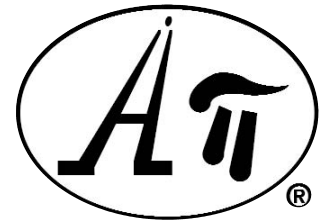


*Absolute Process Instruments, Inc.*



Dear Valued Customer,

Over the years we have collected information that has helped us apply our signal conditioning products to solve real world signal interface and equipment operation challenges. We have attempted to organize this information into useful technical and application sheets that can help our customers during the project design phase or when they are “under the gun” during an installation and start-up.

Our Technical Application booklet consists of several sections.

Feature and Ordering Guide

General and Technical Information

Technical Applications

Temperature

Pressure

Flow

Speed

Weighing

Process

Frequently Asked Questions

Our service begins well before we ever sell a module. Unique features exist on many modules and allow the user to solve more problems than are outlined in this booklet. This is why you will see a “Call for Application Assistance” request in the corner of each technical sheet. When you call you get a qualified technician who can help you utilize the modules’ unique features to solve an application problem.

Absolute Process Instrument’s products are of a rugged American design, backed by solid technical support and a LIFETIME WARRANTY. Please don’t hesitate to call if we can be of service.

Sincerely,

API Sales and Application Engineering

Absolute Process Instruments, Inc.

1220 American Way

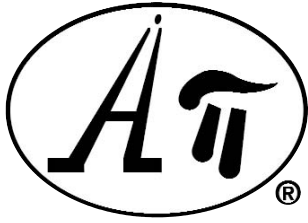
Libertyville, IL 60048

USA

Phone: 800-942-0315

Fax: 800-949-7502

[www.api-usa.com](http://www.api-usa.com)

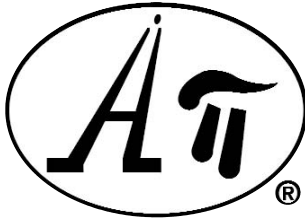


**Features**

- Model Type (See Key)
- Input Loop Tracker® LED
- Output Loop Tracker® LED
- Uni-Alarm BiColor LED
- Isolated BiColor LED
- Non-Isolated Green/Red LED
- 240 VAC 7 Amp Output
- 120/240 VAC 7 Amp Output
- Universal VAC Operation Power
- Universal 85-265 VAC Operating Power
- Universal 9-30 VDC Operating Power
- Loop Powered
- Integral On-Board Loop Input Power
- Functional Test Pushbutton
- Adjustable Test Pushbutton
- Integral Deadband Potentiometer
- Common Mode Rejection for Hi-Noise Immunity
- UL, CUL, CSA Approvals
- No Charge Factory Calibration
- Multi-Turn Zero & Span Potentiometer
- Lifetime Warranty

Input Type	Model	Model Type (See Key)	Input Loop Tracker® LED	Output Loop Tracker® LED	Uni-Alarm BiColor LED	Isolated BiColor LED	Non-Isolated Green/Red LED	240 VAC 7 Amp Output	120/240 VAC 7 Amp Output	Universal VAC Operation Power	Universal 85-265 VAC Operating Power	Universal 9-30 VDC Operating Power	Loop Powered	Integral On-Board Loop Input Power	Functional Test Pushbutton	Adjustable Test Pushbutton	Integral Deadband Potentiometer	Common Mode Rejection for Hi-Noise Immunity	UL, CUL, CSA Approvals	No Charge Factory Calibration	Multi-Turn Zero & Span Potentiometer	Lifetime Warranty
DC	Api 1000 G	A	■	■			■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1005 G	A	■	■			■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1020 G	A	■	■			■	■	*	*				■	*	■	■	■	■	■	■	■
DC	Api 1025 G	A	■	■			■	■	*	*			■	■	*	■	■	■	■	■	■	■
DC	Api 1040 G	A	■	■		■	■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1040 G SPR	A	■	■		■	■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1080 G	A	■	■			■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1080 DIN	A	■	■			■	■	■				■	■	■	■	■	▲	■	■	■	■
DC	Api 1090 G	A	■	■			■	■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 1090 DIN	A	■	■			■	■	■				■	■	■	■	■	▲	■	■	■	■
DC	Api 1090 DD	A	■	■			■	■	■	*			■	■	■	■	■	▲	■	■	■	■
DC	Api 4010 G	T	■	■		■		■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 4050 G	T	■	■		■		■	*	*			■	■	■	■	■	■	■	■	■	■
DC	Api 4300 G	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4300 G HC	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4300 G M01	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4300 G M09	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4300 G EXTSUP	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4310 G	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4380 G	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4380 G DF	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4380 G HV3	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 4380 DIN	T	■	■	■			■					■	■	■	■	■	▲	■	■	■	■
DC	Api 4380 DD	T	■	■	■			■	*				■	■	■	■	■	▲	■	■	■	■
DC	Api 4385 G	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 7500 G	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 7500 G M02	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api 7500 G SS	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
DC	Api DIN-HV-DC	T	■	■	■		■						■	■	■	■	■	■	■	■	■	■
DC	Api LPI-1	T		■	■							■	■	■	■	■	■	▲	■	■	■	■
DC	Api LPI-2	T		■	■							■	■	■	■	■	■	■	■	■	■	■
DC	Api DPI-2	T		■	■							■	■	■	■	■	■	■	■	■	■	■
T/C	Api 1200 G	A	■	■			■	■	*	*			■	■	■	■	■	■	■	■	■	■
T/C	Api 1220 G	A	■	■			■	■	*	*			■	*	■	■	■	■	■	■	■	■
T/C	Api 4000 G	T	■	■	■		■						■	■	■	■	■	■	■	■	■	■
T/C	Api 4100 G	T	■	■		■		■	*	*			■	■	■	■	■	■	■	■	■	■
T/C	Api 4130 G L	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
RTD	Api 1400 G	A	■	■			■	*	*				■	■	■	■	■	■	■	■	■	■
RTD	Api 1420 G	A	■	■			■	*	*				■	*	■	■	■	■	■	■	■	■
RTD	Api 4000 G	T	■	■	■		■						■	■	■	■	■	■	■	■	■	■
RTD	Api 4001 G	T	■	■		■		■	*	*			■	■	■	■	■	■	■	■	■	■
RTD	Api 4001 G L	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■
RTD	Api 4001 G SA-B	T	■	■	■		■	*	*				■	■	■	■	■	■	■	■	■	■

Key: A = Alarm      T = Transmitter      D = Driver      P = Power Supply  
 ■ = Standard      \* = Optional      ▲ = Approvals Pending



Input Type Model

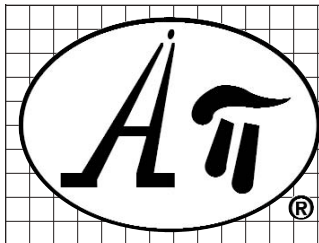
**Features**

Model Type (See Key)  
 Input Loop Tracker® LED  
 Output Loop Tracker LED  
 Uni-Alarm BiColor LED  
 Isolated Linearized Output  
 Non-Isolated Green/Red LED  
 240 VAC 7 Amp Output  
 120/240 VAC Resistive Contact Rating  
 Universal 85-265 VAC Operating Power  
 Universal 9-30 VDC Operating Power  
 Universal 10-30 VDC Operating Power  
 Loop Powered  
 Integral On-Board Loop Input Power  
 Functional Test Pushbutton  
 Adjustable Deadband Potentiometer  
 Integral Filtering for HI-Noise Immunity  
 Common Mode Rejection 100 dB Min.  
 UL, CUL, CSA Approvals  
 No Charge Factory Calibration  
 Multi-Turn Zero & Span Potentiometer  
 Lifetime Warranty

FREQ	Api 1700 G	A	■	■	■	■	■	*	*	*	■	■	■	■	■	■	■	■	■
FREQ	Api 1720 G	A	■	■	■	■	■	*	*	*	■	*	■	■	■	■	■	■	■
FREQ	Api 7010 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
FREQ	Api 7500 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
FREQ	Api 7500 G M02	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
FREQ	Api 7500 G SS	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
FREQ	Api 7580 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
AC	Api 1600 G	A	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
AC	Api 1620 G	A	■	■	■	■	■	*	*	■	*	■	■	■	■	■	■	■	■
AC	Api 6010 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
AC	Api 6010 G 5A	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
AC	Api 6380 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
AC	Api 6380 G S	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
POT	Api 1800 G	A	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
POT	Api 1820 G	A	■	■	■	■	■	*	*	■	*	■	■	■	■	■	■	■	■
POT	Api 4003 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
POT	Api 4003 G I	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
POT	Api 4008 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
STR. G.	Api 1500 G	A	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
STR. G.	Api 1520 G	A	■	■	■	■	■	*	*	■	*	■	■	■	■	■	■	■	■
STR. G.	Api 4051 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
STR. G.	Api 4058 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
STR. G.	Api 4059 G	T	■	■	■	■	■	*	*	■	■	■	■	■	▲	■	■	■	■
STR. G.	Api 4059 G D	T	■	■	■	■	■	*	*	■	■	■	■	■	▲	■	■	■	■
STR. G.	Api SUM 000											■	■						■
STR. G.	Api SUM 025											■	■						■
STR. G.	Api SUM 125											■	■						■
POWER	Api 9046-xx	P	■	■		■						■					■		■
POWER	Api 9046-CH	P	■	■		■						■					■		■
DRIVER	Api 3200 G	D	■	■		■	■	*	*	■	■	■	■	■	■	■	■	■	■
DRIVER	Api 3200 G M01	D	■	■		■	■	*	*	■	■	■	■	■	■	■	■	■	■
DRIVER	Api 3200 GM420	D	■	■		■	■	*	*	■	■	■	■	■	■	■	■	■	■
MATH	Api 440X G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
MATH	Api 4440 G	T	■	■	■	■	■	*	*	■	■	■	■	■	■	■	■	■	■
LOOP	Api LPI-1	T	■	■	■					■	■	■	■	■	▲	■	■	■	■
LOOP	Api LPI-2	T	■	■	■					■	■	■	■	■	▲	■	■	■	■
LOOP	Api DPI-2	T	■	■	■					■	■	■	■	■	▲	■	■	■	■

Key: A = Alarm      T = Transmitter      D = Driver      P = Power Supply  
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- **General Info**
- **Temperature**
- **Pressure**
- **Flow**
- **Speed**
- **Weighing**
- **Process**



**Absolute Process Instruments, Inc.**  
Manufacturer of Quality Signal Conditioners Transmitters & Isolators

## **Application Notes**

### **Signal Conditioners**

While there are many different types of signal conditioners, their basic function is to change or alter signals so that different process devices can communicate with each other accurately. Signal conditioners are most commonly needed to link temperature, pressure, weighing, level and flow devices with indicators, recorders, and computerized process monitoring and control systems. Signal conditioners can also perform some other tasks for you as listed below.

#### **SIGNAL CONVERSION**

A signal conditioner can change an analog signal from one form to another allowing equipment with dissimilar signals to communicate. For instance, if a piece of field equipment puts out a 4-20 mA signal and the control system needs a  $\pm 10$  V input signal, the signal from the field equipment must be converted. A signal conditioner that accepts a 4-20 mA input and produces a  $\pm 10$  V output solves the problem.

#### **SIGNAL BOOSTING**

The signal conditioner increases load drive capability in the loop allowing installation of additional instruments. This works because the input impedance of most isolators is much less the load drive capability of a loop. Therefore adding an isolator to the loop boosts the loop's net load drive capability. This is especially useful when it becomes necessary to add additional devices to an existing overloaded loop.

#### **SIGNAL ALARMING**

Warns of trouble if a process signal reaches a too high or too low level. A signal conditioner that accepts an analog signal (4-20 mA, 1-5 V, etc.) and produces a relay output is an inexpensive way of providing a redundant safety device in the event of a system failure.

#### **SIGNAL ISOLATION**

Stops ground loops from affecting the accuracy of a process signal. Ground loops are a common complaint at system startup and can be eliminated by installing isolated signal conditioners, or isolators, on the process loop between a nonisolated device and a control system.

#### **SPECIFYING**

A signal conditioner requires much of the same information as specifying any other instrument. Always consider these elements:

- Power Source
- Input Signal
- Output Signal
- Desired Options



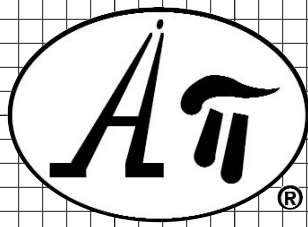
**FREE APPLICATION ASSISTANCE**

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#### **Did You Know...?**

Api will do non-standard and special ranges for all of our products.



**Absolute Process Instruments, Inc.**

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# Application Notes

- **General Info**
- **Temperature**
- **Pressure**
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- **Speed**
- **Weighing**
- **Process**

## Terms and Definitions

**Accuracy:** The closeness of an indication or reading of a measurement device to the actual value of the quantity being measured. Accuracy calculations are based on the linearity, hysteresis, and repeatability characteristics of the transducer/sensor and supporting electronics, the range of the transducer/sensor, as well as the resolution being displayed. It is usually expressed as a  $\pm\%$  of full scale output of the transducer/sensor/system.

**A/D (Analog to Digital):** Conversion of a continuously varying signal (analog) to discrete binary numbered values (digital).

**Alarm Condition:** The input (process signal) has crossed the set (trip) point and the relay has changed states into the alarm condition. The relay will remain in this state until the input signal returns to the normal condition.

**Background Noise:** The total amount of noise from all sources of interference in a process loop, independent of the presence of a data/control signal.

**Chatter:** Describes a condition where the input signal hovers near the set (trip) point, causing the relay to trip off, then back on in short bursts. Generally solved by adding or expanding the deadband.

**Clipping:** A phenomena which occurs when an output signal is limited in some way (usually in amplitude) by the full range of an amplifier/unit.

**Common-Mode Rejection (CMR):** The ability of a device to eliminate the effect of AC or DC noise between the input signal and ground. Normally expressed in dB at DC to 60 Hz.

**D/A (Digital to Analog):** Conversion of a discrete binary numbered values (digital) to a continuously varying signal (analog).

**Deadband:** The range through which an input can be varied without initiating an observable response. Deadband is usually expressed in percent of span.

**Dual Alarm Trip:** A unit that accepts one input signal, has two set (trip) points, and one output relay per set point. Each set point is independent of the other and can be set between 0-100% of the input range.

**Electrical Interference:** Electrical noise induced upon the signal wires that obscures (interferes with) the wanted information signal.

**Fail-Safe:** Relay coil is energized when the input signal is in the normal operating condition. In the alarm condition, the relay coil de-energizes. Considered a safety measure because, in the event of a loss of power to the unit or other failure, the unit "fails" to an alarm condition.

**Gain:** The amount of amplification used in an electrical circuit.

**High Alarm:** The relay changes state when the input signal reaches or exceeds the set (trip) point.

**Hysteresis:** The difference in output from a transducer/sensor when a measured value is first approached with increasing and then decreasing values.

**Input Impedance:** The total opposition, both resistive and reactive, that the unit presents to the input signal loop.

**Linearity:** The closeness of a calibration curve to a specified straight line. Linearity is expressed as the maximum absolute deviation of any calibration point on a specified straight line during any one calibration cycle.

**Loop Resistance:** The total resistance in a circuit to current flow caused by the resistance of all components.

**Loop Impedance:** The total opposition (resistive plus reactive) to current flow in a circuit.

**Low Alarm:** The relay changes state when the input signal falls to or below the set (trip) point

**MOV (Metal Oxide Varistor):** A voltage dependent resistor whose resistance predictably changes with voltage, often used as transient protectors.

**Negative Temperature Coefficient:** A decrease in resistance with an increase in temperature.

**Noise:** An unwanted electrical signal on any signal wires.

**Non-Fail-safe (Reverse Acting):** Relay coil is de-energized when the input signal is in the normal condition. In the alarm condition, the relay coil energizes. There is no alarm when there is a loss of power.

**Normal (Non-Alarm) Condition:** The process signal has not crossed the set (trip) point.

**Normally Closed:** Describes a set of relay contacts that in the unpowered state have continuity across them.

**Normally Open:** Describes a set of relay contacts which in the unpowered state have no continuity across them.

**Optical Isolation:** Two circuits which are connected only through an LED transmitter and photoelectric receiver with no electrical continuity between them.

**Positive Temperature Coefficient:** An increase in resistance with an increase in temperature.

**Relay (Mechanical):** An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts.

**Relay (Solid State):** A solid state switching device which completes or interrupts a circuit electrically with no moving parts. Commonly called an SSR.

**Repeatability:** The ability of a transducer/sensor to reproduce output readings when the same measured value is applied to it consecutively.

**Reset:** The action of returning to the normal (non-alarm) condition.

**Resistance:** Opposition to current flow offered by a purely resistive component, measured in ohms.

**Response Time:** The time required by a sensor to reach 63.2% of its final value in response to a step-change input. This is typically called "one time constant". Five time constants are required for the sensor to stabilize at 100% of the step change value.

**Root Mean Square (RMS):** Square root of the mean of the square of the signal taken during one full cycle.

**Sensitivity:** The minimum change in input signal to which an instrument/sensor can respond.

**Set Point:** The point at which an alarm/controller is set to control a system.

**Single Alarm Trip:** A unit that accepts one input signal, has one set (trip) point, and one output relay. The set point can be set between 0-100% of the input range.

**Span:** The difference between the upper and lower limits of a range expressed in the same units as the range.

**Span Adjustment:** The ability to adjust the gain of a sensor/unit so that the output signal corresponds to the maximum input signal. The adjustment range is normally expressed in counts or percentage.

**Transducer:** A device that converts energy from one form to another. This term is generally applied to devices that take physical phenomenon (pressure, temperature, humidity, flow, etc.) and convert it to an electrical signal.

**Triac:** A solid state switching device used to control alternating current.

**Trip Point:** Value at which the alarm relays change to the alarm condition.

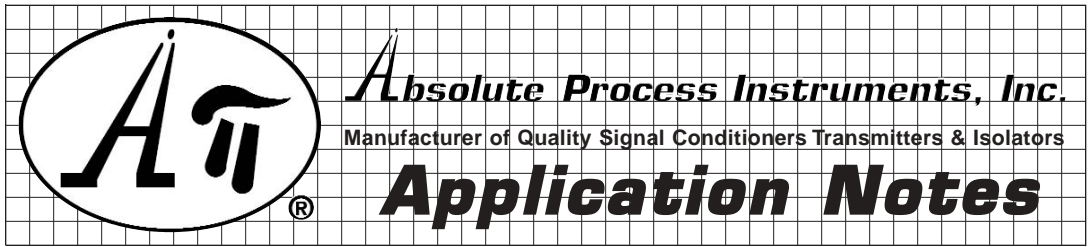
**True RMS:** The true root-mean-square value of an AC or AC-plus-DC signal, for a perfect sine wave the RMS value is 1.11072 times the rectified average value. This value is often used to determine the power of a signal. For significantly non-sinusoidal signals a true RMS converter is required.

**Volt:** The unit of potential difference and electromotive force. One volt will send a current of one ampere through a resistance of one ohm.

**Voltage:** The electrical potential difference that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points.

**Zero Adjustment:** The ability to adjust the output from a sensor/unit so that the minimum output corresponds to the minimum input. The adjustment range is normally expressed in counts or percentage.

- General Info
- Temperature
- Pressure
- Flow
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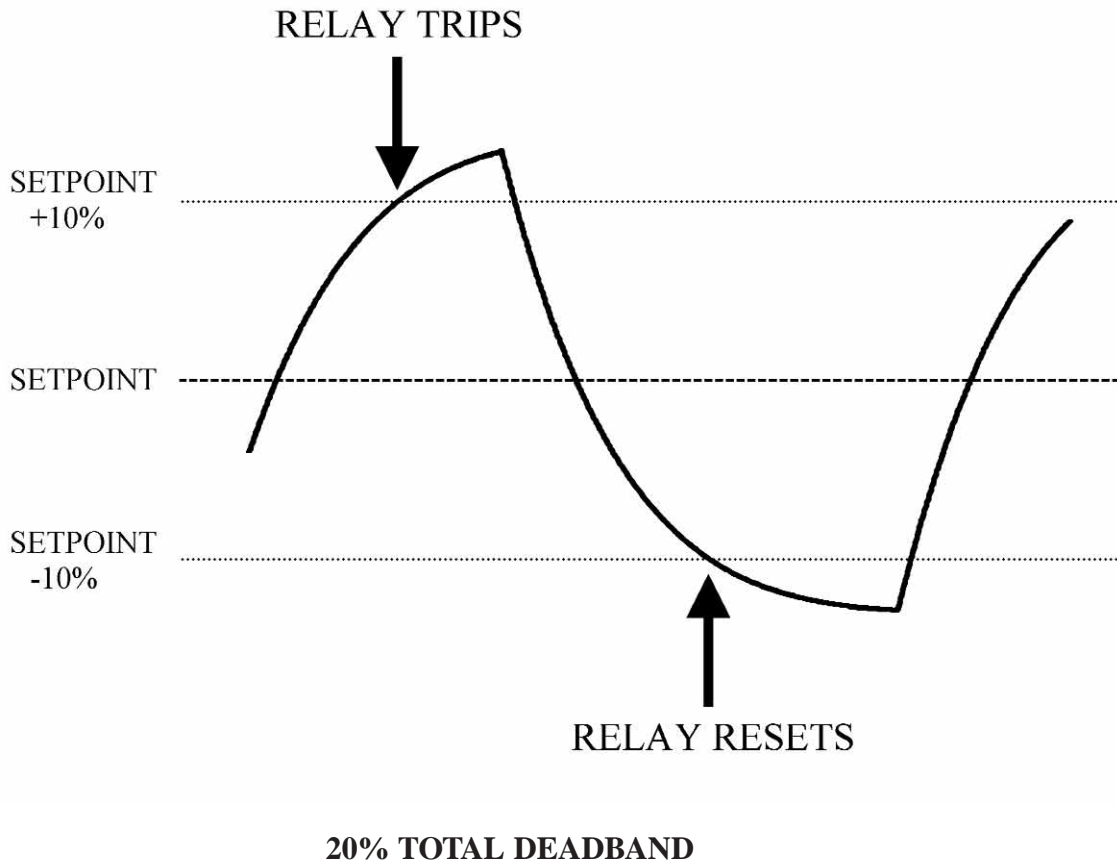
## What is Deadband?

