Strain Gauge/Bridge/Load Cell/Pressure Transducer to DC Transmitters, Field Rangeable  
APD 4059

- Drive up to Four 350 Ω Bridges
- Adjustable Excitation Power Supply
- Sense Lead Compensation
- One Minute Setup for Hundreds of I/O Ranges
- Removable Plugs for Faster Installation
- Non-Interactive Zero and Span
- Full 3-Way Input/Output/Power Isolation
- Input and Output LoopTracker® LEDs
- Output Test or Calibration Resistor Options

Applications
- Load Cell Weighing Systems and Scales
- Strain Gauge Pressure Sensors and Transducers
- Tanks, Scales, Extruder Melt Pressure, Crane Loads

Strain Gauge Input Ranges
100 Ω to 10,000 Ω bridges at 10 VDC
Up to four 350 Ω bridges at 10 VDC

Minimum: 0 to 5 mV range
0.5 mV/V sensitivity
Maximum: 0 to 400 mV range
40 mV/V sensitivity

Millivolt output range is determined by the sensor sensitivity (mV/V) and the excitation voltage:
mV sensitivity \times excitation voltage = total mV range

Input Impedance
200 kΩ typical

Common Mode Rejection
100 dB minimum

Calibration Resistor Options
- M01 option: Switch with calibration resistor inside module. Specify resistor value.
- M02 option: Switch for external (load cell) calibration resistor.

Excitation Voltage
- Switch Selectable: 0-10 VDC in 1 V increments
- Maximum Output: 10 VDC maximum at 120 mA
- Drive Capability: Up to four 350 Ω bridges at 10 VDC
- Fine Adjustment: ±5% via multi-turn potentiometer
- Stability: ±0.01% per °C

Sense Lead Compensation
Better than ±0.01% per 1 Ω change in leadwire resistance
Maximum leadwire resistance: 10 Ω with 350 Ω at 10 VDC

LoopTracker
Variable brightness LEDs for input/output loop level and status
DC Output Ranges
Voltage (10 mA max.): 0-1 VDC to 0-10 VDC
Bipolar Voltage (±10 mA max.): ±5 VDC or ±10 VDC
Current: 0-2 mA DC to 0-20 mA DC
Compliance, drive at 20 mA: 20 V, 10,000 Ω drive
Current output can be selectively wired for sink or source

Output Calibration
Multi-turn zero and span potentiometers
±15% of span adjustment range typical
Zero offset switch: ±100% of span in 15% increments

Output Test
Sets output to test level when pressed
Adjustable 0-100% of span
Not available with M01 or M02 options

Output Ripple and Noise
Less than 10 mVrms ripple and noise

Linearity
Better than ±0.1% of span

Ambient Temperature Range and Stability
−10°C to +60°C operating ambient
Better than ±0.02% of span per °C stability

Response Time
70 milliseconds typical (14.2 Hz)
DF option: 10 millisecond response time typical (100 Hz)
Contact factory for custom response times

Isolation
1200 Vrms min.
Full isolation: power to input, power to output, input to output

Housing and Connectors
IP 40, requires installation in panel or enclosure
For use in Pollution Degree 2 Environment
Mount vertically to a 35 mm DIN rail
Four 4-terminal removable connectors
14 AWG max wire size

Dimensions
0.89” W x 4.62” H x 4.81” D
22.5 mm W x 117 mm H x 122 mm D
Height includes connectors

Power
Standard: 85-265 VAC, 50/60 Hz or 60-300 VDC
D option: 9-30 VDC (either polarity) or 10-32 VAC
Power: 2 to 5 Watts depending on number of load cells

Description
The APD 4059 accepts an input from one to four strain gauges, bridge type sensors, load cells, or pressure transducers. It filters, amplifies, and converts the resulting millivolt signal into the selected DC voltage or current output that is linearly related to the input.

The full 3-way (input, output, power) isolation makes this module useful for ground loop elimination, common mode signal rejection or noise pickup reduction.

