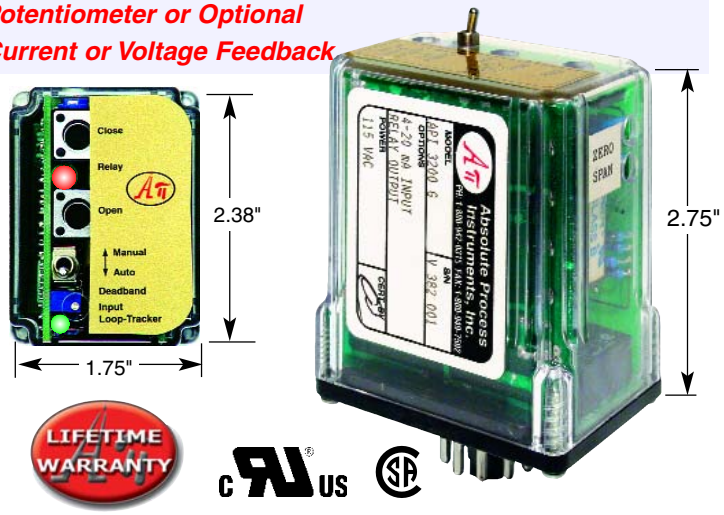
Valve Positioner Actuator Controller

API 3200 G

Input: ***0-1 V to 0-100 VDC or 0-10 mA to 0-1 ADC***
Output: ***7 A SPDT Relay with Neutral Position***

- ***Automatic or Manual Control Modes***
- ***Test/Manual Positioning Pushbuttons***
- ***Input LoopTracker® LED***
- ***Relay Status LEDs***
- ***High Capacity Relay Contacts***

Potentiometer or Optional Current or Voltage Feedback



LIFETIME WARRANTY

Applications

- **Valve Position Controller**
- **Linear Actuator Controller**
- **Damper Controller**

Specifications

Control Input

Factory Configured—Please specify input range
System voltages must not exceed socket voltage rating

	Minimum	Maximum
API 3200 G		
Voltage:	0-1 VDC	0-100 VDC
Current:	0-10 mADC	0-1 ADC

API 3200 G M01
Voltage: 0-1 V, 0-5 V, 1-5 V, 0-10 V

API 3200 G M420
Current: 0-20 mA, 4-20, mA, 10-50 mA

Input Impedance

Voltage inputs: 200 kΩ minimum Current inputs: 50 Ω

Input Voltage Burden (Current)

1.25 VDC maximum

Input Zero and Span

Single turn potentiometers to compensate for load and lead variations
±10% of span adjustment range typical

LoopTracker

Variable brightness LED indicates input level and status

Feedback

API 3200 G
Potentiometer Range: 0-100 Ω to 0-100 kΩ
Potentiometer Excitation: 1.0 VDC nominal, 10 mA maximum

API 3200 G M01
Voltage: 0-1 V, 0-5 V, 1-5 V, 0-10 V

API 3200 G M420
Current: 0-20 mA, 4-20, mA, 10-50 mA

Relay Output

SPDT relay with neutral contact position
7 A @ 240 VAC maximum resistive load
3.5 A @ 240 VAC maximum inductive load

CAUTION: Socket contacts may limit system rating.
External contact protection such as an RC snubber is recommended for inductive loads.

Deadband

12 turn potentiometer, adjustable from 1 to 25% of span

Operational Controls

Automatic/manual switch, Open/close pushbuttons

Response Time

100 milliseconds typical

Ambient Temperature Range and Stability

–10°C to +60°C operating ambient
Better than ±0.02% of span per °C stability

Power

Standard: 115 VAC ±10%, 50/60 Hz, 2.5 W max.
A230 option: 230 VAC ±10%, 50/60 Hz, 2.5 W max.
D option: 9-30 VDC, 2.5 W typical

Description and Features

The **API 3200 G** controls the position of a valve or linear actuator by comparing a DC input (control signal) to that of a position feedback potentiometer or slidewire. An SPDT relay provides bi-directional (open-close) signals to drive a motor to open or close a valve.

When the valve position, as indicated by the feedback potentiometer, becomes equal to the position as represented by the control input, the relay will go to the neutral position and the motor will halt. A top-accessible multi-turn deadband control allows precise positioning of the motor without hunting or oscillation.

The **API 3200 G M420** controls the position of a valve or linear actuator by comparing a DC current input (control signal) to that of a current feedback signal. The **API 3200 G M01** controls the position of a valve or linear actuator by comparing a DC voltage input (control signal) to that of a voltage feedback signal.

All versions of the **API 3200 G** have heavy-duty relay contacts (7 A at 240 VAC, resistive load) allow the modules to directly control high capacity loads without a secondary device. Caution must be exercised when sizing inductive loads (motor loads). For assistance, contact the factory.

A top-accessible Auto/Manual switch allows either closed-loop automatic control of valve position or manual positioning via the Open/Close pushbuttons. The manual mode is useful for troubleshooting, calibration, system testing or as a manual bypass. A bi-color LED indicates the Open/Close relay contact status.

A green ***LoopTracker*** LED varies in intensity with changes in the control input signal. Monitoring this LED can provide a quick visual picture of your process at all times and save time during initial startup and/or troubleshooting.

Industry standard 11-pin sockets **API 011** and finger-safe **API 011 FS** allow either DIN rail or panel mounting and are sold separately.

Models & Options

Factory Configured—Please specify if non-standard input

API 3200 G	DC input valve controller, potentiometer feedback. SPDT relay output, 115 VAC
API 3200 G M01	DC input valve controller, 1-5 V feedback or specify. SPDT relay output, 115 VAC
API 3200 G M420	DC input valve controller, 4-20 mA feedback or specify. SPDT relay output, 115 VAC

Options—Add to end of model number

A230	Powered by 230 VAC, 50/60 Hz
D	Powered by 9-30 VDC
U	Conformal coating for moisture resistance

Accessories—Order as a separate line item

API 011	11-pin socket
API 011 FS	11-pin finger safe socket
API TK36	DIN rail, 35 mm W x 39" L, aluminum

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ELECTRICAL CONNECTIONS

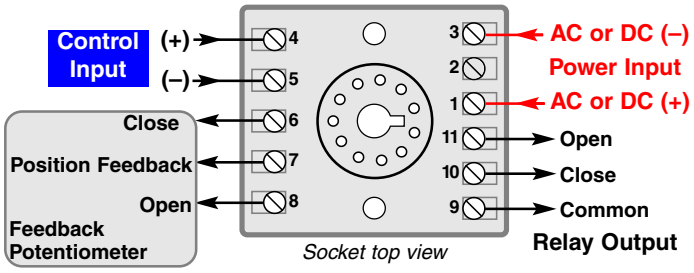
WARNING! All wiring must be performed by qualified personnel only. This module requires an industry-standard 11-pin socket. Order API 011 or finger-safe API 011 FS socket separately.

Power Input Terminals – The white label on the side of the API module will indicate the power requirements. AC power is connected to terminals 1 and 3. For DC powered modules, polarity **MUST** be observed. Positive (+) is wired to terminal 1 and negative (–) is wired to terminal 3.

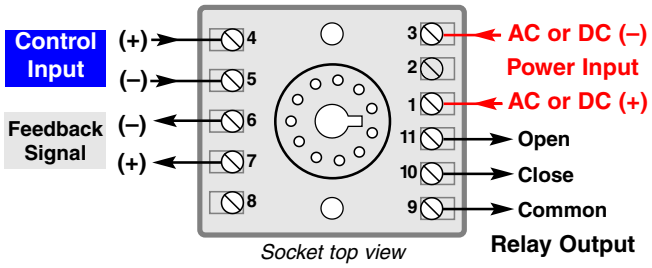
Control Input – Terminals 4 and 5 provide the appropriate connections for the input signal. Polarity must be observed when connecting the signal input. The positive connection (+) is applied to terminal 4 and the negative (–) is applied to terminal 5.

Feedback Signal – Terminals 6, 7, 8 provide the appropriate connections for the desired motor operations.

Relay Output Terminals – Terminals 9, 10, 11 provide the appropriate connections for the desired motor operations. (NO = Normally Open, NC = Normally Closed, C = Common).



3200 G typical wiring



3200 G M420 and 3200 G M01 typical wiring

CALIBRATION

Deadband – For most applications the deadband is the only required adjustment.

1. Deadband is normally adjusted after installation is complete.
2. Turn the deadband potentiometer counterclockwise to minimum.
3. Provide a near mid-level control input signal.
4. Allow the valve to stabilize.
5. If overshoot, oscillation, or hunting are detected, slowly increase the deadband clockwise to eliminate the oscillation.

Zero and Span – Zero and span adjustments are located on the side of the case and normally do not need to be adjusted.

1. If adjustment is required, apply a control input that represents the fully closed position.
2. Adjust the zero control to just close the valve.
3. Apply a full open control input signal.
4. Adjust the span control to just fully open the valve.

OPERATION

The API 3200 G provides an excitation voltage to the feedback potentiometer on the valve or valve actuator and monitors its position. If the difference between the control signal and the feedback signal is greater than the deadband setting, the appropriate relay is energized to actuate the positioning motor.

