Thermocouple & RTD to DC Isolator & Transmitter

Discontinued see APD 4000

API 4000 G

Input: Most Thermocouple and RTD Types
Output: 0-1 V to ±10 VDC or 0-2 mA to 4-20 mA

Field Selectable One Minute Setup!

- ● **Microprocessor-Based with Self Diagnostic LED**
- ● **Automatic Cold Junction Compensation**
- ● **Output LoopTracker® LED**
- ● **Functional Test Pushbutton**
- ● **2000 V Full Isolation Input/Output/Power**

LIFETIME WARRANTY

3.45"
2.38"
1.75"
0.5"

Diagnostic LED
Test Switch
Test Range
Zero
Span
Output Loop-Tracker
Miniature Series
NEG.
POS.

Free Factory Input & Output Calibration!

Applications

■ **Isolate, Linearize, Transmit RTD or T/C Signals**

■ **One Unit to Handle Most RTD and T/C Sensors!**

Specifications

Thermocouple and RTD Types
The **API 4000 G** accepts one thermocouple or one RTD input
J, K, T, E, R, S, Platinel II. Consult factory thermocouple types N or C
100 Ω DIN, 100 Ω American, 10 Ω Cu, 1000 Ω Ni-Fe, 120 Ω Ni

Cold Junction Compensation
Automatic for selected T/C

Thermocouple Burnout Protection
Upscale standard, downscale available via internal jumper

Thermocouple Current
Less than 1.0 µA

RTD Resistance
10 Ω to 1000 Ω

RTD Leadwire Compensation
Less than ±0.05% of span per 1 Ω change in leadwire resistance

RTD Excitation Current
10 Ω to 120 Ω RTD: 1.25 mA   1000 Ω RTD: 0.1 mA

Linearization
12 segment T/C digital linearization, 8 segment RTD digital linearization

LoopTracker
Variable brightness LEDs indicate input/output loop level and status
Input LED diagnostic functions–see table on back

Output Ranges
Call factory for other ranges

	Minimum	Maximum	Load Factor
Voltage:	0-1 VDC	0-10 VDC	
Bipolar Voltage:	±1 VDC	±10 VDC	
Current (20 V compliance):	0-2 mADC	0-20 mADC	1000 Ω at 20 mA

Output Zero and Span
Multiturn potentiometers to compensate for load and lead variations
±12% of span adjustment range typical

Accuracy
Better than ±0.33% of span, includes temperature, linearity, hysteresis effects

Response Time
300 milliseconds

Output Linearity
Better than ±0.1% of span

Output Ripple and Noise
Less than 10 mV$_{RMS}$

Functional Test Button
Sets output to test level when pressed. Potentiometer factory set to approximately 50% of span, adjustable 0 to 100% of span

Isolation
2000 V$_{RMS}$ min. Full isolation: power to input, power to output, input to output
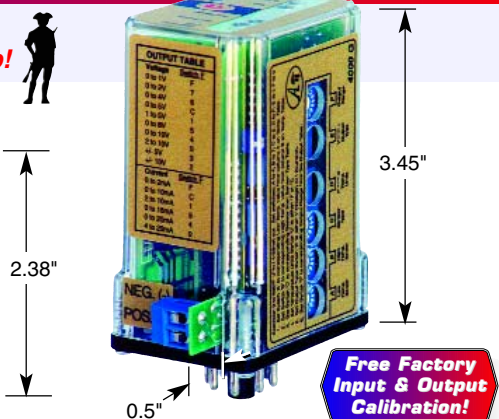
Ambient Temperature Range
−10°C to +60°C operating

Power
Standard: 115 VAC ±10%, 50/60 Hz, 2.5 W max.
A230 option: 230 VAC ±10%, 50/60 Hz, 2.5 W max.