### DEFINITION

Deadband is the range through which an input can be varied without initiating an observable response. Deadband is usually expressed in percent of span.

### EXAMPLE

A 20% total deadband is applied to the setpoint of a monitored parameter. The relay will trip and reset to its untripped state as indicated in the following graph.

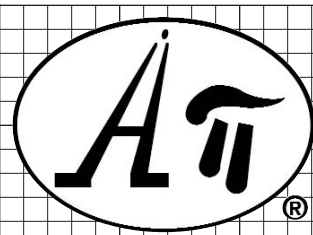


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 Call Customer Service  
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### Did You Know...?

That the functional test pushbutton on all Api Alarm Trip modules will toggle the relays independent of the input signal.





**Absolute Process Instruments, Inc.**

Manufacturer of Quality Signal Conditioners Transmitters & Isolators

## **Application Notes**

- **General Info**
- Temperature**
- Pressure**
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- Speed**
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- Process**

### **RFI and EMI**

Electrical interference, or noise, is an unwanted electrical signal that can cause intolerable error in, or complete disablement of an electronic control or measurement systems. Interference or electrical noise is broken down into two somewhat overlapping categories: Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI). Some of the more commonly encountered sources of interference are:

- Mobile and stationary radio, television and hand-held transmitters (walkie-talkies)
- Cellular telephones
- Fluorescent lights
- Radar
- Weather related electrical discharges such as lightning
- Static discharges
- Induction heating systems
- High speed power switching elements such as SCRs and thyristors
- High AC current conductors
- Large solenoids or relays
- Transformers
- AC or DC motors
- Ultrasonic cleaning or welding equipment
- Welding equipment
- Engine ignition systems

The effects of Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) can cause unpredictable and non-repeatable degradation of instrument performance and accuracy, and even complete instrument failure. This can result in reduced process efficiency and production, plant shutdowns, and sometimes dangerous safety hazards.

There are two basic approaches to protecting an electronic system from the harmful effects of radio frequency and electromagnetic interference. The first is to keep the interference from entering the system or instrument using special shielding, designs and terminal filters. The second is to design the system or instruments circuitry so that it is inherently immune to RFI/EMI.

#### **Did You Know...?**

That Api plug-in and DIN style signal conditioners and isolators use state-of-the-art optical isolation.

**FREE APPLICATION ASSISTANCE**

Call  **Customer Service**

**800-942-0315**



- General Info
- Temperature
- Pressure
- Flow
- Speed
- Weighing
- Process

## **Relay Protection and EMI Suppression**

When using Api alarm module relays to switch inductive loads, maximum relay life and transient EMI suppression is achieved by using external protection. All external protection devices should be placed directly across the load and all leads lengths should be kept to a minimum length.

For AC inductive loads (see Figure 1), place a properly rated MOV across the load in parallel with a series RC snubber. A good RC snubber consists of a 0.1  $\mu\text{F}$  polypropylene capacitor of sufficient voltage and a 47 Ohm  $\frac{1}{2}$  Watt carbon film resistor.

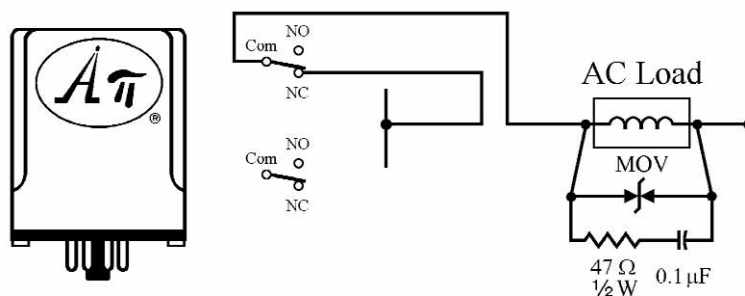


Figure 1: AC inductive loads

For DC inductive loads (see Figure 2), place a diode across the load (1N4006 recommended) being sure to observe proper polarity. Use of an RC snubber is an optional enhancement.

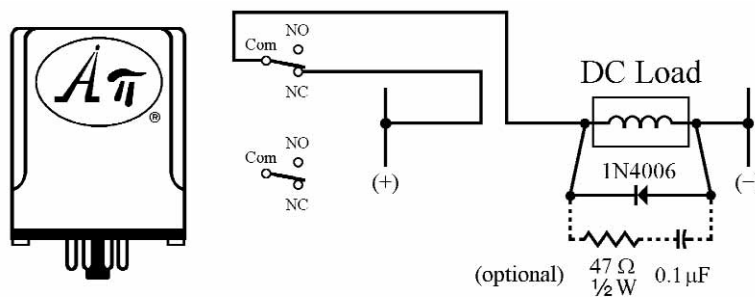


Figure 2: DC inductive loads



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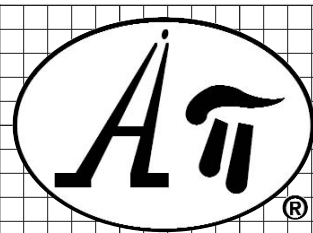
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### **Did You Know...?**

Api's standard heavy-duty relay contacts are rated 7A @ 240 VAC (resistive) and can directly control most devices.





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Manufacturer of Quality Signal Conditioners Transmitters & Isolators

# Application Notes

- **General Info**
- **Temperature**
- **Pressure**
- **Flow**
- **Speed**
- **Weighing**
- **Process**

## Ohm's Law

$$E = I \times R$$

**OHM'S LAW** is the relationship between current, voltage and resistance. It states that current varies directly with voltage and inversely with resistance.

**E (Electromotive Force or Voltage)** is the electrical potential that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points. The unit of measure for voltage is the volt (V). One volt will send one ampere of current through a resistance of one ohm.

**I (current)** is the flow of electrons past a point in a specified period of time, usually one second. The unit of measure for current is the ampere (A). One ampere of current is  $6.24 \times 10^{18}$  electrons passing a point in one second. Ampere is often shortened to amp.

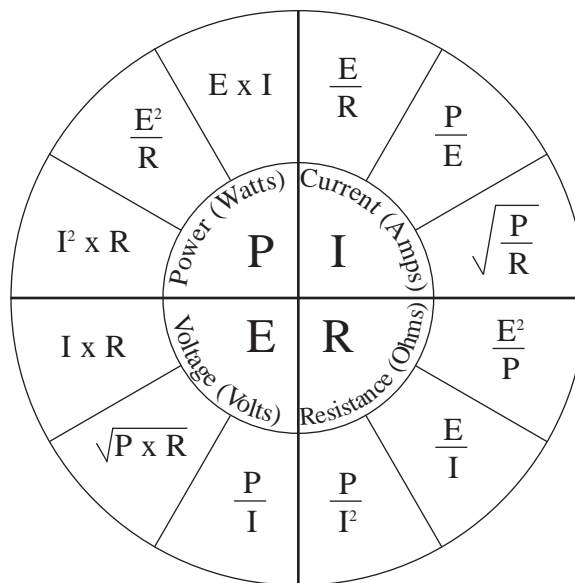
**R (resistance)** is the opposition to current flow offered by a resistive component. The unit of measure for resistance is the ohm. One ohm is the resistance through which a current of one ampere will flow when a voltage of one volt is applied.

### Typical Solid Copper Wire Resistance Ohms per 1000ft

AWG	0°C	20°C	50°C
10	0.92	0.99	1.12
12	1.46	1.59	1.78
14	2.33	2.53	2.82
16	3.70	4.02	4.49
18	5.88	6.39	7.14
20	9.36	10.15	11.35
22	14.87	16.14	18.05
24	23.65	25.67	28.70
26	37.61	40.81	45.63
28	59.80	64.90	72.55
30	95.10	103.20	115.40
32	151.20	164.10	183.40

Resistance may vary  $\pm 10\%$  or more depending on impurities, alloys, coatings, state of annealing, etc. Always check wire manufacturer's specifications.

### Ohm's and Watt's Laws



### Did You Know...?

That Api has UL, C<sub>UL</sub> and CSA approval as well as a LIFETIME WARRANTY on our plug-in and DIN style signal conditioners.

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**800-942-0315**

- **General Info**
- **Temperature**
- **Pressure**
- **Flow**
- **Speed**
- **Weighing**
- **Process**

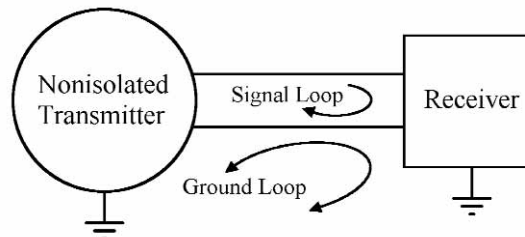
## What is a Ground Loop

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.

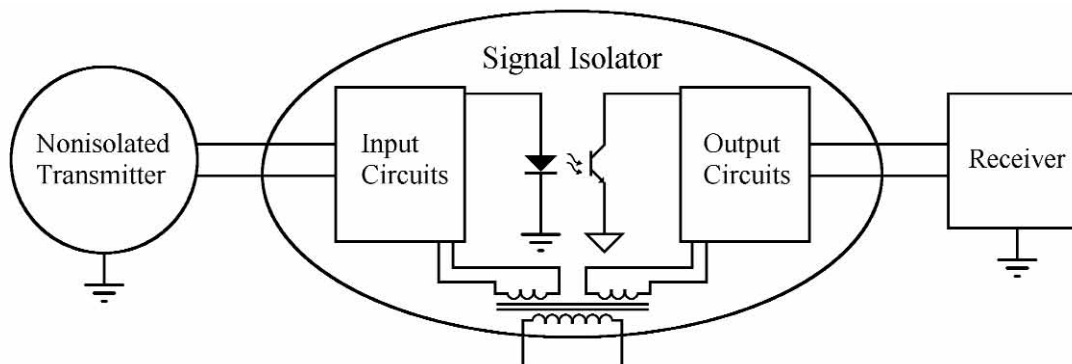
The probability of multiple grounds and ground loops being established is especially high when new programmable logic controllers (PLCs) or distributed control systems (DCSs) are installed. With so many conditions within a facility referenced to ground, the likelihood of establishing more than one ground 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. Also, 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 nonisolated 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.

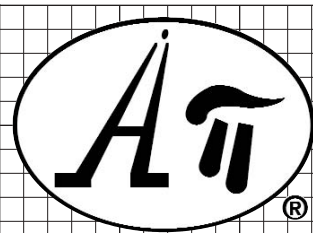


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### Did You Know...?

A common design error is to "save money" by selecting non-isolated transmitters. It costs far more to correct the problem later.

**When in doubt – isolate!**



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# Application Notes

- General Info
- Temperature
- Pressure
- Flow
- Speed
- Weighing
- Process

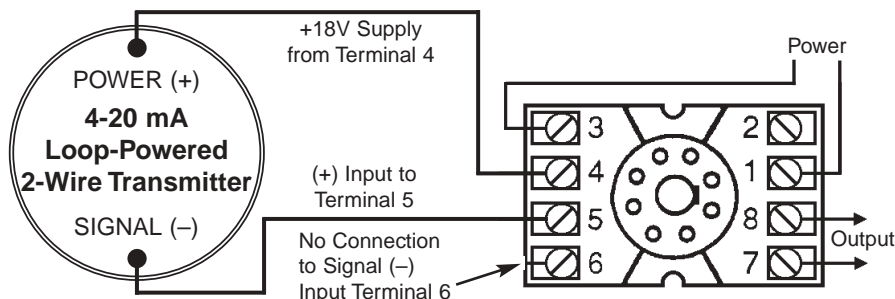
## Using the Built-In 4-20 mA Loop Power Supply

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.

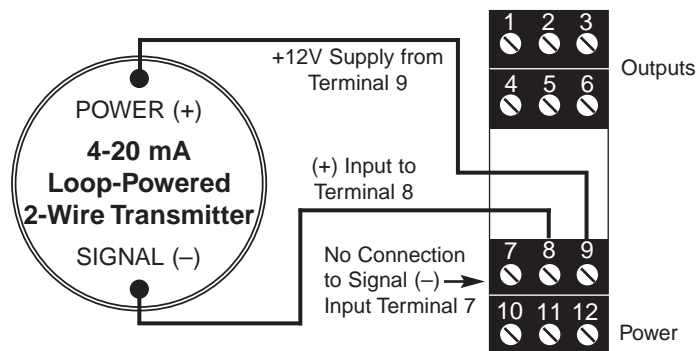
### 8-Pin Modules

- API 4010 G
- API 4050 G
- API 4300 G
- API 4310 G
- API 4380 G
- API 4380 GHV
- API 4385 G
- API 4440 G



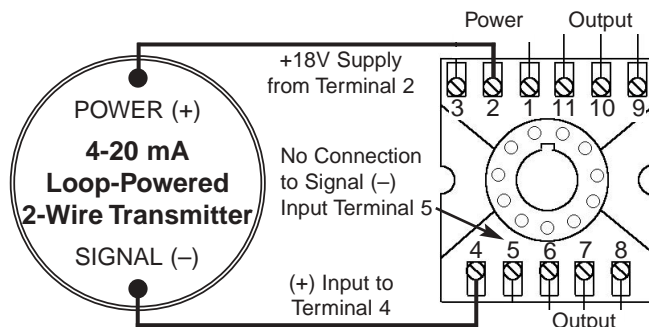
### DIN Pack Modules

- API 1080 DIN
- API 1090 DIN
- API 1090 DD
- API 4380 DIN
- API 4380 DD



### 11-Pin Modules

- API 1005 G
- API 1025 G
- API 1040 G
- API 1080 G
- API 1090 G

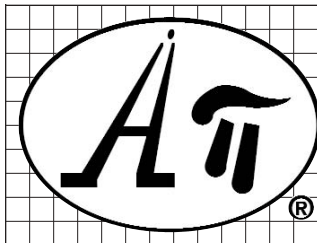


### Did You Know...?

Api plug-in style modules are hot-swappable. You can change them in the field while powered up in order to minimize downtime.

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- **General Info**
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- **Pressure**
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- **Process**



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# Application Notes

## Common Thermocouple Sensors

Type	Polarity & Material	Wire ID Properties	Wire Color	Practical Temp Range	Outer Insulation	Limits of Error
<b>J</b>	+ Iron	Very magnetic	White	32 to 1336°F	Black (Ext. grade)	±4°F or 0.8% of rdg
	- Constantan		Red	0 to 724°C	Brown (T/C grade)	±2°F or 0.4% rdg
<b>K</b>	+ Chromel		Yellow	32 to 2282°F	Yellow (Ext. grade)	±4°F or 0.8% of rdg
	- Alumel	Slightly magnetic	Red	0 to 1250°C	Brown (T/C grade)	±2°F or 0.4% rdg
<b>N</b>	+ NICROSIL	Greater stiffness	Orange	32 to 2282°F	Orange (Ext. grade)	±4°F or ±0.8% of rdg
	- NISIL		Red	0 to 1250°C	Brown (T/C grade)	±2°F or ±0.4% of rdg
<b>T</b>	+ Copper	Copper color	Blue	-299 to 700°F	Blue (Ext. grade)	±1.5°F or 0.8% of rdg, ±1% rdg <32°F
	- Constantan		Red	-184 to 371°C	Brown (T/C grade)	±0.9°F or 0.4% rdg, ±0.8% rdg <32°F
<b>E</b>	+ Chromel	Greater stiffness	Purple	32 to 1652°F	Purple (Ext. grade)	±3°F or 0.5% rdg
	- Constantan		Red	0 to 900°C	Brown (T/C grade)	±1.8°F or 0.4% rdg
<b>R</b>	+ Pt 13%Rh	Greater stiffness	Black	32 to 2700°F	Green (Ext. grade)	±5°F or ±0.5% of rdg
	- Platinum		Red	0 to 1482°C	Green (T/C grade)	±2.5°F or ±0.25% of rdg
<b>S</b>	+ Pt 10%Rh	Greater stiffness	Black	32 to 2700°F	Green (Ext. grade)	±5°F or ±0.5% of rdg
	- Platinum		Red	0 to 1482°C	Green (T/C grade)	±2.5°F or ±0.25% of rdg

Extend thermocouples up to 2000 feet or 100 Ohms maximum resistance.  
 Extension wire must be the same type as the thermocouple.

Atmosphere for exposed junction

- Type **J**            Reducing
- Type **K** or **N**      Clean oxidizing
- Type **T**            Mildly oxidizing and reducing or with moisture
- Type **E**            Vacuum, inert mildly oxidizing or reducing
- Type **R** or **S**      Resists oxidation and corrosion, but contaminated by hydrogen, carbon, and metal vapors

### TEMPERATURE CONVERSION

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$$



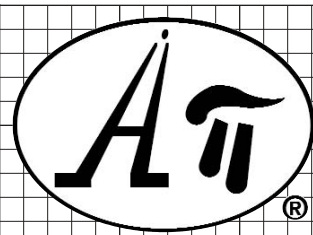
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### Did You Know...?

That the **API 4000 G** can accept either thermocouples or RTDs.



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## Application Notes

- General Info
- Temperature
- Pressure
- Flow
- Speed
- Weighing
- Process

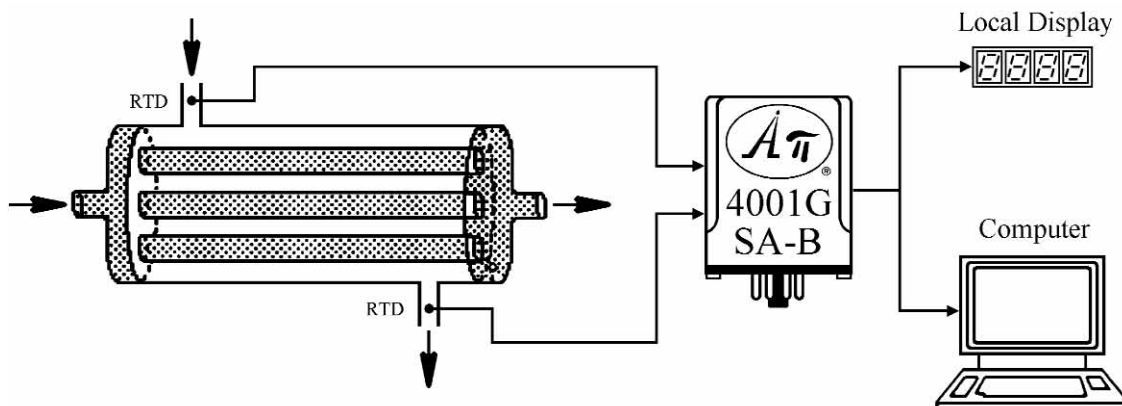
### Monitoring and Controlling Differential Temperature

#### PROBLEM

Monitor the temperature differential across a heat exchanger and provide an output signal for the process control computer and a local display.

#### SOLUTION

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



The **API 4001 G SA-B** will directly measure the temperature differential and provide an output to drive the local display and the process control computer.

#### Did You Know...?

Api will do non-standard and special ranges on all of our products.

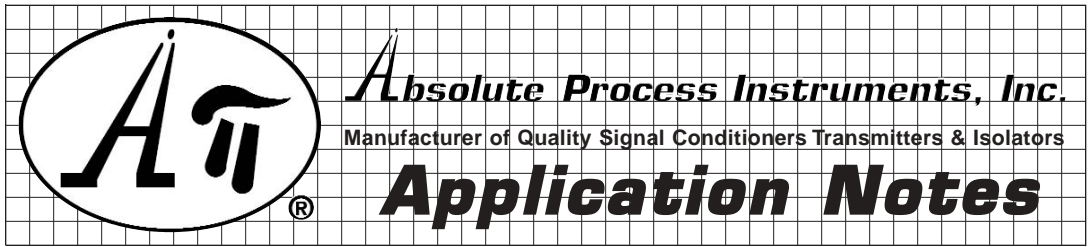
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- General Info
- Temperature
- Pressure
- Flow
- Speed
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- Process



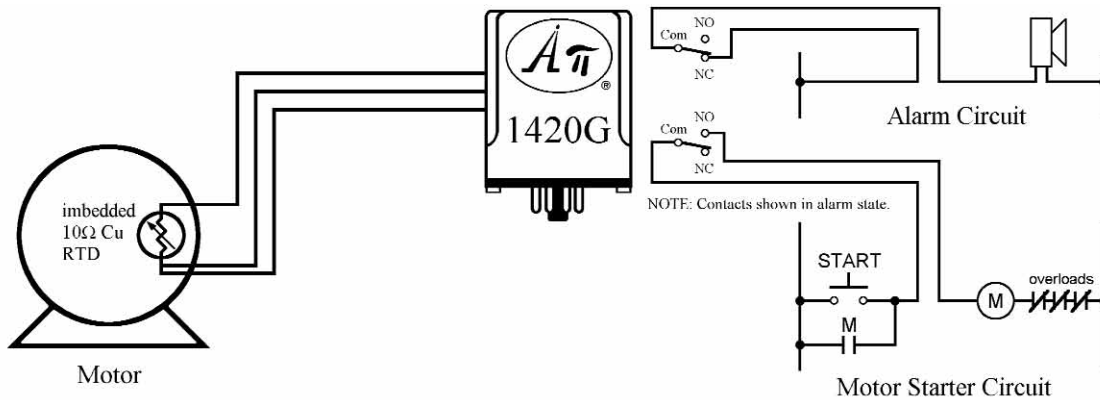
## **Motor Overheating Alarm and Shutdown**

### **PROBLEM**

A motor in a critical process is subject to overload and burnout. An alarm is to be sounded when the motor reaches its rated temperature. The motor is to be shut down if it exceeds its rated temperature by 10 degrees.