The API 3200 G M420 uses a 4-20 mA control signal input and feedback signal (unless another current range was specified). The difference between the control signal input and the feedback signal is compared to the deadband setting. If the difference between the two is greater than the deadband setting, the appropriate relay contact is energized to actuate the positioning motor.

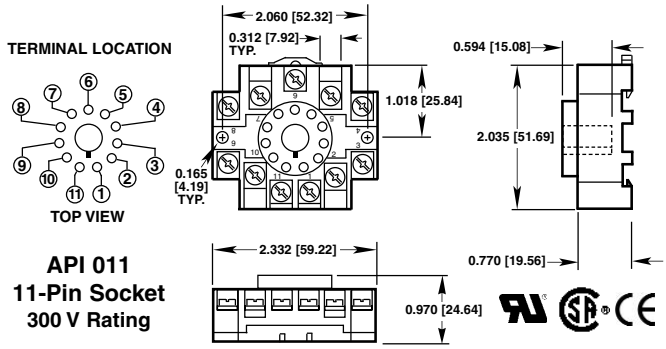
API 3200 G M01 has a 1-5 volt feedback signal and control signal input (unless another voltage range was specified). The difference between the control signal input and the feedback signal is compared to the deadband setting. If the difference between the two is greater than the deadband setting, the appropriate relay contact is energized to actuate the positioning motor.

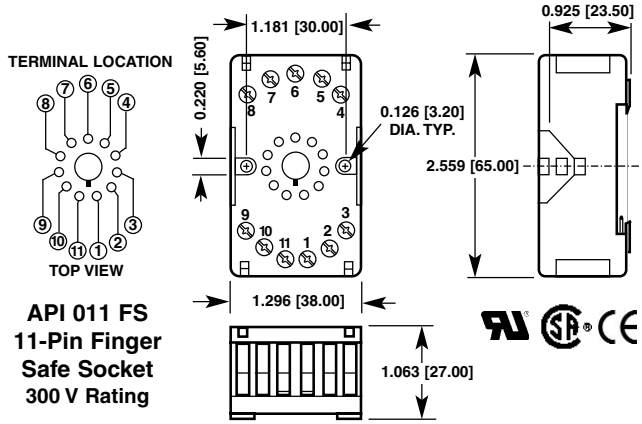
GREEN *LoopTracker*® Input LED – Provides a visual indication that a signal is being sensed by the input circuitry of the module. It also indicates the input signal strength by changing in intensity as the process changes from minimum to maximum to provide a quick visual picture of your process loop at all times. If the LED fails to illuminate, or fails to change in intensity as the process changes, this may indicate a problem with module power or signal input wiring. This features greatly aid in saving time during initial start-up or troubleshooting.

Control Relays – For all versions an electronic lockout circuit is used to prevent both relay contacts from closing simultaneously. When the input and the feedback signals are equal, the relay contacts will go to the neutral position.

Bi-Color Relay LED – Provides a visual indication of the relay status. In all configurations, a GREEN LED indicates a valve open relay position and a RED LED indicates a valve close relay position. In the neutral position, the LED will be off.

Manual/Auto Mode – Switching the top-mounted toggle switch to Manual allows the Open and Close pushbuttons to be used to position the valve independent of the control and feedback signals. The manual mode is useful for troubleshooting, calibration, system testing, or as a manual bypass. The bi-color relay LED indicates the controller's Open/Close relay contact status. Switching to Auto mode allows normal operation.

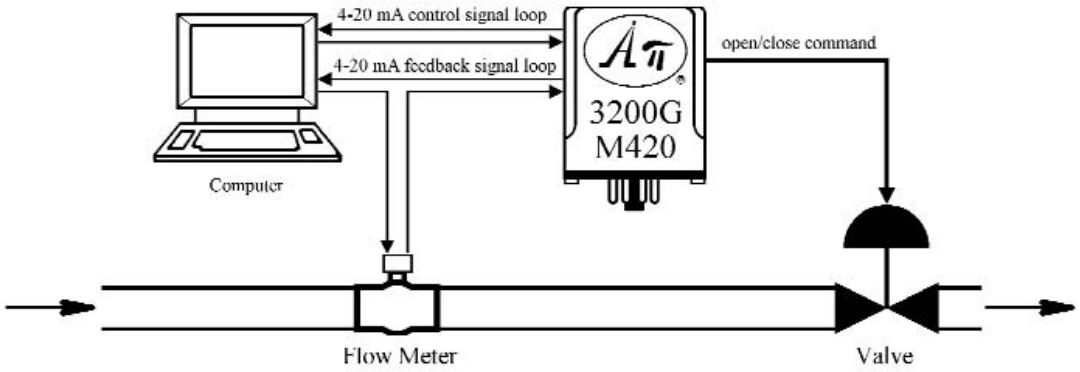




Flow Control with Flow Meter Feedback

PROBLEM
Operate a valve to accurately control the flow of liquid chemical in a pipeline where the feedback signal is 4-20 mA from a flow meter.

SOLUTION
An **API 3200 G M420** Valve/Actuator Positioner/Controller module compares the 4-20 mA flow command signal from the process control computer to the 4-20 mA flow feedback signal from the flow meter.

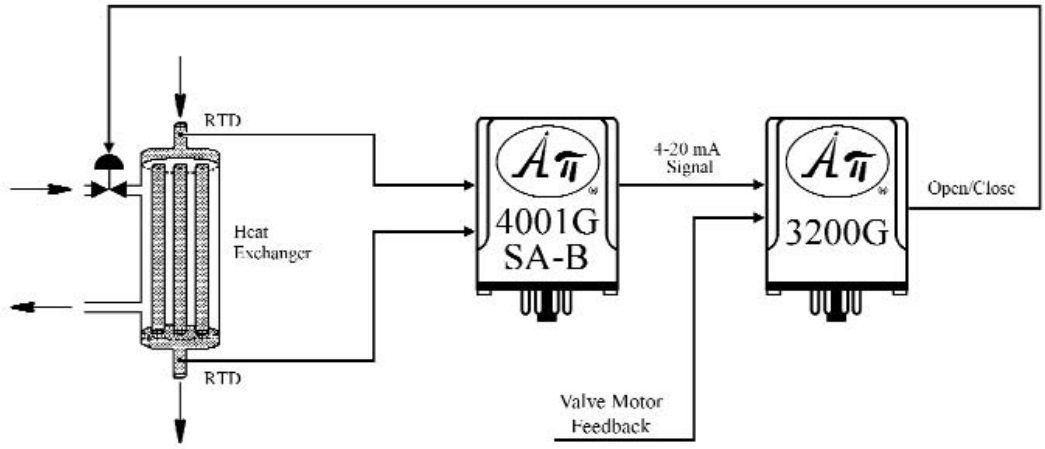


The **API 3200 G M420** positions the valve as necessary to match the feedback signal to the command signal.

Maintaining a Constant Differential Temperature Across a Heat Exchanger

PROBLEM
A critical process requires precise control of the change in temperature of the process fluid across a heat exchanger.

SOLUTION
Install RTDs at the process fluid heat exchanger inlet and outlet and connect the RTDs to an **API 4001G SA-B** Non-Isolated Differential RTD to DC Transmitter module.



The **API 4001 G SA-B** computes the differential temperature and provides a proportional 4-20 mA output signal which is used by the **API 3200 G** Valve/Actuator Positioner/Controller module to drive the temperature control valve open or closed as necessary to maintain the required process fluid temperature differential.

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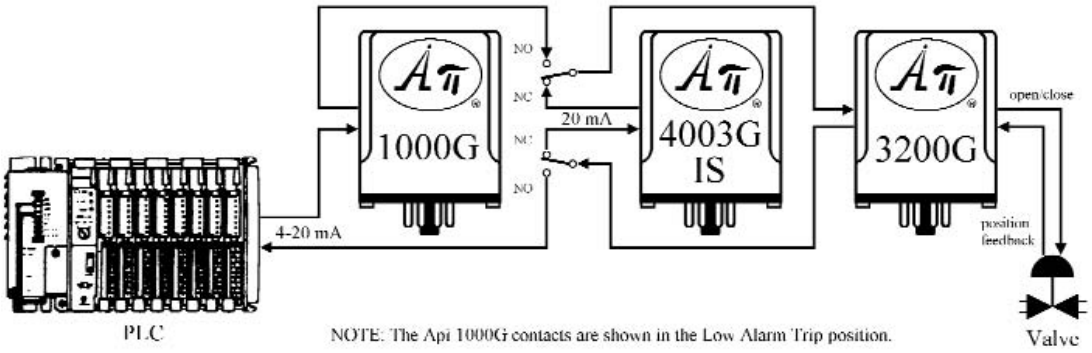
Fail Safe Valve Control

PROBLEM

For safety reasons an automated normally closed valve used in a coal mining operation must go to the full open position if the control signal from the programmable logic controller (PLC) is lost.

