FAC-2100 Hardware Reference Guide

Includes a manual for the FAC-2100 controller's mechanical and electrical systems

Fairmount Automation Controller Series - Model 2100

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1 Warnings and Notice

WARNING

Do not install, maintain or operate this equipment without reading, understanding and following the proper Fairmount Automation instructions and manuals, otherwise injury or damage may result.

Before performing maintenance on the FAC-2100 controller, be sure to disconnect all power sources (including main power and power signals from analog, digital, communications, and relay connections) and secure the process/system being controlled. Adjusting or removing this product while it is in the system may upset the process being controlled. This process upset may cause injury and/or damage.

This device should be installed, serviced, and maintained by qualified personnel only. Always remove all power sources before installing the device or opening any access panels on the FAC-2100. Failure to do so may result in injury and/or damage.

Ensure all environmental, mechanical, and electrical limits are not exceeded during operation, storage, and transportation of the controller. Failure to do so may result in damage or reduced lifetime of the device.

NOTICE

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2 Introduction

The Fairmount Automation Controller Series, Model 2100 *(FAC-2100)* is a general-purpose, highly configurable, multi-loop process controller. Its aluminum-steel construction makes the controller extremely rugged---it is specifically designed for operation in environments susceptible to extreme temperature, humidity, shock, and/or vibration. The *FAC-2100* is the replacement for Fairmount Automation's older *FAC-2000* modules.

The *FAC-2100* digital process controller is equipped with a large array of I/O capabilities. It combines the analog functionality of a standard process controller with the digital functionality normally associated with Programmable Logic Controllers (PLC). In its standard configuration, the *FAC-2100* has three analog inputs, two analog outputs, two universal digital inputs, eight standard digital inputs, two digital outputs, four form-C relays and two solid state relays.

The digital technology used to build the *FAC-2100*, in combination with Fairmount Automation's *Design Pad* software package, makes the *FAC-2100* extremely easy to program and very versatile. Programming the device entails "drawing" a desired control scheme using a vast array of operator functions. These operator functions are wired together to indicate the signal flows from device inputs to device outputs. After the design is done, *Design Pad* offers the ability to simulate the control scheme and model a process, graph any signal in the circuit, and interact with a computer-generated *FAC-2100* front panel and manipulate device inputs.

This instruction bulletin provides detailed descriptions and illustrative examples on how to operate and install the *FAC-2100* controller. For information on how to program the *FAC-2100*, see the *Design Pad G4* instructional bulletin (Fairmount Automation Technical Bulletin PDG-TR-2011/12).

3 Safety Considerations

Before performing maintenance on the *FAC-2100* controller, be sure to disconnect all power sources (including main power and power signals from analog, digital, communications, and relay connections).

While operating, the *FAC-2100* unit must have its case connected to a safety ground. Touching an ungrounded case may result in an electrical shock. Also, be aware that instrumentation connected to AC or DC power sources may still have power even though the unit is not on.

This unit, depending on its configuration, contains up to four fuses. Remove all power sources before inspecting or changing the fuses.

Ensure all environmental, mechanical, and electrical limits are not exceeded during operation, storage, and transportation of the controller. Failure to do so may result in damage or reduced lifetime of the device.

This device should be installed and serviced by qualified personnel only. Always remove all power sources before installing the device or opening any access panels on the *FAC-2100*. Failure to do so may result in serious injury and/or equipment damage.

Care should be taken when touching the controller's all-metal enclosure in high temperature environments. Be aware that the enclosure temperature may be in excess of 85 degrees Celsius.

The *FAC-2100* is constructed with circuit boards containing static-sensitive electrical components. All maintenance on these boards must be performed using standard static-electricity practices. Always use a grounded wrist strap when manipulating these parts and only place the boards on static-free surfaces. Always use static-free bags if transporting these circuit boards (while not in the *FAC-2100*).

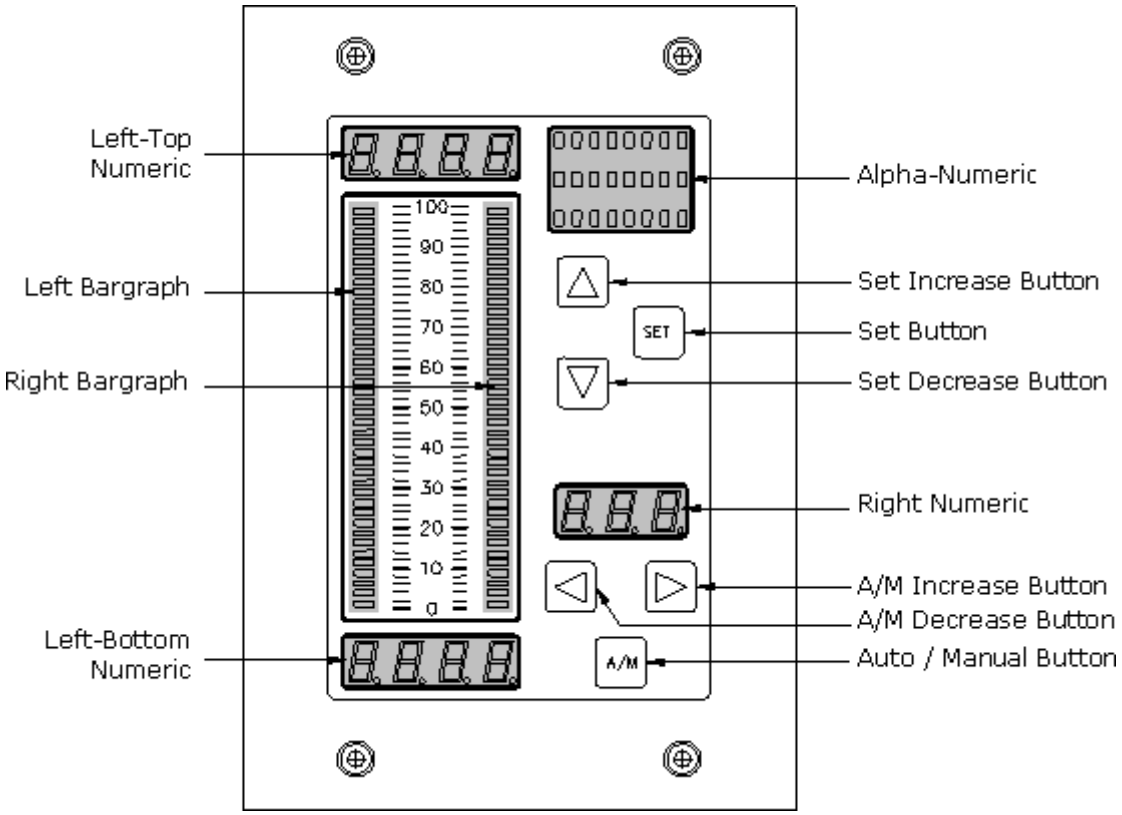
4 General Description

The *FAC-2100* has a variety of Input / Output (I/O) features, including three analog inputs, two analog outputs, ten digital inputs (two universal and eight standard), two digital outputs, form C-relays, form A-relays, DC and AC solid state relays, and a user-interface on the front panel. These, and other features, are described in this section (see the *Product Specifications* section of this bulletin for an overview of all the *FAC-2100* characteristics).

4.1 The User Interface

This part of the bulletin describes the features of the *FAC-2100* controller used to interface with a plant operator. It does not describe the software tools that the control engineer uses to program and maintain the device---see the *Design Pad G4* instruction bulletin (Fairmount Automation Technical Bulletin PDG-TR-2011/12) for more information.

4.1.1 The Front Panel



The *FAC-2100*'s front panel

The figure above shows the front panel of the *FAC-2100* and its user interface components. The panel contains three types of displays (numeric, alphanumeric and bargraph displays) and six membrane-switch keys.

4.1.2 Display Elements

The *FAC-2100* controller contains three numeric displays to indicate signal values (*e.g.*, the process variable, set point, output, *etc.*) These displays are labeled left-top numeric (four-digit), left-bottom numeric (four-digit), and right numeric (three-digit). The four-digit elements display values in the range of -999 to 9999, and the three-digit elements display values in the range of -99 to 999. When the number to be shown is above the range, each numeric element will display an 'H' character (indicating a *HIGH* reading). When the number is below the range, each element will display an 'L' character (indicating a *LOW* reading). The decimal point position of a numeric display can be fixed to a specified digit position (for display consistency) or can be floating (to maximize the display range). When the decimal point position is fixed, the numeric display range is reduced. For example, if the decimal point is fixed at the second digit of a four-digit display element, the values shown will range from -99.9 to 999.9.

Signal values may also be indicated on the *FAC-2100* bargraph displays (labeled left bargraph and right bargraph on The Front Panel (see page 7)). Each bargraph contains 40 LED elements. Typically, the number of elements illuminated is proportional to the signal value. Alternatively, each bargraph can be programmed to illuminate a variable-height band of LEDs above, below, or centered about the signal value of interest.

Each numeric and bargraph display can be configured to flash on and off when a user-specified event occurs (*e.g.,* a digital input channel is *high*). This feature can be useful to indicate dangerous operating conditions. It can also be used to indicate manual mode operation.

The *FAC-2100* controller also provides three eight-character alphanumeric display elements to convey text-based information to plant personnel. ASCII text messages (limited to 256 characters in length) can be scrolled across any of the three-display target lines. These messages can be presented in various ways---they can flash across the display, scroll at variable rates, and repeat a specified number of times. In addition, multiple messages can be assigned to the same target line simultaneously (each target-line maintains a 3-level priority queue of messages to display).

4.1.3 Set Menu System

Plant operators may adjust control scheme parameters (*e.g.,* the process set point, controller gains) via the *FAC-2100 Set Menu* system. The Set Menu is accessed with the SET button and parameter values are adjusted with the UP and DOWN arrow buttons (reference The Front Panel (see page 7)). The adjustment of control scheme parameters with the set menu system is equivalent to the circuit shown in figure below. It consists of a signal generator with a single adjustable output level. It is that output level that is adjusted from the set menu. Note that the generator may be an analog generator (which has many output states) or a digital generator (with exactly two output states).

Typical 'Set' menu object

The set menu system works as follows:

1. Press the SET button to enter the set menu (note: the amount of time the button must be held before the set menu appears is adjustable in software.)
2. If there is only one adjustable signal generator in the controller's program, then go to step 5.
3. The top two lines All user-defined alphanumeric text messages on the top two display lines are paused while the controller is in the set menu system. of the alphanumeric display present the user with a list of parameter names (such as 'PID gain' or 'set point'). Use the UP and DOWN arrow buttons to scroll through this list.
4. If you wish to adjust a parameter, press the SET button again--the current parameter value will then be displayed--and go to step 5. Otherwise, if you wish to exit the set menu, scroll down the list until the 'Press SET to exit set menu' message is displayed. Press the SET button and the device will exit the SET menu.
5. Press the UP arrow button to increase the parameter value; press the DOWN arrow button to decrease the parameter value. If an arrow button is held, the parameter value will begin to change at a rapid rate (note: the repeat rate for a held key is adjustable in software.)
6. When the desired value has been reached, press the SET button to record the change. If there is only one adjustable signal generator, the controller will exit the SET menu. Otherwise, the controller will remain in set menu mode and will again display the list of adjustable parameters. That is, the controller will return to step 3.

4.1.4 Set Menu System with Password Protected Engineering Level Parameters

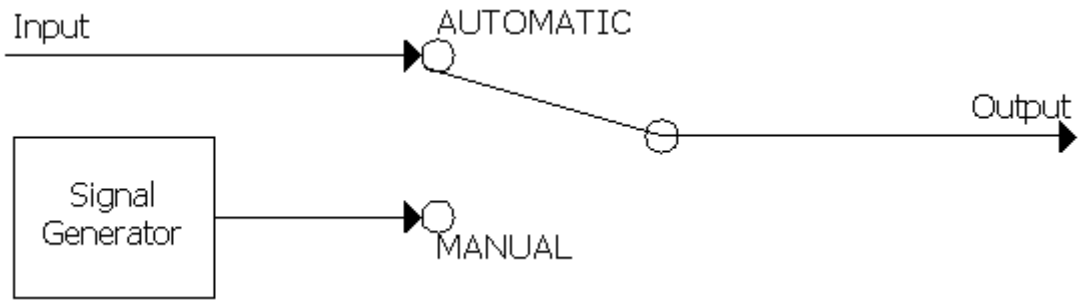
It is sometimes desirable to hide and protect certain plant parameters from operator level users (such as controller gains, critical values, etc.) In these cases, the control engineer should tag such variables as 'Engineer Level' and restrict access to them using a 6-character alphanumeric password. During normal operation of the controller the engineering level parameters will not be visible within the SET menu.

To access these engineering level parameters from the front panel of the controller, press both the UP and DOWN arrows simultaneously while in the SET menu system (note: if the control scheme includes only engineering level parameters, the password entry screen is presented as soon as the SET button is pressed.) The controller will prompt you for the password. The password is entered a single character at a time by using the UP or DOWN arrow to scroll through the character set at each position. When the desired character is displayed, press the SET key to enter it and move to the next position. Repeat this process until all six characters have been entered. After pressing SET to enter the last character, the controller will compare the password with the one in its schema file. If the password is accepted, the list of settable parameters (reference the Set Menu System (see page 9)) will be appended with the engineering level parameters. These parameters will remain accessible via the SET menu (even after the SET menu is exited) until the UP and DOWN arrows are simultaneously pressed while in the SET menu system.

4.1.5 Auto/Manual (A/M) Menu System

A typical process controller may operate in automatic mode (where the device computes a controller output) or in manual mode (where a plant operator specifies the controller output). The *FAC-2100* unit is a versatile multi-loop controller that provides this functionality and more. It can be configured to operate in a partially-manual, partially-automatic mode called *mixed* mode. While in mixed mode, a subset (*e.g.,* an individual loop) of the control scheme executed by the device may operate in automatic mode, while another subset operates in manual mode, while yet another subset operates in automatic mode. (For instance, in a three-loop control scheme, the plant operator may maintain two loops in automatic modes and the third in manual mode.)

The *FAC-2100* contains an *A/M Menu* system that presents a plant operator with a list of all control signals that may be toggled between automatic and manual modes. The menu system also allows the operator to set the controller output signal value when in manual mode. A control signal object in the *A/M Menu* system is equivalent to the circuit shown in the figure below. The figure shows an input signal and an adjustable signal generator connected to a switch. The output of the switch is attached to the output of the circuit. When the switch connects the input signal to the output signal, the switch is said to be in the *automatic* position. The switch is in the *manual* position when the signal generator is connected to the output of the switch. If the switch is in the manual position, adjusting the level of the signal generator can set the output. The *FAC-2100* provides the control engineer with both stand-alone A/M circuits and A/M circuits built into controller blocks (*e.g.,* PID, PD, and PI operators). See the *Design Pad Operators Reference* instructional bulletin (Fairmount Automation Technical Bulletin PDG-TR-2011/13) for more information.



Typical 'A/M' menu object

Notice that in order to adjust a typical A/M menu object, the user must be able to change both the switch position and the signal generator output level.

The A/M Menu system is accessed via the A/M button on the *FAC-2100's* front panel; manual signal adjustments are made with the LEFT and RIGHT arrow buttons (refer to The Front Panel (see page 7)). The flow chart below describes how these buttons are used to operate the *A/M Menu* system. When a control program contains a single A/M circuit (the usual configuration) adjustments are made as follows:

1. Press the A/M button to enter the *Auto-Manual Menu* system. The single A/M circuit will be switched into manual mode.
2. Edit the manual output by pressing the LEFT and RIGHT arrow buttons. If an arrow button is held down, the output value will begin to change at a rapid rate (note: the repeat rate for a held key is adjustable in software.)

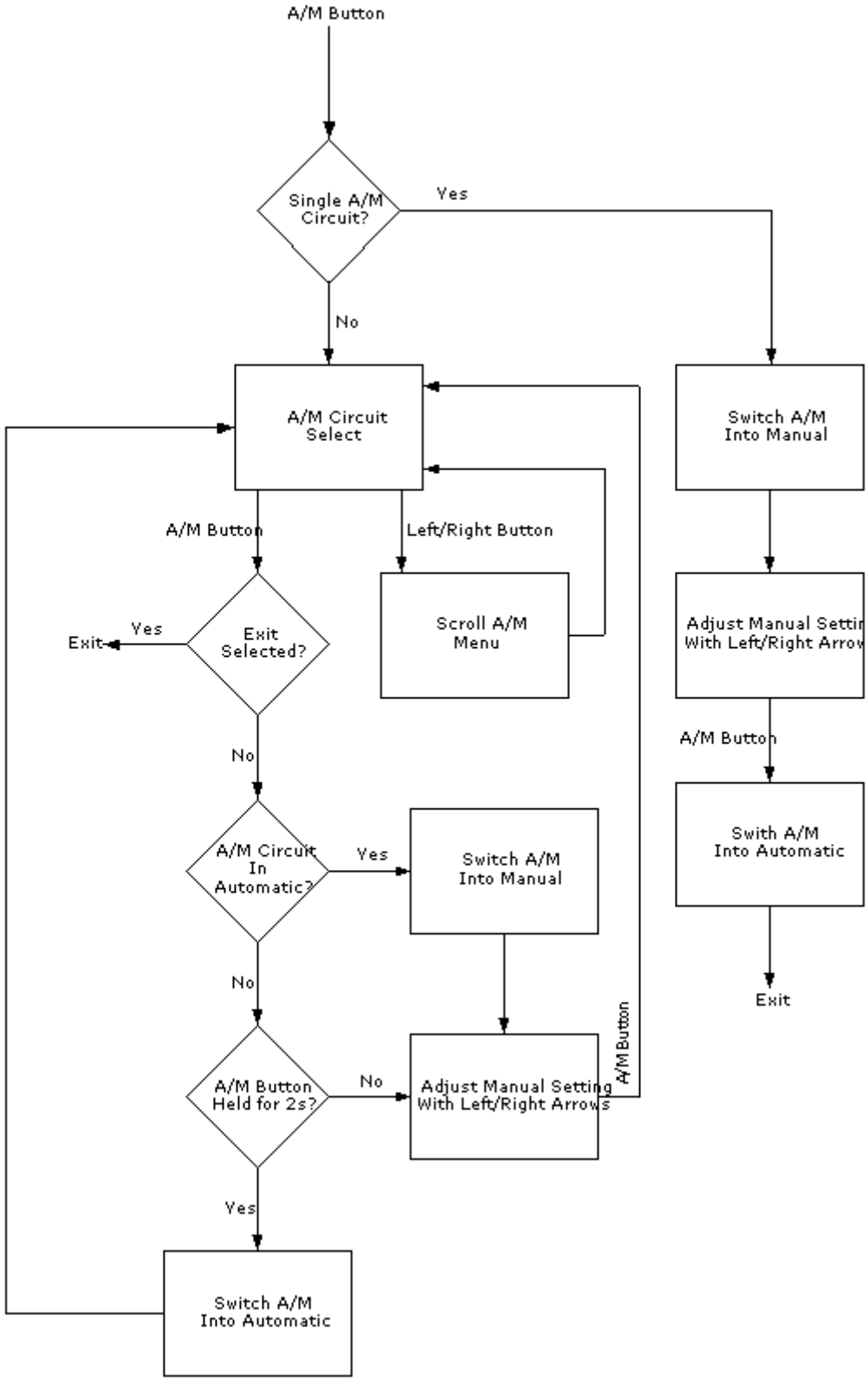
3. To return the system to automatic mode, press the A/M button again.

When the SET menu is active, the status and adjustment value for the A/M Menu system are indicated on the bottom alphanumeric display line. Otherwise they are indicated on the top two alphanumeric display lines.

When a control program contains multiple A/M circuits, adjustments are made as follows:

1. Press the A/M button to enter the *Auto-Manual Menu* system.
2. The top two lines All user-defined alphanumeric text messages on the top two display lines are paused while the controller is in the auto-manual menu system. of the alphanumeric display present a list of A/M circuit names (such as 'water level' or 'temperature') that can be adjusted. Use the LEFT and RIGHT arrow buttons to scroll through the list until the desired name to be changed is displayed.
3. If you wish to exit the *A/M Menu* system, scroll through the list until the 'Press A/M to exit A/M menu' message is displayed and press the A/M button.
4. A/M Mode is controlled as follows:
    1. To switch a selected A/M circuit from automatic mode to manual mode, press the A/M button and go to step 5.
    2. To switch a selected A/M circuit from manual mode to automatic mode, press and hold the A/M button for more than two seconds and go to step 2.
    3. To adjust the generator signal of a selected A/M circuit which is already in manual mode, press and hold the A/M button for less than two seconds and go to step 5.
5. Adjust the manual output by pressing the LEFT and RIGHT arrow buttons. If an arrow button is held down, the parameter value will begin to change at a rapid rate (note: the repeat rate for a held key is adjustable in software.)
6. When the desired value has been reached, press the A/M button to record the change. Note that the A/M circuit will remain in manual mode. Go to step 3.

If the control schema has multiple A/M circuits, you may not enter both the SET and A/M menus simultaneously. Exit out of one menu before attempting to enter the other.



