



## Operating Manual



LC-Series



L-Series



LCR-Series

## Precision Water Flow Meter Precision Water Flow Controller

*The Fastest Flow Controller Company in the World!*



## RECALIBRATION

Your Alicat instrument is a precision device and Alicat strongly recommends that you send it to us on a yearly basis for recalibration.

A yearly recalibration does a few things:

- ▶ It insures that your unit is functioning according to specification.
- ▶ Contamination may cause the instrument to measure flow improperly. Recalibration insures the instrument is clean and free from debris.
- ▶ Recalibration maintains your LIFETIME WARRANTY!

Sending your unit for recalibration is easy and inexpensive. Recalibrations are usually shipped within five days of receipt, so it's fast too.

Please keep the original box to return your Alicat instrument for recalibration.

For more information regarding recalibration see page 44.

## ACCESSORIES

Now that you have your Alicat instrument are you sure you've got everything you need? Alicat accessories can make your job easier.

Many of our customers also order:

- ▶ Power Supplies — A universal wall power supply that makes it easy to power your Alicat unit just about anywhere in the world.
- ▶ BB9 — Alicat's multi-drop box that allows easy connection of up to nine Alicat instruments to a single USB, RS-232 or RS-485 port.
- ▶ MD8DB9 — An RS-232 to 8 pin Mini-DIN cable to connect your Alicat instrument to a computer. A variety of other cables are also available.
- ▶ Flow Vision™ SC — A GUI based Windows® program that allows easy computer access and control for one or multiple Alicat instruments.
- ▶ Fittings and filters — Keep your instrument properly connected to your process and free from harmful contamination.

See pages 50- 53 for a complete description and list of Alicat accessories.



## Notes for Using Alicat Water Flow Devices

- ▶ **USE ONLY PURE, CLEAN DI OR DISTILLED WATER IN THIS DEVICE.**
- ▶ **DO NOT** use tap water or water with any biological components, minerals or oils. Any of these substances will affect the viscosity of the water (creating flow measurement inaccuracies). More importantly, ***these impurities will quickly build up in the laminar flow zone, cause corrosion, and render the measuring capabilities of the device useless. Pure DI water itself is corrosive to some extent, but it is the contaminants in your system that will be most detrimental to your Alicat liquid water flow meter.***  
**If you cannot meet the requirement of pure water, then do not use the Alicat water flow device in your application.** Damage caused by impurity build up is not covered by the warranty.
- ▶ Please read the operating manual that accompanied your device. Keep the manual for future reference.
- ▶ When first using the Alicat water meter or controller for the day, please take the following precautions:
  1. Apply your source pressure (approx. 20-30 psig for best results) to the device with the downstream flow blocked off.
  2. Then slightly open both bleed ports (DO NOT completely remove the screws) and allow any trapped air to escape. Allow some flow and let water pass through while bleeding (if the unit is a controller be sure to give it at least a 50% setpoint). See *page 11* of the manual for more information regarding bleed ports and bleeding.
  3. Try not to get any water in-between the black electronics case and the stainless steel flow body. Wipe up any excess water around these seams.
  4. Tighten up both bleed screws, and then block the downstream water flow again. Visually verify zero flow through.

Please turn the page.



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## Notes for Using Alicat Water Flow Devices continued

5. Now you can safely tare (zero) a meter (*page 23*) using the tare button on the device, or in the case of a water flow controller, command the zero setpoint (*page 35*) which will auto-tare the unit.

- ▶ Smooth and consistent source pressure is highly preferable, as any pulsing or fluctuation in water pressure will hydraulically couple to the differential pressure sensor, and the resultant flow reading will jump analogously.
- ▶ Please note that, depending on model and flow range, water flow meters have an inherent internal pressure drop higher than that of standard gas flow meters of similar flow range. The minimum water device pressure drop is 2 psig, going all the way to 20 psig drop in certain models. ***Your source input pressure must meet or exceed this specification, in addition to any back pressure you may have on the downstream end of your process.*** Please see pages 54 - 59 of the manual or check our online specifications chart for model specific details.

Please contact Alicat if you have any questions. We will be happy to help.

E-mail: [info@alicat.com](mailto:info@alicat.com)

Tel: 520-290-6060 or 888-290-6060

[alicat.com](http://alicat.com)

Thank you for purchasing an L-Series Water Flow Meter or LC or LCR Water Flow Controller.

Please take the time to find and read the information contained in this manual. This will help to ensure that you get the best possible service from your instrument. This manual covers the following Alicat Scientific instruments:

### **L-Series Water Flow Meters**

### **LC-Series Water Flow Controllers**

### **LCR-Series Water Flow Controllers**

This includes L, LC and LCR-Series devices labeled as approved for CSA Class 1 Div 2 and ATEX Class 1 Zone 2 hazardous environments. See pages 66 and 67 for Special Conditions regarding the use of CSA/ATEX labeled devices.

### **LB-Series Portable Water Meters**

**Note:** All Alicat Portable Water Meters operate in accordance with the instructions found in this manual. Please see page 47 for information regarding portable use and recharge.



***Please contact Alicat at 1-888-290-6060 or [info@alicat.com](mailto:info@alicat.com) if you have any questions regarding the use or operation of this device.***

***Many Alicat instruments are built for specific applications. Two instruments with the same flow range and part number may look and act quite differently depending upon the application the instrument was built for. Care should be taken when moving an instrument from one application to another.***



You can find a number of instructional videos related to the operation of this device by visiting the Alicat web site or scanning the QR code.

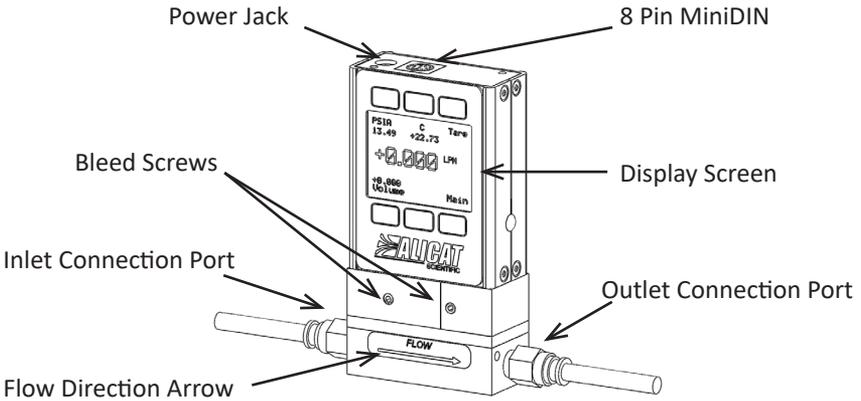
<http://www.alicat.com/support/instructional-videos/>



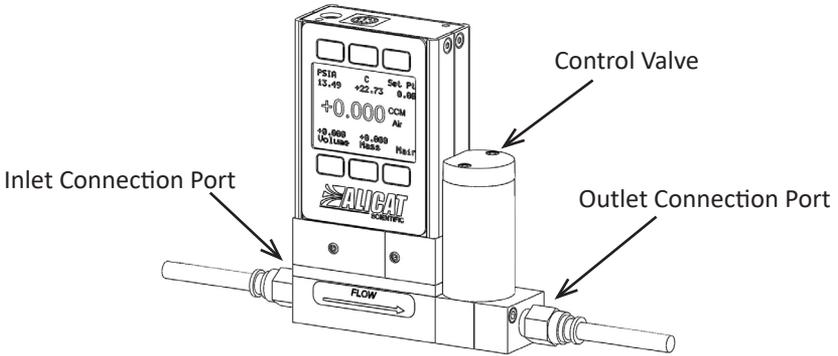
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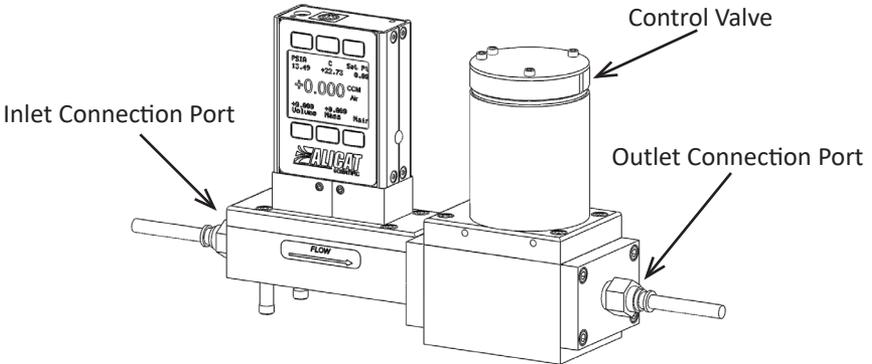
# GETTING STARTED



**L Water Flow Meter** shown with connection port fittings



**LC Water Flow Controller** shown with the standard downstream valve and connection port fittings



**LCR Water Flow Controller** shown with the standard downstream valve and connection port fittings

## MOUNTING

All L-Series Meters and LC-Series Controllers have mounting holes for convenient mounting to flat panels. The sizes and dimensions for the mounting holes are shown on pages 54-59.

Meters and controllers are position insensitive and can be mounted in any orientation.

**Note:** For applications that may continuously introduce occasional air bubbles to the flow stream upstream of the device, the device may be mounted upside down to prevent the bubbles from becoming trapped in the differential pressure sensor ports.



***If the device has been installed upside down, avoid using the bleed screws as water may leak into the electronics housing causing permanent damage that is not covered under warranty!***

## PLUMBING



***Your controller is shipped with plastic plugs fitted in the port openings. To lessen the chance of contaminating the flow stream do not remove these plugs until you are ready to install the device.***

***Make sure that the water will flow in the direction indicated by the flow arrow.***

Standard L-Series Meters and LC-Series Controllers have female inlet and outlet port connections. Welded VCR and other specialty fittings may have male ports.

The inlet and outlet port sizes (process connections) for different flow ranges are shown on pages 54-59.

Instruments with M5 (10-32) ports have O-ring face seals and require no sealant or tape. Do not use tape with welded or o-ring fittings.

For non M5 (10-32) ports use thread sealing Teflon® tape to prevent leakage around the port threads.

***Do not wrap*** the first two threads. This will minimize the possibility of getting tape into the flow stream and flow body.

***Do not use pipe dopes or sealants on the process connections as these compounds can cause permanent damage to the controller should they get into the flow stream.***

When changing fittings, carefully clean any tape or debris from the port threads.



We recommend that a 20 micron filter be installed upstream of meter/controllers with full scale ranges of 100 ccm or less and a 40 micron filter be installed upstream of meter/controllers with full scale ranges above 100 ccm.



***Avoiding long runs of small diameter tubing upstream or downstream of the device will reduce water hammer.***



***Connecting Fittings and Filters***

***<http://www.licat.com/support/instructional-videos/>***

## PRESSURE

Maximum operating line pressure is 100 psig (689 kPa). If the line pressure is higher than 100 psig (689 kPa), use a pressure regulator upstream from the flow controller to reduce the pressure to 100 psig (689 kPa) or less.

Although the meter's operation is uni-directional, reversing the flow direction will inflict no damage as long as the maximum specified limits are not exceeded. The differential pressure sensor utilized in this flow meter/controller is a very sensitive device capable of detecting minute differences in pressure.

Smooth and consistent source pressure is highly preferable, as any pulsing or fluctuation in water pressure will hydraulically couple to the differential pressure sensor, and the resultant flow reading will jump analogously.

Please note that, depending on model and flow range, water flow meters have an inherent internal pressure drop higher than that of standard gas flow meters of similar flow range. The minimum water device pressure drop is 2 psig, going all the way to 20 psig drop in certain models. Your source input pressure must meet or exceed this specification, in addition to any back pressure you may have on the downstream end of your process.



**CAUTION! *EXCEEDING THE MAXIMUM SPECIFIED LINE PRESSURE MAY CAUSE PERMANENT DAMAGE TO THE SOLID-STATE DIFFERENTIAL PRESSURE TRANSDUCER.***

## BLEED PORTS

Alicat Scientific L and LC-Series flow meters and controllers are equipped with bleed ports on the front to aid in the removal of air bubbles from the differential pressure sensor ports. The bleed ports consist of a threaded hole with an 8-32 nylon tipped screw. After installation or anytime it is suspected that air may be trapped in the sensor ports, bleed the ports as follows:

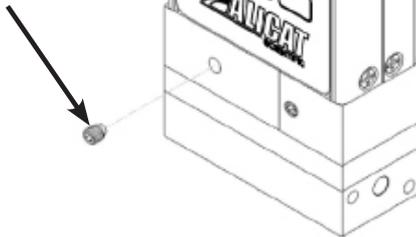


***A small amount of water will leak from the device during this procedure. Take necessary precautions to prevent the leaking water from damaging anything around the unit, taking special care to avoid any live electrical devices or lines.***

1. With the meter/controller installed and line pressure applied, gently loosen the upstream bleed port screw 1-2 turns or until water begins to leak from the threads. **DO NOT REMOVE THE SCREW** as the port is subject to line pressures and injury, equipment damage or loss of required parts may result!
2. Gently tap the flow body (a wooden or plastic screwdriver handle works well for this) to encourage air bubbles to exit the port.
3. Any air in the port will generally be removed as the water leaks out even though you may not see or hear it.
4. Gently tighten the screw until the leakage stops, taking care not to crush the nylon tip.

Repeat steps 1-4 with the second bleed port.

8-32 Nylon Tipped Bleed Screw  
5/64 Hex Loosen to Bleed  
**DO NOT REMOVE!**



***If your device is mounted in an inverted position avoid using the bleed screws as water may leak into the electronics housing causing permanent damage that is not covered under warranty!***

## POWER AND SIGNAL CONNECTIONS

Power can be supplied to your meter/controller through either the power jack (power jack not available on CSA/ATEX approved devices) or the 8 pin Mini-DIN connector.

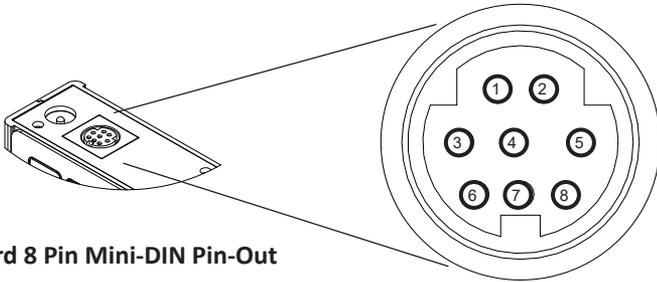
An AC to DC adapter which converts line AC power to DC voltage and current as specified below is required to use the power jack.

A 2.1mm, positive center, 7-30 Vdc AC/DC adapter rated for at least 100 mA is required to use the adapter jack in a **L-Series meter**.

A 2.1mm, positive center, 12-30 Vdc AC/DC adapter rated for at least 250 mA is required to use the adapter jack in a **LC-Series controller**.

A 2.1mm, positive center, 24-30 Vdc AC/DC adapter rated for at least 750 mA is required to use the adapter jack in a **LCR-Series controller**.

**NOTE:** 4-20mA analog output requires at least 15 Vdc.



Standard 8 Pin Mini-DIN Pin-Out

Pin	Function	Mini-DIN cable color
1	Not Connected (or optional 4-20mA Primary Output Signal)	Black
2	Static 5.12 Vdc [or optional Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm]	Brown
3	Serial RS-232RX / RS-485(-) Input Signal (receive)	Red
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Setpoint Input	Orange
5	Serial RS-232TX / RS-485(+) Output Signal (send)	Yellow
6	0-5 Vdc (or optional 0-10 Vdc) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, communications and analog signals)	Purple

**Note:** The above pin-out is applicable to all liquid meters and controllers with the Mini-DIN connector. The availability of different output signals depends on the options ordered. Optional configurations are noted on the unit's calibration sheet.



**CAUTION! Do NOT connect power to pins 1 through 6 as permanent damage can occur!**



*It is common to mistake Pin 2 (labeled 5.12 Vdc Output) as the standard 0-5 Vdc analog output signal.* In fact Pin 2 is normally a constant 5.12 Vdc that reflects the system bus voltage and can be used as a source for the setpoint signal.

*For 6 Pin Locking Connector, DB9 and DB15 Pin-outs see pages 62 to 65.*

*For PROFIBUS Pin-outs see pages 60.*



**Electrical Connections and Basic Wiring**

<http://www.alicat.com/support/instructional-videos/>

## INPUT SIGNALS

**Analog Input Signal** (applicable to controllers only)

Apply analog input to Pin 4 as shown on page 12.

**For 6 Pin Locking Connector, DB9 and DB15 Pin-outs see pages 62 to 65.**

**For PROFIBUS Pin-outs see pages 60.**

**Standard 0-5 Vdc** is the standard analog input signal. Apply the 0-5 Vdc input signal to pin 4, with common ground on pin 8.

**Optional 0-10 Vdc:** If specified at time of order, a 0-10 Vdc input signal can be applied to pin 4, with common ground on pin 8.

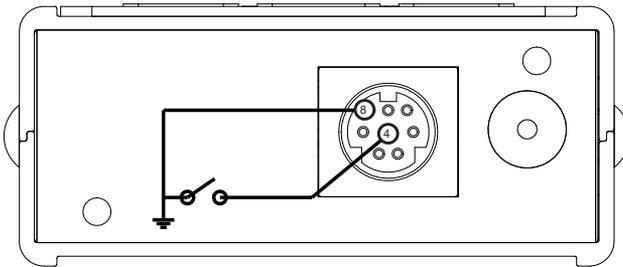
**Optional 4-20 mA:** If specified at time of order, a 4-20 mA input signal can be applied to pin 4, with common ground on pin 8.

**NOTE:** This is a current sinking device. The receiving circuit is essentially a 250 ohm resistor to ground.

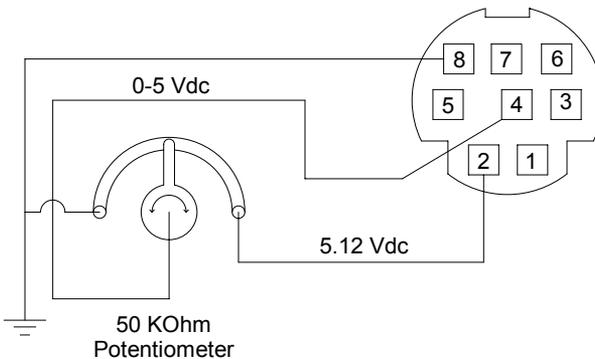
**NOTE:** 4-20mA output requires at least 15 Vdc power input.