Input Ranges

Sensor Type	°C Range	°F Range	Minimum Span
RTD 100 Ω DIN	–200 to 700°C	–250 to 1200°F	50°C or 50°F
RTD 100 Ω American	–200 to 800°C	–250 to 1300°F	50°C or 50°F
RTD 10 Ω Cu	–200 to 200°C	–250 to 500°F	100°C or 150°F
RTD 1000 Ω Ni-Fe	0 to 200°C	0 to 500°F	50°C or 50°F
RTD 120 Ω Ni	–50 to 300°C	–100 to 600°F	50°C or 50°F
T/C type J	–200 to 700°C	–250 to 1300°F	100°C or 200°F
T/C type K	–250 to 1200°C	–250 to 1300°F	100°C or 200°F
T/C type T	–200 to 400°C	–250 to 700°F	100°C or 200°F
T/C type E	–250 to 900°C	–250 to 1300°F	100°C or 150°F
T/C type R	0 to 1300°C	0 to 1300°F	450°C or 850°F
T/C type S	0 to 1300°C	0 to 1300°F	450°C or 800°F
Platinel II	0 to 1200°C	50 to 1300°F	150°C or 300°F

Description and Features

The microprocessor-based **API 4000 G** accepts either a thermocouple or RTD input and provides a linearized and isolated DC voltage or current analog output. The **API 4000 G** can be field-configured for sensor type, temperature range, output type and range via external rotary and slide switches with all set-up information on the module labels.

The **API 4000 G** uses 12-bit A/D and D/A conversion, 8-segment linearity correction and digital isolation for an overall accuracy of ±0.33%. Full 3-way (input, output, power supply) isolation makes this module useful for ground loop elimination, common mode signal rejection or noise pickup reduction.

API exclusive features include two *LoopTracker* LEDs and a **Functional Test Pushbutton**. The LoopTracker LEDs vary in intensity with changes in the input and output signals. The input LED also offers diagnostic functions to aid in setup. The functional test pushbutton provides a fixed output (independent of the input) when held depressed. The test output level can be field-adjusted via a multiturn potentiometer. Monitoring the state of these LEDs can provide a quick visual picture of your process loop at all times and the functional test pushbutton greatly aids in saving time during initial startup and/or troubleshooting.

The **API 4000 G** plugs into an industry standard 8-pin octal socket. Order sockets **API 008** or finger-safe **API 008 FS** for either DIN rail or panel mounting.

Models & Options

Call Factory For Availability. See factory ranged units or V624 Programmable Temperature Transmitter (Catalog page 219)

API 4000 G   Field rangeable temperature transmitter, 115 VAC. Free factory setup—specify input type, temperature range in °F or °C

Options—Add to end of model number
A230   Powered by 230 VAC, 50/60 Hz
B   Downscale T/C burnout protection instead of upscale
U   Conformal coating for moisture resistance

Accessories—Order as a separate line item
API 008   8-pin socket
API 008 FS   8-pin finger safe socket
API TK36   DIN rail, 35 mm W x 39" L, aluminum

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Temperature

ELECTRICAL CONNECTIONS

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

Never connect a temperature sensor to both the module socket and the thermocouple. The module will be damaged.

Power Input Terminals – The white label on the side of the API module will indicate the power requirements. AC power is connected to terminals 1 and 3.

Thermocouple Input – The connection block is located on the side of the module. Polarity must be observed. With thermocouples, the red wire is connected to the negative (–) terminal.

RTD Input – The connections are made to the 8-pin socket. You may wish to check the RTD sensor with an ohmmeter before connecting since RTD wire color-coding varies. The red (or black) wire is connected to terminal 6 and the other two wires with the same color are connected to terminals 4 and 5. When using a 2-wire RTD install a jumper from terminal 4 to terminal 5.

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

T/C Connection Block on Module   *For a 2-wire RTD install a jumper from terminal 4 to terminal 5*

Socket top view
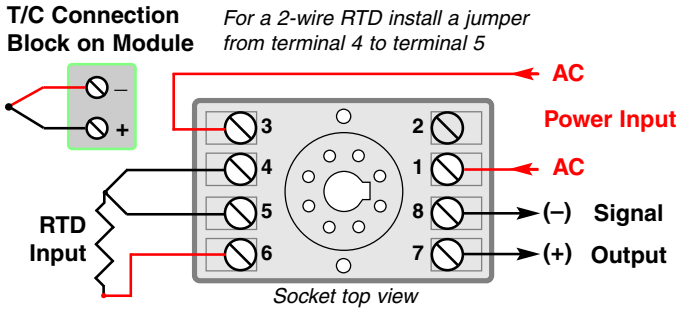
RANGE SELECTION

Four rotary switches and two slide switches located on the side of the module are used to select input and output ranges. Standard ranges are listed on the module labels and at right. Contact factory for special ranges.

