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!

c UL us

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

Valve, Math, P-I

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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

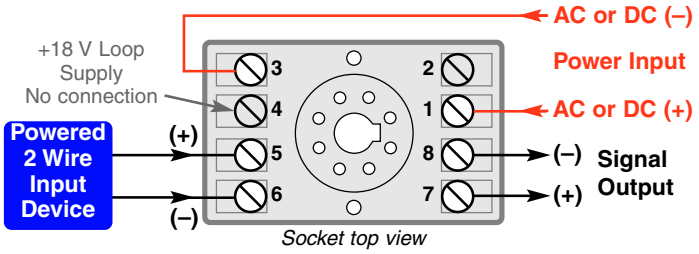
WARNING! All wiring must be performed by qualified personnel only. This module requires an industry-standard 8-pin socket. Order API 008 or finger-safe API 008 FS socket.

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.

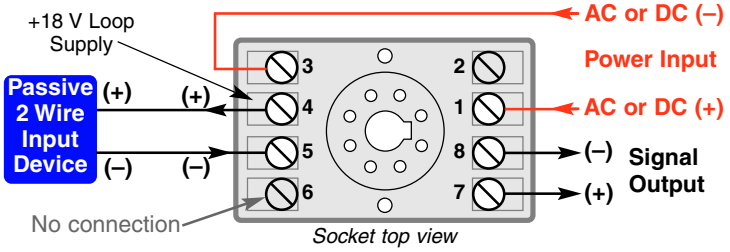
Powered Signal Input – Polarity must be observed when connecting the signal input. The positive connection (+) is applied to terminal 5 and the negative (–) is applied to terminal 6.

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

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

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.

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

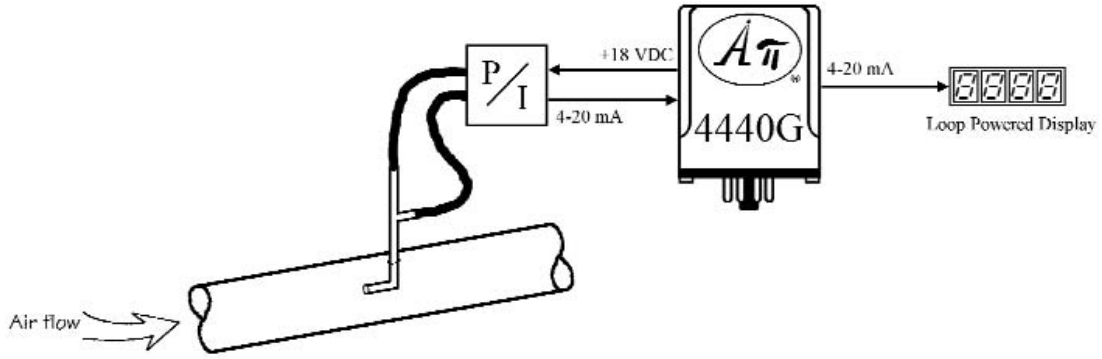
Air Flow Measurement

PROBLEM

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

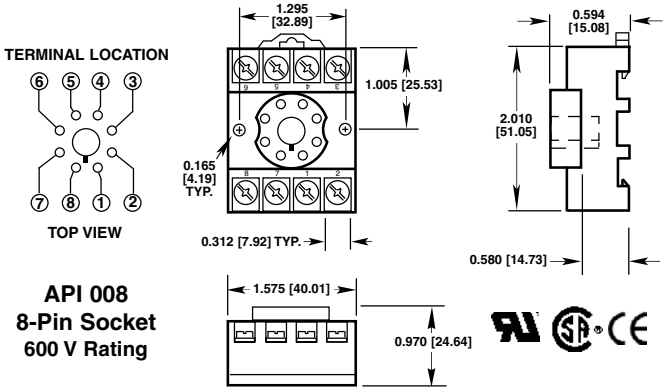
SOLUTION

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.