**CAUTION! Do NOT CONNECT THIS DEVICE TO "LOOP POWERED" SYSTEMS, AS THIS WILL DESTROY PORTIONS OF THE CIRCUITRY AND VOID THE WARRANTY. IF YOU MUST INTERFACE WITH EXISTING LOOP POWERED SYSTEMS, ALWAYS USE A SIGNAL ISOLATOR AND A SEPARATE POWER SUPPLY.**



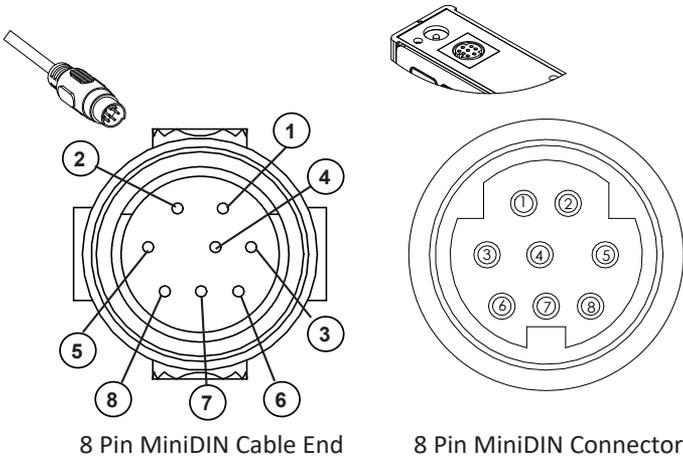
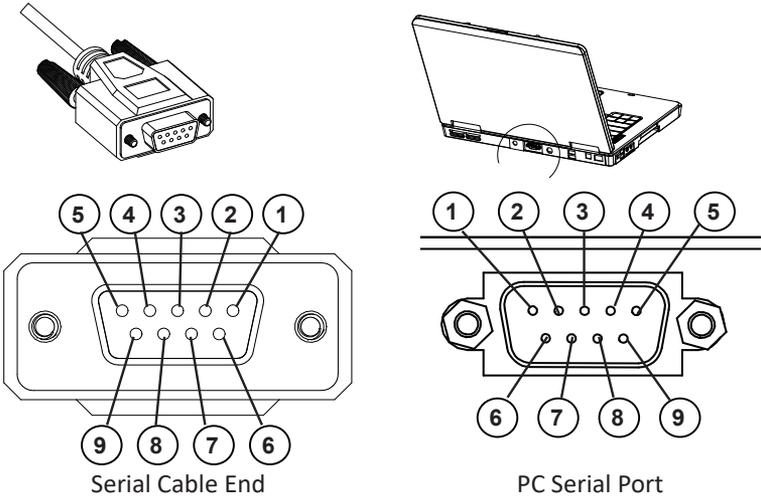
**Meters:** A remote tare can be achieved by momentarily grounding pin 4 to tare.



**Controllers:** A simple method for providing setpoint to controllers

## RS-232 / RS-485 Digital Input Signal

To use the RS-232 or RS-485 input signal, connect the RS-232 / RS-485 Output Signal (Pin 5), the RS-232 / RS-485 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown below. (See page 36 for details on accessing RS-232 / RS-485 input.)



9 Pin Serial Connection		8 Pin MiniDIN Connection	
Pin	Function	Function	Pin
5	Ground	Ground	8
3	Transmit	Receive	3
2	Receive	Transmit	5

DB9 to Mini-DIN Connection for RS-232 / RS-485 Signals



*Electrical Connections and Basic Wiring*

<http://www.alicat.com/support/instructional-videos/>

## OUTPUT SIGNALS

### RS-232 / RS-485 Digital Output Signal

To use the RS-232 or RS-485 output signal, it is necessary to connect the RS-232 / RS-485 Output Signal (Pin 5), the RS-232 / RS-485 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown on page 14. (See page 36 for details on accessing RS-232 / RS-485 output.)

### Standard Voltage (0-5 Vdc) Output Signal

Meters/controllers equipped with a 0-5 Vdc (optional 0-10 Vdc) will have this output signal available on Pin 6. This output is generally available in addition to other optionally ordered outputs. This voltage is usually in the range of 0.010 Vdc for zero flow and 5.0 Vdc for full-scale flow. The output voltage is linear over the entire range. Ground for this signal is common on Pin 8.

### Optional 0-10 Vdc Output Signal

If your meter/controller was ordered with a 0-10 Vdc output signal, it will be available on Pin 6. (See the Calibration Data Sheet that shipped with your meter to determine which output signals were ordered.) This voltage is usually in the range of 0.010 Vdc for zero flow and 10.0 Vdc for full-scale flow. The output voltage is linear over the entire range. Ground for this signal is common on Pin 8.

### Optional Current (4-20 mA) Output Signal

If your meter/controller was ordered with a 4-20 mA current output signal, it will be available on Pin 1. (See the Calibration Data Sheet that shipped with your meter to determine which output signals were ordered.) The current signal is 4 mA at 0 flow and 20 mA at the meter's full scale flow. The output current is linear over the entire range. Ground for this signal is common on Pin 8. (Current output units require 15-30Vdc power.)

### Optional 2nd Analog Output Signal

You may specify an optional 2nd analog output on Pin 2 at time of order. (See the Calibration Data Sheet that shipped with your meter to determine which output signals were ordered.) This output may be a 0-5 Vdc, 0-10 Vdc, or 4-20 mA analog signal that can represent any measured parameter. With this optional output, a meter could output the volume flow rate (0-5 Vdc on pin 6) and the line temperature (0-5 Vdc on pin 2).



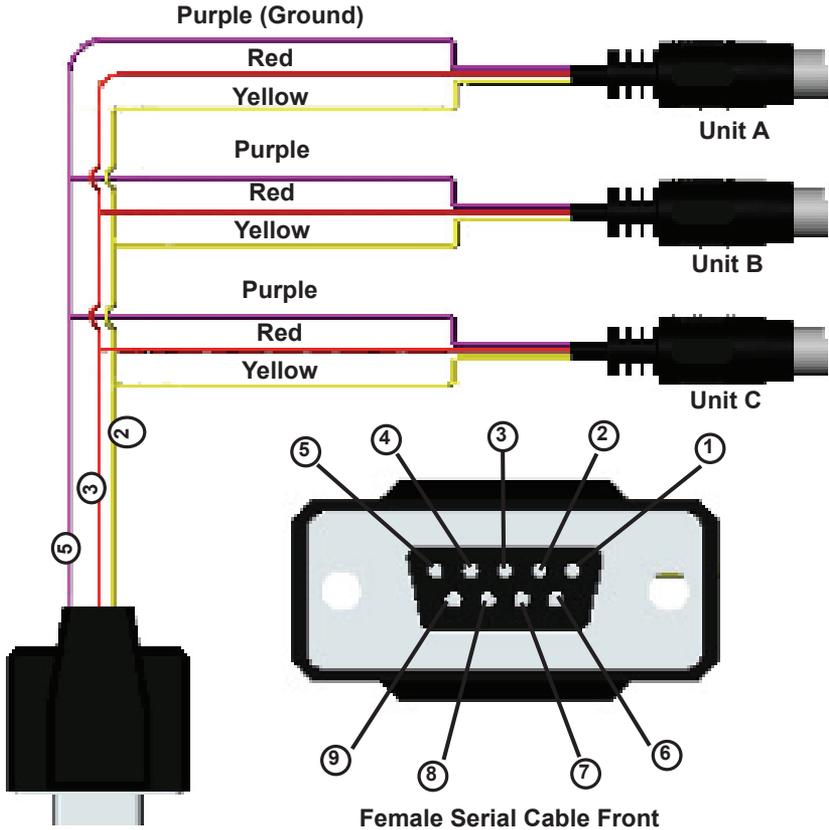
If your device is equipped with the optional six pin industrial connector, please contact Alicat.



**CAUTION! DO NOT CONNECT THIS DEVICE TO "LOOP POWERED" SYSTEMS, AS THIS WILL DESTROY PORTIONS OF THE CIRCUITRY AND VOID THE WARRANTY. IF YOU MUST INTERFACE WITH EXISTING LOOP POWERED SYSTEMS, ALWAYS USE A SIGNAL ISOLATOR AND A SEPARATE POWER SUPPLY.**



**CAUTION! DO NOT CONNECT THIS DEVICE TO "LOOP POWERED" SYSTEMS, AS THIS WILL DESTROY PORTIONS OF THE CIRCUITRY AND VOID THE WARRANTY. IF YOU MUST INTERFACE WITH EXISTING LOOP POWERED SYSTEMS, ALWAYS USE A SIGNAL ISOLATOR AND A SEPARATE POWER SUPPLY.**



Typical Multiple Device (Addressable) Wiring Configuration



**The easiest way to connect multiple devices is with a Multi-Drop Box (see page 50).**

## Information for Alicat TFT (Color Display) Instruments

Alicat TFT (color display) instruments have a high contrast back-lit LCD display. TFT instruments operate in accordance with Alicat standard operating instructions for our monochrome menus and displays with the following differences.

### Multi-Color Display Color Codes:

**GREEN:** Green labels identify the parameters and/or adjustments associated with the button directly above or below the label.

**WHITE:** The color of each parameter is displayed in white while operating under normal conditions.

**RED:** The color of a parameter is displayed in red when operating conditions for that parameter exceed 128% of the device's specifications.

**YELLOW:** Yellow is the equivalent of the selection arrow on the monochrome display.

### LCD Contrast:

LCD contrast is ranged from 0 to 11 on color displays with 11 being the greatest contrast.

### Technical Data for TFT (Color Display) Meters, Gauges and Controllers

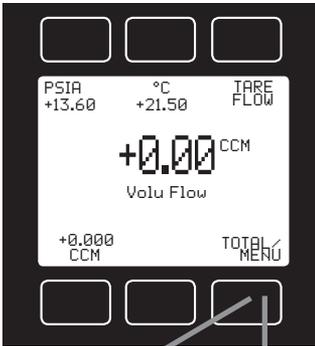
The following specifications are applicable to Alicat **TFT** (color display) meters, gauges and controllers only. All other operating specifications are shown in the Technical Data page for standard Alicat instruments. All standard device features and functions are available and operate in accordance with the Alicat operating manual provided with the device.

Specification	Meter or Gauge	Small Valve Controller	Large Valve Controller
Supply Voltage	7 to 30 Vdc	12 to 30 Vdc	24 to 30 Vdc
Supply Current	80 mA @ 12Vdc 70 mA @ 24Vdc	290 mA @ 12Vdc 200 mA @ 24Vdc	780 mA @ 24Vdc

# DISPLAYS AND MENUS L METERS

(Displays and Menus for LC and LCR Controllers are shown beginning page 28.)  
The device screen defaults to **Main** display as soon as power is applied to the meter.

## Main



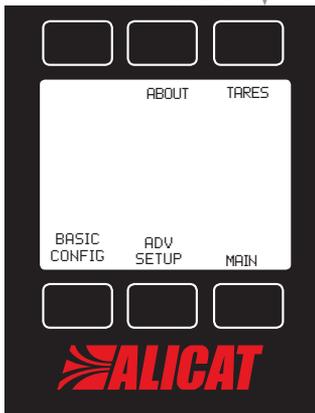
The **Main** display shows pressure, temperature, and volumetric flow. Pressing the button adjacent to a parameter will make that parameter the primary display unit. By hitting the **MENU** button at the bottom right of the screen you will enter the **Select Menu** display.

## Totalizer (option only)



If your meter was ordered with the **Totalizer** option (page 45), pushing the **TOTAL/MENU** button once will bring up the **Totalizing Mode** display. Pushing **MENU** will bring up the **Select Menu** display.

## Select Menu



## Select Menu

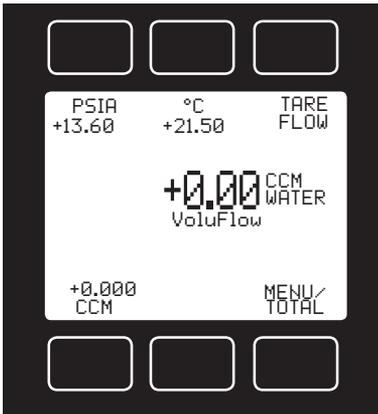
From **Select Menu** you can change the selected gas, interact with your RS-232 / RS-485 settings or read manufacturer's data.

Push **MAIN** to return to the Main display.

## Display On/Off:

Pushing the button under the Alicat name will turn the device display back light on or off.

## MAIN



The following parameters are displayed in the **Main** mode: Pressure; Temperature; and Volumetric Flow.

This mode defaults on power up, with volumetric flow as the primary displayed parameter.

Pressing the button next to the parameter will put that parameter in the primary display.

Press the button a second time to change the engineering unit associated with the device display (button units) and /or the data feed (device units). See page 20.

**Pressure:** This sensor references hard vacuum and reads incoming pressure both above and below local atmospheric

pressure. This parameter is moved to the primary display by pushing the button above **PSIA**. Pushing this button again will allow you to show Absolute Pressure, Gauge Pressure or Barometric Pressure in devices that have a barometer.

**Temperature:** L-Series flow meters measure the incoming temperature of the flow. The temperature is displayed in degrees Celsius (°C). This parameter is moved to the primary display by pushing the button above **°C**.

Pushing the button again allows you to select °C (Celsius), °F (Fahrenheit) or °R (Rankine) for the temperature scale.

**Tare:** Pushing the **TARE FLOW** button tares the flow meter and provides it with a reference point for zero flow. This is an important step in obtaining accurate measurements. It is best to zero the flow meter each time it is powered up. If the flow reading varies significantly from zero after an initial tare, give the unit a minute or so to warm up and re-zero it.

If possible, zero the unit near the expected operating pressure by positively blocking the flow downstream of the flow meter prior to pushing the TARE button.

**➔ Zeroing the unit while there is any flow will directly affect the accuracy by providing a false zero point.** If in doubt about whether a zero flow condition exists, remove the unit from the line and positively block both ports before pressing the TARE button. If the unit reads a significant negative value when removed from the line and blocked, it was given a false zero. It is better to zero the unit at atmospheric pressure and a confirmed no flow condition than to give it a false zero under line pressure.

**Flow Rate:** This parameter is located in the lower left of the display. It is moved to the primary display by pushing the button below **CCM** in this example. Your display may show a different unit of measure.

**MENU:** Pressing **MENU** switches the screen to the **Select Menu** display.



**Flashing Error Message:** An error message ( **VOV** = volumetric overrange, **POV** = pressure overrange, **TOV** = temperature overrange) flashes when a measured parameter exceeds the range of the sensor. When any item flashes, neither the flashing parameter nor the flow measurement is accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy.

**If the unit does not return to normal operation contact Alicat.**

## Choosing Engineering Units from Main Mode

Press the button above or below any of the four flow parameters twice to enter its unit selection menu. You can change units in two ways:

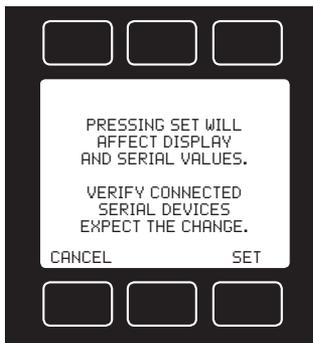
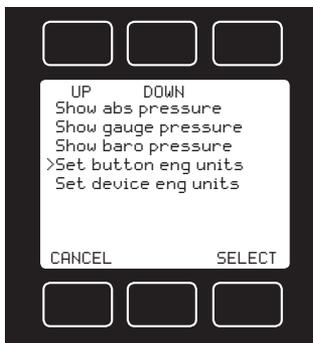
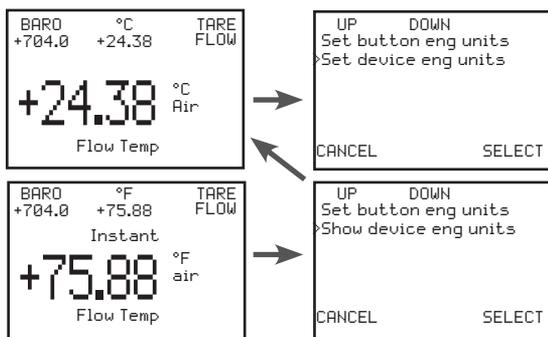
**Button engineering units** alter the display only, not the RS-232 / RS-485 data frame:

- Select Set button eng units and press SELECT to change the engineering unit on the display only. Use the UP and DOWN keys to move the > cursor to the desired unit, and then press SET. This does not alter the data frame.

**Device engineering units** alter both the display and the data frame:

- Select Set device eng units and then choose the engineering unit as above. An additional confirmation screen asks you to confirm the RS-232 / RS-485 change.
- If the button engineering unit is different than the device engineering unit, Set device eng units will not appear. First select Show device eng units to return the button unit to the existing device engineering unit, and then enter the unit selection menu again to change the device engineering unit.

**Examples of changing device engineering units:**



### Changing device units:

°C is the existing device engineering unit, so the unit selection menu displays Set device eng units.