SOLUTION

The valve is controlled by an **API 3200 G** Valve/Actuator Positioner/Controller module. The input to the **API 3200 G** comes through an **API 1000 G** DC Input Single Alarm Trip module, which selects either the PLC output or a constant 20 mA output from an **API 4003 GIS** DC Special Transmitter module.



If the signal from the PLC drops below 4 mA, the **API 1000 G** will trip to a low alarm state, and select the 20 mA signal for the **API 3200 G**, thus commanding the valve to open fully. When the signal from the PLC is 4 mA or greater, the **API 1000 G** selects the PLC output signal for the **API 3200 G**, thus controlling valve position as normal.

Frequently Asked Questions – Valve Actuator

We have an API 3200 G M01 with a 0-10 VDC feedback signal and a 0-10 VDC control input. How do we calibrate this?

1. Set the deadband potentiometer fully CCW (counter-clockwise).
2. Apply the minimum signal (0 VDC) to both the feedback (terminals 6 & 7) and the control (terminals 4 & 5).
3. Turn the zero potentiometer screw until the relay changes state and has continuity from the common to the close position. The relay LED will be red to indicate the close position.
4. Apply the maximum signal (10 VDC) to both the feedback and the control inputs.
5. Turn the span potentiometer screw until the relay changes state and has continuity from the common to the open position. The relay LED will be green signaling the open position.
6. Apply 5 VDC to both the feedback and the control inputs. The relay contact should have no continuity and the relay LED should be off.
7. Use your multimeter to measure across terminals 4 and 7. The positive connections for both the feedback and the control should be within the minimum deadband (about 1% of span) for no relay change of state.
8. Change the feedback voltage to the desired deadband position. Rotate the deadband potentiometer CW (clockwise) until the relay changes state.

We would like to compare two signals. Each is 4-20 mA. If the *difference* between the two signals at any point in the 4-20 mA range becomes greater than the configured deadband, an output relay must change state to provide an alarm. Do you have a product to accomplish this?

Yes. Order the **API 3200 G M420**. The deadband can be adjusted to allow for a 1 to 25% difference in the two signals. If the difference is less than the deadband configured, then both relay contacts will not have continuity with the common terminal.

If the feedback 4-20 mA loop is higher than the control input, then continuity will be from common (9) to open (11). If the feedback is less, than the control input, then continuity will be from the common (9) to closed (10).

FREE APPLICATION ASSISTANCE
Call API Customer Service
800-794-5883

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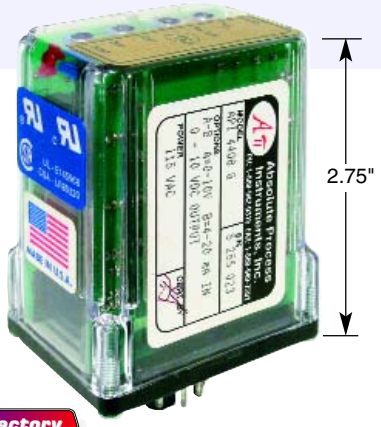
DC to DC Math Modules
Add, Subtract, Average

API 4400 G thru API 4408 G

Input: ***0-100 mV to 0-10 VDC or 0-1 mA to 0-20 mA***
Output: ***0-1 V to ±10 VDC or 0-1 mA to 4-20 mA***

Isolated

- ***Add, Subtract, or Average up to 4 DC Inputs***
- ***Input and Output LoopTracker® LEDs***
- ***Functional Test Pushbutton***
- ***2000 VRMS Input/Output/Power Isolation***
- ***Wide Bandwidth Option***



LIFETIME WARRANTY

Free Factory Input & Output Calibration!

Applications

- **Add, Subtract, Average Flow Signals**
- **Calculate Average Temperatures**

Specifications

Input Range

Factory Configured—Please specify input range

	Minimum	Maximum
Voltage:	0-100 mVDC	0-10 VDC to ±10 VDC
Current:	0-1 mADC	0-20 mADC including 4-20 mA

Popular ranges: 0-1 VDC, 0-5 VDC, 1-5 VDC, 0-10 VDC, ±5 VDC, ±10 VDC, 0-20 mA, 4-20 mA

System voltages must not exceed socket voltage rating
Consult factory for special ranges or functions

Input Impedance

Voltage: 100 kΩ per volt nominal Current: 50 Ω nominal

Input Voltage Burden (Current)

1.0 V_{RMS} maximum

Balance Between Inputs

Better than ±0.5% of span

LoopTracker

Variable brightness LEDs indicate input/output loop level and status

Output Range

Factory Configured—Please specify output range

	Minimum	Maximum	Load Factor
Voltage:	0-1 VDC	0-10 VDC	
Bipolar Voltage:	±1 VDC	±10 VDC	
Current (20 V compliance):	0-1 mADC	0-20 mADC	1000 Ω at 20 mA

Consult factory for special ranges

Output Zero and Span

Multiturn potentiometers to compensate for load and lead variations
±15% of span adjustment range typical

Functional Test Button

Sets output to test level when pressed. Adjustable 0-100% of span.
Potentiometer factory set to approximately 50% of span

Response Time

100 milliseconds typical
Optional 1 millisecond with **DF** option or consult factory

Output Linearity

Better than ±0.1% of span

Output Ripple and Noise

Less than 10 mV_{RMS}

Isolation

2000 V_{RMS} minimum
Full isolation: power to input, power to output, input to output

Ambient Temperature Range and Stability

–10°C to +60°C operating ambient
Better than ±0.02% of span per °C stability

Power

Standard:	115 VAC ±10%, 50/60 Hz, 2.5 W max.
A230 option:	230 VAC ±10%, 50/60 Hz, 2.5 W max.
D option:	9-30 VDC, 2.5 W typical

Description and Features

The **API 4400 G** through **API 4408 G** accept up to four DC voltage or current inputs and provide an optically isolated DC voltage or current output that is proportional to the sum and/or difference of the inputs depending on the model.

The nine different models can accept a variety of additive and subtractive input combinations. A wide bandwidth 1 millisecond response model is available for high-speed applications. The A, B, C, and D inputs should be the same type, but mixing the ranges of the various inputs is possible. Consult the factory when selecting mixed input ranges.

The API 4400 G series uses uses no transformers or choppers in the signal path for best noise immunity and freedom from AC artifacts in the output. The inputs are not isolated from each other and use the same signal common connection. The modules do features full 3-way (input, output, power supply) isolation.

API exclusive features include two ***LoopTracker*** LEDs and a **Functional Test Pushbutton**. The LoopTracker LEDs (Green for input, Red for output) vary in intensity with changes in the process input and output signals. Monitoring these LEDs can provide a quick visual picture of your process loop at all times. The functional test pushbutton provides a fixed output (independent of the input) when held depressed. Both the LoopTracker LEDs and functional test pushbutton greatly aid in saving time during initial startup and/or troubleshooting.

Industry standard sockets **API 011** and finger-safe **API 011 FS** allow either DIN rail or panel mounting, and are sold separately.

Models & Options

Factory Configured—Please specify input & output ranges, power and options

API 4400 G	(A + B + C + D) / 4	Isolated DC to DC math module, 115 VAC
API 4401 G	(A + B + C) / 3	Isolated DC to DC math module, 115 VAC
API 4402 G	(A + B) / 2	Isolated DC to DC math module, 115 VAC
API 4403 G	(A + B + C – D) / 3	Isolated DC to DC math module, 115 VAC
API 4404 G	(A + B – C – D) / 2	Isolated DC to DC math module, 115 VAC
API 4405 G	A – B – C – D	Isolated DC to DC math module, 115 VAC
API 4406 G	(A + B – C) / 2	Isolated DC to DC math module, 115 VAC
API 4407 G	A – B – C	Isolated DC to DC math module, 115 VAC
API 4408 G	A – B	Isolated DC to DC math module, 115 VAC

Options—Add to end of model number

A230	230 VAC, 50/60 Hz
D	9-30 VDC
DF	Fast response time, 1 millisecond
U	Conformal coating for moisture resistance

Accessories—Order as a separate line item

API 011	11-pin socket
API 011 FS	11-pin finger safe socket
API TK36	DIN rail, 35 mm W x 39" L, aluminum

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ELECTRICAL CONNECTIONS

WARNING! All wiring must be performed by qualified personnel only. This module requires an industry-standard 11-pin socket. Order API 011 or finger-safe API 011 FS socket separately.

Power Input Terminals – The white label on the side of the API module will indicate the power requirements. AC power is connected to terminals 1 and 3. For DC powered modules, polarity **MUST** be observed. Positive (+) is wired to terminal 1 and negative (–) is wired to terminal 3.

Signal Inputs – Terminals 4, 5, 6, 7, 8 provide the appropriate connections for the input signal. Polarity must be observed when connecting the signal input. The negative (–) connection for all inputs is connected to terminal 5.

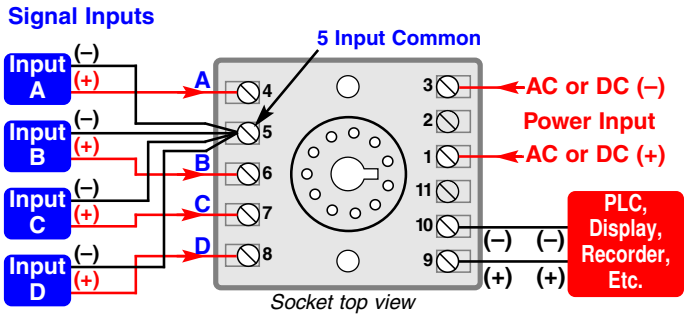
The positive (+) connection for input A is to terminal 4.

