Load Cell/Strain Gauge/Pressure Transducer Transmitters, Cal. Resistor, Field Rangeable

APD 4059 CR

**Input:**
100 Ω to 10,000 Ω Bridges, 0.5 mV/V to 40 mV/V, 1-10 V DC Excitation

**Output:**
0-1 V to ±10 V or 0-2 mA to 4-20 mA (Sink or Source)

- Use Internal or External Calibration Resistor
- Sense Lead Compensation
- Easy to Cancel or Tare Out Deadweights
- Drive up to Four 350 Ω Bridges
- Zero and Span Output Calibration Potentiometers
- One Minute Setup for Hundreds of I/O Ranges
- Removable Plugs for Faster Installation
- Full 3-Way Input/Output/Power Isolation
- Input and Output LoopTracker® LEDs
- Adjustable Excitation Power Supply

**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 V DC

- Up to four 350 Ω bridges at 10 V DC
- 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/V sensitivity \times excitation voltage = total mV range

**Input Impedance**
200 kΩ typical

**Common Mode Rejection**
100 dB minimum

**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 V DC
- Fine adjustment: ±5% via multi-turn potentiometer
- Stability: ±0.01% per °C

**Calibration Resistor**
Provisions for internal and external calibration resistor.
- Test switch shorts calibration resistor across one arm of bridge. Specify value of internal calibration resistor, if required.

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

**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, 1000 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 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, nominal

**Response Time**
Nominal time at 63.2% of step change
- Standard: 70 milliseconds (14.3 Hz)
- DF option: Special response time, DF10 (10 milliseconds) up to DF5000 (5 seconds).
- Faster than standard response times will cause output noise levels to be greater than standard specifications. Contact factory for assistance.

**Isolation**
1200 Vrms minimum
- 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

**Description**
The APD 4059 CR 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.

The APD 4059 CR can be specified with varying degrees of filtering to tailor the response time to the application. Consult factory for assistance.

**Sink/Source Versatility**
For maximum versatility the APD 4059 CR milliamp 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.

**Calibration Resistor**
The APD 4059 CR has provisions for an internal or external calibration resistor. The internal calibration resistor value can be specified at time of order, or the resistor can be customer installed or changed.

For load cells with their own internal calibration resistor, terminals are provided for wiring connections. The test switch is used to shunt the calibration resistor across one arm of bridge to simulate strain.

**Model**

- **APD 4059 CR**
  - Field configurable. Specify following if factory is to set switches
  - Bridge mV/V or mV range
  - Excitation voltage
  - Calibration resistor value, if required

- **APD 4059 CR D**
  - Field configurable. Specify following if factory is to set switches
  - Output range
  - Output type (V or mA)

**Options—add to end of model number**
- **DF** Special response time. Add DF to model number followed by value in milliseconds (10 to 5000)
- **U** Conformal coating for moisture resistance

**Accessories—order as separately**
- SG-E04 Junction/sum board
- SG-E04-80XP07 Junction/sum box
- Trim pots for up to 4 strain gauges.
  - For 4-wire or 6-wire load cells.
- API BF4 Spare 4 terminal plug, black
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! Eviter 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

Internal Calibration Resistor

The APD 4059 CR has provisions for an internal shunt/calibration resistor. It can be ordered with the module or installed by the user. The resistor value should match what is specified by the transducer manufacturer.

The calibration resistor can be installed or changed in the field if required by following the procedure below.

1. Remove all power from the APD 4059 CR, unplug all connectors, and remove unit from DIN rail.
2. Using a small flat-blade screwdriver remove the front panel as shown above.
3. Note the locations of the seven tabs attaching the side cover.
4. Using a small flat-blade screwdriver gently pry the tab ends away from the housing. Start with the large tab at the rear of the unit, and work forward towards the front while gently pulling up on the side cover.
5. When all tabs are unlatched, remove the side cover.
6. To remove the calibration resistor (if one was installed), pull it out of its holder. The calibration resistor should have the leads cut and bent to fit the calibration resistor holder.
7. Align the side cover and snap into place making sure all seven tabs are engaged. Snap front cover back into place. Reinstall unit.

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.

Use the rotary switches and a slide switches on the side of the module to select input and output ranges for 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/sensitivity x 10 VDC excitation = 30 mV range

Précautions, Calibration Resistor, Range Setup

APD 4059 CR

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.

