

# PIECAL 434

## Automated Diagnostic 4-20 mA Calibrator

### Operating Instructions

- **EASY TO USE**

With the PIECAL 434 you can check, calibrate and measure all your current signal instruments in a 4 to 20 milliamp DC loop. It can be used at any access point in your loop. Source & Read 0.000 to 24.000 mA, Simulate a 2 Wire Transmitter or use the PIECAL 434 to simultaneously power your 2 Wire Transmitter and measure its output.

- **EASY TO READ**

Turn on the backlight to easily read the display in dark areas of the plant.

- **TROUBLESHOOT LOOP PROBLEMS**

Quickly diagnose ground fault and current leakage with the patented loop diagnostic technology (US Patent# 7,248,058).

- **SOURCE MILLIAMPS**

Calibrate recorders, digital indicators, stroke valves or any instruments that get their input from a 4 to 20 mA loop. Easily set any value quickly to within 0.001 mA with the adjustable digital potentiometer "DIAL" or use preset **4.000 mA (0.00%)** and **20.000 mA (100.00%)** EZ-CHECK™ settings.

- **AUTOMATIC OUTPUT STEPPING & RAMPING**

Press & hold the dial to automatically step from 4 to 20 in 2, 3 or 5 steps or choose a continuous ramp.

- **CALIBRATE USING LOOP POWER**

Check loop wiring and receivers by using the PIECAL 434 in place of a 2 Wire transmitter. The PIECAL 434 uses any loop power from 2 to 60 V DC.

- **READ LOOP CURRENT**

Check controller outputs or measure the milliamp signal anywhere in the loop. The PIECAL 434 measures 0.000 to 24.000 mA (-25.00 to 125.00%) signals with greater accuracy than a typical multimeter.

- **POWER & MEASURE 2 WIRE TRANSMITTERS**

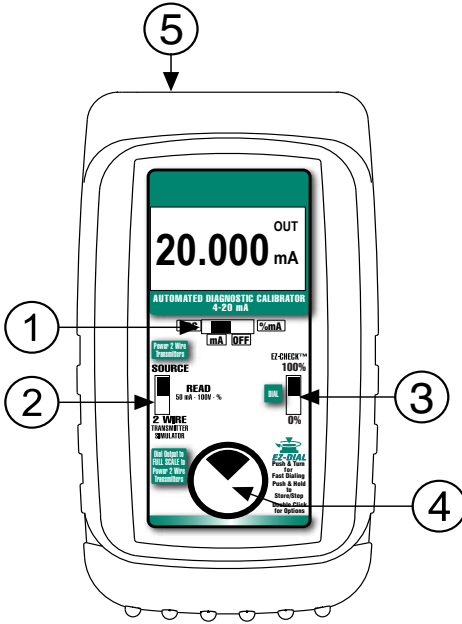
The PIECAL 434 can simultaneously output 24V DC to power any and all devices in a process loop using the internal batteries and internal switching power supply, while measuring the output of a 2 Wire Transmitter and any other loop devices. Powers HART™ transmitters with built-in 250 ohm resistor simplifying hookups with HART communicators.

- **READ DC VOLTS**

The PIECAL 434 can measure from -60.00 to +60.00 VDC with 10mV resolution. Use it to check loop power supplies, I/V converters, 1 to 5 Volt signals, and other voltages making it unnecessary to carry an additional multimeter.



# Basic Operation



## ① POWER SWITCH

Select “mA” to display and calibrate in milliamps. Select “% 4 to 20 mA” to display and calibrate in percent. Select “READ VDC” to read volts DC. Return the slide switch to the “OFF” position when not in use.

### Note:

Percent mode can also be used with chart recorders, valves or current trips that display in percent.

