections

User connections are made to a standard screw terminal strip and the rigid wiring system permits module insertion or removal without disturbing the wiring. Terminal numbering and their corresponding output functions are presented below in Figure 15.

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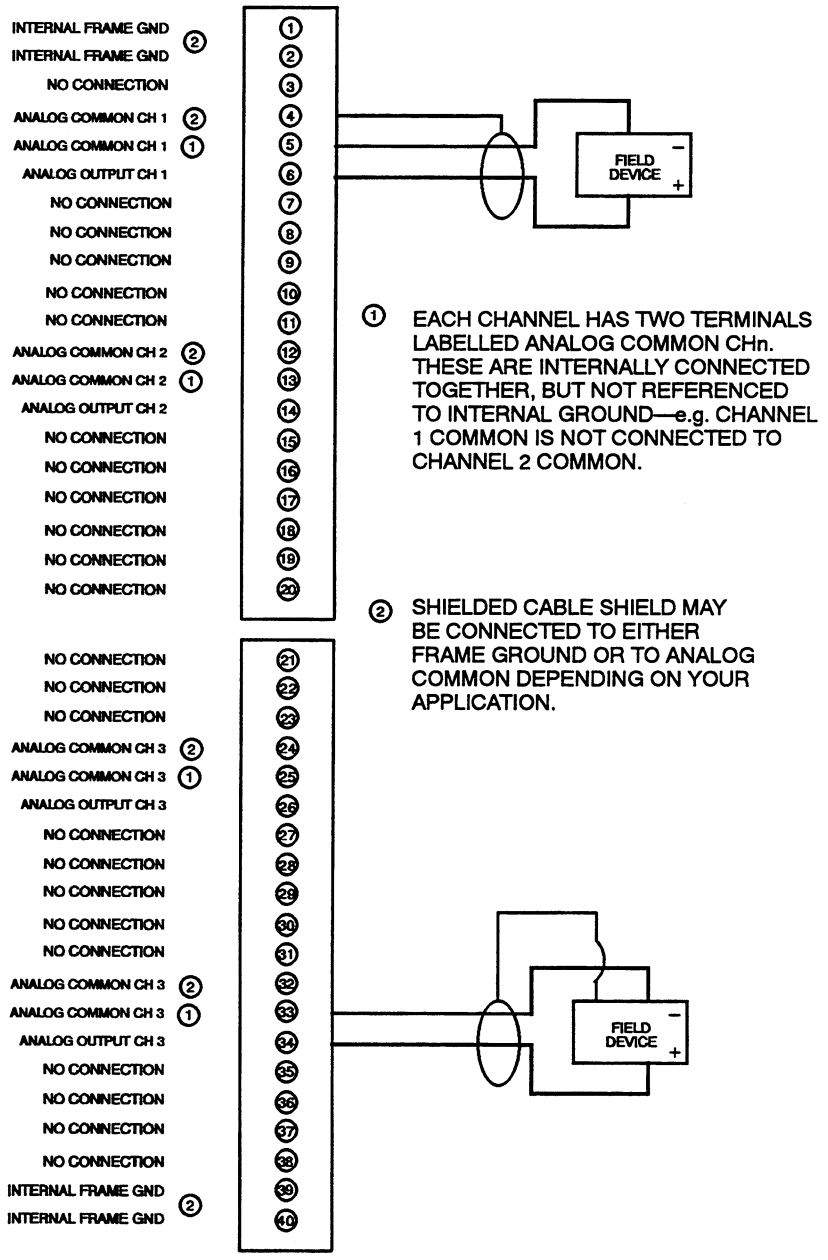


Figure 15 Terminal Numbering and Output Connections

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4.4 Setting Module Jumpers

The jumpers are located on the left side of the module (look for four access holes). The holes allow access to the four pairs of jumpers which are used to select an output voltage range for the associated channel.

Set the desired voltage range for 0 ... 5 V, 0 ... 10 V, −5 ... +5 V, or −10 ... +10 V prior to installation. Refer to Figure 16 for the jumper settings. Also refer to the left side of the module itself. The module is shipped set for 0 ... 10 V.

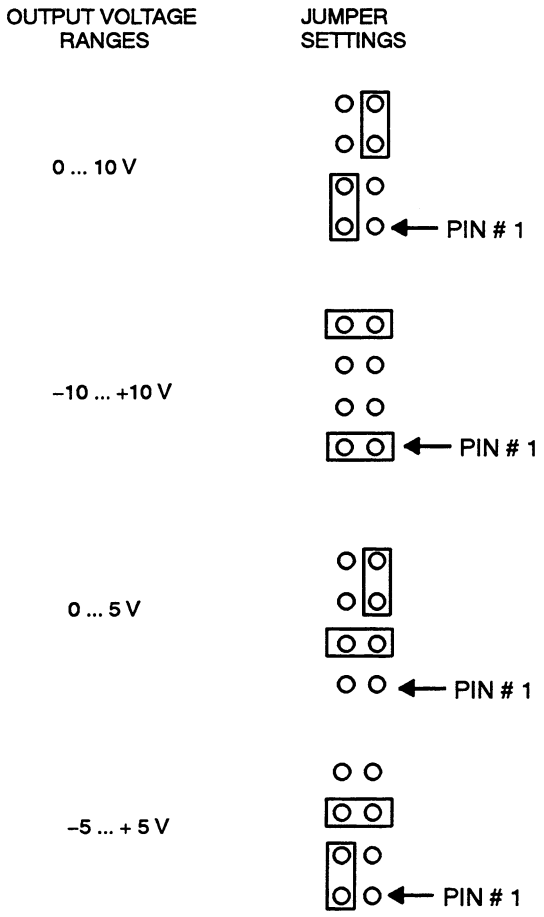


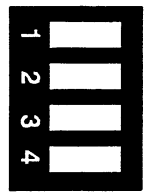
Figure 16 Jumper Settings

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4.5 Switch Settings

The four-position DIP switch is located on the rear of the module. This switch controls the state of each channel when the system is reset or stopped. The output to the channel can either remain at the last value (Hold) or go to 0.0 mA return–to–zero.

Set the switch for either hold or RTZ prior to installation of the module. Each of the four switches control the mode of operation for its associated output—i.e., switch 1 for output 1, etc. Refer to Figure 17 for switch settings. Also, refer to the label located on the left side of the module itself.



SWITCHES	FUNCTIONS
1,2,3,4–Channel	STATE OF OUTPUT WHEN PC RESETS OR STOPS
	FOR RTZ: SW=L
	FOR HOLD: SW=R

Figure 17 DIP–Switch Settings

Set the switch to the left to select return–to–zero or to the right to select hold (viewing the rear of the module when held vertically). Channels are set independently.

☞ **Note:** The output state after power–up initialization is dependent on the position of DIP switch. An open circuit results in current 0 mA.

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Relationship Between Power–up and DIP–Switch Settings

Possible Event During Power–up	Switch = RTZ	Switch = HOLD
At Power–up	0 V*	0 V*
After Receiving Valid Data	Data	Data
PLC Stop (After Run)	0 V*	Last Data
Loss of +5 V	0 V*	0 V*
Loss of +4.3 VIO	0 V*	Last Data
Loss of +5 V and +4.3 VIO	0 V*	0 V*

*Active circuits of module are disconnected from the output terminals, the output terminals are connected to an internal 100 Ω resistor.

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4.6 Quick Start Test

This test configures the module as follows: B872 (analog 4 channel output), and output state set to RTZ (return−to−zero).

4.6.1 Required Parts

- ☐ A digital voltmeter
- ☐ An AS−8535−000 high density connecter

4.6.2 State of Output Control Switch

Step 1 Place the four-position DIP switch (top rear) to the following positions:

SW1 = left
SW2 = left
SW3 = left
SW4 = left

Refer to Figure 17.

4.6.3 Output Voltage Range Jumpers

Step 2 The B872 is shipped with each output set (jumpers located below the side access holes) for 0 ... 10V operation. Therefore, simply verify the jumper settings.

Step 3 Determine your slot location for this module.

☞ **Note:** Remove the keying tabs on the AS−8535−000 high density connector prior to installing module.

Step 4 Stop the PLC, and remove ac power.

Step 5 Insert the module into the rack.

Step 6 Re−apply ac power, attach programmer, and access the I/O map.

Step 7 I/O map the module as a B872, registers 40001 ... 40004 binary.

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Step 8 Start the PLC.

Step 9 Confirm that the module's ACTIVE light is illuminated.

Step 10 Access the programming software. Enter a value of 2048 in any or all of the declared 4*x* registers (40001 ... 40004) of your I/O map assigned to the module.

Step 11 Place your voltmeter leads on pins 5 and 6 of the field wiring connector to read the corresponding output voltage of 5.000V :

Relationship Between Current and Monitor Voltage

Register Value	Monitor Voltage
4*x*=0001	0000 V
4*x*=1024	2.500 V
4*x*=2048	5.000 V
4*x*=3071	7.500 V
4*x*=4095	9.999 V

Step 12 Continue to load values from the table into the other registers to assure each output is capable of a span of 0 ... 10V.

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4.7 Calibration

The Analog Output module is calibrated at the factory prior to shipment. To ensure the module's accuracy you should calibrate the trim−pots for each output regularly. Calibration is recommended at 12 month intervals for operation between 25 ... 45°C and at 6 month intervals between 0 ... 60°C.

4.7.1 Calibration Tools

The following tools are needed to calibrate an Analog Output module:

- ☐ A programming panel
- ☐ A precision voltmeter, with an accuracy of ±0.0001 volts on a 10 V scale
- ☐ A $^1/_4$ in Phillips screwdriver
- ☐ A $^1/_8$ in standard screwdriver

4.7.2 Calibration Procedure

Step 1 Remove the two screws and the label located on the front panel of the Analog Output module. This allows you access to the trim−pots. There is one trim−pot per output. The first trim−pot is for output number one, the second set is for output two, etc. The trim−pots adjusts the range's total magnitude (full scale). Refer to Figure 18.

☞ **Note:** The 0.1% tolerance is the maximum FSR accuracy achievable thru calibration for any volt range. Calibrating any range to the 0.1% tolerance throws the other slightly off; i.e., tolerances for the remaining ranges available to that channel cannot be assumed better than ±0.25% FSR.

Step 2 Open the module handle to expose the connecters and terminals.

Step 3 Connect the voltmeter minus lead (−) to the channel 1 (Analog Common CH1) and the plus lead (+) to the channel 1 (Analog Output CH1) terminal.

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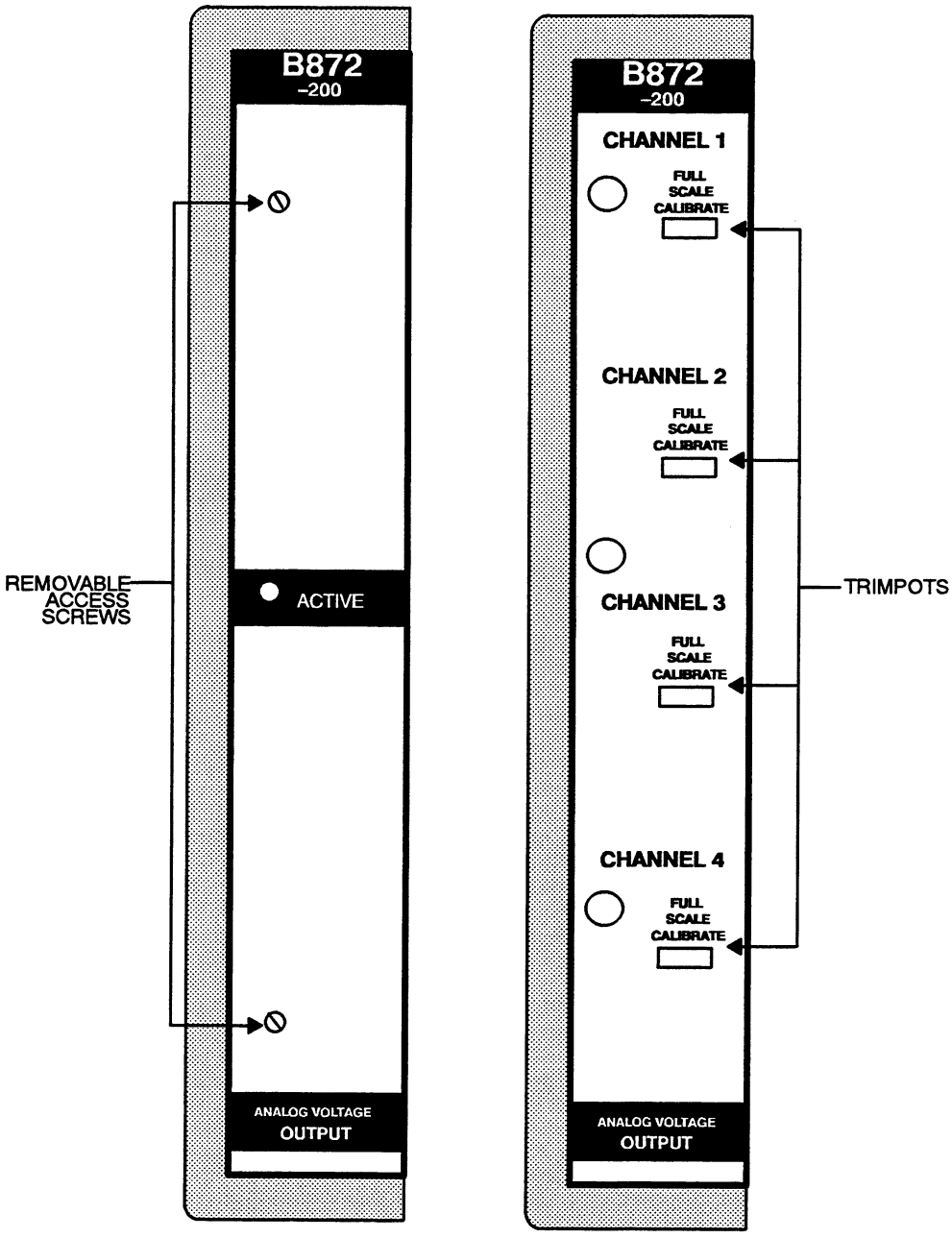


Figure 18 Location of Trim–Pots

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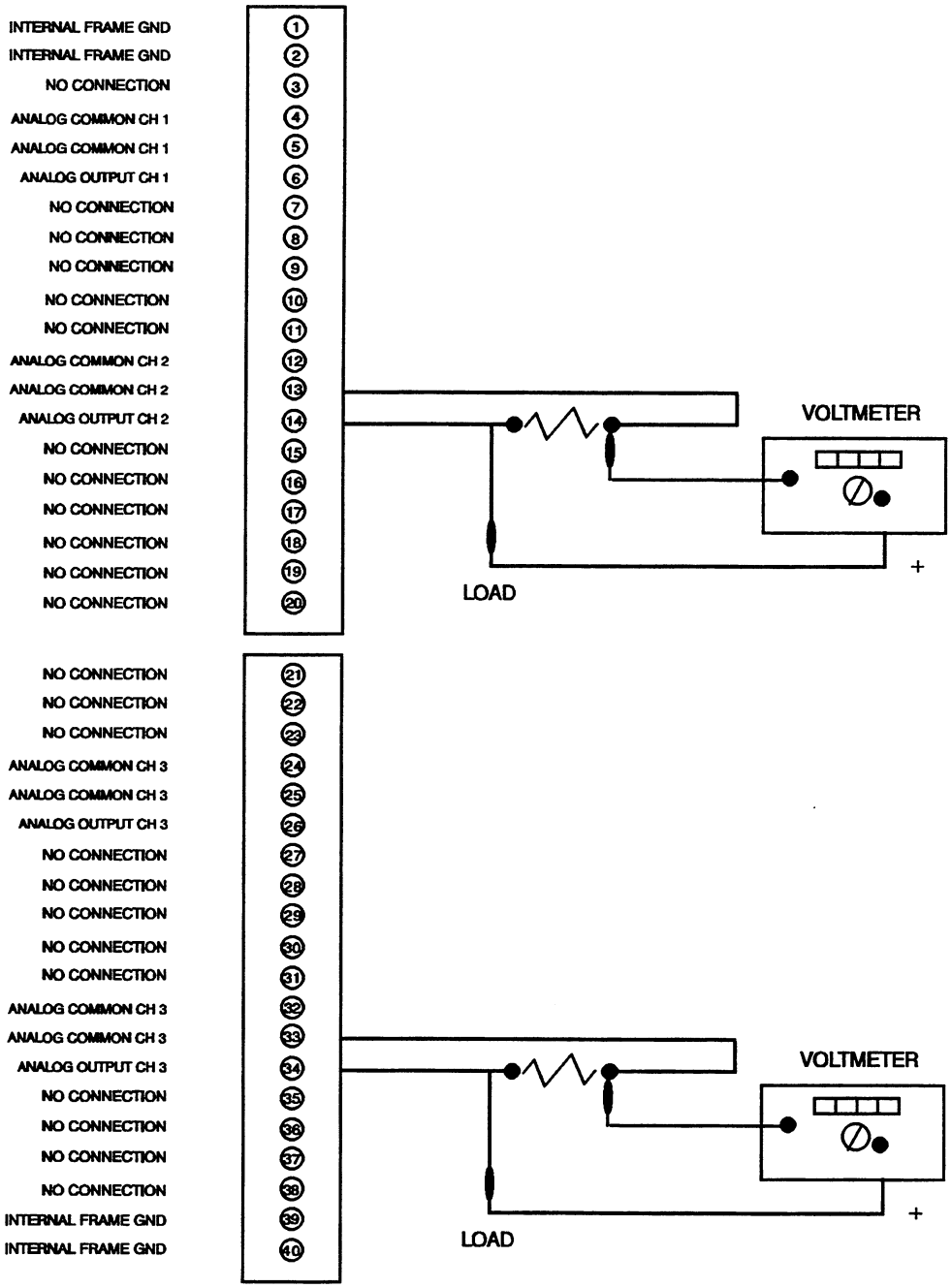


Figure 19 Voltmeter Connections Diagram

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☞ **Note:** Field wiring may remain connected during calibration.

Step 4 With the desired voltage range already selected. Manually program a data value of 4095 into the output register for channel two. Compare channel output voltage with anticipated voltmeter reading given in the table below.

Data Value to Output Channel

Selected Voltage Range	Data Value	Voltmeter to Reading
–5 ... +5V	4095	4.9976
–10 ... +10V	4095	9.99951
0 ... 5V	4095	4.9988
0 ... 10V	4095	9.9976

Step 5 Adjust the (full scale calibrate) trim–pot for corresponding channel to get desired voltmeter reading.

Step 6 Repeat steps 3 through 5 for remaining channels.

Step 7 After the calibration procedure is complete, disconnect the voltmeter, return all connections to their original state, close the module handle, and replace the front label that covers the trim–pots.

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4.8 Specifications

B872-200 Specifications

Description		Analog output D/A
Number of Points		4
Operating Range Voltage		0 ... 5 Vdc, 0 ... 10 Vdc, −5 ... +5 Vdc, −10 ... +10 Vdc; channel-selectable
Maximum Output Current		10 mA
Minimum Load	0 ... 5 V	500 Ω
	0 ... 10 V	1 kΩ
	−5 ... +5 V	500 Ω
	−10 ...+10 V	1 kΩ
Response Time to within ±0.1% of Full Range		.35 ms, all four channels
Valid Data Values		0 ... 4095
Resolution		1 part in 4096 counts
Accuracy***		
Output Errors @ 25° C (77° F)	Overall	±0.1% @ 25°C absolute
	Nonlinearity	±0.024%
	Differential Nonlinearity	±0.036%
Output Errors 0 ... 60° C (32 & 140° F)	Total	±0.17%
	Gain TC	±35 ppm /°C
	Offset TC	±20 ppm/°F
		±15 ppm/°C
		±8.3 ppm/°F
	Nonlinearity	±0.024%
	Differential Nonlinearity	±0.036%
*** All percentages are of full range.		
Output Isolation	Output to OURBUS	1500 Vac or 2500 Vdc for 1 min
		500 Vac or 500 Vdc continuous operation
	Channel to Channel	1500 Vac or 2500 Vdc for 1 min
		500 Vac or 500 Vdc continuous operation
Conversion	Resolution	12-bits (1 part in 4096)
	Update Time	The module can accept new data every 1 ms for a 4-channel update
	Settling Time	Within ±0.1%, < 350 µs
	Linearity	0 ... 60°C, ±1 LSB maximum

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	Differential Nonlinearity	0 ... 60°C, ±1.5 LSB maximum
	Crosstalk	–92 dB
Load Inductance		1 Henry max, with no external diode suppression
Power Required	+5 V	750 mA
	+4.3 V	5 mA
	–5 V	0 mA
Terminal Connector		AS–8535–000

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Chapter 5
B873–002 and B875–002 Analog Input

- ☐ Overview
- ☐ Switch Settings
- ☐ Indicators
- ☐ Installation
- ☐ Calibration
- ☐ Throughput Rate
- ☐ Field Connections
- ☐ Specifications

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5.1 Overview

The B873–002 and B875–002 are analog input modules that can be used with Modicon PLCs. The B873–002 has four input channels and the B875–002 has eight input channels; in all other respects, they are the same.

The module can be set to produce a data value in the standard range (0000 ... 4096) or the elevated range (4095 ... 8192). It accepts inputs of 1.0 ... 5.0 V or 4 ... 20 mA.

The input is converted to a numerical value, ranging from 0001 ... 4095 (standard) or 4096 ... 8191 (elevated). Values of 0000, 4095, 4096, or 8192 indicate invalid data and a possible problem. (Refer to the Data Value Reference Chart.) The value is directly proportional to the input signal. For example, an input voltage of 3.0 V causes the module to send a value of 2048 (standard), or the input could be 12 mA, which would produce a value of 6144 (elevated).

☞ **Note:** Not having voltage or current on an input channel produces a data value of 0000 (standard) or 4095 (elevated).

The PC polls the module and places the values into input registers (3*x*) designated by the programmer.

Each time the module is powered up, it performs diagnostic tests, resets the input latches, and, for each channel, presents a value of 0000 to the controller. The value is present for approximately three seconds after power up. The module will then start converting the inputs according to the schedule found in Section 5.6.

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5.2 Switch Settings

There is a DIP switch located at the rear of the module. Switches 1 and 2 are not used. Switch 3 can be set to either Module Reset or Module Run. It must set to the Module Run position for the module to operate. Switch 4 is used to set which data value range the module will produce. Select either Normal Range or Elevated Range. Make sure you set Switch 3 and 4 before inserting the module into the housing. Refer to Figure 20 for a key to setting the DIP switch.

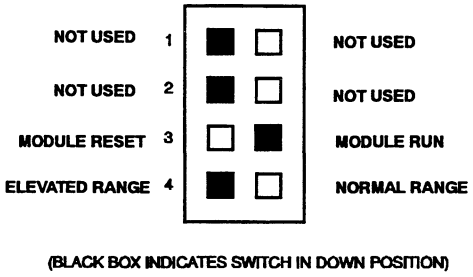


Figure 20 Switch Settings Label

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5.3 Indicators

The ACTIVE, OVER RANGE, UNDER RANGE indicators are located on the front panel of the module. The OVER RANGE and UNDER RANGE indicators are shared by all of the module's input channels. The module's status can be determined as follows:

B873–002 and B875–002 Module Status

Indicator	State	Condition
ACTIVE	ON	The module is communicating properly and the PC is running
	BLINKING	The module failed the powerup reference test
	OFF	The module failed the internal diagnostic test/PLC is not in Run mode/communication from PLC to module has failed
OVER RANGE	ON or BLINKING	One or more inputs have exceeded the valid input range
	OFF	All input are within valid input range
UNDER RANGE	ON or BLINKING	One or more inputs have dropped below the valid input range
	OFF	All inputs are within the valid input range

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5.4 Installation

Remove the module from the box and check for damage. If damage is found, contact your salesman or distributor for correct return procedure.

Set Switch three to the Module Run position and Switch four to the data range selected for input, either Standard or Elevated, before inserting the module into the housing. (Refer to Switch Settings section)

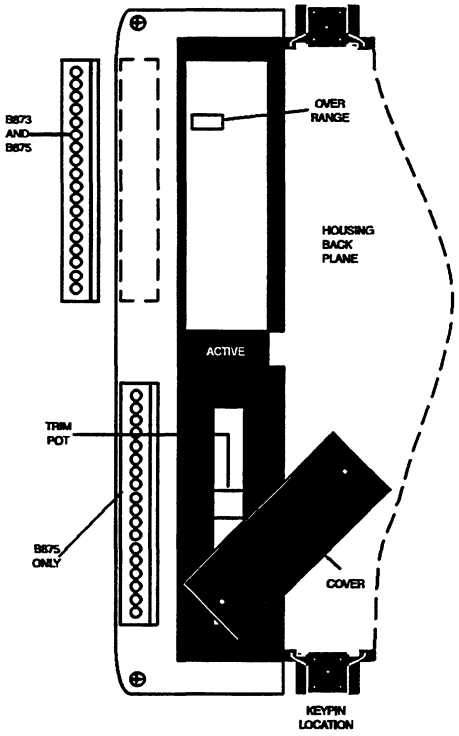


Figure 21 Module Installation

Included with the module is an Analog Connector Set (Part# AS–8533–001 for B873–002 and Part# AS–8533–002 for B875–002).

The Connector Set consists of two mounting screws, a wire duct, and either one (B873–002) or two (B875–002) field wiring connectors. Each connector has eighteen recessed slotted screw terminals and can accept various wire gauges, but 16 ... 20 gauge is recommended for the field side wiring.

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☞ **Note:** The wiring connections can only be made with an 1/8 in blade screwdriver.

The connector plugs into the module with the field wiring to the left. The removable connector permits module removal and replacement without disturbing the wiring. Refer to the diagram for the Terminal Numbering for the terminal functions .

The wire duct protects the connections to the Analog Input Module from being damaged or loosened when the module to it's immediate left is removed.

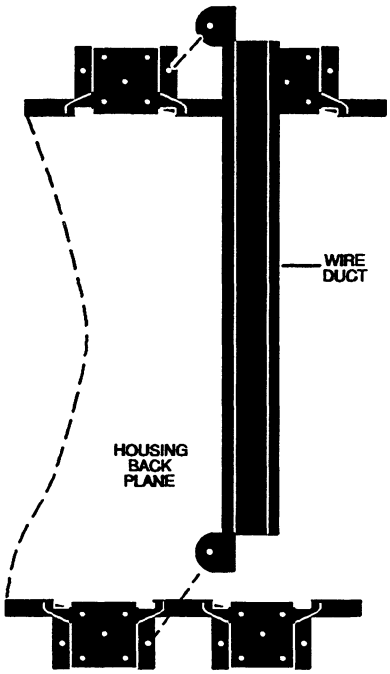


Figure 22 Wire Duct Installation Diagram

To install the wire duct:

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Step 1 Turn off the power to the housing.

Step 2 Determine which slot will be used for the Analog Module. If there is a duct present and it is different from the one provided in the connector set, then it must be removed.This is accomplished by removing the two screws located on the top and bottom of the housing and then pulling the duct out.

☞ **Note:** The wire duct can not be installed for the left−most slot of the housing. Therefore the use of this slot for the Analog Module is not recommended.

Step 3 If there is a module to the left of this slot, it must be removed until installation of the duct is complete.

Step 4 Insert the wire duct between the two slots with the screw holes to the left. (Refer to the Installation Diagram.)