### Changing device units:

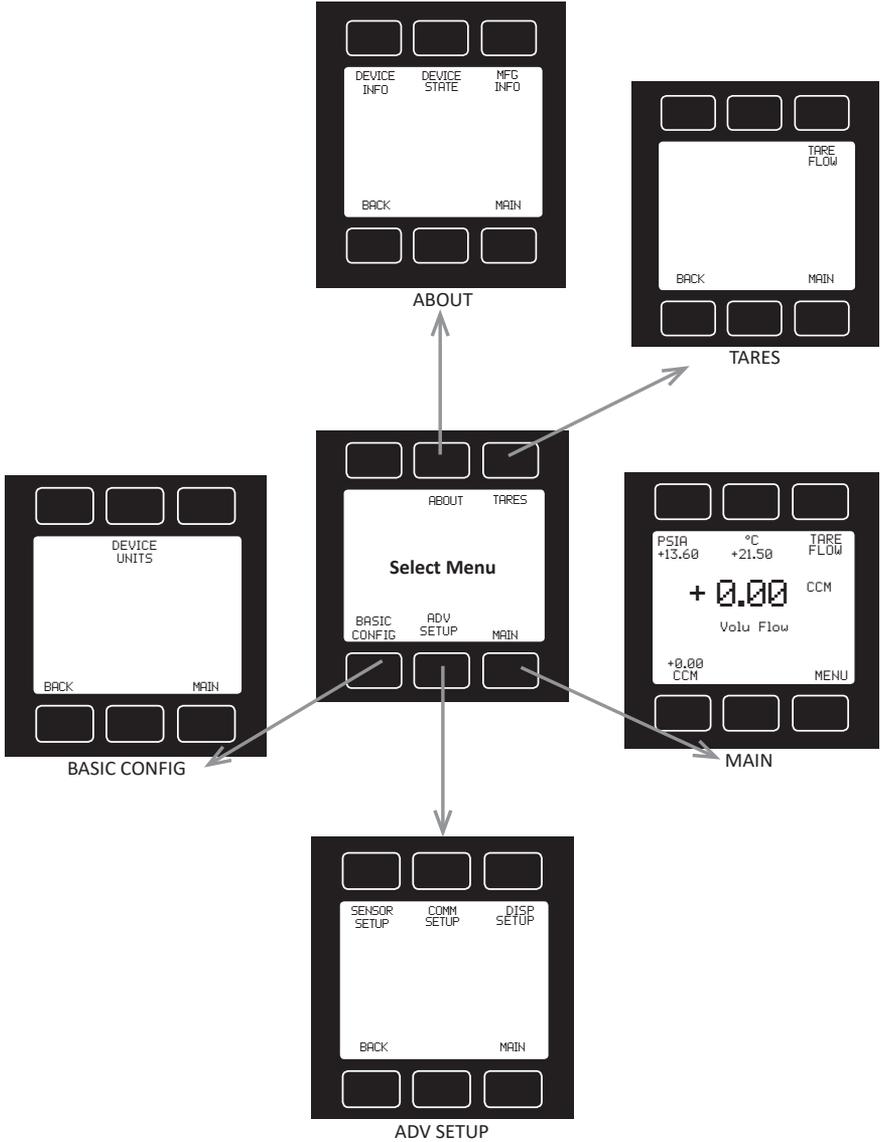
°F is not the existing device engineering unit, so the unit selection menu displays Show device eng units. Enter the unit selection menu again to change the device engineering units.

# SELECT MENU

(The Select Menu for LC and LCR controllers are shown on page 30.)

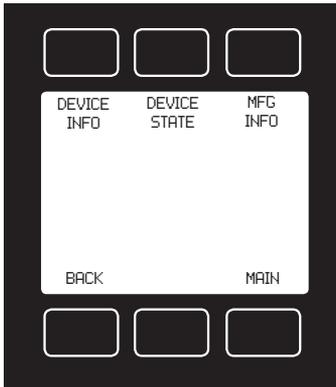
From Select Menu you can change the selected gas, interact with your RS-232 / RS-485 settings or read manufacturer's data.

Press the button next to the desired operation to bring that function to the screen.



An explanation for each screen can be found on the following pages.

## ABOUT



**ABOUT**

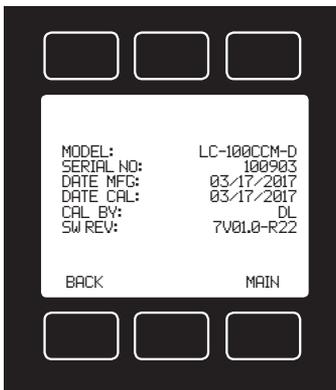
Press **DEVICE INFO** to show important information about your flow device including the model number, serial number, and date of manufacture.

Press **BACK** to return to the About display.

Push **MAIN** to return to the Main display.

Manufacturer information is accessed by pressing the **MFG INFO** button on the About Menu display.

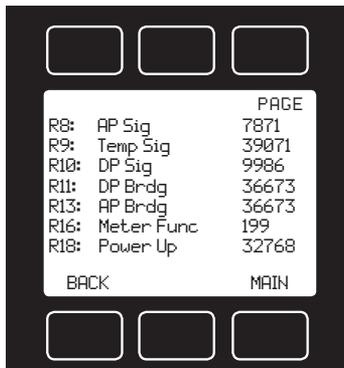
The initial display shows the name and telephone number of the manufacturer.



**DEVICE INFO**



**MFG INFO**



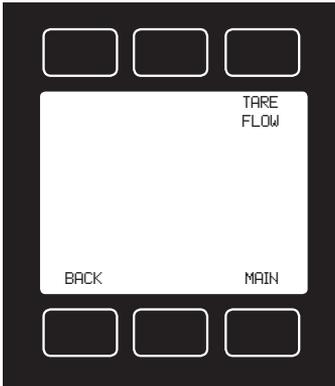
**DEVICE STATE**

**DEVICE STATE:** This diagnostic screen displays the current internal register values, which is useful for noting factory settings prior to making any changes. It is also helpful for troubleshooting with Alicat customer service personnel.

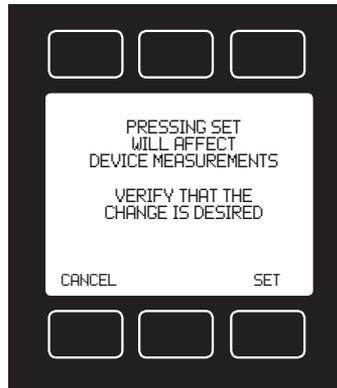
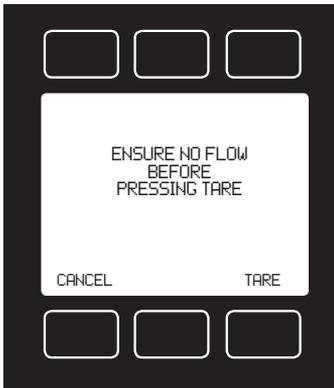
Select the **DEVICE STATE** button from the **ABOUT** screen to view a list of select register values.

Pressing the **PAGE** button will cycle the display through the register screens. An example screen is shown at left.

## TARES

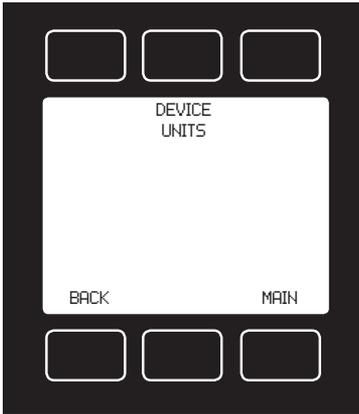


Press **TARES** to access **TARE FLOW**.  
Press **BACK** to return to the Tares display.  
Push **MAIN** to return to the Main display.  
See page 35 for taring LC and LCR controllers.



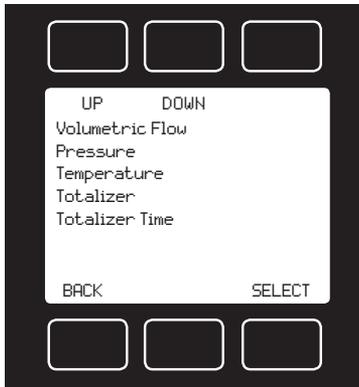
## TARE FLOW

## BASIC CONFIG



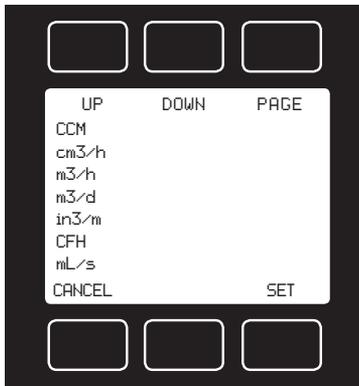
Press **BASIC CONFIG** to select device units  
Press **BACK** to return to the Select Menu display. Push **MAIN** to return to the Main display.

## DEVICE UNITS

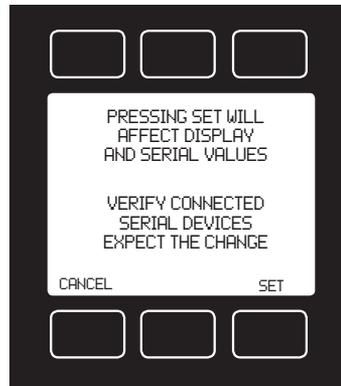


Press **DEVICE UNITS** to access menus of units of measure for each parameter (and totalizer if so equipped).  
Scroll to the desired unit and press select.  
Once selected, you will see the message shown below. Verify that all connected devices expect the change.  
See pages 40 and 41 for a full list of available units.

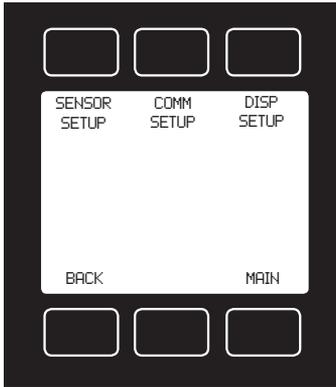
## DEVICE UNITS



## LIQUID FLOW UNITS



## ADV SETUP



ADV SETUP

Press **ADV SETUP** to adjust the sensor settings, unit ID, baud rate, or display settings.

Press **BACK** to return to the Select Menu display. Push **MAIN** to return to the Main display.

### SENSOR SETUP

**ZERO BAND** refers to Display Zero Deadband. Zero deadband is a value below which the display jumps to zero. This deadband is often desired to prevent electrical noise from showing up on the display as minor flows or pressures that do not exist. Display Zero Deadband does not affect the analog or digital signal outputs.

**ZERO BAND** can be adjusted between 0 and 6.3% of the sensor's Full Scale (FS).

Press **ZERO BAND**. Then use SELECT to choose the digit with the arrow and the UP/DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

**Pressure Averaging and Flow Averaging** may be useful to make it easier to read and interpret rapidly fluctuating pressures and flows. Pressure and flow averaging can be adjusted between 1 (no averaging) and 255 (maximum averaging).

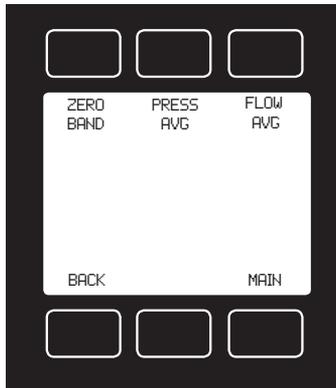
These are geometric running averages where the number between 1 and 255 can be considered roughly equivalent to the response time constant in milliseconds.

This can be effective at "smoothing" high frequency process oscillations such as those caused by diaphragm pumps.

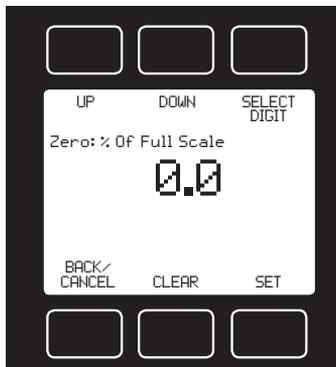
Press **PRESS AVG**. Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

Press **FLOW AVG**. Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

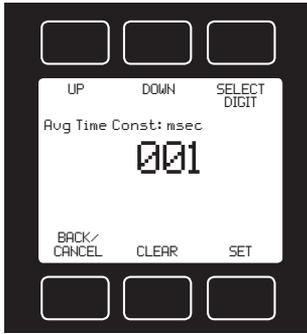
Setting a higher number will equal a smoother display.



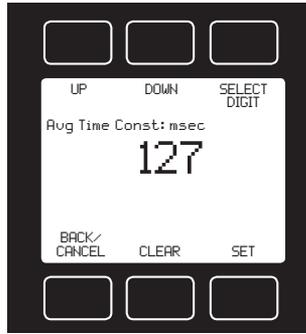
SENSOR SETUP



ZERO BAND



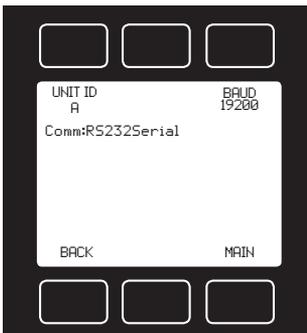
**PRESS AVG**



**FLOW AVG**

## COMM SETUP

Press **COMM SETUP** to adjust the unit ID or baud rate.



**COMM SETUP**

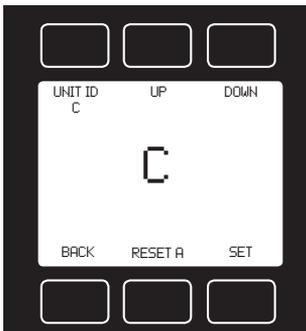
**UNIT ID** – Valid unit identifiers are the letters A-Z and @. The identifier allows you to assign a unique address to each device so that multiple units can be connected to a single RS-232 or RS-485 computer port.

Press **UNIT ID**. Use the UP and DOWN buttons to change the Unit ID. Press SET to record the ID. Press Reset to return to the previously recorded Unit ID. **Any Unit ID change will take effect when SET is pressed.**

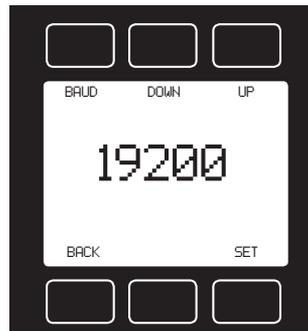
*If the symbol @ is selected as the Unit ID, the device will enter streaming mode when SET is pressed. See RS-232 Communications (page 37) for information about the streaming mode.*

**BAUD** – Both this instrument and your computer must send/receive data at the same baud rate. The default baud rate for this device is 19200 baud.

Press **BAUD**. Use the UP and DOWN buttons to select the baud rate that matches your computer. The choices are 57600, 38400, 19200, 9600, or 2400 baud. Press SET to record the baud rate. **Any baud rate change will take effect when SET is pressed..**



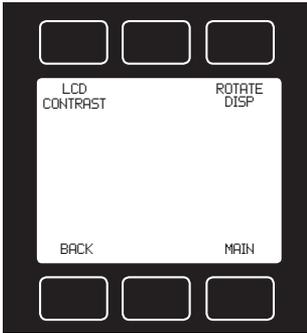
**UNIT ID**



**BAUD**

## DISP SETUP

Press **DISP SETUP** to adjust the LCD contrast or rotate the display.

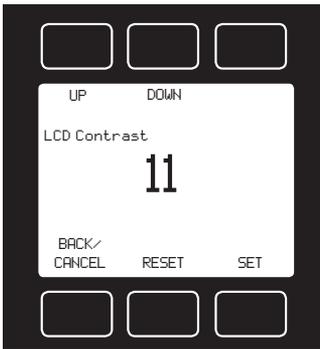


**DISP SETUP**

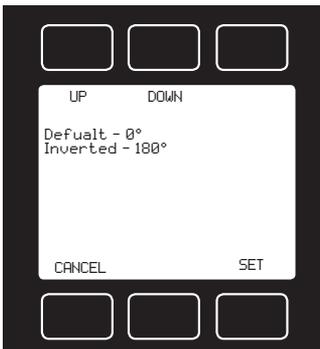
**LCD CONTRAST:** The display contrast can be adjusted between 0 and 28, with zero being the lightest and 31 being the darkest. Use the UP and DOWN buttons to adjust the contrast. Press SET when you are satisfied. Press BACK to return to DISP SETUP.

Press **RESET** to revert to the default contrast level (10)

**ROTATE DISP:** Press **ROTATE DISP** and select **Inverted 180°** if your device is inverted. The display and buttons will rotate together.



**LCD CONTRAST**

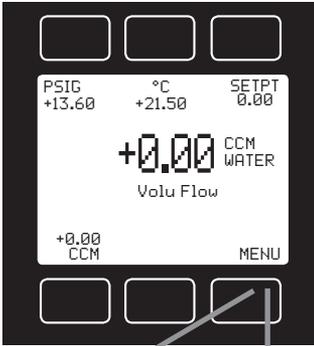


**ROTATE DISPLAY**

## DISPLAYS AND MENUS LC AND LCR CONTROLLERS

(Displays and Menus for L Meters are shown beginning page 18.)

The device screen defaults to **Main** display as soon as power is applied to the controller.

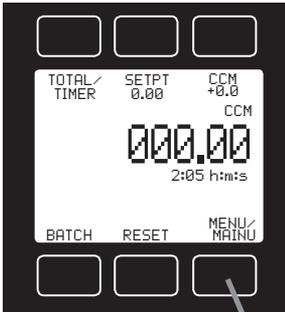


The **Main** display shows, temperature and volume flow. Line pressure will be also be displayed if the meter was order with this option.

Pressing the button adjacent to a parameter will make that parameter the primary display unit.

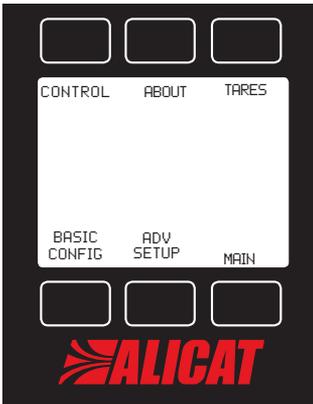
By hitting the **MENU** button at the bottom right of the screen you will enter the **Select Menu** display.

### Totalizer (option only)



If your controller was ordered with the **Totalizer** option (page 45), pushing the **TOTAL** button once will bring up the **Totalizing Mode** display. Pushing **MENU** will bring up the **Select Menu** display.

### Select Menu



### Select Menu

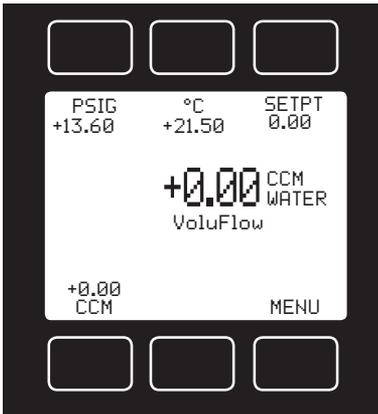
From **Select Menu** you can change the selected gas, interact with your RS-232 / RS-485 settings, read manufacturer's data or access the control set-up display.

Push **MAIN** to return to the Main display.

### Display On/Off:

Pushing the button under the Alicat name will turn the device display back light on or off.

## MAIN



The following parameters are displayed in the **Main** mode: Pressure; Temperature; and Volumetric Flow.

This mode defaults on power up, with volumetric flow as the primary displayed parameter.

Pressing the button next to the parameter will put that parameter in the primary display.

Press the button a second time to change the engineering unit associated with the device display (button units) and /or the data feed (device units). See page 20.

**Pressure:** This sensor references hard vacuum and reads incoming pressure both above and below local atmospheric

pressure. This parameter is moved to the primary display by pushing the button above **PSIA**. Pushing this button again will allow you to show Absolute Pressure, Gauge Pressure or Barometric Pressure in devices that have a barometer.