100.00%	= 20.000 mA
75.00%	= 16.000 mA
50.00%	= 12.000 mA
25.00%	= 8.000 mA
0.00%	= 4.000 mA

To convert from Milliamps to Percent:  
 $\text{Percent} = (\text{Milliamps} - 4) / 0.16$

To convert from Percent to Milliamps:  
 $\text{Milliamps} = \text{Percent} / 6.25 + 4$

## ② SOURCE / READ / 2 WIRE SWITCH

Select “SOURCE” to output in mA or percent. Select “READ” to read in mA or percent. Select “2 WIRE” to simulate a 2 Wire Transmitter.

## ③ EZ-CHECK™ SWITCH

Instantly output 4.000 mA or 20.000 mA by moving the EZ-CHECK™ switch to the “4.00mA” / “0.0%” position or “20.00mA” / “100.0%” position. For fast three point checks select the “DIAL” position. The PIECAL 434 will remember the last “DIAL” value, even with the power off.

Note: The same “DIAL” value is stored for both mA and %. The recalled value will be displayed in the units selected.

## ④ DIAL KNOB

Turn the knob to adjust output level. Turn clockwise to increase the output, counter clockwise to decrease the output 0.001 mA (0.01%) at a time. Push and turn the knob for faster dialing adjusting 0.100 mA (1.00%) at a time. Press and Hold the knob to start automatic stepping or ramping. Double click the knob for stepping and Ground Leak Detection setup.

## ⑤ EXTERNAL POWER JACK (Not Shown)

When used with the optional AC Adaptor, the external power jack will eliminate the drain on your batteries. This is handy for jobs that require extended bench use of the PIECAL 434. See accessories (page 10) for ordering information.

**Note:** This feature does not charge the batteries, it only supplies power to the PIECAL 434.

## CHANGING BATTERIES

Low battery is indicated by “BAT” on the display. Approximately one to four hours of typical operation remain before the 434 will automatically turn off. To change the batteries; remove the rubber boot, remove the battery door from the back of the unit by sliding the door downward. This allows access to the battery compartment. Replace with four (4) “AA” 1.5V batteries being careful to check the polarity. Replace the battery door & replace the boot. All stored configuration options are reset to factory settings when the batteries are removed.

**Note:** Alkaline batteries are supplied and recommended for maximum battery life & performance.

# Configuration

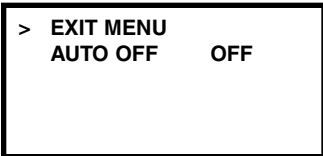
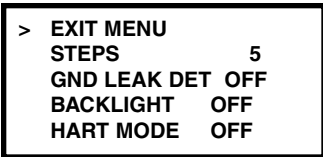
## Configure the Calibrator

Move ① POWER SWITCH to “mA”, “% 4 to 20 mA” or “READ VDC”.

The following display will appear for 3 seconds:



Double click the ④ DIAL KNOB at any time the unit is on and the following display will appear for 30 seconds:



Turn the ④ DIAL KNOB to move through the menu. Press the ④ DIAL KNOB to toggle between OFF and ON. These settings are remembered even with the power off.

**EXIT MENU** - exits this menu immediately and saves any changes. Menu will automatically exit after 30 seconds of inactivity.

**STEPS** - pressing the knob will cycle from 2, 3, 5 steps and RAMP.

**2 steps** will automatically switch between 4 & 20 mA (0 & 100%).

**3 steps** between 4, 12 & 20 mA (0, 50 & 100%).

**5 steps** between 4, 8, 12, 16 & 20 mA (0, 25, 50, 75 & 100%).

**RAMP** will continuously ramp the output between 4 & 20 mA (0 & 100%).

**GROUND LEAK DETECTION** - when ON the PIECAL 434 has the ability to check for current leaks caused by ground faults, moisture or corrosion. This operates in Power/Measure mode while powering up a 2-wire transmitter or loop.

**BACKLIGHT** - If BACKLIGHT is ON the backlight will light all the time the unit is powered up. For maximum battery life turn the backlight off when using the PIECAL 434 in areas with enough ambient light to read the display.

**HART MODE** - when ON a 250 Ohm resistor is automatically inserted in series with the leads in all modes. This allows a HART Communicator to communicate with a HART Transmitter without adding an external resistor in the loop.