A/M Menu System Flow Chart

4.2 The Electrical Interface

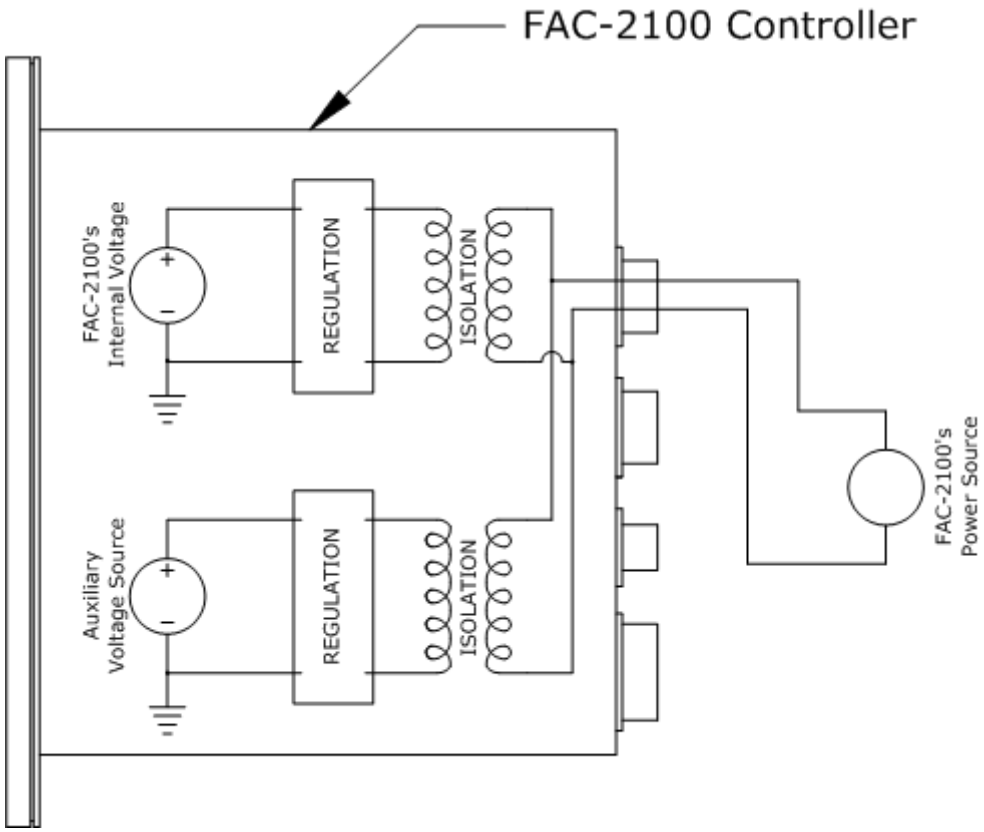
The following section describes all of the electrical connection points on the *FAC-2100* process controller. Refer to the Installation (see page 31) section of this bulletin for additional information and some pictorial examples on how to configure these electrical systems.

4.2.1 Providing Power to the Controller

The *FAC-2100* series controller accepts an unregulated DC input source from 18 to 36 volts that can provide 5 to 10 watts (varies based on application – see installation section for more information) of power for the controller. **Note:** This does not include the power provided to devices external from the *FAC-2100*'s auxiliary power output.

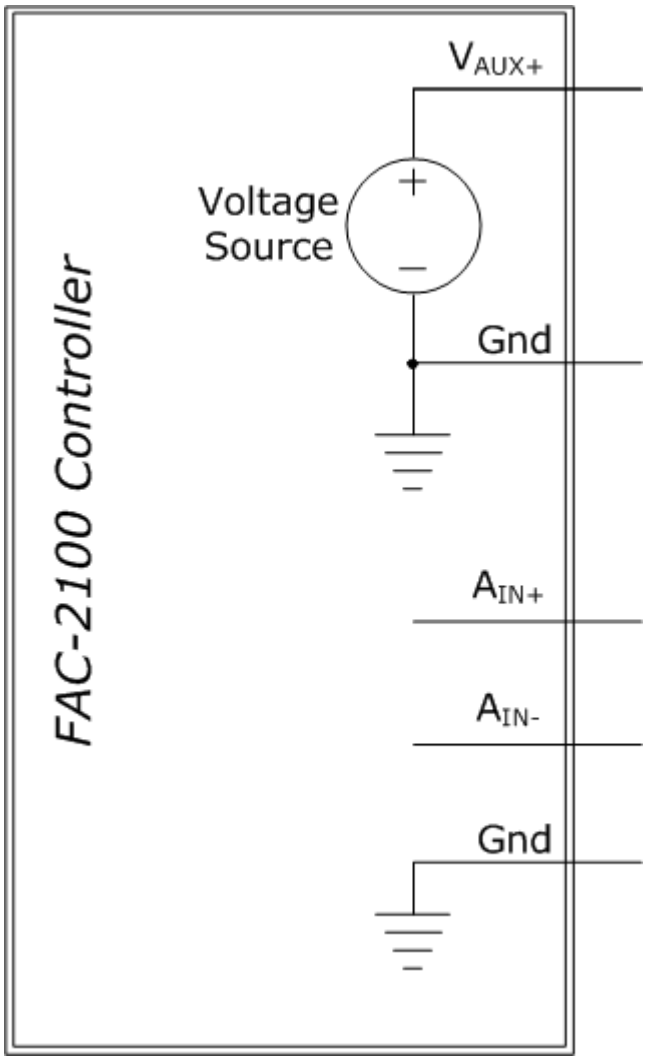
4.2.2 Powering External Devices from the FAC-2100

FAC-2100 controllers include an isolated auxiliary power output to supply the *FAC-2100*'s I/O circuitry and external devices with energy (see below). This 200mA source has a nominal output of 28 volts DC. The auxiliary power output is accessible from the back panel of the controller via miniature cylindrical.



FAC-2100's isolated auxiliary power output

4.2.3 Analog Input Interface



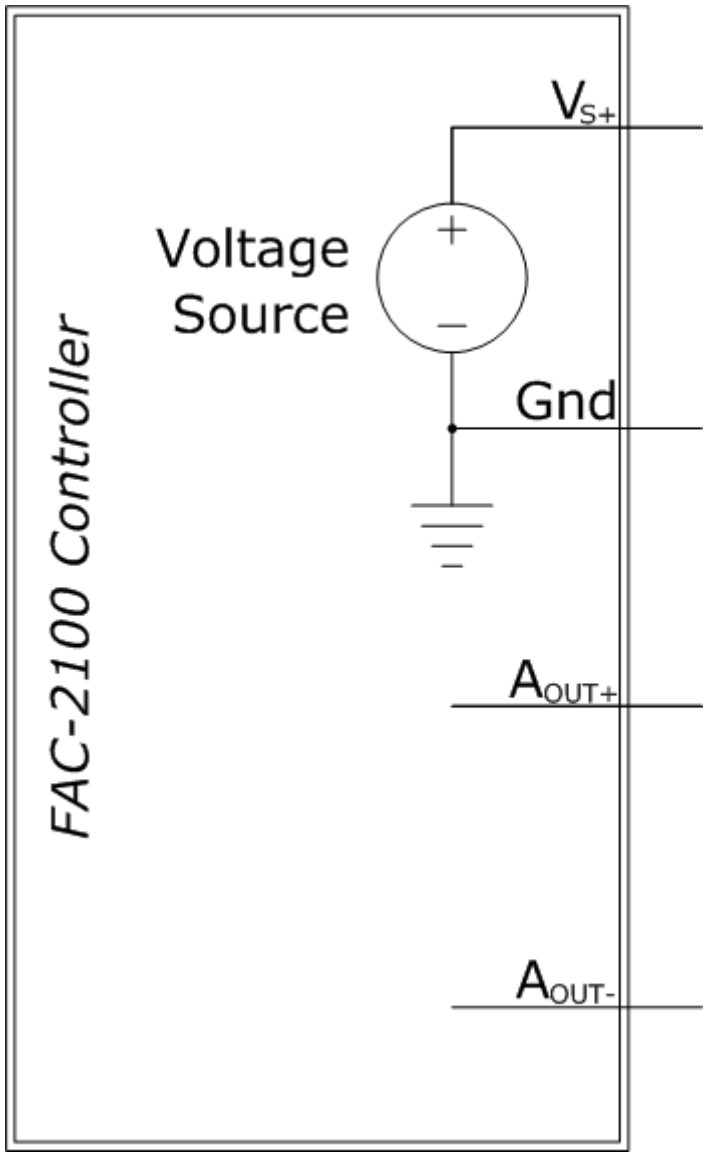
Analog Input

The *FAC-2100* contains three analog inputs each capable of reading a 4-20mA analog current signal, a 0 to 5V single-ended analog voltage signal, a +/-1V differential signal, an Resistance Temperature Device (RTD), or a 0 to 2400 ohm Resistor with connections similar to that shown in the figure above. The figure shows the auxiliary output voltage source and an analog input.

Input signals are attached to the A_{IN+}, A_{IN-}, and/or Gnd (ground) pins through connections made via cylindrical connectors on the rear of the device. All internal electrical routings that are necessary to reconfigure the input for a particular mode are automatically made via software controlled analog switches.

Note: The FAC-2000 controller (the previous version to the FAC-2100) required external wire jumpers to attached to the analog input pins and configure them for various modes. Those jumpers are not required on the FAC-2100. If those jumpers are installed, for example when the FAC-2100 is used as a drop-in replacement to an existing FAC-2000 installation, they do not need to be removed and will not adversely effect the FAC-2100 operation.

4.2.4 Analog Output Interface



Analog Output

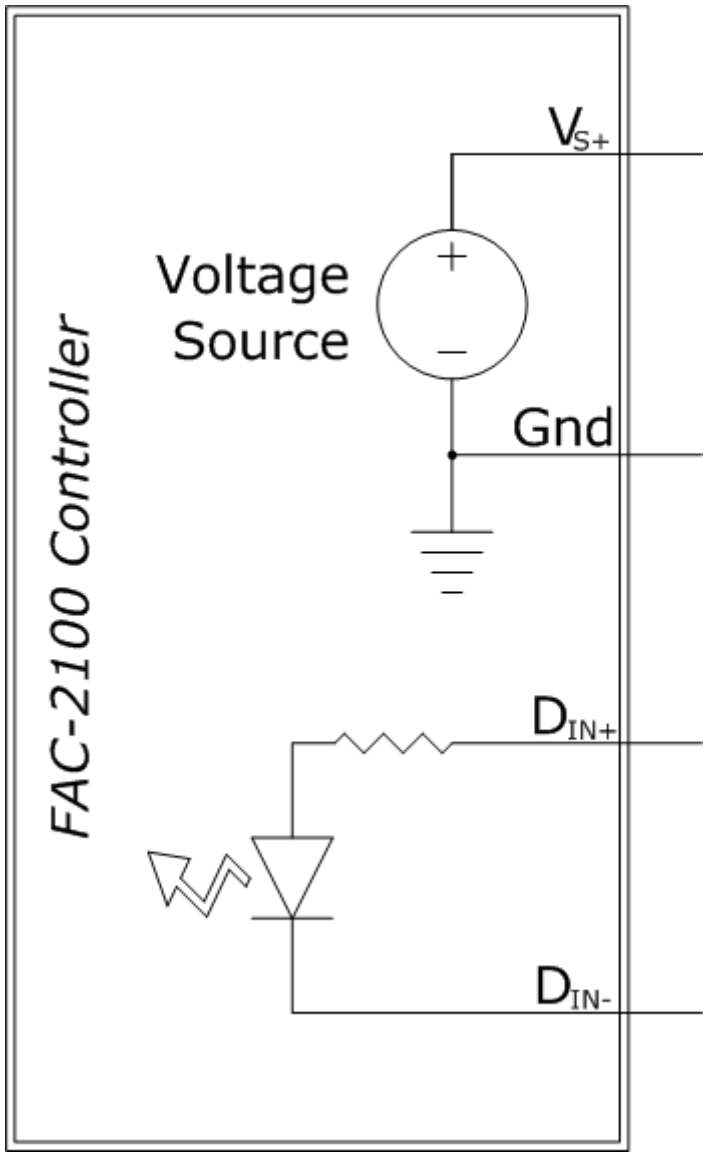
The *FAC-2100* has two analog outputs capable of providing 0 to 20mA, 4 to 20mA, 0 to 5V, or 0 to 10V (all modes are software configured). When outputting current each channel also has the option to be wired in source or sink mode.

Two common questions arise when using the analog outputs. First, what is the difference between wiring the output as a current source versus a current sink? The difference between the two is the position of the load relative to the A_{OUT+} and A_{OUT-} pins. In a current sink scheme, the load is attached to the A_{OUT+} pin. In a current source scheme, the load is attached to the A_{OUT-} pin. See the Current Output Mode (see page 50) (Sink and Source) examples. More importantly, as shown the Current Sink Mode and Current Source Mode examples, the position of the grounding point is different. Notice that if a current source is used, the load is attached directly to the circuit ground. This is important if you wish to transmit an analog signal, for example, from a sending controller to multiple receiving controllers. By attaching the load (in this case the load is the analog inputs of the receiving controllers) to ground, the entire circuit can have a common ground reference point. This common ground can become important if a single source is providing power to all the controllers, sensors, and actuators in the system.

The second common question is when should the circuit be wired as a current source rather than a current sink? In general, wire the circuit using the current sink configuration. If you need to transmit an analog signal between controllers, use the current source configuration. The main reason for this preference is that the analog output circuitry in the controller will sink current over a wider range of load conditions in comparison to a current source configuration.

Note that a voltage source from 4 to 32 V DC is required for the analog outputs to work correctly (see the *Installation* section of this bulletin for additional information). Care must be taken when selecting the source to ensure that grounding loops or unwanted grounding shorts do not occur. Also, the voltage for this analog output source cannot exceed the auxiliary output source. In general, it is recommended that the *FAC-2100's* internal auxiliary output source be used to power the analog outputs.

4.2.5 Digital Input Interface



Digital Input

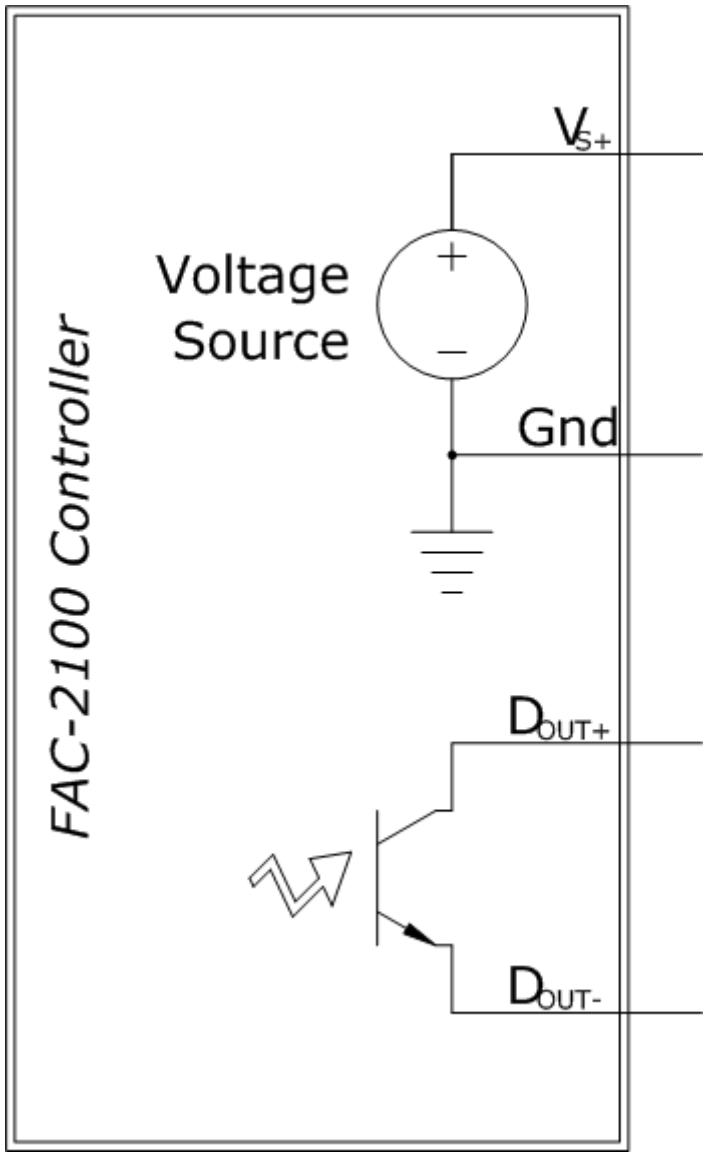
The *FAC-2100* contains ten optically isolated digital inputs. Eight of those inputs are classified as standard inputs and the remaining two as universal inputs. The main difference between the two types is the input voltage range. The figure above shows the equivalent circuit for these inputs. Notice that each input drives an isolating infrared light emitting diode (LED). When current is supplied to the LED, the digital input is said to be in a logic high state. When current is removed from the LED, the digital input is in a logic low state. Table 1 shows the signal range associated with each logic state for each digital input type.

Both the universal and standard digital inputs, when used with a voltage source (such as the *FAC-2100's auxiliary output*), can be used to indicate a switch or contact closure. Use the universal digital input to interface with logic circuits. Use the standard digital input to interface with sources above 30 VDC or with AC signals.

Table 1 - Voltage ranges for the digital inputs

Type	Low Logic Level Input Range (DC)	High Logic Level Input Range (DC)
Standard	0 to 1 VDC or 0 to 0.5 VAC 55-500Hz	5 to 200 VDC or 24 to 130 VAC 55-500Hz 5mA RMA
Universal	0 to 0.8 VDC	4.5 to 30 VDC at 7 mA

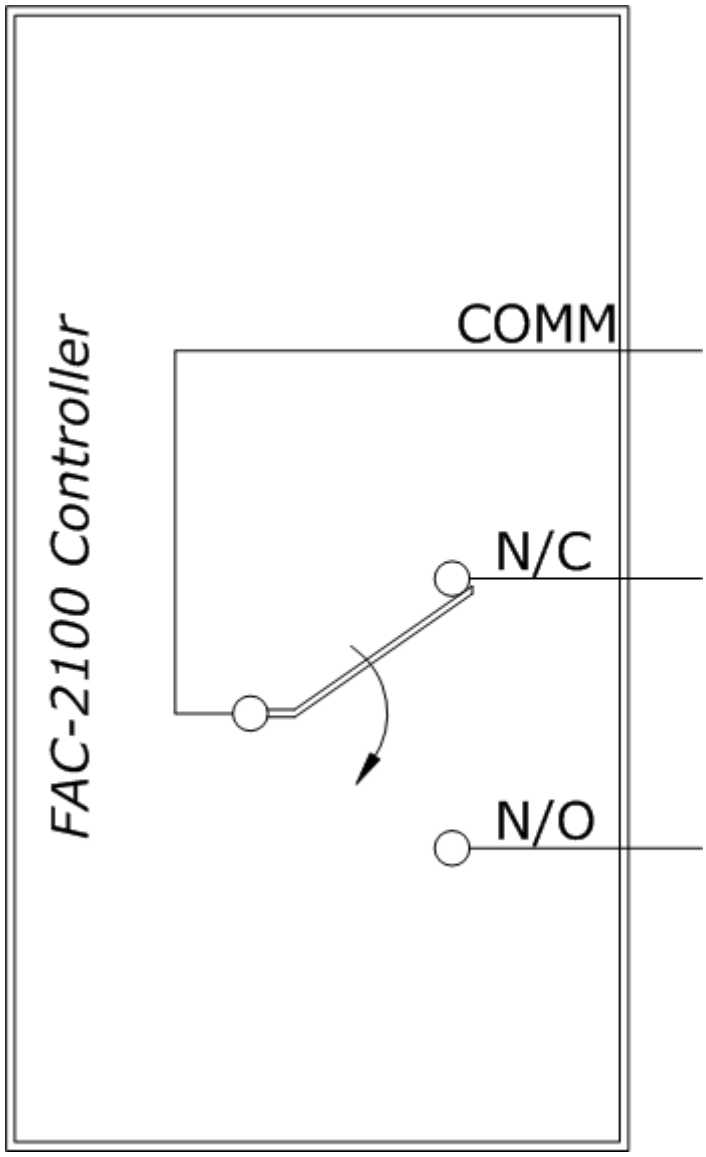
4.2.6 Digital Output Interface



Digital Output

Each *FAC-2100* has two open collector digital outputs. The outputs are optically isolated and can drive a load from a maximum 28 volt DC source with 40 mA (maximum).

4.2.7 Mechanical Relay Output Interface

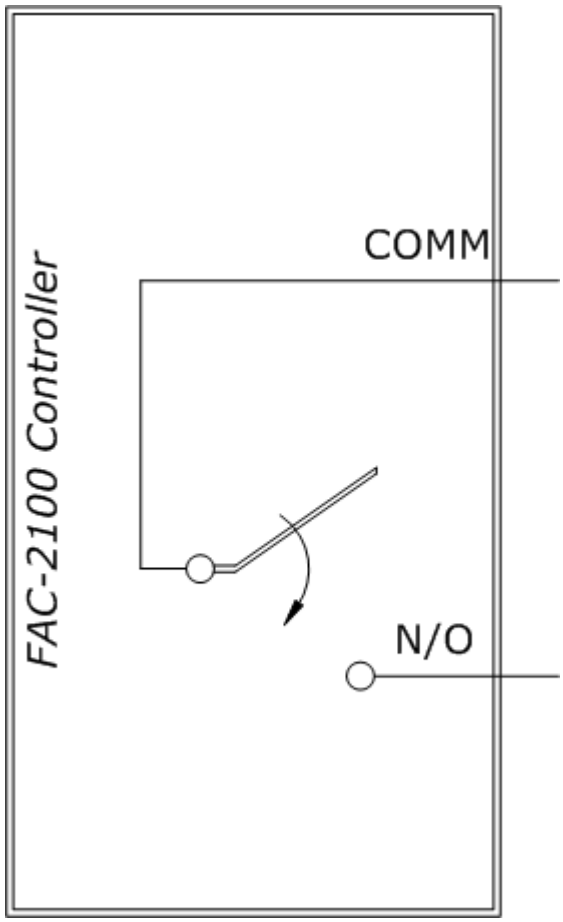


Relay Output

The standard *FAC-2100* provides four form-C outputs. Each relay is capable of switching 4 A (resistive) at 24V DC or 2 A (resistive) at 240 V AC.