Step 5 Using the two 1/4 inch slotted screws provided in the package, secure the wire duct to the housing.

Step 6 Re−install the module(s) and complete the wiring connections.

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5.5 Calibration

Calibration is recommended at 12 month intervals for operation at or below 40° C (104° F) and at 6 month intervals between 40 ... 60° C (104 ... 140° F).

The following tools are needed to calibrate a B873–002 or B875–002 module in a running system:

- ☐ A programmer
- ☐ A precision voltmeter
- ☐ An Analog dc Voltage/Current
- ☐ A 1/4 in Phillips screwdriver
- ☐ A 1/8 in standard screwdriver
- ☐ An adhesive for the trim pot adjusting screw (e.g. Locktight Glyptol)

5.5.1 Calibration Adjustments

To achieve full accuracy of the module, allow it to warm up for one hour with a valid input present at the channel to be used for the calibration. Without warm up, the accuracy of the data values will be ± 2 counts.

The adjustments can be made using a voltage or current source. Use steps 5a through 10a for voltage or steps 5b through 10b for current.

Step 1 Remove trim pot access cover, located on the front panel.

Step 2 Open module handle to expose connector(s) and terminal(s).

Step 3 Unplug field wiring connector(s).

Step 4 Set up Programmer to monitor the register for the channel used for calibration.

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5.5.2 Using a Voltage Source

Step 5a Connect the positive lead of the voltage source to the channel's input + terminal and the negative lead to the channel's input − terminal.

Step 6a Set voltage source to output 1.00048 V.

Step 7a While monitoring the register, adjust the top trim pot until the value toggles between 0000 and 0001 (Standard) or 4095 and 4096 (Elevated).

Step 8a Use an adhesive to secure the adjusting screw on the trimmer.

Step 9a Set voltage source to output 4.99951 V.

Step 10a While monitoring the register, adjust the bottom trim pot until the value toggles between 4095 and 4096 (Standard) or 8191 and 8192 (Elevated).

5.5.3 Using a Current Source

This method requires that a jumper be connected between the Current Sense terminal and the Input + terminal of the channel to be calibrated.

Step 5b Connect the positive lead of the current source to the channel's input + terminal and the negative lead to the channel's input − terminal.

Step 6b Set current source to output 4.002 mA.

Step 7b While monitoring the register, adjust the top trim pot until the value toggles between 0000 and 0001 (Standard) or 4095 and 4096 (Elevated).

Step 8b Use an adhesive to secure the adjusting screw on the trimmer.

Step 9b Set current source to output 19.998 mA.

Step 10b While monitoring the register, adjust the bottom trim pot until the value toggles between 4095 and 4096 (Standard) or 8191 and 8192 (Elevated).

Step 11 Disconnect input source.

Step 12 Re−connect field wiring.

Step 13 Close module handle.

Step 14 Replace trim pot access cover.

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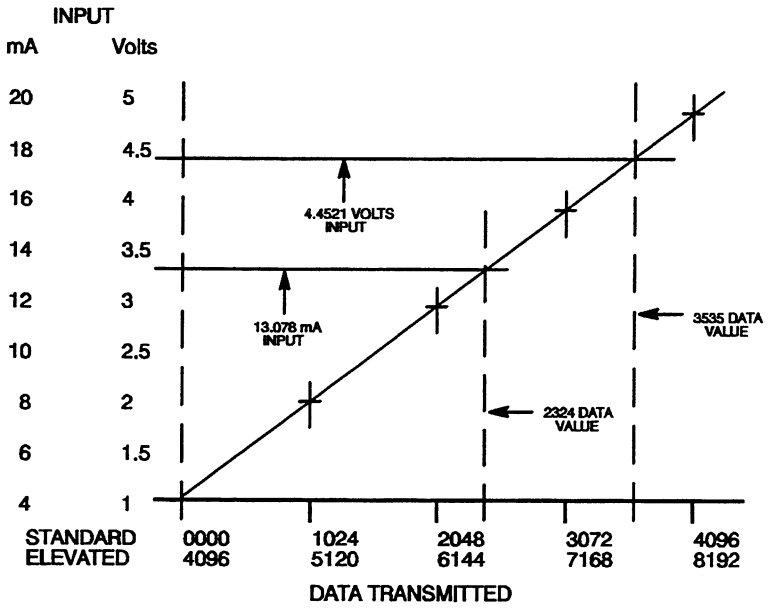


Figure 23 Input to Data Value Conversion

5.5.3.1 Calculatin the Data Value (Voltage)

(Input Voltage − 1) X 1024

Example: (Refer to Graph)

(4.4521V − 1) X 1024

3.4521 X 1024 = 3534.9504 (Add 4096 for Elevated Value)

Data Value = 3535 Standard 7631 Elevated
(Rounded to the nearest whole number)

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5.5.3.2 Calculatin the Data Value (Current)

(Input Current − 4) X 256

Example: (Refer to Graph)

(13.078 mA − 4) X 256

9.078 X 256 = 2323.968 (Add 4096 for Elevated Value)

Data Value = 2324 Standard 6420 Elevated
(Rounded to the nearest whole number)

Data Value Reference Chart

Standard	Elevated	Input Voltage, Current, or Condition
0000	0000	1. First three seconds after power up
		2. During failure recovery
0000	4095	Under range
0000	OFF	1.0000 V or 4 mA
4095	4096	4.999 V or 19.995 mA
4095	8192	Over range

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5.6 Throughput Rate

Update Interval		
B873	Four channels	400 ms
B875	Eight channels	710 ms
Out of Range		220 ms/channel

☞ **Note:** The Update Interval is the amount of time necessary to update the data for all the registers assigned to the module.

All registers are updated every 400 or 710 ms, as long as the inputs on all of the channels are within the valid range. 220 ms is added to the update interval for each channel either under or over range. The input is considered under range when the voltage is at −3 V or below. This keeps unused channels from adding time to the Update Interval.

☞ **Note:** The Over Range indicator will be on or flicker, if the input on any channel is between .999 ... −2.999 V or below 4 mA, but the 220 ms time will not be added to the Update Interval.

Example:

On an eight channel module, two channels are under range. All the registers assigned to the module will be updated every 1150 ms, until the inputs on the out of range channels return to the valid range. When they do, the update interval will return to 710 ms.

Update Interval = (400 or 710) + (Out of Range Channels X 220)

Using the example above:

(710) + (2 X 220) = 1150 ms

If one channel returned to the valid range, the update interval would reduce to 930 ms.

☞ **Note:** As long as the channel is out of range, the register assigned to it will either have data of 0000 (4095 Elevated), under range, or 4096 (8192 Elevated), over range. (Refer to the Data Value Reference Chart)

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5.7 Field Connections

User connections are made to a standard screw terminal strip and the rigid wiring system permits module insertion or removal without disturbing the wiring.

5.7.1 B873–002 Terminal Numbering and Wire Connections

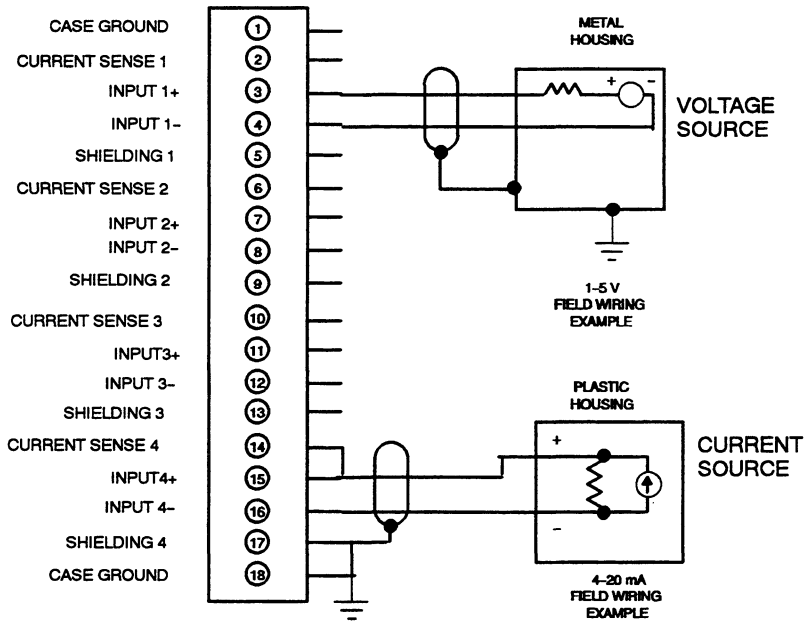


Figure 24 B873–002 Terminal Numbering

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5.7.2 B875–002 Terminal Numbering and Wire Connections

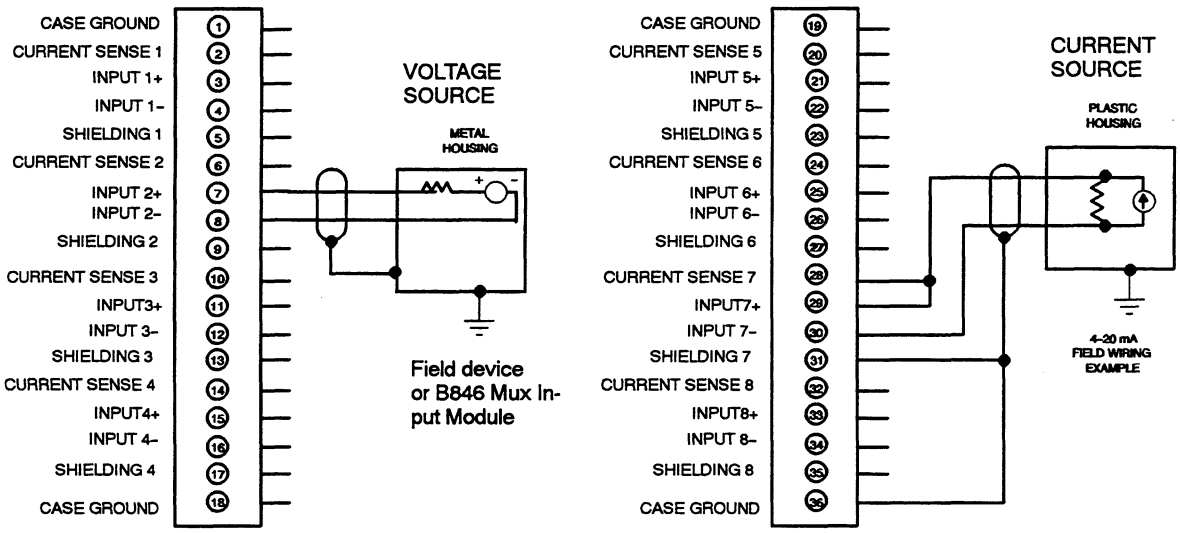


Figure 25 B875–002 Terminal Numbering

☞ **Note:** If a user has a process where the Over–range or Under–range detection is immaterial, the unused voltage or current terminal, including the shields, on the field connector should be jumpered to Case ground.

If over–range or under–range detection is important to your process, and this detection is causing throughput problems with the unused channels, (because they float or spike outside the range) then the unused voltage or current channels at the field connector, should be connected in parallel to a valid Input channel. As long as the valid channel stays within range, the tied channels will also stay within range.

For Current, 4 ... 20 ma operation, the valid Input is the only Input requiring the 250 Ω resistor to be in the circuit. Case ground is effective when the H8XX housing is connected to earth ground.

The shield cannot be connected, both ends, to the device and the module. The exception to this is where the device shield is part of the device input circuit, and is not connected internally to device case ground.

☞ **Note:** Any module run–time diagnostic failure will result in a 0000 value being returned to the controller, regardless of selected range.

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5.8 Specifications

B873-002 and B875-002 Specifications

Description		Analog input, 4 ... 20 mA, 1 ... 5 Vdc
Number of Channels	B873–002	Four
	B875–002	Eight
Operating Range	Voltage	1 ... 5 Vdc
	Current	4 ... 20 mA
Impedance	Voltage	0.5 MΩ/input
	Current	1 MΩ differentially
Resolution		12 bit
Filter		–3 dB @ 18 Hz, Rolloff –20 dB/decade
Linearity		±.05% of full scale @ 25°C (77°F)
Protection		240Vac RMS
Common Mode	Range	0 ... 30 Vac RMS
	Rejection	> –86 dB @ 60 Hz
Isolation	Channel to Channel	250 Vac RMS
	Input to Case	500 Vac RMS for 1 min
	Module	1500 Vac RMS for 1 min
		300 Vac RMS continuous
Accuracy	Overall	7 mV or 19.7 µA
	@ 25°C (77°F)	+0.488 mV or +1.95 µA @ 1.2207 mV
	Offset Drift	±30 µV or ±0.12 µA/°C (±16.7 µV or ±0.07 µA/°F)
	Gain Drift	±15 ppm/°C (±8.3 ppm/°F)
Repeatability		Over a 24 hr period, with a constant voltage and at a constant operating temperature, the input data value will be within ±2 counts.
Power Required	+5 V	300 mA
	+4.3 V	300 mA
	–5 V	0 mA
Data Format	0000	Power Up
		On Diagnostic Failure or during failure Recovery
		Under Range – Standard
	4095	Under Range – Elevated
	0000 ... 4095	Valid – Standard Range
	4096 ... 8191	Valid – Elevated Range

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	4096	Over Range – Standard
	8192	Over Range – Elevated
Throughput Rate Update Interval	Four channels	400 ms
	Eight channels	710 ms (including diagnostics)
	Out of Range	220 ms for each channel in under- or over-range condition (see Section NO TAG)
Terminal Connector	B873–002	AS–8533–001
	B875–002	AS–8533–002

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Chapter 6
B873–012 and B875–012 Analog Input

- ☐ Overview
- ☐ Switch Settings
- ☐ Indicators
- ☐ Installation
- ☐ Calibration
- ☐ Throughput Rate
- ☐ Field Connections
- ☐ Specifications

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6.1 Overview

The B873–012 and B875–012 are analog input modules and can be used with Modicon PLCs. The B873–012 has four input channels and the B875–012 has eight input channels.

Both modules accept inputs of –10 ... +10 V analog signals. The input is converted to a numerical value in the range 0001 ... 8191. Values of 0000 or 8192 indicate invalid data (Refer to Figure 29.) The value is directly proportional to the input signal. For example, an input voltage of –5 V causes the module to send a value of 2048. If the input signal goes to 5 V, the module sends a value of 6144. (Refer to Section 6.5.)

☞ **Note:** 0.0 V or no voltage on an input channel produces a value of 4096.

The PLC polls the module and places the values into input registers (3*x*) designated by the programmer.

Each time the module is powered up, it performs diagnostic tests, resets the input latches, and, for each channel, presents a value of 0000 to the controller. The value is present for approximately three seconds after power up. The module will then start converting the inputs according to the schedule found in Section 6.6.

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6.2 Switch Settings

There is a DIP switch located at the rear of the module. Switches 1, 2 and 4 are not used. Switch 3 can be set to either Module Reset or Module Run. It must set to the Module Run position for the module to operate. Make sure you set Switch 3 before inserting the module into the housing. Refer to Figure 26 for DIP switch settings.

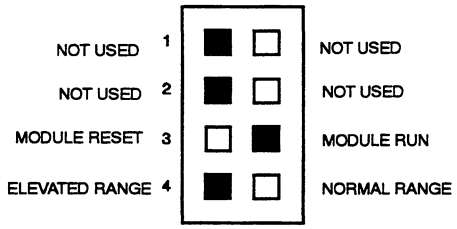


Figure 26 B873–012 AND B875–012 Switch Settings Label

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6.3 Indicators

ACTIVE and OVER RANGE indicators are located on the front panel of the module. The OVER RANGE indicator is shared by all of the module's input channels. The module's status can be determined as follows:

B873–012 and B875–012 Module Status

Indicator	State	Condition
ACTIVE	ON	The module is communicating properly and the PLC is running
	BLINKING	The module failed the powerup reference test
	OFF	The module failed the internal diagnostic test/PLC is not in Run mode/communication from PLC to module has failed
OVER RANGE	ON or BLINKING	One or more inputs have exceeded the valid input range
	OFF	All input are within valid input range

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6.4 Installation

Remove the module from the box and check for damage. If damage is found, contact your salesman or distributor for correct return procedure.

Set Switch three to the Module Run position and Switch four to the data range selected for input, either Standard or Elevated, before inserting the module into the housings (Section 6.2).

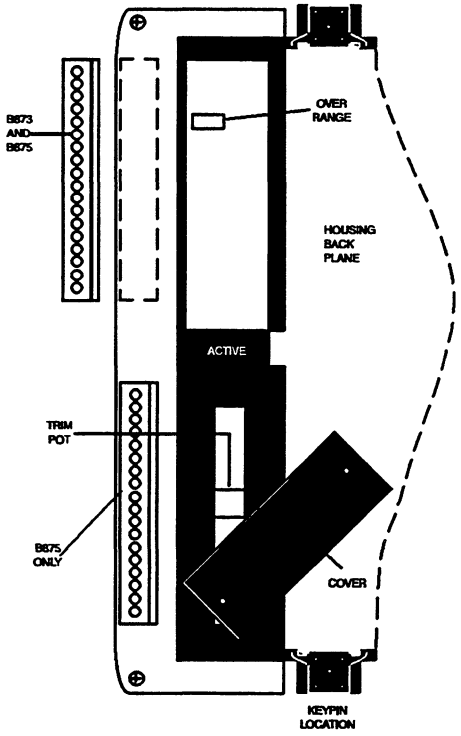


Figure 27 Module Installation

Included with the module is an Analog Connector Set (Part# AS–8533–001 for B873–012 and Part# AS–8533–002 for B875–012).

The Connector Set consists of two mounting screws, a wire duct, and either one (B873–012) or two (B875–012) field wiring connectors. Each connector has eighteen recessed slotted screw terminals and can accept various wire gauges, but 16 ... 20 gauge is recommended for the field-side wiring.

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☞ **Note:** The wiring connections can only be made with an 1/8 in blade screwdriver.

The connector plugs into the module with the field wiring to the left. The removable connector permits module removal and replacement without disturbing the wiring. Refer to the diagram for the Terminal Numbering for the terminal functions .

The wire duct protects the connections to the Analog Input Module from being damaged or loosened when the module to it's immediate left is removed.

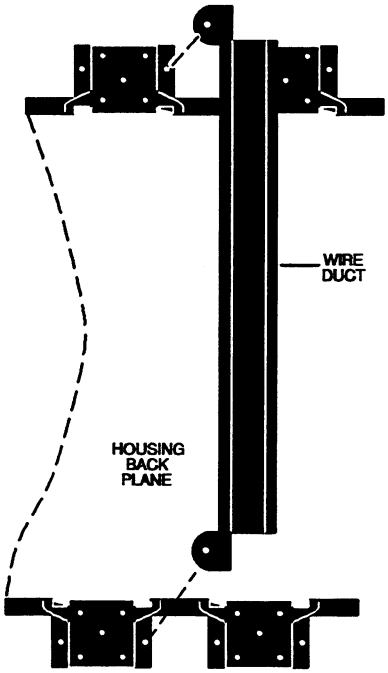


Figure 28 Wire Duct Installation Diagram

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To install the wire duct.

Step 1 Turn off the power to the housing.

Step 2 Determine which slot will be used for the Analog Module. If there is a duct present and it is different from the one provided in the connector set, then it must be removed. This is accomplished by removing the two screws located on the top and bottom of the housing and then pulling the duct out.

☞ **Note:** The wire duct can not be installed for the left−most slot of the housing. Therefore the use of this slot for the module is not recommended.

Step 3 If there is a module to the left of this slot, it must be removed until installation of the duct is complete.

Step 4 Insert the wire duct between the two slots with the screw holes to the left. (Refer to the Installation Diagram.)

Step 5 Using the two $^{1}/_{4}$ in slotted screws provided in the package, secure the wire duct to the housing.

Step 6 Re−install the module(s) and complete the wiring connections.

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6.5 Calibration

Calibration is recommended at 12 month intervals for operation at or below 40° C (104° F) and at 6 month intervals between 40° ... 60° C (104°[illegible]... 140° F).

The following tools are needed to calibrate a B873–012 or B875–012 module in a running system:

- ☐ A programmer
- ☐ A precision voltmeter
- ☐ An Analog dc voltage/current
- ☐ A $^1/_4$ in Phillips screwdriver
- ☐ A $^1/_8$ in standard screwdriver
- ☐ An adhesive for the trim pot adjusting screw—e.g. Locktight Glyptol

6.5.1 Gain Adjustments

To achieve full accuracy of the module, allow it to warm up for one hour with a valid input present at the channel to be used for the calibration. Without warm up, the accuracy of the data values will be ±2 counts.

Step 1 Remove trim pot access cover, located on the front panel.

Step 2 Open module handle to expose connector(s) and terminal(s).

Step 3 Unplug field wiring connector(s).

Step 4 Set up Programmer to monitor the register for the channel used for calibration.

Step 5 Connect the positive lead of the voltage source to the channel's input +terminal and the negative lead to the channel's input −terminal.

Step 6 Set voltage source to output 9.99877 V.

Step 7 While monitoring the register, adjust the trimmer until the value toggles between 8191 and 8192 in binary mode.

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Step 8 Use an adhesive to secure the adjusting screw on the trimmer.

Step 9 Disconnect input source.

Step 10 Re−connect field wiring.

Step 11 Close module handle.

Step12 Replace trim pot access cover.

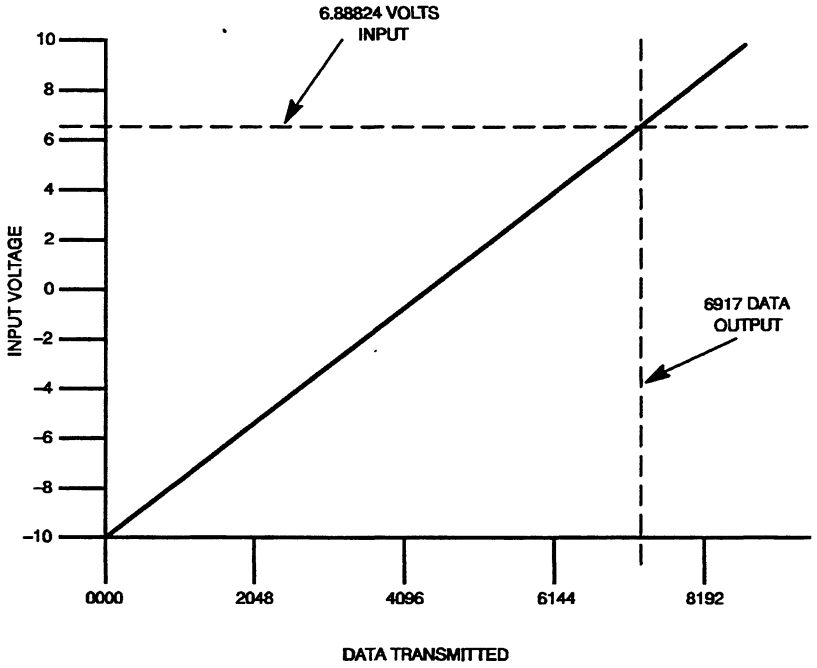


Figure 29 Input Voltage to Output Data Conversion

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Calculation for determining Data Value from Input Voltage (refer to the data value reference chart below):

(Input Voltage + 10) x 409.6

Example: (Refer to Graph)

(6.88824 V + 10) x 409.6

16.88824 x 409.6 = 6917.4231

Data Value = 6917 (Rounded to the nearest whole number)

Data Value Reference Chart

Data Value	Input Voltage, Current, or Condition
0000	1. First 3 s after powerup
	2. During failure recovery
	3. Under range
0001	-9.99756 V
4096	1. 0.00000 V
	2. No voltage at input terminal
8191	9.99756 V
8192	Over range

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6.6 Throughput Rate

Update Interval		
B873	Four channels	400 ms
B875	Eight channels	710 ms
Out of Range		220 ms/channel

☞ **Note:** The *update interval* is the amount of time necessary to update the data for all the registers assigned to the module.

All registers are updated every 400 or 710 ms, as long as the inputs on all of the channels are within the valid range. 220 ms is added to the update interval for each channel either under or over range. The input is considered under range when the voltage is at or below −3 V. This keeps the unused channels from adding time to the update interval.

6.6.1 Example

On an eight channel module, two channels are under range. All the registers assigned to the module will be updated every 1150 ms, until the inputs on the out of range channels return to the valid range. When they do, the update interval will return to 710 ms.

Update Interval = (400 or 710) + (Out of Range Channels X 220)

Using the example above:

(710) + (2 X 220) = 1150 ms

If one channel returned to the valid range, the update interval would reduce to 930 ms.

☞ **Note:** As long as the channel is out of range, the register assigned to it will either have data of 0000 (4095 Elevated), under range, or 4096 (8192 Elevated), over range. (Refer to the data value reference chart)

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6.7 Field Connections

User connections are made to a standard screw terminal strip and the rigid wiring system permits module insertion or removal without disturbing the wiring.

6.7.1 B873–012 Terminal Numbering and Wire Connections

B873–012 terminal numbering and corresponding input functions are presented below in Figure 30.

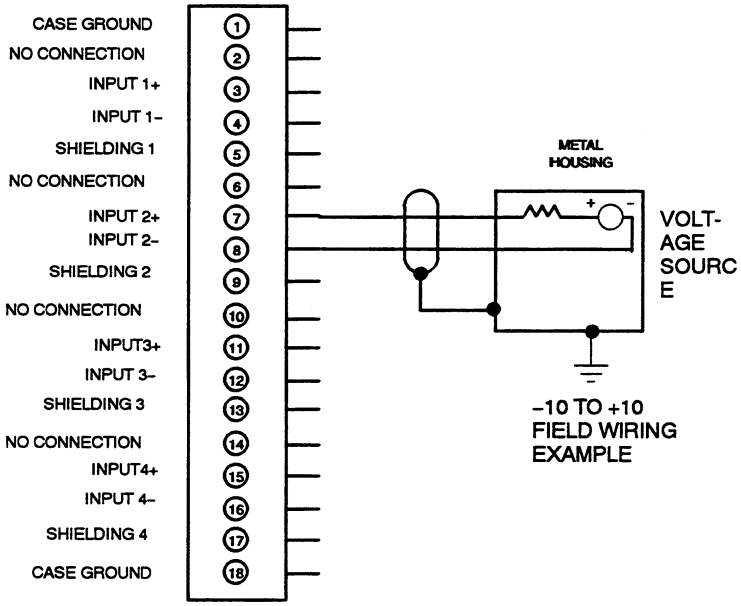


Figure 30 B873–012 Terminal Numbering

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6.7.2 B875–012 Terminal Numbering and Wire Connections

B875–012 terminal numbering and corresponding input functions are presented below in Figure 31.