**Temperature:** L-Series flow meters measure the incoming temperature of the flow. The temperature is displayed in degrees Celsius (°C). This parameter is moved to the primary display by pushing the button above **°C**.

Pushing the button again allows you to select °C (Celsius), K (Kelvin), °F (Fahrenheit) or °R (Rankine) for the temperature scale.

**Setpoint:** The setpoint (**SETPT**) is shown in the upper right of the display.

*For information on changing the setpoint see SETPT SOURCE, page 31.*

**Flow Rate:** This parameter is located in the lower left of the display. It is moved to the primary display by pushing the button below **CCM** in this example. Your display may show a different unit of measure.

**MENU:** Pressing **MENU** switches the screen to the **Select Menu** display.



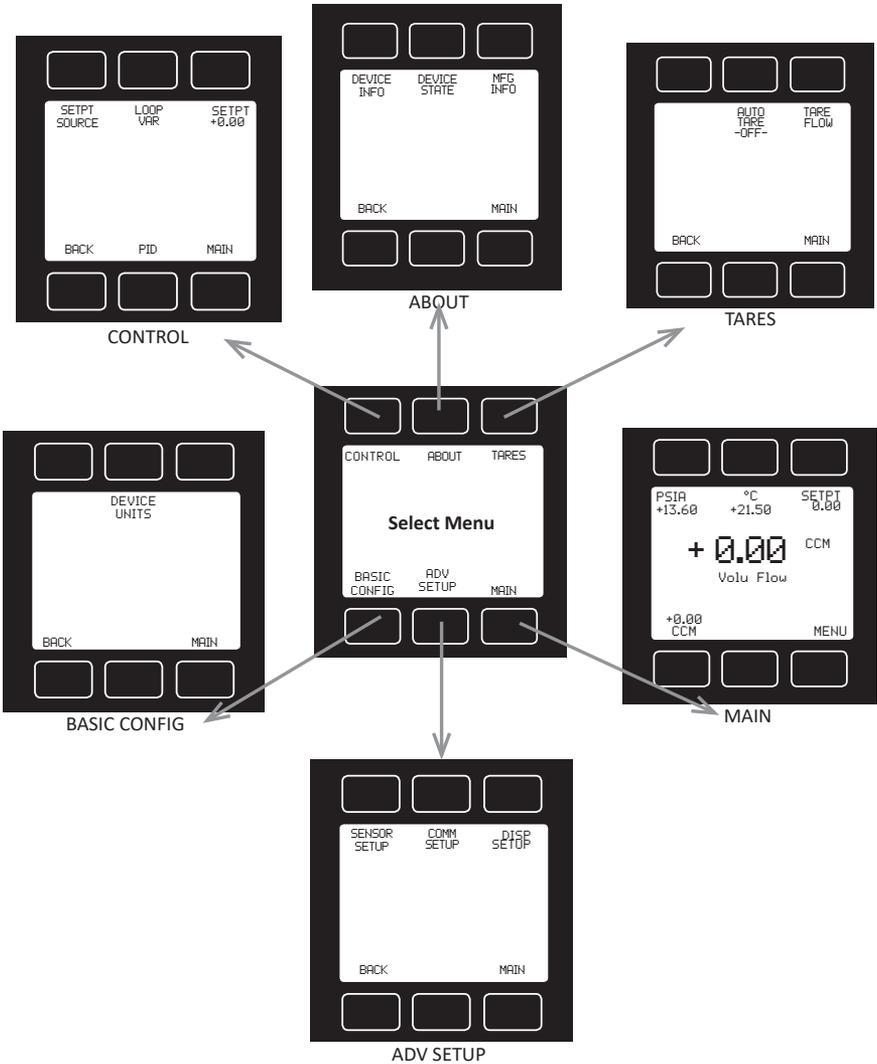
**Flashing Error Message:** An error message (**VOV** = volumetric overrange, **POV** = pressure overrange, **TOV** = temperature overrange) flashes when a measured parameter exceeds the range of the sensor. When any item flashes, neither the flashing parameter nor the flow measurement is accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy.

**If the unit does not return to normal operation contact Alicat.**

## SELECT MENU

From Select Menu you can change interact with your RS-232 / RS-485 settings, read manufacturer's data and access the control screen.

Press the button next to the desired operation to bring that function to the screen.



An explanation for each screen can be found on the following pages:

**ABOUT:** Please see page 22.

**TARES:** Please see page 35.

**MAIN:** Please see page 29.

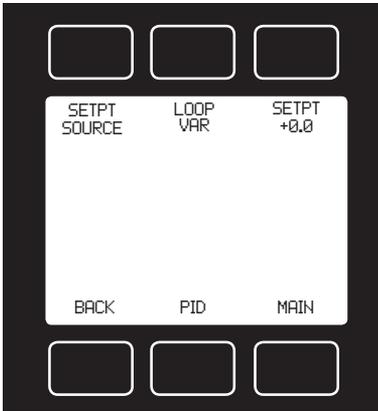
**ADV SETUP:** Please see page 25.

**BASIC CONFIG:** Please see page 24.

**CONTROL:** Please see page 31.

## CONTROL

**Control** setup is accessed by pressing the button below Control on the Select Menu display. From this screen you can select your setpoint source, choose a loop variable and adjust the PID terms.



Press BACK to return to the Select Menu display.

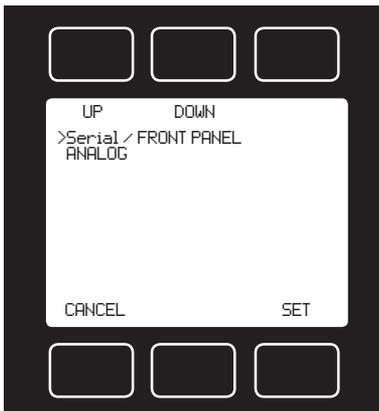
Press MAIN to return to the MAIN display

**SETPT SOURCE** – Pressing the button above SETPT SOURCE will allow you to select how the setpoint will be conveyed to your controller.

Use the Up and Down buttons to move the arrow in front of the desired option. Then press SET.

Press CANCEL to return to the previous display.

The controller will ignore any setpoint except that of the selected setpoint source and it will remember which input is selected even if the power is disconnected.



**Serial** refers to a remote digital RS-232 / RS-485 setpoint applied via a serial connection to a computer or PLC as described in the installation and RS-232 / RS-485 sections of this manual.

**Front Panel** refers to a setpoint applied directly at the controller.

 **Front Panel input must be selected prior to changing the setpoint at the device.**

**Analog** refers to a remote analog setpoint applied to Pin 4 of the Mini-DIN connector as described in the installation

section of this manual. **The standard analog input is 0-5 Vdc.**

 **To determine what type of analog setpoint your controller has, refer to the Calibration Data Sheet that was included with your controller.**

If nothing is connected to Pin 4, and the controller is set for analog control, the device will generate random setpoint values.

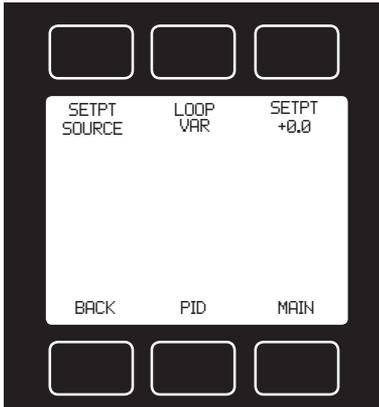
**NOTE:** If your controller has the IPC (Integrated Potentiometer Control) option, the IPC dial will operate with the ANALOG setpoint source selected.

**SETPT** refers to the **setpoint**. This parameter may be changed using the display only if **FRONT PANEL** is selected as the source. Press **SETPT**. Then use SELECT to choose the decimal with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.



**CAUTION! NEVER LEAVE A CONTROLLER WITH A NON-ZERO SETPOINT IF NO PRESSURE IS AVAILABLE TO MAKE FLOW. THE CONTROLLER WILL APPLY FULL POWER TO THE VALVE IN AN ATTEMPT TO REACH THE SETPOINT. WHEN THERE IS NO FLOW, THIS CAN MAKE THE VALVE VERY HOT!**

## CONTROL (continued)



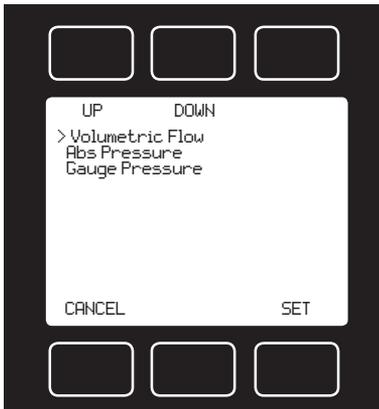
**LOOP VAR** — Pressing the **LOOP VAR** button on the Control Setup screen will allow you to change what variable is controlled.

Use the Up and Down buttons to move the arrow in front of the desired option.

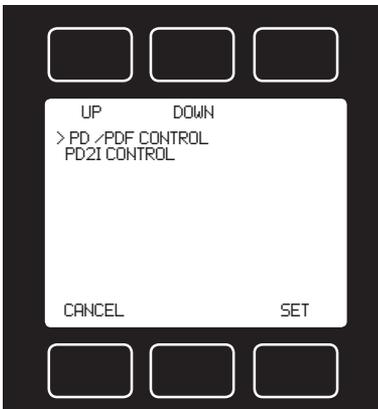
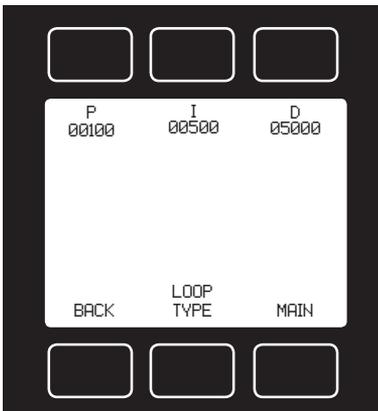
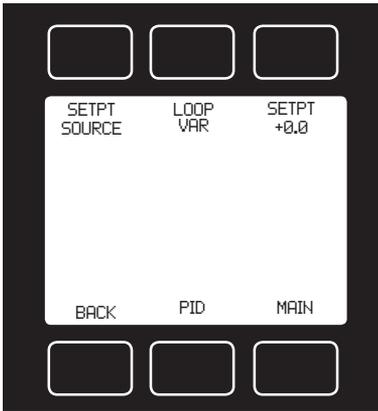
When the flow controller is supplied with the **control valve upstream** of the electronics portion of the system, the unit can be set to control on outlet pressure or volumetric flow rate.

*When you change from controlling flow to controlling pressure, sometimes fairly radical changes must be made to the P & D variables. See page 33 – PID TUNING.*

*Contact Alicat if you are having difficulties with this procedure.*



## PID TUNING



PID Values determine the performance and operation of your proportional control valve. These terms dictate control speed, control stability, overshoot and oscillation. All units leave the factory with a generic tuning designed to handle most applications. If you encounter issues with valve stability, oscillation or speed, fine tuning these parameters may resolve the problem.

Alicat controllers allow you to adjust the Proportional, Integral and Differential terms of the PID control loop.

To change the PID loop parameters, push the button below **PID**.

Press **LOOP TYPE**. Then use the UP and DOWN buttons to select the appropriate PID control algorithm. Press SET.

**See the following page for descriptions of the PID Loop Types (PID Control Algorithms).**

**P** refers to the Proportional term of the PID loop.

**I** refers to the Integral term of the PID loop.

**D** refers to the Differential term of the PID loop.

Press P, I or D. Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

**Before changing the P, I or D parameter, please record the initial value so that it can be returned to the factory setting if necessary.**

**Valve tuning can be complex. If you would like assistance, please contact Alicat for technical support.**



Overview of PID Adjustment on Alicat Flow and Pressure Controllers  
<http://www.alicat.com/support/instructional-videos/>

***The PD algorithm is the PID algorithm used on most Alicat controllers.***

It is divided into two segments:

The first compares the process value to the setpoint to generate a proportional error. The proportional error is multiplied by the 'P' gain, with the result added to the output valve drive.

The second operates on the present process value minus the process value during the immediately previous evaluation cycle. This 'velocity' term is multiplied by the 'D' gain, with the result subtracted from the output valve drive.

The above additions to and subtractions from the output drive register are carried over from process cycle to process cycle, thus performing the integration function automatically.

Increasing the 'P' gain will **promote** the tendency of the system to overshoot, ring, or oscillate.

Increasing the 'D' gain will **reduce** the tendency of the system to overshoot.

***The PD21 algorithm is a PID algorithm used primarily for high performance pressure and flow control applications.***

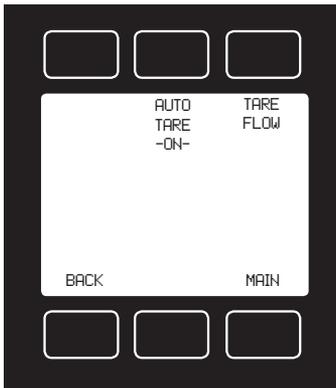
It exhibits two basic differences from the PD algorithm that most controllers utilize.

1. Instead of applying a damping function based upon the rate of change of the process value, it applies a damping function based upon the square of the rate of change of the process value.
2. The damping function is applied directly to the proportional error term before that term is used in the proportional and integral functions of the algorithm. This provides a certain amount of 'look ahead' capability in the control loop.

*Because of these differences, you will note the following:*

1. Increasing 'P' gain can be used to damp out overshoot and slow oscillations in pressure controllers. You will know that 'P' gain is too high, when the controller breaks into fast oscillations on step changes in setpoint. On flow controllers, too low a 'P' gain results in slower response times. Too high a 'P' gain results in overshoot and/or slow oscillation. A good starting value for 'P' gain is 200.
2. If the unit was originally shipped with the PD21 algorithm selected, the 'D' gain value should be left at or near the factory setting because it relates primarily to the system phase lags. If you are changing from the default algorithm to the PD21 algorithm, you should start with a 'D' gain value of 20.
3. The 'I' gain is used to control the rate at which the process converges to the setpoint, after the initial step change. Too low a value for 'I' gain shows up as a process value that jumps to near the setpoint and then takes awhile to converge the rest of the way. Too high a value for 'I' gain results in oscillation. A good starting value for the 'I' gain is 200.

## TARES



Press **TARES** to access **AUTO TARE** and **TARE FLOW**.

Press **BACK** to return to the Tares display.

Push **MAIN** to return to the Main display.

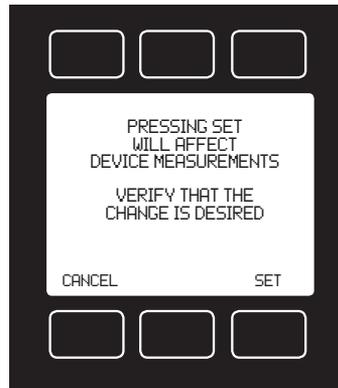
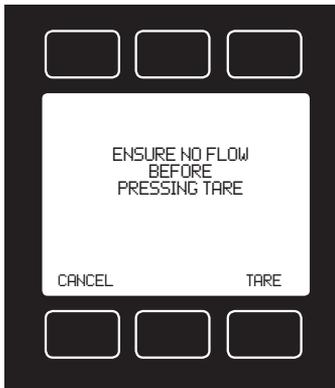
**AUTO TARE ON/ OFF**—refers to the standard auto-tare or “auto-zero” feature.

The auto-tare feature automatically tares (takes the detected signal as zero) the unit when it receives a zero setpoint for more than two seconds.

A zero setpoint results in the closing of the valve and a known “no flow” condition. This feature makes the device more accurate by

periodically removing any cumulative errors associated with drift.

*It is recommended that the controller be left in the default auto-tare ON mode unless your specific application requires that it be turned off.*



## TARE FLOW

## RS-232 / RS-485 Output and Input

Alicat flow and pressure units come standard with Alicat's integrated multi-drop RS-232 connectivity; although, RS-485 can be substituted.

### Alicat's Flow Vision Software

Flow Vision is an affordable software program that interfaces with RS-232 or RS-485 and is compatible with most Alicat flow and pressure instruments. The graphical user interface (GUI) provides automatic configuration, session saving for easy configuration and experiment setup reloads, data capturing and logging (including a graphing tool), simple script building for automating meter and control command sequences, software alarms, and support for multiple devices. Flow Vision SC™ is for general use with up to 26 different Alicat devices, while Flow Vision MX™ is specifically designed for gas mixing applications.

### Alicat's Free Serial Terminal Application

Serial Terminal was written by Alicat as a preconfigured program for RS-232 or RS-485 communication with Alicat devices and can be downloaded from [www.alicat.com/support/software-drivers](http://www.alicat.com/support/software-drivers).

Serial Terminal requires a Microsoft® .Net Framework to run properly which is usually preinstalled on the PC. Once downloaded, simply run SerialTerminal.exe and enter the COM port number and baud rate of your Alicat device as prompted.

The COM port number may be determined using the Device Manager on the computer, and the default baud rate of an Alicat device is 19200.

### Additional Programs that are compatible with Alicat products

Alicat products are compatible with many serial communication type software packages including PuTTY and LabVIEW. A brief set of instructions for each of these programs is available at [www.alicat.com/support/software-drivers](http://www.alicat.com/support/software-drivers).

Many other programs are also compatible with Alicat devices. To set up serial communication it is important to note which COM port the Alicat is connected to and the communication settings required.

The default communication settings are as follows: baud rate = 19200, data bits = 8, stop bits = 1, parity = none, and flow control = none. Not all programs have these options and care should be taken to determine the proper communication setup with the desired program.

Alicat has written drivers specifically for LabVIEW which are available for download at [www.alicat.com/support/software-drivers](http://www.alicat.com/support/software-drivers).

### Sending a Command

In this section, a command will be denoted with a different font. For example, `command<CR>`. <CR> will be used to symbolize a carriage return. How a carriage return is entered is dependent on the serial communication program being used. With Serial Terminal, this can commonly be accomplished by pressing "Enter" or "Return".

Parenthesis denote a value that must be filled in by the user. For example, `(unit ID) <CR>` should be changed to `A<CR>` when using a

device with Unit ID “A”. It may also be useful to note that commands are case insensitive. For example, A<CR> is equivalent to a<CR>.

### **Polling Mode**

All Alicat devices are sent in Polling Mode with Unit ID A unless otherwise requested. Polling a device will return a data frame of the current measurements in the device in units shown on the display. See Data Format, later in this section, for more information. Each unit may be polled individually using the command (unit ID)<CR>.