**AUTO OFF** - If AUTO OFF is ON, the unit will turn off after 30 minutes of inactivity to save battery life. If AUTO OFF is OFF the unit will stay on until the POWER SWITCH is moved to the off position.

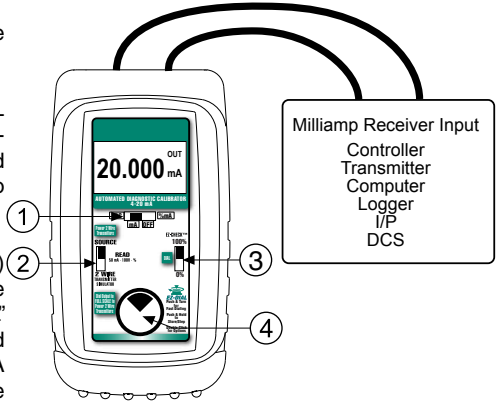
**Note:** All settings are remembered even with the power off. Removing the batteries resets the values to factory defaults.

# Sourcing Milliamps

## mA OUT, % OUT (Percent of 4 to 20 mA)

Choose this function to provide an output from 0.000 to 24.000 milliamps. The compliance voltage is a nominal 24 VDC to provide the driving power to your milliamp receivers.

- 1) Disconnect one or both input wires from the device to be calibrated.
- 2) Select "mA" or "% 4 to 20mA" with slide switch ①.
- 3) Select "SOURCE" using slide switch ②.
- 4) Connect the output leads of the PIECAL 434 to the inputs of the device being calibrated, making sure to check polarity. Red lead to the plus (+) input and black lead to the minus (-) input.



The output is adjusted in 0.001 mA (0.01%) increments by turning the knob ④ while the EZ-CHECK™ switch ③ is in the "DIAL" position, or the current can be set at the fixed points of 4.000mA (0.00%) or 20.000mA (100.00%) with switch ③. Press and turn the knob for faster dialing with 0.100 (1.00%) increments.

Start automatic stepping or ramping by pressing and holding the ④ DIAL KNOB for 3 seconds. The word STEPPING or RAMPING will flash on the display anytime the selected automatic function is running. The PIECAL 434 will automatically step or ramp between 4mA & 20mA (or 20mA & 4mA) for 30 seconds then reverse direction. Stop the stepping or ramping by pressing or turning the knob or moving any switch.

## Using Automatic Stepping & Ramping

### Using Automatic STEP & RAMP output

Move ① POWER SWITCH to "mA", or "% 4 to 20 mA" and the ② SOURCE / READ / 2 WIRE SWITCH to "SOURCE" or "2 WIRE".

The starting point for automatic stepping & ramping is based on the ③ EZ-CHECK SWITCH. Place the EZ-CHECK switch at 20 mA and the automatic stepping or ramping will start at 20.000 mA (100.00%) and the values will decrease. Place the EZ-CHECK switch at 4 mA and the automatic stepping or ramping will start at 4.000 mA (0.00%) and the values will increase.



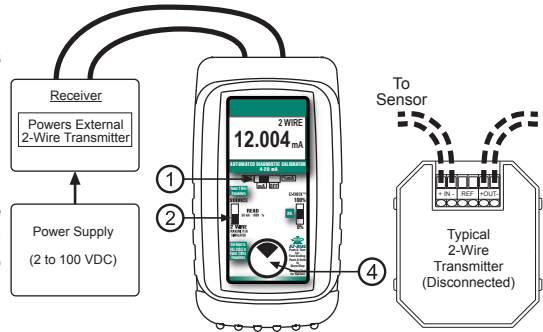
Start automatic stepping or ramping by pressing and holding the ④ DIAL KNOB for 3 seconds. The word STEPPING or RAMPING will flash on the display anytime the selected automatic function is running. The PIECAL 434 will automatically step or ramp between 4mA & 20mA (or 20mA & 4mA) for 30 seconds then reverse direction. Stop the stepping or ramping by pressing or turning the knob or moving any switch.