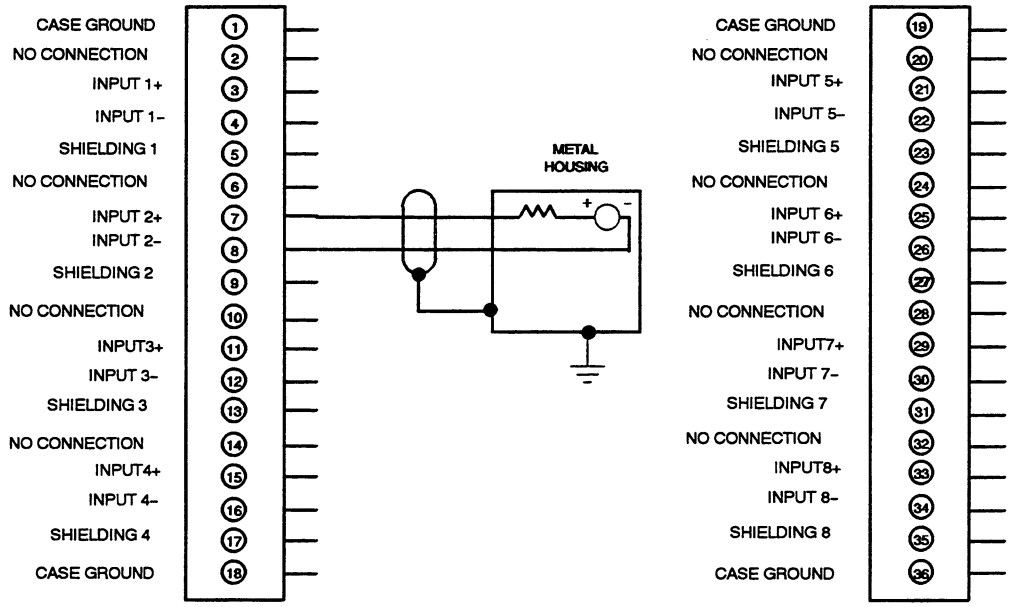


Figure 31 B875–012 Terminal Numbering

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6.8 Specifications

B873-012 and B875-012 Specifications

Description		Analog input, –10 ... +10 Vdc
Number of Channels	B873–012	Four
	B875–012	Eight
Operating Range		–10 ... +10 Vdc
Impedance		0.5 MΩ/input
		1 MΩ differentially
Resolution		13 bit
Filter		–3 dB @ 18 Hz
		Rolloff –20 dB/decade
Linearity		±.05% of full scale @ 25° C (77° F)
Protection		240 Vac RMS
Common Mode	Range	0 ... 30 Vac RMS
	Rejection	> –86 dB @ 60 Hz
Isolation	Channel to Channel	250 Vac RMS
	Input to Case	500 Vac RMS for 1 min
	Module	1500 Vac RMS for 1 min
		300 Vac RMS continuous
Accuracy	Overall	17.1 mV
	@ 25°C (77°F)	1.2207 mV
	Offset Drift	100 µV/° C (55.6 µV/° F)
	Gain Drift	±15 ppm/° C (±8.3 ppm/° F)
Repeatability		Over a 24 hr period, with a constant voltage and at a constant operating temperature, the input data value will be within ±2 counts.
Power Required	+5 V	300 mA
	+4.3 V	300 mA
	–5 V	0 mA
Data Format	0000	Power up
		On diagnostic failure or during failure recovery
		Under range
	0001 ... 8191	Valid
	8192	Over range
Throughput Rate Update Interval	Four channels	400 ms
	Eight channels	710 ms (including diagnostics)
	Out of Range	220 ms for each channel under- or over-range
Terminal Connector	B873–012	AS–8533–001
	B875–012	AS–8533–002

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Chapter 7
B875–102 High Speed Analog Input

- ☐ Overview
- ☐ Inputs
- ☐ Performance Considerations
- ☐ Communications with the PLC
- ☐ Typical Circuit and Ground Connections
- ☐ Switch Settings
- ☐ Indicators
- ☐ Recalibration
- ☐ Installation
- ☐ Specifications

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7.1 Overview

The B875–102 High Speed Analog input module is a field point input device for a Modicon PLC. The module accepts four or eight analog voltage (or current) signal inputs from its field circuitry, converting them to numerical data values proportional to the analog input. It is used both in a local or remote I/O configuration for applications such as motor drives (along with appropriate interfacing devices) and a variety of process control sensors and instrumentation—e.g., thermal sensors, thermocouple or strain gage amplifiers, optical transducers, displacement sensors, accelerometers, and flow, pressure, vacuum, or force gage amplifiers.

The module may be configured to four or eight input circuit configurations. For example, the input circuits may be organized in two groups of 2 (or 4) input circuits through the use DIP switches. Each group may have a different input signal range.

The module accepts input current signals (e.g., 20 mA current loop applications) through a built–in resistor which converts the input current to a voltage drop. Voltage input may be on one input circuit group while current is on the other. The module digitizes the input signals to a resolution of one part in 4096. The resultant digital word for each input circuit is processed and shipped out to the controller for its use. The input module presents new data for all input circuits to the controller no later than 3.0 ms for the eight circuit configuration.

The factory calibrated 10.00 V should be recalibrated annually. The module performs auto calibration (based on this reference) as needed during operation to compensate for stability drift due to external influences such as temperature.

The module is capable of computing *moving averages* for the sampled signal of each input circuit. In this case, the *moving average* is defined as an unweighted average of the last n samples of the input signal, where $n = 1, 2, 4, 8, 16, 32,$ or 64 samplings; $n = 1$ implies instantaneous value rather than an average. When the averaging option is invoked by the user, the moving average value is reported for each sample, for each input circuit.

The module is also capable of presenting its digitized data output to the PLC in raw or converted binary format. Under appropriate conditions, the latter format enables the B875–102 module to appear as if it were a DVM.

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7.1.1 Simplified Block Diagram

In the diagram, data flows essentially from left to right while control is the opposite. The remaining text in this section takes you through the block diagram: the block functions are keyed (n) to the text.

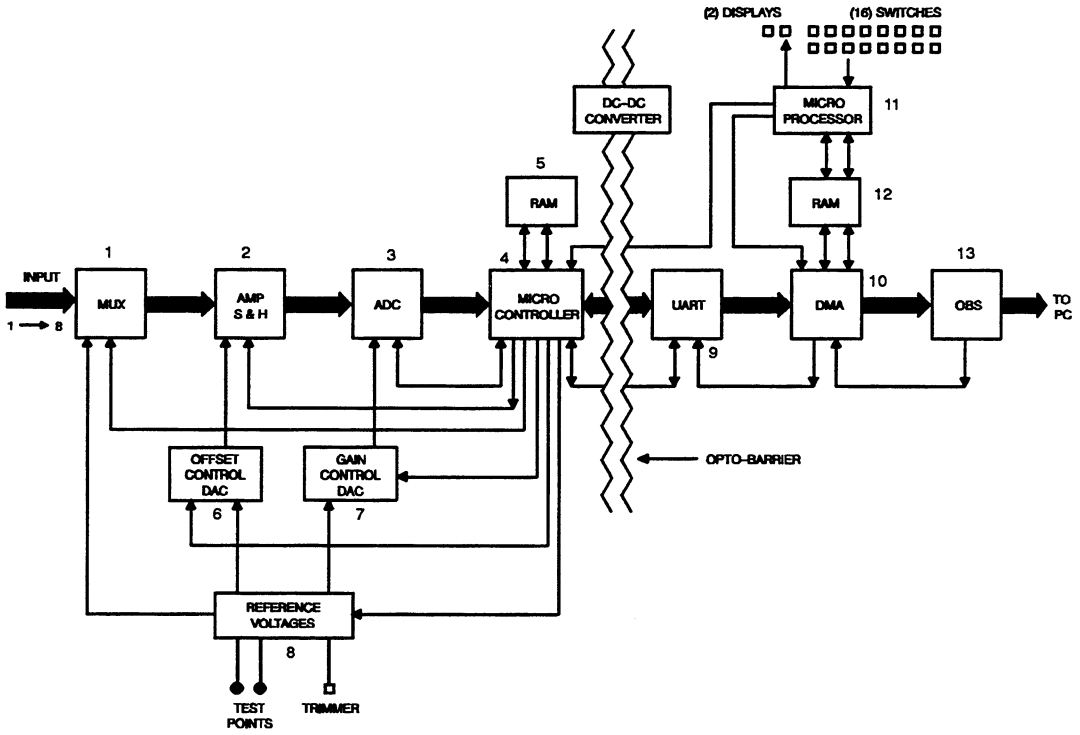


Figure 32 Input Module – functional Block Diagram

Up to eight inputs may come into the module. The analog Multiplexer (MUX) (1) selects the input and passes it to the Programmable Gain Amplifier/Sample & Hold circuit (2) which latches and holds the signal while it is processed by the Analog–to–Digital converter (ADC).

The ADC (3) digitizes the signal which is then acquired by the Microcontroller (4). After the ADC conversion process has started, the MUX is switched to the next input requiring processing.

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Through an internal autocalibration process, the microprocessor monitors and sends information to the microcontroller to adjust signal processing in the analog front end thereby compensating for drift due to influences such as temperature. The autocalibration function employs feedback mechanisms to adjust the reference voltage (8) and send values to the DACs (6), (7) controlling both *gain* and *offset* for the signal being processed.

The microcontroller collects digitized data from various inputs and references in its Random Access Memory (RAM) (5) and ships the data across the opto−barrier upon request from the system side. The opto−barrier provides electrical isolation between the field side and system side.

On the system side, data is received by the UART (9) and transferred to RAM (12) by the DMA controller (10). The DMA controller is also responsible for sending data to the Ourbus interface (13), on demand, from RAM.

The microprocessor (11) performs digital filtering (*moving average*) and format conversions on the RAM data as specified by the configuration switches and controls the status indicators. Autocalibration algorithms are also executed by the microprocessor and control information is forwarded to the microcontroller at appropriate times.

Internal diagnostics are used to check major components during power−up and at run−time; timing is also checked to keep all activities in synchronization.

The A/D converter measures voltage by successive approximation for fast digitization. The module's circuitry also features low noise design characteristics.

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7.2 Inputs

Module inputs are configurable in two groups by means of DIP switches. Switch group assignments for the four or eight input circuit configurations are as follows:

Input Circuit Configuration

Configuration	Input Group A	Input Group B
Eight input circuits	1, 2, 3, 4	5, 6, 7, 8
Four input circuits	1, 2	3, 4

Five input ranges are acceptable to each input range group. The module will accept an input as much as 2% FSR above its specified range without going into an over−range condition but nothing below range:

Input Ranges

Voltage Range (V)	Corresponding Current Range (mA)
0 ... 5	0 ... 20
0 ... 10	0 ... 40
1 ... 5	4 ... 20
−10 ... +10	−40 ... +40
−5 ... +5	−20 ... +20

For purposes of determining load and protection considerations for the inputting of field circuits, Figure 33 diagrams the input circuit's front end. Note the built−in 250 Ω resistor connected to the current input terminal. When the current sense terminal is externally jumpered to the positive input terminal, current input becomes possible for that input regardless of voltage range selected.

☞ **Note:** The current sense function has been provided specifically for 4 ... 20 mA current loop applications (1 ... 5 V input range). However, current mode is operable on all ranges.

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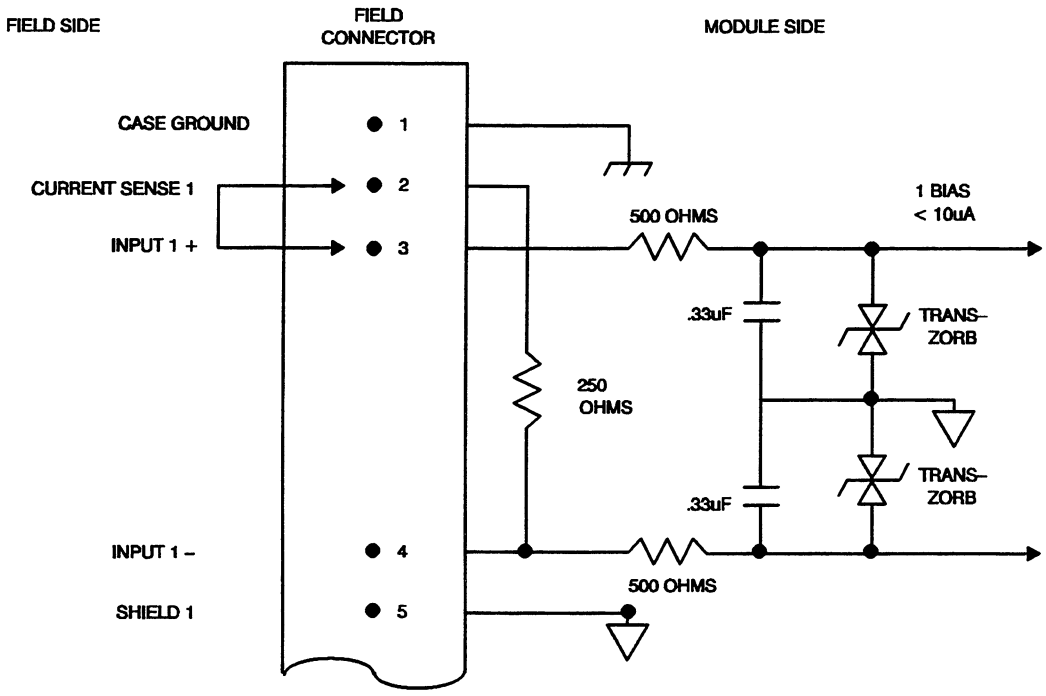


Figure 33 Input Circuit Front End

☞ **Note:** Shield is tied to the ground within the module on the field side of the opto–barrier.

☞ **Note:** Circuit shown with current sense input jumpered to +Input terminal for current inputs (instead of voltage inputs).

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7.3 Performance Considerations

7.3.1 Data Update Period

The data update period is the time taken by the module to present fresh data for each channel. With four input circuits, this period is no more than 2.4 ms; for an eight input circuit configuration, this period is no more than 3.0 ms.

7.3.2 Autocalibration

An internal autocalibration process is executed at appropriate times (if necessary) to compensate signal processing for front end drift. The autocalibration function employs feedback mechanisms to adjust the reference voltage to offset gain in the analog to digital converter. Calibration is monitored continuously in the background and adjusted if and when necessary. Figure 34 shows autocalibration points for all five input ranges. Autocalibration points are indicated by heavy dots on slope line.

The autocalibration process uses the 10 V reference to calibrate the module. The reference voltage is factory preset to exactly 10 V (zeroed to four places). It should be readjusted in the field once per year.

7.3.3 Input Data Conversion

The input module performs an analog–to–digital conversion of an input analog signal with 12 bit resolution (i.e., 1 part in 4096). This implies that the least significant bit of the output code corresponds to slightly more than 0.024% of full scale.

Figure 34 is a coarse grain conversion chart for plotting analog input against the equivalent numerical value output to the PLC in raw binary format. The example illustrated shows an input voltage of 1.25 V (25% of 5 V FSR) and a numerical count of 1024 (25% of 4200) as projected through the 45° slope line.

Calculate exact values using the following proportional equation:

$$\frac{\text{Analog Input}}{\text{FSR}} = \frac{\text{Output Count}}{\text{FCR}}$$

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Where: FSR is full scale range for analog input (including bipolar) and FCR is full count range (4200) in a raw binary format.

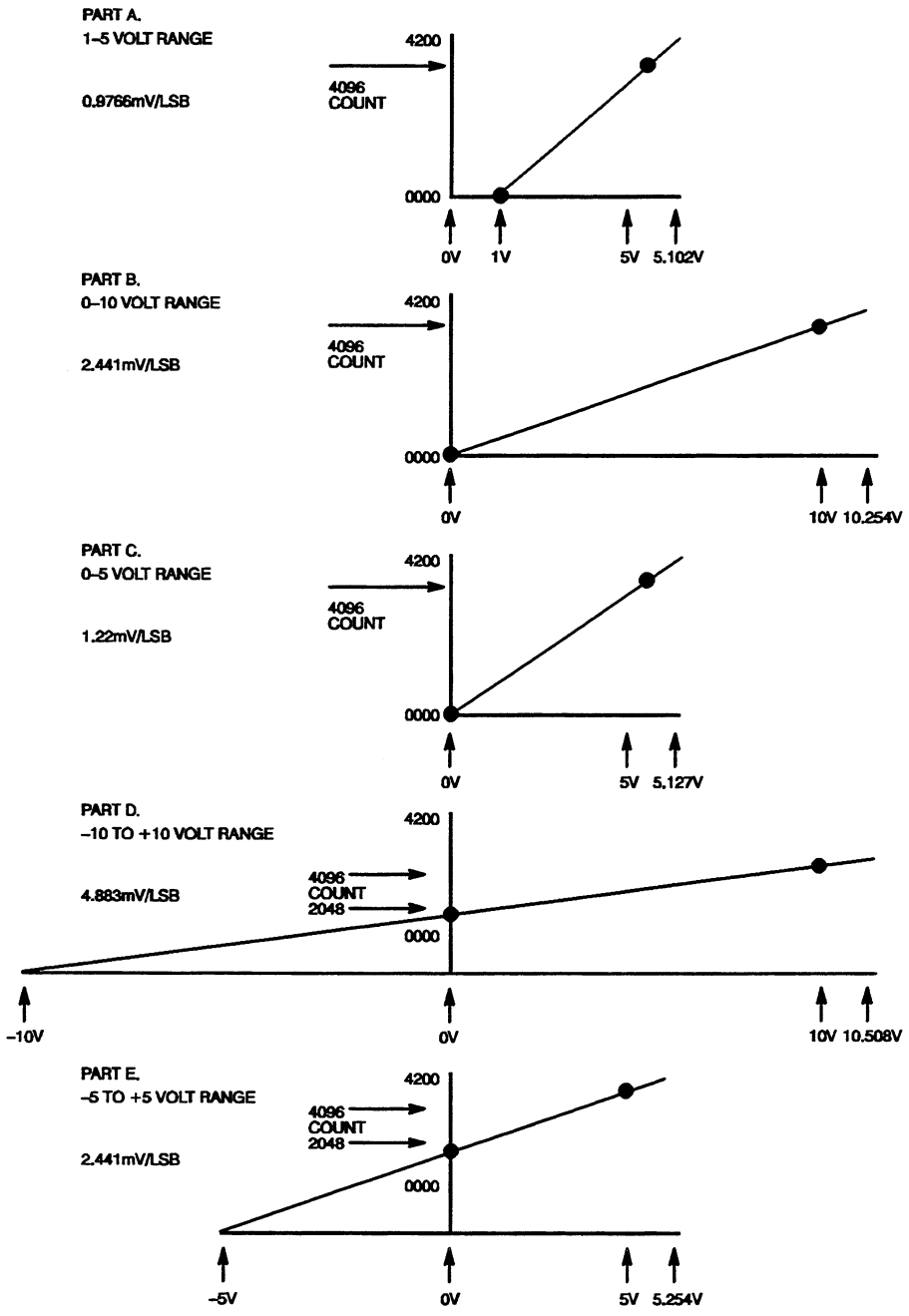
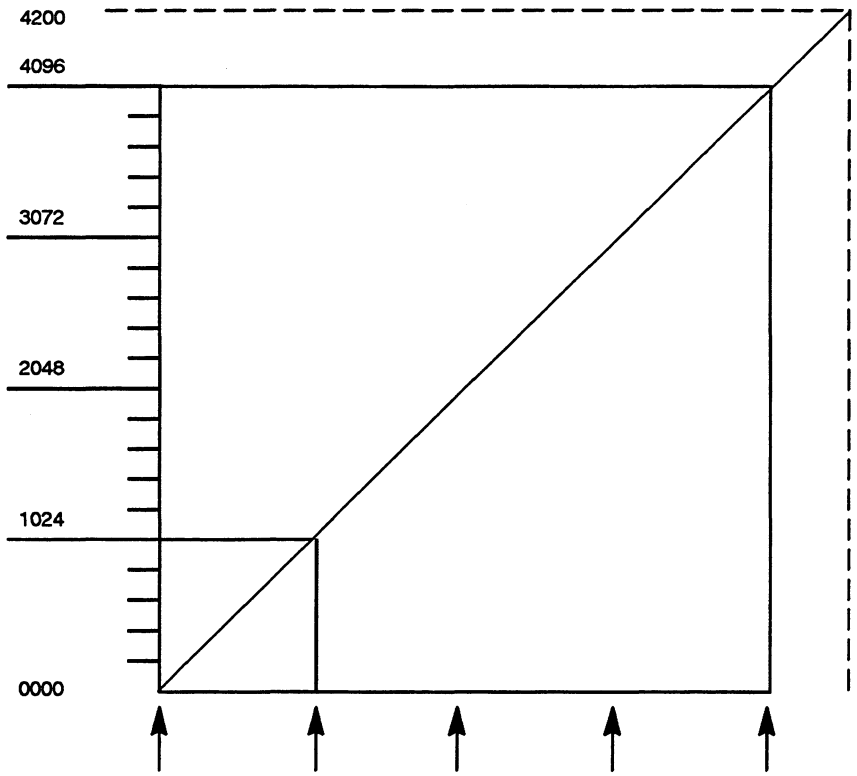


Figure 34 B875–102 Autocalibration Points – All Ranges

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V.	Range 0 ... 5 V	0.0	1.25	2.5	3.75	5.0	5.127
I.	Range 0 ... 20 mA	0.0	5.0	10.0	15.0	20.0	20.500
V.	Range 0 ... 10 V	0.0	2.5	5.0V	7.5	10.0	10.254
I.	Range 0 ... 40 mA	0.0	10.0	20.0	30.0	40.0	41.016
V.	Range –5 ... +5 V	–5.0	–2.5	0.0	2.5	5.0	5.254
I.	Range –20 ... +20 mA	–20.0	–10.0	0.0	10.0	20.0	21.016
V.	Range –10 ... +10 V	–10.0	–5.0	0.0	5.0	10.0	10.508
I.	Range –40 ... +40 mA	–40.0	–20.0	0.0	20.0	40.0	42.032
V.	Range 1 ... 5 V	1.0	2.0	3.0	4.0	5.0	5.102
I.	Range 4 ... 20 mA	4.0	8.0	12.0	16.0	20.0	20.400

Figure 35 Input Signal vs. Output Data (Raw Binary Format)

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7.3.4 Format Conversion

The module is capable of presenting the digitized data to the PLC in either raw binary (RB) or converted binary (CB) format. The bit pattern in each case is different. The format is switch selectable and need not be the same for each group of input circuits. A Modicon programmer will display either type of data in one of three different ways: binary, hexadecimal, or decimal form.

7.3.5 Conversion Accuracy

Conversion linearity for this module is $\pm$ 0.05% of full scale– referenced to a straight line drawn through the measured full scale value and the measured zero point – over the module's operating temperature range.

7.3.5.1 Raw Binary (RB) Format

After digitizing the input signal, the input module presents data in RB format. In decimal representation, data in RB format must be within the 0 to 4200 range. Normally, a 12–bit device would have an upper data limit of 4095. This analog module has the means of allowing the input to be up to 2% over–range at the same resolution (i.e., the count in raw binary may go up to 4200). In RB format, the data range is the same regardless of the voltage range.

7.3.5.2 Converted Binary (CB) Format

CB is obtained by transforming the RB format within the module. When CB data is viewed by the PLC or programmer in decimal mode, it looks like a 4–digit voltmeter (DVM) with no sign or decimal point. In CB format, upper and lower data limits are voltage range dependent. Because of the missing sign, CB format is used only for unipolar voltage ranges.

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Figure 36 shows an example of raw binary output. When a 5 V signal is digitized by the module set for the 0 ... 10 V range, it produces a converted binary code 0800 hex or 2048 decimal.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Figure 36 Raw Binary Word Format

Figure 37 shows the conditions in converted binary format which produce 1388 hex or 5000 decimal.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0

Figure 37 Converted Binary Word Format

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7.4 Communications with the PLC

Data can be in either raw binary or converted binary format. Within the 2% maximum over–range margin allowed, no error code is reported to the PLC.

Input Ranges & Output Data Limits

Voltage Range	Input Voltage	Raw Binary	Converted Binary
0 ... 5 V	0.000	0000	0000
	5.000	4096	5000
	5.127 (max)	4200	5127
1 ... 5 V	1.000	0000	1000
	5.000	4096	5000
	5.127 (max)	4200	5102
0 ... 10 V	0.000	0000	0000
	9.999	4095	9999
	10.000	4096	N/A
	10.254 (max)	4200	N/A
–5 ... +5 V	–5.000	0000	Disallowed
	0.0000	2048	N/A
	5.000 (max)	4096	N/A
	5.254	4200	N/A
–10 ... +10 V	–10.000	0000	Disallowed
	0.000	2048	N/A
	10.000	4096	N/A
	10.508 (max)	4200	N/A

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7.4.1 Diagnostic Communications

Diagnostic procedures are executed during the five second initialization period following power−up. Diagnostic routines are also run during wait states concurrent with executing A/D conversions. System diagnostics are: RAM checks, ROM checks, UART checks, as well as checking the legality of configuration switch settings and monitoring the ability to autocalibrate.

If the module fails to pass an internal diagnostic, two retries are made. If either one succeeds, the temporary failure is considered a *soft* failure and is not reported to the PLC but the module system continues processing uninterrupted. If the module fails the diagnostic three times, the system goes into a power−up reset condition.

☞ **Note:** While power−up diagnostics are running, or following detection of a hard failure, data is not available to the PLC.

7.4.1.1 Good Data

Figure 38 shows status flags and data word format for good data to the PLC. When sending good data, status flag bits 14 and 15 are reset to *0*.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	RAW BINARY DATA												
0	0	CONVERTED BINARY DATA													

Figure 38 Good Data Word Output toPLC

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7.4.1.2 Out-of-Range-Data

Figure 39 shows status flags and data word format of out−of−range data output to the PLC. When sending out−of−range data, status bit 14 will be reset to *0*, bit 15 will be set to *1*, and the OUT−OF−RANGE indicator will go on.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	RAW BINARY DATA												
1	0	CONVERTED BINARY DATA													

Figure 39 Out-of-Range Data Word Output to PLC

Out−of−Range requires careful examination. Since the module receives instantaneous data from the field but sends averaged data to the PLC, instantaneous data less than *0* or greater than 4200 in RB format is considered out−of−range. Such data will be forced (clamped) to 0000 for under−range and 4200 for over−range values. However, the averaged data will not necessarily be out−of−range if the condition existed for less time than the total averaging period.

In this case, the format indicates at least one of the instantaneous data samples in the average is out of range. Its value for averaging purposes is the clamped value; the average may or may not be out of range. The red OUT−OF−RANGE light will remain ON as long as an out−of−range data sample is included in the average.

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7.5 Typical Circuit and Ground Connections

Figure 40 shows typical field circuitry connected to the field connector.

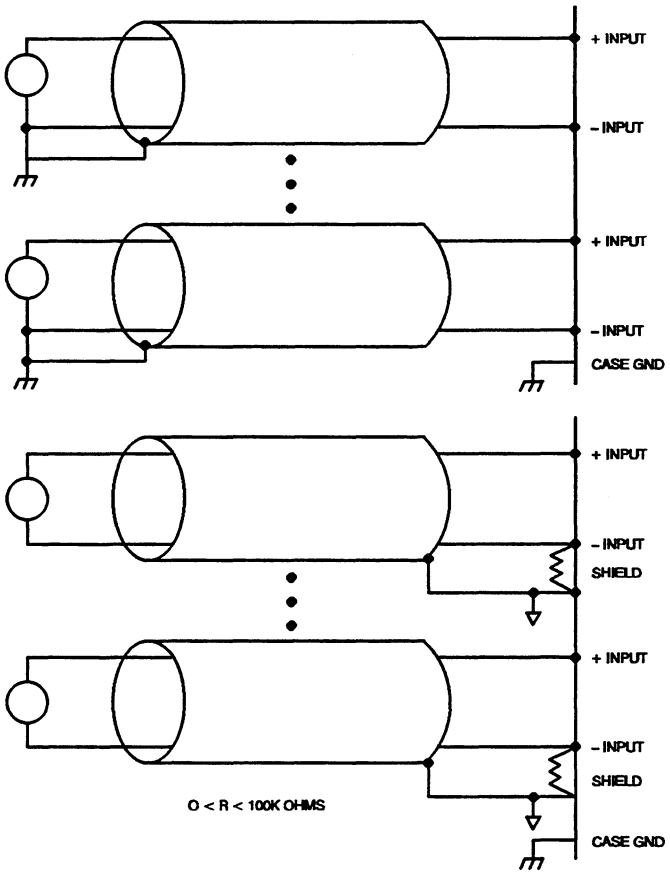


Figure 40 Typical Field Circuit Connections

☞ **Note:** Shields 1 ... 8 are tied together internally and also to field side ground within the module. For grounded sources, a jumper to case ground must be externally supplied by the user.