The positive (+) connection for input B is to terminal 6.

The positive (+) connection for input C is to terminal 7.

The positive (+) connection for input D is to terminal 8.

Signal Output – Terminals 9 (+) and 10 (–) provide the connections for the output. Note that the output provides power to the output loop.



API 3400 G thru API 4400 G typical wiring

CALIBRATION

Input and output ranges are pre-configured at the factory as specified on your order. Top-mounted, Zero and Span potentiometers can be used should fine-tuning be necessary. Custom ranges may require factory modification. Calibration requires accurate signal generation and measurement equipment. Calibration should not be attempted unless such equipment is available.

1. Apply power to the module and allow a minimum 20 minute warm up time.
2. Using an accurate calibration source, provide an input to the module equal to the minimum input required for the application.

   0% output will occur when all inputs (additive or subtractive) are at 0%. Any other calibration is non-standard.

   Note that 0% and 100% refer to percent of span and not the absolute level. For example, in a 4-20 mA loop, 4 mA is considered 0% and 20 mA is considered 100%.
3. Using an accurate measurement device for the output, adjust the Zero potentiometer for the exact minimum output desired. The Zero control should only be adjusted when the input signal is at its minimum. This will produce the corresponding minimum output signal.

   Example: for 4-20 mA output signal, the Zero control will provide adjustment for the 4 mA or low end of the signal.
4. Standard calibration for all models is such that 100% of the output level will occur when all additive inputs are at 100% and all subtractive inputs are at 0%.

   Note that 0% and 100% refer to percent of span and not the absolute level. For example, in a 4-20 mA loop, 4 mA is considered 0% and 20 mA is considered 100%.

   Set the input at maximum, and then adjust the Span pot for the exact maximum output desired. The Span control should only be adjusted when the input signal is at its maximum. This will produce the corresponding maximum output signal.

   Example: for 4-20 mA output signal, the Span control will provide adjustment for the 20 mA or high end of the signal.
5. Repeat adjustments for maximum accuracy.

TEST BUTTON & TEST RANGE

The Test pushbutton may be set to provide the desired output when depressed. This will drive the device on the output side of the loop (a panel meter, chart recorder, etc.) with a known good signal that can be used as a system diagnostic aid during initial start-up or during troubleshooting. It can be adjusted to vary the output signal from 0 to 100% of the calibrated output range. When released, the output will return to normal.

Turn the multiturn Test Range potentiometer while holding the Test Switch depressed until the desired output test level is reached.

Example: If you are isolating a 4-20 mA current loop, when the pushbutton is held depressed, the output from the module will be a constant signal between 4 and 20 mA depending on the setting of the Test Range adjustment pot.

OPERATION

The API 4400 G series is factory configured to your exact input and output requirements. It can be configured to allow up to four inputs to be scaled and connected to either additive or subtractive amplifier inputs according to the model designation.

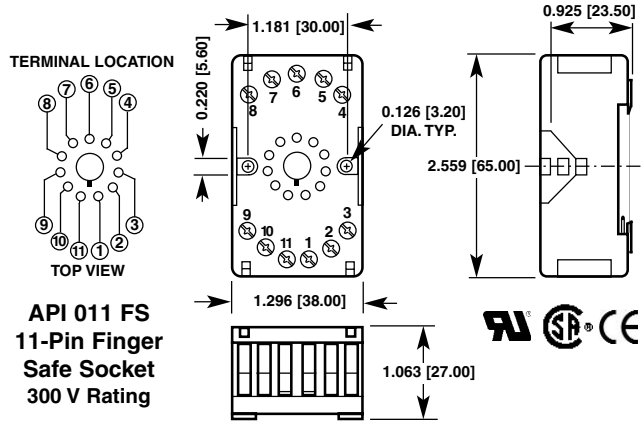
The input signal is filtered, and cancels any offset of the input relative to the output. 50 Ω shunts are used at the input for current-to-voltage conversion if required.

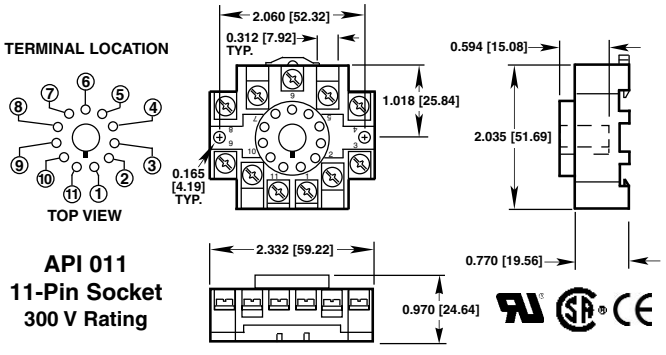
The resulting DC signal is passed through an optical coupler that carries the signal across an isolation barrier. The output stage is then configured to select the particular output range (voltage or current) as required.

The 4400 G series also includes a power supply which provides dual regulated and isolated supplies for circuit operation.

GREEN *LoopTracker*® Input LED – Provides a visual indication that a signal is being sensed by the input circuitry of the module. It also indicates the input signal strength by changing in intensity as the process changes from minimum to maximum to provide a quick visual picture of your process loop at all times. If the LED fails to illuminate, or fails to change in intensity as the process changes, this may indicate a problem with module power or signal input wiring. This features greatly aid in saving time during initial start-up or troubleshooting.

RED *LoopTracker* output LED – Provides a visual indication that the output signal is functioning. It becomes brighter as the input and the corresponding output change from minimum to maximum. For current outputs, the RED LED will only light if the output loop current path is complete. For either current or voltage outputs, failure to illuminate or a failure to change in intensity as the process changes may indicate a problem with the module power or signal output wiring.





Valve, Math, P.I.

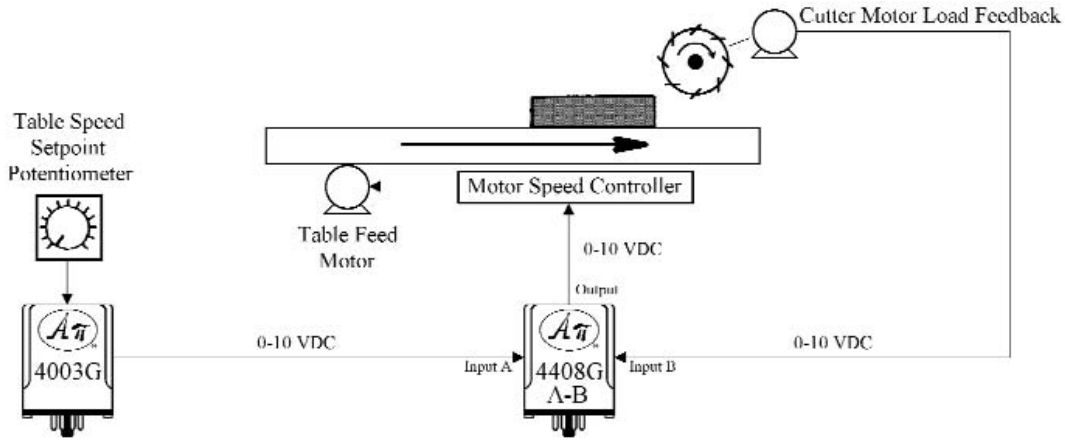
Automation of a Milling Machine Operation

PROBLEM

The optimum speed at which material is fed into a mill cutter is dependent on several factors. Included among these factors is the amount of material to be removed, the density and hardness of the material and the sharpness of the cutter. Ideally, these remain constant and the feed rate can be set and maintained throughout the operation. In the real world, however, material size, shape, density and hardness can vary greatly, and cutters become dull with use. These changes affect the load on the motor driving the mill cutter and a feedback signal of this load can be used to adjust the feed rate to compensate.

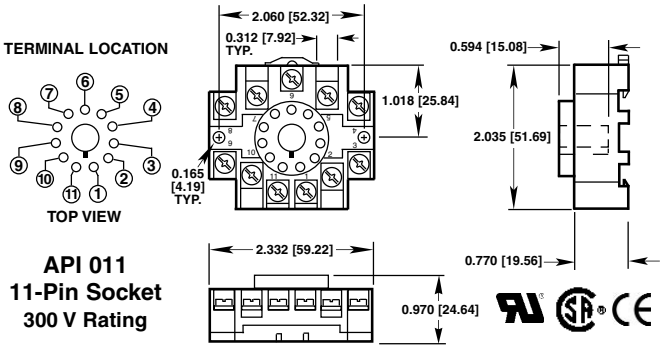
SOLUTION

On a milling machine equipped with load feedback on the cutter, an effective automatic table feed control system can be implemented using an **API 4003 G** Potentiometer to DC Transmitter module for a speed reference signal. An **API 4408 G** A-B Math Function with Isolated DC Output module is used to reduce the speed command to the table motor controller as cutter load increases.