I/O Range Selection

Switches B, D, E

1. From the table at the bottom of the page, find the rotary switch combination that matches your I/O ranges and set rotary switches B and D.

2. For taring, deadweight, zero offset, or a bipolar sensor refer to the "Offset Switch C" section below. 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.

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 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.

| Output | 0-1 V | 0-2 V | 0-4 V | 1-5 V | 0-5 V | 2-10 V | 10-100 | ±5 V | ±10 V | ±2 mA | ±4 mA | ±8 mA | ±10 mA | ±16 mA | ±20 mA | ±30 mA | ±40 mA | ±50 mA | ±60 mA | ±70 mA | ±80 mA | ±90 mA | ±100 mA | ±120 mA | ±200 mA | ±250 mA | ±300 mA | ±400 mA |
|--------|------|------|------|------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Switches | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE | BCDE |
| 0-10 mV | A00V | A08V | A01V | A06V | A09V | A02V | A07V | A03V | A04V | A05V | A001 | A081 | A011 | A061 | A091 | A021 | A071 | 2031 |
| 0-20 mV | 300V | 308V | 301V | 306V | 309V | 302V | 307V | 303V | 304V | 305V | 3001 | 3081 | 3011 | 3061 | 3091 | 3021 | 3071 | 3031 |
| 0-25 mV | 600V | 608V | 601V | 606V | 609V | 602V | 607V | 603V | 604V | 605V | 6001 | 6081 | 6011 | 6061 | 6091 | 6021 | 6071 | 6031 |
| 0-30 mV | E00V | E08V | E01V | E06V | E09V | E02V | E07V | E03V | E04V | E05V | E001 | E081 | E011 | E061 | E091 | E021 | E071 | 6031 |
| 0-40 mV | B00V | B08V | B01V | B06V | B09V | B02V | B07V | B03V | B04V | B05V | B001 | B081 | B011 | B061 | B091 | B021 | B071 | 6031 |
| 0-50 mV | 000V | 008V | 001V | 006V | 009V | 002V | 007V | 003V | 004V | 005V | 0001 | 0081 | 0011 | 0061 | 0091 | 0021 | 0071 | 0031 |
| 0-100 mV | 800V | 808V | 801V | 806V | 809V | 802V | 807V | 803V | 804V | 805V | 8001 | 8081 | 8011 | 8061 | 8091 | 8021 | 8071 | 8031 |
| 0-200 mV | F00V | F08V | F01V | F06V | F09V | F02V | F07V | F03V | F04V | F05V | F001 | F081 | F011 | F061 | F091 | F021 | F071 | F031 |
| 0-250 mV | 400V | 408V | 401V | 406V | 409V | 402V | 407V | 403V | 404V | 405V | 4001 | 4081 | 4011 | 4061 | 4091 | 4021 | 4071 | 4031 |
| 0-300 mV | C00V | C08V | C01V | C06V | C09V | C02V | C07V | C03V | C04V | C05V | C001 | C081 | C011 | C061 | C091 | C021 | C071 | C031 |
| 0-400 mV | 900V | 908V | 901V | 906V | 909V | 902V | 907V | 903V | 904V | 905V | 9001 | 9081 | 9011 | 9061 | 9091 | 9021 | 9071 | 9031 |
**Wiring and Installation**

**APD 4059 CR**

**Settings for Push-Pull Load Cells**
The input range can be thought of as a percentage scale. Zero percent of the signal range will be a negative number for push-pull load cells. The high end of the signal will be a positive number. Add these together to get the span (100% of the total signal range).

For example, if a load cell has a 1.5 mV/V sensitivity with 10 V excitation, the range for push-pull will be –15 mV to +15 mV. This is a span of 30 mV and we would select 30 mV as our input range. If the range does not match up to what is in the table, select the next highest input range setting.

For push-pull applications it is common to use a ±5 V or ±10 V output setting. Use the table below to find your switch settings.

We also need to use "Offset Switch C" to bring the negative end of our input range up by 50% to 0 mV. The closest setting is position “B” 45%. This can be adjusted to 50% with the zero potentiometer when output calibration is done.

**Load Cells with a Built-In Calibration Resistor**
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 CR. If the transducer only has one calibration resistor wire, connect it to terminal 5. No internal calibration resistor should be installed. See instructions on previous page for removal.

**Electrical Connections**
See wiring diagrams. Observe polarity.

* Do not make any connections to unused terminals or use them as wiring junctions for external devices. This may cause permanent damage to the module!

