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***

- ***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***

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.
P option:	80-265 VAC or 48-300 VDC, 50/60 Hz, 2.5 W typical
A230 option:	230 VAC ±10%, 50/60 Hz, 2.5 W max.
D option:	9-30 VDC, 2.5 W typical

LIFETIME WARRANTY

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Free Factory Input & Output Calibration!

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

P	Powered by 80-265 VAC or 48-300 VDC, 50/60 Hz
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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api-usa.com

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.

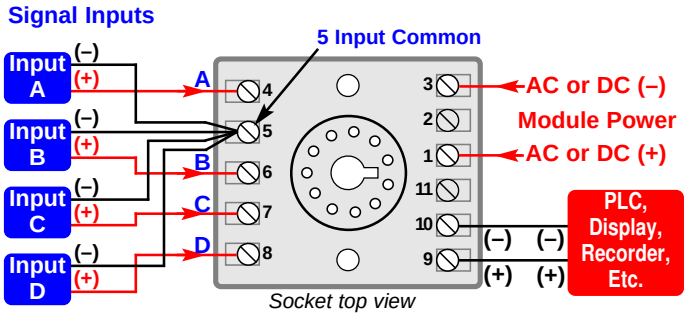
The positive (+) connection for input A is to terminal 4.

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.

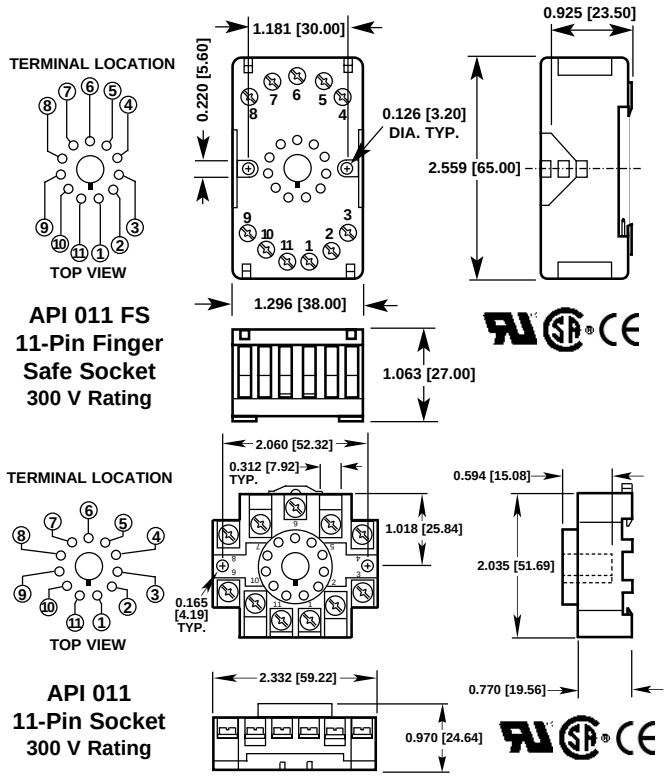
The input signal is filtered, and cancels any offset of the input relative to the output. 50 Ω shunts are used at the input for current-to-voltage conversion if required.

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.



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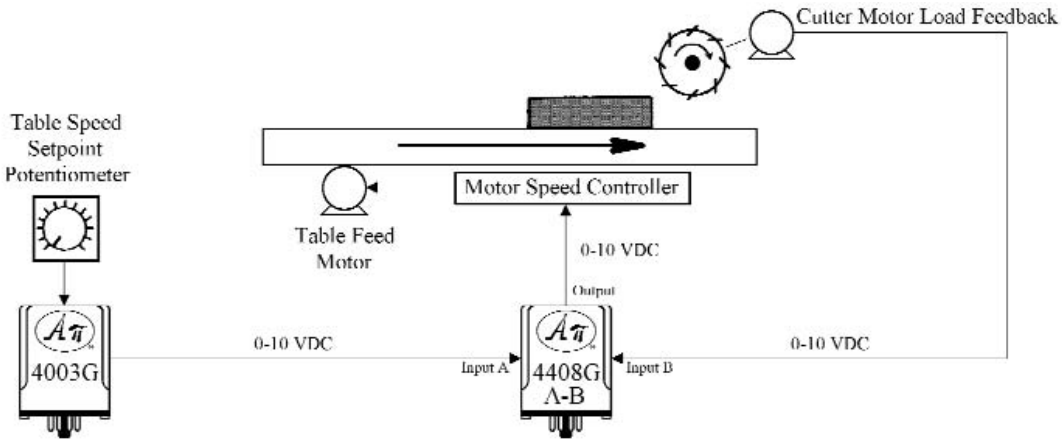
Automation of a Milling Machine Operation

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.