## Simulate 2-Wire Transmitters

### 2 Wire mA, 2 Wire % (Percent of 4 to 20 mA)

Choose this function to simulate a 2 Wire Transmitter output from 0.000 to 24.000 milliamps. Operates in loops with power supply voltages from 2 to 100 VDC

- 1) Disconnect one or both input wires from the device to be calibrated.
- 2) Select “mA” or “% 4 to 20mA” with slide switch ①.
- 3) Select “2 WIRE” using slide switch ②.
- 4) Connect the red input lead of the 434 to the plus (+) input of the field connections and the black lead to the minus (-).



Loop current is adjusted in 0.001 mA (0.01%) increments by turning the knob ④ while the EZ-CHECK™ switch ③ is in the “DIAL” position, or the current can be set at the fixed points of 4.000mA (0.00%) or 20.000mA (100.00%) with switch ③. Press and turn the knob for faster dialing with 0.100 (1.00%) increments.

Start automatic stepping or ramping by pressing and holding the ④ DIAL KNOB for 3 seconds. The word STEPPING or RAMPING will flash on the display anytime the selected automatic function is running. The PIECAL 434 will automatically step or ramp between 4mA & 20mA (or 20mA & 4mA) for 30 seconds then reverse direction. Stop the stepping or ramping by pressing or turning the knob or moving any switch.

## Setting Up Automatic Stepping & Ramping

### To change the Automatic Stepping & Ramping settings

Double click the ④ DIAL KNOB at any time the unit is on and the following display will appear for 30 seconds:

Turn the ④ DIAL KNOB to move through the menu. Press the ④ DIAL KNOB to toggle between OFF and ON or to change the steps setting. These settings are remembered even with the power off.

**EXIT MENU** - exits this menu immediately and saves any changes. Menu will automatically exit after 30 seconds of inactivity.

**STEPS** - pressing the knob will cycle from 2, 3, 5 steps and RAMP.

**2 steps** will automatically switch between 4 & 20 mA (0 & 100%).

**3 steps** between 4, 12 & 20 mA (0, 50 & 100%).

**5 steps** between 4, 8, 12, 16 & 20 mA (0, 25, 50, 75 & 100%).

**RAMP** will continuously ramp the output between 4 & 20 mA (0 & 100%).

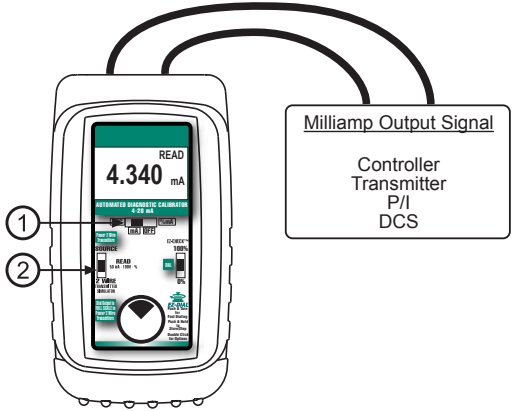
## Reading Milliamp Outputs

### READ mA, READ % (Percent of 4 to 20 mA)

Choose this function to measure from 0.000 to 24.000 milliamps or -25.00 to 125.00%.

- 1) Open the current loop at any convenient point along the signal path.
- 2) Select "mA" or "% 4 to 20mA" with slide switch ①.
- 3) Select "Read" using slide switch ②.
- 4) Connect the red input lead (+) of the PIECAL 434 to the more positive point of the break and the black input to the more negative point.

Signals below 0 mA or open circuits are indicated by 0.000 mA (-25.00%) on the display. Signals above 52 mA are current limited by protection circuitry and "OVERRANGE" is flashed on the display.