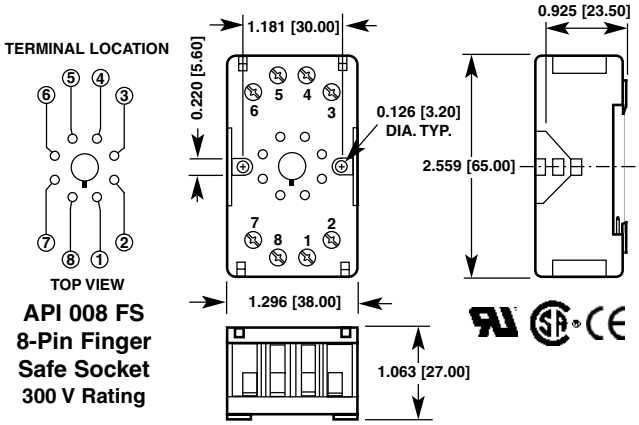


Since Flow = Velocity x Area, the cross sectional area of the pipe will determine the range of the scaling on the loop powered display. This allows the velocity value to be displayed as a flow rate. The optical isolation of the module protects against unwanted ground loops and electrical noise.

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



FREE APPLICATION ASSISTANCE
Call Customer Service
800-794-5883

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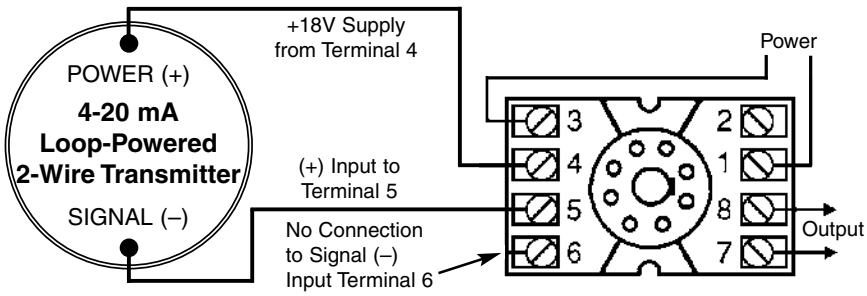
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Using the Built-In 4-20 mA Loop Power Supply

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.

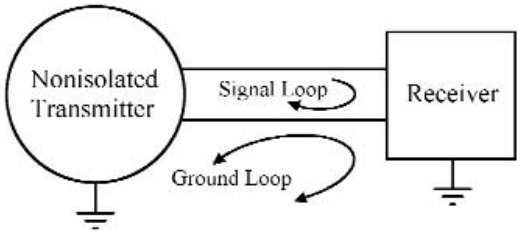


Figure 1. *Ground loops may develop with non-isolated transmitters and receivers, resulting in inaccuracy and unreliability.*

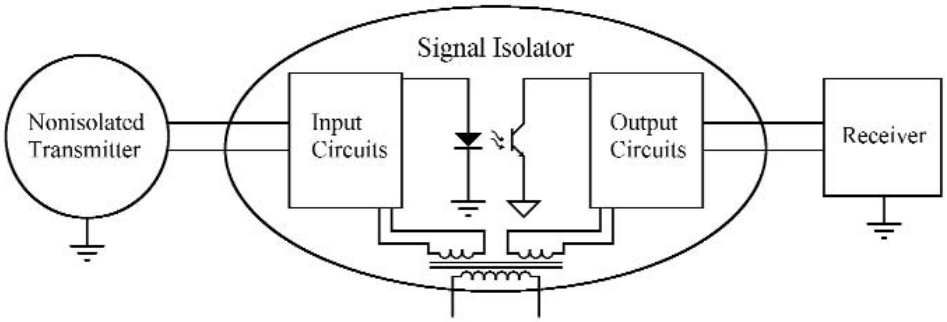


Figure 2. *A signal isolator in the process loop blocks ground current to restore signal accuracy and reliability.*

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