On *FAC-2100* units equipped with miniature cylindrical connectors, some relay outputs may have additional current carrying limitations imposed by the connector pin. Refer to the Connector Pinout (see page 66) section for more information.

4.2.8 Solid State Relay Output Interface



Solid State Relay Output

The *FAC-2100* can be special ordered with an enhanced relay board that can include up to three DC or AC solid-state form A relays (see figure above.) Each solid-state relay is capable of switching 3 amp resistive or inductive loads at 60V DC or 140 V AC.

Each solid-state relay must be individually specified as AC or DC when ordered. You may not use the AC type to switch DC signals and visa-versa.

Do not use the solid-state modules to switch low currents as they typically have a 4-mA leakage current in the off state. Use a mechanical relay if it is necessary to switch low current.

Keep in mind that DC solid-state relays have defined polarities – the terminals labeled common (COMM) are positive and those labeled normally open (N/O) are negative.

Also, note that the AC solid-state modules are zero crossing turn-on. This means that the modules will not energize until the input waveform crosses zero volts. This translates to a maximum switching delay of approximately half the AC line frequency.

On *FAC-2100* units equipped with miniature cylindrical connectors, some relay outputs may have additional current carrying limitations imposed by the connector pin. Refer to the Connector Pinout (see page 66) section for more information.

4.2.9 Networking Options

The standard *FAC-2100* provides hardware support for networks compatible with RS-232, RS-422, and RS-485 voltage levels.

RS-232 point-to-point serial networks in the *FAC-2100* are used to provide an interface between a maximum of two devices (typically between a personal computer and a *FAC-2100* controller). Programming the controller is normally accomplished through this interface. This network can be used to transmit data at a maximum of 57,600 bits per second over a maximum distance of about 49 feet.

RS-422 and RS-485 multi-drop serial networks can connect up to 32 'unit load' devices via a three-wire link (note: more then 32 unit load devices can be connected by using a network repeater/isolator – contact Fairmount Automation for more information.) Each FAC-2100 is 1/8 a unit load so up to 256 FAC-2100s can be networked.

The network contains one master that initiates all communications. Each remaining slave device on the link will respond only when the master device attempts communication with it. This network can be used to transmit information at 115,200 bits per second over a maximum distance of 4000 feet (the network distance can be increase by using a network repeater/isolator.)

Care should be taken when selecting the wire type to be used for the transmission channel. For short distances (typically under 10 feet), standard 22 to 24 AWG twisted pair telephone cable can be utilized. If the network extends over larger distances, higher quality wire should be used (such as Datalene (type 8162) wire from Belden Wire and Cable Company). Note: Cat 5 Ethernet communications cable is an acceptable alternative.

RS-485 networks should be wired in a straight-line bus with biasing and terminated at the two ends. Termination resistors should match the characteristic impedance of the transmission line (typically 120 ohms). Note that the FAC-2100 has internal dip switches that can activate built-in 120 ohm termination resistors.

5 Product Specifications

Environmental Characteristics	
Operating Ambient Temperature Range	-20°C to 65°C
Storage/Transport Ambient Temperature Range	-40°C to 85°C
High Impact Shock	MIL-STD-901D, Grade A
Mechanical Vibration	MIL-STD-167B
Electro-Magnetic Interference	MIL-STD-461E
Facial Protection	NEMA 4
Housing Protection	NEMA 4

Input Power	
Voltage Range	18 to 36 VDC
Typical Power Consumption Range*	4 to 10 Watts (not including Aux. DC Output)

*Reference the Electrical Installation Power (see page 40) section for more information.

Analog Outputs	
Quantity / Resolution	2 Channels / 14 Bits
Current Output Ranges Supported	0-20mA, 4-20mA
Current Output Range Accuracy	+/-40uA at 25°C, +/-100uA Over Temperature
Voltage Output Ranges Supported	0-10V, 0-5V
Voltage Output Range Accuracy	+/-40mV at 25°C, +/-100mV Over Temperature

Analog Inputs	
Quantity / Resolution	3 Channels / 16 Bits
Current Input Ranges Supported	0-20mA, 4-20mA
Current Input Accuracy	+/-40uA at 25°C, +/-100uA Over Temperature
Standard Voltage Input Ranges Supported	0-20V, 0-10V, 0-5V, 1-5V, 0-2.5V
Standard Voltage Input Range Accuracy	+/-36mV at 25°C, +/-86mV Over Temperature
Low Voltage Input Ranges Supported	0-1V, 0-500mV, 0-250mV, 0-100mV
Low Voltage Input Range Accuracy	+/-2mV at 25°C, +/-5mV Over Temperature
Resistance Input Range Supported	0-2400
Resistance Input Range Accuracy	+/-2.4 or +/-0.4% of Reading (whichever is smaller) Over Temperature
RTD Support	3 Wire, 100 Platinum (European or American curve), 120 Nickel, or Custom
RTD Accuracy	+/- 1°C Over Temperature

Standard Digital Inputs	
Quantity / Type	8 Channels / Opto-isolated
Maximum Allowable Continuous Input Voltage	200 VDC or 140 VAC RMS
Maximum Allowable Voltage Spike	1000V peak 1.2µS x 50µS pulse per MIL-STD-1399 Section 300
Logic High Voltage Range	5-200 VDC or 24-130 VAC 55-500 Hz
Minimum Input Duration for Logic High Detection	4 ms
Logic Low Voltage Range	0-1 VDC or 0-0.5 VAC 55-500 Hz
Minimum Input Duration For Logic Low Detection	56 ms
Minimum Input Current Required (AC and DC inputs)	5mA RMS

Universal Digital Inputs	
Quantity / Type	2 Channels / Opto-isolated
Input Signal Support	5VDC, 28VDC (at approximately 7mA)
Single-Input Operating Modes	on/off (i.e., switch), pulse counter, frequency counter
Dual-Input Operating Modes	event timer, quadrature decoder
Maximum Frequency	500 KHz

Low Power Digital Outputs	
Quantity / Type	2 Channels / Opto-isolated Transistor
Output Signal Support	Up to 28VDC (40mA maximum)
Operating Modes	on/off, variable frequency square-wave, pulse width modulation (PWM)
Maximum Frequency	50 Hz

High Power Digital Outputs	
Quantity / Type	5 Relays Maximum / Up to 4 Mechanical Form “C” Relays and up to 3 Opto-isolated Solid State Form “A” Relays
Mechanical Relay Rated Signal Range	4 A (resistive) @ 24VDC or 120 VAC, 2 A (resistive) @240 VAC
Solid State Relay Rated Signal Range	3 A @ 60VDC or 140 VAC

Reference the Mechanical (see page 22) and Solid State (see page 23) Relay sections for more information.

Displays	
Element Type	Yellow, Green, and Red LEDs
Digital Readouts	Two 4 digit, 7 segment digital readouts One 3 digit, 7 segment digital readout Colors are user-specified 0.4" in height 0.3" in width

Displays	
Analog Bar Graphs	Two columns of 40 LEDs (colors are user-specified) 4" in height 0.2" in width 0 to 100% range 2.5% bargraph operation resolution
Alpha-numeric Displays	Three rows with 8 characters (7x5 pixel resolution) each
Keypad	Six positive tactile-feel keys

Network Support	
Point to Point	RS-232 (maximum of 2 devices)
Multi-drop	RS-485 and RS-422

Turn On Time
Less then 5 seconds

Programming Method
Design Pad graphical programming environment on a PC using Windows XP or better — Compiled programs are typically transferred from a PC's COMM port to the controller via RS-232 serial link

Local Adjustments
Outputs and user-specified properties are adjusted using a six-button keypad

Dimensions	
Front	5.5" x 8"
Depth (w/o cylindrical connector shells)	7.75"

Weight
Approximately 7 pounds

6 Installation

The following section provides a general guideline on how to install the *FAC-2100*.

Before installing the controller, inspect it fully for any damage that may have occurred during shipping. Do not install the controller if it appears to be damaged and contact Fairmount Automation for a return materials authorization (RMA) number.

This device must be installed in a manner that ensures no mechanical or electrical limits (as stated in the product specification) are exceeded. Permanent damage to the device may result.

Only qualified personnel should install the FAC-2100 controller. *Always remove all power sources before installing the device---failure to do so may result in serious injury and/or equipment damage.*

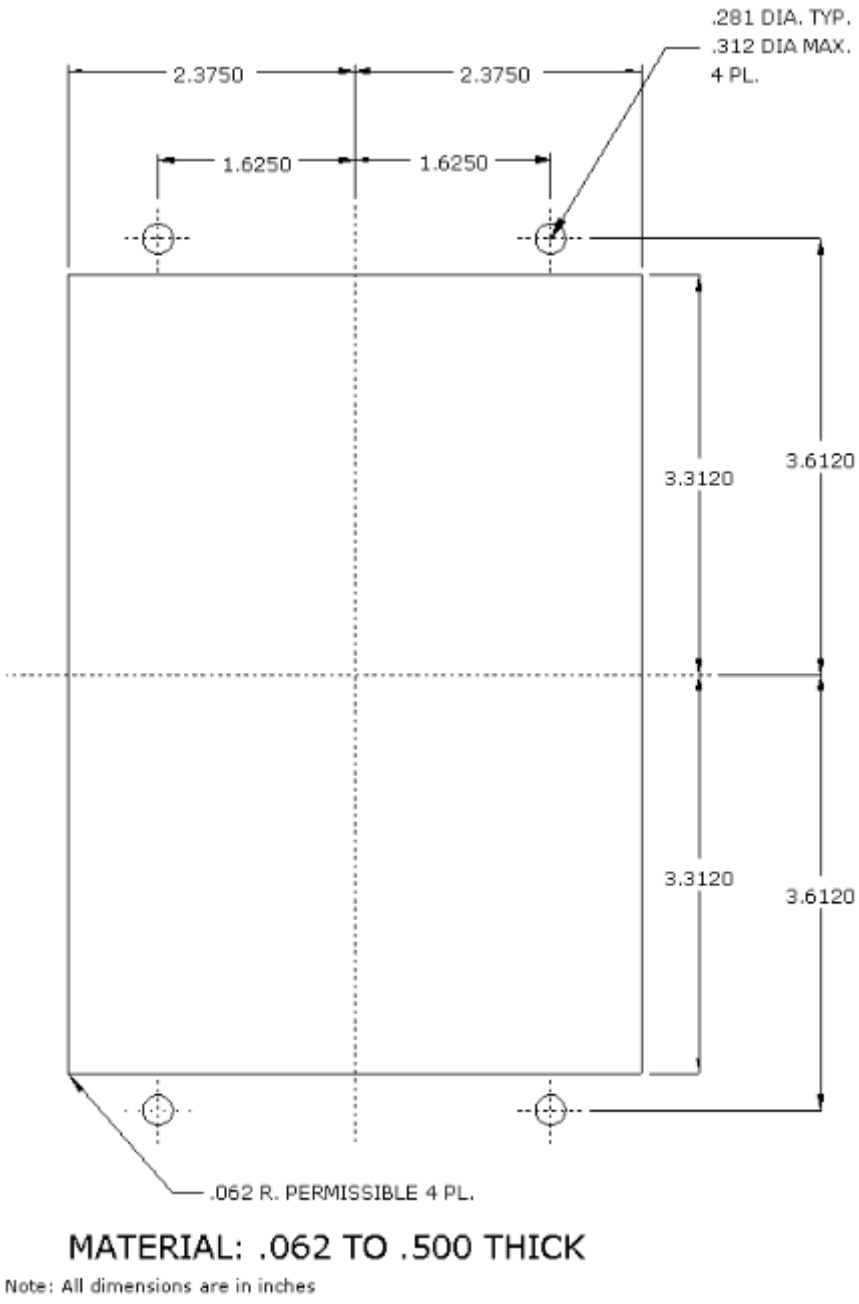
Do not open any covers to the controller while it is located in corrosive or high humidity environments. This may cause damage to the internal circuits.

Cover all unused miniature connector receptacles with receptacle caps.

6.1 Mechanical Installation

6.1.1 Panel / Console Cutout

The *FAC-2100* is designed for installation in a panel or console between 1/16 and 1/2 inch thick. The figure below shows the required panel cutout dimensions.



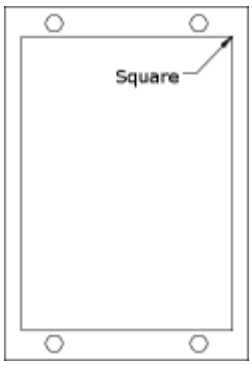
Cutout Required to Install the Controller

IMPORTANT NOTE: The mounting holes must not exceed 0.312" in diameter (the recommended mounting hole diameter is 0.281".)

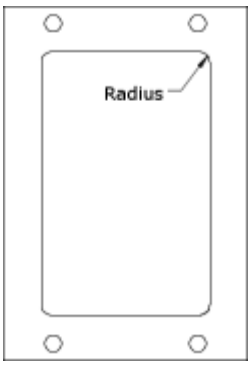
6.1.2 Mechanical Assembly

After cutting out the pattern shown above, place the mounting assembly on the mounting plate in the following order:

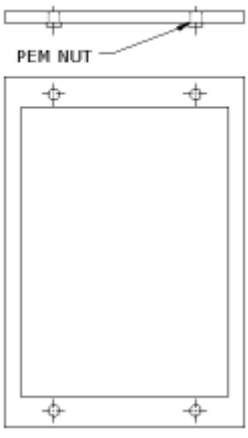
1. Silicone Locking Clamp Gasket
2. *FAC-2100* controller body
3. Silicone Bezel Gasket
4. Four Mounting Spacers
5. Steel Bezel



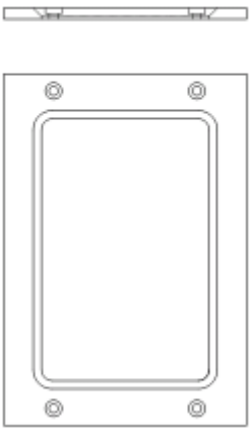
The Silicone Locking Clamp Gasket



The Silicone Bezel Gasket

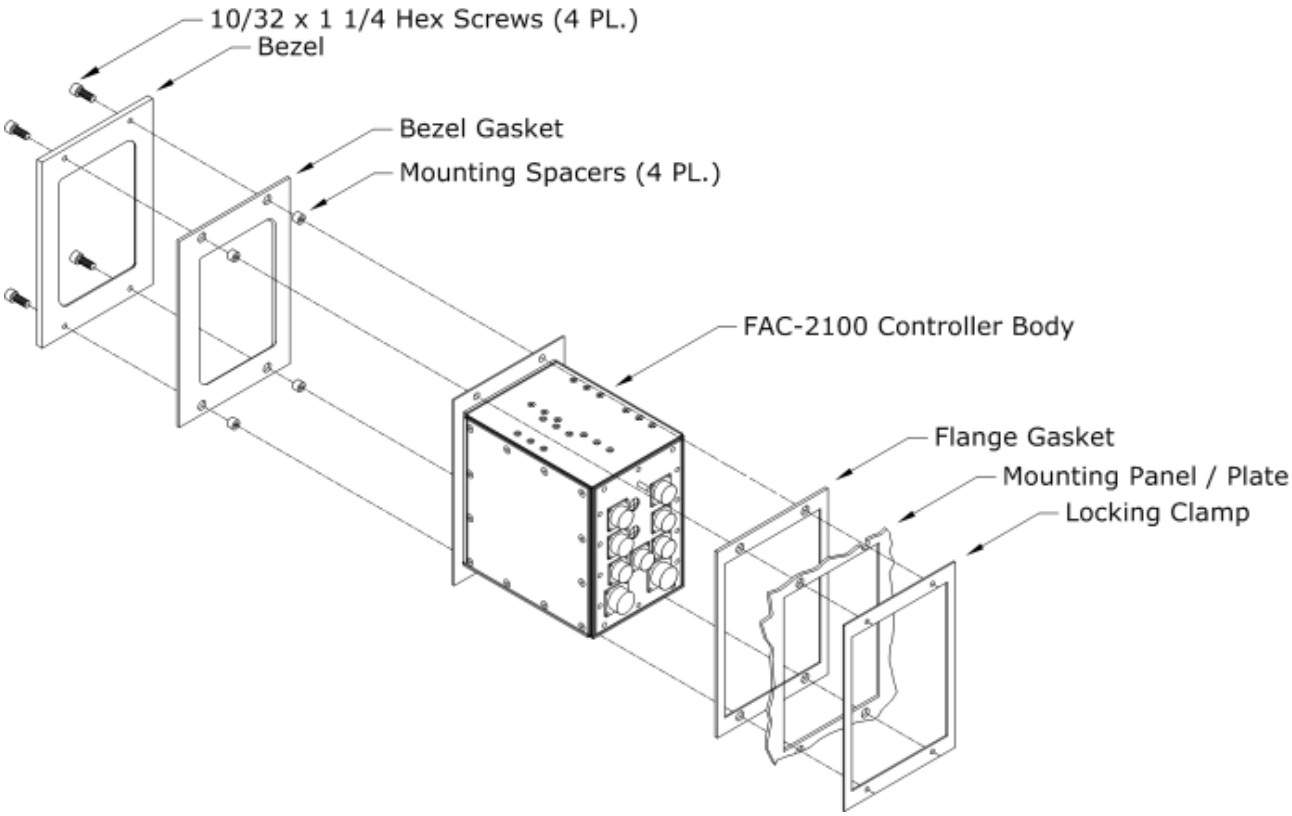


The Steel Locking Clamp



The Steel Bezel

From the rear of the mounting plate, slide the locking clamp over body of the controller with the PEM nuts facing *away* from the mounting plate. While holding the locking clamp, insert the four 10-32 hex socket head cap screws into each hole of the bezel and tighten with a 5/32 hex head wrench. The recommended seating torque for the 10-32 hex socket head screws is 76 in-lbs.

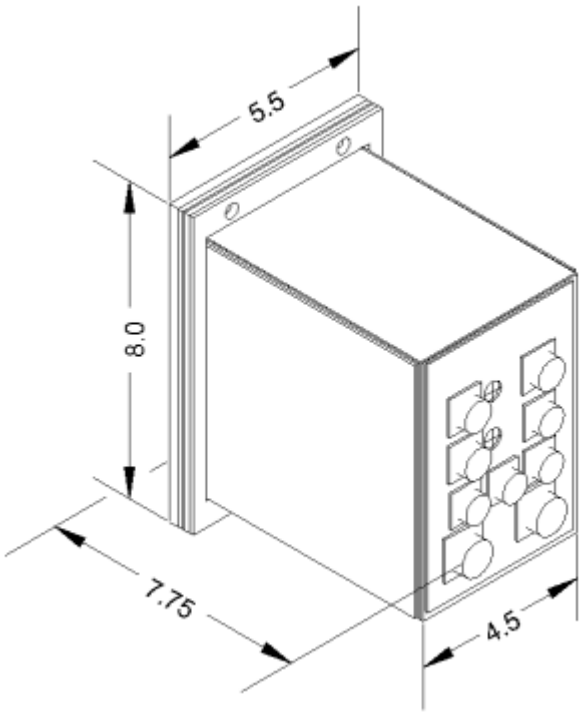


Mounting Configuration

6.1.3 Dimensions

If the *FAC-2100* contains miniature cylindrical connectors, the mounting depth of the controller behind the mounting panel/plate (measured from the front face of the mounting panel/plate to the ends of the miniature cylindrical connector receptacles and fuse holder(s)) is 7.2 inches. When strain-relieving plugs are attached to the connector receptacles (not including the depth associated with wire exiting the plugs), the mounting depth required is 8.5 inches.

The controller will extend 0.56 inches in front of the mounting plate (measured from the front face of the mounting panel/plate to the heads on the four 10/32 x 1/4 mounting bolts).



Case Size

6.2 Electrical Installation

6.2.1 Electrical Installation

The following section provides guidance on electrical installation of the controller. Select from one of the following topics:

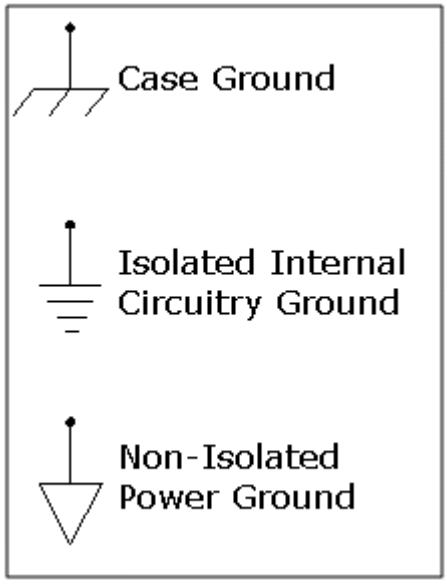
6.2.2 General Wiring Information

In general, all DC analog signals should be wired using shielded cable with a 360 degree braid. The braid should connect to the circular connector shell (i.e. chassis ground). In certain cases, where EMI is a significant concern, the cable shield should also be chassis grounded on the opposite end of the cable as well.