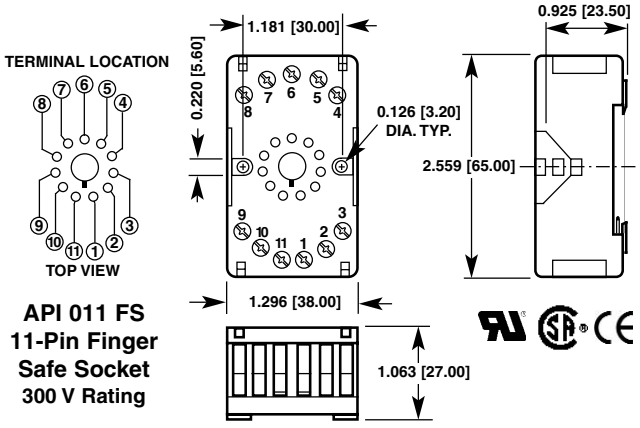


Here, the milling machine is equipped with a controller that accepts a 0-10 VDC input to vary the speed of the moving table. It is also equipped with a 0-10 VDC output signal that is directly proportional to the load on the cutter. The **API 4003 G** sets the maximum speed of the table with no load on the cutter. The **API 4408 G** subtracts the load feedback signal from the maximum table speed signal and sends the resulting signal to the table motor speed controller. Thus, the speed of the table is reduced as the load on the cutter increases, compensating for variations in material shape, density and hardness, as well as cutter sharpness.

API 011 and API 011 FS Sockets



API 011
11-Pin Socket
300 V Rating



API 011 FS
11-Pin Finger Safe Socket
300 V Rating

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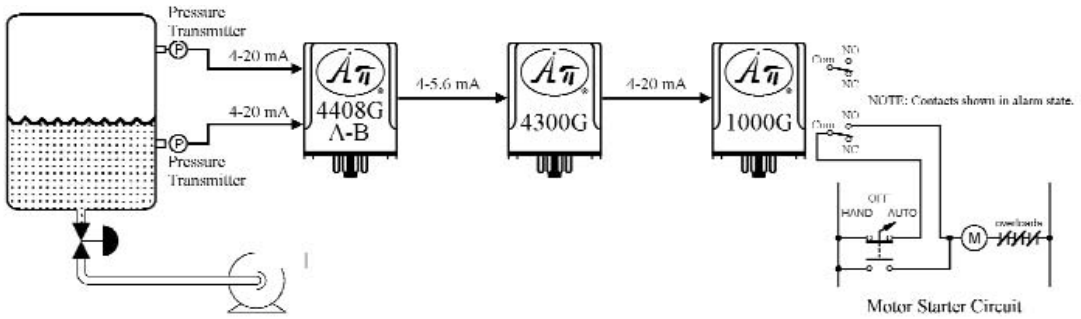
Phase Separator Water Level Control

PROBLEM

A phase separator is equipped with 2 pressure sensors, one located above the water level and one below. During operation, the maximum pressure differential is 10%. It is necessary to maintain the water level so that there is a 1% pressure differential between the sensors.

SOLUTION

Use an **API 4408 G** A-B Math Function module to obtain the pressure differential between the transmitters. With a pressure differential of 0-10%, the output of the **API 4408 G** will be 4-5.6 mA. Expand the 4-5.6 mA signal to 4-20 mA with an **API 4300 G** Isolated DC to DC Transmitter module for better resolution and control.



Use the output of the **API 4300G** to drive an **API 1000 G** DC Input Single Alarm Trip module to provide a relay contact closure to operate a water removal pump. Adjust the setpoint of the **API 1000 G** to maintain the differential pressure at 1%. The second set of isolated relay output contacts can be wired to an annunciator panel or other monitoring system as desired. The standard heavy-duty relay contacts are rated 7A @ 240VAC (resistive) and can directly control most devices.

Frequently Asked Questions

Do you recommend placing a fuse at the power input (115 VAC) for protection?

It is not required, but if desired, a ½ Amp Fast Blow fuse can be used for each module.

We are using many different types of your signal conditioners and wish to protect the inputs and outputs from short circuits and over voltage. How can we achieve this?

Applying a short circuit to any of the signal input terminals will not affect the modules. Exposing the signal input to high voltage will damage the unit but using a zener diode, due to its resistance value, will cause the input range to need recalibrating. Try a Varistor or TransZorb®. Do NOT under any circumstances short circuit the signal output, the unit can be damaged.

We are running a 4-20 mA signal between a chart recorder and a DCS over a distance of 5000 feet (10,000 total loop). Can we use your isolator signal conditioner for this?

Yes, however you must select the proper gauge wire to reduce the impedance of the system

total load = impedance of the instrument + impedance of the wire

For a 4-20 mA loop, our compliance voltage is 20 V and allows a total of 1000 ohm load. To prevent problems from noise, it is recommended that you use shielded, twisted pair wires.

For modules with a 4-20 mA output signal, what are the minimum and maximum output load resistances?

For the units with a 20 V compliance, the output range is 10 to 1000 ohms.
For the units with a 12 V compliance, the output range is 10 to 600 ohms.

For the DC output models, what are the output impedances in the voltage and current mode?

The DC outputs are FET driven and are active outputs that change depending on the mode and range.

	CURRENT Mode	VOLTAGE Mode	
DC output with 12 V Compliance	less than 600 ohms	greater than 1000 ohms
DC output with 20 V Compliance	less than 1000 ohms	greater than 1000 ohms

TransZorb–Reg TM General Semiconductor

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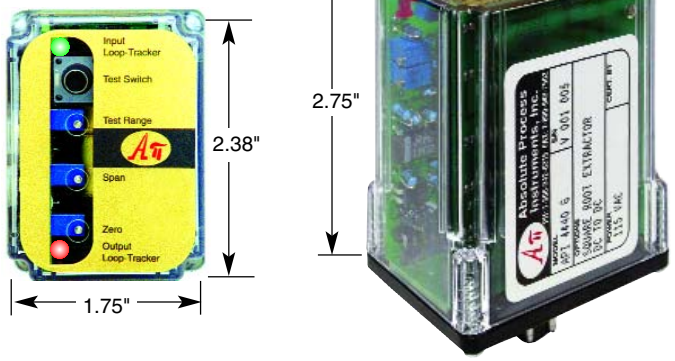
DC to DC Transmitter with Square Root Extraction

API 4440 G

Input: ***0-50 mV to 0-200 VDC or 0-1 mA to 0-50 mADC***
Output: ***0-1 V to ±10 VDC or 0-20 mA to 4-20 mA***

Fully Isolated

- ***Converts ΔP Signal to Linear Flow***
- ***Full Input/Output/Power Isolation***
- ***Input and Output LoopTracker® LEDs***
- ***Functional Test Pushbutton***



Applications

- **Linearize Flow Meters**
- **Linearize Pitot Tube ΔP Measurements**
- **Custom Signal Linearization in One Package**

Specifications

Input Range
Factory Configured—Please specify input range
System voltages must not exceed socket voltage rating
Consult factory for special ranges

DC Voltage: 0-50 mV to 0-200 V
DC Current: 0-1 mA to 0-50 mA

Input Impedance
Voltage: 50 kΩ minimum
Current: 50 Ω nominal

Input Loop Power Supply
18 VDC nom., unregulated, 25 mADC, max. ripple, less than 1.5 V_{p-p}

LoopTracker
Variable brightness LEDs indicate input/output loop level and status

Output Range
Factory Configured—Please specify output range

	Minimum	Maximum	Load Factor
Voltage:	0-1 VDC	0-10 VDC	
Bipolar Voltage:	±1 VDC	±10 VDC	
Current (20 V compliance):	0-1 mADC	0-20 mADC	1000 Ω at 20 mA

Consult factory for special ranges

Accuracy
Better than ±0.25% of span

Output Ripple and Noise
Less than ±0.2% of span

Output Zero and Span
Multiturn potentiometers to compensate for load and lead variations
±15% of span adjustment range typical

Functional Test Button
Sets output to test level, factory set to approximately 50% of span
Adjustable 0-100% of span

Response Time
70 milliseconds typical

Isolation
2000 V_{RMS} minimum
Full isolation: power to input, power to output, input to output

Common Mode Voltage/Rejection
Greater than 100 dB at 500 VAC 60 Hz

Ambient Temperature Range
–10°C to +60°C operating

Temperature Stability
Better than ±0.03% of span per °C

Power
Standard: 115 VAC ±10%, 50/60 Hz, 2.5 W max.
A230 option: 230 VAC ±10%, 50/60 Hz, 2.5 W max.
D option: 9-30 VDC, 2.5 W typical

LIFETIME WARRANTY

Free Factory Input & Output Calibration!

Description and Features

The **API 4440 G** square root extractor accepts a DC voltage or current input and provides a DC voltage or current output proportional to the square root of the input. The **API 4440 G** can be factory-configured and calibrated for most popular input and output ranges.

Common applications include linearization of flow sensing elements such as differential pressure cells, pitot tubes, flow meters, etc.