### **SOLUTION**

A 10 ohm copper RTD commonly imbedded in many motors is connected to an **API 1420 G** RTD Input Dual Alarm Trip module which provides two independent setpoints and two independent isolated Form C (NO/NC) relay contacts. One set of these contacts is wired to an alarm or annunciator panel to alert the proper personnel of the overload condition. The other set of contacts is wired in series with the coil of the motor starter and shuts down the motor when tripped.



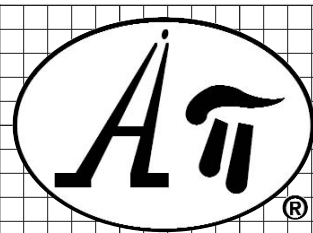
Setpoint 1 is adjusted to the rated temperature, and Setpoint 2 is adjusted to the rated temperature plus 10 degrees. The standard heavy-duty relay contacts are rated 7A @ 240 VAC and can directly control most devices.

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### **Did You Know...?**

All Api dual alarm modules can be configured for HI/HI, HI/LO or LO/LO operation.





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## Application Notes

- General Info
- Temperature
- Pressure
- Flow
- Speed
- Weighing
- Process

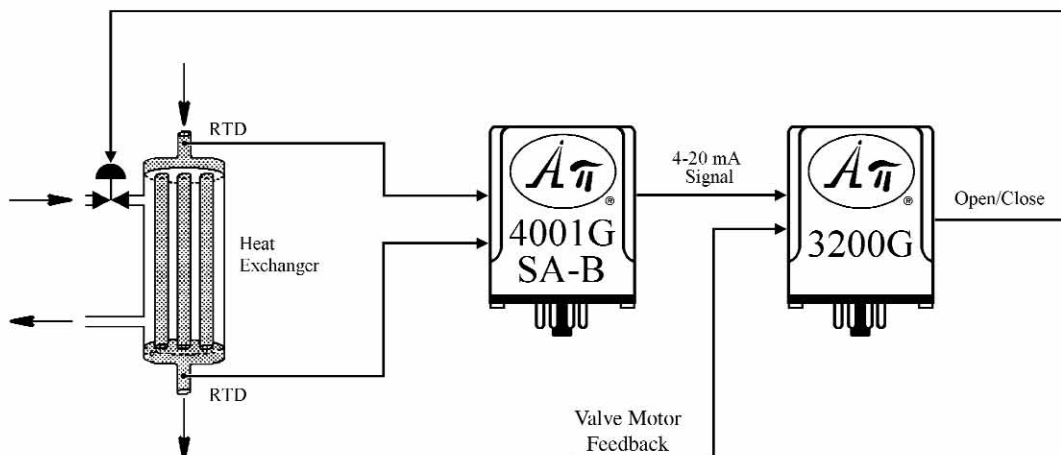
### Maintaining a Constant Differential Temperature Across a Heat Exchanger

#### 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.

#### Did You Know...?

Api never charges an expediting fee and will accept American Express, MasterCard, and Visa credit cards.

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- General Info
- Temperature
- Pressure
- Flow
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- Weighing
- Process



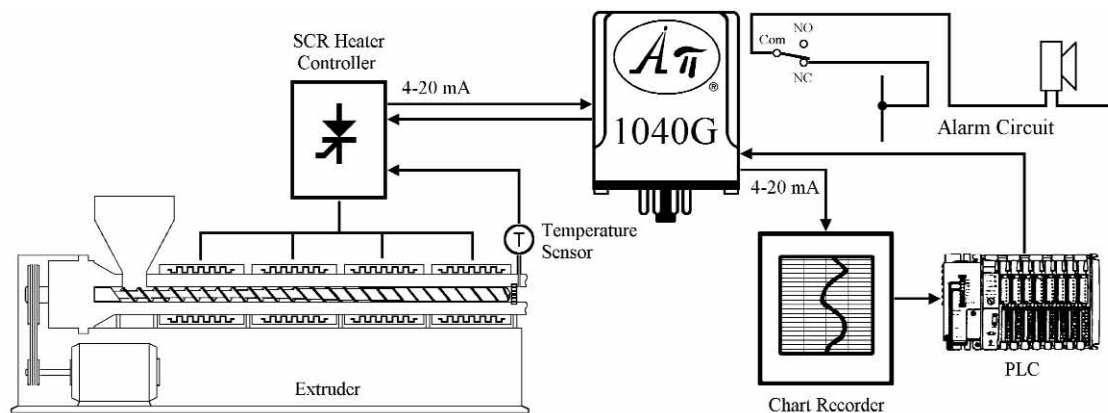
## **Over-Temperature Alarm with Retransmitted Temperature Signal**

### **PROBLEM**

An extruder temperature controller has a 4-20 mA output that is capable of driving only 250 ohms. The application requires enough drive for an over-temperature alarm trip (250 ohms), an analog temperature signal for a chart recorder (250 ohms) and a programmable logic controller (250 ohms) for a total required drive of 750 ohms.

### **SOLUTION**

Use the 4-20 mA output of the controller to drive an **API 1040 G** Non-Isolated DC to Single Alarm with DC Transmitter module.

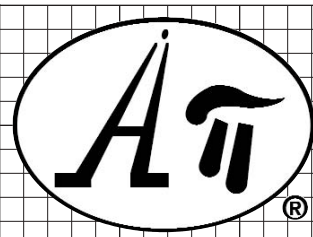


The **API 1040 G** provides a relay contact output for an over-temperature alarm in the event of SCR runaway and retransmits the temperature signal to drive the inputs of the chart recorder and the PLC. The input impedance of the **API 1040 G** is 50 ohms and its output can drive up to 1000 ohms.

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### **Did You Know...?**

The **API 1040G** is available with an additional Q-1 VDC setpoint retransmit output.



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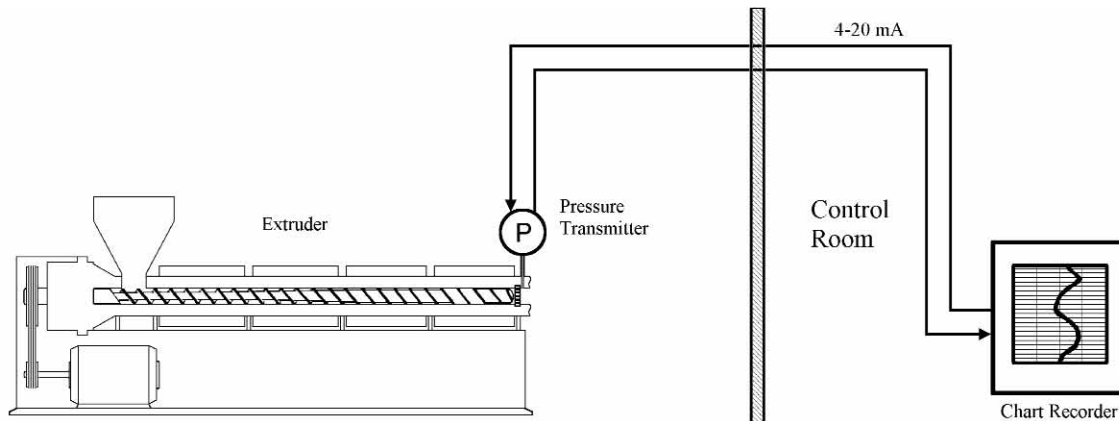
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# Application Notes

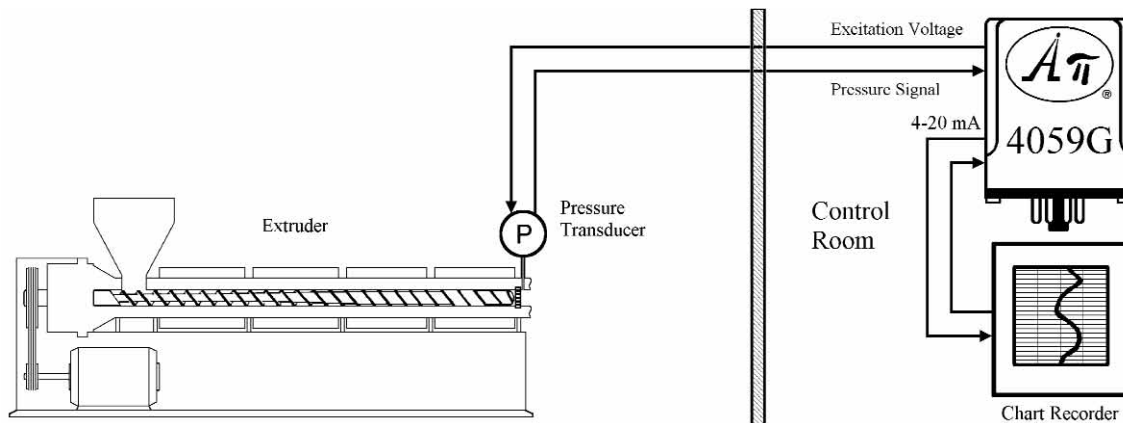
- General Info
- Temperature
- Pressure
- Flow
- Speed
- Weighing
- Process

## Why Take the Heat When You are Under Pressure?

Sometimes it is necessary to locate a pressure sensor where it is continuously exposed to temperatures near or exceeding its upper temperature limits. When a pressure transmitter is used, the high temperatures gradually degrade the electronics and considerably shorten the life of the sensor. The cost of production downtime and repair or replacement of the sensor can run into thousands of dollars.



A solution would be to use a pressure transducer in the high temperature area and an Api Strain Gauge Signal Conditioner mounted in a remote location such as the control room. The transducer will likely withstand the high temperatures for longer periods of time and is less costly to replace should it become necessary. The **API 4059 G** module provides the power to the transducer and is fully field rangeable for the excitation supply, sensitivity and DC voltage or current output. The **API 4059 G** can be calibrated and fine tuned to the new transducer in minutes reducing the downtime to a minimum.

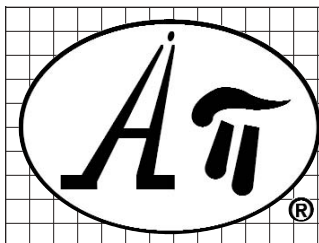


### Did You Know...?

The **API 4059 G** can drive up to four load cells for summing applications.

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- General Info
- Temperature
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# Application Notes

## Troubleshooting a Pressure Transducer, Load Cell, Strain Gauge or Bridge

Using a meter with at least 10 megaohm input impedance, measure the voltage coming from the strain gauge at the locations shown. Sensitivity is measured in mV/V.

Positive Meter Lead	Negative Meter Lead	Meter Reading No pressure/load	Meter Reading Full pressure/load
+ Exc	- Exc	Excitation Voltage	Excitation Voltage
+ Sig	- Exc	+ ½ Excitation Voltage	½ Excitation Voltage + (½ x Excitation Voltage x Sensitivity)
- Sig	- Exc	+ ½ Excitation Voltage	½ Excitation Voltage - (½ x Excitation Voltage x Sensitivity)
+ Sig	- Sig	Zero Volts	Excitation Voltage x Sensitivity

### Typical Wiring Color Code For Load Cells. Always consult manufacturer; exceptions and/or custom wire colors exist!

Manufacturer	+ Excitation	- Excitation	+ Signal	- Signal	Shield	+ Sense	- Sense
A & D	Red	White	Green	Blue	Yellow		
Allegany	Green	Black	White	Red	Blare		
Artech	Red	Black	Green	White	Blare		
Beowulf	Green	Black	White	Red	Bare		
BLH	Green	Black	White	Red	Yellow		
Cardinal	Green	Black	White	Red	Bare		
Celtron	Red	Black	Green	White	Bare		
Digi Matex	Red	White	Green	Yellow	Silver		
Dillon	Green	White	Black	Red	Orange		
Electroscale	Red	Black	Green	White	Bare		
Entran	Red	Black	Yellow or Green	White			
Evergreen	Green	Black	White	Red	Bare		
Flintec	Green	Black	White	Red	Yellow		
Force Measurement	Red	Black	Green	White	Bare		
Futek	Red	Black	Green	White			
General Sensor	Red	Black	Green	White	Bare		
GSE	Red	Black	White	Green	Bare		
HBM	Green	Black	White	Red	Yellow		
HBM (PLC/SBE)	Red	Black	Green	White	Yellow		
Interface	Red	Black	Green	White	Bare		
Kubota	Red	White	Green	Blue	Yellow		
LeBow	Red	Black	Green	White	Bare		
Mettler Toledo	White	Blue	Green	Black	Orange	Yellow	Red
National Scale	Green	Black	White	Red	Yellow		
NCI	Red	Black	White	Green	Bare	Yellow	Blue
Nikkei	Red	Black	Green	White	Bare		
Pennsylvania	Orange	Blue	Green	White	Blare		
Philips	Red	Blue	Green	Gray	Bare		
Presage Promotion	Blue	White	Red	Black	Yellow		
Revere	Green	Black	White	Red	Orange		
Rice Lake	Red	Black	Green	White	Blare		
Sensortronic	Red	Black	Green	White	Blare		
Sensortronic (column)	Green	Black	White	Red	Blare		
Sensotec	Red	Black	White	Green	Bare		
Strainsert	Red	Black	Green	White	Bare		
T-Hydraulics	Red	Black	Green	White	Bare		
Tedea Huntleigh	Green	Black	Red	White	Blare	Blue	Brown
Thames Side	Red	Blue	Green	Yellow	Bare		
Toledo	Green	Black	White	Red	Yellow		
Totalcomp	Red	Black	Green	White	Blare		
Transducers Inc.	Red	Black	Green	White	Orange		
Weigh-Tronix	Green	Black	White	Red	Orange		



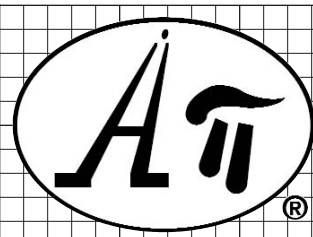
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### Did You Know...?

The **API 4059 G** Isolated Strain Gauge Input to DC Transmitter module uses state-of-the-art optical isolation and has NON-INTERACTIVE zero and span controls.



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## Application Notes

- General Info
- Temperature
- Pressure
- Flow
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- Weighing
- Process

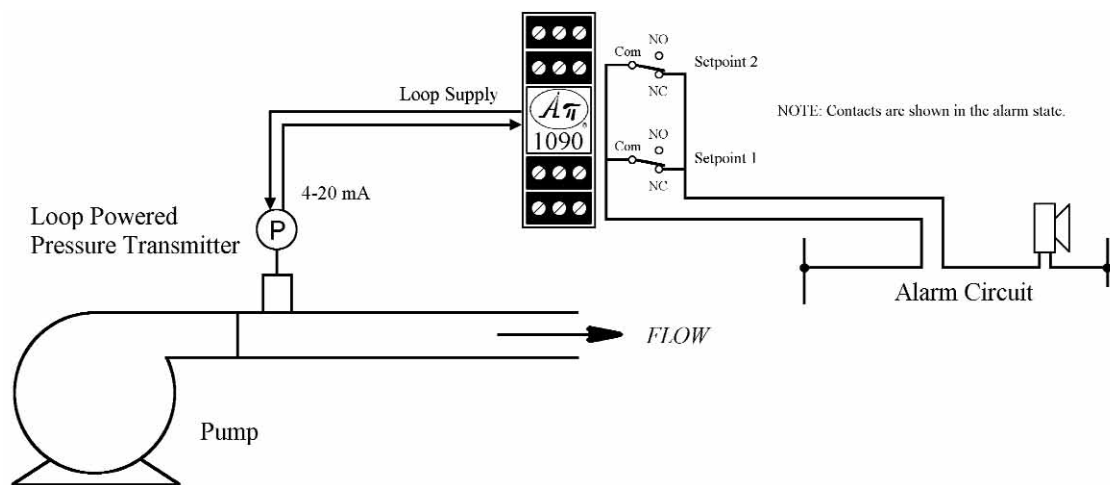
### Pumping System High/Low Pressure Alarm

#### PROBLEM

A pump is required to maintain line pressure within set tolerances. Excess pressure may indicate a blockage or restriction in the line, while low pressure may indicate pump failure or a major leak in the line. If the pressure exceeds or drops below the normal pressure range, a remote alarm must be activated.

#### SOLUTION

A loop powered pressure transducer is installed at the discharge side of the pump. The pressure transducer is connected to an **API 1090 DIN** DC Input, Field Selectable, Dual Setpoint Alarm module.



The **API 1090 DIN** provides the loop power for the 4-20 mA pressure transducer from its built-in loop excitation supply. Setpoint 1 is adjusted to the low pressure limit, and Setpoint 2 is adjusted to the high pressure limit. The relay contacts are wired in parallel such that if the pressure is not between the setpoints (which in this application is the safe operating condition), a single remote alarm is activated. The standard heavy-duty relay contacts are rated 7A @ 240 VAC and can directly control most devices.

#### Did You Know...?

Selected Api transmitters have 20V output compliance.

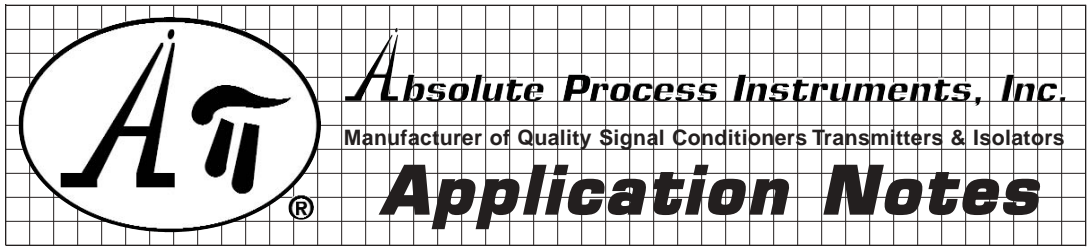
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- ❑ General Info
- ❑ Temperature
- Pressure
- ❑ Flow
- ❑ Speed
- ❑ Weighing
- ❑ Process



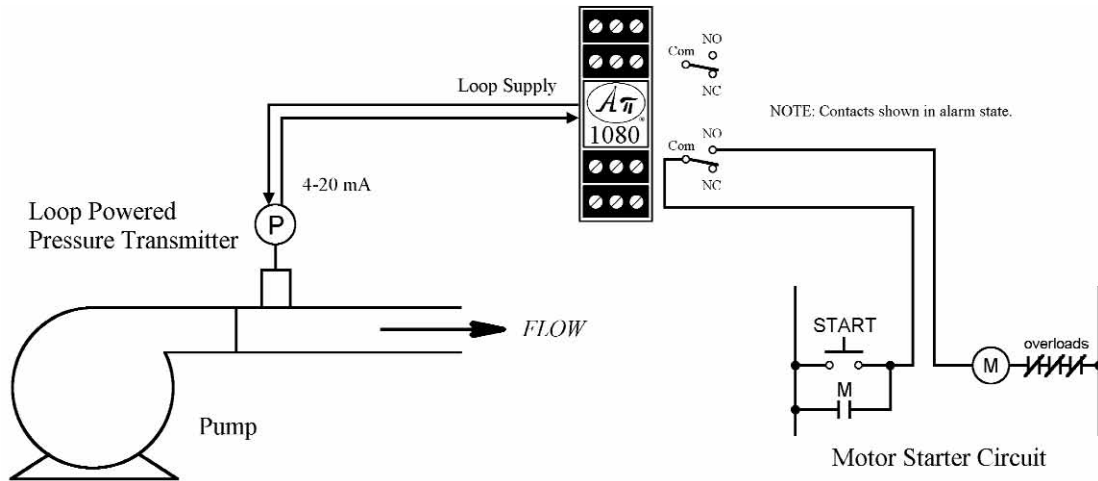
## **Pumping System High Pressure Shutdown**

### **PROBLEM**

High head pressure is causing pump failures. If the pressure exceeds a preset limit, the pump must be shut down. A manual reset is necessary to restart pump.

### **SOLUTION**

A loop powered pressure transducer is installed at the discharge side of the pump. The pressure transducer is connected to an **API 1080 DIN** DC Input, Field Selectable Single Setpoint Alarm module.



The **API 1080 DIN** provides the loop power for the 4-20 mA pressure transducer from its built-in loop excitation supply. The setpoint is adjusted to the high pressure limit. The relay contacts are wired in series with the motor starter such that if the pressure is not below the setpoint, the pump will be stopped. It is necessary to press the **START** push button to restart the pump. The standard heavy-duty relay contacts are rated 7A @ 240 VAC and can directly control most devices.

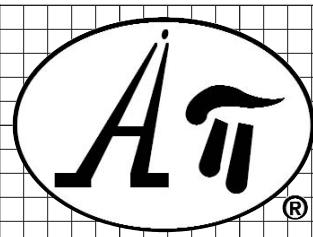


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**800-942-0315**

### **Did You Know...?**

The functional test pushbutton on all Api alarm modules will toggle the relays independent of the input signal.





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## Application Notes

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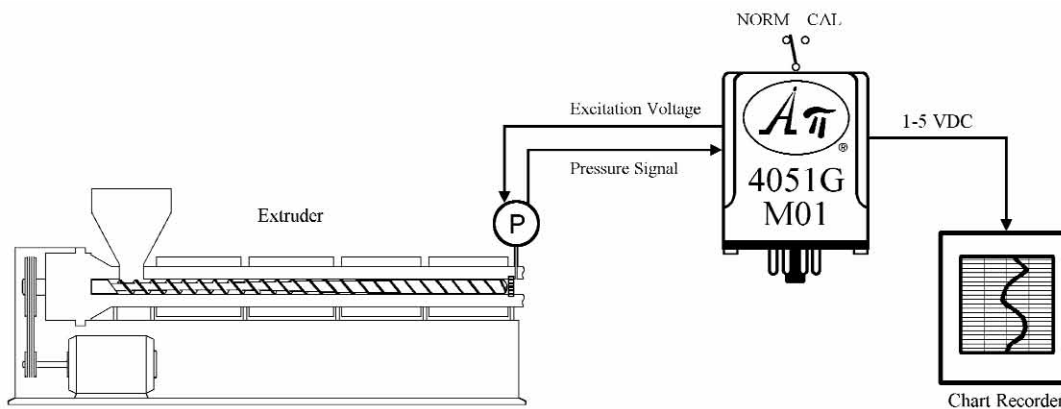
### Calibration of a Pressure System

#### PROBLEM

The pressure of an extrusion process is to be monitored and charted. To ensure ongoing accuracy, the pressure monitoring system must be capable of frequent calibration without having to use any external test equipment.