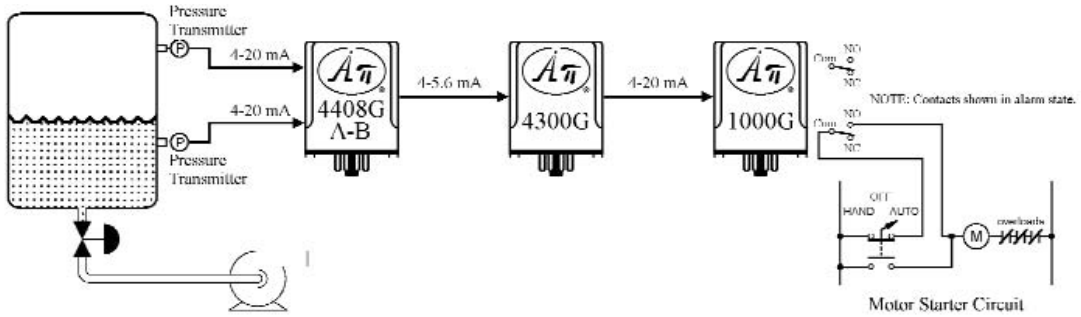
Phase Separator Water Level Control

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.

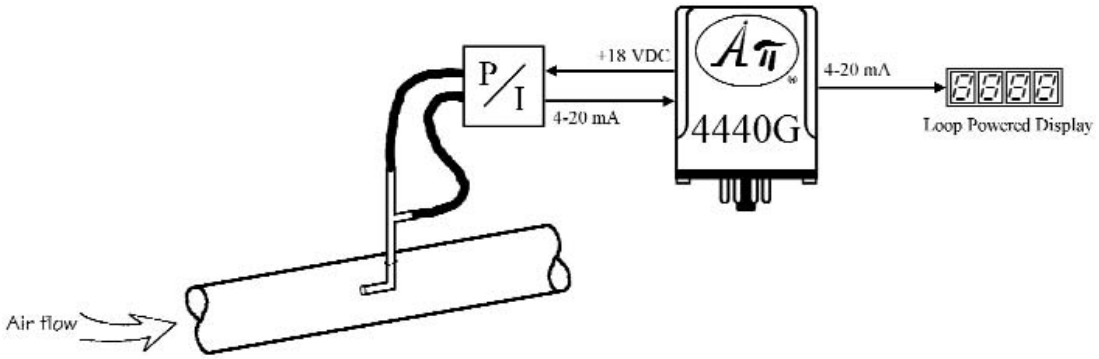
For Your Local Area Representative See *www.api-usa.com*

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

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.

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 Input Square Root Transmitter, Isolated

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***

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

LIFETIME WARRANTY

c UL us

Free Factory Input & Output Calibration!

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.
P option: 80-265 VAC or 48-300 VDC, 50/60 Hz, 2.5 W typical
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 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

P	Powered by 80-265 VAC or 48-300 VDC, 50/60 Hz
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 008	8-pin socket
API 008 FS	8-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

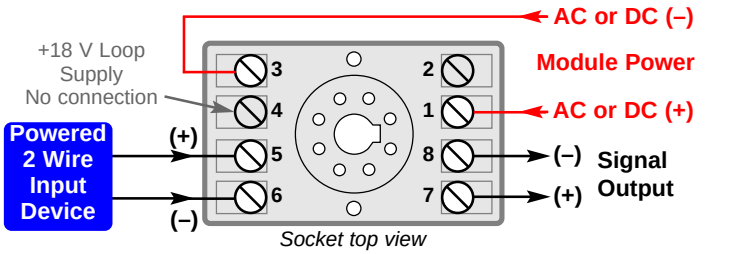
WARNING! All wiring must be performed by qualified personnel only. This module requires an industry-standard 8-pin socket. Order API 008 or finger-safe API 008 FS socket.

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.

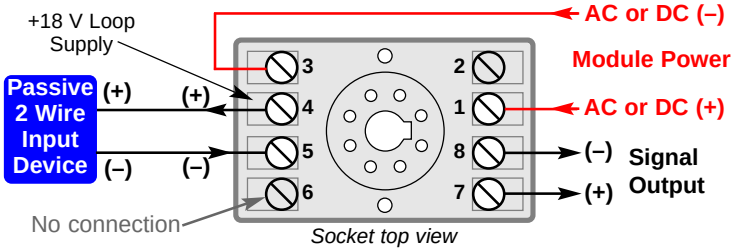
Powered Signal Input – Polarity must be observed when connecting the signal input. The positive connection (+) is applied to terminal 5 and the negative (–) is applied to terminal 6.

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

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

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

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.

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