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7.6 Switch Settings

The high speed analog input module can be set for any of the five input voltage or current ranges by means of DIP switches. You can also select from seven periods of digital filtering; a feature which allows an instantaneous voltage sample to become part of a moving average. The DIP switches also set the module for 4 or 8 circuit mode and binary or decimal output.

For discussion purposes, we will designate the upper DIP switch bank, *A* (DIP Sw–A) and lower bank, *B* (DIP Sw–B). These switches are accessed through ports at the rear of the module.

Figure 41 and Figure 42 illustrate the *A* and *B* switch banks as seen from the rear of the module. Sw–A is used for selecting an input range and Sw–B for selecting input averaging.

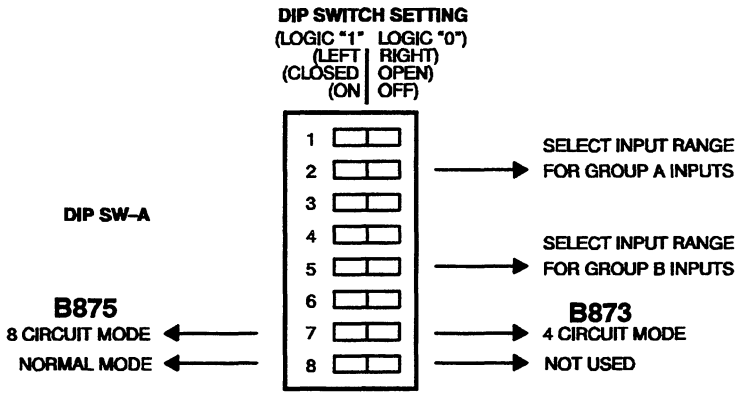


Figure 41 DIP Switch Bank A – Normal Operation

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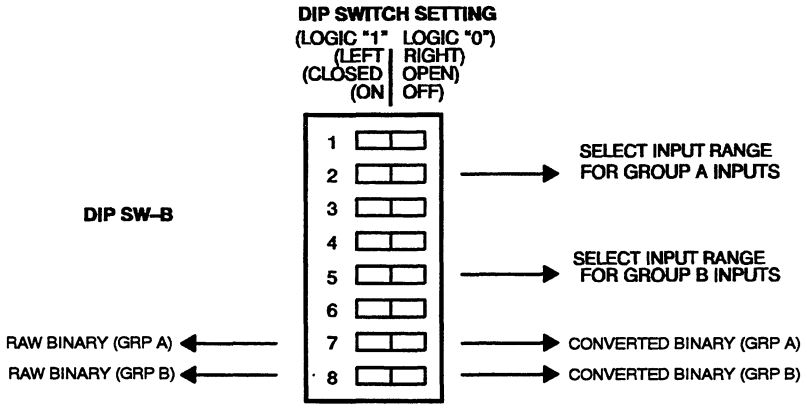


Figure 42 DIP Switch Bank B – Normal Operation

☞ **Note:** Both Sw–A and Sw–B follow the same switch setting conventions:

- ON, CLOSED, LEFT, and logic "1" all mean the same
- OFF, OPEN, RIGHT, and logic "0" all mean the same
- The switch bank views shown are looking at the back of the module

7.6.1 How to Set Your Input Range

SW–A settings for all input ranges for both 8 and 4 input configurations, respectively, are shown in the following tables. SW–A has two functions in addition to input range setting:

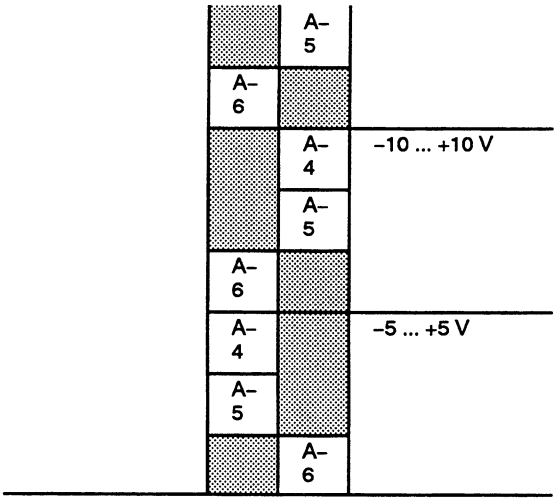
- Switch A7 is ON for an 8–circuit configuration and OFF for a 4–circuit configuration
- Switch A8 must be ON for normal operation

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SW–A Settings for All Ranges (Eight Circuits)

Group	State ON	State OFF	Input Range
A (Inputs 1 ... 4)	A–1		1 ... 5 V
	A–2		(4 ... 20 mA)
	A–3		
		A–1	0 ... 10 V
	A–2		
	A–3		
	A–1		0 ... 5 V
		A–2	
	A–3		
		A–1	–10 ... +10V
		A–2	
	A–3		
	A–1		–5 ... +5V
	A–2		
		A–3	
B (Inputs 5 ... 8)	A–4		1 ... 5 V
	A–5		(4 ... 20 mA)
	A–6		
		A–4	0 ... 10 V
	A–5		
	A–6		
	A–4		0 ... 5 V

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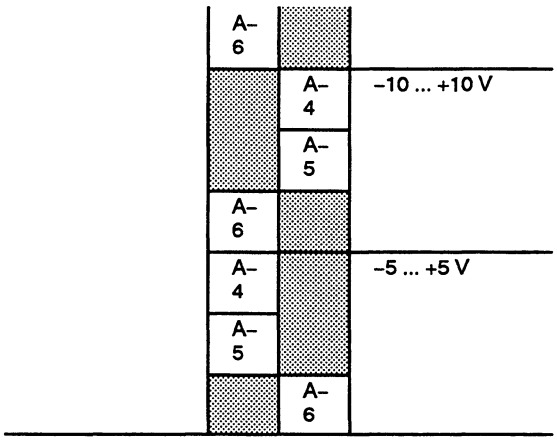


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SW–A Settings for All Ranges (Four Circuits)

Group	State		Input Range
	ON	OFF	
A (Inputs 1 ... 2)	A–1		1 ... 5 V
	A–2		(4 ... 20 mA)
	A–3		
		A–1	0 ... 10 V
	A–2		
	A–3		
	A–1		0 ... 5 V
		A–2	
	A–3		
		A-1	–10 ... +10 V
		A-2	
	A-3		
	A–1		–5 ... +5 V
	A–2		
		A–3	
B (Inputs 3 ... 4)	A–4		1 ... 5 V
	A–5		(4 ... 20 mA)
	A–6		
		A–4	0 ... 10 V
	A–5		
	A–6		
	A–4		0 ... 5 V
		A–5	

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7.6.2 How to Setup for Input Averaging

It is possible to compensate for spurious noise and other forms of amplitude modulation coming through the analog input filter by making the latest input sample part of a moving average – a form of digital filtering. This moving average technique has no affect upon the update interval.

The following tables show SW–B settings for selecting among seven input average sample periods for both 8 and 4 circuit configurations.

SW–B has other functions in addition to average sampling; Switch B7 is set to ON for binary code output or OFF for decimal code output for Group A (inputs 1 ... 4 in the 8 circuit mode and inputs 1 ... 2 in the 4 circuit mode). Switch B8 does the same for Group B.

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SW–B Settings for All Periods of Input Averaging (Eight Circuits)

Group	State ON	State OFF	# of Samples Averaged
A (Inputs 1 ... 4)	B–1		1
	B–2		
	B–3		
		B–1	2
	B–2		
	B–3		
	B–1		4
		B–2	
	B–3		
		B–1	8
		B–2	
	B–3		
	B–1		16
	B–2		
		B–3	
		B–1	32
	B–2		
		B–3	
	B–1		64
		B–2	
		B–3	

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SW–B Settings for All Periods of Input Averaging (Eight Circuits)

Group	State		# of Samples Averaged
	ON	OFF	
B (Inputs 5 ... 8)	B–4		1
	B–5		
	B–6		
		B–4	2
	B–5		
	B–6		
	B–4		4
		B–5	
	B–6		
		B–4	8
		B–5	
	B–6		
	B–4		16
	B–5		
		B–6	
		B–4	32
	B–5		
		B–6	
	B–4		64
		B–5	
		B–6	

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SW–B Settings for All Periods of Input Averaging (Four Circuits)

Group	State		# of Samples Averaged
	ON	OFF	
A (Inputs 1 ... 2)	B–1		1
	B–2		
	B–3		
		B–1	2
	B–2		
	B–3		
	B–1		4
		B–2	
	B–3		
		B–1	8
		B–2	
	B–3		
	B–1		16
	B–2		
		B–3	
		B–1	32
	B–2		
		B–3	
	B–1		64
		B–2	
		B–3	

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SW-B Settings for All Periods of Input Averaging (Four Circuits)

Group	State		# of Samples Averaged
	ON	OFF	
B (Inputs 3 ... 4)	B-4		1
	B-5		
	B-6		
		B-4	2
	B-5		
	B-6		
	B-4		4
		B-5	
	B-6		
		B-4	8
		B-5	
	B-6		
	B-4		16
	B-5		
		B-6	
		B-4	32
	B-5		
		B-6	
	B-4		64
		B-5	
		B-6	

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7.7 Indicators

The following standard front panel indicators reflect module communications status with the controller and provide an indication of field–side signal status.

Indicator Status Summary

Indicator	State	Condition
ACTIVE	ON	The module is communicationg properly with the PLC
	OFF	The module failed the internal diagnostic test which tests to determine if valid communication is possible
OUT OF RANGE	OFF	All inputs are within the valid input range
	BLINKING	One or more inputs are outside the valid input range

The traffic cop for a eight-circuit configuration (B875) and four-circuit configuration (B873 look alike).

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7.8 Recalibration

Since the module is shipped factory calibrated, it is the designer's intention that the 10V reference voltage adjustment will be good for one year. It should be recalibrated annually thereafter.

The following tools are needed to adjust the B875–102 analog input module's reference voltage:

- ☐ A precision digital readout voltmeter with an accuracy of ±0.0001 V on a 10 V scale: 6 $^1/_2$ digits, to guarantee ±4 bit count accuracy.
- ☐ A $^1/_8$ in bit, thin blade screwdriver
- ☐ A small-bit Phillips screwdriver
- ☐ An adhesive for securing trim pot adjustment screws (e.g., Locktite or Glyptol)

Step 1 As shown in Figure 43, remove the reference voltage adjustment cover to gain access to the trim pot.

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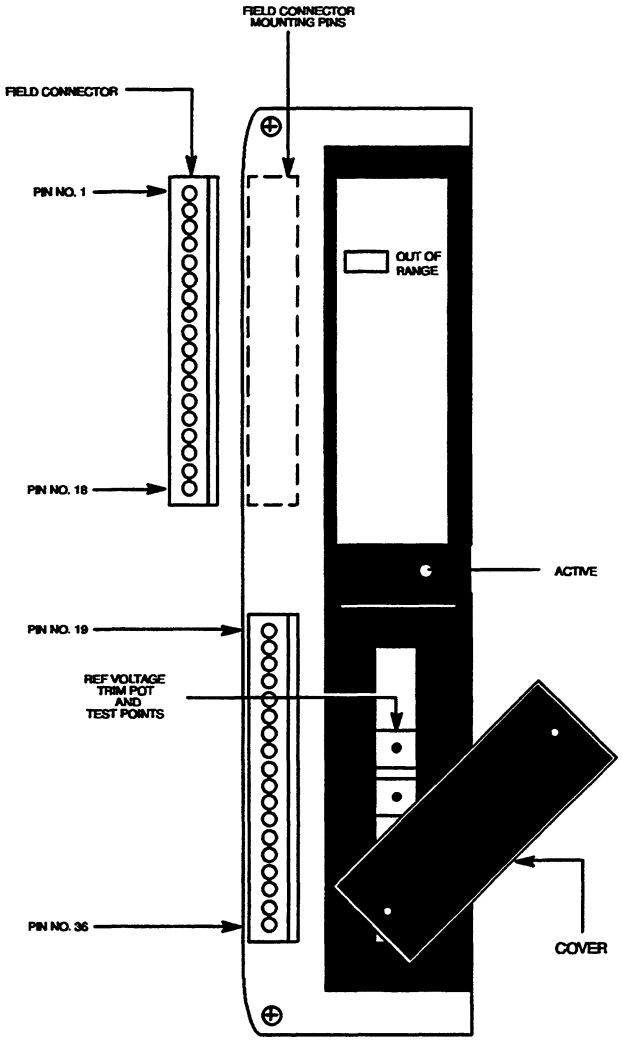


Figure 43 Reference Voltage Trim Pot Adjustment

Step 2 Connect your DVM as shown in Figure 44.

☞ **Note:** Field wiring may remain connected during this adjustment as the module's working state is not interactive with the reference voltage adjustment. Also, the module does not require warmup to attain temperature.

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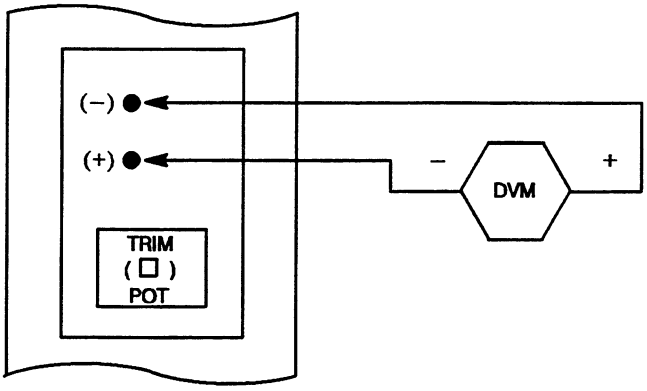


Figure 44 Reference Voltage Adjustment Circuit

Step 3 Adjust the reference voltage trim pot for exactly 10 V, zeroed to four places (10.0000).

Step 4 Secure the trim pot with adhesive.

Step 5 Disconnect the voltmeter and secure the trim pot access cover.

Step 6 Turn OFF the power to the housing.

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7.9 Installation

Installation of your module involves; unpacking the module, setting up the configuration switches, installing key pins in the housing, mounting the module in the housing and wiring the connector.

Step 1 Remove the module from its shipping box and check for physical damage. If damage is found, contact your distributor (or salesman) for the correct return procedure.

Step 2 Ensure that power to the housing is OFF.

Step 3 Referring to Section 7.6, configure switch bank A as follows:

- ☐ A−1 through A−6 for the desired input voltage ranges appropriate to the eight- or four-circuit configuration planned
- ☐ A7 to select the eight- or four-circuit input mode
- ☐ A8 to ON for normal operation

Step 4 Referring to Section 7.6, configure switch bank B as follows:

- ☐ B−1 through B−6 for the desired number of input averaging samples appropriate to the eight- or four-circuit configuration designated above
- ☐ B7 to select the output code format

Step 5 If using key pins (provided with housing shipment), install them above and below housing slot selected for this modules installation.

Step 6 Open the handle and insert the module into the housing, firmly seating the edge connector in the backplane

Step 7 Secure the module using captive mounting screws at the top and bottom of the module's front panel.

Step 8 Referring to the pinout diagram in Figure 45, connect the field side wiring to the double field connector (located on the left side, front edge), laying in your cable fan−out as desired.

☞ **Note:** Recommended field connector wiring sizes are AWG 16 ... 20 inclusive (solid or stranded).

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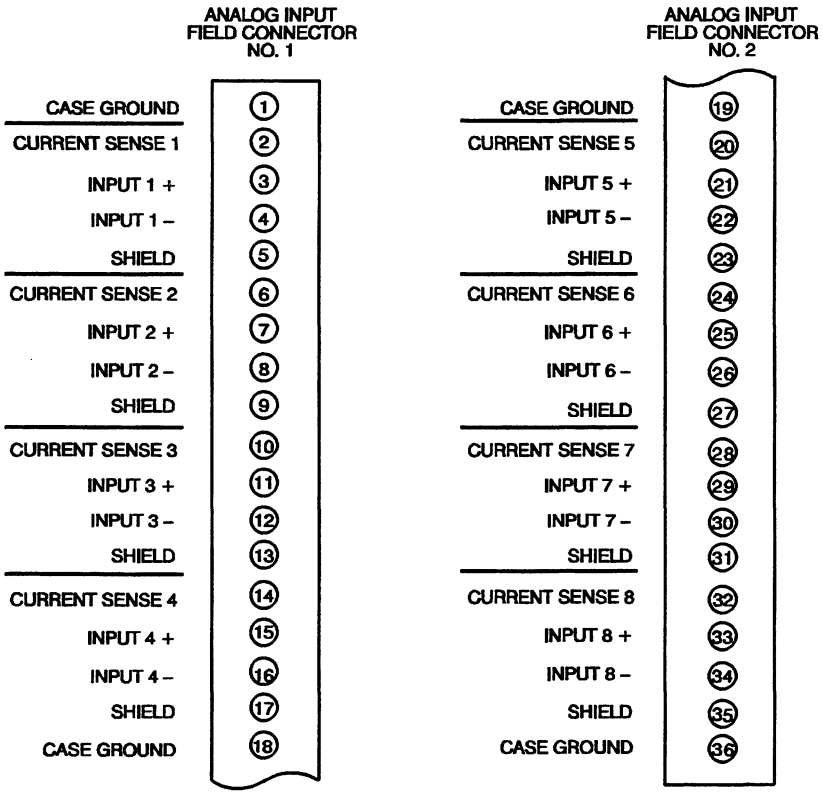


Figure 45 Field Connector/Input Circuit Pinout

Step 9 If a current sense input circuit(s) is being used, jump the appropriate current sense terminal on the field connector to the corresponding hot input (+) as previously shown in Figure 45.

☞ **Note:** The correct method of terminating unused inputs, required to reduce ingress of electrical noise, and, module misreads due to floating input lines.

The unused voltage or current terminals, including the shields, on the field connector should be jumpered to case ground.

Case ground will only be effective if the H8XX housing is connected to earth ground.

The shield cannot be connected, both ends, to the device and the module. The exception to this is where the device shield is part of the device input circuit, and is not connected internally to device case ground.

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If over−range and under−range detection is important to your process, and this detection is causing throughput problems with the unused channels, (because they float or spike outside the range) then the unused voltage or current channels at the field connector, should be connected in parallel to a valid input channel. As long as the valid channel stays within range, the tied channels will also stay within range.

For current, 4 ... 20 mA operation, the valid input is the only input requiring the 250 Ω resistor to be in the circuit.

Step 10 Per Figure 46, mount the two *wired* field connectors on the analog module with Pin 1 positioned at the top and the field wiring to the left.

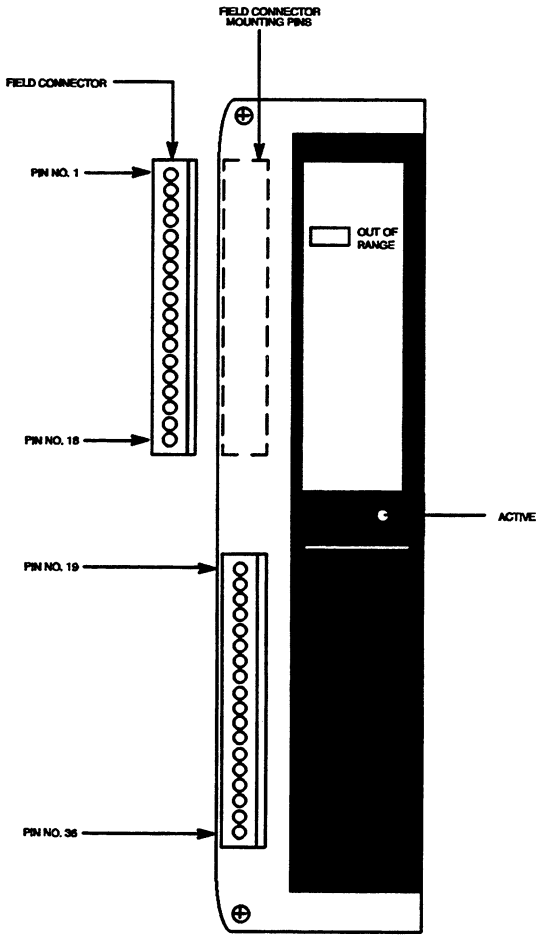


Figure 46 Field Connector Mounting

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Step 11 Close the module handle

Step 12 Turn ON power to the housing if desired.

☞ **Note:** When operating in voltage mode and an open circuit condition occurs the input may take several seconds to decay to zero, due to the front end RC network. If open circuit detection is required, the module should be used in current mode. The addition of the 250 ΩR forces the RC to discharge rapidly.

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7.10 Specifications

B875-102 Specifications

Description		Fast A/D voltage or current input
Number of Channels	B873/B875	Four or eight isolated inputs
Operating Range	Voltage	1 ... 5 Vdc
		0 ... 5 Vdc
		0 ... 10 V
		–5 ... +5 V
		–10 ... +10 V
	Current	4 ... 20 mA
		0 ... 20 mA
		0 ... 40 mA
		–20 ... +20 mA
		–40 ... +40 mA
Impedance	Voltage Mode	> 10 MΩ /input differentially
		1.5 kΩ with power removed
	Current Mode	250 Ω/input
Resolution		12 bit
Filter		Single Pole dc to 1.0 kHz
Linearity	Error	±.05% of full scale over range operating temp range
	Differential	±0.0244% of full scale @ 25°C (77°F)
Protection		120 Vac differential input (voltage mode only)
Common Mode	Range	Input voltage plus common mode voltage less than 12 V
	Rejection	> –70 dB, dc to 60 Hz
Isolation	Input to Case	1500 Vac RMS for 1 min
	Input to Input	30 Vdc
	Input to OUR-BUS	1500 Vac RMS for 1 min
Accuracy	@ 25°C (77°F)	±0.1% of full scale (±4 counts)
	Over 0 ... 60°C	±0.25% of full scale (±10 counts)
Repeatability		±0.25% of full scale (±10 counts) of full scale RMS, constant temperature, no averaging
Autocalibration		High/low range points recalibrated during run time
Power-up Time		5 s maximum
Warm-up Time		5 s concurrent with power–up
Power Required	+5 V	650 mA max, 300 mA typical

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	+4.3 V	975 mA max, 550 mA typical
	–5 V	0 mA
Data Format	0000	Power Up
	8000 Hex	Out of Range
	0001 ... 4200	Valid – All Ranges
	9068 Hex	Over Range
Data Update Period Rate	Four channels	2.4 ms
	Eight channels	3.0 ms (including diagnostics) No additional time penalty for process or data for out-of-range condition
Terminal Connector		AS–8533–004

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Chapter 8
B875–111 Analog Input

- ☐ Overview
- ☐ Module Configuration
- ☐ Field Connections
- ☐ Quick Start Test
- ☐ Application Example
- ☐ Calibration
- ☐ Quick Reference
- ☐ Specifications

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8.1 Overview

The B875−111 Analog analog−to−digital (A/D) Input Module converts input voltage and/or input current ranges into binary data. This module can be configured to accept eight differential or 16 single-ended inputs. When selected for eight differential inputs, the module is displayed in the I/O map as a *B875−111*; when selected for 16 single-ended inputs, it is displayed in the I/O map as a *B877−111*.

The module allows you to poll a wide array of field devices requiring different voltages and different currents based upon your unique application. You can select from five available input voltage ranges on a module-wide basis. The ranges, which are 0 ... 5 V, 1 ... 5 V, −5 ... +5 V, 0 ... 10 V, and −10 ... +10 V, are selected by means of four DIP−switches on the Module Configuration Switch.

You can select from three available input current ranges—0 ... 20 mA, 4 ... 20 mA, and −20 ... +20 mA.

You can select from four available output formats. The formats, which are standard, elevated, full resolution, and decimal, are selected by means of two DIP−switches on the Module Configuration Switch.

You can select either no averaging, or 8, 16, or 32 sample inputs to be averaged to generate each output by means of two DIP switches on the Module Configuration Switch.

The module has eight/sixteen analog inputs and is capable of updates to all channels every 10 ... 20 ms. The greater than 12−bit resolution and the absolute accuracy of ±0.1% at 0 ... 60° C provides precise control of your application.

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8.1.1 Simplified Schematic

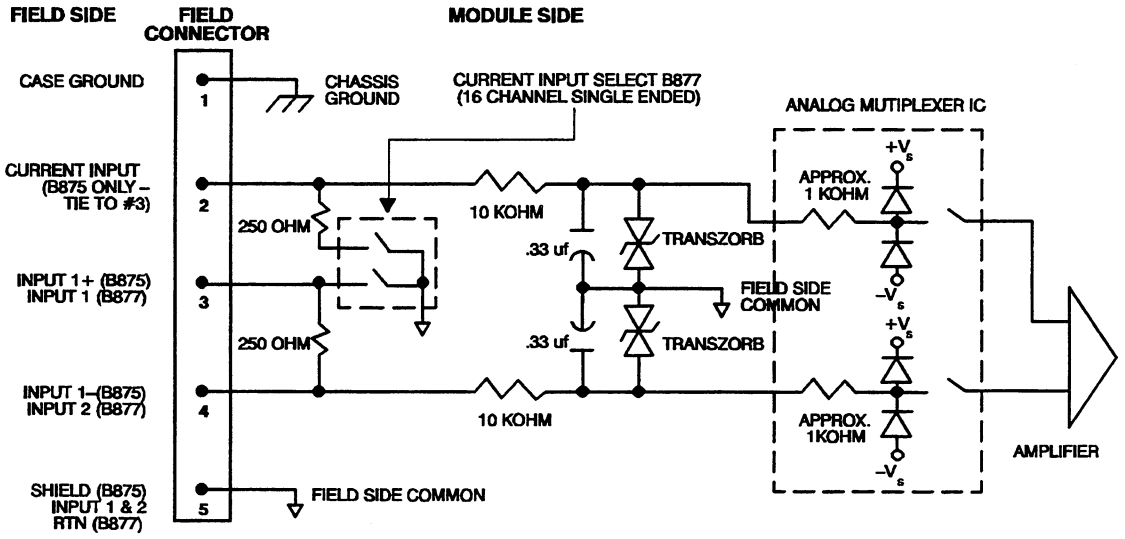
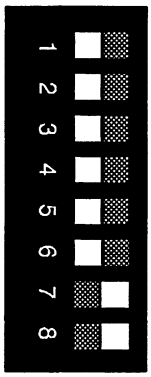


Figure 47 B875–111 Simplified Schematic

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8.2 Module Configuration

Step 1 Set the Module Configuration Switch and the five-position DIP switch based upon your application needs prior to installing. The Analog Input module is shipped in the 1 ... 5 V range with 0 ... 4095 output format (standard), one sample averaged, and voltage inputs, 8 channel (B875–111)—i.e., all DIP switches to the right.