#### SOLUTION

An **API 4051 G M01** Strain Gauge (Bridge) Input to DC Transmitter module provides the excitation voltage for the pressure transducer and provides the 1-5 VDC output required by the chart recorder.



The **API 4051 G M01** has an internal calibration resistor to unbalance a 350 ohm bridge to an 80% of span value when the test switch is in the CAL position, allowing for convenient and accurate calibration.

#### Did You Know...?

That the **API 4058 G4** and the **API 4059 G** are field rangeable and can drive up to four load cells.

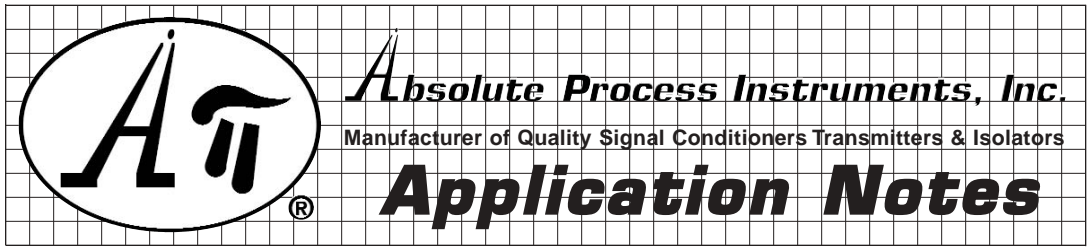
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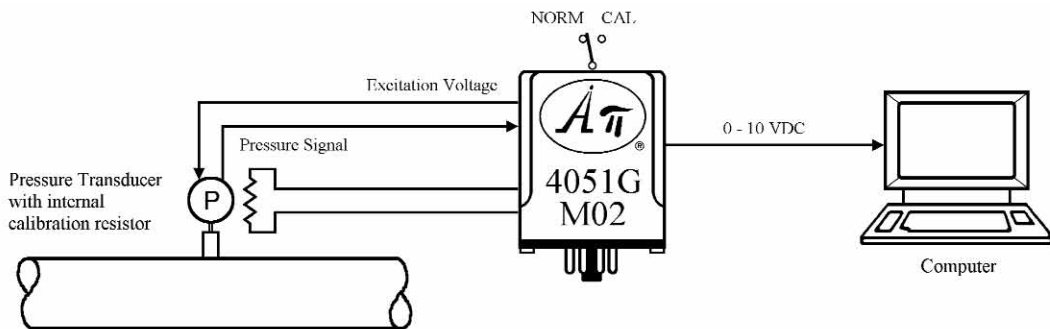
## **Calibration of a Pressure Transducer**

### **PROBLEM**

The pressure of a critical process is to be monitored by a computer. To ensure accuracy and reliability, attention has to be paid to the entire system calibration. How can the pressure system be calibrated using the internal calibration resistor of the pressure transducer?

### **SOLUTION**

The **API 4051 G M02** Strain Gauge (Bridge) Input to DC Transmitter module provides the stable excitation voltage for the pressure transducer and produces the required 0-10 VDC output for the computer.

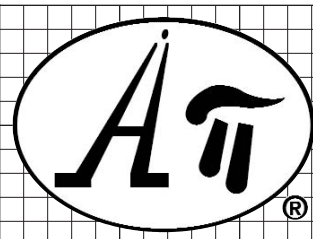


The **API 4051 G M02** utilizes the pressure transducer's internal calibration resistor to unbalance the bridge to a specified value when the test switch is in the CAL position, ensuring accurate system calibration.

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### **Did You Know...?**

All Api plug-in and DIN style modules are covered by a LIFETIME WARRANTY.



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# Application Notes

- General Info
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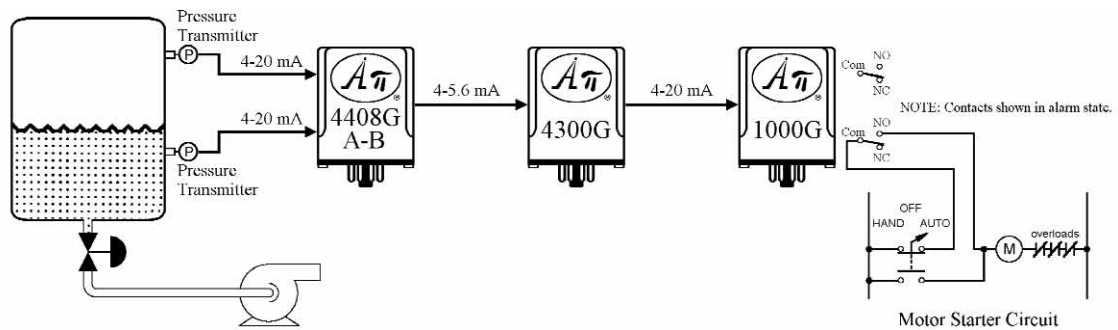
## Phase Separator Water Level Control

### 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.

### Did You Know...?

Api isolated transmitters have 2000 VRMS input, output, and power isolation.

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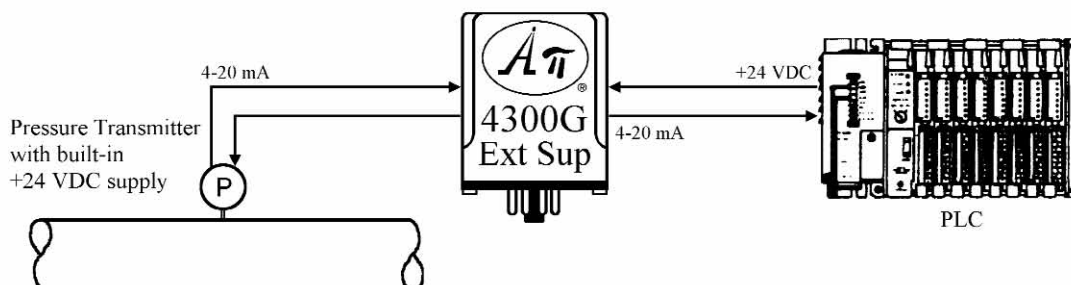
## **Monitoring Pressure with a PLC**

### **PROBLEM**

A pressure transmitter with an internally powered 4-20 mA output must be monitored by a programmable logic controller (PLC) for use in control of a process, but the 4-20 mA input of the PLC is also powered from the PLC's built-in power supply. The standard **API 4300 G** Isolated DC to DC Transmitter generates a 4-20 mA output at a 20 V compliance voltage. The output of the module would conflict with the power generated by the PLC input channel.

### **SOLUTION**

An **API 4300 G EXTSUP** Isolated DC to DC Transmitter module with External Supply modification will allow the pressure signal to be transmitted to the PLC's powered input.



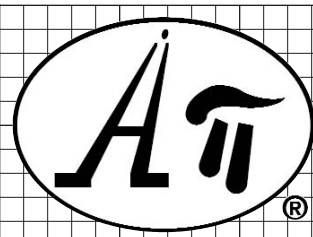
The external supply modification uses the +24 VDC power supplied by the PLC and regulates the 4-20 mA output signal in proportion to the input signal it receives from the pressure transmitter. The 2000 VRMS isolation of the module protects against unexpected ground loops and electrical noise.



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### **Did You Know...?**

The external supply modification is available on Api modules with other input types.



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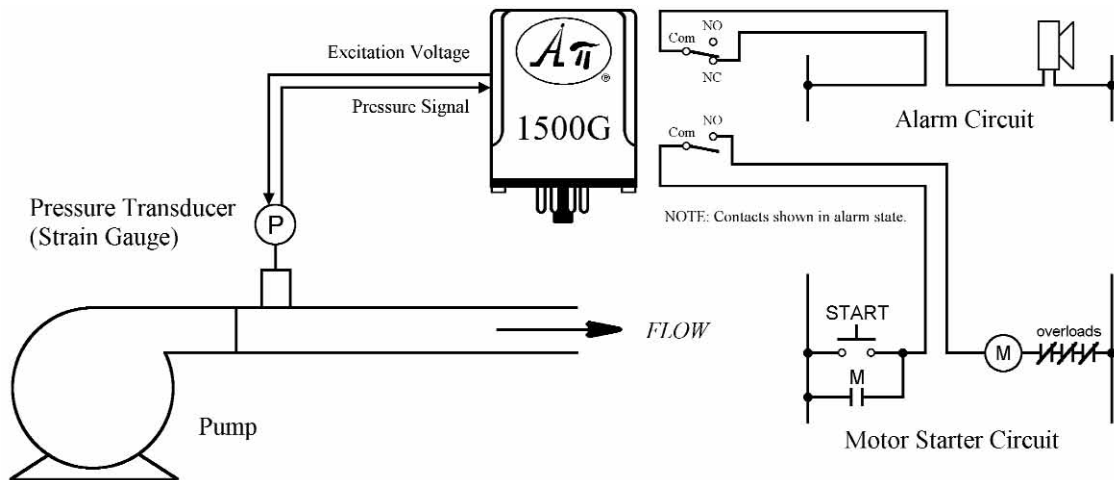
Pumping System High Pressure Alarm and Shutdown

PROBLEM

A pump is supplying liquid to a process which requires the line pressure to be maintained below some maximum value. If the pressure exceeds the preset limit, the pump must be shut down and a remote alarm activated.

SOLUTION

A pressure transducer is installed in the line on the discharge side of the pump. The pressure transducer is connected to an API 1500 G Strain Gauge (Bridge) Input Single Alarm Trip module which provides two isolated Form C (NO/NC) relay contacts. One set of these contacts is wired in series with the coil of the pump motor starter and shuts down the pump when tripped. The other set of contacts is wired to a remote alarm or annunciator panel to alert the proper personnel of the overpressure shutdown. The setpoint is field adjustable from 0-100% of the input span.



The API 1500 G provides the stable excitation voltage for the pressure transducer from its built-in excitation supply. The standard heavy-duty relay contacts are rated 7A @ 240 VAC and can directly control most devices.

Did You Know...?

All Api alarm modules have a bi-color (red/green) LED to indicate alarm status.

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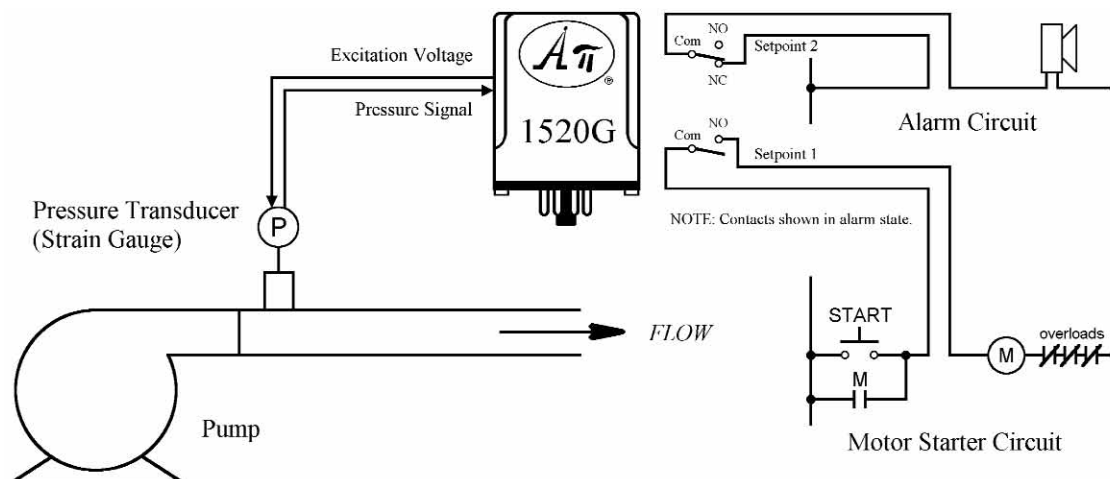
## **Pumping System High/High Pressure Alarm and Shutdown**

### **PROBLEM**

A pump is supplying liquid to a process which requires the line pressure to be maintained below some maximum value. If the pressure exceeds a preset warning limit, an alarm must be activated. If the pressure exceeds a preset shutdown limit, the pump must be stopped.

### **SOLUTION**

A pressure transducer is installed in the line on the discharge side of the pump. The pressure transducer is connected to an **API 1520 G** Strain Gauge (Bridge) Input Dual Alarm Trip module which provides two independent setpoints and two independent isolated Form C (NO/NC) relay contacts. One set of these contacts is wired to an alarm or annunciator panel to alert the proper personnel of the overpressure condition. The other set of contacts is wired in series with the coil of the pump motor starter and shuts down the pump when tripped.



The **API 1520 G** provides the stable excitation voltage for the pressure transducer from its built-in excitation supply. Setpoint 2 is adjusted to the warning pressure limit, and Setpoint 1 is adjusted to the pressure shutdown limit. The standard heavy-duty relay contacts are rated 7A @ 240 VAC and can directly control most devices. Both setpoints are adjustable from 0-100% of the input span.

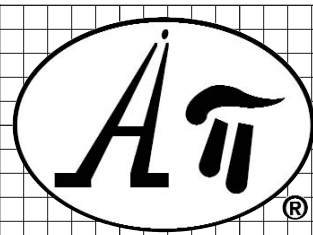


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### **Did You Know...?**

Api will do non-standard and special ranges on all of our products.





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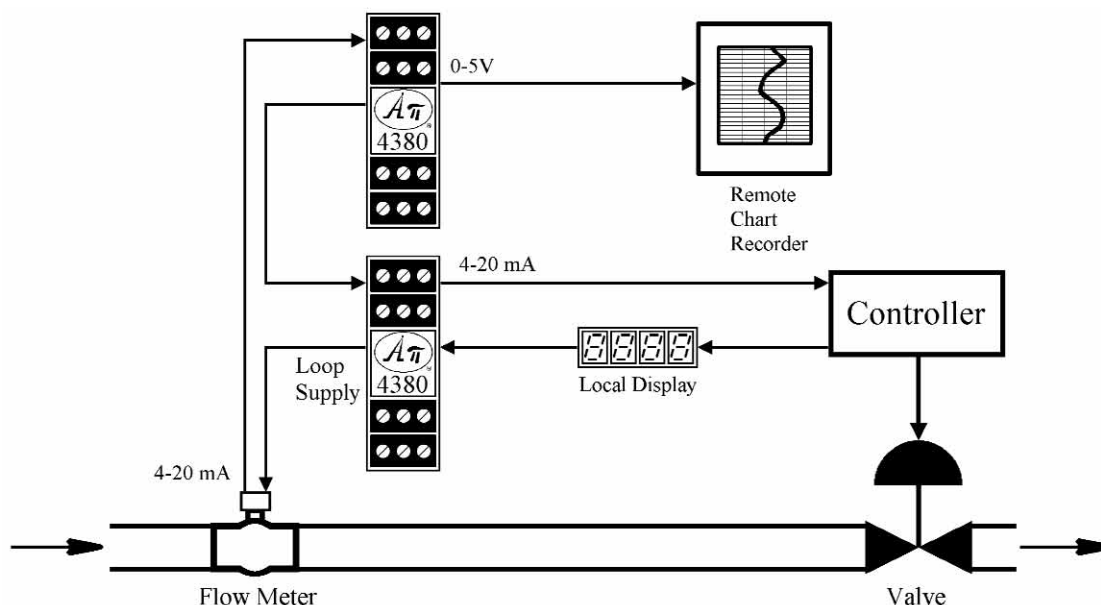
### Monitoring and Controlling Liquid Flow From a Single Flow Meter

#### PROBLEM

A process requires a controlled flow rate of a liquid with a local display of that flow rate and also a chart of the flow rate for record keeping purposes.

#### SOLUTION

A single flow meter can be utilized for control and monitoring of flow rate if appropriate signal conditioning is provided. In this example, the local display and the flow controller require a 4-20 mADC signal, while the remote chart recorder requires a 0-5 VDC signal.



The flow meter is connected to a pair of **API 4380 DIN** Isolated, Field Ranging DC to DC Isolators. The first **API 4380 DIN** provides loop power for the flow meter from its built-in loop excitation supply, and its 4-20 mADC output drives both the local display and the flow controller. The second **API 4380 DIN** converts the 4-20 mADC signal from the flow meter to a 0-5 VDC signal which is sent to the remotely located chart recorder.

#### Did You Know...?

The **API 4380 DIN** is available with a 9-30 VDC power supply. Specify **API 4380 DD**.

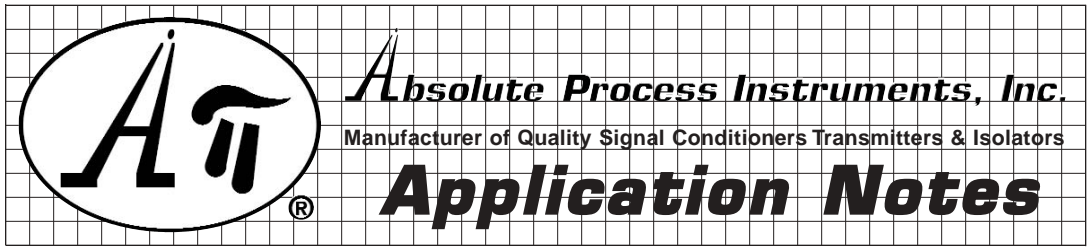
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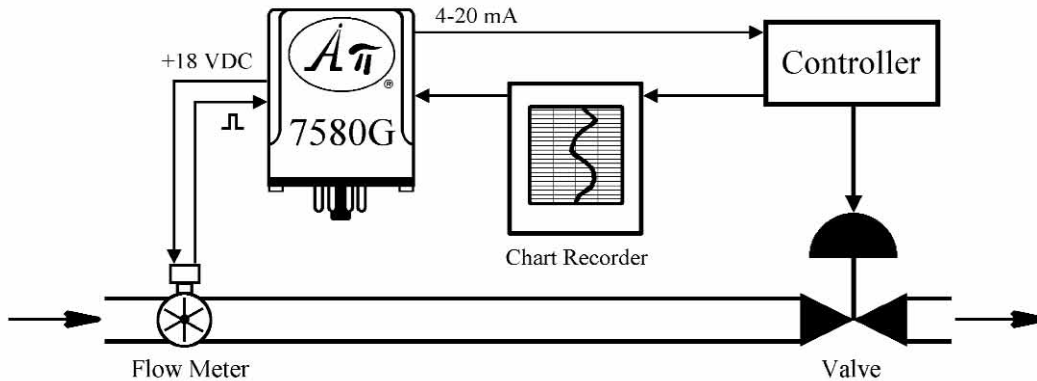
## ***Controlling and Recording Water Flow***

### **PROBLEM**

A process requires a controlled water flow which must also be recorded.

### **SOLUTION**

A linear flow meter and a control valve are installed in the water line. Power for the flow meter is provided by the +18 VDC loop excitation supply available as standard on an **API 7580 G** Field Selectable Isolated Frequency to DC Transmitter module. The **API 7580 G** converts the frequency output of the flow meter to a 4-20 mA signal which is used to control and monitor the flow to the process.



The **API 7580 G** features 30 selectable input ranges from 0-100 Hz to 0-30 KHz, and 16 selectable output ranges. In addition, the optical isolation protects against unwanted ground loops and electrical noise.



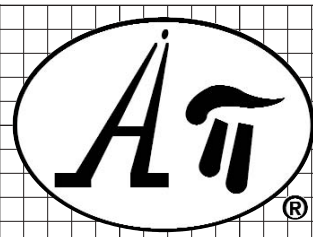
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### **Did You Know...?**

Many Api transmitters & alarms come standard with a +18 VDC input loop excitation power supply.



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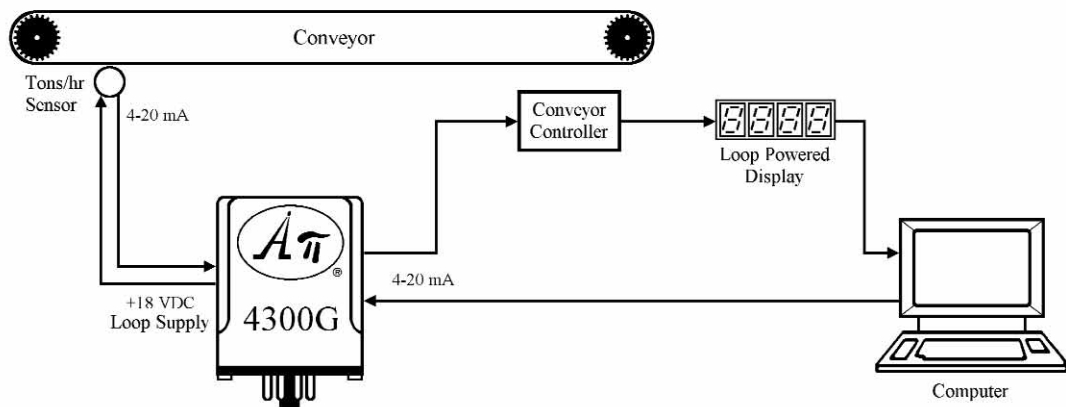
### Monitoring Product Moved by a Conveyor

#### PROBLEM

The amount of product in tons per hour moved by a conveyor is required for the conveyor controller, for a local display, and for computer monitoring. The total loop impedance is 875 ohms.

#### SOLUTION

A sensor which produces an output proportional to the rate of movement of product is installed on the conveyor.



An **API 4300 G** Isolated DC to DC Transmitter module provides power for the sensor from its built-in +18 VDC loop excitation supply. The 4-20 mADC output of the sensor is replicated by the **API 4300 G** and its 4-20 mADC output loop drives the conveyor controller, a loop powered display and the computer input. The output of the **API 4300 G** is capable of driving up to 1000 ohms.