A device’s Unit ID may be changed using the command (current unit ID)@=(desired unit ID)<CR>. The Unit ID can also be changed via the front panel using the RS-232 / RS-485 communication select menu. Care should be taken not to assign the same unit ID to more than one device on a single COM port. Up to 26 units may be connected simultaneously as Unit IDs between A and Z are allowed.

### **Streaming Mode (RS-485 units do not have streaming mode)**

In Streaming Mode, a device will automatically output the data stream at a pre-determined rate. The default rate is set to 50 ms and can be changed via register values for units with software version 4v30 or newer. Only one unit on a given COM port may be in streaming mode at a time.

To change a unit from Polling Mode to Streaming Mode, type (unit ID) @=@<CR>. This is equivalent to changing the unit ID to “@”. If data does not appear, check all the connections and COM port settings.

When sending a command to a unit in streaming mode, the flow of information will not stop while the user is typing; and the typed text may not be readable depending on the terminal settings. If the unit does not receive a valid command, it will ignore it. If in doubt, simply perform another carriage return and start again.

To change a unit from Streaming Mode to Polling Mode, type @@=(unit ID) <CR>. If entered correctly, the data stream will stop and the device will now be in polling mode.

### **Data Format**

The data frame on the screen represents the current measurements in the device in the units shown on the display. By default, liquid flow meters are configured to output three columns of data, and liquid flow controllers are configured to output four.

All data is displayed in the “device units” selected on the unit. Devices come standard with units of °C and either LPM or CCM, depending on the flow range of the device. Note that the “button units” available on portable units will not affect the serial output. The first column is the unit ID. This column will be excluded if the device is in streaming mode. The next columns are temperature and volumetric flow rate, respectively. For controllers, the setpoint value will be listed after the volumetric flow rate.

For example, suppose a meter with unit ID A was ordered with units of CFM or the “device units” are currently selected as CFM. At atmospheric temperature, the data frame may read:

A	+014.70	+025.00	+02.004
Unit ID	Pressure	Temp	Vol. Flow

L-Series Liquid Flow Meter Data Format

Similarly, a controller with unit ID A in the same conditions, with a setpoint value set to 2.004 CFM will have a data frame that may read:

A	+014.70	+025.00	+02.004	2.004
Unit ID	Pressure	Temp	Vol. Flow	Setpoint

LC-Series Liquid Flow Controller Data Format

On units with an optional pressure sensor, the pressure will be displayed in column two, with temperature, volumetric flow and setpoint shifting accordingly. On units with the totalizer function, the totalized flow will be displayed after the volumetric flow on meters and after the setpoint for controllers. Additional columns, including status codes, may be present to the right of the last column.

**Sending a Setpoint via RS-232 / RS-485 (Controllers Only)**

To send a setpoint via RS-232 / RS-485, serial communication must be selected under the “Setpt Source” list in the control set up menu.

**Method 1:** Setpoint may be set as a floating point number in serial communication using the setpoint command (unit ID)S(floating point number) <CR>. For example, AS4.54<CR> changes the setpoint for unit “A” to 4.54 in the current device units.

**Method 2:** The setpoint can also be set in reference to a portion of the full scale. Type (unit ID) (integer) <CR>. Values between 0 and 64000 are acceptable, which correspond linearly to 0 and 100% full scale flow respectively.

Once a setpoint is accepted, the data frame will be returned with the setpoint column changed accordingly. If no change is observed, make sure that “Analog” is not the selected “Setpt Source” in the Control Setup menu.

The formula for performing linear interpolation is as follows:

$$\text{Value} = (\text{desired setpoint}) \times 64000 / (\text{full Scale})$$

For example, when changing the setpoint on a 100 LPM full scale controller to 35 LPM, the following value should be entered:

$$22400 = (35 \text{ LPM}) \times 64000 / (100 \text{ LPM})$$

**Additional Serial Commands**

For more advanced serial communication commands, please contact Alicat or view the User’s Guide to Advanced Serial Programming at Alicat.com/knowledge/documents-resources

## FLOW MEASUREMENT OPERATING PRINCIPLE

All L or LC-Series Water Flow Meters/Controllers accurately determine the flow rate by creating a pressure drop across a unique internal restriction, known as a Laminar Flow Element (LFE), and measuring differential pressure across it. The restriction is designed so that the water molecules are forced to move in parallel paths along the entire length of the passage; hence laminar (streamline) flow is established for the entire range of operation of the device. Unlike other flow measuring devices, in laminar flow meters the relationship between pressure drop and flow is linear.

In order to have an accurate reading of the flow rate, the absolute viscosity of the fluid must be established. The rate at which liquids change viscosity with changes in temperature is not linear. The relationship between temperature and viscosity for water is well established and Alicat Scientific L and LC-Series units utilize a high accuracy temperature sensor and this relationship to provide an accurate viscosity reference. **For this reason, these meters and controllers are generally recommended only for use with pure water.** Any additives to water (such as antifreeze or disinfectants) that might affect the viscosity should be avoided.



*Please visit the Alicat web site for a detailed explanation this principle.  
<http://www.alicat.com/technical-information/theory-of-operation/>*

**SUPPORTED UNITS:** This device supports many different units. You may select the desired units (see page 28). Note that only units appropriate to this device are available for selection.

**Pressure Units**

Absolute	Gauge	Differential	Notes
PaA	PaG	PaD	pascal
hPaA	hPaG	hPaD	hectopascal
kPaA	kPaG	kPaD	kilopascal
MPaA	MPaG	MPaD	megapascal
mbarA	mbarG	mbarD	millibar
barA	barG	barD	bar
g/cm2A	g/cm2G	g/cm2D	gram force per square centimeter
kg/cmA	kg/cmG	kg/cmD	kilogram force per square centimeter
PSIA	PSIG	PSID	pound force per square inch
PSFA	PSFG	PSFD	pound force per square foot
mTorrA	mTorrG	mTorrD	millitorr
torrA	torrG	torrD	torr
mmHgA	mmHgG	mmHgD	millimeter of mercury at 0 C
inHgA	inHgG	inHgD	inch of mercury at 0 C
mmH2OA	mmH2OG	mmH2OD	millimeter of water at 4 C (NIST conventional)
mmH2OA	mmH2OG	mmH2OD	millimeter of water at 60 C
cmH2OA	cmH2OG	cmH2OD	centimeter of water at 4 C (NIST conventional)
cmH2OA	cmH2OG	cmH2OD	centimeter of water at 60 C
inH2OA	inH2OG	inH2OD	inch of water at 4 C (NIST conventional)
inH2OA	inH2OG	inH2OD	inch of water at 60 C
atm			atmosphere
m asl			meter above sea level (only in /ALT builds)
ft asl			foot above sea level (only in /ALT builds)
V	volt; no conversions are performed to or from other units		
count	count	count	setpoint count, 0 – 64000
%	%	%	percent of full scale

**Flow Units**

Volumetric	Notes
uL/m	microliter per minute
mL/s	milliliter per second
mL/m	milliliter per minute
mL/h	milliliter per hour
L/s	liter per second
LPM	liter per minute
L/h	liter per hour
US GPM	US gallon per minute
US GPH	US gallon per hour
CCS	cubic centimeter per second
CCM	cubic centimeter per minute
cm3/h	cubic centimeter per hour
m3/m	cubic meter per minute
m3/h	cubic meter per hour
m3/d	cubic meter per day
in3/m	cubic inch per minute
CFM	cubic foot per minute
CFH	cubic foot per hour
	1000 cubic feet per minute
count	setpoint count, 0 – 64000
%	percent of full scale

### Totalizer Units

Volumetric	Notes
uL	microliter
mL	milliliter
L	liter
US GAL	US gallon
cm <sup>3</sup>	cubic centimeter
m <sup>3</sup>	cubic meter
in <sup>3</sup>	cubic inch
ft <sup>3</sup>	cubic foot
uP	1000 cubic feet

### Temperature Units

Label	Notes
°C	degree Celsius
°F	degree Fahrenheit
K	Kelvin
°R	degree Rankine

### Time Units

Label	Notes
h:m:s	Displayed value is hours:minutes:seconds
ms	millisecond
s	second
m	minute
hour	hour
day	day

### Valve Drive Units

Label	Notes
count	+/- 65536 at full drive
%	Percent of full scale drive

## TROUBLESHOOTING

### ***Display does not come on or is weak.***

Check power and ground connections and supply voltage. Please reference the technical specifications (page 54-59) to assure you have the proper power for your model.

### ***Flow reading is approximately fixed either near zero or near full scale regardless of actual line flow.***

Differential pressure sensor may be damaged. A common cause of this problem is instantaneous application of high pressure as from a snap acting solenoid valve upstream of the meter. If you suspect that your pressure sensor is damaged please discontinue use of the device and contact Alicat.

### ***Displayed volumetric flow, pressure or temperature is flashing and message VOV, POV or TOV is displayed:***

Our flow meters and controllers display an error message (VOV = volumetric overrange, POV = pressure overrange, TOV = temperature overrange) when a measured parameter exceeds the range of the sensors in the device. When any item flashes on the display, neither the flashing parameter nor the flow measurement is accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy. If the unit does not return to normal contact Alicat.

### ***Meter reads negative flow when there is a confirmed no flow condition.***

This is an indication of an improper tare. If the meter is tared while there is flow, that flow is accepted as zero flow. When an actual zero flow condition exists, the meter will read a negative flow. Simply re-tare at the confirmed zero flow condition. Also note that while the meter is intended for positive flow, it will read negative flow with reasonable accuracy (it is not calibrated for bi-directional flow) and no damage will result. See TARE page 23 .

### ***After installation, there is no flow.***

LC-Series controllers incorporate normally closed valves and require a setpoint to operate. Check that your setpoint signal is present and supplied to the correct pin and that the correct setpoint source is selected under the SETPT SOURCE list in the control set up display (page 31). Also check that the unit is properly grounded.

### ***My controller does not respond to the setpoint.***

Check that your setpoint signal is present and supplied to the correct pin and that the correct setpoint source is selected under the SETPT SOURCE list in the control set up display (page 31). Also check that the unit is properly grounded.

### ***The flow lags below the setpoint.***

Be sure there is enough pressure available to make the desired flow rate. If either the setpoint signal line and/or the output signal line is relatively long, it may be necessary to provide heavier wires (especially ground wiring) to negate voltage drops due to line wire length. An inappropriate PID tuning can also cause this symptom if the D term is too large relative to the P term (page 33).

***Meter does not appear to be accurate when compared against another valid measurement of the physical flow (such as weight over time).***

Water flow meters can normally be compared against one another provided there are no leaks between the two meters. One common cause of inaccuracy, inconsistency, or unusual readings is air bubbles trapped in one or both of the legs of the differential pressure sensor. Bleed the ports as described in this manual to remove this possibility (See page 11). Another possibility is that the water has some contaminant or additive, such as antifreeze, that affects the viscosity of the water. A third possibility is an improper tare error (see page 23).

***Controller is slow to react to a setpoint change or imparts an oscillation to the flow.***

An inappropriate PID tuning can cause these symptoms. Use at conditions considerably different than those at which the device was originally set up can necessitate a re-tuning of the PID loop (page 33).

***Flow flutters or is jumpy.***

The meters are very fast and will pick up any actual flow fluctuations such as from a diaphragm pump, etc. Also, inspect the inside of the upstream connection for debris such as Teflon tape shreds. Note: L & LC-Series devices feature a programmable geometric running average (GRA) that can aid in allowing a rapidly fluctuating flow to be read. Please see “Pressure Averaging” and “Flow Averaging” on page 25.

***The output signal is lower than the reading at the display.***

This can occur if the output signal is measured some distance from the meter as voltage drops in the wires increase with distance. Using heavier gauge wires, especially in the ground wire, can reduce this effect.

***My controller oscillates wildly and/or exhibits very different reactions to the setpoint than I expect.***

Conditions considerably different than those at which the device was originally set up can necessitate a re-tuning of the PID loop. Avoid long runs of small diameter tubing in the system, increase line size.

***RS-232 / RS-485 Serial Communications is not responding.***

Check that your meter is powered and connected properly. Be sure that the port on the computer to which the meter is connected is active. Confirm that the port settings are correct per the RS-232 / RS-485 instructions in this manual (Check the RS-232 / RS-485 communications select screen for current meter readings). Close HyperTerminal® and reopen it. Reboot your PC. See pages 14, 15 and 36 for more information on RS-232 / RS-485 signals and communications.

***Slower response than specified.***

L-Series Meters and LC-Series Controllers feature a programmable Geometric Running Average (GRA). Depending on the full scale range of the meter, it may have the GRA set to enhance the stability/readability of the display, which would result in slower perceived response time. Please see “Pressure Averaging” and “Flow Averaging” on page 25.

***Jumps to zero at low flow.***

L-Series Meters and LC-Series Controllers feature a programmable zero deadband. The factory setting is usually 0.5% of full scale. This can be adjusted between NONE and 6.3% of full scale. See page 25.

**MAINTENANCE AND RECALIBRATION**

**General:** L and LC-Series Water Flow Meters and Controllers require minimal maintenance. The primary cause of damage and/or long-term inaccuracy in these devices is contamination and/or corrosion damage. Water should be filtered for particulates or biological materials that may grow in the device. When removing these units from the line for any extended period of time, make an effort to remove all of the water from the device, as deposits of calcium or other soluble minerals can affect the accuracy of the device.

**Recalibration:** The recommended period for recalibration is once every year. A label located on the back of the device lists the most recent calibration date. The device should be returned to the factory for recalibration within one year from the listed date. Before calling to schedule a recalibration, please note the serial number on the back of the meter. The Serial Number, Model Number, and Date of Manufacture are also available on the Model Info screen (page 24).

**Cleaning:** L and LC-Series Flow Meters/Controllers require no periodic cleaning. If necessary, the outside of the meter can be cleaned with a soft dry cloth. Avoid excess moisture or solvents.

For repair, recalibration or recycling of this product, contact:

Alicat Scientific, Inc.  
7641 N Business Park Drive  
Tucson, Arizona 85743  
USA  
Ph. 520-290-6060  
Fax 520-290-0109  
E-mail: [service@alicat.com](mailto:service@alicat.com)  
Web site: [www.alicat.com](http://www.alicat.com)

**Flow Conversion Table:**

	CCM	CCH	LPM	LPH	CFM	CFH
CFH	0.0021	0.00003	2.1189	0.035	60.0	1.0
CFM	0.000035	0.0000005	0.035	0.00059	1.0	0.0166
LPH	0.06	0.001	60.0	1.0	1699.0	28.316
LPM	0.001	0.000017	1.0	0.0166	28.316	0.4719
CCH	60.0	1.0	60000.0	1000.0	1699011.0	28317.0
CCM	1.0	0.0167	1000.0	16.667	28317.0	471.947

### Option: Totalizing Mode

Meters and controllers can be purchased with the Totalizing Mode option. For controllers this option adds an additional mode screen that displays the total flow (normally in the units of the main flow screen) that has passed through the device since the last time the totalizer was cleared. The Totalizing Mode screen is accessed by pushing the TOTAL button on the MAIN display.

**TOTAL/TIMER:** Pushing the TOTAL/TIMER button will cycle the large numbers on the display between total volume and time elapsed.



**Rollover** – The customer can also specify at the time of order what the totalizer is to do when the maximum count is reached. The following options may be specified:

**No Rollover** – When the counter reaches the maximum count it stops counting until the counter is cleared.

**Rollover** – When the counter reaches the maximum count it automatically rolls over to zero and continues counting until the counter is cleared.

**Rollover with Notification** – When the counter reaches the maximum count it automatically

rolls over to zero, displays an overflow error, and continues counting until the counter is cleared.

**TOTAL VOLUME:** The counter can have as many as seven digits. At the time of order, the customer must specify the range. This directly affects the maximum count. For instance, if a range of 1/100ths of a liter is specified on a meter which is totalizing in liters, the maximum count would be 99999.99 liters. If the same unit were specified with a 1 liter range, the maximum count would be 9999999 liters.

**ELAPSED TIME:** The small numbers below the volume total show the elapsed time since the last reset in hours, minutes and seconds. The maximum measurable elapsed time is 9999 hours 59 minutes 59 seconds. The hours count resets when **RESET** is pushed, an RS-232 or RS-485 clear is executed or on loss of power. Press **TOTAL/TIMER** to show this as the primary display.

**PEAK (Meters Only):** PEAK will display the most recent peak flow rate until totalizer is reset.

**SETPT (Controllers Only):** Pushing SETPT will allow you to change the controller's setpoint.

**RESET** – The counter can be reset to zero at any time by pushing the RESET button. To clear the counter via RS-232 or RS-485, establish serial communication with the meter or controller as described in the RS-232 or RS-485 section of the manual. To reset the counter, enter the following commands:

In Polling (addressable) Mode: Address\$\$T <Enter> (e.g. B\$\$T <Enter>)

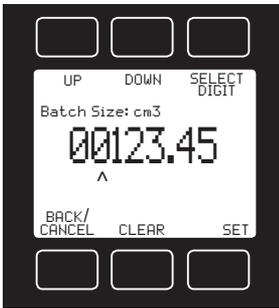


**WHEN USING A FLOW CONTROLLER AS AN ABSOLUTE PRESSURE CONTROLLER, THE FLOW RATE MAY MOMENTARILY EXCEED THE FLOW MEASUREMENT CAPABILITY (FULL SCALE + 28%) OF THE UNIT. THIS MAY OCCUR WHEN THE UNIT IS ASKED TO MAKE AN ABRUPT PRESSURE CHANGE.**

**IF THE TOTALIZER IS IN USE AT THAT TIME, THE TOTALIZED VALUE WILL NECESSARILY BECOME INCORRECT. PLEASE RESET THE TOTALIZER IF SUCH AN 'OVER-FLOW' CONDITION HAS OCCURRED.**

## BATCH PROCESSING MODE – CONTROLLERS ONLY

Batch mode is a function within the optional Totalizing mode. Batch mode is designed to provide repeatable, finite flow quantities.



**To activate Batch Mode:** Press **BATCH**. Then use **SELECT DIGIT** to move the arrow to the desired digit, and the UP and DOWN buttons to change the value. Press **CLEAR** to return to zero. Press **SET** to record your value. If the controller has a non-zero Setpoint, flow will start immediately. If not, press **SETPT** to select a Setpoint.

Batch values can also be established via RS-232/RS-485 communication using Register 92. (See RS-232/RS-485 Section of this manual for serial communication methods.)