SWITCH TO FUNCTION RELATIONSHIP

SW1= BIPOLAR/UNIPOLAR

SW2= ALL OTHER RANGES/1 ... 5 V, 4 ... 20 mA

SW3= OUTPUT FORMAT

SW4= OUTPUT FORMAT

SW5= NO. OF SAMPLES AVERAGED

SW6= NO. OF SAMPLES AVERAGED

SW7= 16/8 CHANNELS

SW8= 10 V/5 V

SWITCHES	FUNCTIONS
SW1	**INPUT RANGE** FOR BIPOLAR (±10 V, ±5 V, ±20 mA): SW1 = L FOR UNIPOLAR (0 ... 10 V, 0 ... 5 V, 0 ... 20 mA, 1 ... 5 V, 4 ... 20 mA): SW1 = R
SW2	**INPUT RANGE** FOR OFFSET (1 ... 5 V OR 4 ... 20 mA): SW2 = R FOR NO OFFSET (ALL OTHER RANGES): SW2 = L

Figure 48 Module Configuration DIP Switch Settings

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SWITCHES	FUNCTIONS
SW3&4	**OUTPUT FORMAT** *SEE TABLE 20 FOR RESOLUTIONS FOR STANDARD (0000 ... 4095): SW3 = R AND SW4 = R FOR ELEVATED (4096 ... 8191): SW3 = L AND SW4 = R FOR FULL RESOLUTION (RAW BINARY): SW3 = R AND SW4 = L FOR DECIMAL (0001 ... 9999): SW3 = L AND SW4 = L
SW5&6	**SAMPLES TO AVERAGED** FOR 1 SAMPLE: SW5 = R AND SW6 = R FOR 8 SAMPLES: SW5 = L AND SW6 = R FOR 16 SAMPLES: SW5 = R AND SW6 = L FOR 32 SAMPLES: SW5 = L AND SW6 = L
SW7	**INPUT TYPES** FOR 8 DIFFERENTIAL: (B875) SW7 = R FOR 16 SINGLE ENDED: (B877) SW7 = L
SW8	**INPUT RANGES** FOR 10V (±10 V OR 0 ... 10 V): SW8 = L FOR 5V (ALL OTHERS): SW8 = R

Figure 49 DIP-Switch Settings Cont.

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8.2.1 Output Format Selection

The following table provides the output formats and their resolution relationships:

Output Format and Resolution Relationship

Output Format	Under Range	Normal Range	Over Range	Resolution	Actual Format
Standard	0000	0000 ... 4095	4096	12 bits	Raw binary, unsigned
Elevated	4095	4096 ... 8191	8192	12 bits	Raw binary, unsigned
Full resolution	Bit 16 =1	Bit 16 =0	Bit 16 =1	Bipolar=1/15000 counts	*Raw binary and two flags
	Bit 15 =1	Bit 15 =0	Bit 15 =0	Unipolar= 1/7500 counts	
		1 ... 7499		Offset=1/6000 counts	
Decimal	Bit 16 =1	Bit 16 =0	Bit 16 =1	Bipolar= 1/10000 counts	*Raw binary and two flags
	Bit 15 =1	Bit 15 =0	Bit 15 =0	Unipolar= 1/7500 counts	1 ... 9999 counts
		1 ... 9999		Offset= 1/6000cts	1 ... 9999 counts

* When an under or over range condition exists the output word contains the applicable flag and the under or out-of-range value.

Standard output format is raw binary output, 0 ... 4095 counts. Under range is 0000 and over range is 4096.

Elevated output format is raw binary output, 4096 ... 8191 counts. Under range is 4095 and over range is 8192.

Full resolution output format provides the true resolution of the module which depends on the input range.

- ☐ Bipolar inputs produce an output of 0001 ... 14,999 counts
- ☐ Unipolar inputs produce an output of 0001 ... 7499 counts
- ☐ Unipolar and offset inputs produce an output of 0001 ... 5999 counts

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In the full resolution format, out−of−range values of ±2.4% may be read to the specified accuracy of the module. They can be read in this manner. When an out−of−range condition occurs which is over range the MSB (bit 16) is set to 1. If an under range occurs the second MSB (bit 15) is also set to 1. The remaining 14 bits give the absolute value of the amount over or under range. For example, for a unipolar input of 5.120 V the output would have bit 16 set to 1. The remaining output bits equaling the raw binary representation of 120 mV. Any input above the .120 V in this range will not be within the specified accuracy of the module.

Decimal output format allows scaled outputs to provide 0001 ... 9999 counts full scale. This format does not indicate the true resolution of the module. For bipolar inputs the output is scaled down and for unipolar inputs the output is scaled up. This format also reports out-of-range values in the same manner as the full resolution mode.

☞ **Note:** For unipolar and unipolar with offset input ranges, the process of scaling the lower resolution output values to the 1 ... 9999 output format creates the possibility of missing codes due to rounding off of numbers in the microcontroller.

☞ **Note:** At power−up, or after a reset the module transfers 4000 Hexadecimal during its internal reset, and initialization time until valid data is ready to be transferred. (4000 Hexadecimal corresponds to the second MSB = 1, all other bits = 0).

Step 2 Locate the four access holes on the left side of the module. These holes allow access to three four−position and one five−position DIP switch.

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8.2.2 Input Selection

Step 3 Set switch position 5 (SW5) of the five–position DIP switch found in the bottom access hole on the left side of the module, to select input range. This switch must correspond to switch position 8 (SW8) of the eight–position module configuration DIP switch. SW5 and SW8 settings must be identical. Refer to Figure 50 and Figure 53.

WHERE:	**SWITCHES**	**FUNCTIONS**
	SW5	**INPUT RANGES** FOR 10V (±10 V OR 0 ... 10 V): SW5 = L FOR 5V (ALL OTHERS): SW5 = R

Figure 50 Input Range Settings

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8.3 Field Connections

There are two ways to configure the Analog Input module to accept current inputs; for 16 single ended inputs or for 8 differential inputs.

8.3.1 Eight Differential Current/Voltage Inputs (B875)

Step 1 If you are configuring a B875–111 for eight differential current inputs, note the channels that are receiving these inputs. Current inputs are selected by placing a jumper on the field connector between the positive voltage input and the current input terminal for the appropriate channel. For example, If channel 2 is to receive a current input a jumper must be made between terminal #7 (CH2), and terminal #6 (Current Input CH 2). Refer to Figure 51.

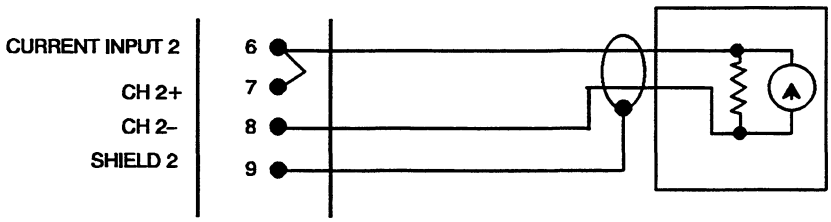


Figure 51 Current Input Example

Caution: DIP switches accessible through side cover are not used in differential mode, and should be left in the voltage input position, as set at the factory.

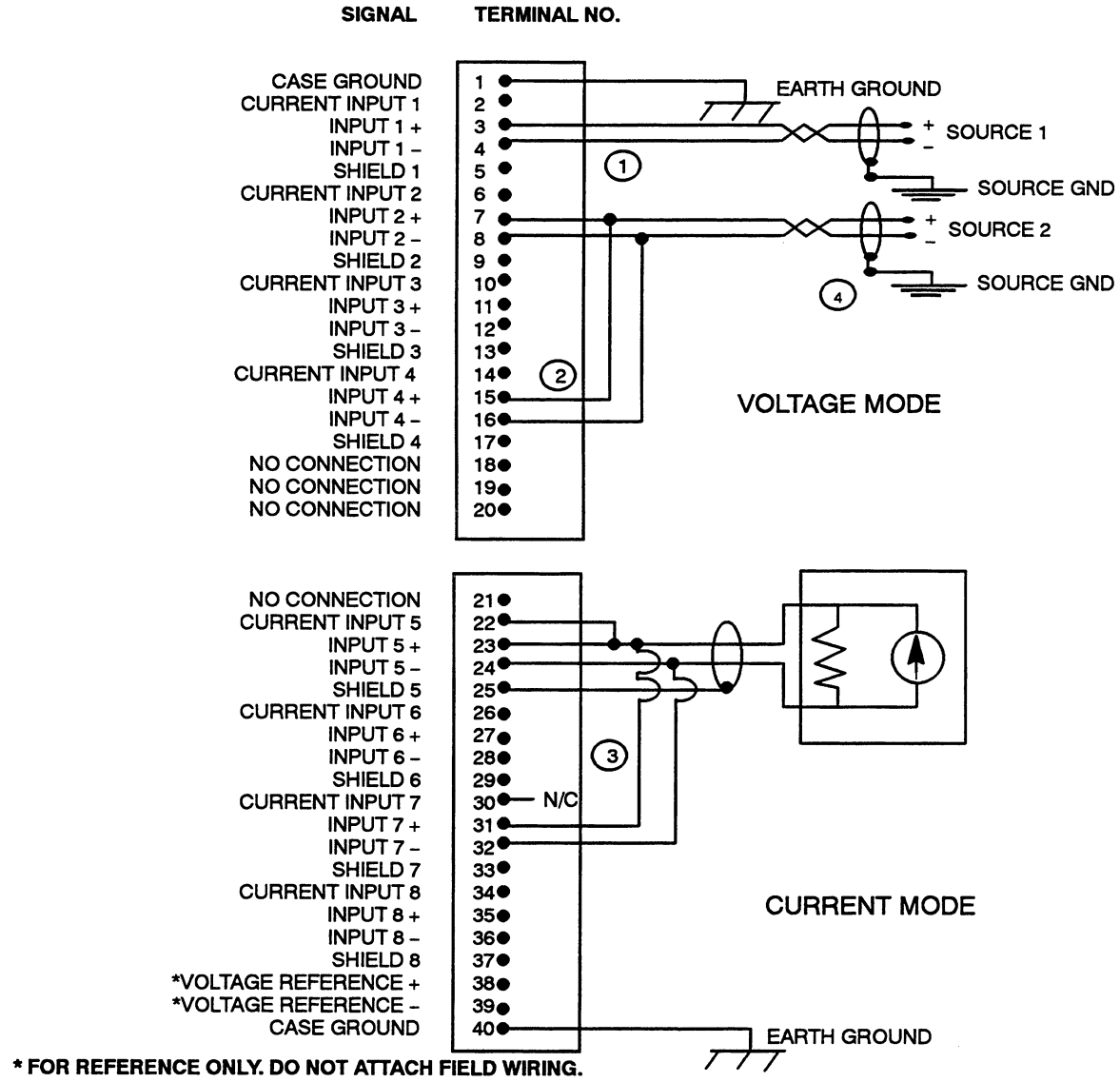
Note: You can have both current and voltage inputs only if one of these three conditions exist: 1 ... 5 V and 4 ... 20 mA, or 0 ... 5 V and 0 ... 20 mA, or ±5 V and ±20 mA.

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Step 2 Referring to Figure 52, connect field side wiring to proper pins on the field connector when the Analog Input module is configured for 8 differential inputs. Voltage inputs do not require a jumper on the field connector.

☞ **Note:** Open circuit voltage inputs may drift either positively or negatively. If open circuit detection is required a current input should be used. When using voltage inputs an open circuit can be detected if a large value resistor (2 MΩ or greater) is placed at the field connector across the plus (+) and negative (−) inputs. The resistor clamps the channel to a small offset voltage (<100 mV), if the field connections are broken.

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*** FOR REFERENCE ONLY. DO NOT ATTACH FIELD WIRING.**

1 SHIELDS 1–8 ARE COMMON AND TIED TO FIELD SIDE GROUND.

2 JUMPER UNUSED CHANNELS IN PARALLEL WITH A VALID INPUT TO AVOID OUT OF RANGE ERRORS.

3 WHEN TERMINATING UNUSED CHANNELS IN CURRENT MODE, DO NOT JUMPER THE "CURRENT INPUT" PIN OF THE UNUSED CHANNEL.

4 WHEN USING SHIELDED FIELD CIRCUIT WIRES, GROUND SHIELD AT ONE END ONLY.

Figure 52 Typical Field Circuit Connections, 8 Differential Inputs (B875)

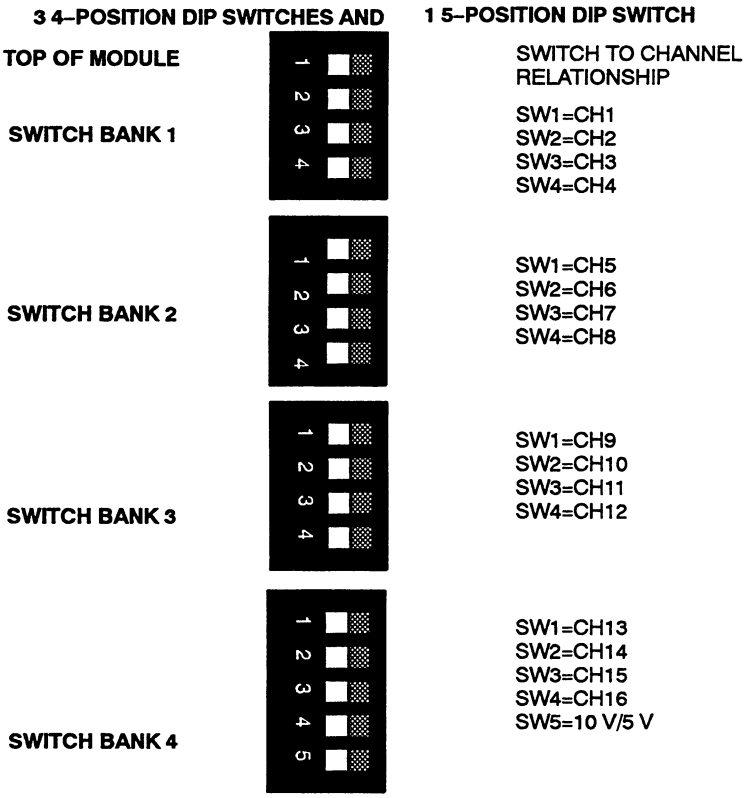
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8.3.2 16 Single Ended Current/Voltage Inputs (B877)

Step 1 If configuring a B877−111 for 16 single ended inputs, refer to Figure 54 for field connections for either voltage or current inputs. (Remember that the module will be displayed in the I/O map as a B877−111 module in this configuration.) Current inputs are selected by setting the DIP switches accessible through the side cover for each channel that is receiving an input. This switch places a 250 Ω precision resistor between the plus input and analog return.

The fifth switch (SW5) on switch bank 4, located on the left side selects the voltage range for both B875 and B877 operation. This switch must correspond to (SW8) of the module configuration switch, located on the rear of the module. Refer to Figure 53 for the DIP switch settings. Also, refer to the label located on the left side of the Analog Input module itself.

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WHERE:	SWITCHES	FUNCTIONS
		CURRENT INPUTS
	SWITCH BANK 1	FOR CHANNELS 1 ... 4 : SW1 ... 4 = RIGHT SIDE DOWN
	SWITCH BANK 2	FOR CHANNELS 5 ... 8: SW1 ... 4 = RIGHT SIDE DOWN
	SWITCH BANK 3	FOR CHANNELS 9 ... 12: SW1 ... 4 = RIGHT SIDE DOWN
	SWITCH BANK 4	FOR CHANNELS 13 ... 16: SW1 ... 4 = RIGHT SIDE DOWN
		INPUT RANGES
	SWITCH BANK 4	FOR 10 V (±10 V OR 0 ... 10 V): SW5 = LEFT SIDE DOWN
		FOR 5 V (ALL OTHERS): SW5 = RIGHT SIDE DOWN

Figure 53 Current Settings for Single Ended Inputs (B877)

Caution: DIP switches accessible through side cover are not used in differential mode, and must be left in the voltage input position, as set at the factory.

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Step 2 Referring to Figure 54, connect field side wiring to proper pins on the field connector when the Analog Input module is configured for 16 single ended inputs.

☞ **Note:** Open circuit voltage inputs may drift either positively or negatively. If open circuit detection is required a current input should be used. When using voltage inputs an open circuit can be detected if a large value resistor (2 MΩ or greater) is placed at the field connector across the plus (+) and negative (−) inputs. The resistor clamps the channel to a small offset voltage (<100 mV), if the field connections are broken.

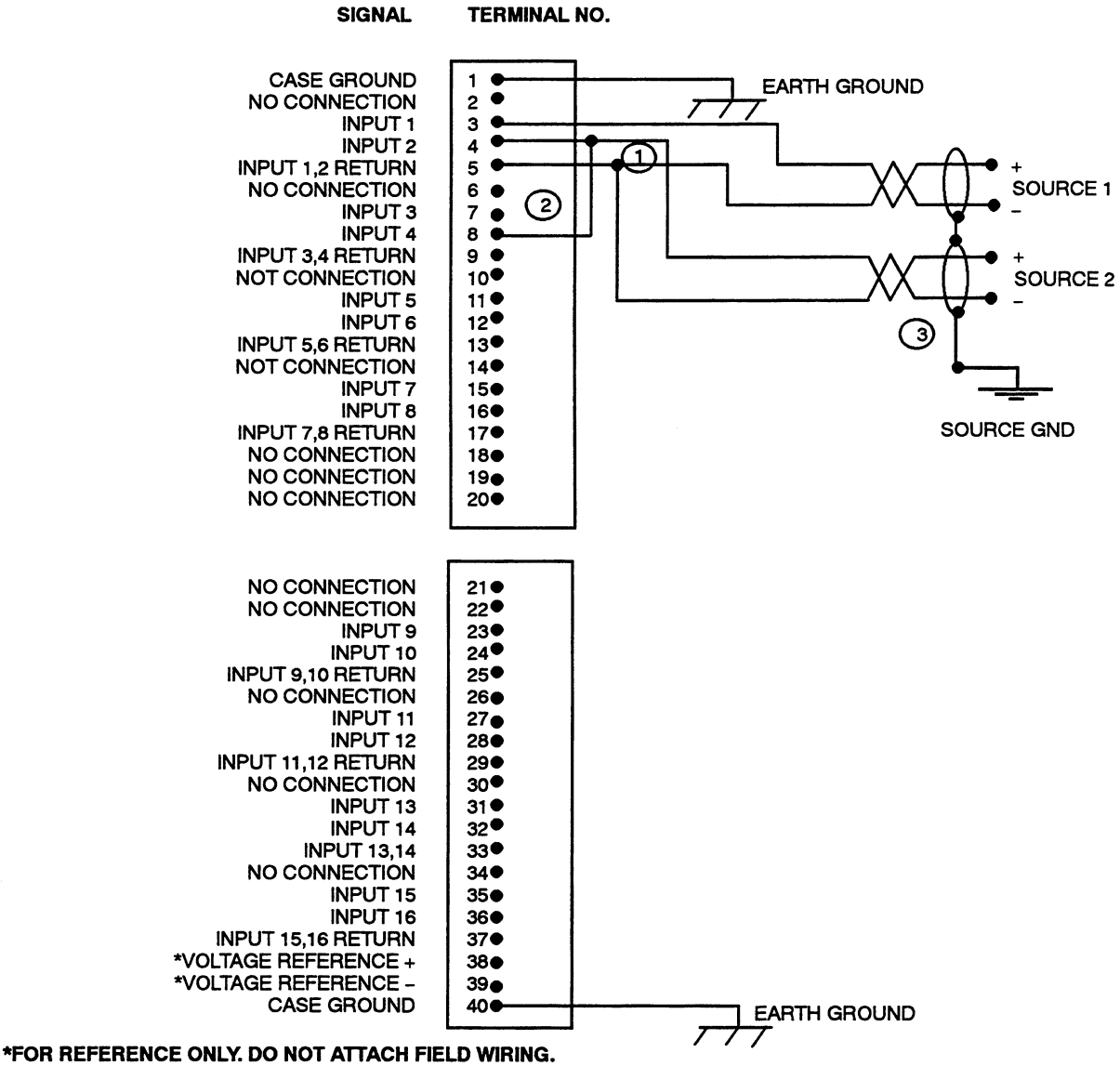
Step 3 Re−install any module temporarily removed.

Step 4 When using key pins (provided with housing shipment), install them above and below the housing slot selected for this module's installation.

Step 5 Insert the module into the housing firmly but carefully, seating the edge connector in the backplane.

Step 6 Secure the module to the housing using the captive slotted mounting screws at the top and bottom of the module front panel.

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***FOR REFERENCE ONLY. DO NOT ATTACH FIELD WIRING.**

1 ALL RETURNS ARE ELECTRICALLY TIED TOGETHER INSIDE THE MODULE.

2 JUMPER UNUSED CHANNELS IN PARALLEL WITH A "VALID" INPUT TO AVOID OUT OF RANGE ERRORS. YOU MUST SELECT VOLTAGE MODE FOR THE UNUSED CHANNEL.

3 WHEN USING SHIELDED FIELD CIRCUIT WIRES, GROUND SHIELD AT ONE END ONLY.

Figure 54 Typical Field Circuit Connections, Single Ended Inputs (B877)

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8.4 Quick Start Test

This test configures a B875−111 eight−channel differential module as follows: 0 ... 10 V input range, 0 ... 4096 counts output format, and no sample averaging.

Step 1 Set the Module Configuration Switch as follows: (viewing the rear of the module when held vertically)

Switch	Position	Selection
SW1	Right	Selects Unipolar Inputs
SW2	Left	Selects no offset (not 1 ... 5 V, 4 ... 20 mA)
SW3 and SW4	Right	Selects 0 ... 4096 output format
SW5 and SW6	Right	Selects no averaging
SW7	Right	Selects 8 channel (B875)
SW8	Left	Selects 10 V inputs

Step 2 Set the Voltage/Current Switches as Follows: All channels set for voltage inputs 10 Vdc input range. Place all switches (located below the side access holes) to the left.

Step 3 Wire input terminal 38 to 3 and terminal 39 to 4 on AS−8535−000 high density connector.

☞ **Note:** Terminals 38 ... 39 are a voltage reference only (4.5000 Vdc). They are not to be used for anything other than this test and calibration of the module.

☞ **Note:** Remove the keying tabs on the AS−8535−000 high density connector prior to installing module.

Step 4 Determine which channel and slot location are being used for this module.

Step 5 Stop the controller, turn power off and insert module, then power up.

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Step 6 I/O map the module as a B875, registers 30001 ... 30008 binary.

Step 7 Start the controller.

Step 8 Confirm that the modules active light is illuminated.

☞ **Note:** Active on steady = OK. Active blinking = OK, but inputs may be out of range.

Step 9 Monitor input 30001 it should read approximately 1843 decimal.

☞ **Note:** 4096 format / 10 V range = 409.6 counts/V
409.6 X 4.5000 Vdc = approximately 1843 decimal.

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8.5 Application Example

8.5.1 Set-up

8.5.1.1 Configuration Switch Pack

The B875−111 can be configured to accept eight differential inputs or 16 single-ended inputs. The selection is made via switch 7 on the configuration switch pack, found at the rear of the module. SW7 in the left position is equal to 16 inputs, in the right position it is equal to 8 inputs.

In addition to selecting the number of inputs, you also select voltage range, output format, polarity, offset and number of samples. Refer to the Installation Instructions and the DIP−switch chart on the left side of the module for details.

For a quick start setup, you can use the following settings to interface a 0 ... 10 V input signal. For the following input parameters:

- ☐ 0 ... 10 V input
- ☐ 0 to full scale output format
- ☐ One sample
- ☐ Eight differential inputs

Set your switch settings as follows:

SW1 =R
SW2 =L
SW3 =R
SW4 =L
SW5 =R
SW6 =R
SW7 =R
SW8 =L

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8.5.1.2 Input Type Selection (Voltage or Current)

If configured as for eight differential inputs (B875), current inputs (4 ... 20 mA) are selected by placing a jumper at the field connector between the positive voltage input and the current input terminal for the appropriate channel. Refer to Figure 55.

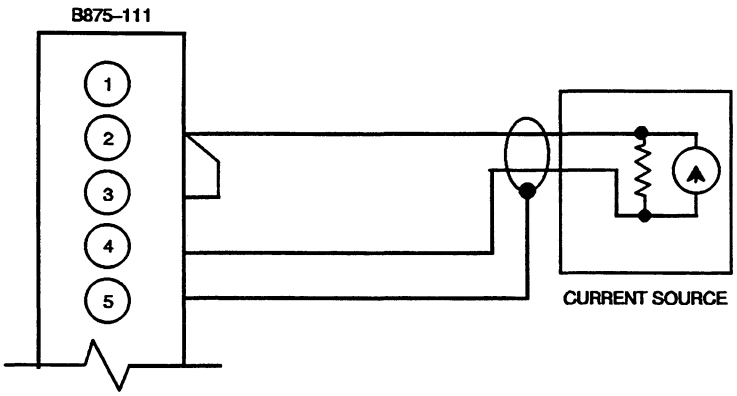


Figure 55 Channel 1 Shown

If configured for16 single ended current inputs (B877), input type is selected by the switches on the left side of the module. There is one switch for each of the 16 inputs. This switch places a 250 Ω precision resistor between the plus input and analog return. External jumpers are not used and must be removed. The left position is equal to voltage input, and the right position is equal to current input.

The fifth switch on switch bank 4 (left side) selects the voltage range for both B875 and B877 operations. This switch must correspond to switch 8 of the configuration switch bank (at rear of module). The left position of SW5 is equal to 10 V, and the right position is equal to 5 V. SW8 must be in the same position as SW5.

For the 0 ... 10 V input signal example, set all the input switches to the left (down or towards the numbers).

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8.5.2 I/O Map

8.5.2.1 S908

Install the module and initialize the I/O map drop. The controller will read the module and the I/O map will indicate the module type and slot location on the screen. If setup for eight differential inputs, the module type will be a B875 and requires eight contiguous 3*x* registers. If setup for 16 single-ended inputs, the module will require 16 contiguous 3*x* registers. Refer to the *J890/J892 Installation Instructions* (GI–J890–001) for switch settings.

8.5.2.2 S901/J200

The I/O map must be updated to reflect the addition of the module to a channel. If the module is configured for eight differential inputs, the I/O map will require eight 3*x* registers. If the module is configured for 16 single-ended inputs, the I/O map will require 16 registers.

Care must be taken when utilizing a S901/J200 and multi–word modules. Refer to the *J810/J812 Installation Instructions* (GI–J810–002) for configuration guidelines and switch settings of the J810/J812 for your particular application.

☞ **Note:** Upon power–up the module's active indicator flashes rapidly showing that communication with the programmable controller has been established but, that the input data being returned is not valid. (4000 Hexadecimal is sent to the controller during the initialization time). When module initialization is complete, and valid input data is being transferred, the indicator is either steady on, or flashing slowly when any input is out–of–range.

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8.5.3 Wire Inputs

The B875–111 and B877–111 requires a high density connector part number AS–8535–000. Refer to the left side of the module for pinouts. Refer to Figure 56.