1. Find the **Low Temperature** range in the table. Set rotary switch **A** to the position that corresponds to this value.
2. Find the **High Temperature** range in the table. Set rotary switch **B** to the position that corresponds to this value.
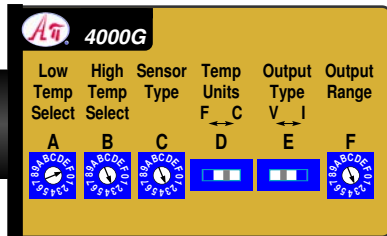
3. Find your **Sensor Type** in the table. Set rotary switch **C** to the letter or number position that corresponds to your sensor type.
4. Set **Temp Units** slide switch **D** to °F or °C depending on temperature units.
5. Set **Output Type** slide switch **E** to voltage or (**V**) current (**I**).
6. Find your **Output Range** in the table. Set rotary switch **F** to the letter or number position that corresponds to your sensor type.
7. The Zero, Span and Test Range potentiometers can now be adjusted.

CALIBRATION

Input and output ranges are listed on module labels. Custom ranges may require factory modification. Top-mounted, Zero and Span potentiometers can be used should fine-tuning of the output be necessary.

1. Apply power to the module and allow a minimum 20 minute warm up time.
2. Using an accurate temperature simulator, provide an input to the module equal to the minimum input required for the application.
3. Connect an accurate measurement device to the output. Adjust the Zero potentiometer for the exact minimum output desired. The Zero control should only be adjusted when the input signal is at its minimum to produce the corresponding minimum output signal. Example: for a 4-20 mA output signal, the Zero control will allow adjustment of the 4 mA or low end of the signal.

CALIBRATION (Continued)

4. Set the input at maximum, and then adjust the Span pot for the exact maximum output desired. The Span control should only be adjusted when the input signal is at its maximum. This will produce the corresponding maximum output signal. Example: for 4-20 mA output signal, the Span control will provide adjustment for the 20 mA or high end of the signal.
5. Repeat adjustments for maximum accuracy.

TEST BUTTON & TEST RANGE

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

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

OPERATION

The API 4000 G microprocessor reads sensor and temperature range configuration settings and electronically switches to the RTD amplifier, which includes leadwire compensation circuitry, or the thermocouple amplifier. The resulting signal is applied to a 12-bit analog-to-digital (A/D) converter. For thermocouples, the microprocessor reads the sensor temperature and compensates for the cold junction sensor in the T/C connector block. The digital temperature value is optically isolated and sent to the 12-bit digital-to-analog output circuitry. The output range and type selector switches determine the actual output generated.

GREEN LoopTracker® Input & Diagnostic LED – Provides a visual indication that a signal is being sensed by the module input circuitry. It also indicates the input signal strength by changing in intensity as the process changes from minimum to maximum. Failure to illuminate, or change in intensity as the process changes, may also indicate a problem with module power or signal input wiring.

This LED can also flash to give the operator feedback on the input status.

2 Flashes	Under-range condition or shorted sensor
3 Flashes	Over-range condition or open sensor
4 Flashes	Invalid sensor selection
5 Flashes	Invalid sensor range
6 Flashes	Insufficient Span
7 Flashes	Excessive low-end-to-span ratio (offset greater than the span)