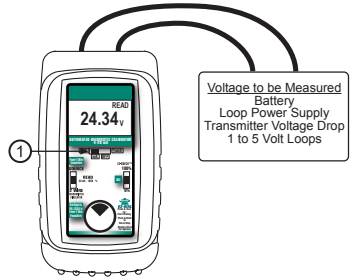
## Read DC Volts

### READ V

Choose this function to measure from -99.99 to +99.99V DC.

- 1) Select "VDC" with slide switch ①.
- 2) Connect the red (+) and black (-) leads of the PIECAL 434 across the voltage source to be measured.

Any DC voltage from -60.00 to +60.00 volts may be measured. Loop power supplies, signal voltages at receivers, batteries and transmitter voltage drops may be measured. Signals exceeding  $\pm 60.00$  VDC are indicated by  $\Delta$  on the display. Signals exceeding  $\pm 99.99$  VDC will be indicated by "OVERRANGE" flashing on the display.



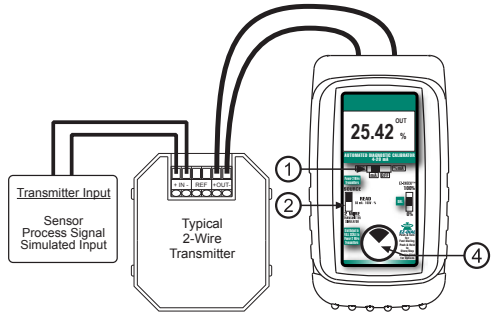
Signals exceeding  $\pm 60.00$  VDC are indicated by  $\Delta$  on the display.

## Power & Measure 2-Wire Transmitters

### mA OUT, % OUT (Percent of 4 to 20 mA)

Choose this function to simultaneously supply power to a 2 Wire Transmitter while displaying the 4 to 20 mA output of the transmitter.

- 1) Disconnect one or both input wires from the device to be calibrated.
- 2) Select “mA” or “% 4 to 20mA” with slide switch ①.
- 3) Select “SOURCE” using slide switch ②.
- 4) Press and turn the knob ④ clockwise several times until full scale output (24.000 mA/125.00%) is obtained. The display will indicate “PWR MEASURE”.
- 5) Connect the red source lead of the PIECAL 434 to the plus (+) input of the device and the black source lead to the minus (-).



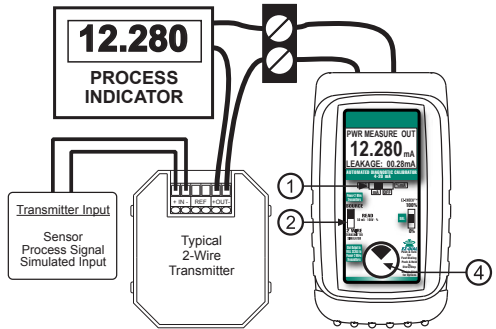
The PIECAL 434 supplies a nominal 24 volts DC at 24 mA to the 2 Wire Transmitter. The current passed by the transmitter will be accurately displayed by the PIECAL 434. Calibrate the transmitter in the usual manner and disconnect the PIECAL 434. If Ground Leak Detection is enabled the amount of milliamps leaking in the transmitter or loop is indicated on the display.

# Using Ground Leak Detection

## mA OUT, % OUT (Percent of 4 to 20 mA)

Find current leaks in loops caused by ground faults, moisture or corrosion. The 434 simultaneously supplies power to a 2 Wire Transmitter (or loop with a transmitter) while displaying the 4 to 20 mA output and the amount of current leaking in the loop.

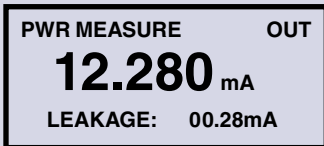
- 1) Disconnect one or both input wires from the device to be calibrated.
- 2) Select “mA” or “% 4 to 20mA” with slide switch ①.
- 3) Select “SOURCE” using slide switch ②.
- 4) Turn the knob ④ clockwise several times until full scale output (>24.000 mA/125.00%) The display will indicate “PWR MEASURE” and “LEAKAGE:”
- 5) Connect the red source lead of the PIECAL 434 to the plus (+) input of the device and the black source lead to the minus (-).