**Note:** While the Totalizer counter will still reset across power cycles, the Batch process value is stored in EEPROM and will remain valid until updated by the user.

While the Batch is processing, the remaining amount of the Batch value is displayed above **REMAIN** on the Totalizer screen. Time elapsed during the Batch processing is displayed below the totalizing counter. Press **TOTAL/TIMER** to toggle these values.

When the active Totalizer reaches the preset Batch value, flow ceases, and **REMAIN** updates to **Done Batch**.



- **To start a new batch of the same size**, simply press RESET. The Totalizer can reproduce any number of fixed Batches in this manner.

- **To stop flow with a batch in progress**, clear the Setpoint and press **SET**.

If the Batch value is changed while a batch is in progress, the new Batch value is used when **SET** is pressed.

**Note:** Batch mode operates independently of the desired flow rate, but requires a non-zero flow rate to run. The rate of flow is determined by the controller Setpoint value, which is established by the user via analog, front panel or serial communication methods. Batches can be produced more slowly or more rapidly as determined by the user-selected Setpoint flow rate.

**To turn off Batch Mode:** Set the Batch value to zero (0.0) via the front panel or RS-232/RS-485 communication using Register 92. If there is a non-zero flow Setpoint, flow will immediately resume, and the Totalizer counter will continue per the user established Setpoint flow rate.

## Alicat Portable Meters and Gauges

Alicat Rechargeable Flow Meters and Pressure Gauges use a Li-Ion 3.7V cell located in the top section of the device. **The Li-Ion cell must not be removed.**

Normal battery life of a fully-charged cell is 18 hours with a monochrome display or 5 hours with a TFT color display, when the backlight is set to 10. Dimming the backlight will increase battery life.

The battery can be charged through either the micro-USB port or the mini-DIN connector. When the device is connected to external power it will function normally while the battery is charging. **Note: If the battery has no charge, a charge time of one minute will be required before the unit can be turned on.** Charge rates will be fastest through the micro-USB port using the included power supply or equivalent. The device will charge fastest when it is turned off.

**Recharge Time:** 3.5 hours with 2A USB supply. The micro-USB port is for charging purposes only. The green/red indicator LED on top of the device will light up green to indicate that the unit is charging. The green LED will turn off when the battery is charged and the power switch is turned to "I" for ON.

A small lightning bolt symbol will display next to the battery symbol while the device is charging. It will no longer appear when the device is fully charged.

The indicator LED flashes red when the device has about 1 hour of battery life remaining. The LED will flash red at a faster rate when the device has about 15 minutes of battery life remaining. It is highly recommended that the device be charged immediately. When the battery charge runs out, the display contrast will turn to 0 and device performance is no longer guaranteed.



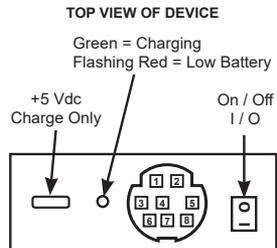
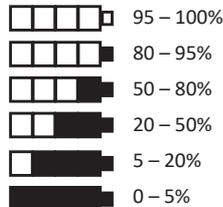
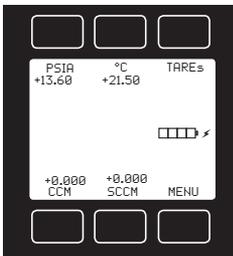
Output signals from the meter are passed through the mini-DIN connector on top of the device. Rechargeable battery units do not support 0-10V analog output. Receiver resistance must be below 250Ω.

**Turn the power switch on top of the device to "O" for OFF when it is not in use.**



**Warning:** If the device is left ON until the battery can no longer power it, the charge indicator will fall out of sync with the actual charge. The device can be re-synced by fully charging the battery once.

A Battery Charge Indicator appears below Tare on the display.



**CAUTION! DO NOT OPERATE OR STORE THE DEVICE OUTSIDE OF THE -10° TO +50°C TEMPERATURE RANGE. IF INTERNAL SENSORS DETECT THAT THE TEMPERATURE IS OUTSIDE OF THIS RANGE, THE DISPLAY CONTRAST WILL TURN TO 0 AND THE METER'S PERFORMANCE IS NO LONGER GUARANTEED.**

**THE SAFE CHARGING TEMPERATURE RANGE IS 0° TO +45°C. IF INTERNAL SENSORS DETECT TEMPERATURES OUTSIDE OF THIS RANGE, THE BATTERY WILL NOT CHARGE.**

## Pressure Menu for Portable Meters

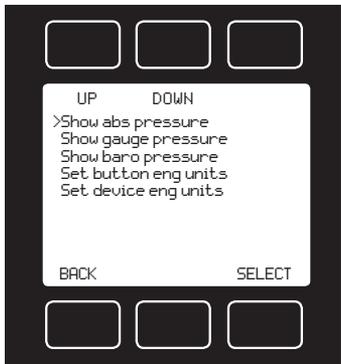
Alicat portable meters are programmed with additional pressure read options. Pressing the pressure button once (upper left) will move the pressure reading to the main display. Pressing the button a second time will open a menu of pressure read options. Scroll **UP** or **Down** and press **Select** to make a change.



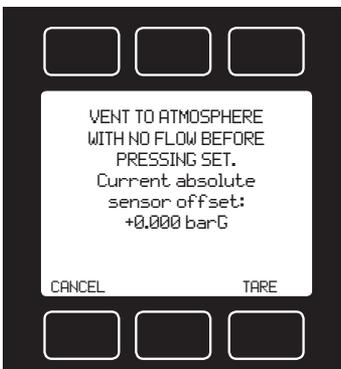
When the pressure button is already using the device engineering units, the bottom menu option displays as “**Set device eng units**”.

When the pressure button is using something different than device engineering units (e.g., bar instead of PSI), the bottom menu option displays as “**Show device units**”.

The serial data line changes only when device engineering units are changed, and the instrument will prompt you to accept these changes to the serial line.



Tare **PRESS**: The stream absolute pressure sensor can be tared to the barometric pressure sensor. In this case, the absolute pressure is offset by the differential between the two readings. Tare **PRESS** can be accessed from the **TARES** display.



### Option: Remote Electronics for High Line or Gas Temperatures

Some applications involve operating temperatures outside the standard Alicat device specifications. A solution using remote electronics is available. (This option is not applicable for liquid devices.)

The flow body's components are minimized to only the required sensors. The flow data is sent to the microprocessor electronics up to 6 feet away from the sensor package.

Relocating the sensitive electronics allows for installation of the flow body in ambient temperatures as high as 85° Celsius with gas temperatures under 100° Celsius.

In these applications we recommend our custom gauge calibration at a gas temperature of up to 70° Celsius. This will reduce zero shift errors that occur when actual gas flow temperatures deviate substantially from the gas calibration temperature.

This configuration is also used in integrations that require a compact flow package at the installation point.



### Option: Remote Panel Display



Our Remote Display option offers the flexibility of using Alicat's display with units that are embedded inside processes or instrument enclosures.

The Remote Display retains all of the same features as our standard display.

The Remote Display is ideal for:

- OEMs Remote Panel Mounting
- Embedded Systems
- Gas Panels
- Fuel Cell Test Stations
- Leak Detection Systems
- Artificial Environments

## Accessory: BB9 Multi-Drop Box

The **BB9 Multi-Drop Box** makes it convenient to wire multiple flow and/or pressure devices to a single RS-232 or RS-485 port. **Now with an RS-232 to USB interface!**

The Multi-Drop Box has nine 8 pin Mini-DIN ports available. The ports are to be used with a standard double ended 8 pin Mini-DIN (DC-62) style cable going from the box to each flow or pressure device. (The BB9 can also be ordered with locking industrial connectors.)



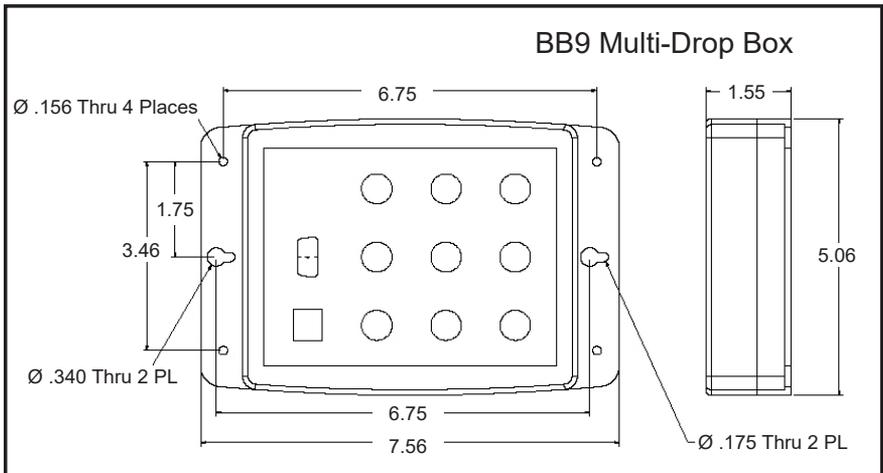
A single DB9 D-SUB type connector (COM PORT) connects, using the included cable, to the serial connector on a PC or laptop.

All of the flow and/or pressure devices are powered via a terminal block on the front of the box.

If more than nine devices will be required, additional Multi-Drop Boxes can be daisy chained together with a double ended 8 pin Mini-DIN cable plugged into any receptacle on both boxes.

**BB9 Power Supply for Large Valve Controllers:** The PS24VHC (Power Supply 24Vdc High Current) is a 6.5Amp 24Vdc power supply designed for running multiple large controllers on a BB9.

The 6.5Amp power supply can run as many as 8 large valve controllers, which makes it ideal for the BB9 and multiple large valve (or small valve / large valve combination) controllers on a BB9.



## Accessory: Flow Vision™ SC Software

**Flow Vision™ SC** is an intuitive software interface to help your test cycles run smoother and shorten your engineering time!

**Flow Vision™ SC** lets you connect to and communicate with multiple Alicat units simultaneously. Now you can view virtual displays, control tabs, charts and data lines from every connected Alicat device on the same screen.

**Flow Vision™ SC** supports all RS-232 and RS-485 Serial communication functions, including: **gas selection, tareing, setpoint control, valve tuning and flow averaging.**

**Session Saving:** Save and reload your configuration data with confidence.

**Script Building:** Create scripts to adjust a controller's setpoint value at variable specified time intervals.

**Charting:** Chart as many parameters as you want off as many devices as you want, with color coding, zooming, and printing functionality.

**Alarms:** Create software alarms that will notify you of given parameter conditions.

**Data Capture & Logging:** Capture and log data to either a .csv file or a .txt file. Improved Data Logging and Data Log File Splitting for easy to manage data.

## Accessory: Flow Vision™ MX Software

**Alicat's Flow Vision™ MX** software gives you an easy way to do **GAS BLENDING** using Alicat Mass Flow Controllers and your own PC.

**Flow Vision™ MX** software is a simple way to connect up to six Alicat mass flow controllers and create your own gas mix concentrations.

Using our inexpensive **BB9-232** and a single USB connection you can:

- **Create** your own gas blends
- **Adjust** flow rates
- **Save** your specific blend formulas.

All the controllers can be powered through the BB9-232 with a single power supply.

Just connect your unique gases to each controller, select the gas type either locally on the controller or through Flow Vision™ MX, manifold the flow outputs and create your gas mix.

## Accessories

Part Number	Description
FLOWVISIONSC	Flow Vision™ SC software for interface with all Alicat instruments
FLOWVISIONMX	Flow Vision™ MX software for gas blending
BB9-232	9 position Multi Drop Box with 9-pin serial port and USB to PC
BB9-I	9 position Multi-Drop Box, Industrial connectors
BB9-485	9 position Multi Drop Box with serial port only
BB9-I-485	9 position Multi-Drop Box, industrial connectors, serial port only
PVPS24U	Universal 100-240 VAC to 24 Volt DC Power Supply Adapter
PS24VHC	High current power supply for BB9 use with Large Valve Controllers
PVPS5USB	micro-USB to wall adapter
PCASE	Industrial carry and storage case for up to 2 portable meters/gauges
PCASE-L	Industrial carry and storage case for up to 6 meters and controllers
DC-61	8 Pin Male Mini-DIN connector cable, single ended, 6 foot length
DC-6RT	8 Pin Male Right Angle Mini-DIN Cable, single ended, 6 foot length
DC-251	8 Pin Male Mini-DIN connector cable, single ended, 25 foot length
DC-501	8 Pin Male Mini-DIN connector cable, single ended, 50 foot length
DC-751	8 Pin Male Mini-DIN connector cable, single ended, 75 foot length
DC-1001	8 Pin Male Mini-DIN connector cable, single ended, 100 foot length
DC-32RS	8-pin Male Mini-DIN connector cable, double ended, no analog, 3 foot length
DC-62RS	8-pin Male Mini-DIN connector cable, double ended, no analog, 6 foot length
DC-62	8 Pin Male Mini-DIN connector cable, double ended, 6 foot length
DC-252	8 Pin Male Mini-DIN connector cable, double ended, 25 foot length
DC-502	8 Pin Male Mini-DIN connector cable, double ended, 50 foot length
MD8DB9	8 Pin Male Mini-DIN to DB9 Female Adapter, 6 foot length
DBC-251	DB15 cable, single ended, 25 foot length
510199	DB9 cable, double-ended female, 3 meter length
IC10	Industrial cable, 6 Pin, single ended, 10 foot length
IC20	Industrial cable, 6 Pin, single ended, 20 foot length
IC50	Industrial cable, 6 Pin, single ended, 50 foot length
IC-102	Industrial cable, 6 pin double ended, 10 foot length
USB-RS232	RS-232 to USB Converter

## Accessories

MNPT to Compression Fittings	
10-32 - 1/8"	SS-200-1-0157
10-32 - 1/4"	SS-400-1-0256
1/8" - 1/8"	SS-200-1-2
1/8" - 1/4"	SS-400-1-2
1/8" - 3/8"	SS-600-1-2
1/8" - 1/2"	SS-810-1-2
1/8" - 3mm	SS-3M0-1-2
1/8" - 4mm	SS-4M0-1-2
1/8" - 6mm	SS-6M0-1-2
1/8" - 8mm	SS-8M0-1-2
1/8" - 12mm	SS-12M0-1-2
1/4" - 1/8"	SS-200-1-4
1/4" - 1/4"	SS-400-1-4
1/4" - 3/8"	SS-600-1-4
1/4" - 1/2"	SS-810-1-4
1/4" - 3mm	SS-3M0-1-4
1/4" - 4mm	SS-4M0-1-4
1/4" - 6mm	SS-6M0-1-4
1/4" - 8mm	SS-8M0-1-4
1/4" - 12mm	SS-12M0-1-4
1/2" - 1/8"	SS-200-1-8
1/2" - 1/4"	SS-400-1-8
1/2" - 3/8"	SS-600-1-8
1/2" - 1/2"	SS-810-1-8
1/2" - 3/4"	SS-1210-1-8
1/2" - 6mm	SS-6M0-1-8
1/2" - 8mm	SS-8M0-1-8
1/2" - 12mm	SS-12M0-1-8
1/2" - 16mm	SS-16M0-1-8
3/4" - 1/4"	SS-400-1-12
3/4" - 1/2"	SS-810-1-12
3/4" - 3/4"	SS-1210-1-12
3/4" - 12mm	SS-12M0-1-12
3/4" - 16mm	SS-16M0-1-12

Filters & Elements FNPT-MNPT	
10-32 5μ	510053
10-32 20μ	510054
1/8" 20μ	ILF-1/8-20
1/4" 40μ	ILF-1/4-40
1/2" 40μ	ILF-1/2-40*
3/4" 40μ	ILF-3/4-40*
20μ element	ILFE20
40μ element	ILFE40
40μ element	ILFE40L*

Filters & Elements FNPT-FNPT*	
10-32 5μ	CF-303-20-316
*requires MNPT to MNPT coupler to interface with Alicat flow bodies	

10-32 Male UNF to 1/8 FNPT Adapter	
410133	
Male M5 (10-32) Buna-N O-ring face seal to 1/8" Female NPT	

## Technical Data for Alicat L - Series Water Flow Meters 0 – 0.5 ccm Full Scale through 0 – 10 lpm Full Scale

Alicat L-Series water flow meters read liquid flow, liquid temperature and pressure.

### Standard Specifications (Contact Alicat for available options.)

Performance	L Meters
Available Ranges	0.5 ccm to 10 lpm
Accuracy at calibration conditions after tare	± 2% Full Scale
Repeatability	± 2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / °Celsius / Atm
Operating Range / Turndown Ratio	2% to 100% Full Scale / 50:1 Turndown
Maximum Flow Rate	128% FS Measurable
Typical Response Time	20 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	L Meters
Operating Temperature	Non-Freezing -10 to +60 °Celsius
Maximum Internal Pressure	100 psig
Maximum Pressure	200 psig
Mounting Attitude Sensitivity	None
Ingress Protection	IP40
Wetted Materials	302 & 303 Stainless Steel, 316L Stainless Steel, Viton®. If your application demands a different material, please contact Alicat.