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

Switch Settings

Low Temp	A	High Temp	B	Sensor Type	C	Temp Units	D	Output Type	E	Output Range	F
–250	0	–100	0	100 Ω DIN	0	°F	F	Voltage	V	0-1 V	F
–200	1	0	1	100 Ω Amer.	1	°C	C			0-2 V	7
–100	2	50	2	10 Ω Cu	2					0-4 V	6
–50	3	100	3	1000 Ω Ni-Fe	3					0-5 V	C
0	4	200	4	120 Ω Ni	4					1-5 V	1
50	5	300	5	J T/C	5					0-8 V	5
100	6	400	6	K T/C	6					0-10 V	4
150	7	500	7	T T/C	7					2-10 V	0
200	8	600	8	E T/C	8					±5 V	3
250	9	700	9	R T/C	9					±10 V	2
300	A	800	A	S T/C	A			Current	I	0-2 mA	F
350	B	900	B	Platinel II	B					0-10 mA	C
400	C	1000	C							2-10 mA	1
450	D	1100	D							0-16 mA	5
500	E	1200	E							0-20 mA	4
550	F	1300	F							4-20 mA	0

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

Temperature

Common Thermocouple Specifications

Type	Polarity & Material	Wire ID Properties	Pol./Wire Colors	Practical Temp Range	Outer Insulation	Limits of Error
J	+ 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% of rdg
K	+ 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% of rdg
N	+ 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
T	+ Copper	Copper color	+ Blue	–299 to 700°F	Blue (Ext. grade)	±1.5°F or ±0.8% 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
E	+ Chromel	Greater stiffness	+ Purple	32 to 1652°F	Purple (Ext. grade)	±3°F or ±0.5% of rdg
	– Constantan		– Red	0 to 900°C	Brown (T/C grade)	±1.8°F or ±0.4% of rdg
R	+ 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
S	+ 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 type must be the same type as the thermocouple type.
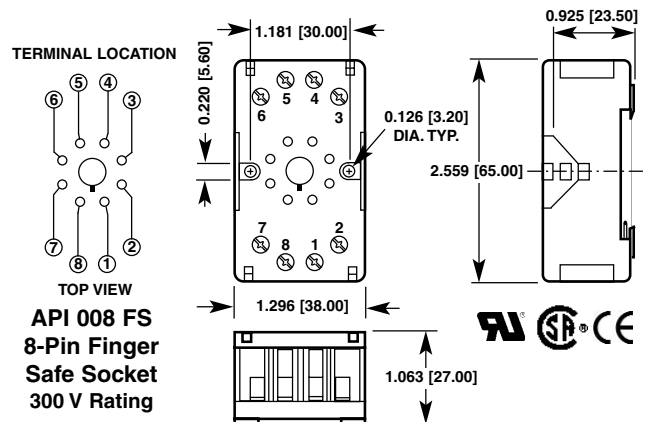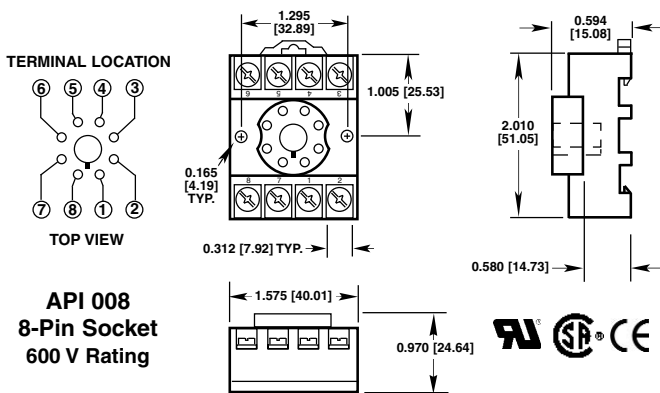
Atmosphere for exposed junction
Type **J**　　　　　　Reducing
Type **K** or **N**　　Clean oxidizing
Type **T**　　　　　　Mildly oxidizing and reducing or with moisture
Type **E**　　　　　　Vacuum, inert mildly oxidizing or reducing
Type **R** or **S**　　Resists oxidation and corrosion, but contaminated by hydrogen, carbon, and metal vapors

TEMPERATURE CONVERSION

　　　　°F = (°C x 9/5) + 32　　　　　　　°C = (°F – 32) x 5/9

API 008 and API 008 FS Sockets

TERMINAL LOCATION

TOP VIEW

**API 008
8-Pin Socket
600 V Rating**

1.295 [32.89]
1.005 [25.53]
0.165 [4.19] TYP.
0.312 [7.92] TYP.
1.575 [40.01]
0.970 [24.64]
0.594 [15.08]
2.010 [51.05]
0.580 [14.73]

TERMINAL LOCATION

TOP VIEW

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

1.181 [30.00]
0.220 [5.60]
1.296 [38.00]
1.063 [27.00]
0.126 [3.20] DIA. TYP.
0.925 [23.50]
2.559 [65.00]

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Call Aπ Customer Service
800-942-0315

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Temperature

Frequently Asked Questions

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.