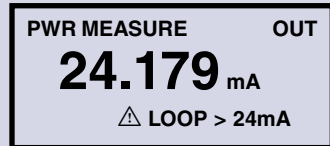
The PIECAL 434 supplies a nominal 24 volts DC at 24 mA to the 2 Wire Transmitter or loop. The current passed by the transmitter will be accurately displayed by the PIECAL 434 along with an indication of leakage current at the bottom of the display. If there is an uncontrolled loop, a transmitter with upscale burnout and bad or missing sensor or a short the display shows “△LOOP > 24mA”

**Note:** Many installed DIAL transmitters will normally indicate 0.01 to 0.10 mA leakage without significant control problem. Unstable readings may indicate loose connections or the presence of moisture.

## Typical Error Conditions



The PIECAL 434 is supplying the loop voltage. A calibrated transmitter is limiting the loop current to 12.00 mA. An additional 0.28 mA is not controlled by the transmitter and is leaking somewhere in the loop.



The PIECAL 434 is supplying the loop voltage. There is an control loop error. This may be a transmitter (set for upscale burnout) with a bad or missing sensor, or a short in the loop.

## Setting Up Ground Leak Detection

### Enabling Ground Leak Detection

Double click the ④ DIAL KNOB at any time the unit is on and the following display will appear for 30 seconds:

Turn the ④ DIAL KNOB to move through the menu. Press the ④ DIAL KNOB to toggle between OFF and ON or to change the steps setting. These settings are remembered even with the power off.

**EXIT MENU** - exits this menu immediately and saves any changes. Menu will automatically exit after 30 seconds of inactivity.

**GROUND LEAK DETECTION** - when ON the PIECAL 434 has the ability to check for current leaks caused by ground faults, moisture or corrosion that bypass the current control element or transmitter.



# Application Notes

## GROUND LEAK DETECTION

Have you ever replaced a “faulty” transmitter only to find the problem was somewhere else in the loop? And did you end up throwing the transmitter away after you fixed the other problem “just in case” the transmitter was faulty?

If you find a loop where the transmitter is calibrated correctly but all the readings elsewhere in the loop have a fixed offset this is due to a zero shift. This zero shift is typically caused by some current in the loop bypassing the transmitter. This might be caused by ground faults, moisture or corrosion.

If you have some loops that are erratic after it rains there may be moisture present in a junction box or where insulation has broken down. Turn on Ground Leak Detection and use the PIECAL 434 to power up the loop. Any current that isn't controlled by the transmitter or other current control element will be indicated as leakage on the PIECAL 434 display.

The PIECAL 434 powers up the 2-Wire transmitter or loop and indicates the total current and the uncontrolled current. This provides information useful in troubleshooting loop errors.

## KEEPING THE PROCESS GOING

When an instrument in a critical control loop develops a problem it is important to maintain control of the process. The PIECAL 434 can be substituted for a faulty controller or transmitter to provide temporary manual control of the process. One technician takes manual control of the process while a second technician retrieves, installs and configures a replacement instrument.

## OUT OF RANGE SIGNALS

Signals below 0 mA or open circuits are indicated by 0.000 mA (-25.00%) on the display. Signals above 24 mA are current limited by protection circuitry to approximately 25 mA.

## OPEN LOOPS

The display will indicate ERROR and 0.000 mA or -25.00% if there is an open loop or if the polarity is reversed. Check all the connections in the loop or try reversing the leads.

## POWER TRANSMITTER

Adjusting the SOURCE output to full scale (>24 mA) supplies a nominal 24V DC to power a 2 Wire Transmitter while simultaneously displaying the 4 to 20 mA output of the transmitter.

## READ MILLIAMPS

Select READ milliamps by moving slide switch ① to “mA” or “% 4 to 20mA” and moving slide switch ② to “READ”. Place the PIECAL 434 in the loop in series with the current to be measured.