6.2.3 Grounding

As with all electrical devices, it is important to keep in mind the layout of the *grounds* when wiring a control circuit. There are three types of grounds to keep track of (see figure below):

1. Earth / Case Ground,
2. Isolated ground for the controller, and
3. External power supply ground or a non-isolated ground for the controller.



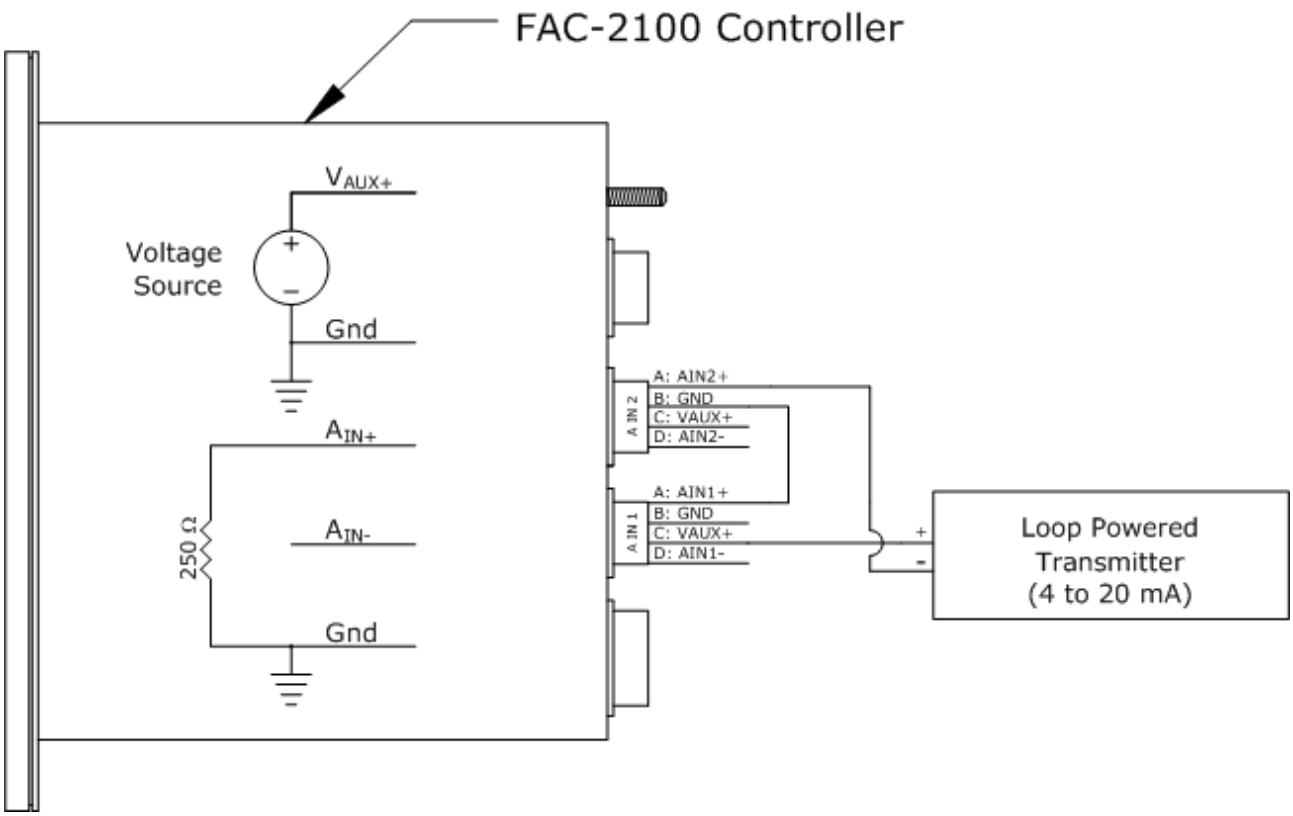
Ground Symbols and Associated Labels

The ground symbols shown above are used throughout the installation figures in this section. Like symbols in each of the figures represent the same circuit point. Make sure that joining these common grounds to different voltage potential levels does not create unwanted shorts.

The circuitry ground and the auxiliary output ground are both isolated from the input power source, and as a result, are isolated from the external world. Thus, the designer only needs to be concerned with not mixing grounds within the same controller.

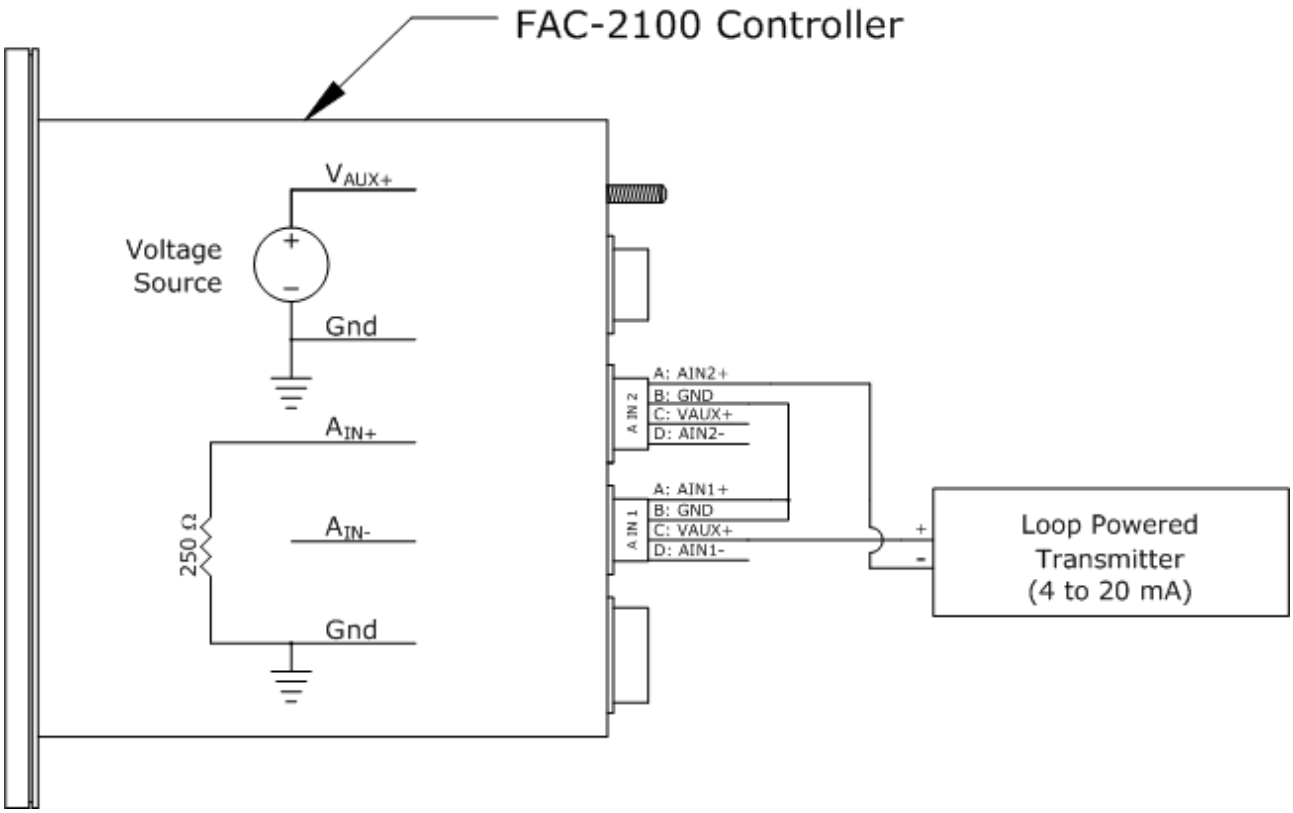
Connections to the analog inputs and analog outputs are all referenced to the same isolated internal circuitry ground. The communications, relay, digital inputs, and digital outputs are optically or mechanically isolated and therefore pose no ground-mixing risk.

Consider the example connection diagram shown below, where both analog inputs are connected to the same signal. In the figure, a loop-powered transmitter is connected in series to both analog input 1 and analog input 2 of the same controller. Inside the *FAC-2100* silhouette, the equivalent circuit of each analog input is shown. Notice that the negative analog input terminal is connected to the internal circuitry ground symbol. This is true for all analog inputs.



Incorrect Grounding Scheme Example

Since the ground (Gnd) terminal of each analog input is at the same ground potential, the wiring below is equivalent to the above example. Notice that in the equivalent circuit, the analog input 1 leads are shorted together, thereby totally bypassing the input. This problem can be resolved by wiring analog input 2 as a voltage input and wiring it in parallel to analog input 1 (reference Voltage Input Mode (see page 45)).



Incorrect Grounding Scheme Equivalent Wiring Diagram

6.2.4 Power

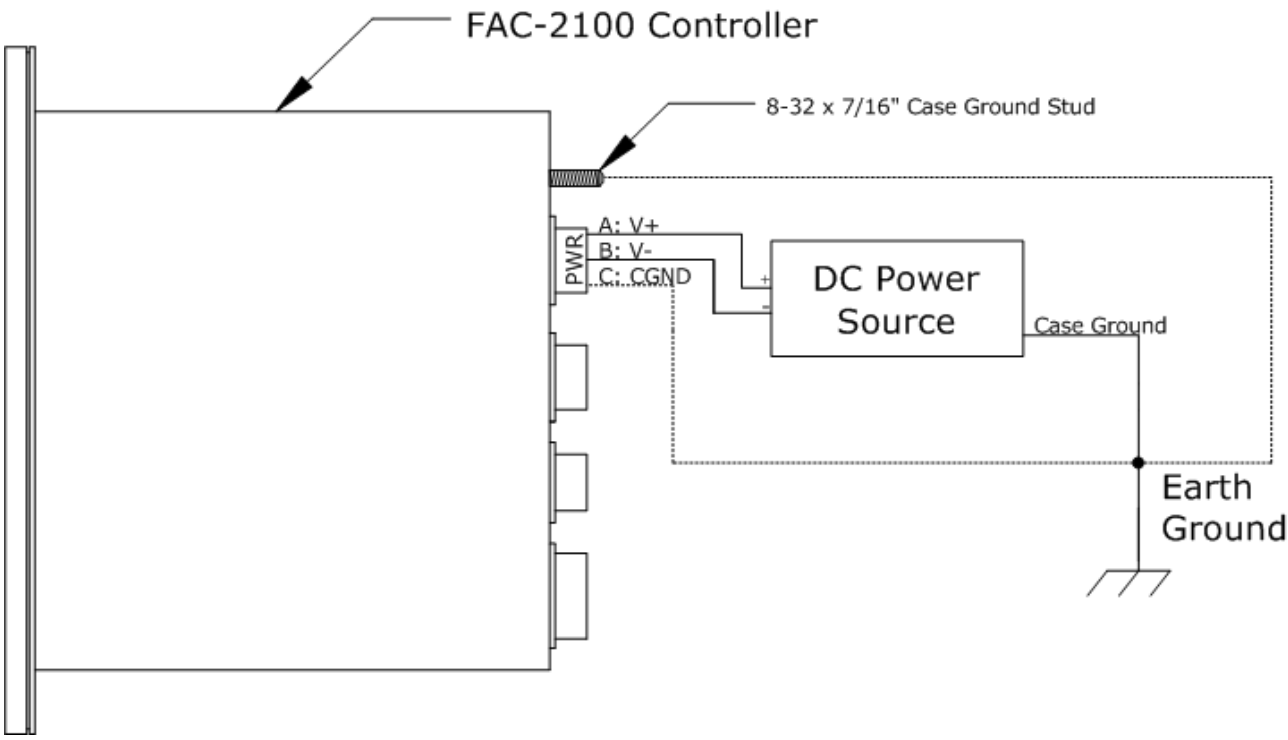
Typical Power Draw

The following table shows the typical power draw (in Watts) for the *FAC-2100* under various conditions:

Test Condition	18VDC Power	24VDC Power	28VDC Power	36VDC Power
Unit On, Idle (No Schema)	4.2	4.4	4.7	5.7
Additional Power for All Front Panel LED On	2.8	2.8	2.8	2.8
Additional Power for Analog and Digital Outputs On	0.25	0.25	0.25	0.25
Additional Power for 3 Solid State Relays and 2 Mechanical Relays	1.3	1.3	1.3	1.3
Additional Power per mA of Load on 28V Auxiliary Output	0.05	0.05	0.05	0.05

Power Connection Diagram

The diagram below shows the connections for powering the device. Note that a chassis ground braid must be connected between the stud on the back of the device and an Earth/chassis grounding point to provide EMI and ESD protection. The braid used during MIL-STD 461 EMI testing can be ordered using Fairmount Automation Part Number: 30110-015.



Wiring the FAC-2100's DC Input Power

Warning: An improperly grounded case could result in electrical shock or incorrect operation of the controller.

Fuses

Each FAC-2100 has a fuse located in the rear of the device on the connector panel. Refer to the Parts List (see page 75) section for the fuse specification and ordering information.

Auxiliary Output Power

The FAC-2100 contains a 28V isolated (from the DC input power source) output source available to power sensors, actuators, etc. Most circular connectors on the back of the FAC-2100 contain pins that provide access to this source.

Note that the design of the Auxiliary Output Power source allows for multiple FAC-2100s to short together (no steering diodes are required) their power sources to provide a redundant source. As an example, this feature can be useful when multiple controllers are reading the same powered sensor – by connecting the Auxiliary Output Power from all controllers to the sensor it ensures that all controllers will be able to read the sensor if any or all others are offline.

6.2.5 Analog Inputs

Analog Inputs

The FAC-2100 contains three analog inputs each capable of operating in current, voltage, resistance, or RTD measurement modes. The modes are software controlled and all internal circuitry reconfiguration is automatic (i.e. no external jumpers are required).

Select from one of the following modes to get additional information:

- Current Input Mode (FAC2100) (see page 43)
- Voltage Input Mode (FAC2100) (see page 45)
- Resistance and RTD Input Mode (FAC2100) (see page 47)

Auto-Connect / Disconnect

The internal controller electronics will automatically isolate themselves from the external circuitry via a high impedance switch when the analog input is either not configured for use in the software or the unit is powered off. The required configuration will automatically become connected (i.e. low impedance) when the device is powered and the input is configured for a particular function.

Replacing FAC-2000 Controllers with FAC-2100s

Note that the FAC-2000 (the previous model FAC-2100) did require external jumpers to configure the inputs. The FAC-2100 is 100% backwards compatible with the FAC-2000 and, if those jumpers are installed, they do not need to be removed when replacing the FAC-2000 with a FAC-2100.

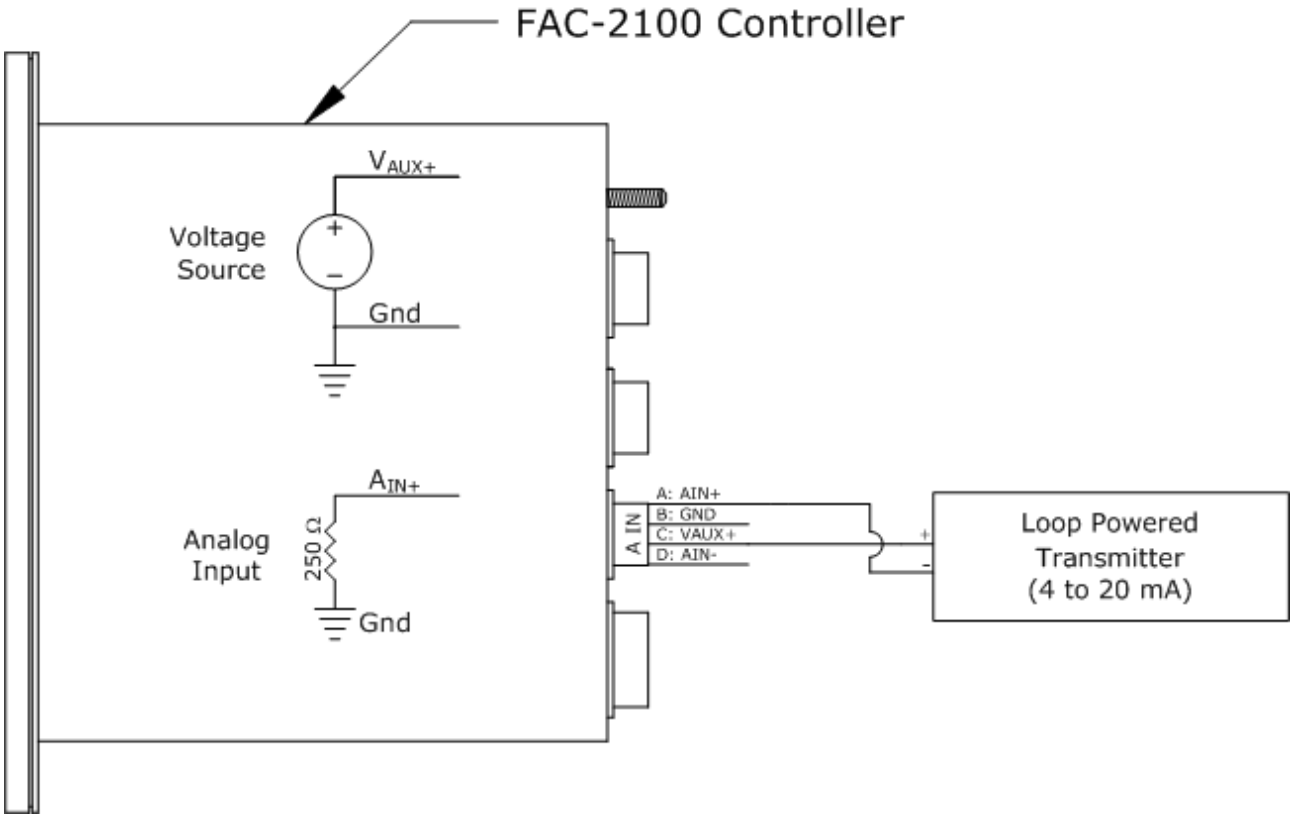
Current Input Mode

Current Input

The FAC-2100 can read 0/4mA to 20mA currents on any of its analog inputs. An analog input configured in software for current mode will automatically engage a 250 ohm resistor (physically located in the controller) from the A_{IN+} pin to GND.

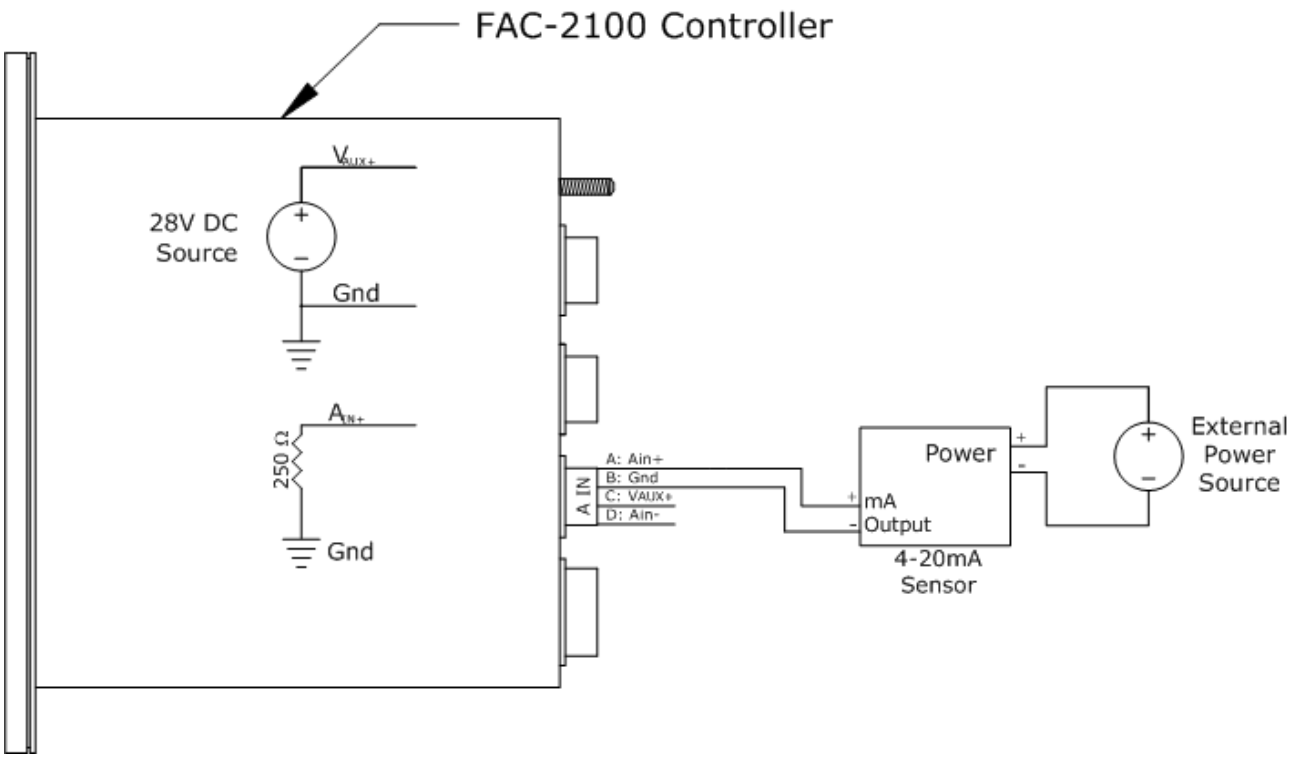
Typical Wiring Diagram

The figure below shows a typical hook-up for loop powered 4-20mA transmitters. This configuration uses the internal 28V axillary voltage source to power the transmitter. Note the connection from the analog input return back to ground of the voltage source is made internal to the controller. Also note that the A_{IN-} pin is not used in this mode.