The adjustable excitation power supply generates a stable source of voltage to drive from one to four 350 Ω (or greater) devices. Sense lead circuitry is included to cancel the effects of leadwire resistance, if required.

Input, output, excitation and zero offset are field configurable, via external rotary and slide switches. Offsets up to ±100% of span can be used to cancel sensor offsets or non-zero deadweights (taring). Non-interactive zero and span simplifies calibration.

Output Test
An API exclusive feature includes the test button to provide a fixed output (independent of the input) when held depressed. The output test button greatly aids in saving time during initial startup and/or troubleshooting. The test output level is potentiometer adjustable from 0 to 100% of output span.

The output test is not available with the M01 or M02 options. A calibration resistor switch replaces the test button.

Model | Input | Output | Power
--- | --- | --- | ---
APD 4059 | Field configurable. Specify the following if factory is to set switches | Bridge mV/V or mA range Excitation voltage | 85-265 VAC or 60-300 VDC
APD 4059 D | Field configurable. Specify following if factory is to set switches | Output range Output type (V or mA) | 9-30 VDC or 10-32 VAC

Options—add to end of model number
- M01 Switch with built-in calibration resistor. Specify resistor value.
- M02 Switch for external calibration resistor.
- DF 10 millisecond response time, or consult factory. DF option will cause output noise levels to be greater than standard specifications.
- U Conformal coating for moisture resistance

Sink/Source Versatility
For maximum versatility the APD 4059 milliamper output can be selectively wired for sinking or sourcing. This allows connection to any type of mA input receiving device.

LoopTracker
API exclusive features include two LoopTracker LEDs (green for input, red for output) that vary in intensity with changes in the process input and output signals. These provide a quick visual picture of your process loop at all times and can greatly aid in saving time during initial startup and/or troubleshooting.

APIusa.com
Precautions

WARNING! All wiring must be performed by a qualified electrician or instrumentation engineer. See diagram for terminal designations and wiring examples. Consult factory for assistance.

WARNING! Avoid shock hazards! Turn signal input, output, and power off before connecting or disconnecting wiring, or removing or installing module.

Précautions

ATTENTION! Tout le câblage doit être effectué par un électricien ou ingénieur en instrumentation qualifié. Voir le diagramme pour désignations des bornes et des exemples de câblage. Consulter l’usine pour assistance.

ATTENTION! Éviter les risques de choc! Fermez le signal d’entrée, le signal de sortie et l’alimentation électrique avant de connecter ou de déconnecter le câblage, ou de retirer ou d’installer le module.

API maintains a constant effort to upgrade and improve its products. Specifications are subject to change without notice. See api-usa.com for latest product information. Consult factory for your specific requirements.

WARNING! This product can expose you to chemicals including nickel, which are known to the State of California to cause cancer or birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Range Selection

It is generally easier to select ranges before installing the module on the DIN rail. The tables list available settings for excitation voltages, ranges and offsets. Any custom range settings will be listed on the module’s serial number label.

Rotary switches and a slide switches on the side of the module are used to select input and output ranges to match your application.

Switch A: Excitation voltage
Switch B: Input range
Switch C: Input offset
Switch D: Output range
Switch E: Set to “V” for voltage output or “I” for current output.

Determine how much output in millivolts the load cell will produce at full load. Multiply the manufacturer’s mV/sensitivity specification by the applied excitation voltage.

For example, a load cell rated for 3 mV/V sensitivity using 10 VDC excitation will produce an output of 0 to 30 mV for load variations from 0 to 100%.

3 mV/V sensitivity X 10 VDC excitation = 30 mV range

Switch A Excitation Voltage

Refer to the sensor manufacturer’s recommendations to determine what excitation voltage to use.

Set Excitation rotary switch A to desired excitation voltage. After installation the Excitation fine adjust potentiometer may be used to precisely trim this voltage, if desired.