#### Did You Know...?

The **API 4300 G** can be provided with a reverse acting output.

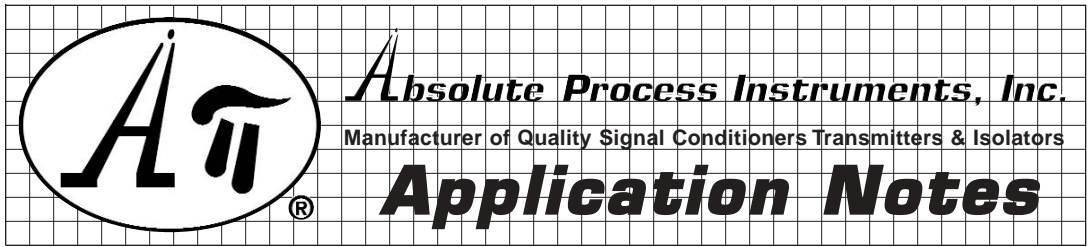
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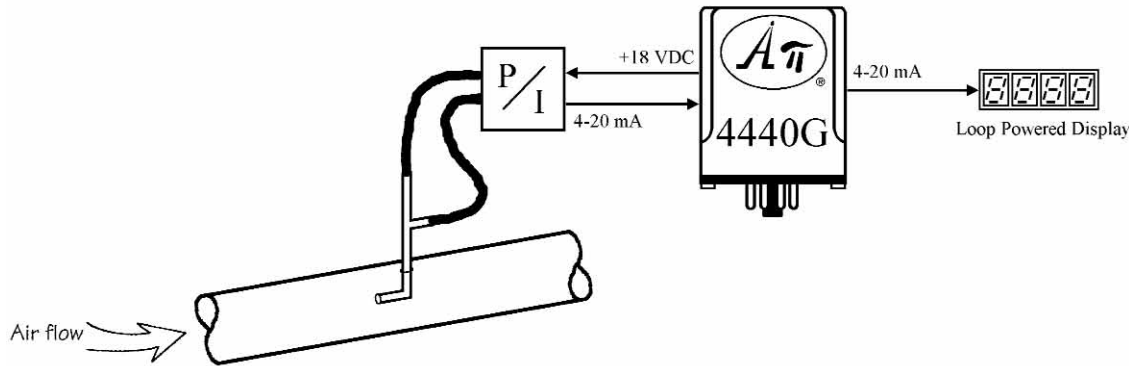
## **Air Flow Measurement**

### **PROBLEM**

Measure an air velocity value, convert it and display it as an air flow 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 and its output loop is capable of driving up to a 1000 ohm load.



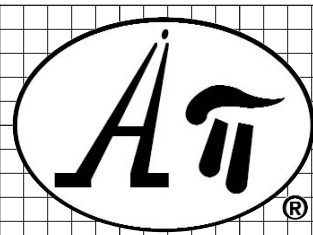
Since Flow = Velocity x Area, the cross sectional area of the pipe will determine the range of the scaling on the loop powered display. This allows the velocity value to be displayed as a flow rate. The optical isolation of the module protects against unwanted ground loops and electrical noise.



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### **Did You Know...?**

Api plug-in and DIN style modules have a LIFE-TIME WARRANTY.



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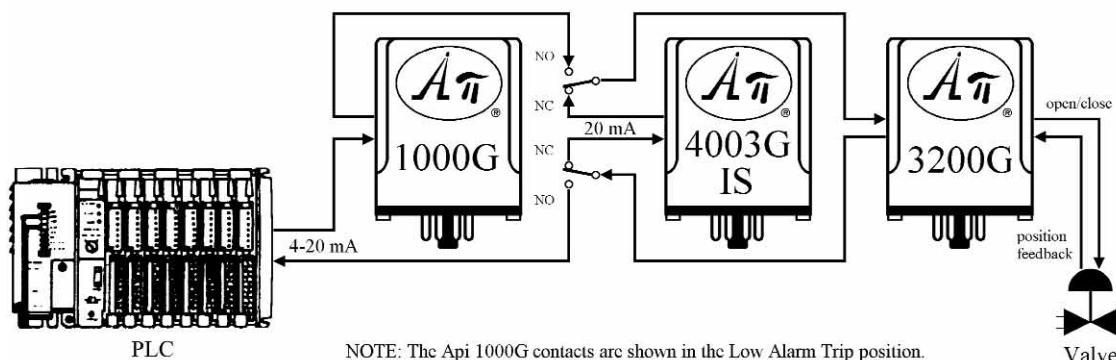
## Fail Safe Valve Control

### 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.

### Did You Know...?

Api can do input to output reversals on our transmitters.

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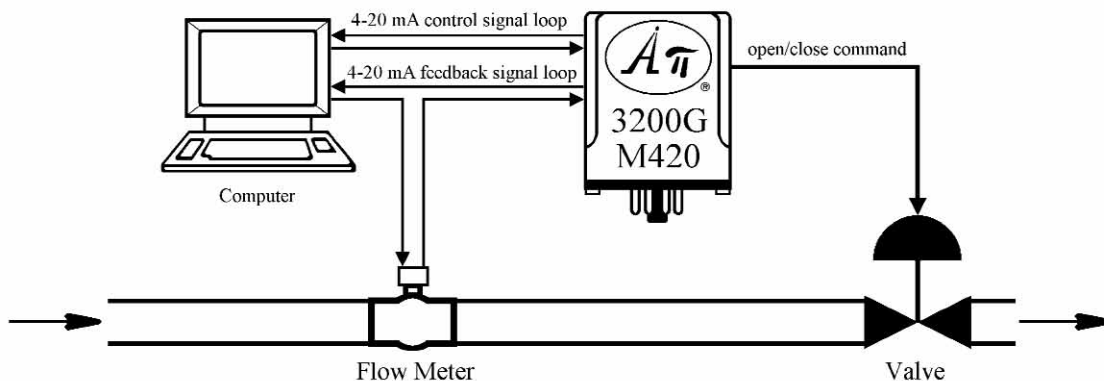
## **Flow Control with Flow Meter Feedback**

### **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.

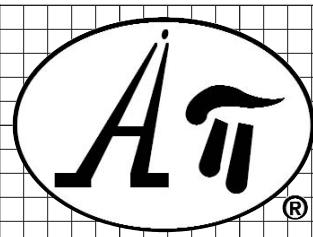


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### **Did You Know...?**

Api also offers a Model API 3200 G with a potentiometer feedback.





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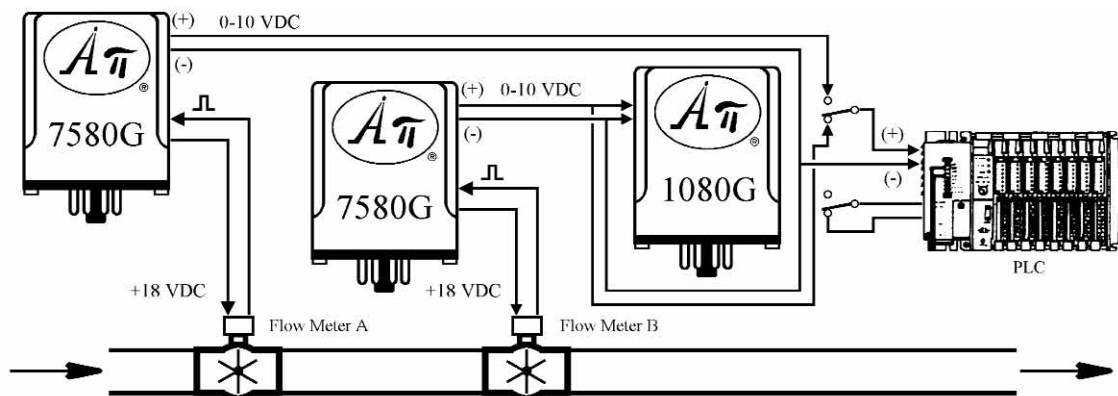
### Auto-Ranging Flow Meter

#### PROBLEM

A flow in a process must be accurately measured throughout a wide range. The flow rate is used by a PLC to control the process. Two flow meters are utilized, one very accurate at low flow and one very accurate at high flow. A means for automatic selection of the appropriate flow meter is required.

#### SOLUTION

An **API 7580 G** Field Selectable Isolated Frequency to DC Transmitter module is used with each flow meter to convert the frequency output to a 0-10 VDC signal proportional to flow. An **API 1080 G** DC Input, Wide Ranging, Field Selectable Single Alarm Trip module monitors the flow rate and transfers the PLC analog input to the flow meter appropriate for that range.



The second set of relay contacts of the **API 1080 G** provides a PLC binary input with a closure to indicate which flow meter is selected.

#### Did You Know...?

Api isolated transmitters have 2000 volt input, output and power isolation and are covered by a LIFETIME WARRANTY.

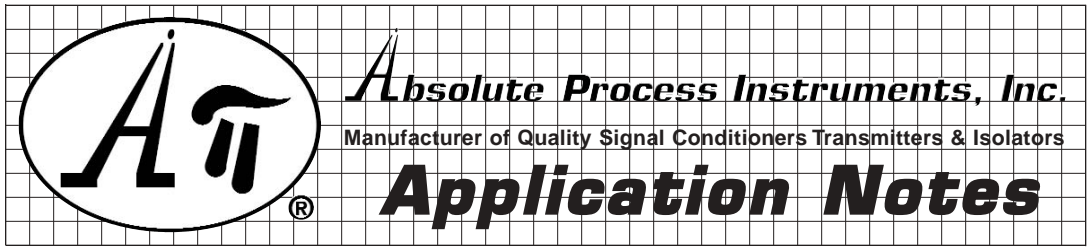
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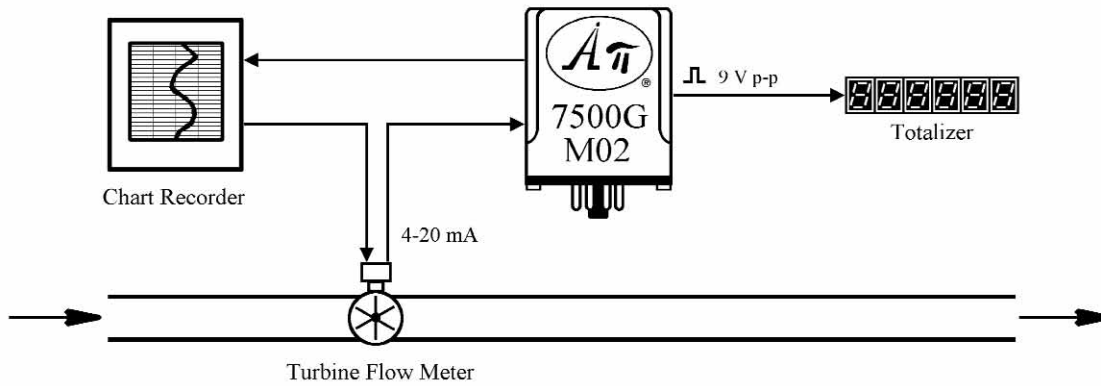
## **Flow Meter Auto-Select**

### **PROBLEM**

A flow in a process must be accurately measured throughout a wide range. The flow rate is used by a PLC to control the process. Two flow meters are utilized, one calibrated for maximum accuracy at low flow and one for maximum accuracy at high flow. A means for automatic selection of the appropriate flow meter is required.

### **SOLUTION**

An **API 7580 G** Field Selectable Isolated Frequency to DC Transmitter module is used with each flow meter to convert the frequency output to a 0-10 VDC signal proportional to flow. Each flow meter is powered by the built-in loop excitation supply from the corresponding **API 7580 G**.

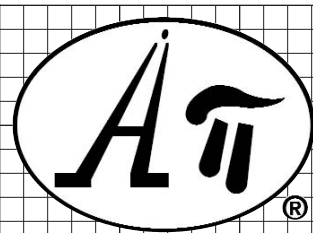


An **API 1080 G** DC Input, Wide Ranging, Field Selectable Single Alarm Trip module monitors the flow rate and transfers the the flow meter signal corresponding to the appropriate range to the PLC analog input.

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### **Did You Know...?**

All Api plug-in and DIN style modules are covered by a LIFETIME WARRANTY.



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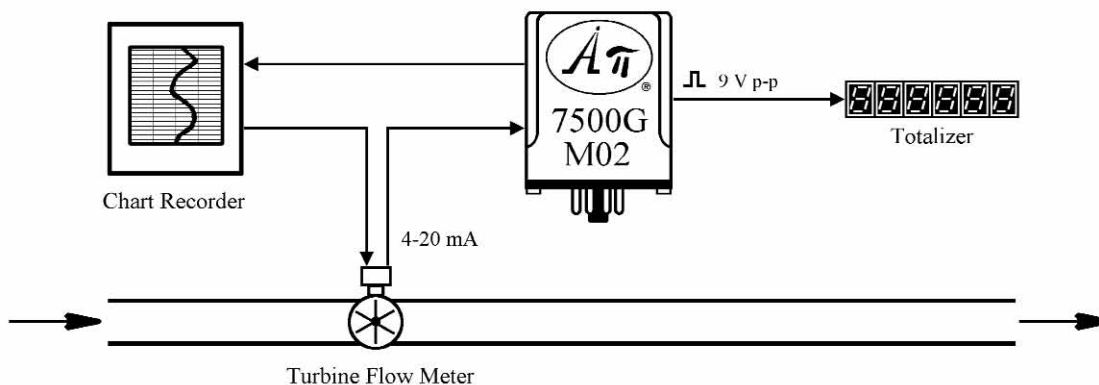
## Monitoring and Totalizing Flow

### PROBLEM

Add a totalizer to a process flow monitoring system.

### SOLUTION

An **API 7500 G M02** Field Selectable Isolated DC to Frequency Transmitter module is inserted in the 4-20 mA loop between the turbine flow meter and the chart recorder.



The API 7500 G M02 provides the 9 V p-p square wave required by the totalizer system.

### Did You Know...?

That Api has field selectable units to convert frequency to voltage (**API 7580 G**) and voltage to frequency (**API 7500 G**).

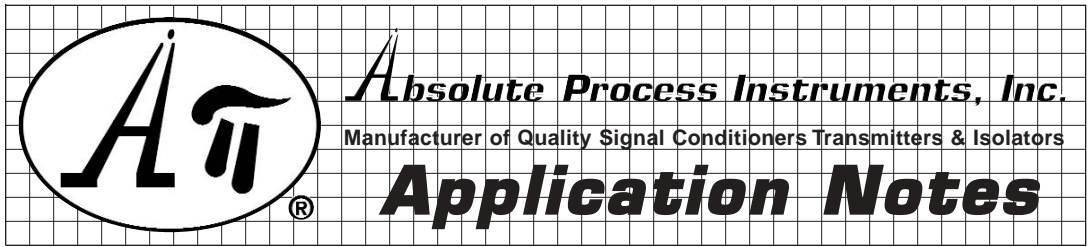
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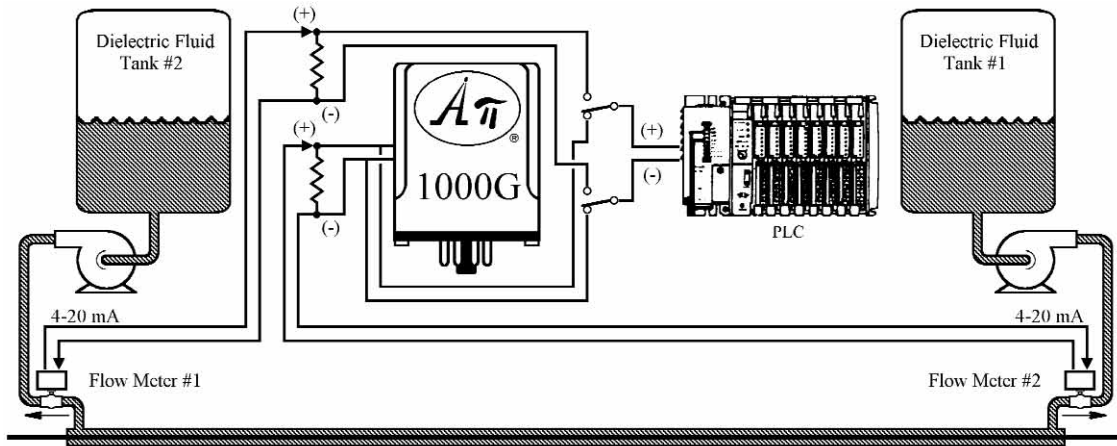
## **Monitoring Bi-Directional Flow**

### **PROBLEM**

Dielectric fluid is continuously pumped through the jacket of an underground electric cable. There is a holding tank and a pump at each end of the cable and the fluid is pumped from one tank to the other and back again. A programmable logic controller with one analog input must monitor the flow at the downstream end of the cable as a leak detection system to satisfy regulatory requirements.

### **SOLUTION**

A flow meter with a 4-20 mA output is installed at each end of the cable. Flow Meter #1 measures the flow when the fluid is being pumped from Dielectric Fluid Tank #1, and Flow Meter #2 measures the flow when the fluid is being pumped from Dielectric Fluid Tank #2. An **API 1000 G** DC Input Single Alarm Trip module monitors the flow at Flow Meter #2 to select which flow meter is connected to the input of the PLC.



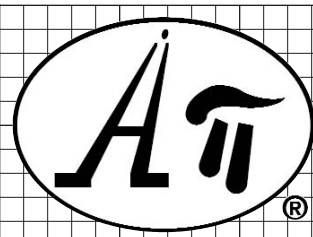
When there is flow at Flow Meter #2, it is selected for the PLC. When there is no flow at Flow Meter #2, Flow Meter #1 is selected for the PLC. Thus, regardless of the direction, the PLC can monitor for a low flow condition which may be caused by leakage.



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### **Did You Know...?**

Api plug-in modules come standard with UL, CUL and CSA approval.



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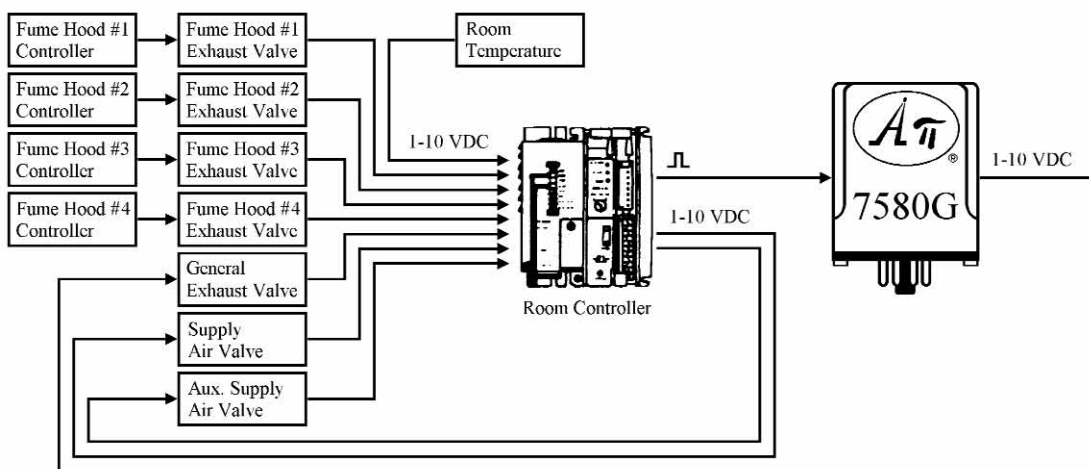
## HVAC Variable Air Volume Control

### PROBLEM

The constant volume heating, ventilating and air conditioning (HVAC) system for a wet chemistry laboratory is being converted to variable air volume (VAV) to save energy. The amount of air exhausted by four fume hoods in the lab will vary depending upon their sash positions. A room controller must monitor the room temperature, the quantity of air exhausted and the quantity of air supplied, and operate supply air, auxiliary supply air, and general exhaust air valves to maintain room temperature, room pressure and a minimum number of air changes per hour for comfort and safety. The standard room controller has 8 analog inputs, 2 analog outputs and 1 frequency output, but 3 analog outputs are required.

### SOLUTION

The room temperature sensor and valve position feedback potentiometers are monitored by the eight room controller analog inputs, and the supply air and the auxiliary supply air valves are controlled by the two 1-10 VDC analog outputs.



An API 7580 G Isolated Frequency to DC Transmitter module converts the frequency output of the room controller to a 1-10 VDC signal to control the general exhaust air valve.

### Did You Know...?

The API 7580 G has field rangeable frequency inputs and DC voltage or current outputs for total flexibility.

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# Application Notes

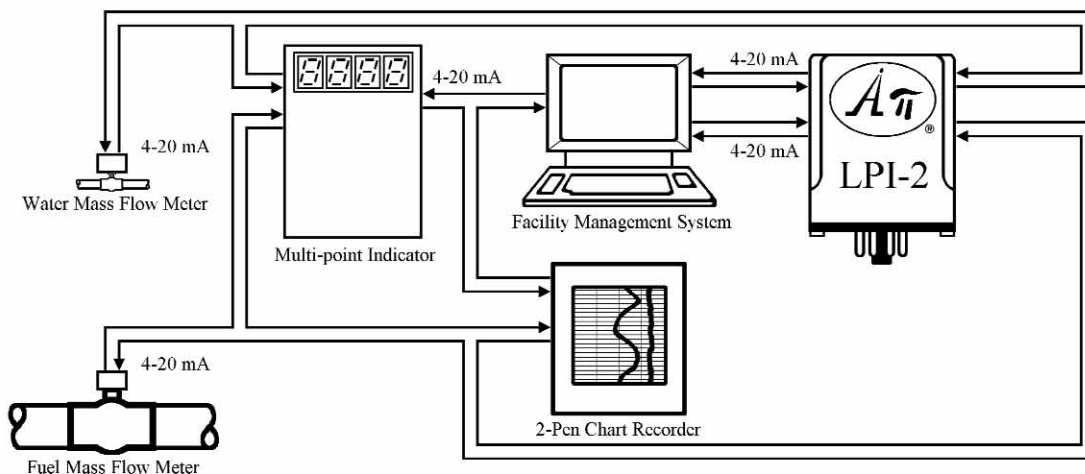
## **Monitoring and Recording Mass Flow and Mass Flow Ratio**

### **PROBLEM**

A natural gas turbine is equipped with water injection to satisfy environmental regulations. Mass flow meters are installed on the fuel and water injection lines to the turbine, and are monitored by a local multi-point indicator which also calculates, displays and provides an analog output of the water to fuel mass flow ratio. The fuel mass flow and the water to fuel mass flow ratio need to be plotted on a 2-pen chart recorder and also be monitored by a computer-based facility management system. The mass flow meters and the multi-point indicator are independently self-powered.