## SOURCE MILLIAMPS or 2-WIRE SIMULATOR

Select “SOURCE” using slide switch ② to output from 0.000 to 24.000 milliamps using the PIECAL 434's internal power source. This will provide 24V DC. Select “2-WIRE” to control the current in a loop that is using an existing power supply.

To change the output current adjust the dial knob ④. Turning clockwise will increase the output value, turning counter-clockwise will decrease the output value with 0.001 mA (0.01%) resolution. Press and turn the knob for faster dialing with 0.100 mA (1.00%) resolution. The output is adjustable in all EZ-CHECK™ positions.

When returning to the “4.00mA”/“0.0%” and “20.00mA”/“100%” positions they will always return to 4.00 (0.0%) and 20.00 (100.0%) mA. This method is superior to keypad units. The zero and full scale positions can be adjusted smoothly making easy valve end stop testing, trip point testing, alarm testing, etc. There is virtually no overshoot/undershoot simplifying testing.

## READ DC VOLTS

Select “VDC” using slide switch ① to read volts DC. Clip the leads across the voltage to be measured.

## Stroking Valves

### SETTING UP VALVES

When setting up a valve it is important to correctly set the end stops. Use the PIECAL 434 to supply the 4 to 20 mA control signal to stroke the valve. Select "SOURCE" and the PIECAL 434 will use the internal power source for outputting current or switch to 2-WIRE SIMULATOR to stroke a valve using any pre-existing installed loop power supply as the power source.

Example:

- 1) Disconnect the 4-20 mA control wires from the Current-to Pressure (I/P) converter or the actuator.
- 2) Connect the PIECAL 434 following the connection diagrams on the previous pages for Simulate 2-Wire Transmitters
- 3) Move the EZ-CHECK™ switch ③ to "**4.00 mA**"/"**0.0%**" and adjust the fully closed stop on the actuator.
- 4) Turn the PIECAL 434's knob ④ slowly counterclockwise and verify that the actuator and valve don't move. Repeat steps 3 & 4 until no movement is detected.
- 5) Move the EZ-CHECK™ switch ③ to **DIAL** and quickly back to "**4.00 mA**"/"**0.0%**" then turn the PIECAL 434's knob ④ clockwise. The actuator and valve should begin to move.
- 6) Move the EZ-CHECK™ switch ③ to "**20.00 mA**"/"**100.0%**" and adjust the fully open stop on the actuator.
- 7) Turn the PIECAL 434's knob ④ slowly clockwise and verify that the actuator and valve don't move. Repeat steps 6 & 7 until no movement is detected.
- 8) Move the EZ-CHECK™ switch ③ to **DIAL** and quickly back to "**20.00 mA**"/"**100.0%**" then turn the PIECAL 434's knob counterclockwise. The actuator and valve should begin to move.

## Warranty

Our equipment is warranted against defective material and workmanship (excluding batteries) for a period of three years from the date of shipment. Claims under warranty can be made by returning the equipment prepaid to our factory. The equipment will be repaired, replaced or adjusted at our option. The liability of Practical Instrument Electronics (PIE) is restricted to that given under our warranty. No responsibility is accepted for damage, loss or other expense incurred through sale or use of our equipment. Under no condition shall Practical Instrument Electronics, Inc. be liable for any special, incidental or consequential damage.

## Additional Information

This product is calibrated on equipment traceable to NIST and includes a Certificate of Calibration. Test Data is available for an additional charge.

Practical Instrument Electronics recommends a calibration interval of one year. Contact your local representative for recalibration and repair services.