Using Offset Switch C

Offset switch C allows canceling or taring of non-zero deadweights or other sensor offsets such as:

- Compensate for tare weights or scale deadweight to get zero output when a load is on the platform.
- Compensate for low-output sensors (e.g., less than 1 mV/V) that may have large zero offsets. Switch C can realign the zero control so it has enough range to produce a zero output.
- Raising the offset to allow calibration of bipolar sensors such as ±10 mV.
- Lowering the offset to compensate for elevated input ranges such as 10-20 mV.

1. Switch C does not interact with any other switch and is the only switch needed to correct zero offsets. Its only purpose is to adjust or cancel effects of the low end of the input range not corresponding nominally to 0 mV. Setting this switch to “0” results in no offset.
2. To RAISE the output zero, rotate switch C from “1” thru “7”, until the Zero control can be set for your application.
3. To LOWER the output zero, rotate switch C from “9” thru “F”, until the Zero control can be set for your application.
4. If switch positions are changed, repeat the calibration procedure on the last page.

I/O Range Selection Switches B, D, E

1. Set switch E to “V” for voltage output or “I” for current output.
2. For taring, deadweight, zero offset, or a bipolar sensor refer to the “Offset Switch C” section on right. Otherwise set switch C to zero.
3. Set switch E to “V” for voltage output or “I” for current output.
4. For ranges that fall between the listed ranges use the next highest setting and trim the output signal with the zero and span potentiometers as described in the Calibration section.

Output Specifications

Precautions, Range Setup

APD 4059

<table>
<thead>
<tr>
<th>Output</th>
<th>0-1 V</th>
<th>0-2 V</th>
<th>0-4 V</th>
<th>1-5 V</th>
<th>0-5 V</th>
<th>0-8 V</th>
<th>2-10 V</th>
<th>0-10 V</th>
<th>±5 V</th>
<th>±10 V</th>
<th>0-2 mA</th>
<th>0-4 mA</th>
<th>0-8 mA</th>
<th>2-10 mA</th>
<th>0-10 mA</th>
<th>0-16 mA</th>
<th>4-20 mA</th>
<th>0-20 mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switches</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
<td>BCDE</td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-10 mV</td>
<td></td>
<td>200V</td>
<td>208V</td>
<td>201V</td>
<td>206V</td>
<td>209V</td>
<td>202V</td>
<td>207V</td>
<td>203V</td>
<td>204V</td>
<td>205V</td>
<td>2001</td>
<td>2081</td>
<td>2011</td>
<td>2061</td>
<td>2091</td>
<td>2021</td>
<td>2071</td>
</tr>
<tr>
<td>0-20 mV</td>
<td></td>
<td>300V</td>
<td>308V</td>
<td>301V</td>
<td>306V</td>
<td>309V</td>
<td>302V</td>
<td>307V</td>
<td>303V</td>
<td>304V</td>
<td>305V</td>
<td>3001</td>
<td>3081</td>
<td>3011</td>
<td>3061</td>
<td>3091</td>
<td>3021</td>
<td>3071</td>
</tr>
<tr>
<td>0-25 mV</td>
<td></td>
<td>600V</td>
<td>608V</td>
<td>601V</td>
<td>606V</td>
<td>609V</td>
<td>602V</td>
<td>607V</td>
<td>603V</td>
<td>604V</td>
<td>605V</td>
<td>6001</td>
<td>6081</td>
<td>6011</td>
<td>6061</td>
<td>6091</td>
<td>6021</td>
<td>6071</td>
</tr>
<tr>
<td>0-30 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-40 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-50 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-100 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-120 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-200 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-250 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-300 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
<tr>
<td>0-400 mV</td>
<td></td>
<td>000V</td>
<td>008V</td>
<td>001V</td>
<td>006V</td>
<td>009V</td>
<td>002V</td>
<td>007V</td>
<td>003V</td>
<td>004V</td>
<td>005V</td>
<td>0001</td>
<td>0081</td>
<td>0011</td>
<td>0061</td>
<td>0091</td>
<td>0021</td>
<td>0071</td>
</tr>
</tbody>
</table>
M01 Option: Internal Calibration Resistor
The APD 4059 M01 has a user-specified internal calibration resistor. A switch on the front of the module allows switching of the APD’s internal calibration resistor in or out of the circuit. The sensor manufacturer should provide the percentage of full-scale output for the transducer when using the APD’s internal resistor for calibration.