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 that 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, and any additional connections with dissimilar metals creates new thermocouple junctions adding to the error.

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 ±0.5% of span which is ±10°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 mA / 2000°F = .008 mA per °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.

Temperature Conversions and Information

From	To	Formula
Fahrenheit	Celsius	$°C = (°F – 32) / 1.8$
Fahrenheit	kelvin	$K = (°F + 459.67) / 1.8$
Fahrenheit	Rankine	$°R = °F + 459.67$
Fahrenheit	Réaumur	$°Re = (°F – 32) / 2.25$
Celsius	Fahrenheit	$°F = °C × 1.8 + 32$
Celsius	kelvin	$K = °C + 273.15$
Celsius	Rankine	$°R = °C × 1.8 + 32 + 459.67$
Celsius	Réaumur	$°Re = °C × 0.8$
kelvin	Celsius	$°C = K – 273.15$
kelvin	Fahrenheit	$°F = K × 1.8 – 459.67$
kelvin	Rankine	$°R = K × 1.8$
kelvin	Réaumur	$°Re = (K – 273.15) × 0.8$
Rankine	Celsius	$°C = (°R – 32 – 459.67) / 1.8$
Rankine	Fahrenheit	$°F = °R – 459.67$
Rankine	kelvin	$K = °R / 1.8$
Rankine	Réaumur	$°Re = (°R – 459.67 – 32) / 2.25$
Réaumur	Celsius	$°C = °Re × 1.25$
Réaumur	Fahrenheit	$°F = °Re × 2.25 + 32$
Réaumur	kelvin	$K = °Re × 1.25 + 273.15$
Réaumur	Rankine	$°R = °Re × 2.25 + 32 + 459.67$

The **Celsius** scale (°C), sometimes referred to as the "centigrade" scale, was devised by Swedish astronomer Andres Celsius (1701-1744) for scientific purposes. It has 100 degrees between the freezing point of 0 °C and boiling point of 100 °C of pure water at a standard air pressure of 29.92 inches of mercury. The term Celsius was adopted in 1948 by an international conference on weights and measures to replace the term centigrade. This is the most widely used temperature scale in the world.

The **Fahrenheit** scale (°F) is used primarily in the United States. The freezing point of water is 32 °F and the boiling point is 212 °F while measured at a standard air pressure of 29.92 inches of mercury. What then is 0 °F based on? 0 °F was the coldest temperature that Dr. Gabriel Daniel Fahrenheit (1686-1736) could create with a mixture of ice and salt. He is credited with the invention of the mercury thermometer introducing it and the °F scale in 1714. His thermometer was based on a design by Galileo.

The absolute or **kelvin** (K) scale is used primarily for scientific work. It was invented by William Thomson, also know as Lord Kelvin. The hypothetical temperature characterized by a complete absence of heat energy and the point at which molecular motion would theoretically stop is –273.15 °C or "absolute zero". The kelvin scale uses this number as 0 K with divisions being the same as the Celsius scale. Temperatures on this scale are called kelvins, thus the degree symbol is not used with the capital "K" symbol, nor is the word kelvin capitalized when referring to the temperature units.

A scale lesser-known today was created by R A F de **Réaumur** (1683-1757). He used the freezing point of water as 0 °Re and the boiling point at 80 °Re. It was used in the 18th and 19th centuries mainly in France for scientific work, but is still used today by some European wine and cheese makers.

W J M **Rankine** (1820-1872) created this scale, which was merely the kelvin scale using the Fahrenheit degree instead of the Celsius. It has been used in some scientific and thermodynamics work but is not commonly used today.

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800-942-0315

API maintains a constant effort to upgrade and improve its products. Specifications are subject to change without notice. Consult factory for your specific requirements.   **For Your Local Area Representative See** *www.api-usa.com*