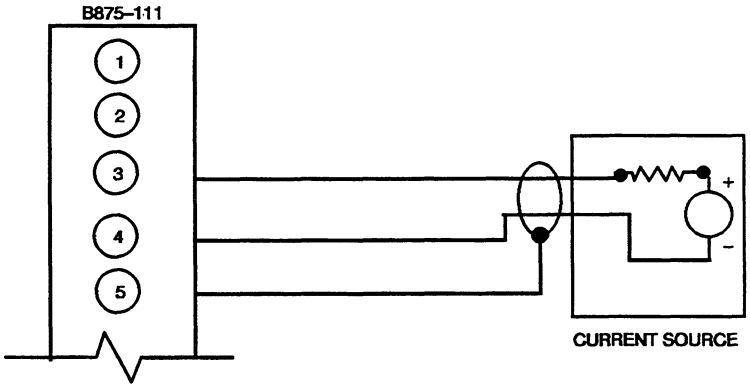


Figure 56 0 ... 10 V Input Example

8.5.4 Module Checkout

The B875–111 and B877–111 will perform an analog to digital conversion on the inputs. The resolution of the analog to digital conversion is dependent upon the input range and output format selected with the configuration switch bank.

Using a Modicon programmer, call up the appropriate I/O mapped registers. Vary the input signal and check that the register content varies correctly.

For the quick start example:

@ 0 V	3*x* = ±001 (decimal)
@ 5 V	3*x* = ±3750
at 10 V	3*x* = ±7500
at 11 V	3*x* > 9999 (decimal)*

* The active light indicator should be flashing indicating the input is out of range.

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8.5.5 Sample Averaging Input Data

The output data can be processed by a low pass digital filter in the module to average out and remove any low frequency noise in the converted input analog data. The digital filter algorithm is:

$$Y_n = Y_{n-1} + \frac{X_n - Y_{n-1}}{2N}$$

where

X_n = Current input data sample
Y_n = New output filter data value
Y_{n-1} = Previous output filter data value

The digital filter alogorithm approximates a classical exponential response characteristic with both the Cut–off Frequency, F_c, and the Time Constant, T_c, related to the Number of Samples to be averaged, N, and the Throughput Time, T. The N is user-selected (8,16, 32) with DIP–Switches. Throughput time, T, equals 10 ms for the B875–111, and 20 ms for the B877–111.

$$T_c = 2 \times N \times T \quad (s)$$

$$F_c = \frac{1}{2 \times Pi \times T_c} = \frac{.08}{N \times T} \quad (Hz)$$

where

Pi = 3.141

As with any filter, the user must establish what Time Constant and Cut–Off Frequency is suitable for the specific application. Below is a reference table that approximates the digital filter characteristics for various user settings.

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Digital Filter Approximates (B875–111)

Through-put Time (T)	Number of Samples (N)	Cut–Off Frequency (F_c)	Time Constant (T_c)
10 ms	8	1 Hz	160 ms
10 ms	16	.5 Hz	320 ms
10 ms	32	.25 Hz	1640 ms

Digital Filter Approximates (B877–111)

Through-put Time (T)	Number of Samples (N)	Cut–Off Frequency (F_c)	Time Constant (T_c)
20 ms	8	.5 Hz	320 ms
20 ms	16	.25 Hz	640 ms
20 ms	32	.125 Hz	1280 ms

Approx. step Settling–time to 63% of final value = 1 x T_c
Approx. step Settling–time to 99% of final value = 4.5 x T_c
Approx. step Settling–time to 99.9% of final value = 6.8 x T_c

☞ **Note:** As your scan time increases your average response time may decrease as viewed in ladder logic.

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8.5.6 Application

In many applications, analog signals are provided to operators in units (points, gal/s, degrees C, ft/min, etc.) via LED displays, CRT monitors or report printouts. An analog input can be scaled to engineering units.

To illustrate the technique, assume that the 0 ... 10 V signal in the quick start example (page 140) represents a temperature from −40 ... +140° F. Refer to Figure 57.

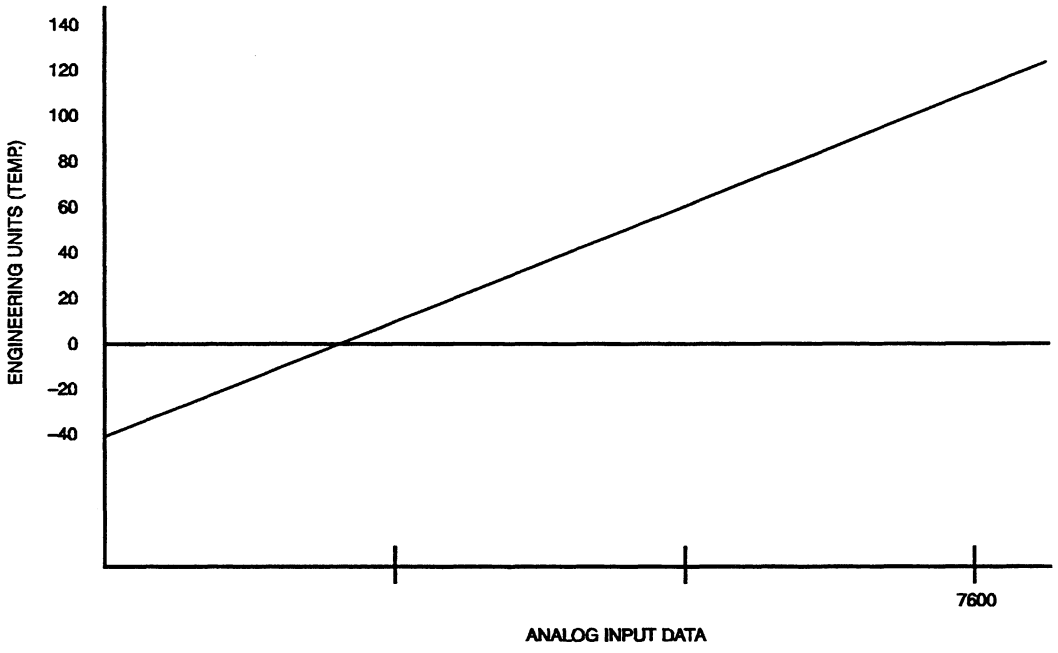


Figure 57 Signal to Temperature Relationship

- ☐ What is the engineering unit range? In this example it is 140 − (−40) = 180.
- ☐ Divide this number by 7500 using a calculator. 180/7500 = .024.
- ☐ Multiply this answer by 10,000 to obtain the multiply block constant. .024 x 10,000 = 240.
- ☐ Multiply analog input by the above constant. The high order result register will contain the range.

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- ☐ Add or subtract the Y intercept (−40 in this example) to obtain the answer.

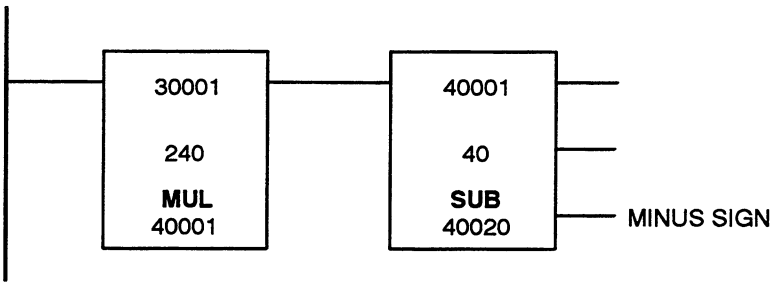


Figure 58 Scaled Value from Analog Signal Example

☞ **Note:** The logic shown in used to generate the scaled value in register 40020, from the analog signal in 30001. For example:

30001 = 3800
40020 = 0051° F

☞ **Note:** Only the high order result of the multiply is used and no compensation for round off is used in this example.

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8.6 Calibration

8.6.1 Calibration Tools

The Analog Input module is calibrated at the factory prior to shipment. To ensure the module's accuracy you should calibrate the trim−pot regularly. Calibration is recommended at 12 month intervals.

The following tools are needed to calibrate an Analog Input module:

- ☐ A precision digital readout voltmeter with an accuracy of ±0.0001 V on a 10 V scale
- ☐ A $^1/_4$ in Phillips screwdriver
- ☐ A $^1/_8$ in standard screwdriver
- ☐ An adhesive for the trim−pot adjusting screw (e.g. Locktight Glyptol)

8.6.2 Calibration Procedure

Step 1 Remove the two screws and the label located on the front panel of the Analog Input module. This allows you access to the trim−pot. The trim−pot adjusts the range's total magnitude (full scale). Refer to Figure 59.

Step 2 Open the Analog Input module handle to expose the connectors and terminals.

Step 3 Connect the digital voltmeter (DVM) minus lead to the Voltage Reference− (terminal number 38) and the plus lead to the Voltage Reference+ (terminal number 39). Refer to Figure 60.

☞ **Note:** Field wiring may remain connected during calibration. Also, five minutes of warm up is sufficient to attain temperature stability.

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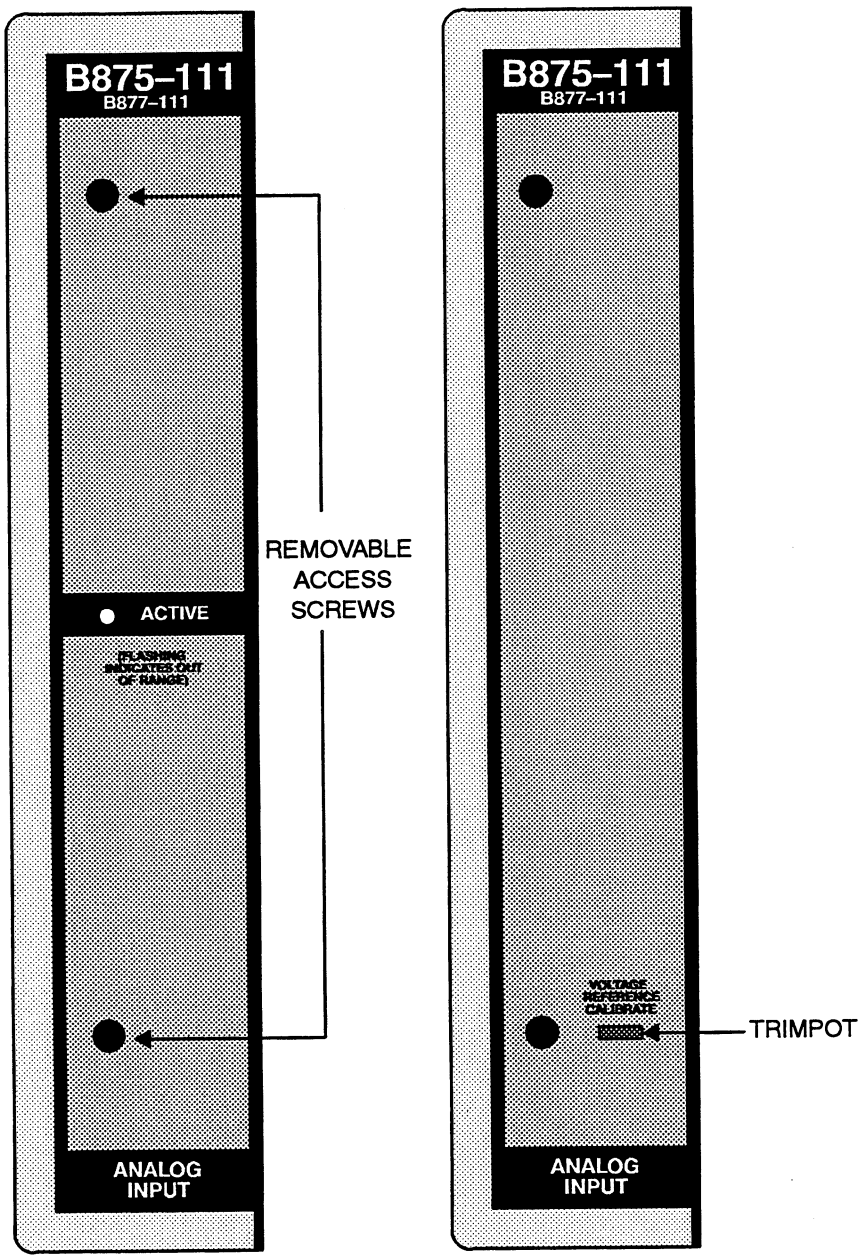


Figure 59 Location of Trim-Pot

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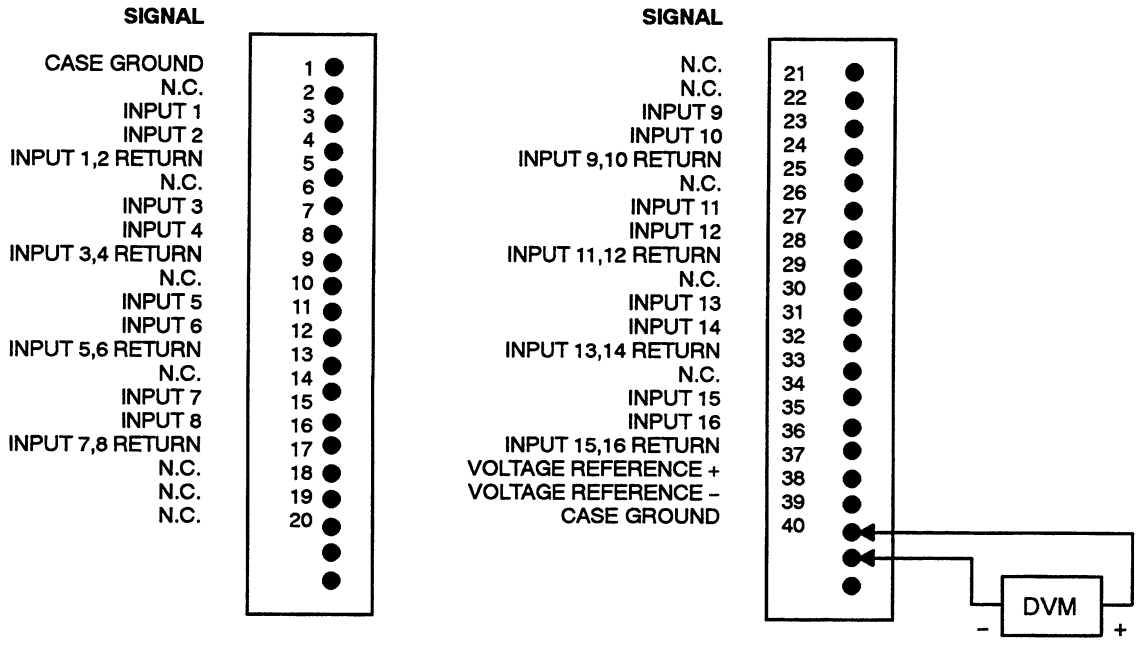


Figure 60 Voltmeter Connections Diagram

Step 4 Adjust reference voltage trim pot for 4.500 V, $\pm$0.0001 V.

Step 5 Secure (glue) trim–pot.

Step 6 After the calibration procedure is complete, disconnect the voltmeter, return connections to their original state, close module handle, and replace front label that covers the trim–pot.

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8.7 Quick Reference

To setup the Analog Input module you need to establish your input range, output format, number of samples to be averaged, and the type of inputs to fit your specific application. This requires you to set an eight–position DIP switch and SW5 of a five–position DIP switch located on the left side of the Analog Input module.

DIP–Switch Configuration Parameters

		Switches: 8–Position			5–Position
Input Range		**SW1**	**SW2**	**SW8**	**SW5**
	±5 V, ±20 mA	L	L	R	R
	0 ... 5 V, 0 ... 20 mA	R	L	R	R
	1 ... 5 V, 4 ... 20 mA	R	R	R	R
	± 1 0V	L	L	L	L
	0 ... 10 V	R	L	L	L
Output Format		**SW3**	**SW4**		
	Standard (0 ... 4096)	R	R		
	Elevated (4096 ... 8192)	L	R		
	Variable (0 to full res.)	R	L		
	Decimal (0 ... 10,000)	L	L		
Samples To Be Averaged		**SW5**	**SW6**		
	1 or no averaging	R	R		
	8	L	R		
	16	R	L		
	32	L	L		
Type of Inputs		**SW7**			
	8 Differential	R			
	16 Single-ended	L			

For example, assume that you want the following: ±5 V input, 0 ... 10,000 counts output, no averaging, and differential inputs. Your switches should be set as noted here:

Module Configuration Switch
SW 1 ... 4 = L
SW 5 ... 8 = R

Switch Bank 4
SW 5 = R

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8.8 Specifications

B875-111 Specifications

Analog Inputs/Module	I/O mapped as B875–111	Eight differential
	I/O mapped as B877–111	16 Single-ended
Input Ranges	Voltage	0 ... 5 V
		1 ... 5 V
		–5 ... +5 V
		0 ... 10 V
		–10 ... +10 V
	Current	0 ... 20 mA
		4 ... 20 mA
		–20 ... +20 mA
Input Analog Filter		Single pole low pass, with –3 dB cut–off frequency of 48 Hz, ±10%
Input Resistance	Current Mode	250 Ω, ±0.05%
	Voltage Mode	Within range >10 MΩ, outside range 10,000 Ω
Input Resistance (No power)	Differential Inputs	20 kΩ/channel
	Single-ended Inputs	10 kΩ/channel
Input Protection	Normal Mode	120 V RMS differential input
	Common Mode	120 V RMS
Throughput (T)	eight channels	10 ms without input sampling
	16 channels	20 ms without input sampling
Over Current Protection		Up to 30 mA
Common Mode Range		±2 V for 10 V, ±7 V for 5 V
Rejection		–40 dB typical, dc to 60 Hz
Input Isolation	Input to OURBUS	1500 Vac RMS for 1 min
	Input to Case	1500 Vac RMS for 1 min
	Input to Input	25 Vac
Conversion Resolution	All ranges	>12 bits
	Bipolar	1 part in 15,000
	Unipolar	1 part in 7,500
	Unipolar with offset	1 part in 6,000
Accuracy		±0.1% absolute accuracy over temperature range
Linearity Error		±0.05% of full scale over the operating range

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Differential	Nonlinearity	±0.006% of full scale over the operating range
	Repeatability	0.025% of full scale RMS, constant temperature, no averaging
Output Range		Four selectable output formats
Output Averaging		Options are: N = 8, 16, and 32 samples to be averaged
Output Digital Filter, F_c		Single pole low pass with cut–off frequency dependent upon the number of averaged samples, N and T
Out-of-range Data		2.4% above and below range
Power Required	+5 V	500 mA
	+4.3 V	900 mA
	–5 V	0 mA
Terminal Connector		AS–8535–000

☞ **Note:** The module has an internal scan time set to start every 10 ... 20 ms. More than three interrupts/internal scan time increases throughput time (T).

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Chapter 9
B875–200 Configurable A/D Input

- ☐ Overview
- ☐ Input Insertion Pack
- ☐ Module Configuration
- ☐ Field Connections
- ☐ Quick Start Test
- ☐ Calibration
- ☐ Available Input Packs
- ☐ Simplified Schematics for Input Packs
- ☐ Specifications

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9.1 Overview

The B875–200 Configurable A/D Input Module converts a variety of signal sources: thermocouple, RTD, strain gauge/load cell, voltage and current input ranges into binary data. When selected for eight channels, the module is displayed in the I/O map as a *B875–200*; when selected for four channels, it is displayed in the I/O map as a *B873–200*.

The module allows you to poll a wide array of field devices requiring different signal sources based upon your unique application. You can select from more than 48 available input packs, and any mix per module is acceptable. Information pertaining to input packs is given in Section 9.7.



Caution: Performance is not guaranteed with third party 5B type packs. When using third party packs, contact the manufacturer for support.

You can select from 1 ... 8 input channels per module by means of an eight position DIP switch. In addition, you can select either 0, 2, or 4 samples to be averaged per input point by means of a two position jumper. Averaging helps reduce the impact of spurious noise on the input.

Some application examples include food processing, press operating, chemical processing, painting, and foundry casting.

The module has four/eight analog inputs and is capable of updates to all eight channels every 4 ms. The 12–bit resolution for all ranges and the absolute accuracy is dependent on input pack type. This allows for fast and precise control of your application. Also refer to Section 9.7 for different types of input packs.



Note: This module requires two slots.

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9.1.1 Simplified Schematic

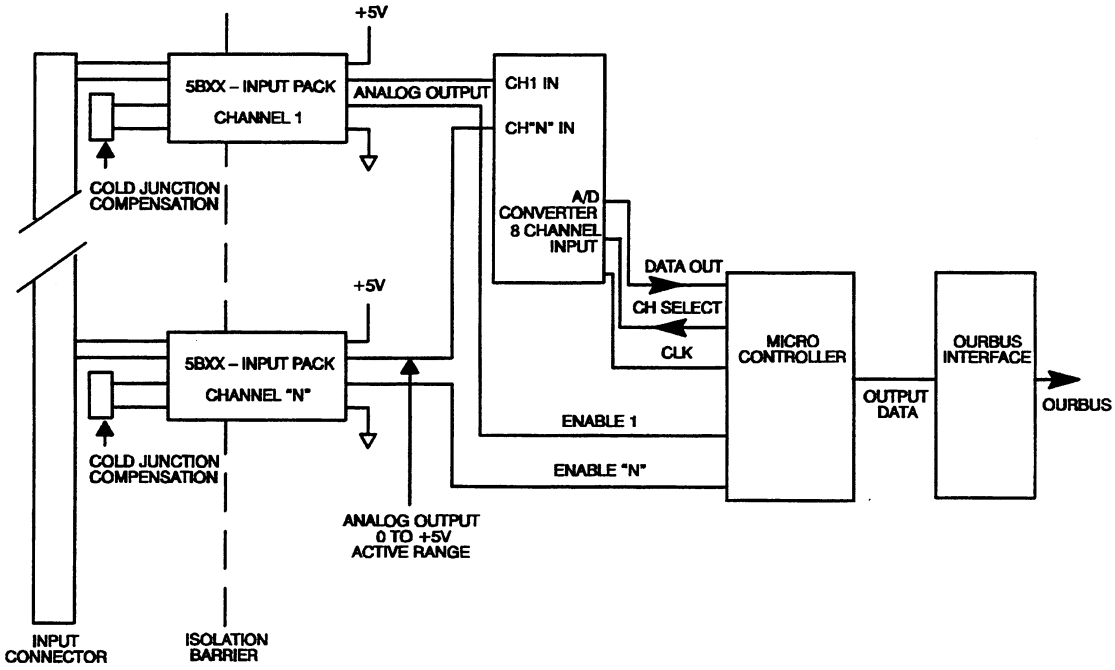


Figure 61 B875–200 Simplified Schematic

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9.2 Input Pack Insertion

☞ **Note:** Refer to Section 9.7 for a complete listing of the input pack part numbers.

Step 1 Remove the channel pull−off tabs that correspond with the desired placement of your input packs.

Step 2 Insert the input packs into the right side of the module corresponding to the desired channels. Align the input pack so that the Phillips head screw is on top, and the 14 leads are at the bottom of the input pack. Next, tighten the Phillips head screw on top.

When using either a AS−5B32001A or AS−5B32002A Current Input Pack, a fusible resistor must also be inserted into the board. The proper fusible resistor (Modicon part # AS−0418−000) comes with the Current Input Pack.

☞ **Note:** Always insert the fusible resistor before inserting the input pack. If your fusible resistor is rectangular, ensure that the side with the two leads is next to the input pack.

☞ **Note:** Never place the fusible resistor between adjacent channels. This can be detected when the fusible resistor hides the **CH** on the **CHANNEL** label on the board.

Step 3 Locate the write−on label plate (Modicon part # AS−157A−000) that is shipped with the module. The input pack catalog numbers, and input register numbers for each input pack installed should be clearly identified on the label.

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9.3 Module Configuration

Step 1 Locate the eight−position DIP switch on the rear of the module. These DIP switches are used to select the desired number of channels, from 1 ... 8.

Step 2 Set the DIP switches based upon your application needs prior to installing. Refer to Figure 62, for the DIP switch settings. Also, refer to the label located on the left side of the Analog Input module itself. **The Analog Input module is shipped with channel 1 ON, (B873), DIP switch (SW1) set to ON.** The module is I/O mapped as a B873 when *only* channels 1 ... 4 are in use. The module is I/O mapped as a B875 when *more than* 4 channels are in use.

Caution: Ensure all unused DIP switches are kept to the right.

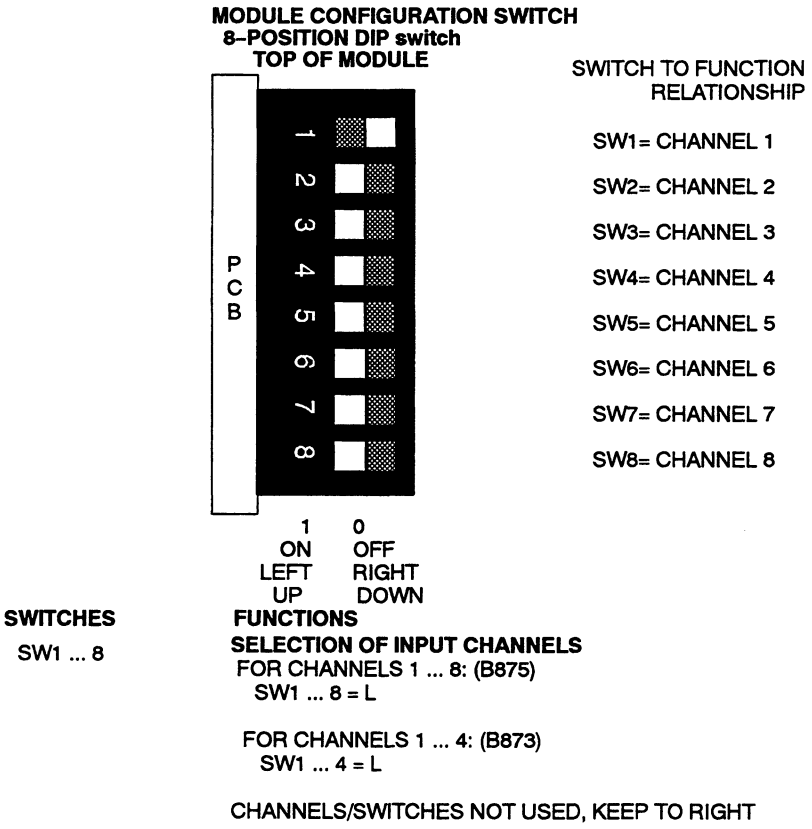


Figure 62 Module Configuration DIP switch Settings

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☞ **Note:** The B873 mode provides a faster throughput. Ensure that the placement of the Input Packs correspond with the DIP switch settings.

9.3.1 Sample Averaging Selection

Step 1 Locate the access hole on the left side of the module. This hole allows access to three leads and a two−position jumper, that select the number of samples to be averaged per input channel. Select from either 0, 2, or 4 samples to be averaged.

Step 2 Set the desired averaging prior to installing. Refer to Figure 63 for the jumper settings. Also, refer to the label located on the left side of the module itself. **The module is shipped with the jumper set for four samples.**

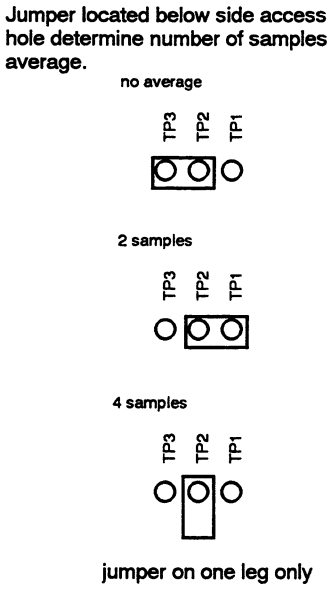


Figure 63 Jumper Settings

☞ **Note:** Sample averaging helps reduce the impact of serious noise on the input.

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9.4 Field Connections

There are five ways to wire the module, to accept

- ☐ Current input packs
- ☐ Voltage input packs
- ☐ RTD input packs
- ☐ Linear thermocouple input packs
- ☐ Strain gauge/load cell input packs

Refer to the applicable wiring diagram from the following selections as needed for your application.