## PIECAL 434 Specifications

(Unless otherwise indicated all specifications are rated from a nominal 23 °C, 70 % RH for 1 year from calibration)

<b>General</b>	
Operating Temperature Range	-20 to 60 °C (-5 to 140 °F)
Storage Temperature Range	-30 to 60 °C (-22 to 140 °F)
Relative Humidity Range	10 % ≤RH ≤90 % (0 to 35 °C), Non-condensing
	10 % ≤RH ≤ 70 % (35 to 60 °C), Non-condensing
Size	5.63 x 3.00 x 1.60 inches, 143 x 76 x 41 mm (L x W x H)
Weight	12.1 ounces, 0.34 kg (including boot & batteries)
Batteries	Four "AA" Alkaline 1.5V (LR6)
Optional AC Adaptors	120 VAC 50/60 Hz [Part # 020-0100] 240 VAC 50/60 Hz [Part # 020-0101]
Optional NiMh Rechargeable battery kit	120 VAC for North America Only; charger, four NiMh batteries, AC & DC cords [Part # 020-0103]
Low Battery	Low battery indication with nominal 1 hour of operation left
Protection against misconnection	Over-voltage protection to 135 vrms (rated for 30 seconds) or 240 vrms (rated for 15 seconds)
Display	High contrast graphic liquid crystal display with 0.315" (8.0 mm) high digits. LED backlighting for use in low lit areas.

<b>Read mA</b>	
Ranges and Resolution	0.000 to 24.000 mA or -25.00 to 125.00% of 4-20 mA
Accuracy	≤ ± (0.01 % of Reading +0.002 mA)
Voltage burden	≤ 2V at 50 mA
Overload/Current limit protection	25 mA nominal
Battery life	≥ 125 Hours nominal
	≥ 100 hrs with backlight on

## PIECAL 434 Specifications (continued)

(Unless otherwise indicated all specifications are rated from a nominal 23 °C,  
70 % RH for 1 year from calibration)

<b>Source/Power &amp; Measure Two Wire Transmitters</b>	
Ranges and Resolution	0.000 to 24.000 mA or -25.00 to 125.00% of 4-20 mA
<b>Accuracy</b>	$\leq \pm (0.01 \% \text{ of Reading} + 0.002 \text{ mA})$
Noise	$\leq \pm \frac{1}{2}$ Least Significant Digit
Temperature effect	$\leq \pm 0.005 \% / ^\circ\text{C}$ of FS
Loop compliance voltage	$\geq 24 \text{ DCV @ } 20.00\text{mA}$
Loop drive capability - Leak Detection Off	1200 $\Omega$ at 20 mA for 15 hours nominal; 950 $\Omega$ with Hart Resistor enabled
Loop drive capability - Leak Detection On	1000 $\Omega$ at 20 mA for 15 hours nominal; 750 $\Omega$ with Hart Resistor enabled
Battery life	$\geq 30 \text{ hrs}$ at 12 mA nominal; $\geq 25 \text{ hrs}$ with backlight on

<b>2-Wire Transmitter Simulation</b>	
Accuracy	Same as Source/Power & Measure
Voltage burden	$\leq 2\text{V}$ at 20 mA
Overload/Current limit protection	24 mA nominal
Loop voltage limits	2 to 60 VDC (fuse-less protected from reverse polarity connections)
Battery life	$\geq 125 \text{ hours}$ nominal; $\geq 100 \text{ hrs}$ with backlight on

<b>Voltage Read</b>	
Range and Resolution	-60.00 to +60.00 VDC Full Span (FS)
Accuracy	$\leq \pm 0.05 \% \text{ of FS}$
Temperature effect	$\leq \pm 100 \text{ ppm} / ^\circ\text{C}$ of FS
Input resistance	$\geq 2 \text{ M}\Omega$
Battery life	$\geq 125 \text{ hours}$ nominal; $\geq 100 \text{ hrs}$ with backlight on

## Accessories

**INCLUDED:**

Carrying Case with Belt Loop

Part No. 020-0205

**OPTIONAL:**

AC ADAPTOR (200 to 240 VAC)

Part No. 020-0100

AC ADAPTOR (100 to 120 VAC)

Part No. 020-0101

Ni-MH 1 Hour Charger w/4 Ni-MH AA Batteries

Part No. 020-0103

(100-120 V AC input for North America Only)