### **SOLUTION**

Use an API LPI-2 Loop Powered Isolator Twin-Pack module to prevent ground loops.



The API LPI-2 allows the Facility Management System computer to monitor both the inputs and the output of the multi-point indicator without introducing errors due to ground loops.

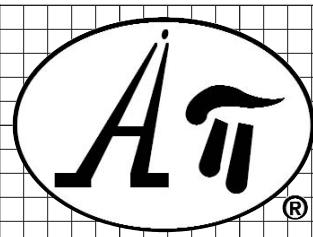


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### **Did You Know...?**

That a DIN style version of the LPI-2 is also available. Specify model DPI-2.





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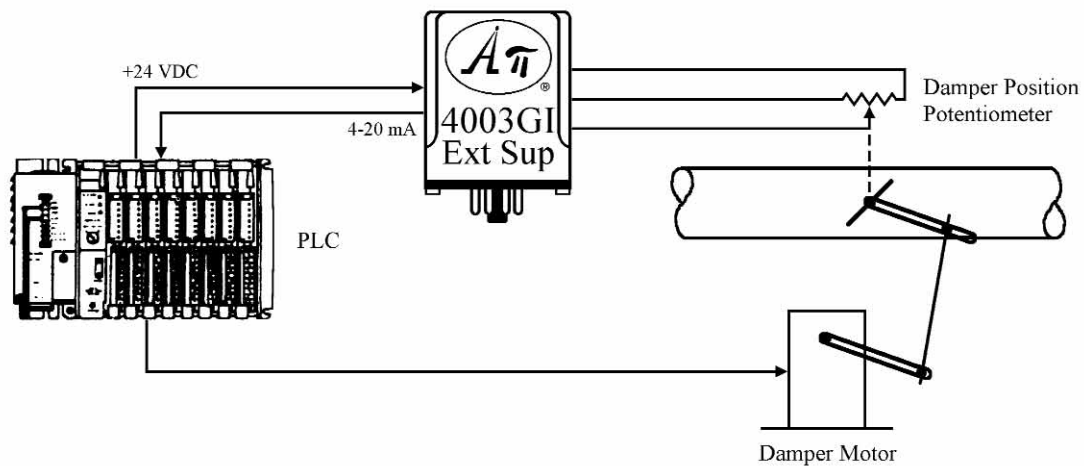
## Controlling Damper Position

### PROBLEM

A programmable logic controller (PLC) is controlling a damper motor as part of a process. The damper is equipped with a linear potentiometer for position feedback, and the PLC has a single-ended 4-20 mA input and generates its own 24 VDC power for the loop.

### SOLUTION

An API 4003 G I EXTSUP Isolated Potentiometer to DC Transmitter module with External Supply modification measures the resistance of the damper position feedback potentiometer and transmits it to the PLC's powered input as a 4-20 mA signal.



The external supply modification uses the +24 VDC power supplied by the PLC and regulates the 4-20 mA signal. The 2000 VRMS isolation protects against unexpected ground loops and electrical noise.

### Did You Know...?

The API 4003 G will accept potentiometer inputs from 100 ohms to 1 megohms.

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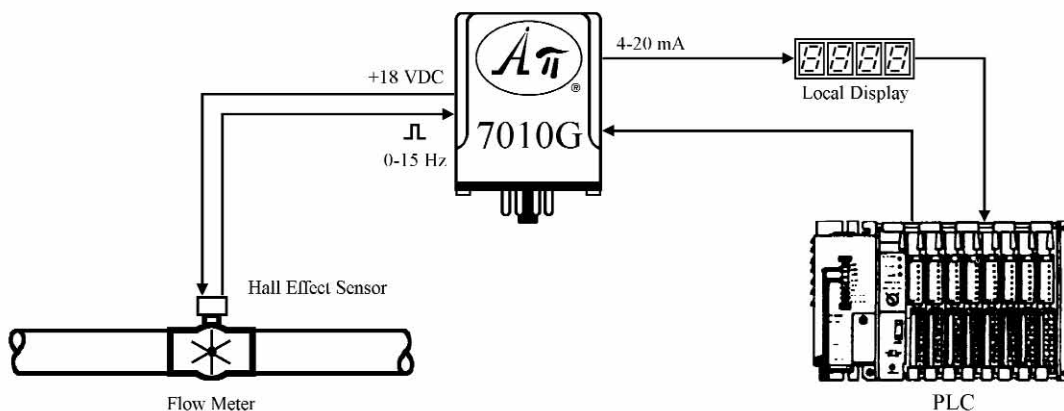
## **Using a Hall Effect Flow Sensor**

### **PROBLEM**

An accurate flow measurement is required at low flow rates for a process controller. A local display is also desired.

### **SOLUTION**

Hall effect sensors are recommended when the output frequency from a flow meter over any part of the application flow range is 15 Hz or less. This frequency typically occurs at approximately the 10 to 1 turndown point for flow meters.



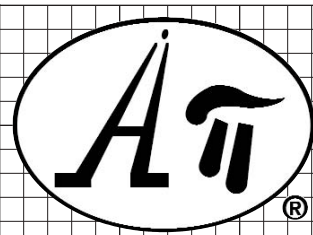
An **API 7010 G** Isolated Frequency to DC Transmitter module provides the DC power for the Hall Effect sensor from its built-in loop excitation supply and converts the 0-15 Hz flow signal into a 4-20 mA signal to drive the local display and the PLC. The 2000 VRMS isolation protects against unwanted ground loops and electrical noise.



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### **Did You Know...?**

For frequency inputs of 0-100 Hz or greater, select the **API 7580 G** which is field rangeable up to 0-30 KHz.



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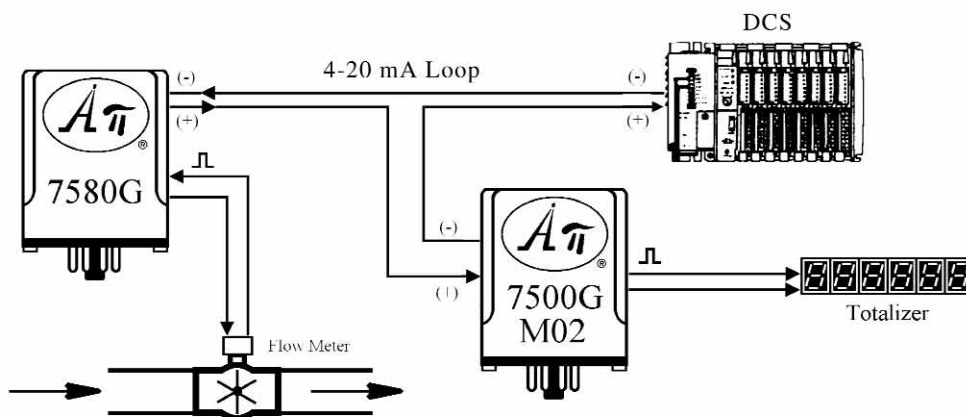
## Monitoring and Totalizing Flow Meter Output

### PROBLEM

The frequency output signal of a flow meter must be monitored by a DCS as well as a remotely located counter/totalizer. The counter/totalizer accepts a TTL frequency input.

### SOLUTION

An API 7580 G Isolated Frequency to DC Transmitter module is connected to the frequency output of the flow meter. The API 7580 G has a built-in loop power supply to power the current loop.



The 7580 G converts the frequency to a 4-20 mA output which is sent to the DCS and an API 7500G M02 mounted near the remote counter/totalizer. The API 7500 G M02 converts the 4-20 mA signal to a TTL frequency signal for the counter/totalizer.

### Did You Know...?

Most Api plug-in style modules are hot swappable?

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- ❑ Process



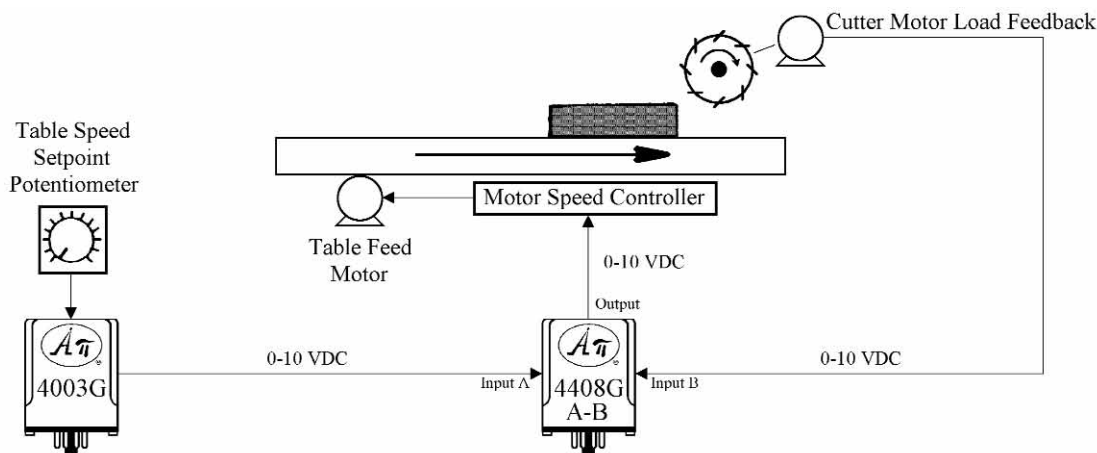
## **Automation of a Milling Machine Operation**

### **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 and an **API 4408 G** A-B Math Function with Isolated DC Output module to reduce the speed command to the table motor controller as cutter load increases.



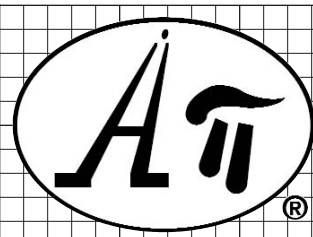
Here, the milling machine is equipped with a controller which accepts a 0-10 VDC input to vary the speed of the moving table. It is also equipped with a 0-10 VDC output signal which is directly proportional to the load on the cutter. The **API 4003 G** sets the maximum speed of the table with no load 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.



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### **Did You Know...?**

Poor quality sockets put your process at risk. For your convenience, Api stocks quality 8-pin and 11-pin sockets for use with our modules.



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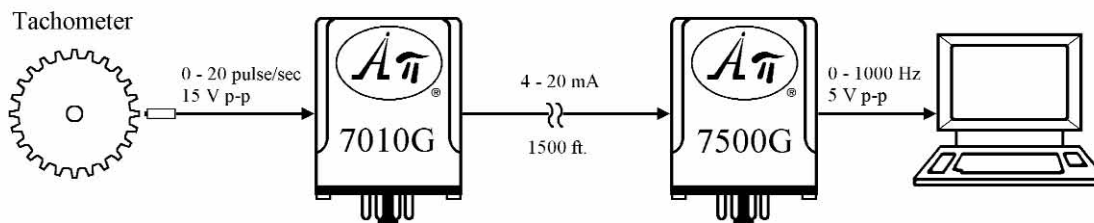
### Monitoring Mixer Speed at a Remote Computer

#### PROBLEM

The speed of a mixing machine must be monitored by a computer located 1500 feet away, across an electrical-ly noisy area. The tachometer on the mixer produces 24 pulses per revolution at 15 V peak-to-peak and the mixer runs at speeds up to 50 RPM. The computer input accepts a frequency of 0-1000 Hz at 5 V peak-to-peak.

#### SOLUTION

Api signal conditioning is applied at the tachometer output and at the computer input to provide noise immuni-ty and signal compatibility.



The tachometer output (24 pulse/rev x 50 rev/min x 1 min/60 sec = 20 pulse/sec) is converted to a 4-20 mADC signal by the **API 7010 G** Isolated Frequency to DC Transmitter module. At the computer, the 4-20 mADC signal is converted by the **API 7500 G** Field Selectable Isolated DC to Frequency Transmitter module to a frequency of 0-1000 Hz.

#### Did You Know...?

Api isolated transmitters have 2000 volt input, output and power isolation.

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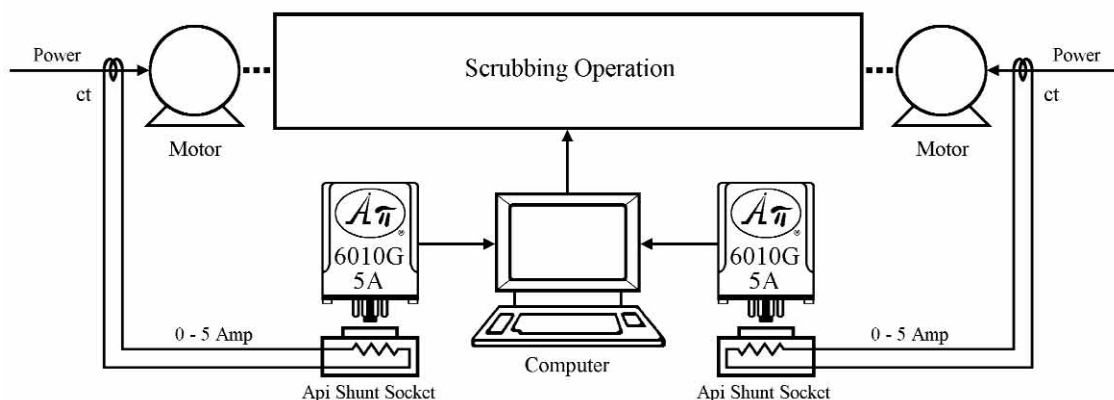
## Monitoring the Speed of Scrubbers

### PROBLEM

Material is fed to a pair of scrubbers rotating at 3600 RPM. If the speed of the scrubbers decreases due to overloading, the material is not adequately cleaned.

### SOLUTION

As loading on a motor increases its speed will decrease and its electrical current draw will increase. The amount of current drawn by the motor can be monitored and used as an indication of motor speed.



Current transformers are installed on the electrical lines supplying the motors. Each current transformer is connected to an **API 6010 G 5A** isolated AC to DC Transmitter, which consists of a socket with a built-in shunt, and a plug-in module. This arrangement prevents damage to the current transformer if the plug-in module is removed from the socket without powering down the scrubbers. The DC output from each **API 6010 G 5A** is connected to a computer and can be used for monitoring scrubber speed or for controlling the feed rate of material to the scrubbers for most efficient operation. The 2000 VRMS optical isolation protects against unwanted ground loops and electrical interference.

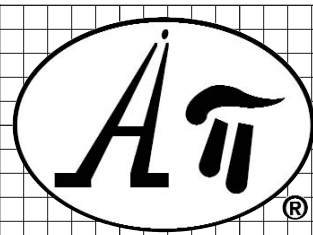


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### Did You Know...?

Single (**API 1600 G 5A**) and dual (**API 1620 G 5A**) alarm modules are also available.





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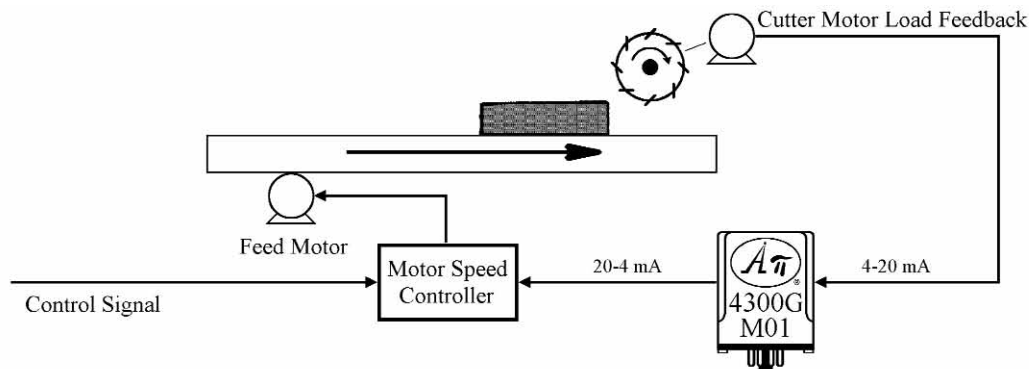
### Motor Load Controller

#### PROBLEM

A DC motor driving a cutter may become overheated and damaged if stock is fed into the cutter too rapidly, but production requirements dictate maximum machine output.

#### SOLUTION

A 4-20 mA DC signal proportional to the cutter motor load is available to provide feedback for the feed motor controller. An API 4300 G M01 Isolated DC to DC Transmitter module reverses the feedback signal so that increasing load on the cutter will decrease the speed of the feed motor.



Conversely, decreasing load on the cutter increases the speed of the feed motor. The feed rate is controlled to maintain the optimum load on the cutter at all times. In addition, the 2000 VRMS isolation protects against unwanted ground loops and electrical noise commonly found in industrial environments.

#### Did You Know...?

All Api plug-in and DIN style modules are covered by a LIFETIME WARRANTY.

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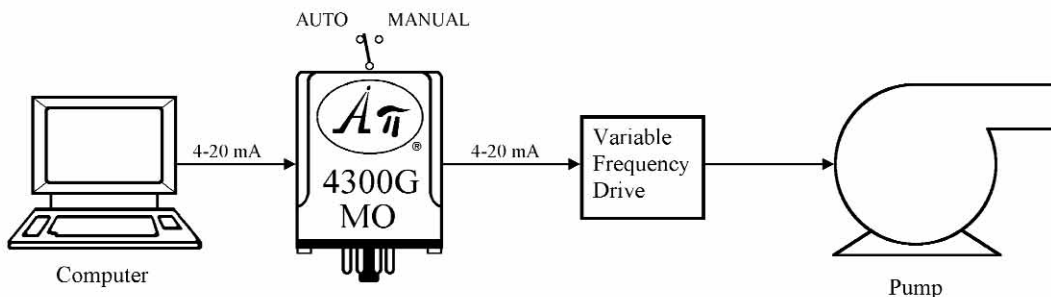
## **Manual Override of Computer Control**

### **PROBLEM**

The speed of a pump is controlled by a computer. A means to operate the pump at a fixed speed is necessary when the computer fails or is shut down for maintenance.

### **SOLUTION**

An **API 4300 G MO** Isolated DC to DC Transmitter module is installed between the computer and the pump's speed controller.

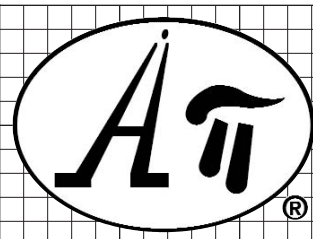


When the switch is in the **AUTO** position, the speed control signal from the computer is replicated by the output of the **API 4300 G MO** and sent to the variable frequency drive for the pump. When the switch is in the **MANUAL** position, the output of the **API 4300 G MO** holds a constant preset value regardless of the signal from the computer. This manual output is field adjustable via a potentiometer on top of the module.

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### **Did You Know...?**

Api isolated plug-in and DIN style modules use state-of-the-art optical isolation.



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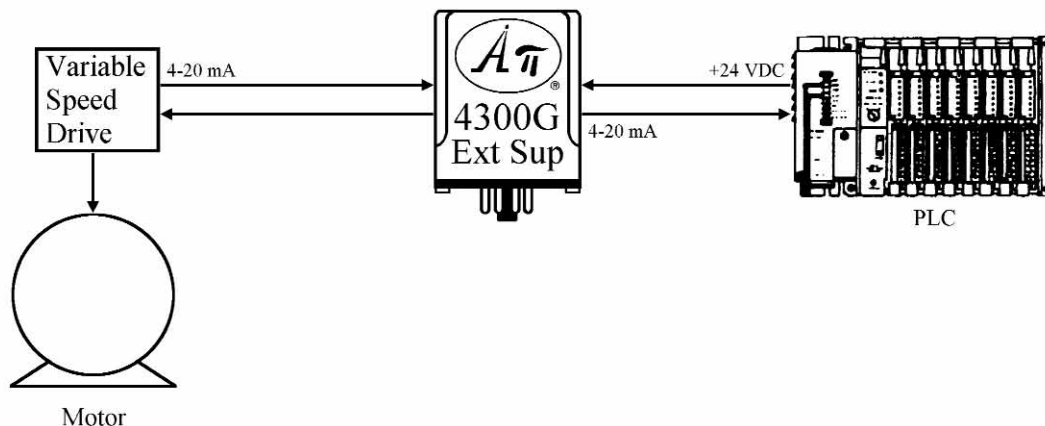
## Monitoring Motor Speed with a PLC

### PROBLEM

A variable speed drive has an internally powered 4-20 mA output proportional to the speed of the motor it is driving. The motor speed must be monitored by a programmable logic controller (PLC) for use in control of a process, but the 4-20 mA input of the PLC is also powered from the PLC's built-in power supply. The standard **API 4300 G** Isolated DC to DC Transmitter generates a 4-20 mA output at a 20 V compliance voltage. The output of the module would conflict with the power generated by the PLC input channel.

### SOLUTION

An **API 4300 G EXTSUP** Isolated DC to DC Transmitter module with External Supply modification will allow the drive's powered output to be transmitted to the PLC's powered input.