The **API 4440** filters and converts the DC input into a standard internal range. A precision integrated circuit extracts the square root of this signal. This extracted signal is passed thru a linear opto-coupler circuit that uses no pulse width modulators, transformers or capacitors to produce unwanted coupling or noise into the output.

This extracted and isolated signal is then trimmed by the external zero and span controls for fine adjustment. It is then passed to the output stage, which is internally configured for voltage or current output, with the gain scaled to the specific range required.

API exclusive features include two ***LoopTracker*** LEDs and a **Functional Test Pushbutton**. The LoopTracker LEDs (Green for input, Red for output) vary in intensity with changes in the process input and output signals. Monitoring these LEDs can provide a quick visual picture of your process loop at all times. The functional test pushbutton provides a fixed output (independent of the input) when held depressed. Both the LoopTracker LEDs and functional test pushbutton greatly aid in saving time during initial startup and/or troubleshooting.

An 18 VDC unregulated loop excitation power supply is standard and can be used to power passive input devices.

Industry standard sockets **API 008** and finger-safe **API 008 FS** allow either DIN rail or panel mounting, and are sold separately.

Models & Options

Factory Configured—Please specify input & output ranges, power and options

API 4440 G DC to DC square root extractor, isolated, 115 VAC

Options—Add to end of model number

A230	230 VAC, 50/60 Hz
D	9-30 VDC
U	Conformal coating for moisture resistance

Accessories—Order as a separate line item

API 008	11-pin socket
API 008 FS	11-pin finger safe socket
API TK36	DIN rail, 35 mm W x 39" L, aluminum

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RANGES

Listed below are commonly ordered input and output ranges. Contact factory for special ranges. Note that when a current output is ordered, it provides power to the output current loop (sourcing).

Common Voltage Inputs	
0 to 100 mV	0 to 50 V
0 to 200 mV	0 to 100 V
0 to 500 mV	±100 mV
0 to 1 V	±200 mV
0 to 2 V	±500 mV
0 to 5 V	±1 V
1 to 5 V	±2 V
0 to 10 V	±5 V
0 to 20 V	±10 V
0 to 100 V	0-200 V
Common Current Inputs	
0 to 1 mA	0 to 100 mA
0 to 10 mA	0 to 200 mA
0 to 20 mA	0 to 500 mA
4 to 20 mA	0 to 1 A
10 to 50 mA	

Square Root of Input

Common Voltage Outputs
0 to 1 V
0 to 5 V
1 to 5 V
0 to 10 V
±5 V
±10 V
Common Current Outputs
0 to 20 mA
4 to 20 mA

ELECTRICAL CONNECTIONS

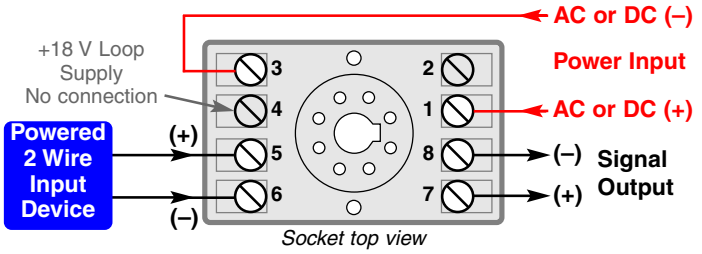
WARNING! All wiring must be performed by qualified personnel only. This module requires an industry-standard 8-pin socket. Order API 008 or finger-safe API 008 FS socket.

Power Input Terminals – The white label on the side of the API module will indicate the power requirements. AC power is connected to terminals 1 and 3. For DC powered modules, polarity **MUST** be observed. Positive (+) is wired to terminal 1 and negative (–) is wired to terminal 3.

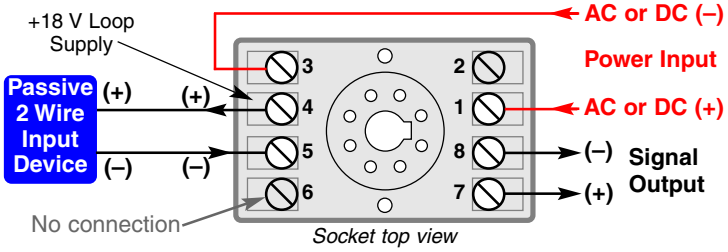
Powered Signal Input – Polarity must be observed when connecting the signal input. The positive connection (+) is applied to terminal 5 and the negative (–) is applied to terminal 6.

Passive Signal Input – Polarity must be observed when connecting the signal input. A passive input device can be powered by the 18 volt DC power supply at terminal 4. This may save the expense of purchasing a separate power supply for the input device. A typical example is shown, however it is very important to consult the manufacturer of your specific sensor to determine its compatibility and proper wiring.

Signal Output Terminals – Polarity must be observed when connecting the signal output to the load. The positive connection (+) is connected to terminal 7 and the negative (–) is connected to terminal 8. Output provides power to the output current loop (sourcing).



Connecting an input device which provides power to the input circuit



Using the built-in 18 VDC loop supply to power a passive input device

API maintains a constant effort to upgrade and improve its products. Specifications are subject to change without notice. Consult factory for your specific requirements.

CALIBRATION

The API 4440 G is shipped from the factory calibrated to your input and output specifications. Recalibration of the API 4440 G will require an accurate simulation source of DC voltage or current for the range of interest plus an accurate DC digital voltmeter for best results.

1. Connect a DC calibrator to the module input.
2. Connect an accurate DC voltmeter (or milliammeter, as required) to the module output.
3. Set the input simulator to the low end of the input range.
4. Adjust the module's Zero control for the specified 0% (low end) output. Because of the steep slope of the square root function near zero, careful calibration at the low end is important to accuracy.
5. For some applications, it may be better to adjust the Zero control at a slightly elevated input level (5 to 10% of input span) for the corresponding square root value at the output, rather than zero, to avoid calibrating on the very large input slope near zero.
6. Set the input simulator to the high end of the input range.
7. Adjust the module Span control for the specified high (100%) output level.
8. The zero and span controls normally have little interaction, but it may be best to repeat the above steps to ensure maximum accuracy.
9. The Test Cal control may be set to provide the desired output when the test pushbutton is held depressed.

TEST BUTTON & TEST RANGE

The Test pushbutton may be set to provide the desired output when depressed. This will drive the device on the output side of the loop (a panel meter, chart recorder, etc.) with a known good signal that can be used as a system diagnostic aid during initial start-up or during troubleshooting. It can be adjusted to vary the output signal from 0 to 100% of the calibrated output range. When released, the output will return to normal.

Turn the multiturn Test Range potentiometer while holding the Test Switch depressed until the desired output test level is reached.

OPERATION

The API 4440 G square root calculation is based on "percentage math." The output in percent of span is the square root of the percent of the input span. For example, a module using 4-20 mA input/output, the output algorithm is

$$\frac{\sqrt{\%\text{Input} \div 100} \times \text{Output Span}}{+ \text{ Output Base Value}}$$
$$= \textbf{Module Output Value}$$

Input Value	% Input ÷100	$\left[\sqrt{\%\text{ Input} \div 100} \times \text{Output Span}\right]$	+	Output Base	=	Output Value
4 mA	0.00	[0.000 x 16 mA]	+	4 mA	=	4.000 mA
8 mA	0.25	[0.500 x 16 mA]	+	4 mA	=	12.000 mA
12 mA	0.50	[0.707 x 16 mA]	+	4 mA	=	15.313 mA
16 mA	0.75	[0.866 x 16 mA]	+	4 mA	=	17.856 mA
20 mA	1.00	[1.000 x 16 mA]	+	4 mA	=	20.000 mA

GREEN *LoopTracker*® Input LED – Provides a visual indication that a signal is being sensed by the input circuitry of the module. It also indicates the input signal strength by changing in intensity as the process changes from minimum to maximum to provide a quick visual picture of your process loop at all times. If the LED fails to illuminate, or fails to change in intensity as the process changes, this may indicate a problem with module power or signal input wiring. This features greatly aid in saving time during initial start-up or troubleshooting.

RED *LoopTracker* output LED – Provides a visual indication that the output signal is functioning. It becomes brighter as the input and the corresponding output change from minimum to maximum. For current outputs, the RED LED will only light if the output loop current path is complete. For either current or voltage outputs, failure to illuminate or a failure to change in intensity as the process changes may indicate a problem with the module power or signal output wiring.

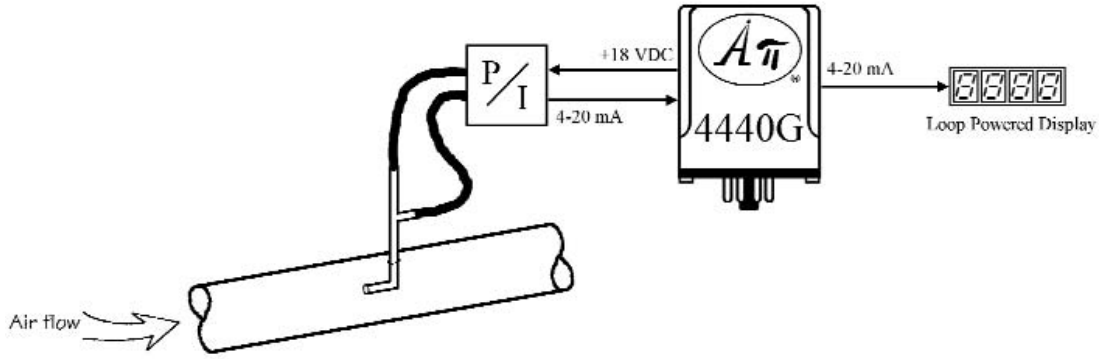
Air Flow Measurement

PROBLEM

Measure an air velocity value, convert it and display it as an airflow value.