Communication / Power	L Meters
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Flow and Temperature
Digital Output Signal <sup>1</sup> Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / PROFIBUS
Analog Output Signal <sup>2</sup> Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA
Optional Secondary Analog Output Signal <sup>2</sup>	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA
Electrical Connection Options	8 Pin Mini-DIN / 9-pin D-sub (DB9) / 15-pin D-sub (DB15) / 6 pin locking
Supply Voltage	7-30 Vdc (15-30 Vdc for 4-20 mA outputs)
Supply Current	0.040 Amp
1. The <b>Digital Output Signal</b> communicates Flow and Temperature (optional Pressure sensor available) 2. The <b>Analog Output Signal</b> and <b>Optional Secondary Analog Output Signal</b> communicate your choice of Flow or Temperature	

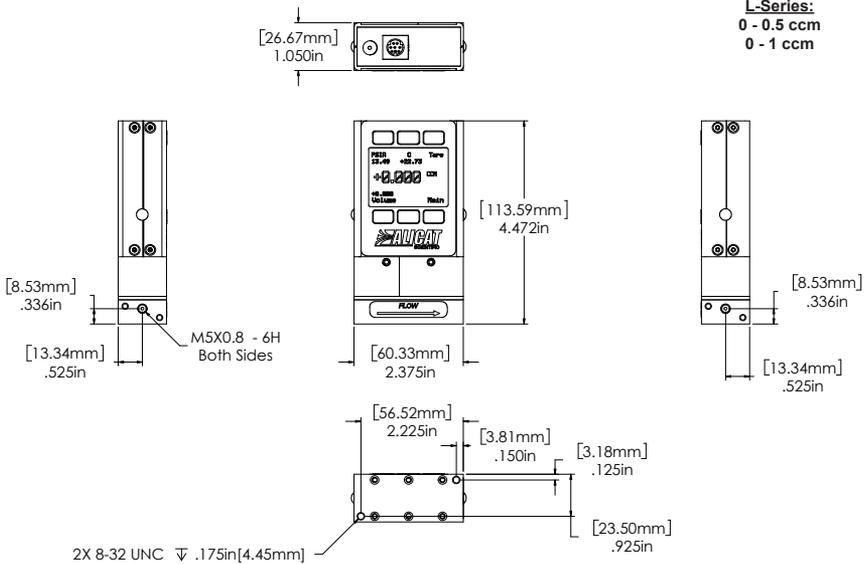
### Range Specific Specifications

L Meters Full Scale Flow	Pressure Drop <sup>1</sup> at FS Flow (PSID)	Mechanical Dimensions	Process Connections <sup>2</sup>
0.5 ccm to 1 ccm	2.0	4.4"H x 2.4"W x 1.1"D	<b>M5 (10-32) Female Thread<sup>3</sup></b>
2 ccm to 500 ccm	2.0	4.6"H x 2.4"W x 1.1"D	1/8" NPT Female
1 lpm	4.0		
2 lpm	4.0	4.7"H x 2.7"W x 1.1"D	1/4" NPT Female
5 lpm	10.0	5.1"H x 4.0"W x 1.6"D	1/4" NPT Female
10 lpm	20.0		

1. Lower Pressure Drops Available, please contact Alicat.

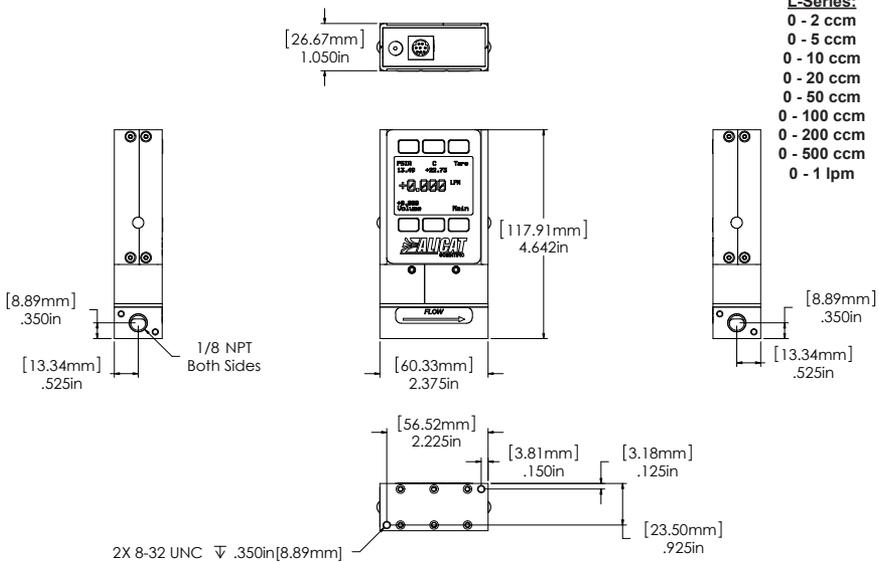
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

3. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.



**L-Series:**  
0 - 0.5 ccm  
0 - 1 ccm

0.5 ccm to 1 ccm approximate shipping weight: 1.0 lb

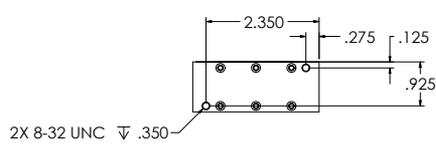
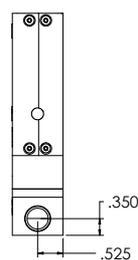
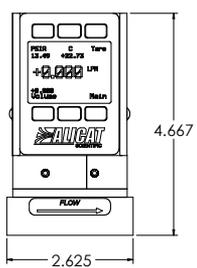
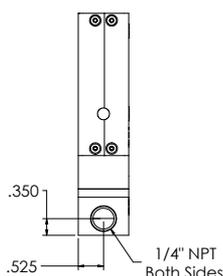


**L-Series:**  
0 - 2 ccm  
0 - 5 ccm  
0 - 10 ccm  
0 - 20 ccm  
0 - 50 ccm  
0 - 100 ccm  
0 - 200 ccm  
0 - 500 ccm  
0 - 1 lpm

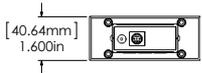
10 ccm to 1 lpm approximate shipping weight: 1.2 lb



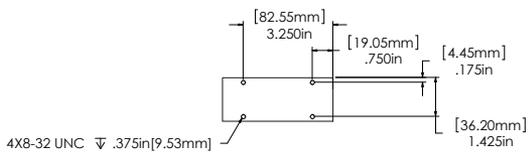
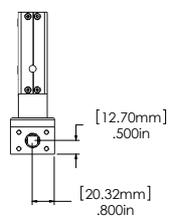
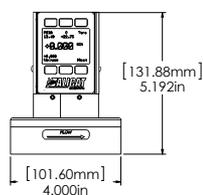
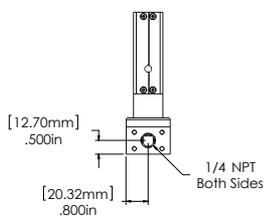
**L-Series:**  
0 - 2 lpm



2 lpm approximate shipping weight: 1.5 lb



**L-Series:**  
0 - 5 lpm  
0 - 10 lpm



5 lpm to 10 lpm approximate shipping weight: 2.6 lb

## Technical Data for Alicat LC & LCR Water Flow Controllers 0 – 0.5 ccm Full Scale through 0 – 10 lpm Full Scale

Alicat LC and LCR-Series water flow controllers display liquid flow, liquid temperature and pressure.

### Standard Specifications (Contact Alicat for available options.)

Performance	LC Controllers	LCR Controllers
Available Ranges	0.5 ccm to 500 ccm	1 lpm to 5 lpm
Accuracy at calibration conditions after tare	± 2% Full Scale	
Repeatability	± 2% Full Scale	
Zero Shift and Span Shift	0.02% Full Scale / °Celsius / Atm	
Operating Range / Turndown Ratio	2% to 100% Full Scale / 50:1 Turndown	
Maximum Flow Rate	102.4% FS Controllable	
Typical Response Time	100 ms (Adjustable)	
Warm-up Time	< 1 Second	

Operating Conditions	LC Controllers	LCR Controllers
Operating Temperature	Non-Freezing -10 to +60 °Celsius	
Maximum Internal Pressure	100 psig	
Proof Pressure	200 psig	
Mounting Attitude Sensitivity	None	Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	<b>LC, LCR:</b> 430FR Stainless Steel, 302 & 303 Stainless Steel, 316L Stainless Steel, Viton®, FFKM. <b>LCR Controllers Add</b> 416 Stainless Steel, Delrin®. If your application demands a different material, please contact Alicat.	

Communication / Power	LC Controllers	LCR Controllers
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Flow and Temperature	
Digital Output Signal <sup>1</sup> Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / PROFIBUS	
Analog Output Signal <sup>2</sup> Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Optional Secondary Analog Output Signal <sup>2</sup>	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Electrical Connection Options	8 Pin Mini-DIN / 9-pin D-sub (DB9) / 15-pin D-sub (DB15) / 6 pin locking	
Supply Voltage	12-30 Vdc (15-30 Vdc for 4-20 mA outputs)	24-30 Vdc
Supply Current	0.250 Amp	0.750 Amp (LCRH: 2.0 Amp)
1. The <b>Digital Output Signal</b> communicates Flow and Temperature (optional Pressure sensor available) 2. The <b>Analog Output Signal</b> and <b>Optional Secondary Analog Output Signal</b> communicate your choice of Flow or Temperature		

### Range Specific Specifications

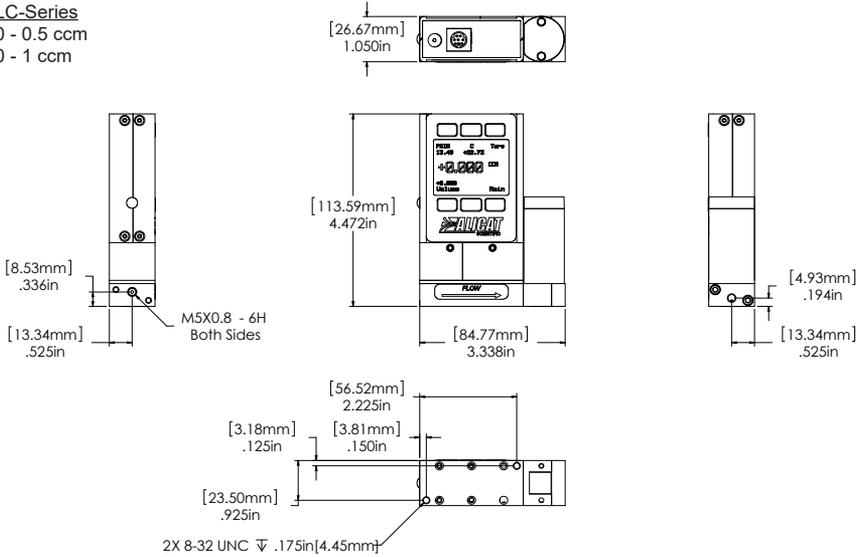
Full Scale Flow	Pressure Drop <sup>1</sup> at FS Flow (PSID)	Mechanical Dimensions	Process Connections <sup>2</sup>
<b>LC Controllers</b>			
0.5 ccm to 1 ccm		4.4"H x 3.4"W x 1.1"D	<b>M5 (10-32) Female Thread<sup>3</sup></b>
2 ccm		4.6"H x 3.6"W x 1.1"D	
5 ccm to 50 ccm	5.0		
100 ccm	5.0		
200 ccm to 500 ccm	7.5		
<b>LCR Controllers</b>			
1 lpm	4.0	5.7"H x 7.7"W x 2.3"D	1/4"NPT Female
2 lpm	4.0		
5 lpm	10.0		
LCRH 10 lpm		6.5"H x 9.4"W x 4.5"D	1/2"NPT Female

1. Lower Pressure Drops Available, please contact Alicat.

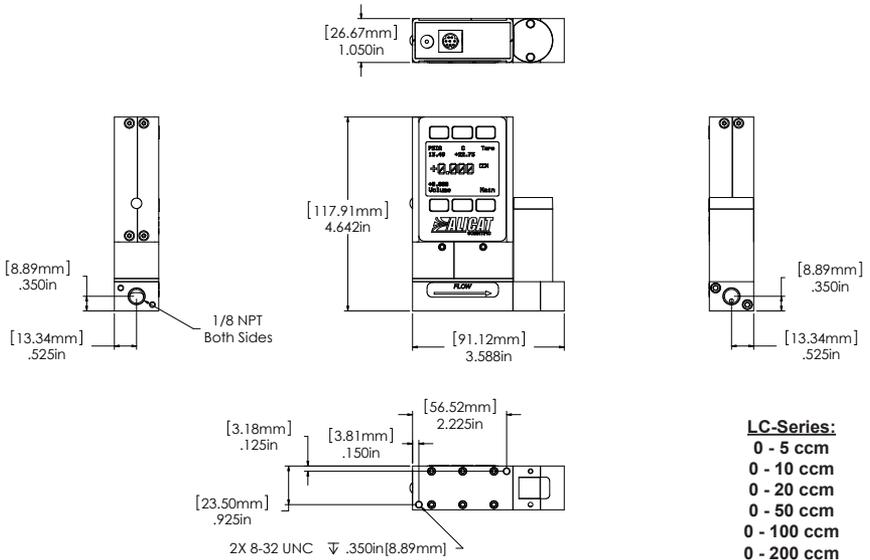
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

3. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

**LC-Series**  
 0 - 0.5 ccm  
 0 - 1 ccm



0.5 ccm to 1 ccm approximate shipping weight: 1.1 lb.

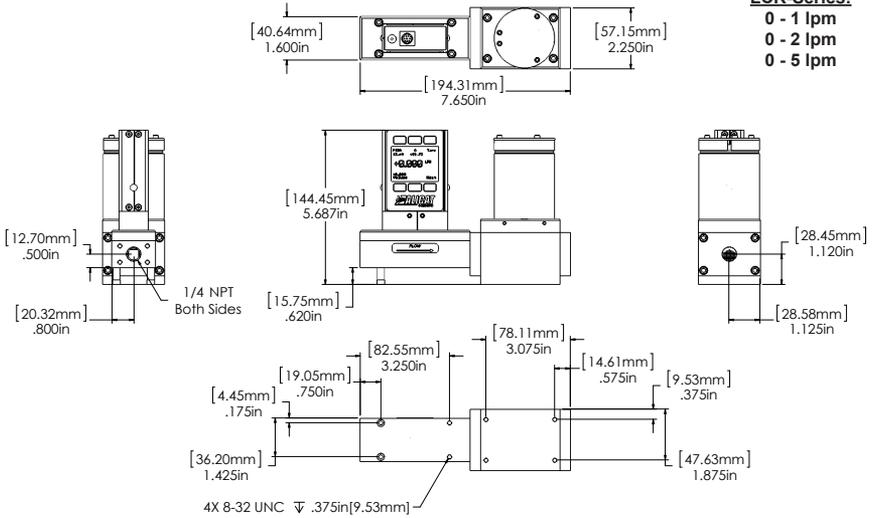


- LC-Series:**  
 0 - 5 ccm  
 0 - 10 ccm  
 0 - 20 ccm  
 0 - 50 ccm  
 0 - 100 ccm  
 0 - 200 ccm  
 0 - 500 ccm

100 ccm to 500 ccm approximate weight: 1.6 lb

**LCR-Series:**

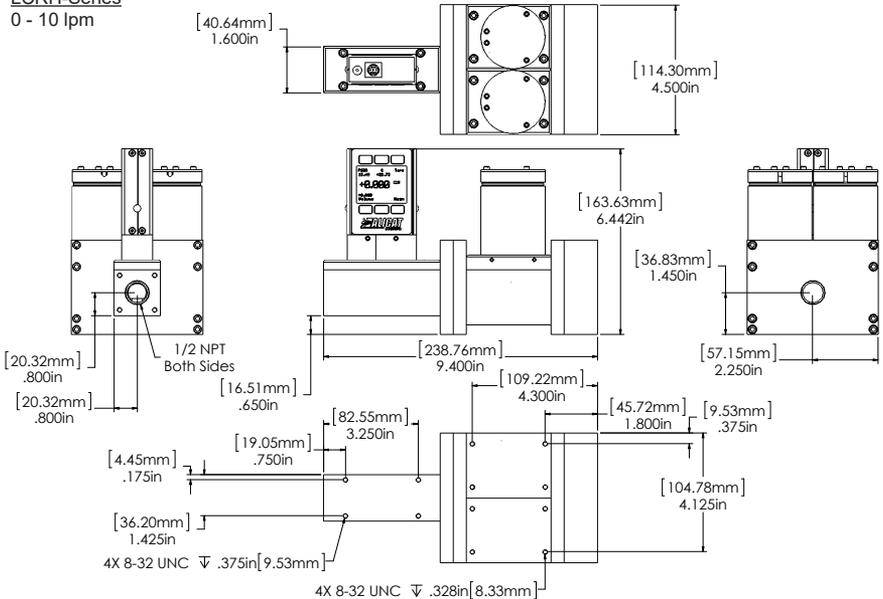
- 0 - 1 lpm
- 0 - 2 lpm
- 0 - 5 lpm



1 lpm to 5 lpm approximate weight: 9.0 lb.

**LCRH-Series**

0 - 10 lpm



10 lpm approximate weight: 26.0 lb.

## Technical Data for PROFIBUS Meters, Gauges and Controllers

**NOTICE:** The following specifications are applicable to Alicat PROFIBUS enabled meters, gauges and controllers only.

All other operating specifications are shown in the Technical Data page for standard Alicat instruments.

All standard device features and functions are available and operate in accordance with the standard Alicat Scientific device operating manual provided with the device.

Specification	Meter or Gauge	Small Valve Controller	Large Valve Controller	Description
Input /Output Signal Digital				PROFIBUS DP
Electrical Connections	DB9			
Supply Voltage:	7 to 30 Vdc	12 to 30 Vdc	24 to 30 Vdc	
Supply Current	80mA @ 12Vdc 65mA @ 24Vdc	295mA @ 12Vdc 280mA @ 24Vdc	780mA @ 24Vdc	

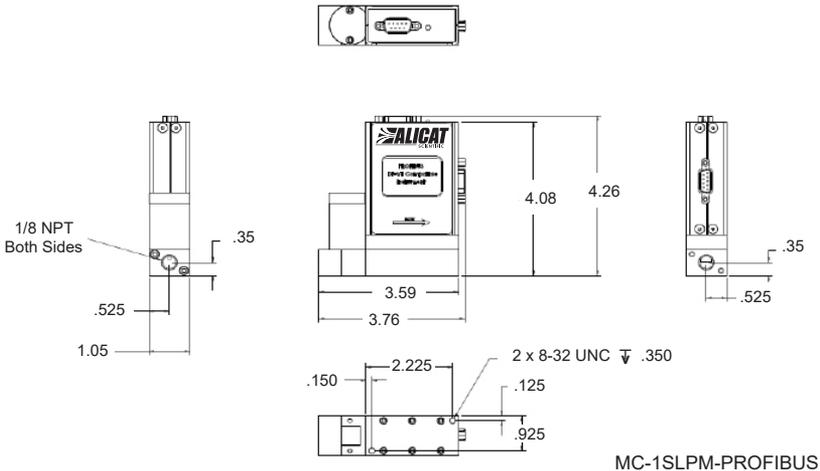
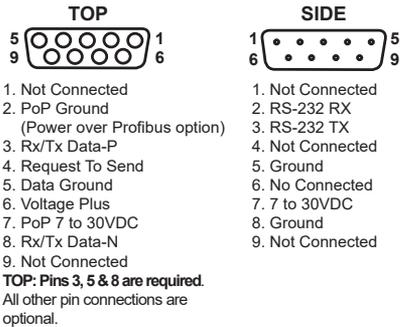
### Power and Signal Connections:

Connect to the device using two DB9 connectors.