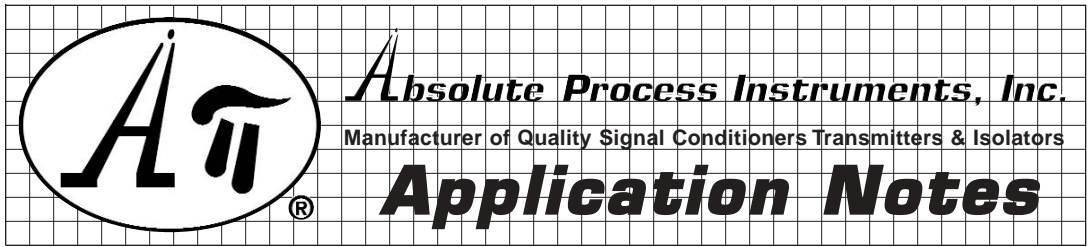
The external supply modification uses the +24 VDC power supplied by the PLC and regulates the 4-20 mA output signal in proportion to the input signal it receives from the variable speed drive. The 2000 VRMS isolation of the module protects against unexpected ground loops and electrical noise.

### Did You Know...?

Many PLC inputs are isolated only from the backplane they plug into and not channel to channel. Api's isolators can eliminate this problem.

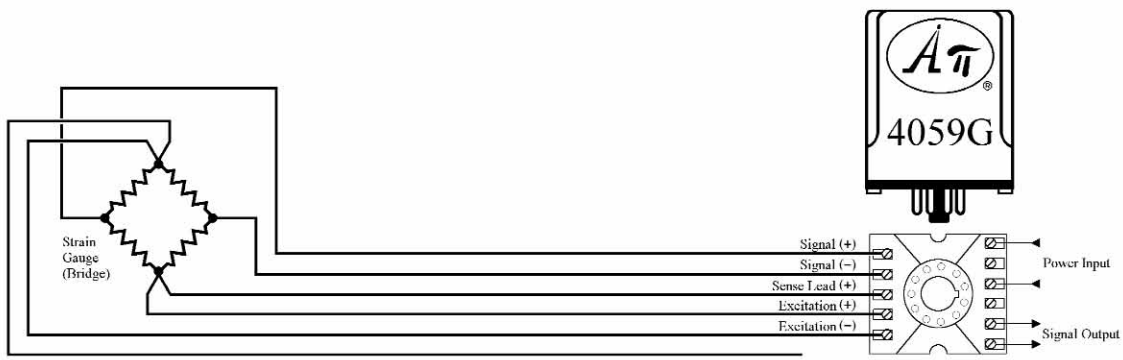
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## When Does Six Make Sense Over Four?

Many strain gauges (bridges) are located a considerable distance from the Api Strain Gauge Signal Conditioner. The long leads add an additional lead resistance which can result in a drop in the excitation supply voltage at the bridge and unwanted errors in the measurement. Although the excitation supply on all Api Strain Gauge Signal Conditioners is adjustable, it is suggested a six wire bridge be used to compensate for variations in the lead resistance due to temperature changes. The additional two wires are called Sense Leads.



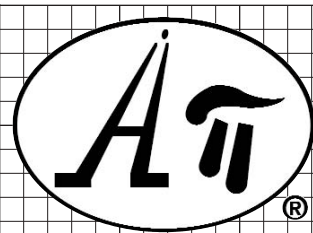
The **API 4059 G** Isolated Strain Gauge Signal Conditioner accepts a Sense Lead input. Internal circuitry in the module monitors the voltage drop in the bridge leads and automatically compensates the excitation voltage at the module so the actual excitation voltage at the bridge remains constant. Due to the design of the **API 4059 G**, it is only necessary to connect one of the sense leads for the feature to be effective.



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### Did You Know...?

The **API 4059 G** is optically isolated, has non-interactive zero and span adjustments and is field rangeable for input, output, excitation and tare offset. Only a screwdriver is required to make the changes.



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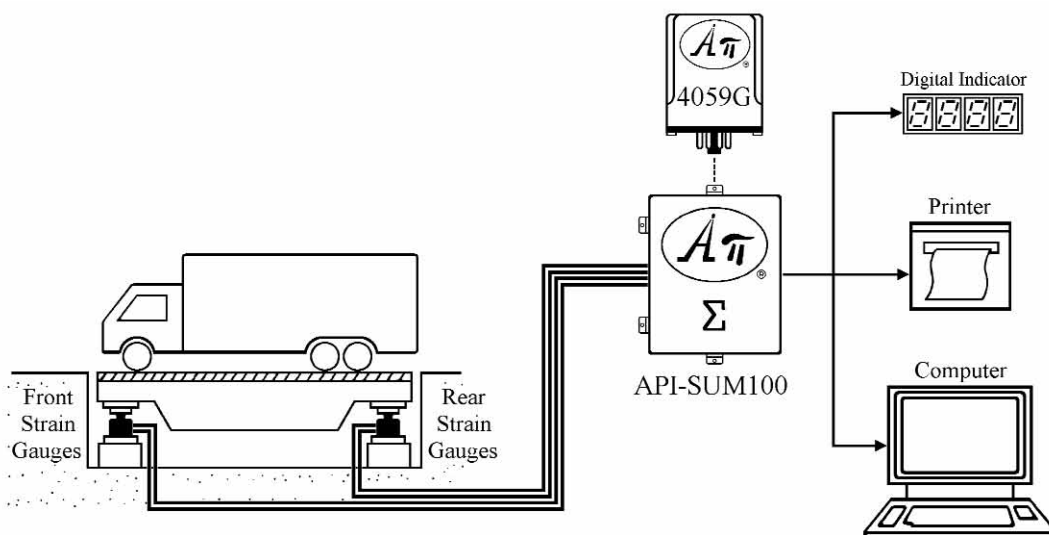
### Truck Scale System

#### PROBLEM

Total vehicle weight is to be displayed, printed out and sent to a computer for record keeping purposes.

#### SOLUTION

A weighing platform is equipped with strain gauges at each of its four corners, and the strain gauges are wired to an Api summing box with an **API 4059 G** Field Selectable Isolated Strain Gauge (Bridge) to DC Transmitter module.



The **API 4059 G** plugs into a socket on the **API SUM 100** board and provides excitation voltage for all four of the strain gauges from its built-in excitation power supply. The **API SUM 100** summing box combines the four strain gauge outputs and the **API 4059 G** converts the signal and drives the display, the printer and the computer.

#### Did You Know...?

The **API 4059 G** is standard with non-interacting zero and span adjust

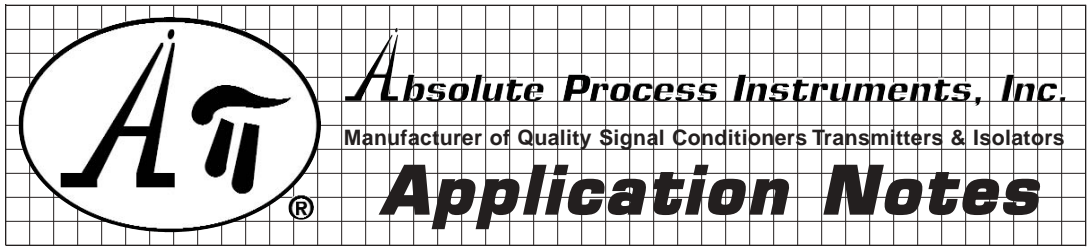
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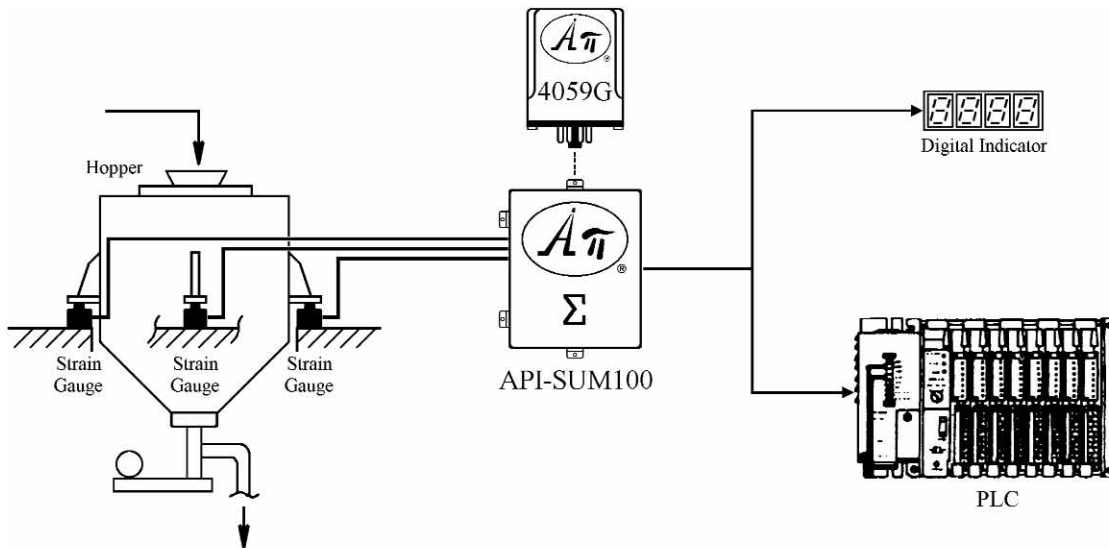
## **Automation of a Dispensing Operation**

### **PROBLEM**

Automatically control the amount and rate of feed to a hopper dispensing dog food into a container.

### **SOLUTION**

The hopper is equipped with three strain gauge load cells which are wired to an Api summing box with an **API 4059 G** Isolated Strain Gauge Input to DC Transmitter Module.



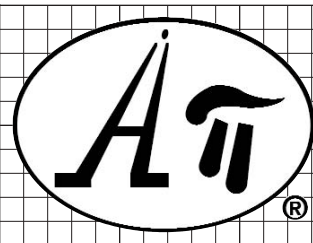
The **API 4059 G** plugs into a socket on the **API SUM 100** board and provides excitation voltage for all three of the strain gauges from its built-in excitation power supply. The **API SUM 100** summing box combines the three strain gauge outputs and the **API 4059 G** converts the signal and drives the display and the PLC.

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### **Did You Know...?**

The **API 4059 G** comes standard with field adjustable excitation supply, tare offset, input sensitivity and DC voltage or current output.





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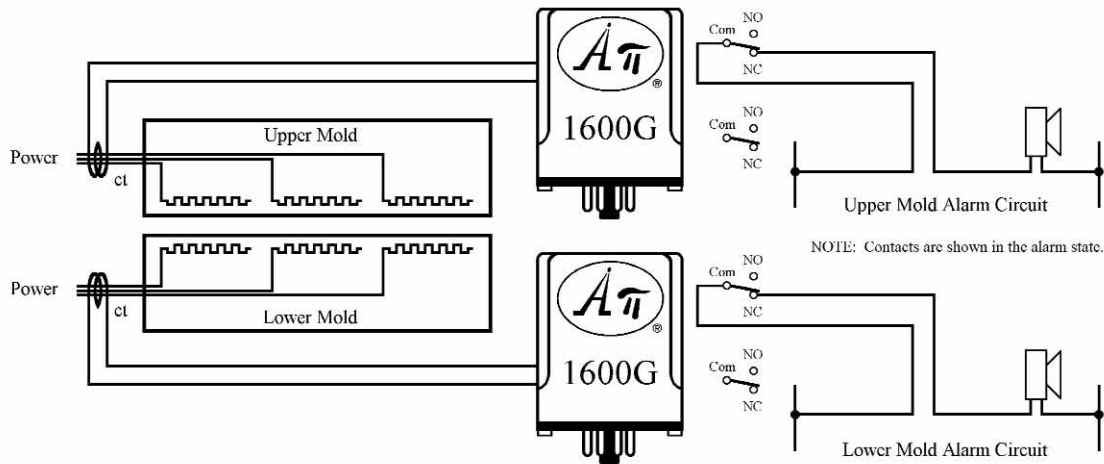
## Monitoring Critical Heater Operation

### PROBLEM

There is a multi-heater mold where constant temperature is critical to the quality of a product. If a single heater in the mold goes down, the operator must know as soon as possible and shut the mold down to prevent scrap.

### SOLUTION

The **API 1600 G** AC Input Single Alarm Trip module will accept a mAAC input from a current transformer (CT) and provide a contact closure when the detected current falls below a preset level. For example if the output from the CT is 60 mAAC when all three heaters are on, you would adjust the setpoint for 55 mA. Should one of the heaters fail the total current would fall approximately 20 mA causing an alarm indication and allowing the operator to shut down the system. By using a separate alarm for the upper and lower portions of the mold the troubleshooting time for the repair crew is reduced. Scrap is also reduced by detecting and correcting the problem before a large amount of defective product is produced.



NOTE: During the normal ON/OFF cycle of the temperature controller the low current alarm will cycle with the heater. When the alarm fails to reset as the heaters are turned back on or if an alarm indication occurs during the "heat" cycle one or more of the heaters have failed.

### Did You Know...?

The socket which we include with the **API 6010 G 5A** AC to DC Transmitter module has the shunt resistor built-in, allowing the module to be removed without damage to the current transformer.

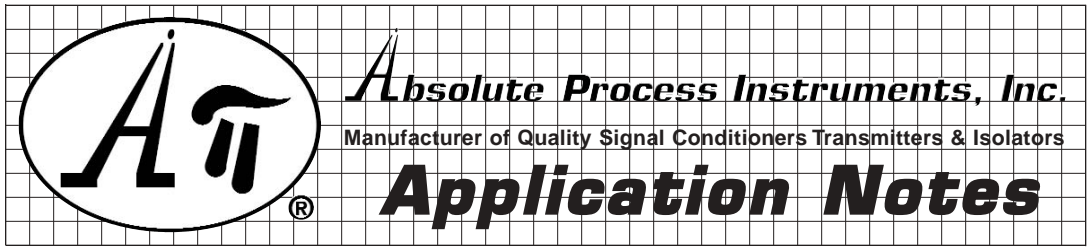
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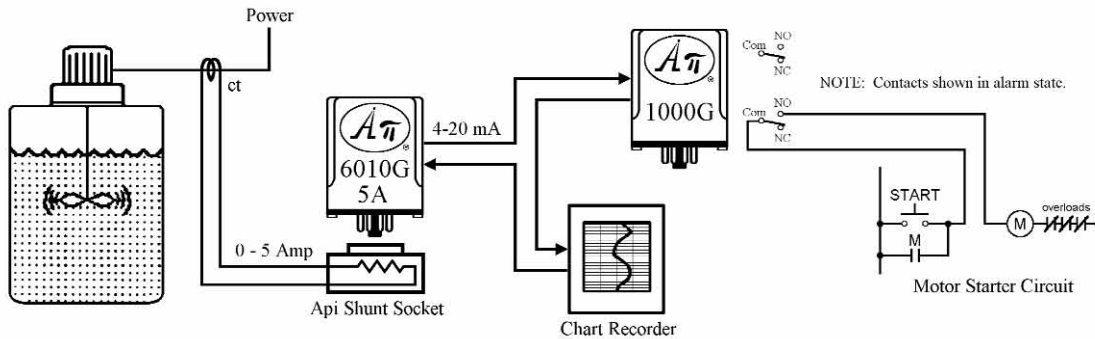
## Motor Current Monitor and Overcurrent Shutdown

### PROBLEM

Monitor and record mixer motor current and provide overcurrent shutdown.

### SOLUTION

Install a properly sized current transformer in the power line feeding the motor to provide a 0-5 Amp signal for an API 6010 G 5A AC to DC Transmitter module. Use the 4-20 mADC output to drive an API 1000 G DC Input Single Alarm Trip module and a chart recorder. Use one set of relay contacts of the API 1000 G in the motor starter circuit to shut down the motor if the current exceeds the setpoint.



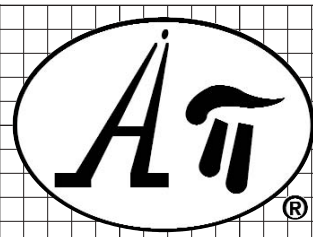
The other set of relay contacts may be wired to an annunciator or an alarm horn if so desired. The dual SPDT contacts are isolated and are rated 7A @ 240VAC resistive, making them capable of driving most loads directly.



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### Did You Know...?

Api plug-in modules come standard with UL, CUL, and CSA approval.



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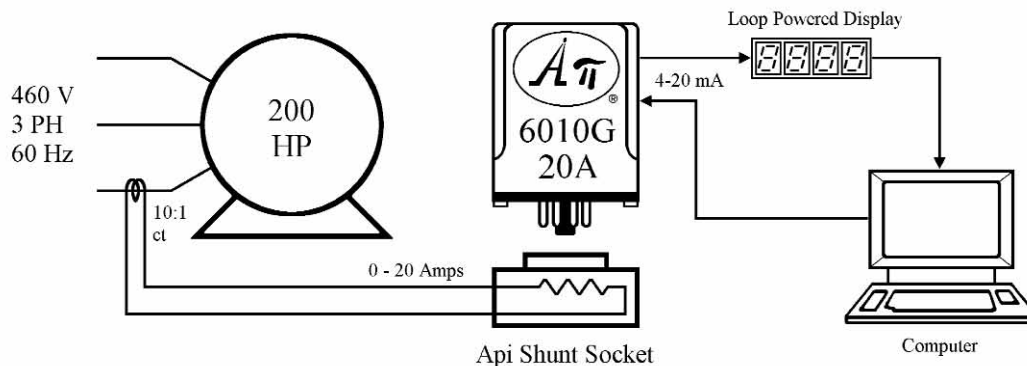
### Monitor and Display AC Motor Load

#### PROBLEM

The load on a motor is to be monitored by a computer and displayed locally as a percent of full load current. The motor is rated 200 horsepower, and operates at 460 volts, 3-phase, with a full load current of 200 amps.

#### SOLUTION

Install a suitable current transformer (CT) with a 10:1 ratio on one of the legs of the input power to the motor, and connect the CT output to an Api Shunt Socket with an **API 6010 G 20A** AC to DC Transmitter.



Use the 4-20 mA output of the **API 6010 G 20A** to drive a loop powered local display and the computer input. Scale the loop powered display for an indication of 100% at 200 amps motor load. The 2000 VRMS optical isolation protects against unexpected ground loops and electrical interference commonly found in industrial applications.

#### Did You Know...?

All Api alarm modules come configured as true failsafe unless otherwise specified.

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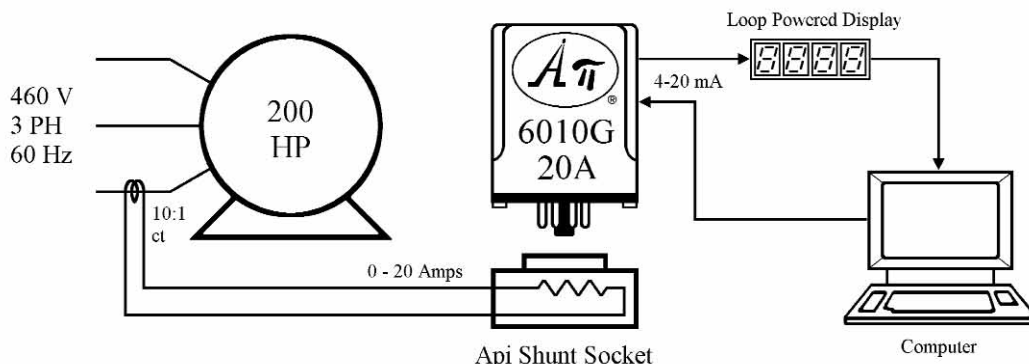
## **Monitoring Computer and Process Status**

### **PROBLEM**

A critical process is monitored by a computer which is powered independently. If power is lost to either the process or the computer, or if the computer locks up, an alarm is to be activated.

### **SOLUTION**

The computer is programmed to produce an output of 100 Hz at its analog output port. This output will not be present when power to the computer is lost or when the program locks up for any reason.



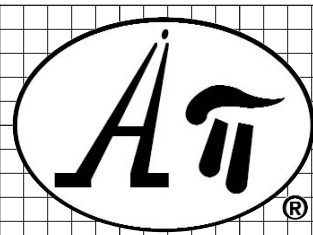
The **API 1700 G** Frequency Input Single Alarm Trip module monitors the 100 Hz analog output of the computer and holds its normally closed alarm trip contacts open as long as the output signal is present. If power is lost to the computer or if the program locks up, the contacts will return to their normally closed state and the battery powered alarm will be activated. Since the **API 1700 G** is powered from the same source as the process, the alarm will also be activated if power to the process is lost.



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### **Did You Know...?**

Api will do non-standard and special ranges on all of our modules.



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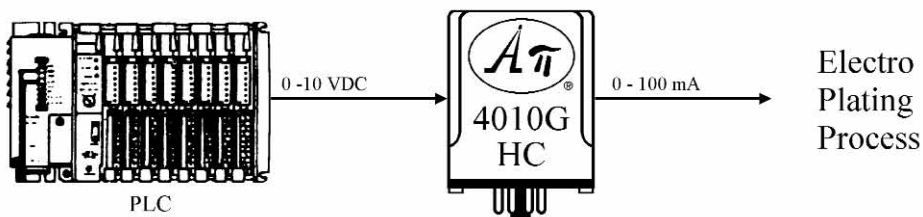
### Converting a Control Signal for a Process

#### PROBLEM

A programmable logic controller (PLC) is to be used to control an electroplating system which requires a 0-100 mA signal. The analog output of the PLC is 0-10 VDC and is not modifiable.

#### SOLUTION

An **API 4010 G HC** Non-isolated DC to DC Transmitter module is connected to the 0-10 VDC analog output of the PLC.



The **API 4010 G HC** converts the PLC output to the 0-100 mA required by the electroplating system.

#### Did You Know...

Most Api plug-in style modules are hot swappable?

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## Frequently Asked Questions – General

1. **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.
  
2. **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.
  
3. **How much can you vary the voltage using the output adjustment potentiometer on the API 9046-24?**  
 The output adjustment potentiometer is single turn and might provide about ±1.5 volts.
  