M02 Option: Load Cell Calibration Resistor
The APD 4059 M02 has provisions for a load cell with its own calibration resistor. A switch on the front of the module allows switching of the load cell internal calibration resistor in or out of the circuit. Refer to the load cell manufacturer’s specifications and the wiring diagram when connecting a transducer with its own internal calibration resistor.

The transducer’s calibration resistor wires are connected to terminals 5 and 11 on the APD 4059. If the transducer only has one calibration resistor wire, connect it to terminal 5.

Input
Refer to strain gauge manufacturer’s data sheet for wire color-coding and identification. Polarity must be observed when connecting inputs.

CAUTION: Do not miswire the load cell and never short the excitation leads together. This will cause internal damage to the module.

No Sense Leads
When no sense leads are used, jumper terminals 6 and 12.

With Sense Leads
Some bridges or load cells have one or two sense leads. Sense leads allow the APD 4059 to compensate for leadwire resistance effects. Connect the sense leads if used. Polarity must be observed.

Never jumper terminals 6 and 12 when using sense leads.

Output
Polarity must be observed when connecting the signal output. If your device accepts a current input, determine if it provides power to the current loop or if it must be powered by the APD module. Use a multi-meter to check for voltage at the device’s input terminals. Typical voltage may be 9-24 VDC.

To avoid damage to the module, do not make any connections to unused terminals.

Wire terminal torque 0.5 to 0.6 Nm or 4.4 to 5.3 in-lbs

Module Power
Check model/serial number label for module operating voltage to make sure it matches available power. Connect power last.

When using DC power, either polarity is acceptable, but for consistency with similar API products, positive (+) can be wired to terminal 13 and negative (–) can be wired to terminal 16. Connect I/O wiring before power wiring.

CAUTION: To maintain full isolation avoid wiring DC power supplies in common with input, output, or unit power.

Shield wires should be grounded at one end only.

Colors shown are an example only. See manufacturer’s specifications for wiring designations.

To maintain full isolation, avoid combining power supplies in common with input, output, or unit power.

Output Wiring
Current sinking output switch E set to “I” External device provides power to output loop

Current sourcing output switch E set to “V” external device powered by module powers mA output loop

Voltage output switch E set to “V”

No Sense Leads
M02 option for load cell with built-in cal. resistor. Connect to terminals 5 and 11

With Sense Leads
M02 option for load cell with built-in cal. resistor. Connect to terminals 5 and 11

Input
Power

Module Power

13 Power AC or DC
14 Earth Ground
16 Power AC or DC

APD 4059

Strain Gauge to DC Isolated Transmitter

Cu 60/75°C
conductors 14 AWG max.
Basic Calibration

The Zero, Span, and Excitation potentiometers are used to calibrate the output. This calibration procedure does not account for offsets or tare weights. If your system has an offset, tare weight or deadweight, refer to the Offset Switch procedure.

Note: Perform the following calibration procedure any time switch settings are changed.

To achieve optimum results, the system should be calibrated using an accurate bridge simulator, pressure calibrator, or calibration weights depending on the application.

1. Apply power to the module and allow a minimum 20 minute system warm up time.
2. Using an accurate voltmeter across terminals 10 and 12, adjust the Excitation voltage potentiometer on front of the APD 4059 for the exact voltage desired.
3. With the input set at zero or the minimum, adjust the front Zero pot for a zero or low-end output (for example, 4 mA for a 4-20 mA output or ~10 V with a ±10V output).
4. The zero pot may also be adjusted for a zero reading on the output display instrumentation, e.g. control system or process indicator. Adjusting the zero pot this way eliminates calibration errors in the display instrumentation.
5. 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.