Suggested Analog Input Wiring with a Loop Powered Transmitter

The figure below shows a 4-20mA sensor (not loop powered) connected to the controller where the sensor is powered by an external source. Note that a similar connection is made when using a 4-20mA loop sensor that is externally powered.



Suggested Analog Input Wiring with an Externally Powered 4-20mA Sensor

Over-Current Shutoff

When the input is in current mode the device will automatically protect itself from currents that exceeds approximately 25mA. When this condition is detected the circuitry will automatically disconnect the 250 ohm resistor and thereby open the circuit (this will also turn off an attached loop transmitter). A short time later the 250 ohm resistor will be reengaged to see if the fault has cleared. If not, the cycle will repeat.

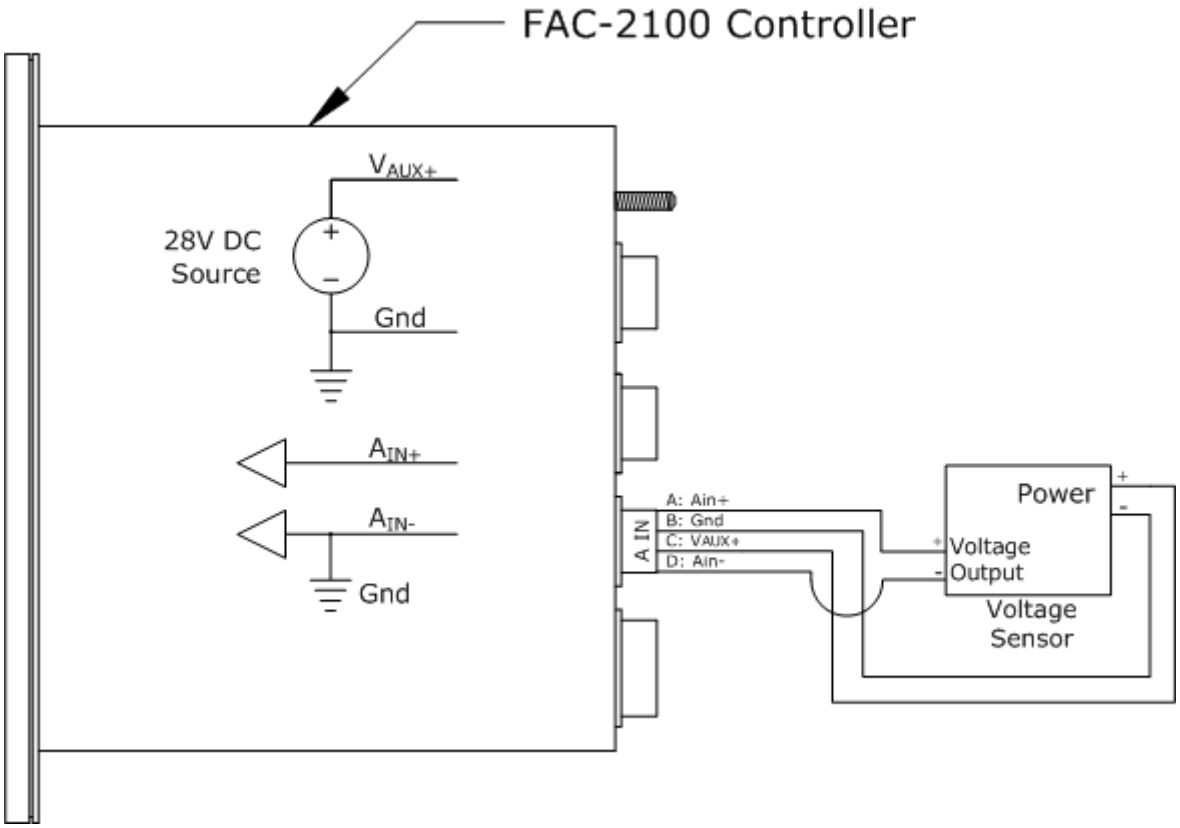
Voltage Input Mode

Voltage Reading

In voltage reading mode the input signal is connected to the A_{IN+} and A_{IN-} pins. Note that the A_{IN-} pin is internally connected to ground.

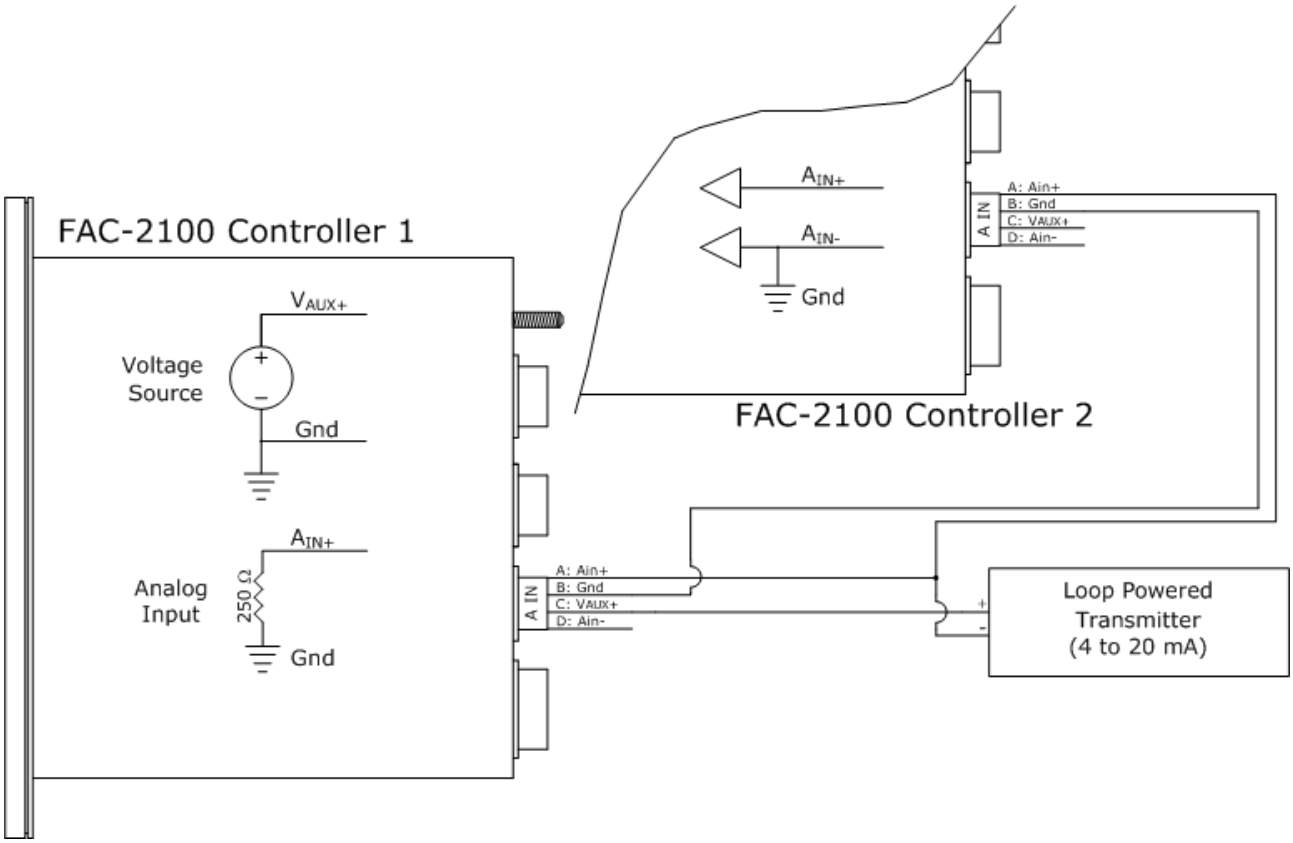
Wiring Diagram

The figure below shows a typical wiring for reading a voltage signal. In this particular example, the voltage sensor requires power which it is getting from the FAC-2100 auxiliary output.



Suggested Analog Input Wiring to a Sensor with a Voltage Output

In certain cases it is necessary to share the analog signal from one transmitter across multiple controllers. The figure below shows one example circuit. In this example, controller 1 is configured for current mode and is supplying the 250 ohm resistor (internally) that controller #2 (configured for voltage mode) is reading the voltage across.



Example Analog Input Wiring for Two Controllers Reading the Same Output from a Loop Powered Transmitter

An alternate configuration for the above circuit is to setup both controllers for voltage mode and install an external 250 ohm resister in the circuit. Also, connect the auxiliary voltage source from both controllers to the positive terminal of the loop transmitter (the FAC-2100 aux voltage outputs can be safely paralleled in this manner.) This will give the advantage that controller #1 does not need to be working or installed for controller #2 to read the signal (and vice-versa).

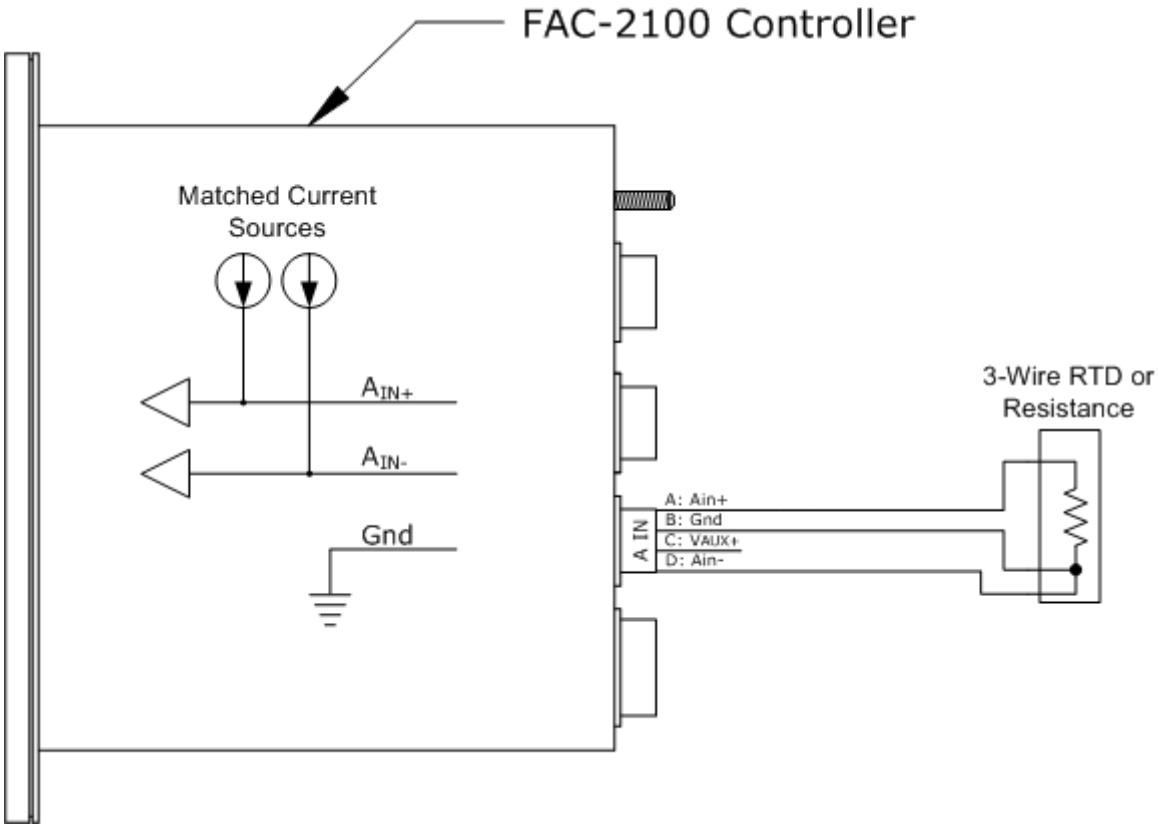
Resistance and RTD Input Mode

Resistance and RTD Readings

The FAC-2100 uses a three-wire technique to read resistors and RTD sensors. This technique involves having one wire (signal) connected to one end of the resistor and two wires (common) be connected to the other end. The advantage of this technique is that the resistance associated with the cable negated and only the resistance of the sensor element is measured.

Wiring Diagram

The following figure shows the typical wiring for a resistor or RTD:



Example Analog Input Wiring for Reading a Resistor or RTD

If the reading error associated with the resistance of the cable is not significant for your system (or can be compensated for using some other means) then it is possible to use a two wire cable and short the ground and A_{IN-} pins together in the FAC-2100 connector.

6.2.6 Analog Outputs

Analog Outputs

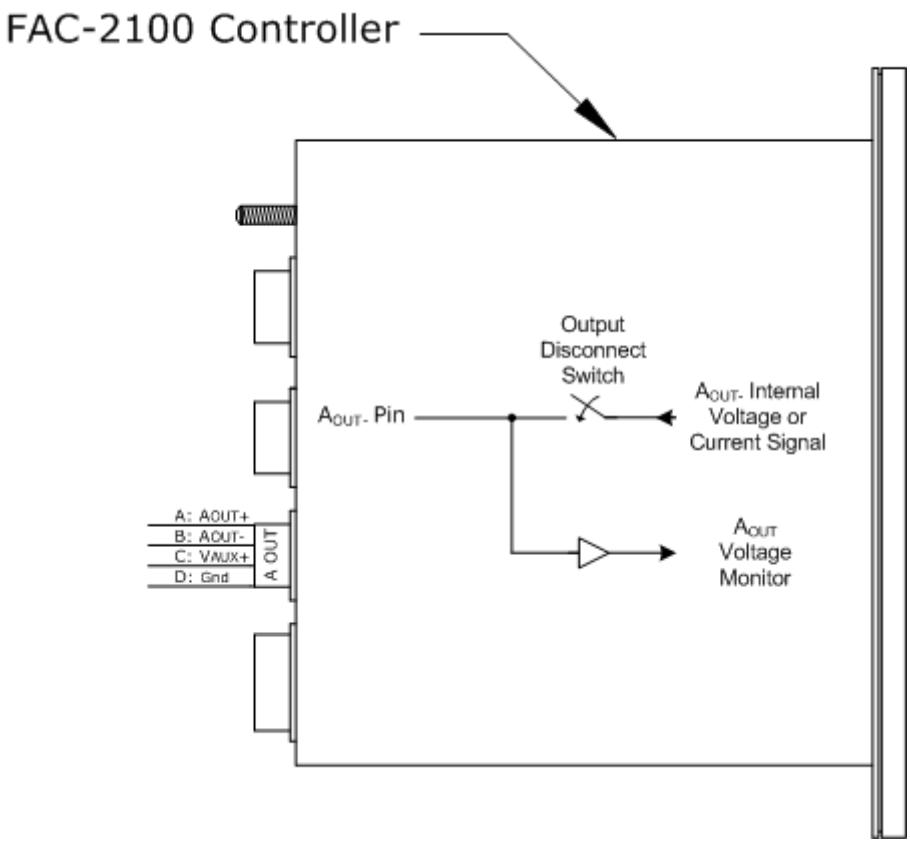
The FAC-2100 contains two analog outputs that can operate in a voltage or current output mode.

Select from one of the following modes to get additional information:

- Current Output Mode (FAC2100) (see page 50)
- Voltage Output Mode (FAC2100) (see page 52)

Disconnect Switch and Voltage Feedback

Each analog output contains both an internal on/off disconnect switch and a voltage feedback monitor mechanism as shown in the following diagram:



Analog Output Signal Disconnect and Voltage Monitor

This mechanism is useful to:

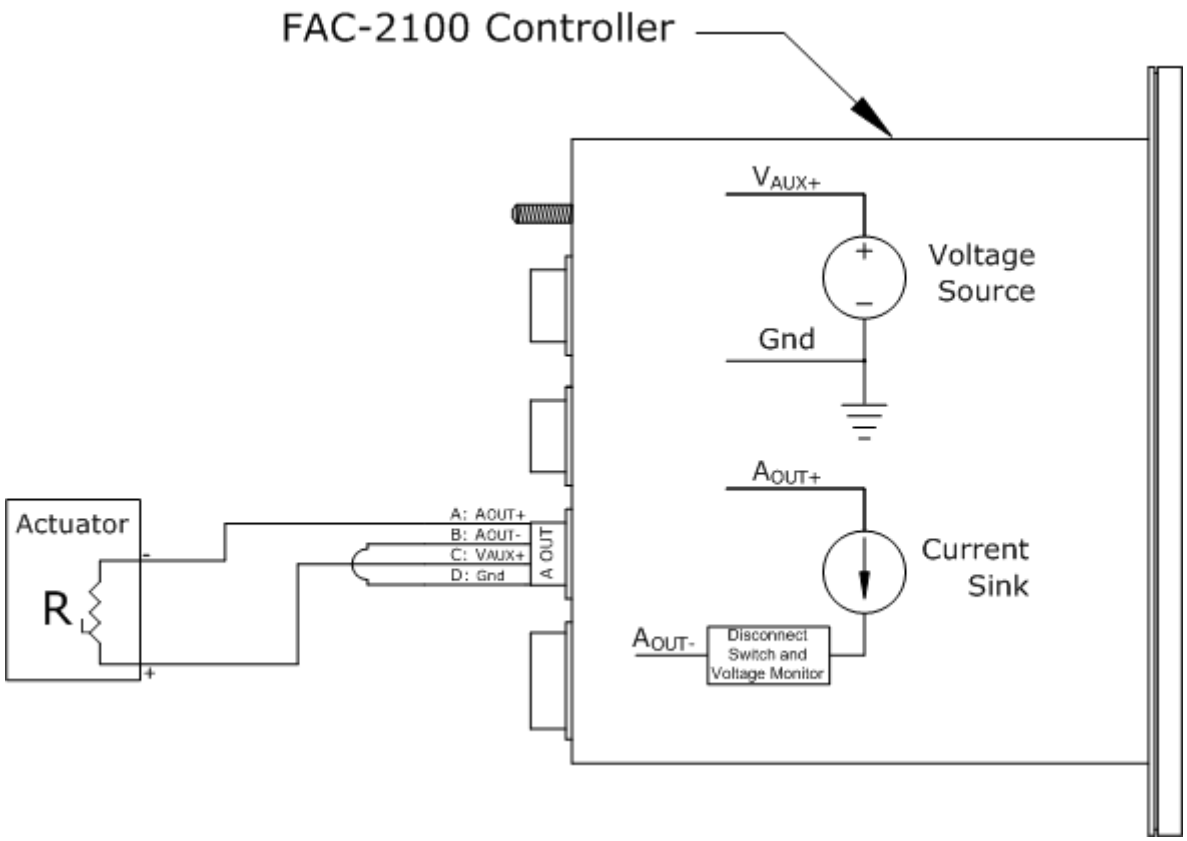
1. Provide a diagnostic to monitor the analog output signal for issues. For example, if a 4-20mA output signal is driving a 250 ohm device, the voltage monitor should measure a voltage equal to the current output times 250 ohms. Or, if the channel is in voltage mode, use the monitor the verify the output level is what the program is requesting. If it does not match, an error can be called.

2. Disconnect the analog output signal from the actuator device in applications where two redundant analog outputs are driving the actuator. In this case the voltage monitor can measure the voltage output from the redundant pair while the controller's output is in standby.
3. Create additional analog inputs. In cases where the application requires more analog inputs and does not need all the analog outputs, disconnect the analog output signal and use the voltage monitor as an additional analog input channel. The monitor channel does not have as much resolution as a standard input channel, but in many applications it is sufficient.