9.4.1 Current Inputs, Low Bandwidth (AS-5B32)

If you are using current inputs, note the channels that are receiving these inputs. Current inputs are selected by inserting the input pack, and a fusible resistor beside the pack for the appropriate channel. Referring to Figure 64, connect field side wiring to proper pins on the field connector.

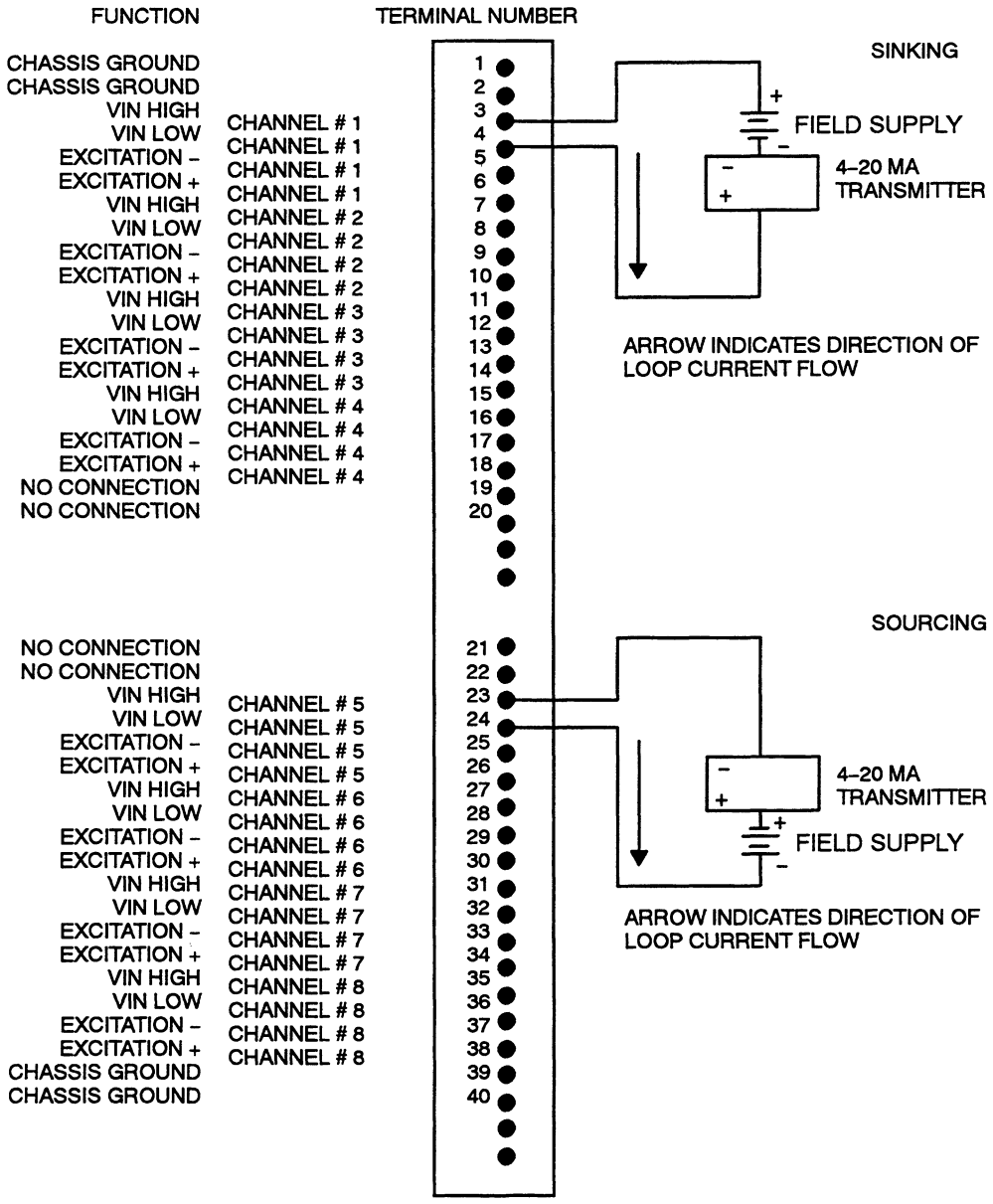
☞ **Note:** All input packs provide 1500 Vac/2500 Vdc isolation from bus to field wiring. Since any floating inputs may be exposed to static charges as high as 15 kV, you should supply a path for static charges on the inputs to be drained off to chassis ground. Do this by connecting one of the signal input leads to the chassis ground either directly or through a resistor in the range of 1 kΩ ... 10 MΩ The chassis ground at terminals 1, 2, 39, or 40 may be used for this purpose. If the signal source used with an input has a dc signal path to chassis ground, no additional path is required at the B875 end of the field wiring.

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☞ **Note:** Channels are set independently. You can have any mix of current,voltage, RTD, linear thermocouple, or strain gauge/load cell inputs.

⚠ **Caution: Neat and proper workmanship methods by qualified personnel must be employed when making connections to this module. Take extra precautions if you are using stranded wire. Insure that loose or projecting strands do not short circuit or ground the other terminals. We recommend that you use solid wire.**

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NOTE: A PRECISION 20 Ω FUSIBLE RESISTOR MUST BE INSTALLED IN EACH CURRENT INPUT CHANNEL. THIS FUSIBLE RESISTOR IS SUPPLIED WITH EACH 4 ... 20 mA OR 0 ... 2 mA INPUT PACK. THE B875–200 MAY BE INSTALLED IN EITHER THE SINKING OR SOURCING CONFIGURATION.

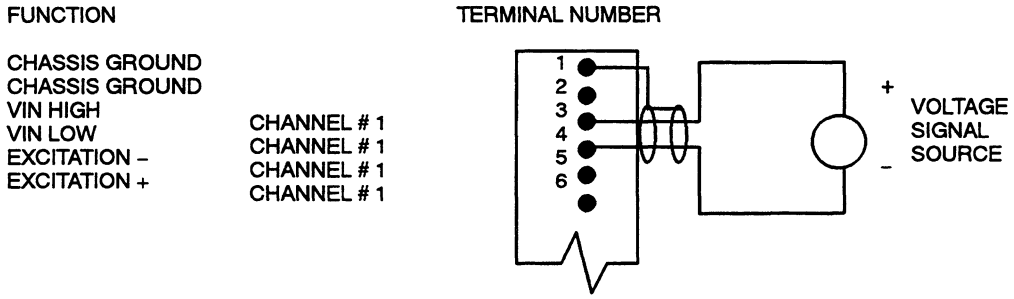
EACH CHANNEL IS FLOATING. SHOULD YOU NEED A GROUND YOU MAY TIE ONE SIDE OF FIELD WIRING TO CHASSIS GROUND OR USE SHIELDED WIRING WITH SHIELD TIED TO CHASSIS GROUND. REFER TO NOTE BELOW.

Figure 64 Typical Field Circuit Connections for Current Inputs, L.B.

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9.4.2 Voltage Inputs, Low & Wide Bandwidths (AS-5B30/31 and AS-5B40/41)

If you are using voltage inputs, note the channels that are receiving these inputs. Voltage inputs are selected by inserting the input pack for the appropriate channel. Referring to Figure 65, connect field side wiring to proper pins on the field connector.



NOTE: VOLTAGE WIDE BANDWIDTH INPUT PACKS ARE SIGNIFICANTLY MORE SENSITIVE TO NOISE ON INPUT LINES. LOW BANDWIDTH PACKS ARE RECOMMENDED FOR GENERAL PURPOSE INPUT VOLTAGE USAGE.

Figure 65 Typical Field Circuit Connections for Voltage Inputs, L.B.&W.B.

☞ **Note:** Shield shown is recommended. One side of signal source may be connected to chassis ground when using twisted pair wiring.

☞ **Note:** Channels are set independently. You can have any mix of current,voltage, RTD, linear thermocouple, or strain gauge/load cell inputs.

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9.4.3 RTD Inputs, (AS-5B34)

If you are using RTD inputs, note the channels that are receiving these inputs. RTD inputs are selected by inserting the input pack for the appropriate channel. Referring to Figure 66, connect field side wiring to proper pins on the field connector.

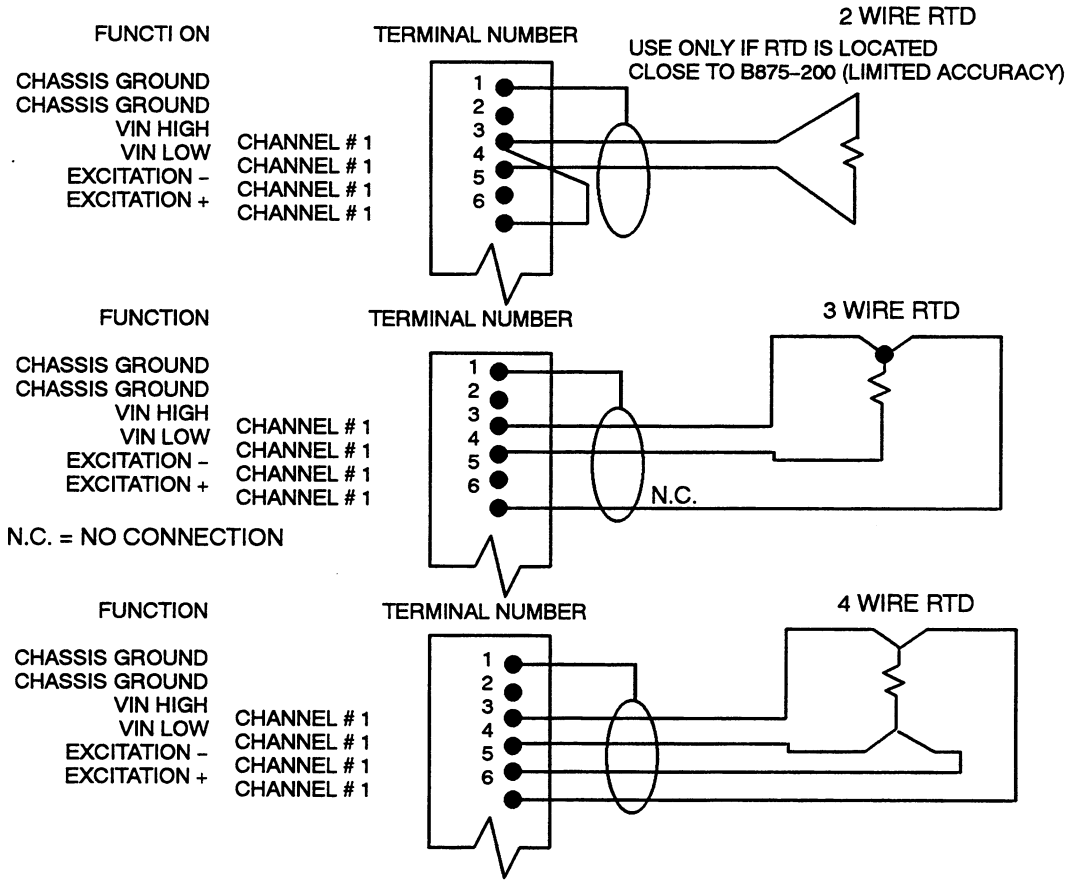


Figure 66 Typical Field Circuit Connections for RTD Inputs

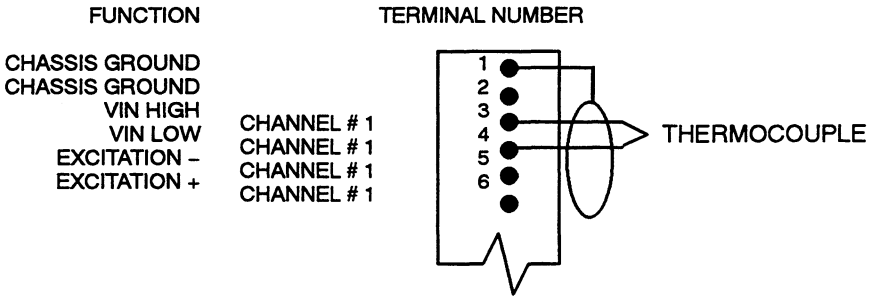
☞ **Note:** Shield shown is recommended. One side of signal source may be connected to chassis ground when using twisted pair wiring.

☞ **Note:** Channels are set independently. You can have any mix of current,voltage, RTD, linear thermocouple, or strain gauge/load cell inputs.

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9.4.4 Linear Thermocouple, (AS-5B47)

If you are using linear thermocouple inputs, note the channels that are receiving these inputs. Linear thermocouple inputs are selected by inserting the input pack for the appropriate channel. Referring to Figure 67, connect field side wiring to proper pins on the field connector.



NOTE: THERMOCOUPLE MUST BE OF THE TYPE DESIGNATED BY THE DASH NUMBER OF THE AS-5B47 INPUT PACK IN USE. COLD JUNCTION COMPENSATION IS DONE BY A TEMPERATURE SENSOR LOCATED IMMEDIATELY BEHIND THE CONNECTOR BLOCK.

Figure 67 Typical Field Circuit Connections for Linear T.C. Inputs

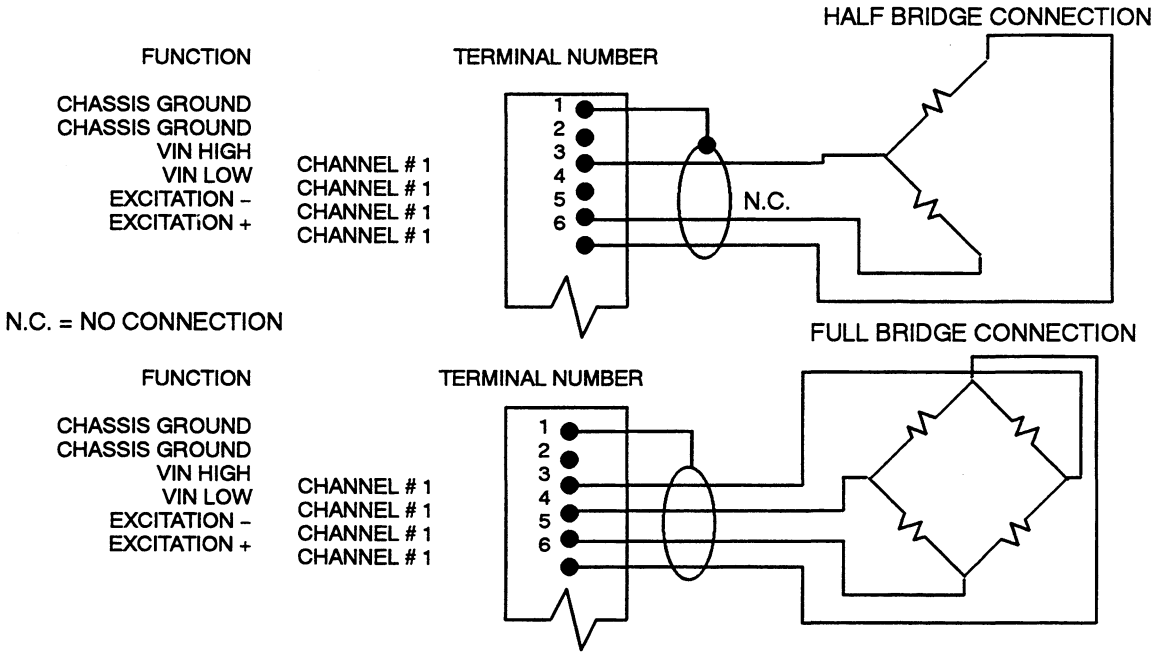
☞ **Note:** Shield shown is recommended. One side of signal source may be connected to chassis ground when using twisted pair wiring.

☞ **Note:** Channels are set independently. You can have any mix of current,voltage, RTD, linear thermocouple, or strain gauge/load cell inputs.

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9.4.5 Strain Gauge/Load Cell, 0 ... +5 V Output (AS-5B38)

If you are using strain gauge/load cell inputs, note the channels that are receiving these inputs. Strain gauge/load cell inputs are selected by inserting the input pack for the appropriate channel. Referring to Figure 68, connect field side wiring to proper pins on the field connector.



NOTE: CONNECTION MUST BE SUCH THAT STRAIN IN NORMAL DIRECTION OF APPLICATION RESULTS IN A POSITIVE OUTPUT VOLTAGE APPLIED TO VIN HIGH. WIRING TO PINS 5 AND 6 MAY BE REVERSED IF OUTPUT IS NEGATIVE.

Figure 68 Typical Field Circuit Connections for Strain Gauge/L.C. Inputs

☞ **Note:** Shield shown is recommended. One side of signal source may be connected to chassis ground when using twisted pair wiring.

☞ **Note:** Channels are set independently. You can have any mix of current,voltage, RTD, linear thermocouple, or strain gauge/load cell inputs.

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Procedure **Securing the Module**

Step 1 Re-install any module temporarily removed.

Step 2 When using key pins (provided with housing shipment), install them above and below the housing slot selected for this module's installation.

Step 3 Insert the module into the housing firmly but carefully, seating the edge connector in the backplane.

Step 4 Secure the module to the housing using the captive slotted mounting screws at the top and bottom of the module front panel.

Step 5 Locate the write-on label plate (Modicon part # AS-157A-000) for writing the input pack catalog numbers, and input register numbers on, for each input pack you installed.

Step 6 Insert the write-on label plate right of the installed module. Using the two standard screws supplied in the bag, tighten them into the upper and lower portions of the housing slot as shown in Figure 69.

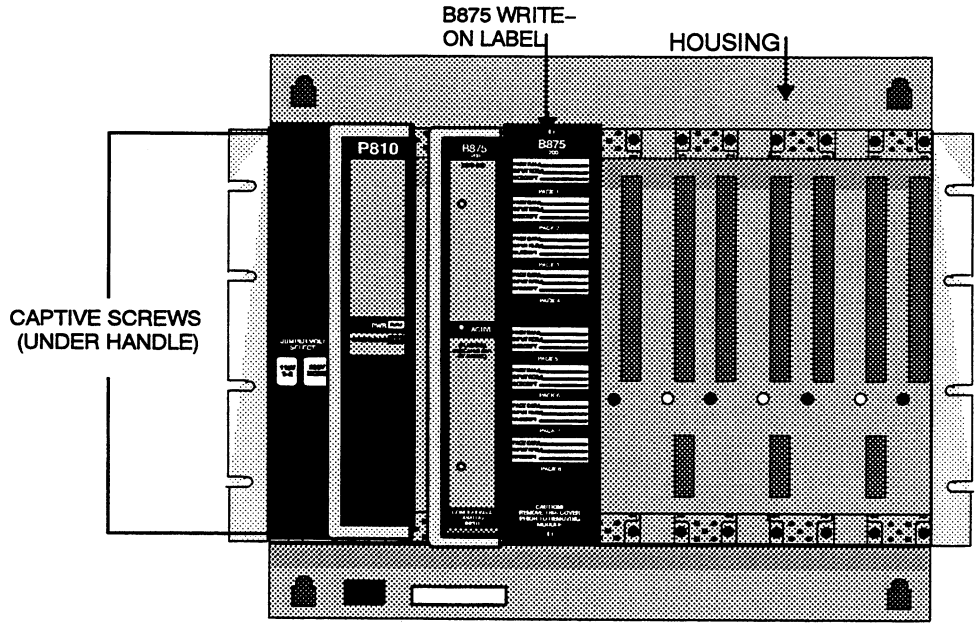


Figure 69 Write-on Label Plate Placement

☞ **Note: Ensure that all input packs are removed prior to returning module to Modicon for repair work.**

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9.5 Quick Start Test

☞ **Note:** This module has had nyogel grease applied at the factory to the connector pins to ensure good terminal block connections. This grease should not be removed.

9.5.1 Isolated Voltage Input (–10 ... +10 V)

This test configures the module as follows: eight channels (B875 in the I/O map), AS–5B31006A isolated voltage Input Pack, and four samples to be averaged.

Step 1 Insert the eight AS–5B31006A voltage Input Packs.

Step 2 Set all the eight–position DIP switches to the left (viewing the rear of the module when held vertically). This setting selects eight channels.

Step 3 Set the two–position jumper so that pins T1, T2, and T3 (located below the access hole on the left side of the module) are not jumpered. This setting selects four average.

Step 4 Wire the (+) side of field device to input terminal 3 (VIN HIGH); wire the (–) side of field device to 4 (VIN LOW) on the AS–8535–000 high density connector.

☞ **Note:** Remove the keying tabs on the AS–8535–000 high density connector prior to installing module.

Step 5 Determine which channel and slot location are being used for this module.

Step 6 Stop the controller, remove power, and insert the module in housing.

Step 7 Reapply power.

Step 8 I/O map the module as a B875, registers 30001 ... 30008 binary.

Step 9 Start the controller.

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Step 10 Confirm that the modules active light is flashing.

☞ **Note:** Active ON steady = OK. The Active light may also be blinking for one of two reasons—the input to the module is out of range, or the selected channel (SW1 ... 8) has no input pack installed.

Step 11 Using a programming panel call up appropriate traffic copped registers of the B875.

Step 12 Using a measurable voltage source or field device, vary the input voltage to the B875. Compare these values to those in the following table.

Signal to Output Value Relationship

Voltage Input	I/O Mapped Registers	Output Value
–9.99 V	30001 =	0001
–5.00 V	30001 =	1024
0.00 V	30001 =	2048
+5.00 V	30001 =	3072
+9.99 V	30001 =	4095

9.5.2 Isolated Current Input (4 ... 20 mA)

This test configures the module as follows: eight channels (B875 in the I/O map), AS–5B32001A isolated current Input Pack, and four samples to be averaged.

Step 1 Insert the eight fusible resistors shipped with the AS–5B32001A Input Packs.

Step 2 Insert the eight current Input Packs (AS–5B32001A).

Step 3 Set all the eight–position DIP switches to the left (viewing the rear of the module when held vertically). This setting selects eight channels.

Step 4 Set the two–position jumper so that pins T1, T2, and T3 (located below the access hole on the left side of the module) are not jumpered. This setting selects four average.

Step 5 Wire input terminal 3 (VIN HIGH), 4 (VIN LOW), and 1 (CHASSIS GROUND) on AS–8535–000 high density connector per Figure 64.

☞ **Note:** Remove the keying tabs on the AS–8535–000 high density connector prior to installing module.

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Step 6 Determine which channel and slot location are being used for this module.

Step 7 Stop the controller, remove power, and insert module in housing

Step 8 Reapply power.

Step 9 I/O map the module as a B875, registers 30001 ... 30008 binary.

Step 10 Start the controller.

Step 11 Confirm that the modules active light is illuminated.

☞ **Note:** Active ON steady = OK. The Active light may also be flashing for one of two reasons: input to the module is out of range or the selected channel (SW1 ... 8) has no input pack installed.

Step 12 Using a programming panel call up appropriate I/O mapped registers of the B875.

Step 13 Using a measurable current source or field device, vary the input to the B875. Compare these values to those in the following.

Signal to Output Value Relationship

Current Input	I/O Mapped Registers	Output Value
4.01 mA	30001 =	0001
8.00 mA	30001 =	1024
12.00 mA	30001 =	2048
16.00 mA	30001 =	3072
19.99 mA	30001 =	4095

9.5.3 Isolated Voltage Input (-10 ... +10 mv)

This test configures the module as follows: eight channels (B875 in the I/O map), AS-5B40004A isolated voltage wide bandwidth current Input Pack, and four samples to be averaged.

Step 1 Insert the eight AS-5B40004A voltage Input Packs you ordered.

Step 2 Set all the eight-position DIP switches to the left (viewing the rear of the module when held vertically). This setting selects eight channels.

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Step 3 Set the two−position jumper so that pins T1, T2, and T3 (located below the access hole on the left side of the module) are not jumpered. This setting selects four average.

Step 4 Wire input terminal 3 (VIN HIGH), 4 (VIN LOW), and 1 (CHASSIS GROUND) on AS−8535−000 high density connector. Wire the remaining inputs (2 ... 8) in a similar manner—e.g., + to V_{in} high, V_{in} low).

☞ **Note:** Remove the keying tabs on the AS−8535−000 high density connector prior to installing module.

Step 5 Determine which channel and slot location are being used for this module.

Step 6 Stop the controller, remove power, and insert module in housing.

Step 7 Re-apply power.

Step 8 I/O map the module as a B875, registers 30001−30008 binary.

Step 9 Start the controller.

Step 10 Confirm that the modules active light is illuminated.

☞ **Note:** Active ON steady = OK. The Active light may also be blinking for one of two reasons: input to the module is out of range (+10 ... −10 mv $\pm$4 counts) or the selected channel (SW1 ... 8) has no input pack installed.

Step 11 Using a programming panel call up appropriate I/O mapped registers of the B875.

Step 12 Using a measurable voltage source or field device, vary the input voltage to the B875. Compare these values to those in the following table.

Signal to Output Value Relationship

Voltage Input	I/O Mapped Register	Output Value
-9.99 mV	30001 =	0001
-5.00 mV	30001 =	1024
0.00 mV	30001 =	2048
+5.00 mV	30001 =	3072
+9.99 mV	30001 =	4095

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9.6 Calibration

The Configurable A/D Input module is calibrated at the factory prior to shipment. To ensure the module's accuracy you should calibrate the trim−pot regularly. Calibration is recommended at 12 month intervals.

The following tools are needed to calibrate a Configurable A/D Input module:

- ☐ A precision digital readout voltmeter with an accuracy of ±0.0001 V on a 10 V scale
- ☐ A $^1/_4$ in Phillips screwdriver
- ☐ A $^1/_8$ in standard screwdriver

☞ **Note:** Calibration is not recommended for Analog Current, Low Bandwidth, 4 ... 20 mA (AS−5B32001A) type input packs because, of their reduced accuracy.

When you calibrate a given channel, you calibrate all eight channels of this module. There is no provision to calibrate a particular channel. Therefore, calibration can be performed with any one channel with any type of input pack. Calibration does require the calibration signals to pass through an input pack.

⚠ **Caution: If the particular input pack used in calibration is itself out of calibration then, all B875 modules calibrated with this input pack will be improperly calibrated.**

A 0 ... +10 V, (AS−5B31003A), Low Bandwidth Input Pack, is used as an example only in the following procedure. We recommend a five minute warm-up time to attain a stable temperature.

Step 1 Remove the two screws and the label located on the front panel of the module. This allows you access to the trim−pots. The top trim−pot adjusts the range's total magnitude (full scale), while the lower adjusts the zero offset scale. Refer to Figure 70.