**Signal Input Terminals**
Refer to strain gauge manufacturer’s data sheet for wire coloring 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 CR 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.

<table>
<thead>
<tr>
<th>Type of Device for Output</th>
<th>– Term.</th>
<th>+ Term.</th>
</tr>
</thead>
<tbody>
<tr>
<td>mA (current) input device that powers the current loop. Switch E set to “I”</td>
<td>2 (-)</td>
<td>3 (+)</td>
</tr>
<tr>
<td>mA (current) input device that is passive. APD module provides the loop power. Switch E set to “EX”</td>
<td>3 (-)</td>
<td>4 (+20 V)</td>
</tr>
<tr>
<td>Measuring/recording device accepts a voltage input. Switch E set to “V”</td>
<td>3 (-)</td>
<td>4 (+)</td>
</tr>
</tbody>
</table>

**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 output and unit power.

**Mounting to a DIN Rail**
Install module vertically on a 35 mm DIN rail in a protective enclosure away from heat sources. Do not block air flow. Allow 1” (25 mm) above and below housing vents for air circulation.

1. Tilt front of module downward and position against DIN rail.
2. Clip lower mount to bottom edge of DIN rail.
3. Push front of module upward until upper mount snaps into place.

**Removal**
1. Push up on the bottom back of the module.
2. Tilt front of module downward to release upper mount from top edge of DIN rail.
3. The module can now be removed from the DIN rail.

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

Current sourcing output switch E set to “EX”
+20 V at terminal 4
Module powers mA output loop

Voltage output switch E set to “V”

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

**No Sense Leads**
M02 option for load cell with built-in cal. resistor. Connect to terminals 6 and 12.

**1 strain gauge shown. Connect up to 4 in parallel if all leads are equal length. Unequal length leads or strain gauges with calibration variances may require sum box SG-EQ4-BOXPG7 or similar to aid in equalization.**

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.

If your load cell has an internal calibration resistor, remove the calibration resistor inside the APD4059 CR

**Module Power**
Cu 60/75°C
Conductors 14 AWG max.

**APD 4059 Strain Gauge to DC Isolated Transmitter**

1220 American Way Libertyville, IL 60048
Phone: 800-942-0315 Fax: 800-942-7502

api-usa.com
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.

Input and output ranges, if specified on your order, are factory pre-configured (at 24°C ±1°C).

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 warm up time.
2. Using an accurate voltmeter across terminals 10 and 12, adjust the Excitation voltage potentiometer on front of the APD 4059 CR 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 CR for a zero or low-end output (for example, 4 mA for a 4-20 mA 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 CR 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 ¼ output specified by the transducer manufacturer. This is 80% of maximum output.
7. Return the Test switch to the opposite position and readjust the zero pot if necessary.

Push-Pull Calibration
No internal calibration resistor should be installed. See instructions on previous page for removal.

1. Apply power to the module and allow a minimum 20 minute warm up time.
2. Using an accurate voltmeter across terminals 10 and 12, adjust the Excitation voltage potentiometer to the exact voltage desired.
3. Connect the precision resistor between Exc+ and Sig+. This will simulate the cell under tension and apply negative voltage to the input.
4. Adjust the Zero control to ~80% output since the resistor is scaled for 80% of deflection.
5. Remove the precision resistor.
6. Connect the precision resistor between Exc– and Sig–. This will simulate the cell under compression and apply a positive voltage to the input.
7. Adjust the Span control for +80% output since the resistor is scaled for 80% of deflection.
8. Remove the precision resistor. The output should be near 0 V. It is possible for zero to be off a small amount due to stacking of tolerances within both the load cell, wiring, and the module.

Diagnostic Voltage Measurements
Using a meter with at least 10 megohm input impedance, measure the voltage coming from the strain gage at the locations shown. Sensitivity is measured in mV/V.

<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 + (¼ x Excitation Voltage x Sensitivity)</td>
</tr>
<tr>
<td>− Sig.</td>
<td>− Exc.</td>
<td>+ ½ Excitation Voltage</td>
<td>½ Excitation Voltage – (¼ x Excitation Voltage x Sensitivity)</td>
</tr>
<tr>
<td>+ Sig.</td>
<td>− Sig.</td>
<td>Zero Volts</td>
<td>Excitation Voltage</td>
</tr>
</tbody>
</table>

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 to maintain a constant excitation voltage at the sensor.

The APD 4059 CR provides the excitation voltage to the sensor 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 sensed by the input 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.