Current Output Mode

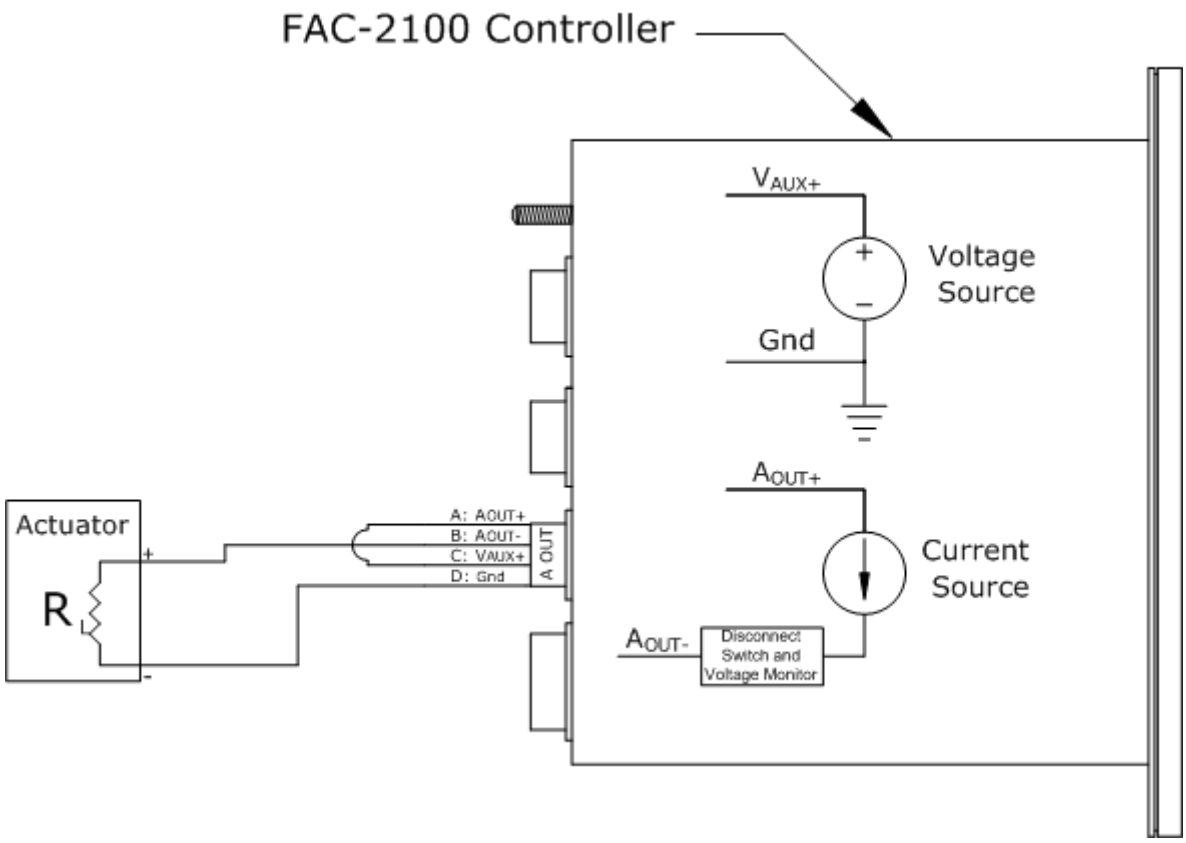
Current Mode

The analog output operating in current mode can supply 0-20mA or 4-20mA and can be wired as either a current sink or a current source. The figure below shows the FAC-2100 wired in a current sink configuration:



Suggested Analog Output Wiring with the Controller Configured as a Current Sink

The following figure shows the FAC-2100 wired in a current source configuration:



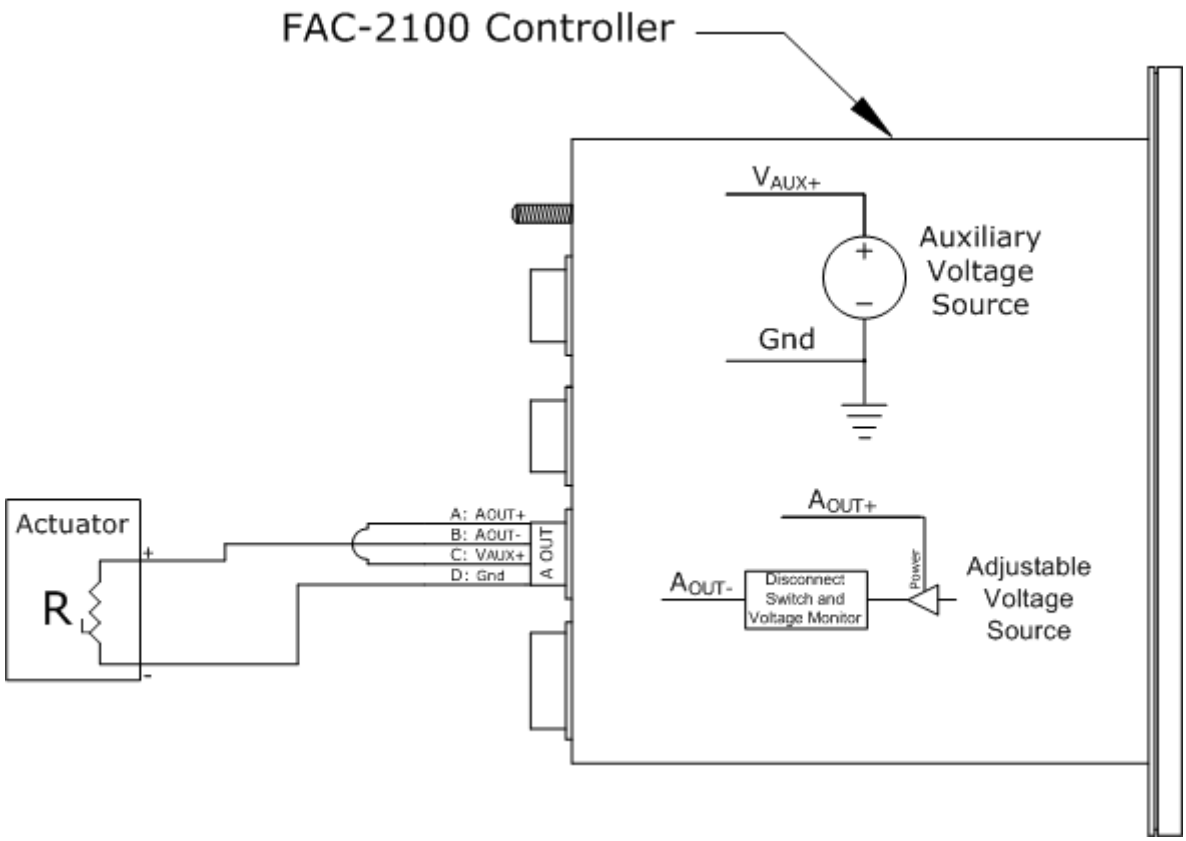
Suggested Analog Output Wiring with the Controller Configured as a Current Source

The decision to use a current source or sink configuration is dependent on the installation, but typically the current source configuration is appropriate for most. Also, note that in the current sink configuration the voltage feedback monitor will be tied to ground and always read approximately zero volts.

Voltage Output Mode

Voltage Mode

Each analog output can be setup in voltage mode to produce a 0 to 5V or 0 to 10V signal as shown in the following figure:



Suggested Wiring for a Voltage Mode Analog Output

Note that the voltage on the A_{OUT+} pin is used as the power source for the internal voltage regulator in the circuit.

6.2.7 Digital Inputs

Digital Inputs

The FAC-2100 has ten total digital inputs with following capability:

- Eight *Standard Digital Inputs* that can read a wide voltage range which includes 200VDC and 120VAC signals.
- Two *Universal Digital Inputs* that can read digital waveform signals with voltages up to 28VDC. These channels allow the FAC-2100 to read frequency and duty cycle and can be paired for quadrature decoding.

Basic On/Off Mode

Both the *Universal* and *Standard Digital Inputs* can read in basic on/off mode. In this mode the controller determines if the input signal is present or not.

Frequency and Duty Cycle Measurements

Universal Digital Inputs can process a waveform and determine the signal's frequency and duty cycle.

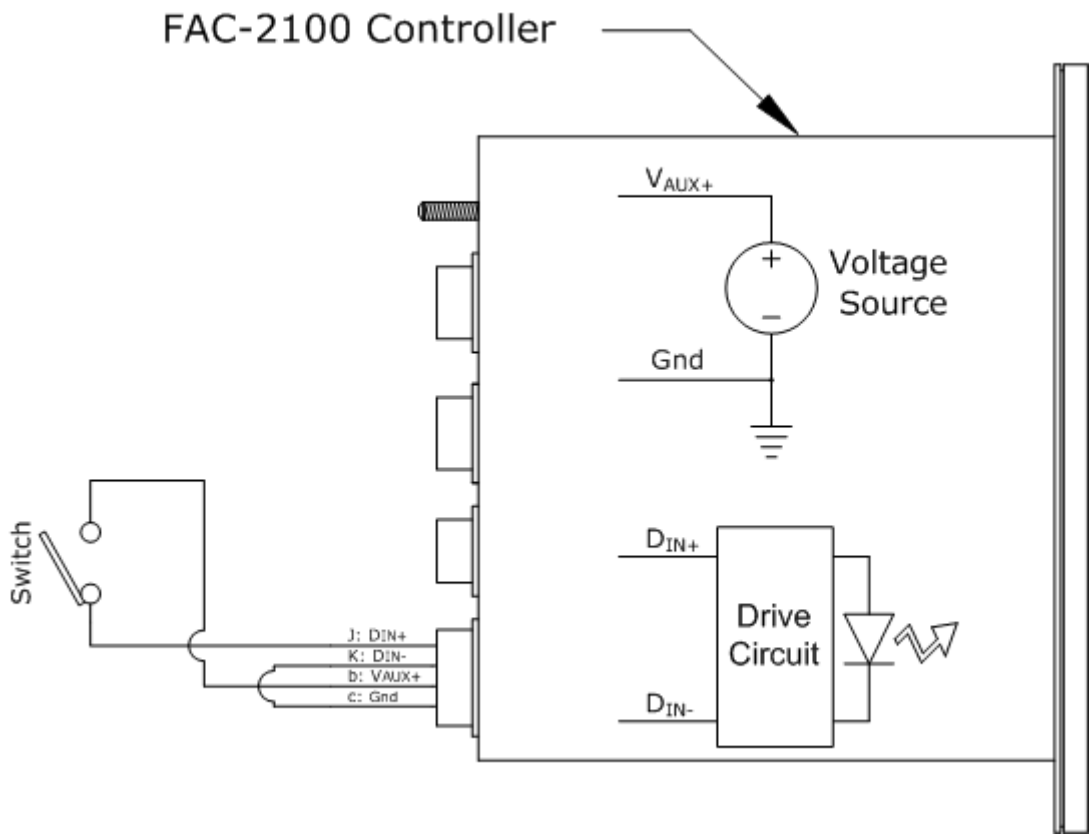
Quadrature Decoder

Signals that are quadrature encoded provide direction and speed of an attached sensor from two signals (typically called Channel A and Channel B). The *Universal Digital Inputs* can be used as a pair to decode these types of signals with Channel A going to D_{UIN1} and Channel B to D_{UIN2}.

If the quadrature encoder output is using a driver such as an RS-485 or RS-422 transceiver, it is recommended that each D_{UIN+} and D_{UIN-} signals be terminated with an impedance that matches the transmission line. To accomplish this, install a resistor (typically around 120 ohms) across both the D_{UIN1} and D_{UIN2} plus and minus terminals.

Wiring

Each digital input channel consists of an opto-isolated LED / transistor pair with a dynamic drive circuit that permits a wide input voltage range to be applied. Each of the modes described above utilize the same wiring configuration.



Suggested Digital Input Wiring to a Mechanical Switch

Notes: The suggested wiring above uses digital input 1. Any digital input could be wired in a similar configuration. Also, because the digital inputs are opto-isolated, the circuit could have been wired with a jumper between pins b and J with wires from K and c connecting to the switch.

6.2.8 Digital Outputs

Digital Outputs

Each FAC-2100 has two opto-isolated digital outputs that can operate in a Basic On/Off mode or Waveform Mode.

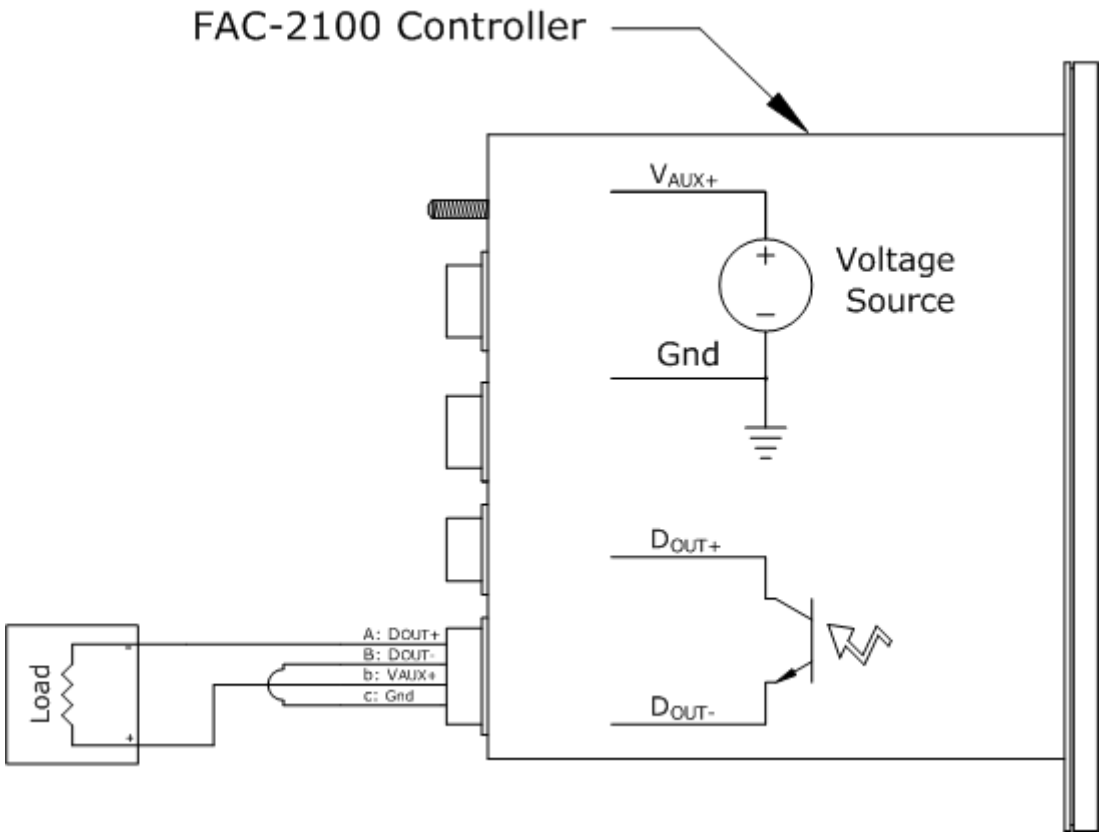
Basic On/Off Mode

In Basic On/Off Mode the digital output is controlled to a static activate on state or to a static deactivated off state.

Waveform Mode (Variable Frequency and Duty Cycle)

Waveform Mode transforms the channel into a variable frequency and duty cycle waveform generator.

Wiring



Suggested Digital Output Wiring

The suggested wiring above uses digital output 1 that can be used for Basic On/Off or Waveform Mode. Digital output 2 could be wired in a similar configuration. Also, since the output is isolated, the load can be driven in a source or sink configuration. For example, in the above diagram place a jumper from pins A to b, Load+ to pin B, and Load- to pin c.

6.2.9 Relay Outputs

Relays

The FAC-2100 can be ordered with a Standard or Enhanced Relay Board.

Standard Relay Board

The Standard Relay Board contains four Form-C mechanical relays. This is the default ordering option and does not require any additional order codes post-pended to the model number.

Enhanced Relay Board

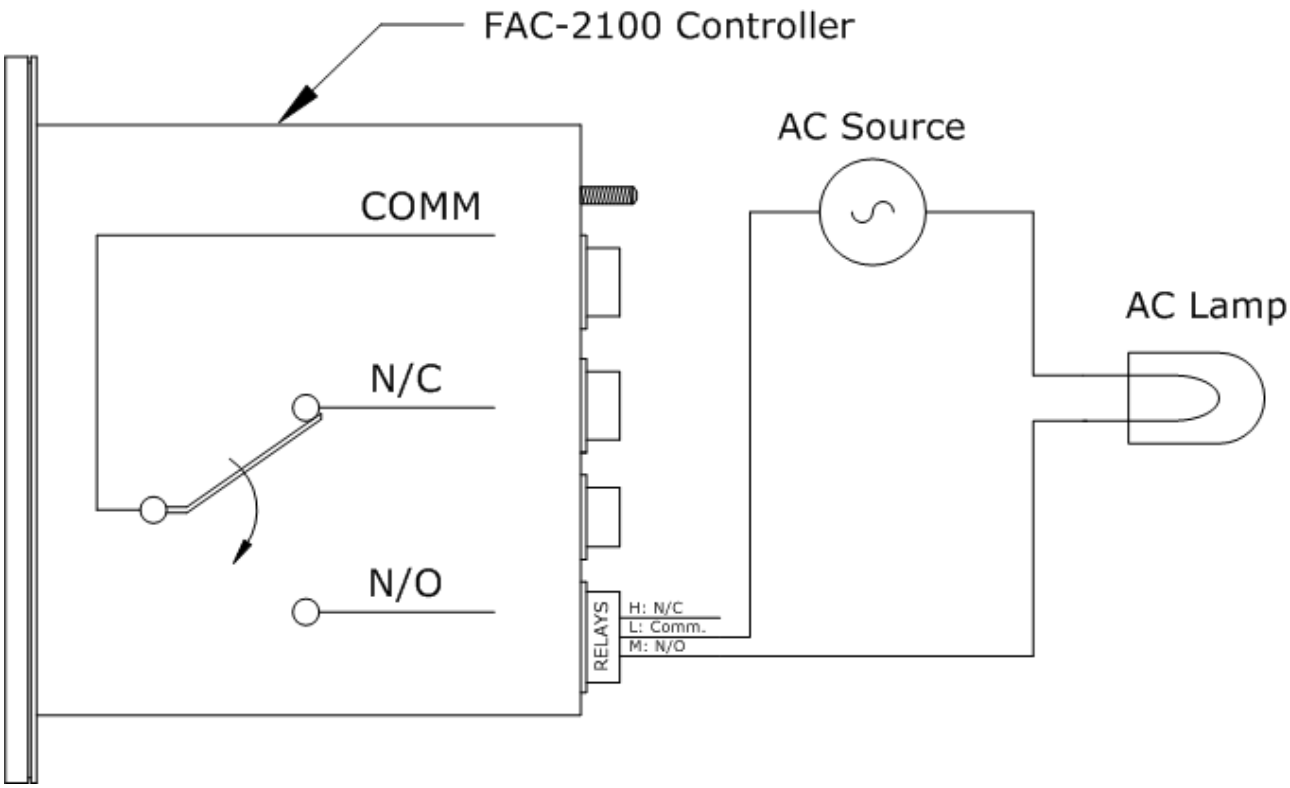
The Enhanced Relay Board contains three Form-A solid state relays and two Form-C mechanical relays. To order a FAC-2100 with the Enhanced Relay Board, post-pend the model number with '-R$X_2X_3X_5$', where:

- X_n is either an 'A' or 'D' and specifies if the output is **A**C or **D**C, and
- n in X_n is the solid state relay number.

The most common option is '-RAAA' for an Enhanced Relay Board with three AC solid state relays.

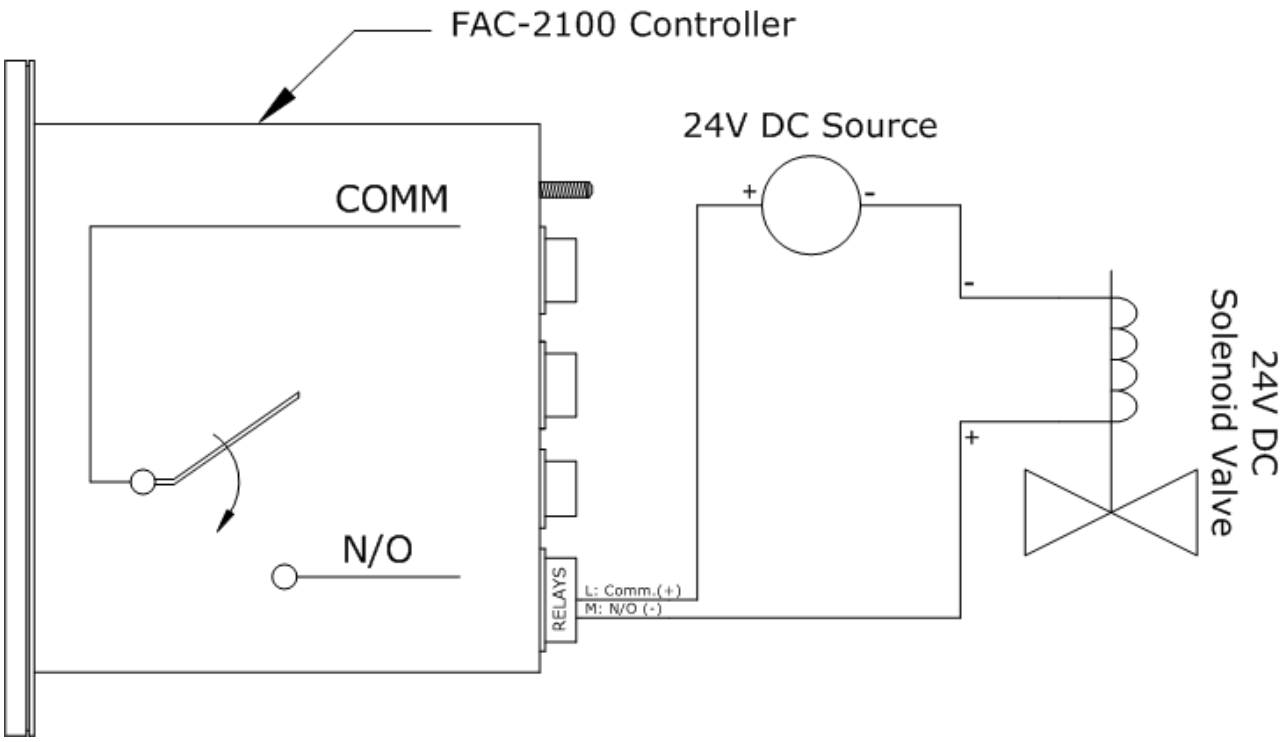
Solid state relays offer near zero volt turn-on and near zero current turn-off. This feature makes them ideal options for applications that need to switch inductive loads such as a solenoid or motor.