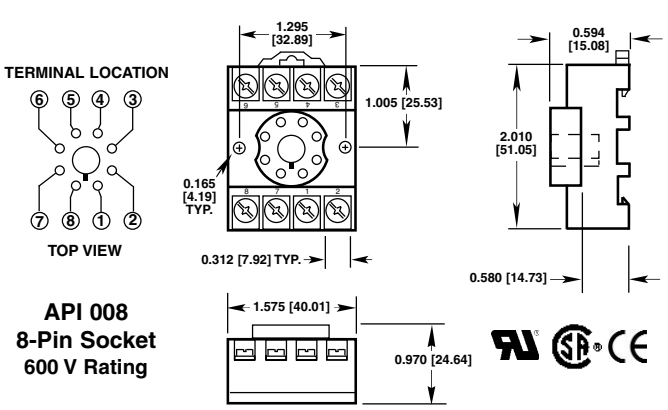
SOLUTION

In accordance with Bernoulli's equation the velocity of a fluid stream is proportional to the square root of the difference in pressure (DP) between the direct impact and stagnation pressures as measured with a pitot tube. An **API 4440 G** Isolated DC to DC Transmitter with Square Root Extraction module performs the square root function on the 4-20 mA signal obtained from the P/I device and produces an interpolated 4-20 mA output signal of velocity. The **API 4440 G** provides power for the P/I device from its standard built-in +18 VDC loop excitation supply capable of driving up to a 1000 ohm load.

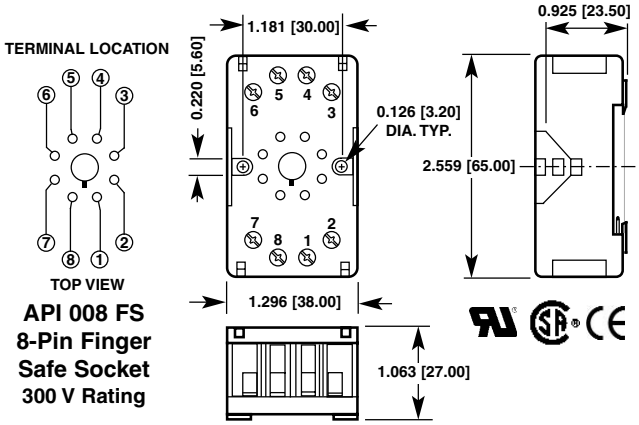


Since Flow = Velocity x Area, the cross sectional area of the pipe will determine the range of the scaling on the loop powered display. This allows the velocity value to be displayed as a flow rate. The optical isolation of the module protects against unwanted ground loops and electrical noise.

API Sockets API 008 and API 008 FS



API 008
8-Pin Socket
600 V Rating



API 008 FS
8-Pin Finger Safe Socket
300 V Rating

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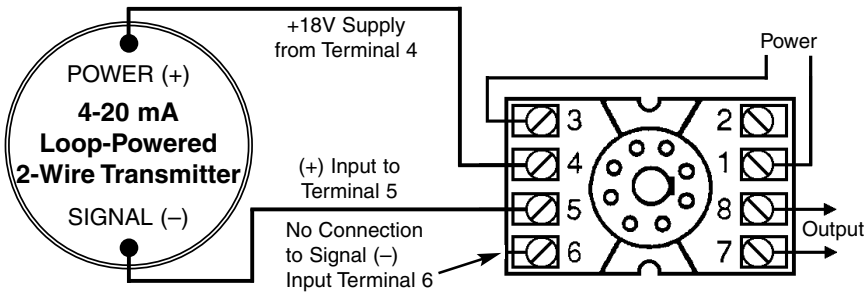
Using the Built-In 4-20 mA Loop Power Supply

Many Api modules have a built in loop power supply which can be used to power the 4-20 mA input current loop. The wiring diagrams below give examples of how a two-wire transmitter can be powered by the module's loop power supply and also provide input to the module.

When using the built-in loop power supply, there is no connection to the module's signal minus (–) input terminal. An **internal** 50 ohm resistor across the input terminals allows you to do this without any problems.

8-Pin Modules
API 4010 G
API 4050 G
API 4300 G
API 4310 G
API 4380 G
API 4380 GHV
API 4385 G
API 4440 G



What is a Ground Loop?

In a process control loop, a ground loop circuit can develop when each device's ground is tied to a different earth potential thereby allowing current to flow between the grounds by way of the process loop (Figure 1).

Ground loops cause problems by adding or subtracting current or voltage from the process loop. This addition and/or subtraction causes the receiving device to be unable to differentiate between the wanted and unwanted signals and thus can't accurately reflect actual process signals.

The probability of multiple grounds and ground loops being established is especially high when new programmable logic controllers (PLCs) or distributed control systems (DCSs) are installed. With so many conditions within a facility referenced to ground, the likelihood of establishing more than one ground point is great. Thus, if an instrumentation system seems to be acting strangely or erratically, and the problem seems to point toward ground loops, the chore of eliminating all unintended ground connections becomes overwhelming.

Keep in mind that eliminating ground loops just isn't feasible for some instruments, such as thermocouples and some analyzers, because they require a ground to obtain accurate rate measurements. In addition, some instruments must be grounded to ensure personnel safety.

When ground loops can't be eliminated, the solution lies in the use of signal isolators. These devices break the galvanic path (DC continuity) between all grounds while allowing the analog signal to continue throughout the loop. An isolator also can eliminate the electrical noise of AC continuity (common mode voltage).

Signal isolators can use numerous techniques to achieve their function but the best signal isolators usually employ optical isolators (Figure 2). Regardless of the isolation method used, an isolator must provide input, output, and power isolation. If this three-way isolation is not provided, then an additional ground loop can develop between the isolator's power supply and the process input and/or output signal.

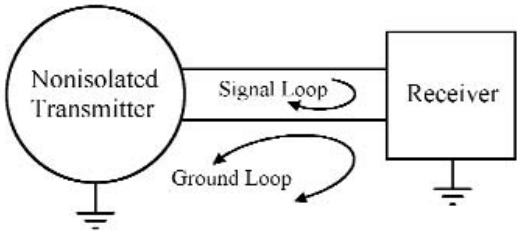


Figure 1. *Ground loops may develop with non-isolated transmitters and receivers, resulting in inaccuracy and unreliability.*

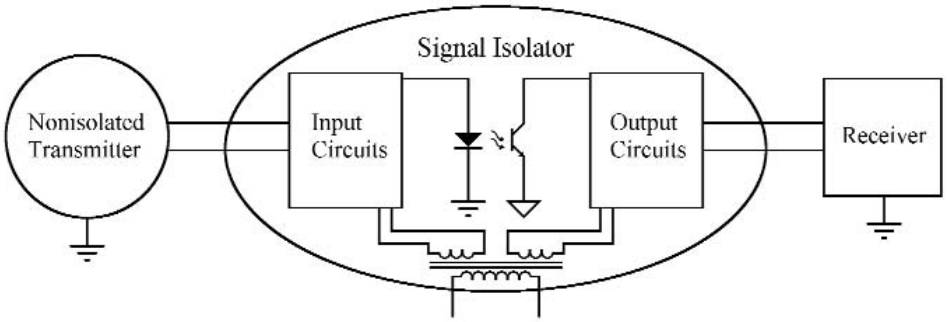


Figure 2. *A signal isolator in the process loop blocks ground current to restore signal accuracy and reliability.*

Valve, Math, P-I

Pressure to Current Converters

DPG1000L3-15PSIG
F4L3-15PSIG

Input: ***3 to 15 psig***
Output: ***4-20 mA***

- ***Converts Pressure Signal to Analog 4-20 mA***
- ***F4L Model NEMA 4X Rated***
- ***Display Ranges from 3.00 to 15.00 psig***
- ***Functional Test Pushbutton***

DPG1000L3-15PSIG

F4L3-15PSIG

Free Factory Input & Output Calibration!