Output Test Function

Models with the M01 or M02 option do not have a Test function. With either of these options the Test Cal. potentiometer is non-functional.

When the Test button is depressed it will drive the output with a known good signal that can be used as a diagnostic aid during initial start-up or troubleshooting. When released, the output will return to normal.

The Test Cal. potentiometer can be used to set the test output to the desired level. It is factory set to approximately 50% output. It is adjustable from 0 to 100% of the output span. Press and hold the Test button and adjust the Test Cal. potentiometer for the desired output level.

Diagnostic Voltage Measurements

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.

Calibration with Resistor Options M01 or M02

Use this calibration procedure if your APD 4059 was ordered with a calibration resistor or if your sensor has its own internal calibration resistor.

Note: Perform the following calibration procedure any time switch settings are changed.

The M01 option uses a resistor installed internally in the APD 4059. The resistance is specified by the transducer manufacturer.

The M02 option is specified when the transducer incorporates an internal calibration resistor. The transducer must be connected per the manufacturer’s specifications.

The sensor manufacturer should provide the percentage of full-scale output for the transducer when using a calibration resistor. This is often 80% of maximum output.

1. Apply power to the module and allow a minimum 20 minute system warm up time.
2. Using an accurate voltmeter across terminals 10 and 12, adjust the Excitation voltage potentiometer on front of the APD 4059 for the exact voltage desired.
3. With the input set at zero or the minimum, adjust the Zero potentiometer on front of the APD 4059 for a zero or low-end output (for example, 4 mA for a 4-20 mA output or ~10 V with a ±10V output).
4. The zero pot may also be adjusted for a zero reading on the output display instrumentation, e.g. control system or process indicator. Adjusting the zero pot this way eliminates calibration errors in the display instrumentation.
5. Set the APD 4059 Test toggle switch to the Test position. The calibration resistor is switched into the circuit to unbalance the bridge.
6. Adjust the span pot to the for the % output specified by the transducer manufacturer. This is often 80% of maximum output.
7. Return the Test switch to the opposite position and readjust the zero pot if necessary.

Operation

Strain gauges and load cells are normally passive devices that are commonly referred to as “bridges” due to their four-resistor Wheatstone bridge configuration. These sensors require a precise excitation source to produce an output that is directly proportional to the load, pressure, etc. that is applied to the sensor.

The exact output of the sensor (measured in millivolts) is determined by the sensitivity of the sensor (mV/V) and the excitation voltage applied.

An additional input, the sense lead, monitors the voltage drop in the sensor leads and automatically compensates the excitation voltage at the module in order to maintain a constant excitation voltage at the sensor.

The APD 4059 provides the excitation voltage to the sensors and receives the resulting millivolt signal in return. This input signal is filtered and amplified, then offset, if required, and passed to the output stage. Depending on the output configuration selected, a DC voltage or current output is generated.

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

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

<table>
<thead>
<tr>
<th>Positive Meter Lead</th>
<th>Negative Meter Lead</th>
<th>Meter Reading No pressure/load</th>
<th>Meter Reading Full pressure/load</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Exc.</td>
<td>– Exc.</td>
<td>Excitation Voltage</td>
<td>Excitation Voltage</td>
</tr>
<tr>
<td>+ Sig.</td>
<td>– Exc.</td>
<td>+½ Excitation Voltage</td>
<td>½ Excitation Voltage + (½ x Excitation Voltage x Sensitivity)</td>
</tr>
<tr>
<td>– Exc.</td>
<td>– Exc.</td>
<td>+½ Excitation Voltage</td>
<td>½ Excitation Voltage – (½ x Excitation Voltage x Sensitivity)</td>
</tr>
<tr>
<td>+ Sig.</td>
<td>– Sig.</td>
<td>Zero Volts</td>
<td>Excitation Voltage x Sensitivity</td>
</tr>
</tbody>
</table>

Typical Wiring Color Codes for Load Cells

Always consult manufacturer. Exceptions and/or custom wire colors exist!