The female top connection is PROFIBUS.

The male connection on the side is power and RS-232 or RS-485.

Pin out diagrams for all PROFIBUS enabled Alicat devices are shown:

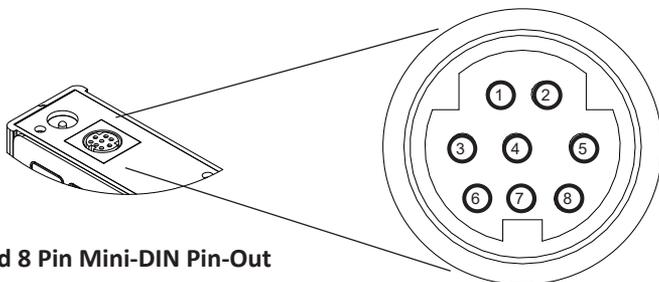


PROFIBUS MC1SLPM shown to provide PROFIBUS connector dimensions only. Flow body and valve dimensions will vary with range. Please see Alicat's device specifications for complete dimensions.

PROFIBUS units do not have a display screen.

## Eight Pin Mini-DIN Connector Pin-Outs

If your Alicat Instrument was ordered with the standard Eight Pin Mini-DIN connection, please be sure to reference the following pin-out diagram.



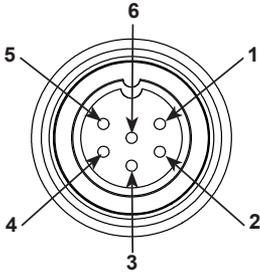
Standard 8 Pin Mini-DIN Pin-Out

Pin	Function	Mini-DIN cable color
1	Inactive (or optional 4-20mA Primary Output Signal)	Black
2	Static 5.12 Vdc [or optional Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm]	Brown
3	Serial RS-232RX / RS-485(-) Input Signal (receive)	Red
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Setpoint Input	Orange
5	Serial RS-232TX / RS-485(+) Output Signal (send)	Yellow
6	0-5 Vdc (or optional 0-10 Vdc) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, digital communications, analog signals and alarms)	Purple

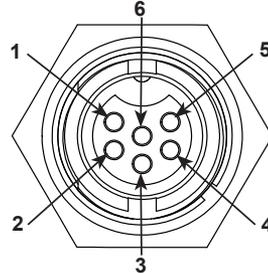
**Note:** The above pin-out is applicable to all flow meters and controllers with the Mini-DIN connector. The availability of different output signals depends on the options ordered. Optional configurations are noted on the unit's calibration sheet.

## Locking Industrial Connector Pin-Outs

If your Alicat Instrument was ordered with a Six Pin Locking Industrial connection, please be sure to reference the following pin-out diagram.



**Male Connector: Cable**



**Female Connector: Device**

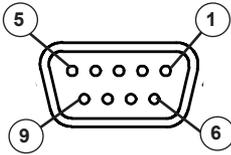
Pin	Function
1	Power In ( + )
2	RS-232TX / RS-485(+)
3	RS-232RX / RS-485(-)
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Setpoint Input
5	Ground (common for power, communications and signals)
6	Signal Out (Voltage or Current as ordered)



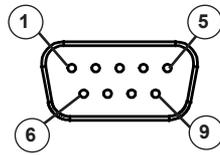
The above pin-out is applicable to all flow meters and controllers ordered with the industrial connector. The availability of different output signals depends on the flow meter options ordered.

## 9 pin D-Sub Common Pinouts

If your instrument was ordered with a DB9 connection, be sure to check the calibration label on the device or the calibration data sheet and reference the appropriate pinout diagram.



Female Connector Front View



Male Connector Front View

### Common Pinouts

Pin	DB9 (Female) DB9M (Male)	DB9A / DB9K	DB9R	DB9T	DB9U
1	Current Out	NC	TX (+)	TX (+)	RX (-)
2	Analog Out 2	Analog Out	Analog Out	Analog Out	Analog Out
3	RX (-)	Power In	Analog In	Power In	Power In
4	Analog In	Ground	Ground	Ground	Ground
5	TX (+)	TX (+)	NC	NC	NC
6	Analog Out	Analog In	RX (-)	Analog In	Analog In
7	Power In	Ground	Power In	Ground	Ground
8	Ground	Ground	Ground	Ground	Ground
9	Ground	RX (-)	Ground	RX (-)	TX (+)

**Current Out** = Not Connected or optional 4-20mA analog output signal

**Analog In** = setpoint for controllers or remote tare function for meters

**Analog Out** = 0-5 Vdc Output Signal (or 0-10 Vdc optional)

**Analog Out 2** = 5.12Vdc or Optional Secondary Analog Output

**TX (+)** = Serial RS-232TX or RS-485(+)

**RX (-)** = Serial RS-232RX or RS-485(-)

**NC** = Not Connected

**Power In** = (+Vdc)

**Ground** = Common for power, digital communications, analog signals and alarms

### Additional Pinouts

Pin	DB9B	DB9G	DB9H	DB9I	DB9N
1	Analog Out 2	RX (-)	TX (+)	NC	Power In
2	Analog Out	Analog Out	Analog Out	Analog Out	Analog In
3	Power In	Ground	Analog In	Power In	Analog Out
4	Ground	Power In	RX (-)	Ground	NC
5	Ground	Ground	Analog Out 2	NC	Ground
6	Analog In	TX (+)	NC	Analog In	Ground
7	Ground	Analog In	Power In	Ground	RX (-)
8	TX (+)	Current Out	Ground	RX (-)	TX (+)
9	RX (-)	Ground	Ground	TX (+)	NC5

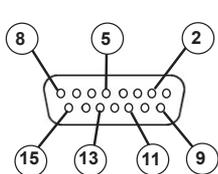
Individual pinouts available at [www.alicat.com/pinout](http://www.alicat.com/pinout)



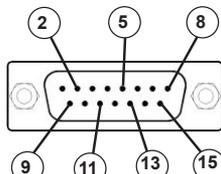
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

## 15 pin D-Sub Common Pinouts

If your instrument was ordered with a DB15 connection, be sure to check the calibration label on the device or the calibration data sheet and reference the appropriate pinout diagram.



Female Connector Front View



Male Connector Front View

Pin	DB15	DB15A	DB15B	DB15H	DB15K	DB15O	DB15S
1	Ground	Ground	Ground	NC	NC	Ground	Ground
2	Analog Out	Analog Out	Analog Out	RX (-)	Analog Out	NC	Analog Out
3	Ground	Analog In	NC	NC	NC	NC	NC
4	NC	Ground	NC	NC	NC	Analog Out	NC
5	Power In	Ground	Power In	Ground	Ground	Power In	Ground
6	NC	Ground	NC	Analog Out	NC	NC	NC
7	NC	Power In	NC	Ground	Power In	Analog In	NC
8	Analog In	TX (+)	Analog In	NC	Analog In	NC <sup>5</sup>	Analog In
9	Ground	Ground	Ground	NC	Analog Out2	Ground	Ground
10	Ground	NC	Ground	Analog Out2	NC	Ground	Ground
11	Analog Out2	NC	Analog Out2	Power In	Ground	Analog Out2	Analog Out2
12	NC	Analog Out2	NC	Ground	Ground	NC	RX (-)
13	RX (-)	NC	NC	NC	RX (-)	NC	Power In
14	Ground	NC	RX (-)	Analog In	TX (+)	RX (-)	TX (+)
15	TX (+)	RX (-)	TX (+)	TX (+)	Ground	TX (+)	Ground

**Analog In** = setpoint for controllers or remote tare function for meters

**Analog Out** = 0-5 Vdc Output Signal (or 0-10 Vdc optional)

**Analog Out 2** = 5.12Vdc or Optional Secondary Analog Output

**TX (+)** = Serial RS-232TX or RS-485(+)

**RX (-)** = Serial RS-232RX or RS-485(-)

**NC** = Not Connected

**Power In** = (+Vdc)

**Ground** = Common for power, digital communications, analog signals and alarms

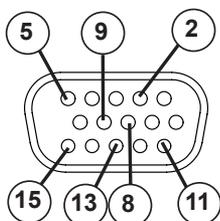
Individual pinouts available at [www.alicat.com/pinout](http://www.alicat.com/pinout)



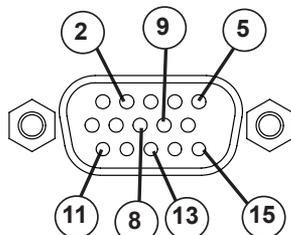
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

## High Density 15 pin D-Sub Common Pinouts

If your instrument was ordered with a High Density DB15 connection, be sure to check the calibration label on the device or the calibration data sheet and reference the appropriate pinout diagram.



Female Connector Front View



Male Connector Front View

Pin	DB15HD	DB15HDS
1	Ground	Ground
2	Analog Out	Analog Out
3	Ground	Analog In
4	NC	Ground
5	Power In	Ground
6	NC	Ground
7	NC	Power In
8	Analog In	TX (+)
9	Ground	Ground
10	Ground	NC
11	Analog Out 2	NC
12	NC	Analog Out 2
13	RX (-)	NC
14	Ground	NC
15	TX (+)	RX (-)

**Analog In** = setpoint for controllers or remote tare function for meters

**Analog Out** = 0-5 Vdc Output Signal (or 0-10 Vdc optional)

**Analog Out 2** = 5.12Vdc or Optional Secondary Analog Output

TX (+) = Serial RS-232TX or RS-485(+)

RX (-) = Serial RS-232RX or RS-485(-)

NC = Not Connected

Power In = (+Vdc)

Ground = Common for power, digital communications, analog signals and alarms

Individual pinouts available at [www.alicat.com/pinout](http://www.alicat.com/pinout)



Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

## Additional Information for Alicat CSA and ATEX Approved Devices



**EEx nA IIC T4**

**Class I, Div. 2 Group A, B, C and D T4**

**24 Vdc, 0.800A max**

**Class I, Zone 2 AEx nA IIC T4**



**WARNINGS:**

**EXPLOSION HAZARD** – DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS.

**EXPLOSION HAZARD** – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

Alicat CSA / ATEX approved devices are equipped with either a locking six pin industrial connector (IC), locking D-sub 15 pin connector (DB15) or locking D-sub 9 pin connector (DB9). Please see pages 58 - 70 for the correct power and signal connections for each type of connector.

**See the following page for special conditions regarding the use of these units!**

**USE of Alicat instruments (L, LC, LCR, M, MW, MS, MC, MCW, MCS, MCR, MCRW, MCRS, MCD, P, PS, PC, PCD, PCS, PCR and PCRS product families) in Class 1 Division 2 applications.**



CSA certifies the use of this product for general use as well as use in hazardous locations as defined by Class 1 Division 2 Group A, B, C and D T4.

**CSA certification is indicated by the product label as shown below and not by the statements in this, or any accompanying documentation.**

**Special Conditions:**

To comply with CSA certification the following information is included in the product literature:

- When equipment is properly labeled, it is suitable in Class I, Division 2, Group A, B, C and D, T4
  - Tamb. -40°C to +50°C
- Electrical Rating 24Vdc, 0.800A max
- Instruments shall be powered by a CSA certified, UL listed, Class II external power supply suitable for the application
- Instruments shall be housed in an enclosure with a minimum IP54 rating or location providing equivalent protection
- Instrument's final approval shall be provided by the local authority having jurisdiction



**USE of Alicat instruments (L, LC, LCR, M, MW, MS, MC, MCD, MCW, MCS, MCR, MCRW, MCRS, P, PS, PC, PCD, PCS, PCR and PCRS product families) in applications requiring ATEX Class 1 Zone 2 Certification.**



Properly labeled Alicat instruments comply to the following ATEX standard:

Ex IIC T4 EEx nA IIC T4 (-40°C ≤ Ta ≤ +50°C)

The examination certificate was issued by the CSA in accordance with accepted practices and procedures. This confirms compliance with the European ATEX Directive or Group II Category 3G equipment.

**ATEX certification is indicated by the product label as shown above and not by the statements in this, or any accompanying documentation.**

**Special Conditions:**

- Properly labeled equipment is only certified for use in ambient temperatures in the range of -40°C to +50°C only
- Electrical Rating 24Vdc, 0.800A max
- Instruments shall be powered by a CSA certified, UL listed, Class II external power supply suitable for the application
- Instruments shall be housed in an enclosure with a minimum IP54 rating or location providing equivalent protection
- Instrument's final approval shall be provided by the local authority having jurisdiction



**Serial Number:** \_\_\_\_\_

**Model Number:** \_\_\_\_\_

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Note: Although we provide assistance on Alicat Scientific products both personally and through our literature, it is the complete responsibility of the user to determine the suitability of any product to their application.

### **Limited Lifetime Warranty**

Alicat Scientific, Inc. warrants to the original purchaser (hereinafter referred to as "Buyer") that instruments manufactured by Alicat Scientific (hereinafter referred to as "Product") shall be free from defects in materials and workmanship for the life of the Products.

Under this warranty, the Products will be repaired or replaced at manufacturer's option, without charge for parts or labor when the Product is carried or shipped prepaid to the factory together with proof of purchase. The foregoing shall constitute the exclusive and sole remedy in lieu of other remedies of the Buyer for any breach by Alicat Scientific of this warranty to the maximum extent permitted by law.

This warranty does not apply to any Product which has not been installed or used in accordance with the Product operation and installation specifications provided to Buyer verbally or in writing by Alicat Scientific for the proper and normal use of the Product.

Buyer agrees hereunder that Alicat reserves the right to void any warranty, written or implied, if upon Alicat's examination of Product shall disclose to Alicat's satisfaction that the Product failure was due solely, or in part, to accident, misuse, neglect, abuse, alteration, improper installation, unauthorized repair or improper testing by Buyer or agent of Buyer.

Alicat Scientific shall not be liable under any circumstances for indirect, special, consequential, or incidental damages in connection with, or arising out of, the sale, performance, or use of the Products covered by this warranty.

Alicat Scientific does not recommend, warrant or assume responsibility for the use of the Products in life support applications or systems.

Alicat's warranties as herein above set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of Alicat's rendering of technical advice in connection with Buyer's order of the Products furnished hereunder.

If Product becomes obsolete, Alicat Scientific, at its own discretion, reserves the right to repair the Product with available replacement parts or upgrade the Product to a current, commercially available version of the original Product. Should upgrading the Product be deemed necessary by Alicat, Buyer hereby agrees to pay an upgrade fee equal to seventy percent of the retail value of the replacement Product. Alicat Scientific hereunder makes no claim that replacement Products will look, function or operate in the same or similar manner as the original product.

When a Product is returned to Alicat Scientific for recalibration this service is considered normal preventative maintenance. Recalibration of Product shall not be treated as a warranty service unless recalibration of Product is required as the result of repairs to Product pursuant to this Warranty. Failure of Buyer to send Product to Alicat Scientific for recalibration on a yearly basis after a period of 36 months from date of manufacture will remove any and all obligations regarding repair or replacement of Product as outlined by this Warranty to Buyer from Alicat Scientific.

This Warranty is in lieu of all other relevant warranties, expressed or implied, including the implied warranty of merchantability and the implied warranty of fitness for a particular purpose, and any warranty against infringement of any patent.

Continued use or possession of Products after expiration of the applicable warranty period stated above shall be conclusive evidence that the warranty is fulfilled to the full satisfaction of Buyer.

Alicat makes no warranty as to experimental, non-standard or developmental Products.

Accessories purchased from Alicat are not covered by this warranty.

Conformity / Supplemental Information:

The product complies with the requirements of the Low Voltage Directive 2014/35/EU, the EMC Directive 2014/30/EU and the RoHS Directive 2011/65/EU and carries the CE Marking accordingly. Contact the manufacturer for more information.

## Gas Viscosity, Density and Compressibility:

#	Gas	Absolute Viscosity* 25°C	Density ** 25°C	Compressibility 25°C
0	Air	184.8989	1.1840	0.9997
1	Argon	226.2399	1.6339	0.9994
2	Methane	110.7595	0.6569	0.9982
3	Carbon Monoxide	176.4933	1.1453	0.9996
4	Carbon Dioxide	149.3184	1.8080	0.9950
5	Ethane	93.5412	1.2385	0.9924
6	Hydrogen	H2	0.08235	1.0006
7	Helium	He	0.16363	1.0005
8	Nitrogen	N2	1.1453	0.9998
9	Nitrous Oxide	N2O	1.48.4124	0.9945
10	Neon	Ne	311.1264	0.8244
11	Oxygen	O2	205.5021	1.3088
12	Propane	C3H8	81.4631	1.8320
13	normal-Butane	n-C4H10	74.0536	2.4493
14	Acetylene	C2H2	104.4480	1.0720
15	Ethylene	C2H4	103.1839	1.1533
16	iso-Butane	i-C4H10	74.7846	2.4403
17	Krypton	Kr	251.3249	3.4323
18	Xenon	Xe	229.8483	5.3950
19	Sulfur Hexafluoride	SF6	153.5320	6.0383

## Flow Conversions:

SCFM	1.00 = 28.3160	SLPM	SLPM	100.00 = 3.5316	SCFM
SCFH	1.00 = 0.4719	SLPM	SLPM	100.00 = 211.9093	SCFH
SCIM	100.00 = 1.6390	SLPM	SLPM	1.00 = 61.0128	SCIM
SCIH	1000.00 = 0.2732	SLPM	SLPM	1.00 = 3660.7688	SCIH

[alicat.com](http://alicat.com)

#	Gas	Absolute Viscosity* 25°C	Density ** 25°C	Compressibility 25°C
20	75%Ar / 25% CO2	C-25	206.9763	1.6766
21	90%Ar / 10% CO2	C-10	218.6026	1.6509
22	92% Ar / 8% CO2	C-8	220.1352	1.6475
23	98% Ar / 2% CO2	C-2	224.7148	1.6373
24	75% CO2 / 25% Ar	C-75	168.2250	1.7634
25	75% Ar / 25% He	HE-75	231.6056	1.2660
26	75% He / 25% Ar	HE-25	234.6860	0.5308
27	90% He / 7.5% Ar / 2.5% CO2 Helistar® A1025	A1025	214.9760	0.3146
28	90% Ar / 8% CO2 / 2% O2 Star29® CS	Star29	219.7934	1.6410
29	95% Ar / 5% CH4	P-5	223.9106	1.5850

\*In micropoise (1 Poise = gram / (cm) (sec))

\*\*Grams/Liter

Reference: NIST REFPROP 9 Database



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