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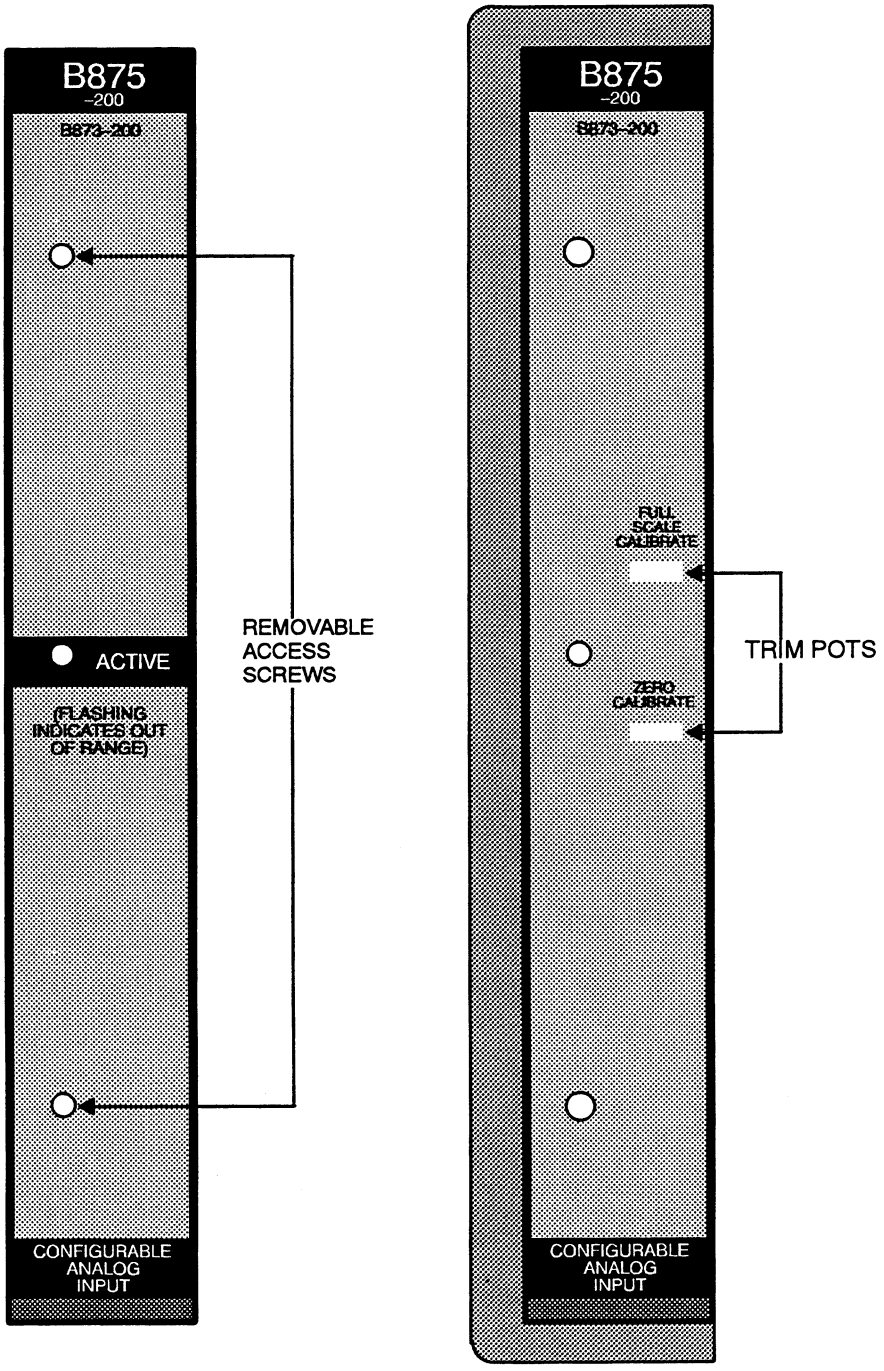


Figure 70 Location of Trim–Pot

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Step 2 Open the module handle to expose the connectors and terminals.

Step 3 Install an input pack in any channel, and connect an appropriate signal source to that channel. Refer to Figure 71.

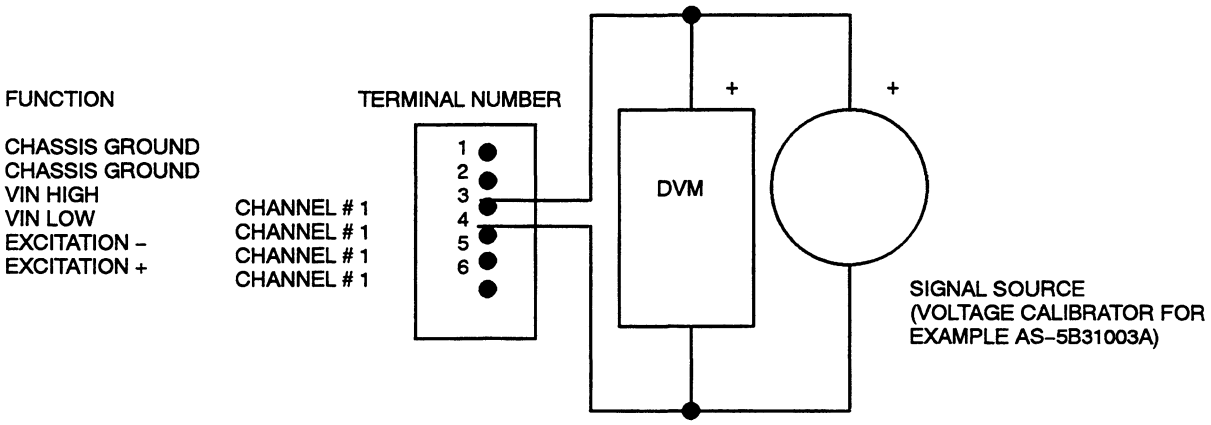


Figure 71 Voltmeter Connections Diagram

Step 4 Apply an input signal to the selected channel which represents zero signal (0 V when using Analog, V input pack, Low Bandwidth, 0 ... +10 V (AS–5B31003A). On the programming panel observe the input from the B875 for the selected channel. Adjust zero cal control (R29) as required to read 0000.

Step 5 Apply an input signal which results in an output between 80 ... 90% of full scale. Use 9.375 V if calibrating with an Analog, V input pack, Low Bandwidth, 0 ... +10V (AS–5B31003A). Resultant reading should be set for 0F00 Hex, or 3840 decimal with full scale calibration control (R57).

Step 6 Repeat Steps 4 and 5 until readings are correct at both zero and near full scale points.

Step 7 After the calibration procedure is complete, disconnect the voltmeter, return connections to their original state, close module handle, and replace front label that covers the trim–pot.

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9.7 Available Input Packs

The module accepts up to eight input packs of any mix. You can choose from six categories:

- ☐ Voltage–low bandwidth
- ☐ Current–low bandwidth
- ☐ RTD
- ☐ Strain gauge
- ☐ Voltage–wide bandwidth
- ☐ Linear thermocouple

Refer to the following tables for the desired input range, output range, and part number required for your application.



Caution: Performance is not guaranteed with third party 5B type packs. When using third party packs, contact the manufacturer for support.



Note: Input packs are issued as revision level A's, denoted by the last item of the part number, for example, (AS–5B30001A). Changes will be noted by higher revision levels.



Note: Useable output range of all AS–5BXX Input Packs is 0 ... +5 V when used with this module.

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Analog mV, V Input Packs, Low Bandwidth (4 Hz)

Part Number	Input Range
AS-5B30001A	0 ... 10 mV
AS-5B30002A	0 ... 50 mV
AS-5B30003A	0 ... 100 mV
AS-5B30004A	-10 ... +10 mV
AS-5B30005A	-50 ... +50 mV
AS-5B30006A	-100 ... +100 mV
AS-5B31001A	0 ... 1 V
AS-5B31002A	0 ... 5 V
AS-5B31003A	0 ... +10 V
AS-5B31004A	-1 ... +1 V
AS-5B31005A	-5 ... +5V
AS-5B31006A	-10 ... +10 V

Analog Current Input Packs, Low Bandwidth (4 Hz)

Part Number	Input Range
AS-5B32001A	4 ... 20 mA
AS-5B32002A	0 ... 20 mA

☞ **Note:** Each Current Input Pack (4 ... 20 mA) comes with a fusible resistor that must be inserted in addition to the input pack.

RTD Input Packs, (4Hz)

Part Number	Type	Input Range
AS-5B34P01A	100 Ω Pt	-100 ... +100°C (-148 .. +212°F)
AS-5B34P02A	100 Ω Pt	0 ... 100°C (32 ... 212°F)
AS-5B34P03A	100 Ω Pt	0 ... 200°C (32 ... 392°F)
AS-5B34P04A	100 Ω Pt	0 ... 600°C (32 ... 1112°F)
AS-5B34C01A	10 Ω Cu @ 0° C	0 ... 120°C (32 ... 248°F)
AS-5B34C02A	10 Ω Cu @ 25° C	0 ... 120°C (32 ... 248°F)
AS-5B34N01A	120 Ω Ni	0 ... 300°C (32 ... 572°F)

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Strain Gauge/Load Cell Input Packs, Wide Bandwidth (10 kHz)

**Part Number	Input Range
AS–5B38002A	3 mV/V, Full Bridge
AS–5B38004A	3 mV/V, Half Bridge
AS–5B38005A	2 mV/V, Full Bridge

**Isolated strain gauge input 10 kHz bandwidth, all have 10.0 V excitation for bridges with resistance range of 300 Ω ... 10kΩ.

Analog Voltage Input Packs, Wide Bandwidth (10 kHz)

Part Number	Input Range
AS–5B40001A	0 ... 10 mV
AS–5B40002A	0 ... 50 mV
AS–5B40003A	0 ... 100 mV
AS–5B40004A	–10 ... +10 mV
AS–5B40005A	–50 ... +50 mV
AS–5B40006A	–100 ... +100 mV
AS–5B41001A	0 ... 1 V
AS–5B41002A	0 ... 5 V
AS–5B41003A	0 ... 10 V
AS–5B41004A	–1 ... +1 V
AS–5B41005A	–5 ... +5 V
AS–5B41006A	–10 ... +10 V

☞ **Note:** Wide bandwidth input packs are only used for high speed applications. They are more susceptible to external noise levels, and require careful routing and shielding of input signal leads.

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Linear Thermocouple Input Packs

Part Number	Type	Input Range
AS-5B47J01A	J	0 ... 760°C (32 ... 1400°F)
AS-5B47J02A	J	-100 ... +300°C (-148 ... +572°F)
AS-5B47J03A	J	0 ... 500°C (32 ... 932°F)
AS-5B47K04A	K	0 ... 1000°C (32 ... 1832°F)
AS-5B47K05A	K	0 ... 500°C (32 ... 932°F)
AS-5B47T06A	T	-100 ... +400°C (-148 ... +752°F)
AS-5B47T07A	T	0 ... 200°C (32 ... 392°F)
AS-5B47E08A	E	0 ... 1000°C (32 ... 1832°F)
AS-5B47R09A	R	500 ... 1750°C (932 ... 3182°F)
AS-5B47S10A	S	500 ... 1750°C (932 ... 3182°F)
AS-5B47B11A	B	500 ... 1800°C (932 ... 3272°F)

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9.8 Simplified Schematics for Input Packs

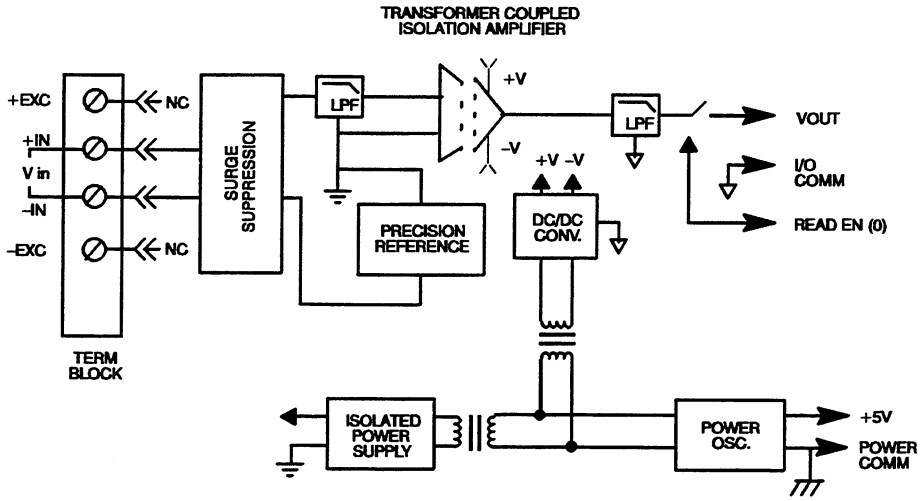


Figure 72 Typical Analog mV, 5B30 Schematic

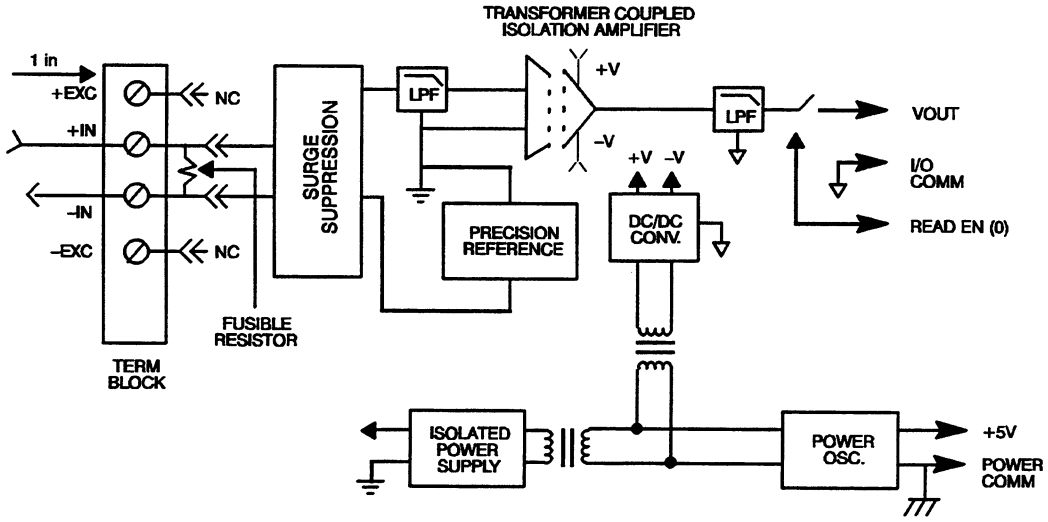


Figure 73 Typical Analog Current, 5B32 Schematic

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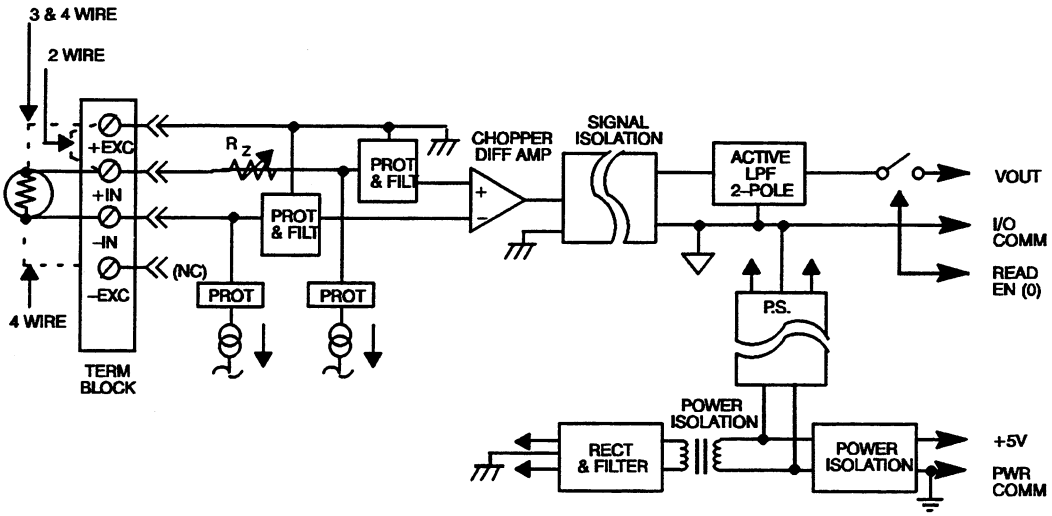


Figure 74 Typical RTD, 5B34 Schematic

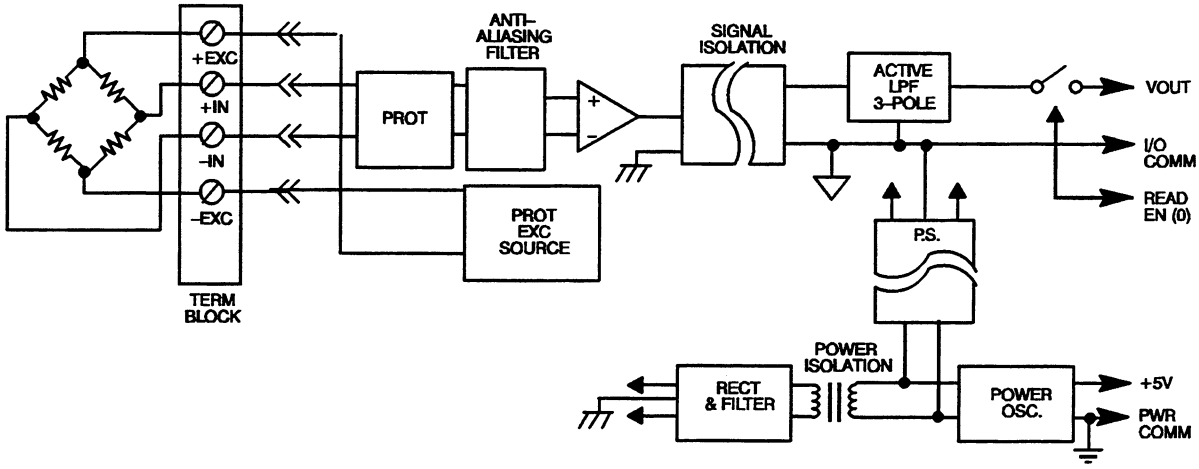


Figure 75 Typical Strain Gauge/Load Cell, 5B38 Schematic

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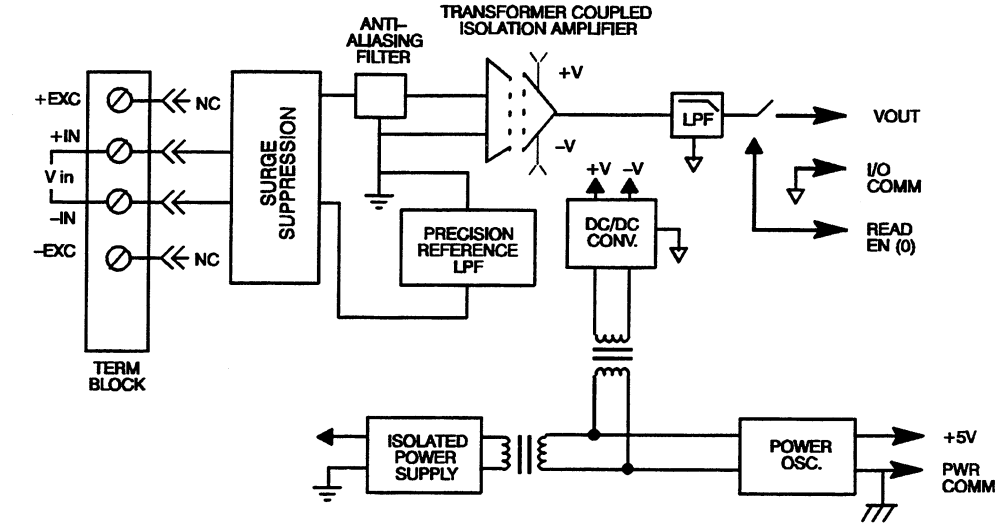


Figure 76 Typical Analog Voltage, 5B40 and 5B41 Schematic

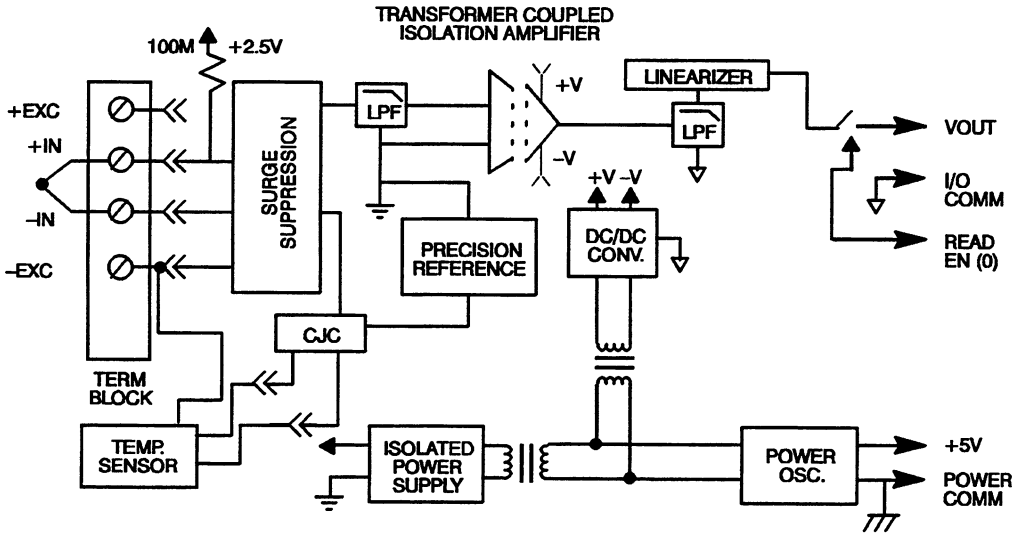


Figure 77 Typical Linear Thermocouple, 5B47 Schematic

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9.9 Specifications

B875-200 Specifications

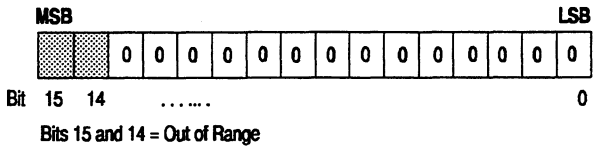
Analog Channels	B873–200 in I/O Map	Four		
	B875–200 in I/O Map	Eight		
Voltage Range		Varies with selected input pack (see Section 9.7)		
Current Range				
Thermocouple Types				
RTD Types				
Strain Gauge/Load Cell Types				
Input Filter		Three pole or more low pass, with –3dB cut–off frequency of 4 Hz, ±10% on low bandwidth units, 10 kHz ±10% on wide bandwidth units		
Input Resistance	Current Mode	20 Ω		
	Voltage Mode	**Pack Number**	**In Range**	**Power Off and/or Over Range**
		AS–5B30	5 MΩ	40 kΩ
		AS–5B31	650 kΩ	650 kΩ
		AS–5B40	200 MΩ	40 kΩ
		AS–5B41	650 kΩ	650 kΩ
Input Protection Normal Mode		All input packs can withstand 240 V RMS without damage, however fusible resistor used with current input packs will be destroyed by over-current conditions.		

☞ **Note:** Input over range, or under range on an input pack will not produce reading errors on adjacent channels in excess of ±1 count.

Common Mode		Each input pack can withstand 1500 V RMS	
Rejection		In excess of 140 dB for all input packs except AS–5B40 and AS–5B41 which are 80 dB	
Input Isolation	Input to OURBUS	1500 Vac RMS or 2500Vdc for 1 min	
	Input to Case	1500 Vac RMS or 2500 Vdc for 1 min	
	Input to Input	1500 Vac RMS or 2500 Vdc for 1 min	
Conversion Resolution		12 bits all ranges	
Out of Range Data		Four counts above and below range	
Out of Range Error (flags)		**Data Flagged**	**Description**
		Not Ready	Bit 14 set high (4000 Hex)
		Over Range	Bit 15 set high (800*x* Hex, *x* = 1 ... 4 bits over range)
		Under Range	Bits 14 and 15 set high (c00*x* Hex, *x* =1 ... 4 bits under range)

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	Normal Data	Bits 14 and 15 are low, normal data range is 0 ... 4095 (0 ... 1FFF Hex)



Input Averaging		Options are 0, 2, or 4 samples
Throughput		1.7 ms typical for four channels, 4 ms for eight channels maximum
Power Required	+5 V	550 mA
	+4.3 V	10 mA
	–5 V	0 mA
Terminal Connector		AS–8535–000

Accuracy of Input Pack

AS–5B30 AS–5B40	Calibration Accuracy at 25°C	*Accuracy Over Temp 0 ... 60°C	Nonlinearity	Gain Drift***	Offset Drift ***
Unipolar	±0.15	±0.73	±0.05	±.007%/°C	±.008%/°C
Bipolar	±0.20	±0.78	±0.05	±.007%/°C	±.008%/°C
AS–5B31 AS–5B41 Unipolar	±0.15	±0.62	±0.05	±.01%/° C	±.002%/°C
Bipolar	±0.20	±0.67	±0.05	±.01%/°C	±.002%/°C
AS–5B32	±0.25	±0.70	±0.05	±.01%/°C	±.001%/°C
AS–5B47	±0.1 +1°C**	+0.4 +2° C	±0.05	±.007%/° C	±1 µV%/5C typ
AS–5B38	±0.15	±0.80	±0.05	±.010%/° C	±1 µV%/5C typ
AS–5B34	±0.15	±2.0	±0.05	±.01%/° C	±.04%/° C

Unless noted all entries are % of full scale.

*Accuracy = Calibration + gain drift + offset + non linearity for the range 0 ... 60°C ambient.

**Calibration accuracy for types J,K,T. For types R&S =±4° C. For type B =±6° C.

***Both gain and offset drift are from 25° C.

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Appendix A
I/O Key Pin Assignments

- Key Pin charts for all 800 Series I/O Modules

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TOP OF HOUSING (CARD BASKET) KEYING (FRONT VIEW)

BOTTOM OF HOUSING (CARD BASKET) KEYING (FRONT VIEW)

	AS–B802–008	AS–B803–008	AS–B804–016	AS–B805–016	AS–B806–032
	AS–B808–016	AS–B809–016	AS–B820–008	AS–B821–008 AS–B821–108	AS–B822–008*
	AS–B824–016	AS–B825–016	AS–B826–032	AS–B827–032	AS–B875–011 AS–B875–012
	AS–B840–008 AS–B840–108	AS–B841–008*	AS–B850–016*	AS–B842–008	AS–B852–016*
	AS–B855–016	AS–B810–008	AS–B828–016	AS–B873–011	AS–B833–016
	AS–B862–001	AS–B863–001	AS–B864–001	AS–B857–032*	AS–B851–016*
	AS–B865–001	AS–B868–001	AS–B869–001	AS–B872–002	AS–B873–001
	AS–B875–111	AS–B881–308	AS–B872–100	AS–B872–200	AS–B875–200
	AS–B819–232*	AS–B804–148	AS–B882–116		
		AS–B806–124			

● Indicates keying pin locations.

* Indicates these modules may be obsoleted or superseded, please contact your local distributor for more details.

Figure 78 Key Pin Assignments Chart

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TOP OF HOUSING (CARD BASKET) KEYING (FRONT VIEW)

BOTTOM OF HOUSING (CARD BASKET) KEYING (FRONT VIEW)

	AS–B807–032	AS–B814–001 AS–B814–108	AS–B814–002	AS–B816–016	AS–B817–116
	AS–B823–008*	AS–B846–002	AS–B836–016	AS–B837–016	AS–B849–016
	AS–B829–016 AS–B829–116	AS–B872–011	AS–B883–200	AS–B883–211	AS–B817–216
	AS–B853–016	AS–B883–001	AS–B886–001	AS–B884–001	AS–B883–201
	AS–B832–016	AS–B883–101 AS–B883–111	AS–B886–011	AS–B885–001 AS–B885–002	AS–B838–032
	AS–B846–001	AS–B881–001	AS–B882–239	AS–B984–100	AS–B885–100
	AS–B875–001 AS–B875–002	AS–B875–101 AS–B875–102	AS–B880–108	AS–B880–208	AS–B882–032
	AS–B863–032	AS–B881–508	AS–B881–408	AS–B863–132	AS–B875–114
					
					

● Indicates keying pin locations.

* Indicates these modules may be obsoleted or superseded, please contact your local distributor for more details.

Figure 79 Key Pin Assignments Chart Cont.

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