Applications

- **Monitor Pneumatic Control Systems**
- **Local Display for On-Site Inspection**

Specifications

Range and Resolution
3.00 to 15.00 psig, resolution fixed at 0.01 psi
Consult factory for special ranges

Accuracy (linearity, hysteresis, repeatability)
Standard: ±0.25% of full scale ±1 least significant digit
-HA option: ±0.1% FS ±1 LSD

Zero and Span
Non-interactive display zero and span, ±10% range

Display
3 readings per second nominal display update rate
3½ digit LCD, ½" digit height

Output Range and Characteristics
3.00 psig 4 mA
15.00 psig 20 mA

See chart on other side for compliance
True analog output, 50 millisecond typical response time
Gauge terminal voltages less than 7.8 VDC may cause erratic operation

Functional Test Button
Sets loop current and display to test calibration level, independent of pressure input, to allow testing of system operation
Multiturn potentiometer to set Test level from 0 to 100% of full scale

Housing Material
DPG1000L Extruded aluminum case, light gray epoxy powder coated, blue ABS/polycarbonate bezel, front and rear gaskets
F4L ABS/polycarbonate bezel, rear gasket, NEMA 4X

Pressure Connection and Material
¼" NPT male, 316 stainless steel

Media Compatibility
All wetted parts are 316 SS, Compatible with most liquids and gases

Temperature Stability (relative to 77°F or 25°C)
±1% FS for offset and span, 32 to 158°F (0 to 70°C) typical

Compensated Temperature
32 to 158°F (0 to 70°C)

Operating Temperature
–4 to 185°F (–20 to 85°C)

Storage Temperature
–40 to 203°F (–40 to 95°C)

Overpressure and Burst
2x rated over-pressure minimum, 4x rated burst pressure minimum

Power
Powered by 4-20 mA current loop
Order optional **API 9046-24** loop power supply or use with any DC supply or loop resistance that maintains 8 to 32 VDC at gauge terminals

Reverse polarity protected

3 ft long, 2-conductor 22 AWG cable

Weight (approximate)
Gauge weight 9 ounces
Shipping weight 1 pound

Description and Features

All operating power for the **DPG1000L** or **F4L** converter is supplied by the 4-20 mA current loop. The 2-wire connection allows the **DPG1000L** or **F4L** to be used as a pressure to current converter in any 3 to 15 psig system. The output is a continuous analog signal based on the transducer output rather than the display. The output is filtered to improve noise immunity and has a response time of about 50 msec. The temperature compensated piezoresistive transducer features 316 stainless steel wetted parts.

The TEST pushbutton, when depressed, switches the display and output loop to a preset level determined by the setting of a Test potentiometer.

Models & Options

DPG1000L3-15PSIG	Pressure to current converter, 3-15 psig to 4-20 mA, 2-wire loop-powered
F4L3-15PSIG	NEMA 4X pressure to current converter, 3-15 psig to 4-20 mA, 2-wire loop-powered

Options—Add to end of model number

-HA	High accuracy, ±0.1% FS ±1 LSD
-CC	Conformal coating for moisture resistance

Accessories

API 9046-24	Loop power supply
CD	Calibration data
NC	Calibration data with NIST certificate

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Valve, Math, P-I

DPG1000L3-15PSIG
F4L3-15PSIG

Installation and Setup

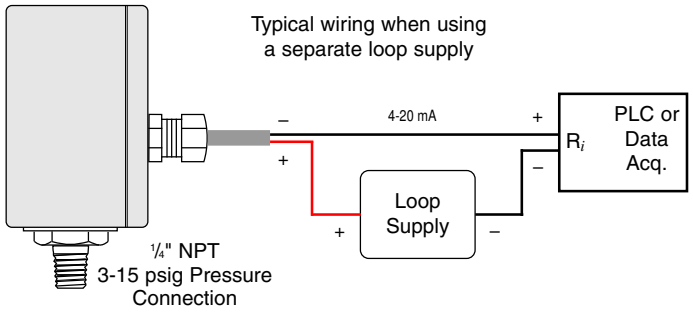
INSTALLATION AND PRECAUTIONS

Install or remove gauge using wrench on hex fitting only. Do not attempt to tighten by turning housing or any other part of the gauge. Use fittings appropriate for the pressure range of the gauge. Do not apply vacuum to gauges not designed for vacuum operation. Due to the hardness of 316 stainless steel, it is recommended that a thread sealant be used to ensure leak-free operation.

NEVER insert objects into the gauge port or blow out with compressed air. Permanent damage not covered by warranty will result to the sensor.

ELECTRICAL CONNECTION

Connection to the **DPG1000L** or **F4L** is made with the 2-wire cable at the gauge rear. Connect the loop (+) supply to the RED lead and the loop (–) supply to the BLACK lead. Reversing the connections will not harm the gauge but the unit will not operate with incorrect polarity.



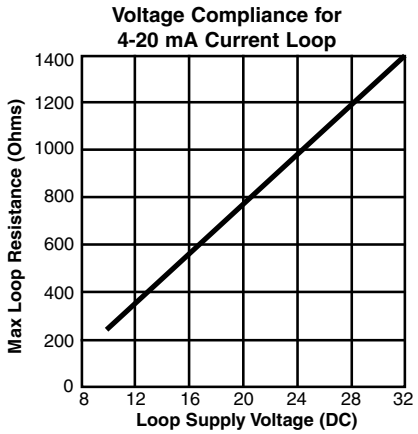
LOOP VOLTAGE

Select a loop power supply voltage and total loop resistance so that when the loop current is 20 mA, the gauge will have at least 8 VDC at its terminals. For correct operation and to avoid erratic or erroneous readings, the gauge terminal voltage must not fall below 8 VDC. Too large a loop resistance will cause the gauge output to "limit" or saturate before reaching its full 20 mA output.

The **minimum** loop supply voltage may be calculated from the formula:

$$V_{min} = 8V + (20mA \times \text{Total loop resistance})$$

If the terminal voltage of the gauge falls below about 7.8 VDC erratic operation may occur. This is an indication that the loop supply/resistance may not allow adequate headroom for reliable operation. This should never occur in normal use. If it does, examine the loop supply/resistance.



OPERATION

The **DPG1000L** or **F4L** is designed for continuous operation. Warm-up time is negligible. The display will show the system pressure and the loop current will be proportional to the system pressure.

4 mA = 3 psig
20 mA = 15 psig

TEST BUTTON

When the front-panel TEST button is held depressed, the display and loop current are switched, independent of the system pressure, to a test level determined by the setting of the Test potentiometer. This test mode will allow setup and testing of the current loop by switching to this test level whenever desired without having to alter the system pressure.

To set the test output level, see gauge label for location of Test potentiometer. Press and hold the front-panel TEST button and adjust the Test potentiometer to set the display and loop current to the desired test level.

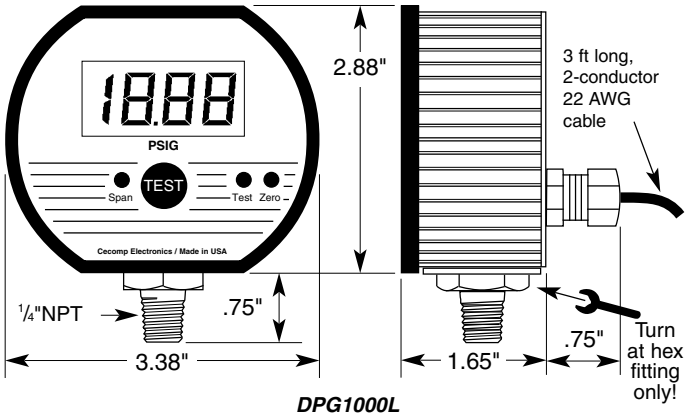
CALIBRATION

See gauge label for location of individual controls to adjust the zero and span of the display.

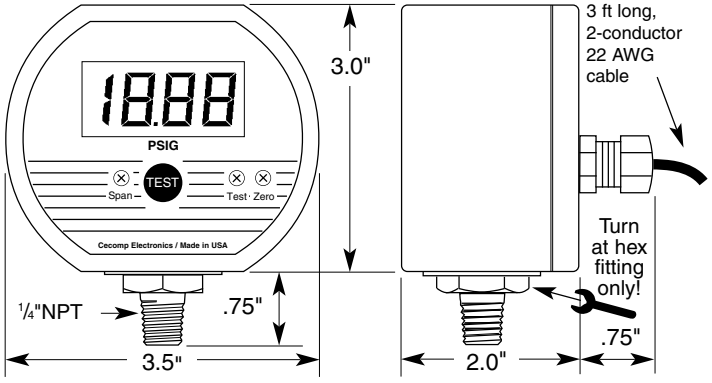
Units may be re-zeroed without affecting the span calibration. The gauge port must be open to the ambient with no pressure or vacuum applied. Adjust the Zero control until the gauge reads zero with the minus (–) sign occasionally flashing. Note that the Zero is set with the gauge at zero psig even though the output is ranged for 3 to 15 psig.

Span calibration should only be attempted if the user has access to a pressure reference of known accuracy. The quality of the calibration is only as good as the accuracy of the calibration equipment and ideally should be at least four times the gauge accuracy. Zero calibration must be done before span calibration. Record readings at three to five points over the range of gauge and adjust span control to minimize error and meet specifications.

The **DPG1000L** and **F4L** have internal controls to adjust the agreement between the displayed value and the 4-20 mA loop current. These are set at the factory and should not normally be adjusted. If adjustment is necessary, consult factory. Accurate pressure generation and measurement and current measurement equipment are required to successfully complete this calibration.



DPG1000L



F4L

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