4. **Which direction do we turn the deadband potentiometer screw to give the minimum and the maximum deadband?**  
 For the minimum amount (1%), turn the potentiometer screw CCW, counter-clockwise. For the maximum amount (100%), turn the potentiometer screw CW, clockwise.
  
5. **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  

$$\text{total load} = \text{impedance of the instrument} + \text{impedance of the wire}$$
 For a 4-20 mA loop, our compliance voltage is 20 V which allows a total of 1000 ohm load. Also, to prevent problems from noise, it is recommended that you use shielded, twisted pair wires.
  
6. **For modules with a 4-20 mA output signal, what are the minimum and maximum output load resistance?**  
 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.
  
7. **What are the relay contacts rated for in your alarm output modules for a motor load?**  
 For inductive loads, our relay contacts are rated for 3.5 Amps Inductive at 250 VAC or 30 VDC.
  
8. **We have a relay alarm output and would like to adjust the set point for 5 VDC input and the reset point for 4 VDC input. How do we adjust the set point pot and the deadband pot to do this?**  
 The deadband is the difference in the input signal between the points at which the relay energizes and de-energizes. The midpoint between the set and reset points is 4.5 VDC. Turn the deadband pot fully counterclockwise for minimum deadband. With a 4.5 VDC input signal, turn the set point pot until the relay changes state. Then, increase the the input signal to 5 VDC. Turn the deadband pot clockwise until the relay changes state.
  
9. **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.
 

	<b>CURRENT Mode</b>	<b>VOLTAGE Mode</b>
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
  
10. **For your DC Input modules in the current mode, the input impedance rating is 50 ohms. For troubleshooting purposes, is that value the same with and without power applied to the module?**

Yes.

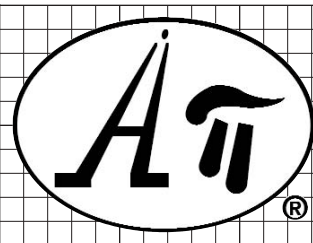
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### Did You Know...?

That the functional test pushbutton on all Api Alarm Trip modules will toggle the relays independent of the input signal.





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### Frequently Asked Questions - DC Inputs

1. Do you have a signal conditioner that will source up to an 800 mA output?

No. The highest outputs available are 100 mADC non-isolated (API 4010 G) and 50 mADC isolated (API 4300 G). The API 4300 G EXTSUP will sink up to 200 mADC with an external power supply.

2. We have a 4-20 mA input and require 4 set points at the output. Do you have a product for this?

Yes, you can connect 2 of our API 1020 G units in series in the 4-20 mA input loop since the input impedance for current is 50 ohms and the drop is very low.

3. I have an API 4385 G, with an input range of 12-20 mA and an output range of 4-20 mA. How do you set the offset so that when the input is 12 mA, the output will be 4 mA?

$$\text{Percent offset} = \text{Minimum Input Value} / \text{Input Span}$$

For this example it is  $12 / 8 = 1.5 \times 100 = 150\%$ . The offset chart with the API 4385 G allows for up to 100% making this a special. Set switches B, D, E to 3, 4, F.

4. Do you have a DC-DC transmitter that will accept an input of  $\pm 5$  VDC and provide an output of  $\pm 40$  mA, ideally a  $\pm 20$  mA minimum?

No, the maximum bipolar output we can provide is  $\pm 6$  mA and possibly  $\pm 10$  mA on the API 4300 G BP.

5. Can you provide a transmitter that will accept a 4-20 mA input and split the output to give two outputs that would be 4-20 mA for output 1 and 20-4 mA for output 2?

No. You can use two transmitters in series in the input loop to give the two outputs. Select the API 4380 G for the 4-20 mA output and an API 4385 G for the 20-4 mA output.

6. Do you have a 4-20 mA DC transmitter that can operate a load of 1800 to 2000 ohms?

The API 4300 G with a 4-20 mA output can operate a maximum load of 1000 ohms maximum with its 20 Volt compliance. To control a load of 1800-2000 ohms, you can use the API 4300 G EXTSUP. A 42 Volt power supply is required for the 1800 ohm load, and a 48 Volt power supply is required for the 2000 ohm load. The power supply voltage can not be less than these requirements or there will not be enough power to reach 20 mA. Also, the power supply can not be more than these requirements or the API 4300 G EXTSUP will be damaged.

7. We need a 0-10 VDC input with a 0-10 VDC output and be able to adjust the output down to any lower value from the linearized output, for example, if the input is 8 V, then the output can be 8 V or less. Is this possible?

Yes. Use the API 4300 G set up for 0-10 VDC in and 0-10 VDC output with a 10K ohm potentiometer at the signal input. One side of the pot would wire to the (+) signal, the other side of the pot. would wire to the (-) signal and terminal 6, then wire the wiper from the pot to terminal 5 of the module.

Continued on next page...

#### Did You Know...?

Api will do non-standard and special ranges for all of our products.

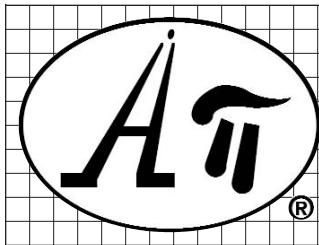
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## **Application Notes**

### **Frequently Asked Questions – DC Inputs**

8. Do you have a signal conditioner that will accept a 0-5 VDC input and provide an output of 0-500 mVDC?

Yes, the **API 4300 G** with these ranges specified at the time of ordering.

9. What is the output impedance of the **API 4380 G** for the 4-20 mA mode?

The output drive circuit uses a MOSFET which is an active device with an impedance of at least 100 K ohms or greater in the current mode.

10. Can we use the **API 4300 G** for an input signal of 500 VDC with the negative side of the signal floating and not at true ground?

It depends. The socket is rated to 600 VDC maximum. So with true ground on the socket at the output side, no other point on that socket can be above 600 VDC. Even though the **API 4300 G** is isolated and the input will accept the 500 VDC differential between terminals 5 and 6, the socket rating is between two points anywhere on the surface.

11. We would like to use the **API 4380 G DF** for the 100 microsecond response time but need an input range of 0 to 25 mV. Can you do this?

Yes, however the unit will be fixed for that input and the specified output. It will not be field selectable. The new part number will be **API 4300 G M80**. The **API 4300 G** does not offer a response time as fast as the **API 4380** product.

12. What is the fastest response time that is available in the **API 4385 G DF**?

This version offers a response time of 5 milliseconds.

13. What is the maximum current allowed for the 18 VDC unregulated loop power supply and what does the waveform look like?

The maximum current is 25 mA and the waveform is a filtered full wave rectified +18 V with a maximum ripple of 1.5 V p-p.

14. We are using a DCS system that requires a 4-20 mA isolated input which also provides 24 VDC to power the loop. Do you have an isolated signal conditioner that will sink the output loop?

Yes, the **API 4300 G EXTSUP**. This module controls the 4-20 mA output loop but derives the power from an external source. The connection from the output of the **API 4300 G EXTSUP** to the input of the DCS requires no additional components (resistors) other than the connecting wires.



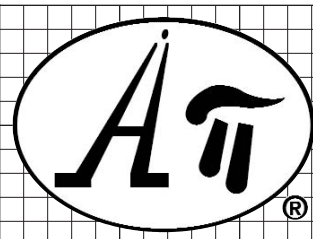
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#### **Did You Know...?**

Many PLC inputs are isolated only from the backplane they plug into and not channel to channel. Api's isolators can eliminate this problem.



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### **Frequently Asked Questions – Current Loops**

1. Are the API LPI-1 and the API LPI-2 UL recognized or listed ?

No. These should not be required for UL listing since the operating current and voltage are below the covered standards.

2. We have an API DPI-2. Can we have an input of 0-20 mA and an output of 0-20 mA?

No. The loop powered device requires a minimum of 4 mA to supply power to the module.

3. For the API DPI-2, what is the maximum voltage we can use with the 4-20 mA input loop?

60 VDC is the maximum voltage that can be used to power the input loop.

### **Frequently Asked Questions – RTDs**

1. Do you have a temperature differential unit that will measure a difference of 10° C between the two inputs?

Yes, the API 4001 G SA-B, but the two RTDs will require very precise matching ( $\pm 0.1\%$ ) and it would be helpful to know the operating temperature point so the factory can calibrate the unit precisely.

2. We are using an API 4001 G with an input of 0-100°C and output of 0-20 mA. If the input runs above 100°C (say 150°C) what will the output do?

The output will go higher, maybe to 21 mA but then stop there. If the output must remain at about 20 mA and go no higher, then a special clamp circuit can be ordered.

3. Will an API 4000 G work with an input temperature range of 1000 to 2000°F?

Yes, however to utilize the charts for selecting the switch positions in the field, we need to convert °F to °C. This would give 550°C to 1100°C which can be selected from the charts.

#### **Did You Know...?**

Api never charges an expediting fee and will accept American Express, MasterCard, and Visa credit cards.

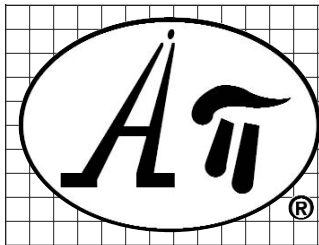
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### Frequently Asked Questions – Thermocouples

1. Will an API 4000 G work with an input temperature range of 1000 to 2000°F?

Yes, however to utilize the charts for selecting the switch positions in the field, we need to convert °F to °C. This would give 550°C to 1100°C which can be selected from the charts.

2. We have four of your API 4130 GL modules set for a K type thermocouple with an input range of 0-2000°F and an output range of 4-20 mA. For an input of 0°C, the outputs on all 4 units are calibrated to 4 mA. For an input of 2000°F, the outputs of all 4 units are calibrated to 20 mA. When the input is at 1000°F, the outputs of each of the 4 units is different (11.8, 11.9 etc.). Can better performance be achieved?

The linearity specification is  $\pm 0.5\%$  of span which is  $\pm 10^\circ\text{F}$  for a range of 2000°F. For an input of 1000°F, the output can vary from 990°F to 1010°F.

Also, output span / input temp range gives  $(20 - 4 = 16)$ ,  $16 \text{ mA} / 2000^\circ\text{F} = .008 \text{ mA per } ^\circ\text{F}$  for the entire range. For an input of 1000°F, the output can be in the range of 11.92 mA to 12.08 mA. You are getting 11.8, 11.9 etc. which are probably the variations in the accuracy of the four thermocouples, the extension wire, the thermocouple simulator, the multimeter and the wiring connections.

If you want Api to verify this with our NIST traceable simulators just call customer service at 800-942-0315 for an RMA number. The **API 4000 G** is even more accurate which should be used for high precision applications.

3. Can the API 1200 G provide a setpoint of 7°C and a reset point of 6°C with an overall temperature span of 0-10°C?

No. The minimum span we can operate in is a temperature difference equivalent to 5 mV of output change from the thermocouple. For example, a type J will produce 0.000 millivolts thermoelectric voltage at 0°C and 5.268 millivolts at 100°C. Therefore, the minimum temperature span is about 100°C. For the set point at 7°C and reset point at 6°C, the thermocouple itself has enough of a variance (usually 5%) to it that its output will not be exactly the same. So, we can not guarantee the repeatability of the system to trip at 7°C each time.

4. What is cold junction compensation and why is it necessary?

Cold junction compensation is required for accurate temperature measurement when using a thermocouple. A thermocouple junction, created whenever two dissimilar metals are connected together (such as Iron and Copper-Nickel), produces a potential difference that varies with temperature. Thermocouples generate a millivolt signal which increases in proportion to the difference in temperature between the hot and the cold junctions. Thermocouple tables are based on a standard 0°C cold junction temperature. Instruments designed to read thermocouples have a temperature sensor at the instrument connection point designed to electronically correct the reading to the 0°C standard. A millivolt meter can't be used to accurately read a thermocouple directly since it has no 0°C compensation. Additional connections with dissimilar metals create new thermocouple junctions also adding to the error if their temperature varies.



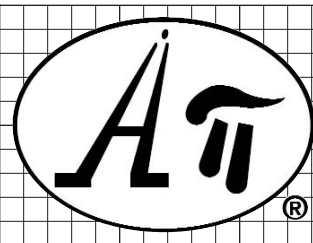
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#### Did You Know...?

That the **API 4000 G** can accept either thermocouples or RTDs.



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### Frequently Asked Questions – Frequency

1. Do you have a product that can provide an output signal of 5 KHz, 50% duty cycle, 20 mA max and 24 V p-p max with no input?

Yes, the API 7500G M03.

2. We have an application which requires a signal conversion of 1/2 Hz to 6 Hz input to a DC output. Do you have a signal conditioner to do this?

No. The minimum input frequency range that we offer is 0 to 15 Hz.

3. We have a PNP proximity sensor powered by the +18 VDC input loop supply of the Api 7580 G. It reads the flywheel gear teeth and a sends a frequency signal to the API 7580 G and works fine throughout the range. However, if the wheel is stopped with a tooth in-line with the sensor, the output will stay high (PNP output) and the API 7580 G output will go high to the maximum of the range. How can we prevent this?

The +18 volt loop supply from the API 7580 G has a maximum ripple of 1.5 V p-p so the high output from the prox sensor will have this ripple. The signal input to the 7580 G has a capacitor in series so any DC input charges, then opens the circuit. However with the ripple, there will be a 50/60 Hertz signal present.

You must use a magnetic pick-up in place of the proximity sensor since the amplitude signal from the magnetic pick-up will decrease as the flywheel slows down and when stopped, there will be no amplitude even with a tooth in-line with the sensor head. The magnetic pick-up generates its own signal as the field changes. When the field stops changing, the signal goes to zero.

4. Can you provide a module that will generate an output frequency (square wave) that we can vary between 55 and 75 Hz with No input signal?

Yes. Our API 7500 G M03 with a modification to utilize the test circuit that is adjustable with the test range potentiometer. The test circuit is disabled internally and is always on. With the span pot set to the middle of the range, adjust the test range pot to give an output of 65 Hz which is the center point for 55-75 and serves to orient the window. Then, use the span pot to adjust the output frequency from 55 to 75 (the window is actually about 40 Hz). The zero pot and the cutout pot are disabled and have no effect.

5. We have a 4-20 mA signal and want to convert it to a pulsed output of 0-270 pulses/minute so we can drive a counter. Can you do this?

Yes. Convert the output to Hertz (cycles/second) so  $270 / 60 = 4.5$  Hz. Our API 7500 G SS has an output range of 0-5 Hz and the span pot can adjust down by 10 % to allow for 0-4.5 Hz. The counter, which will trip on either rising or falling edges, can be set up to count at the edge of each cycle (square wave).

#### Did You Know...?

For frequency inputs of 0-100 Hz or greater, select the API 7580 G which is field range-able up to 0-30 KHz.

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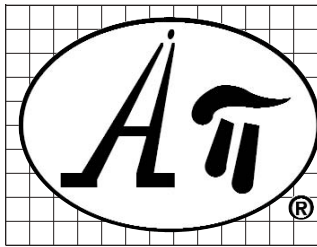
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## **Application Notes**

### **Frequently Asked Questions – Strain Gauges**

1. **What is the performance over the entire range for the API 4058 G? How well does the output track the input over the entire range?**

· The linearity specification for the **API 4058 G** is  $\pm 0.1\%$  of span. The **API 4059 G** is the same.

2. **What does the 70 msec response time mean on the API 4059 G? Are faster times available? If a signal with pulse width of less than 70 msec is present at the input, will it show up at the output?**

The output will track the input with about a 70msec delay. The **API 4059 G** can be factory set to 10 msec minimum. If a pulse of less than the response time (70 msec or 10 msec) occurs at the input, the output will not reveal it, or there might be a small blip.

3. **Is the API 4058 G approved for Europe's CE standards?**

No, but if the entire system in the application needs to be CE approved, then our unit does not.

4. **Our weighing scale uses a strain gauge with an excitation voltage of 10 V and a calibrated sensitivity of 2.2447 mV/V. The API 4058 G has been set up for an input of 0-20 mV by the OEM which supplied the equipment to us. Are these switch settings correct?**

If you are using all of the available range of the strain gauge, the maximum input signal to the module will be 22.447 mV which is beyond the switch settings. So, you need to verify the maximum load conditions and change the switch settings to 0-25 mV if required.

5. **When trying to adjust the span potentiometer on an API 4058 G the output signal, which drives a numerical display, jumps by too large an amount when barely turning the potentiometer screw. What is wrong?**

The resolutions of the zero and span potentiometers are related to the amount of turns of the pot screw and the amount of adjustment capability ( $\pm 15\%$ ). The factory can provide a finer resolution which means that the potentiometer screw must be turned more to have the same amount of change in signal, however the total amount of adjustment capability of the potentiometer will be reduced.

6. **We have a load cell application with a very low output signal and we would like to drive the cell with a higher excitation voltage (the load cell is rated 24 VDC max. and 10 VDC typical). Can your modules provide an excitation voltage higher than 10 VDC?**

No, however you can use an **API 9046-24** power supply with 24 VDC output to excite the load cell. The output signal would then be higher for the same load which could then drive an **API 4310 G**, narrow input span.

7. **We have your API 4059 G and are trying to set up the unit to allow a  $\pm 30$  mV input signal (3mV/V load cell operating in the tension/compression mode) with a  $\pm 10$  V output signal. The unit does not have a code to select for the input of  $\pm 30$  mV. Can we have this input option?**

No, the **API 4059 G** will not accept  $\pm 30$  mV and the span potentiometer does not have enough adjustment for this special range. You can lower the excitation voltage to 7 VDC so that you would have a  $\pm 20$  mV input (7V excitation  $\times$  3 mV/V = 21 mV). If isolation is not necessary, select the **API 4058 G** which allows a  $\pm 30$  mV to  $\pm 10$  VDC input/output combination.



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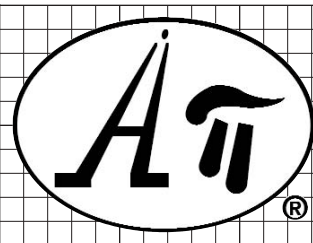
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#### **Did You Know...?**

The **API 4059 G** is standard with non-interacting zero and span adjust.





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### Frequently Asked Questions - Strain Gauges

8. What would be the input range for our load cell that has a maximum capacity of 200 pounds, an excitation voltage of 10 VDC, a rating of 2 mV/V, operating in the tension/compression mode, and measuring 75 pounds full scale?

Full scale input to our module would be  $(75 / 200) \times 10 \text{ V} \times 2 \text{ mV/V} = 7.5 \text{ mV}$ . For tension and compression, the signal will be  $\pm 7.5 \text{ mV}$ .

9. We have two load cells and wish to wire them to your API 4059 G. How do we accomplish this?

Connect both load cells in parallel. Each load cell would be wired the same, excitation voltage and return signals, to the API 4059 G so there would be two sets of wires to terminals 4 & 5 and 7 & 8.

10. We have an API 4058 G and need to set it up with a load cell for tension and compression operation. The load cell has a sensitivity of 2 mV/V and a maximum capacity of 50 pounds. Our largest load will be 40 pounds. We also need the output to provide a 4-20 mA signal. What are the switch settings?

The maximum input signal to our module will be  $\pm(40/50 \times \text{Excitation Voltage} \times 2 \text{ mV/V})$ . This input value needs to be close to one of the available input ranges for the API 4058 G. If we had an excitation voltage of 10 V, then the input signal would be  $\pm 16 \text{ mV}$  which would be 25% too low for the  $\pm 20 \text{ mV}$  range since the zero & span potentiometers only have  $\pm 15\%$  adjustment. The excitation voltage should be lowered to provide an input signal that is close to our next lower range of  $\pm 10 \text{ mV}$ . If the excitation voltage is set to 6 V, then the signal from the load cell will be  $\pm(40/50 \times 6 \times 2) = 9.6 \text{ mV}$ . Then we can adjust the zero and span potentiometers to allow a 4 mA output for a  $-9.6 \text{ mV}$  input and a 20 mA output for a  $+9.6 \text{ mV}$  input.

11. We use an API 4059 G with a load cell that comes with a calibration resistor to simulate 80% of full load. The load cell will be used in both the tension and compression modes. How do we connect the calibration resistor to your API 4059 G?

For both tension and compression modes, the signal will be bipolar ( $\pm$ ). The tension mode (negative) places the resistor between the (+) excitation signal, terminal 7, and the (-) signal input, terminal 5. This will simulate  $-80\%$  of full tension load. To calibrate the output, adjust the zero potentiometer to set the output to 10% of span.

The compression mode (positive) places the resistor between the (+) excitation signal, terminal 7, and the (+) signal input, terminal 4. This will simulate  $+80\%$  of full compression load. To calibrate the output, adjust the span potentiometer to set the output to 90% of span.

Total span is  $\pm 100\%$  (bipolar) = 200% of full capacity, with 100% being the midpoint.

$$-80\% = 20\% / 200\% = 10\%$$

$$+80\% = 180\% / 200\% = 90\%$$

12. We have 4 load cells in our application each with a resistance of 350 ohms. Can we use your API 4051 G in this application?

No. The API 4051 G excitation circuit can only source 30 mA maximum. Since your 4 load cells require about 114 mA total current, you must use either the API 4058 G or the API 4059 G.

#### Did You Know...?

The API 4059 G comes standard with field adjustable excitation supply, tare offset, input sensitivity and DC voltage or current output.

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## ***Frequently Asked Questions - Valve Actuator***

**1. 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?**

- Set the deadband potentiometer fully CCW (counter-clockwise). Apply the minimum signal (0 VDC) to both the feedback (terminals 6 & 7) and the control (terminals 4 & 5). 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.

Now apply the maximum signal (10 VDC) to both the feedback and the control inputs. 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.

Finally, 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. Using 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. Change the feedback voltage to the desired deadband position. Rotate the deadband potentiometer CW (clockwise) until the relay changes state.

**2. 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 deadband configured, an output relay must change state to provide for 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, then then continuity will be from the common (9) to closed (10).



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### **Did You Know...?**

All Api plug-in and DIN-style modules are covered by a LIFETIME WARRANTY.