Mechanical Relay Wiring

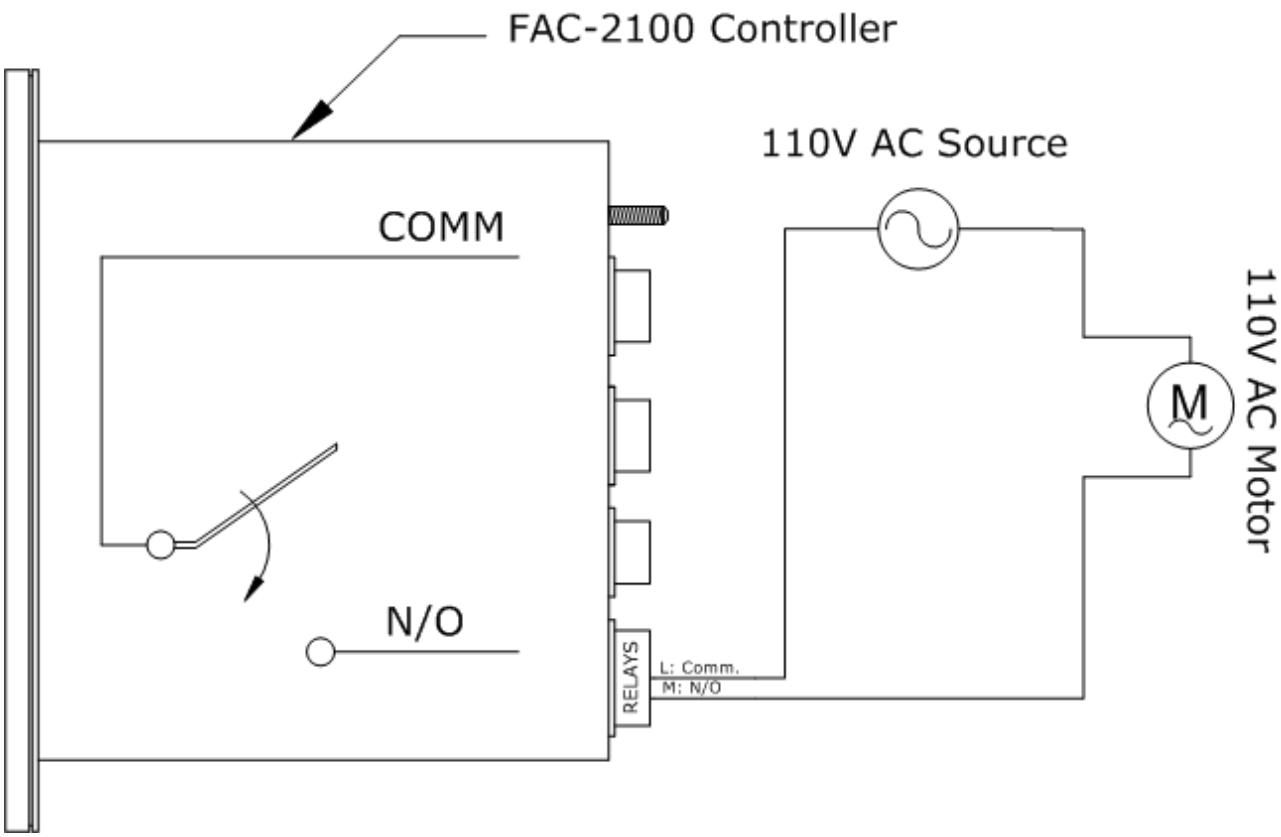


Typical Relay Output Wiring for a Non-Inductive Load Using the Standard Relay Board

Solid State Relay Wiring



Typical Relay Output Wiring for a 24 Volt DC Inductive Load using the Enhanced Relay Board and a DC Solid-State Relay



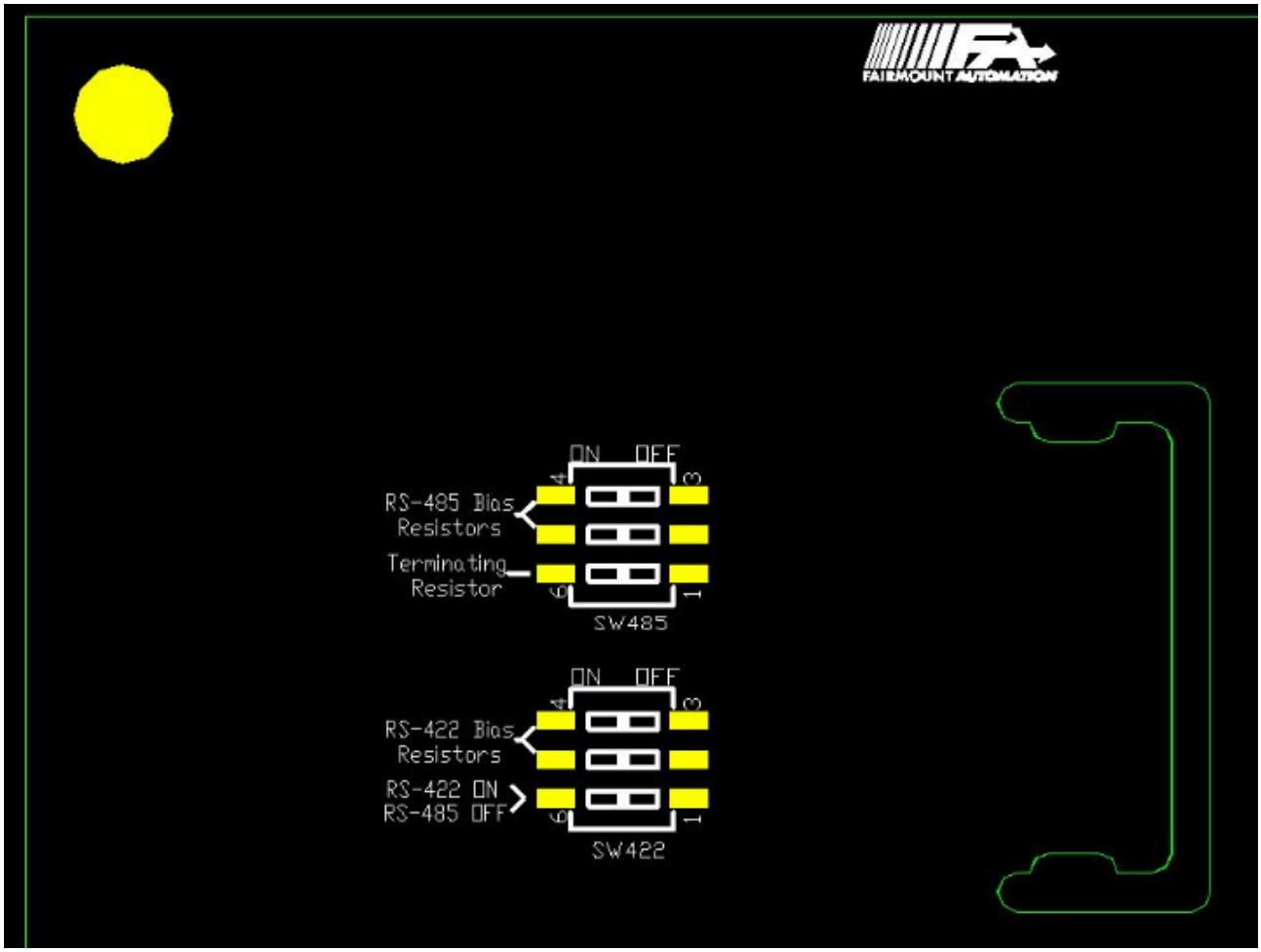
Typical Relay Output Wiring for an AC Inductive Load Using the Enhanced Relay Board and an AC Solid-State Relay

6.2.10 Networking

Network Port Settings

The FAC-2100 supports RS-485 or RS-422 network communications. Selection of the physical network type, termination, and biasing options are set via dip-switch type jumpers internal to the unit.

Remove the side cover of the FAC-2100 (item 22 in the Parts List Exploded View (see page 75)) to gain access to the board with the dip-switches. The board with the dip switches is the Microprocessor and I/O Board (item 29 in the Parts List Exploded View (see page 75)). See the figure below for an image of the surface of the Microprocessor and I/O Board in the vicinity of the switches. Note that adjacent to the switch are labels for the switch function as well as an indicator for the direction of the ON and OFF positions.



Network Configuration Dip-Switches on Microprocessor and I/O Board

The switches have the following function:
SW485 Switch

- Termination Resistor: In the ON position a termination resistor is added to the network wires. Note that if the network is in RS-422 mode that termination is added to the Rx+ and Rx- pair.
- RS-485 Bias Resistors: These two switches should be set in the same position. If in the ON position, biasing resistors are added to the networking wires.

SW422 Switch

- RS-422 ON/RS-485 OFF: In the ON position, the network port is configured for RS-422. In the OFF position, the network port is configured for RS-485.
- RS-422 Bias Resistors: These two switches should be set in the same position. In the ON position, biasing resistors are added to the RS-422 2nd set of networking wires.

RS-485 Mode

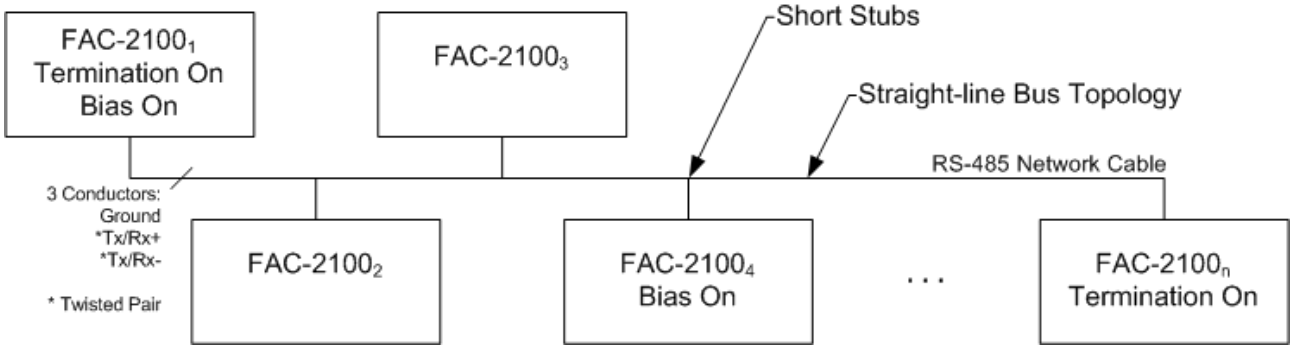
The FAC-2100 RS-485 mode allows up to 32 RS-485 unit load devices to communicate with one another (the FAC-2100 is a 1/8th unit load device).

The RS-485 network topology is one of a straight line bus with each controller directly connected to the bus using as short a stub as possible. Each end of the network should be terminated with approximately 120 ohms and the network must be properly biased.

The network cable must be compatible with RS-485 and have a characteristic impedance of approximately 120 ohms. Note that Cat 5 Ethernet network cable is typically an acceptable alternate. RS-485 requires a cable consisting of two twisted pair signal wires (i.e. 2 wires in 1 pair) and one ground return. It is important to make sure that the twisted pair wires are connected to the RS-485 Tx/Rx+ and RS-485 Tx/Rx- signal pins.

RS-485 Dip Switch Settings

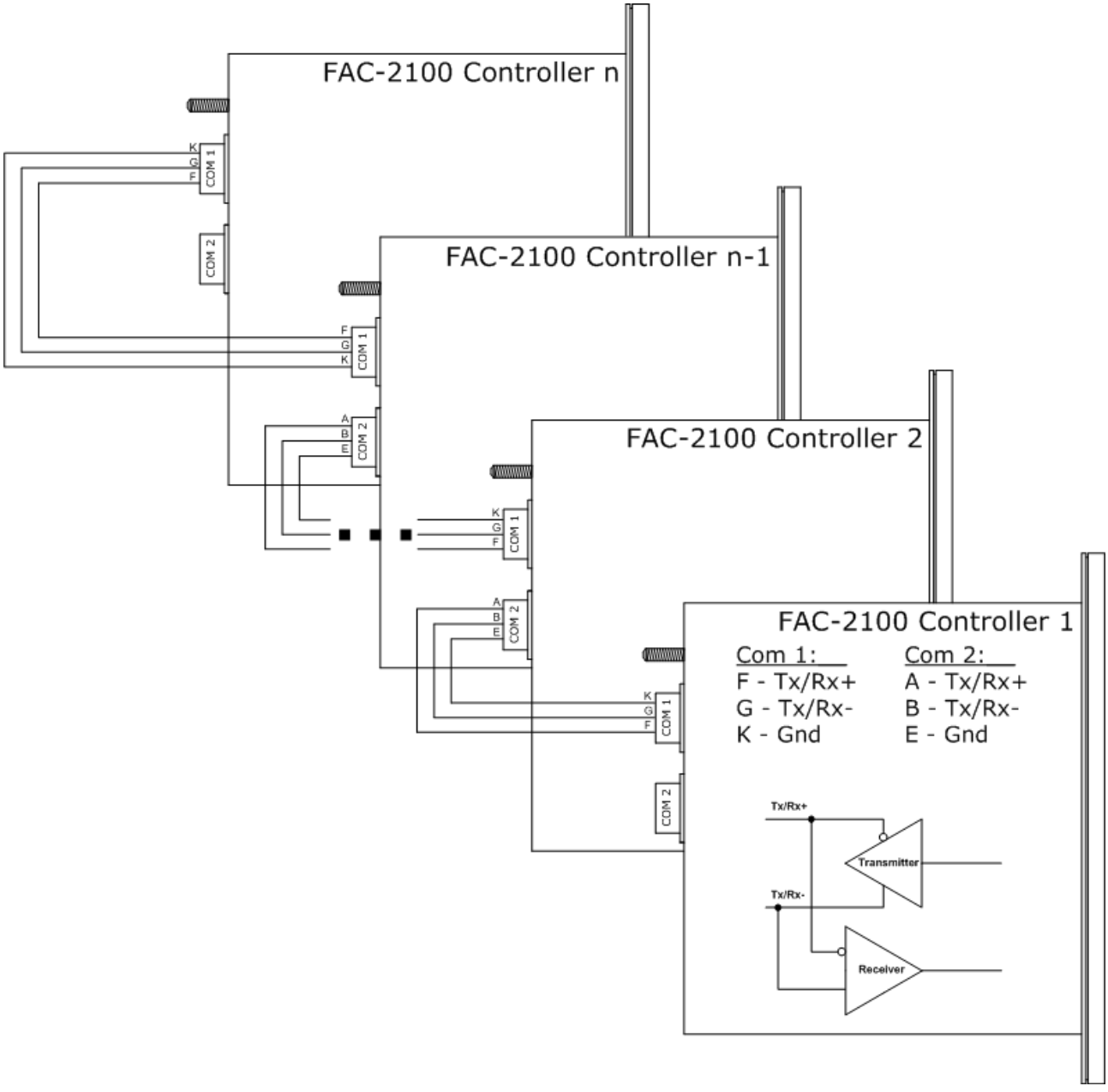
For RS-485 mode, keep all of SW422 switches in the OFF position (to the right). On two controllers in the network, activate the network biasing by setting their RS-485 bias resistors in the ON position (to the left). All the other controller in the network should have these switches in the OFF position (to the right). The controllers on each end of the bus should have their termination resistors set ON (to the left) or use external 120 ohm terminators.



Example RS-485 Network Cabling Topology

The figure above shows a typical RS-485 network. Note the following In this example:

1. The cable topology is that of a straight-line bus.
2. The controllers on the end of the bus have their termination switches activated.
3. Two controllers on the network (doesn't matter which two) have their bias switches activated.
4. Stubs (the cable length between the 'T' connection in the bus and the controller) are kept as short as possible. Ideally, there are no stubs and the wiring simply chains from controller to controller.



Example RS-485 Network Wiring

The above figure shows another example of RS-485 network wiring. In this case the network cabling goes from the COM 1 connecter of one controller to the COM 2 connector of the next controller in the bus. An alternative approach (which leaves the COM 1 connector open for connection to a configuration PC) is to go from COM 2 to COM 2 and splice the connections in the circular connector.

RS-422

Similar to RS-485, the network topology is one of a straight line bus with each controller directly connected to the bus using as short a stub as possible.

Again, similar to RS-485, the network cable must have a characteristic impedance of approximately 120 ohms. Cat 5 Ethernet network cable is typically an acceptable alternate. RS-422 requires a cable consisting of two sets of twisted pair signal wires (i.e. 4 wires in 2 pairs) and one ground return.

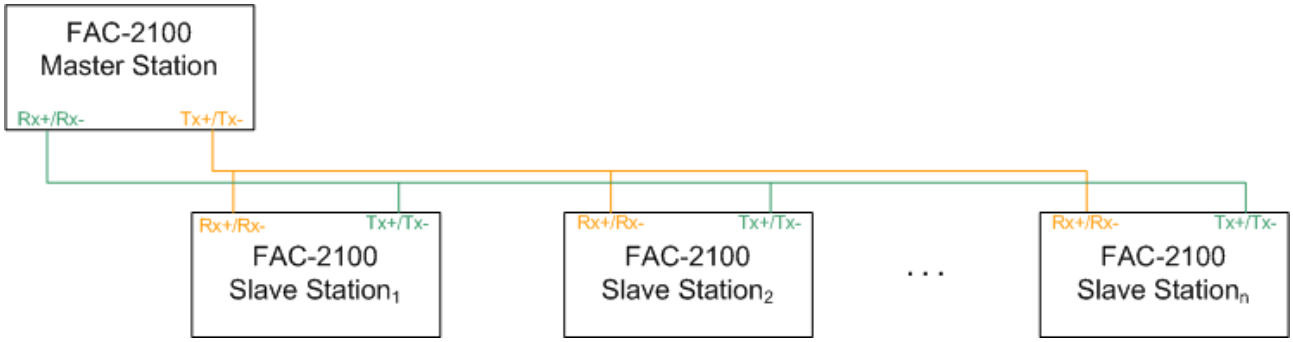
RS-422 differs from RS-485 in that the physical wiring will define one master station and a set of slave stations. The wiring is as follows:

- The master station transmit lines (Tx+/Tx-) are attached to all the slave station receive lines (Rx+/Rx-) in parallel.
- The master station receive lines (Rx+/Rx-) are attached to all the slave station transmit lines (Tx+/Tx-) in parallel.

In this setup the master station sends information to all the slaves. Slave stations (one at a time) can send information to only the master station. There is no mechanism for direct slave to slave communication – this virtual link must be made through software in the master.

Note that with the above configuration there are two channels and it is possible to have full duplex communication.

The following diagram shows the configuration:



Example RS-422 Network Connections

It is important to make sure that the twisted pair wires are connected to the RS-422 +/- pairs. In the diagram above, the tan and green lines each represent a twisted pair communication channel.

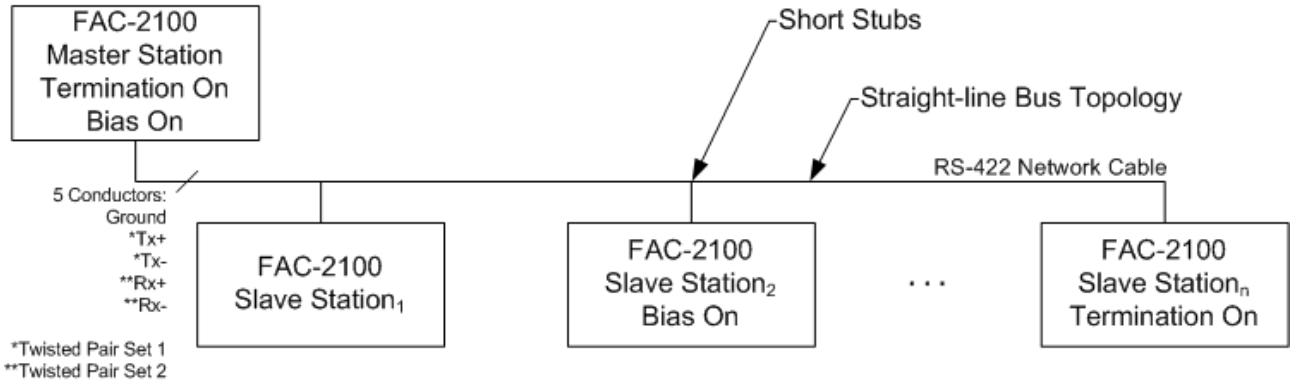
RS-422 Dip Switch Settings

Each twisted pair should be terminated with approximately 120 ohms at the most distant receiver and the pair must be properly biased.

Recall that in RS-422 mode the termination dip switch installs the resistor across the Rx+/Rx- lines.

Since the master's receiver is the only receiver on the green twisted pair, it should be have termination and biasing turned on. If possible, install the master at one end of the bus to ensure it is physically located at the end of the green channel.

The tan twisted pair represents the second channel on the bus. For the tan channel, activate the termination resistor on the slave at the remaining end of the bus (slave station n in the diagram below). At least one slave station must have its biasing resistors activated. For redundancy it is recommended to active two slave station RS-422 biasing (no more then two should be activated).



RS-422 Network Topology

For RS-422 mode, place the RS-422 ON/RS-485 OFF switch to the ON position (to the left).

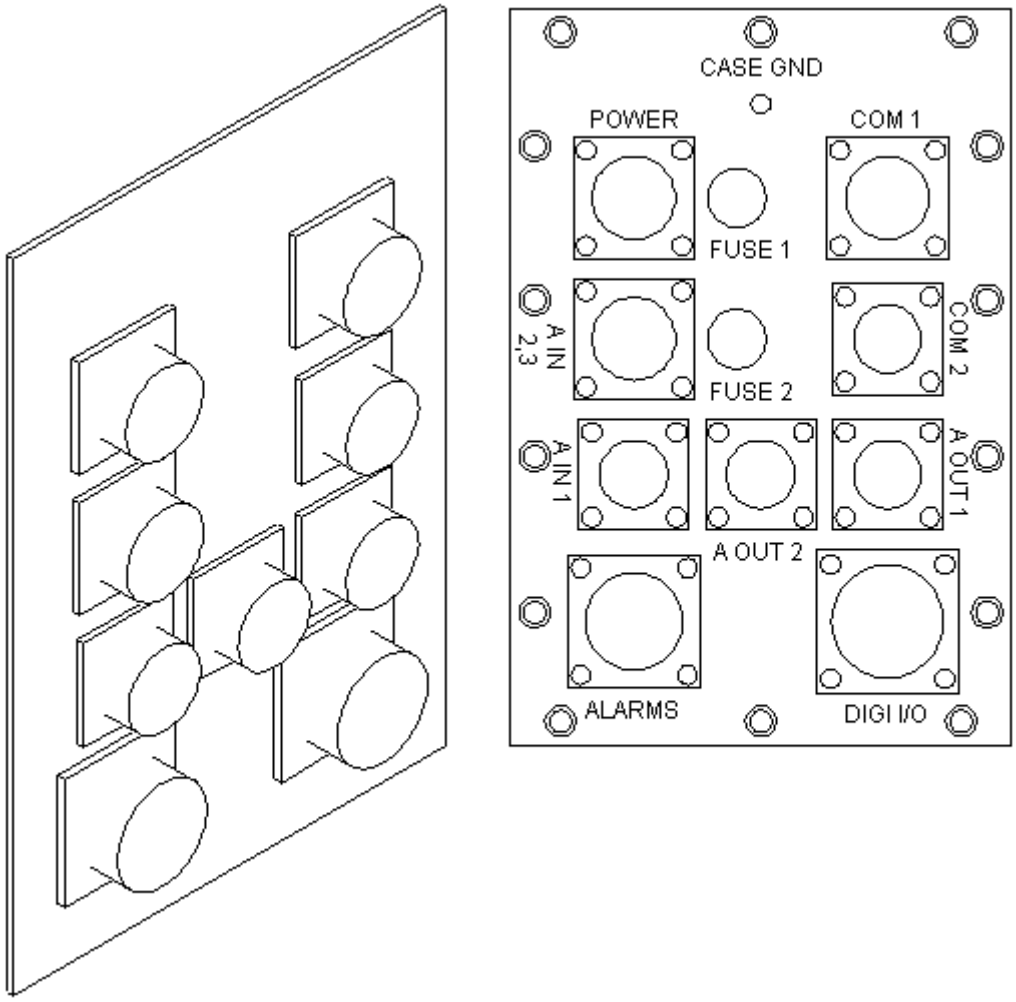
For the controllers that need to install the receiver termination, set the termination Resistor to the ON position (to the left). Otherwise, set this switch OFF.

For the controllers that need to activate biasing, set the pair of RS-422 Bias Resistors to the ON position (to the left). Otherwise, these pair of switches should be to the right (OFF) position.

In all cases, the RS-485 Bias Resistors should both be set to the OFF position (to the right).

6.2.11 Connector Pinout

Connector Panel Layout



Miniature cylindrical connector layout

Connector Pinout

The chart below shows the pinout for each of the connectors in the above figure. Note the relative position of the items in the chart below matches the relative positions of the associated connector on the panel above.

POWER

Pin	Function
A	DC V+ / AC Line 1
B	DC V- / AC Line 2
C	CASE GND

COM 1

Pin	Function
A	232 Rx
B	232 Tx
C	232 RTS
D	232 CTS
E	Ground
F	485 Tx/Rx+ or 422 Tx+
G	485 Tx/Rx- or 422 Tx-
H	422 Rx+
J	422 Rx-
K	Ground

A IN 2, 3

Pin	Function
A	A_{IN2+}
B	Ground
C	V_{AUX+}
D	$A_{IN\ 2-}$
E	A_{IN3+}
F	Ground
G	V_{AUX+}
H	$A_{IN\ 3-}$

COM 2

Pin	Function
A	485 Tx/Rx+ or 422 Tx+
B	485 Tx/Rx- or 422 Tx-
C	422 Rx+
D	422 Rx-
E	Ground

A IN 1

Pin	Function
A	A_{IN1+}
B	Ground
C	V_{AUX+}
D	$A_{IN\ 1-}$
E	Ground
F	Ground

A OUT 1

Pin	Function
A	A_{OUT1+}
B	A_{OUT1-}
C	V_{AUX+}
D	Ground

A OUT 2

Pin	Function
A	A_{OUT2+}
B	A_{OUT2-}
C	V_{AUX+}
D	Ground

ALARMS (Standard Relay Board Only)

Pin	Function
J	1 N.C.*
K	1 COMM*
G	1 N.O.
H	2 N.C.
L	2 COMM*
M	2 N.O*
A	3 N.C.
B	3 COMM
C	3 N.O.
D	4 N.C.
E	4 COMM
F	4 N.O

DIG IO

Pin	Function
A	D_{O1+}
B	D_{O1-}
C	D_{O2+}
D	D_{O2-}
E	D_{UI1+}
F	D_{UI1-}
G	D_{UI2+}
H	D_{UI2-}
J	D_{I1+}
K	D_{I1-}
L	D_{I2+}
M	D_{I2-}
N	D_{I3+}
P	D_{I3-}
R	D_{I4+}
S	D_{I4-}
T	D_{I5+}
U	D_{I5-}
V	D_{I6+}
W	D_{I6-}
X	D_{I7+}

ALARMS (Enhanced Relay Board Only)

Pin	Function	
J	3 COMM (+ DC)**	
K	3 N.O. (- DC)**	
G	2 COMM (+ DC)	
H	2 N.O. (- D.C.)	
L	5 COMM (+ D.C.)**	
M	5 N.O (-D.C.)**	
A	1 N.C.	
B	1 COMM	
C	1 N.O.	
D	4 N.C.	
E	4 COMM	
F	4 N.O	

Pin	Function
Y	D_{I7-}
Z	D_{I8+}
a	D_{I8-}
b	V_{AUX+}
c	Ground

NOTES for the ALARMS Connector
* Denotes connector pins support a 4 amp carrying capacity; remaining pins are 1.5 amp.
** Denotes connector pins support a 3 amp carrying capacity; remaining pins can carry 1.5 amps.

The current limit for the ALARM circuit may be smaller depending on the type of relays ordered. Reference the Mechanical (see page 22) and Solid State (see page 23) Relay Output Interface sections for more information.

7 Controller Accessories

The following miniature cylindrical connector shells should be used to mate with the *FAC-2100's* miniature cylindrical box mount connector receptacles:

Miniature cylindrical connector shell part numbers (crimp type)

Description	Fairmount Automation #	Amphenol #	MIL-C-26482, Series 1 #
DC Power Connector	30090-000	PT 06 SE 12-3 S SR	MS3126F123S
AC Power Connector	30090-001	PT 06 SE 12-3 S Y SR	MS3126F123SY
COM1 Connector	30090-002	PT 06 SE 12-10 P SR	MS3126F1210P
COM2 Connector	30090-003	PT 06 SE 10-6 S W SR	MS3126F106SW
Analog Input 1 Connector	30090-004	PT 06 SE 10-6 S SR	MS3126F106S
Analog Input 2-3 Connector	30090-005	PT 06 SE 12-8 S SR	MS3126F128S
Analog Output 1 Connector	30090-006	PT 06 SE 10-6 P W SR	MS3126F106PW
Analog Output 2 Connector	30090-007	PT 06 SE 10-6 P SR	MS3126F106P
Digital I/O Connector	30090-008	PT 06 SE 16-26 S SR	MS3126F1626S
Alarms Connector	30090-009	PT 06 SE 14-12 S SR	MS3126F1412S

Miniature cylindrical connector shell part numbers (solder type)

Description	Fairmount Automation #	Amphenol #	MIL-C-26482, Series 1 #
DC Power Connector	30090-020	PT 06 E 12-3 S SR	MS3116F123S
AC Power Connector	30090-021	PT 06 E 12-3 S Y SR	MS3116F123SY
COM1 Connector	30090-022	PT 06 E 12-10 P SR	MS3116F1210P
COM2 Connector	30090-023	PT 06 E 10-6 S W SR	MS3116F106SW
Analog Input 1 Connector	30090-024	PT 06 E 10-6 S SR	MS3116F106S
Analog Input 2-3 Connector	30090-025	PT 06 E 12-8 S SR	MS3116F128S
Analog Output 1 Connector	30090-026	PT 06 E 10-6 P W SR	MS3116F106PW
Analog Output 2 Connector	30090-027	PT 06 E 10-6 P SR	MS3116F106P
Digital I/O Connector	30090-028	PT 06 E 16-26 S SR	MS3116F1626S
Alarms Connector	30090-029	PT 06 E 14-12 S SR	MS3116F1412S

Use the following receptacle caps to cover all unused box mount connectors:

Miniature cylindrical connector receptacle cap part numbers

Description	Fairmount Automation #	Amphenol #	Base MS #
Shell Size 10 Protection Cap (ANALOG IN 1, ANALOG OUT 1, ANALOG OUT 2, COM 2)	30093-001	10-101960-10	MS3181-10
Shell Size 12 Protection Cap (DC POWER, AC POWER, COM1, ANALOG IN 2-3)	30093-002	10-101960-12	MS3181-12
Shell Size 14 Protection Cap (ALARMS)	30093-003	10-101960-14	MS3181-14
Shell Size 16 Protection Cap (DIGITAL I/O)	30093-004	10-101960-16	MS3181-16

Use the following sealing plugs for unused pins in the miniature cylindrical connector shells:

Miniature cylindrical connector sealing plug part numbers

Description	Fairmount Automation #	Amphenol #	MS #
Contact Size 16 Sealing Plug	30093-101	10-405996-16	MS27488-16
Contact Size 20 Sealing Plug	30093-102	10-405996-20	MS27488-20

The table below shows the COM 1 to 9 and 25 pin D cable used to export programs from a configuration PC to the controller.

Communication Cable Part Number

Description	Fairmount Automation #
FAC-2100 COM 1 to 9 and 25 pin D RS-232 Serial Cable (5 ft.)	01004-000
*USB to RS-232 Adapter	01004-003

*Note: Order both 01004-000 and 01004-003 if USB to FAC-2100 COM 1 connection is needed.

The EMI ground braid shown in the following table was used to pass MIL-STD-461 testing and should be installed on the rear grounding stud to a chassis ground point on projects that require resilience to EMI and/or ESD.

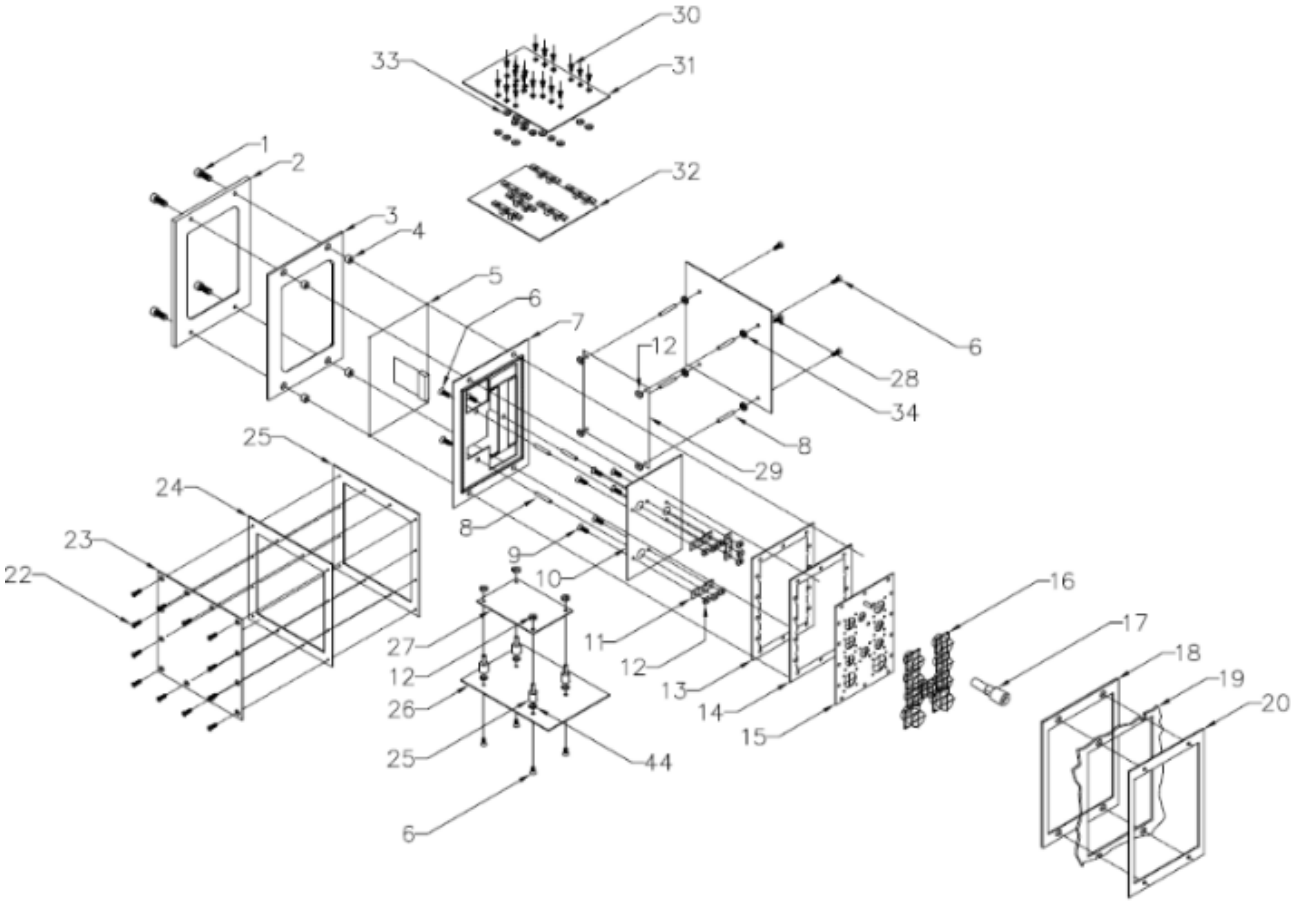
EMI Braid Part Number

Description	Fairmount Automation #
EMI Chassis Grounding Braid	30110-015

8 Parts List

The following figure shows an isometric exploded view of the controller and its components. Descriptions and part numbers of all the components referenced in the figure are shown below.

***FAC-2100* Exploded Isometric View**



***FAC-2100* Parts List**

Drawing Reference	Description	Fairmount Automation #
1	10-32 x 1 1/4" Socket Head Cap Screw SS	50010-007
2	Bezel	21001-000
3	Bezel Gasket	01001-007
4	Mounting Spacer	21011-000
5	Keypad	30070-000
6	8-32 x 3/8" Flat Undercut M/S SS	50010-004

Drawing Reference	Description	Fairmount Automation #
7	Enclosure Front Plate	21002-000
8	8-32 x 7/16 M-F Hex Standoff	50060-026
9	8-32 x 3/8" Phil MS SS	50010-001
10	User-Interface PC Board	11003-101
11	User-Interface Shock-Mount Bracket	21006-000
12	8-32 Kep Nut	50020-001
13	Enclosure Back Plate	21002-000
14	Connector Plate Gasket	01001-010
15	Connector Plate	21004-000
16	Miniature Cylindrical Connector Receptacles	See Tables Below
17	Fuse Holder	30130-002*
18	Flange Gasket	01001-008
19	Console/Mounting Panel	
20	Locking Clamp	21005-000
21	6-32 X 1/4" Flat Undercut M/S SS	50010-006
22	Side Access Panel	21003-000
23	Side Access Panel Gasket	01001-009
24	Enclosure Access Panel Plate	21002-000
25	7/16" 8-32 M-F Shock Mounts	50060-001
26	Enclosure Bottom Plate	21002-000
27	Standard Relay PC Board / Enhanced Relay PC Board	11002-101 / 11011-101
28	Enclosure Side Plate	21002-000
29	Microprocessor and Input/Output Board	11059-100
30	Power Board 3/8" Flat Undercut M/S SS	50010-002
31	Enclosure Top Plate	21002-000

Drawing Reference	Description	Fairmount Automation #
32	FAC-2x00 Power Board	11060-100
33	Power Board Sealing Washers	50040-002
34	Relay and I/O Board Sealing Washers	50040-003

*See below for a listing of replacement fuses.

Miniature Cylindrical Connector Box-Mount Receptacle Part Numbers (solder type)

Description	Fairmount Automation #	Amphenol #	MIL-C-26482, Series 1#
DC Power Connector	30090-100	PT 02 E 12-3 P	MS3112E123P
AC Power Connector	30090-101	PT 02 E 12-3 P Y	MS3112E123PY
COM1 Connector	30090-102	PT 02 E 12-10 S	MS3112E1210S
COM2 Connector	30090-103	PT 02 E 10-6 P W	MS3112E106PW
Analog Input 1 Connector	30090-104	PT 02 E 10-6 P	MS3112E106P
Analog Input 2-3 Connector	30090-105	PT 02 E 12-8 P	MS3112E128P
Analog Output 1 Connector	30090-106	PT 02 E 10-6 S W	MS3112E106SW
Analog Output 2 Connector	30090-107	PT 02 E 10-6 S	MS3112E106S
Digital I/O Connector	30090-108	PT 02 E 16-26 P	MS3112E1626P
Alarms Connector	30090-109	PT 02 E 14-12 P	MS3112E1412P

Miniature Cylindrical Connector Box-Mount Receptacle Part Numbers (crimp type)

Description	Fairmount Automation #	Amphenol #	MIL-C-26482, Series 1#
DC Power Connector	30090-120	PT 02 SE 12-3 P	MS3122E123P
AC Power Connector	30090-121	PT 02 SE 12-3 P Y	MS3122E123PY
COM1 Connector	30090-122	PT 02 SE 12-10 S	MS3122E1210S
COM2 Connector	30090-123	PT 02 SE 10-6 P W	MS3122E106PW
Analog Input 1 Connector	30090-124	PT 02 SE 10-6 P	MS3122E106P
Analog Input 2-3 Connector	30090-125	PT 02 SE 12-8 P	MS3122E128P
Analog Output 1 Connector	30090-126	PT 02 SE 10-6 S W	MS3122E106SW
Analog Output 2 Connector	30090-127	PT 02 SE 10-6 S	MS3122E106S
Digital I/O Connector	30090-128	PT 02 SE 16-26 P	MS3122E1626P
Alarms Connector	30090-129	PT 02 SE 14-12 P	MS3122E1412P

Miniature Cylindrical Connector Box-Mount Gasket Part Numbers

Description	Fairmount Automation #	Amphenol #
Shell Size 10 Gasket (ANALOG IN 1, ANALOG OUT 1, ANALOG OUT 2, COM 2)	30093-201	10-101949-10
Shell Size 12 Gasket (DC POWER, AC POWER, COM1, ANALOG IN 2-3)	30093-202	10-101949-12
Shell Size 14 Gasket (ALARMS)	30093-203	10-101949-14
Shell Size 16 Gasket (DIGITAL I/O)	30093-204	10-101949-16

Replacement Fuses

Description	Fairmount Automation #
3 Amp, 250V, ¼ x 1¼", time-delay (1 required)	30130-001

9 Ordering Codes

9.1 Base Ordering Code

The FAC-2100 controller basic root ordering code is:

FAC2100-DC-28-C

This describes a unit that accepts DC input power, provides 28V on the axillary power output terminals, uses a standard relay board (reference Relay Outputs (see page 57) for more information), and has circular connectors.

9.2 Ordering Options

The controller's relay outputs can be changed from the standard set of mechanical relays to an enhanced mix of solid state and mechanical (again, reference Relay Outputs (see page 57) for more information.)

To change the installed relay option, append a -R to the end of the root ordering code. In addition, append three digits where each digit is an 'A' or a 'D'. The last three digits indicate if relay #2, #3, and #5 (respectively) should be AC (A) or DC (D).

FAC2100-DC-28-C-R$X_2X_3X_5$, where:

- X_n is either an 'A' or 'D' and specifies if the output is **A**C or **D**C, and
- n in X_n is the solid state relay number.

For example:

- **FAC2100-DC-28-C-RDDA** specifies that there should be DC solid relays for relay #2 and #3 and AC solid state relay for Relay #5.
- **FAC-2100-DC-28-C-RAAA** specifies that relays #2, #3, and #5 should all be AC solid stat