

Operating Manual



16 Series Precision Water Flow Meter and Water Flow Controller

Innovative Flow and Pressure Solutions



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Thank you for purchasing an L Series Water Flow Meter or LC 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 16 Bit Water Flow Meters	L-XXCCM-D
	L-XXLPM-D
LC Series 16 Bit Water Flow Controllers	LC-XXCCM-D
	LC-XXLPM-D
	LCR-XXLPM-D

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. The underlying principle of operation of the 16 Series Flow Meters is known as the Poiseuille Equation:

$$Q = (P_1 - P_2) \pi r^4 / 8 \eta L \quad (\text{Equation 1})$$

Where: Q = Volumetric Flow Rate
P₁ = Static pressure at the inlet
P₂ = Static pressure at the outlet
r = Radius of the restriction
η = (eta) absolute viscosity of the fluid
L = Length of the restriction

Since p, r and L are constant; Equation 1 can be rewritten as:

$$Q = K (\Delta P / \eta) \quad (\text{Equation 2})$$

Where K is a constant factor determined by the geometry of the restriction. Equation 2 shows the linear relationship between volumetric flow rate (Q) differential pressure (DP) and absolute viscosity (h) in a simpler form.

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. As shown in Equation 2, an error in viscosity between the actual fluid and water will result in a 1:1 error percentage in the flow rate reported by the meter. For instance if the actual fluid passing through the meter is 5% different than that of pure water at a given temperature, the reported flow rate will be 5% inaccurate.

Flow Control Operating Principle

For the purposes of this explanation, the term “valve” will refer to the proportional control valve mounted on the controller. The term “controller” will refer to the flow meter and the measurement and control electronics portion of the device. In actuality, the whole device is generally referred to as a controller. The valve normally mounted downstream of the controller.

LC Series Flow Controllers ship with a normally closed proportional control valve. No flow will occur until the valve receives a voltage signal from the controller, and the controller will not send a voltage signal to the valve until the user provides a set-point to the controller. The user can provide a set-point either locally via the display and user interface buttons, or more commonly, by providing an external signal that corresponds to the flow range of the controller. This external signal can be an analog voltage or current signal such as a 0-5 Vdc or 4-20 mA signal, or a digital RS-232 signal via serial communication with a computer.

The controller utilizes what is called PID (Proportional, Integral, Derivative) loop control circuitry and software. The PID loop control works by repeatedly comparing the measured flow rate to the set-point and incrementally adjusting the voltage signal to the valve in a continuous attempt to match the measured flow rate to the set-point. For example, at any given time the controller looks at the measured flow rate and the set-point, if the set-point is higher than the measured flow rate, the controller will slightly increase the voltage signal to the valve and thus open it little more. If the set-point is lower than the measured flow rate, the controller will slightly decrease the voltage signal to the valve and thus close it off a little more. This look, compare, and adjust “loop” occurs on the order of 1000 times each second.

LC Series Flow Controllers ship with a general PID tuning that is usually sufficient for most applications. Occasionally an application will require the customer to change this tuning. The Proportional and Derivative terms can be field adjusted in all LC controllers. In very general terms, the P term can be thought of as how fast the controller responds to change and the D term can be thought of as a damping factor.

Installation

Plumbing

All L Series Meters and LC Series Controllers are equipped with female inlet and outlet port connections. Because the flow meters set up a laminar flow condition within the flow body, no straight runs of pipe are required upstream or downstream of the meter. The inlet and outlet ports are equal in size and symmetric (in-line). The port sizes (process connections) and mechanical dimensions for different flow ranges are shown on page 29.

Meters with M5 (10-32) ports have o-ring face seals and require no further sealant or tape. On other meters/controllers, avoid the use of pipe dopes or sealants on the ports as these compounds can cause permanent damage to the meter should they get into the flow stream. Use of thread sealing Teflon tape is recommended to prevent leakage around the threads. When applying the tape, avoid wrapping the first thread or two to minimize the possibility of getting a piece of shredded tape into the flow stream. When changing fittings, always clean any tape or debris from the port threads.

It is also recommended that a 20 micron filter be installed upstream of meters/controllers with full scale ranges of 100CCM or less and a 50 micron filter be installed upstream of meters/controllers with full scale ranges above 100CCM.

Note: Avoiding long runs of small diameter tubing upstream or downstream of controllers will reduce water hammer.

Mounting

All L Series Meters and LC Series Controllers have mounting holes for convenient mounting to flat panels. These meters are position insensitive and can be mounted in any orientation. The sizes and dimensions for the mounting holes are shown on pages 30-32.

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!

Application

Maximum operating line pressure is 100 PSIG (689 kPa). **Caution: Exceeding the maximum specified line pressure may cause permanent damage to the solid-state differential pressure transducer.**

If the line pressure is higher than the 100 PSIG (689 kPa), a pressure regulator should be used upstream from the flow meter to reduce the pressure to 100 PSIG (689 kPa) or less if possible. 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.

Avoid installations (such as snap acting solenoid valves upstream) that apply instantaneous high pressure to the meter as permanent damage to the differential pressure sensor could result. This damage is not covered under warranty!

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 as shown in Figure 1. After installation or anytime it is suspected that air may be trapped in the sensor ports, bleed the ports as follows:

CAUTION: *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.*

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!

Gently tap the flow body (a wooden or plastic screwdriver handle works well for this) to encourage air bubbles to exit the port.

Any air in the port will generally be removed as the water leaks out even though you may not see or hear it.

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.

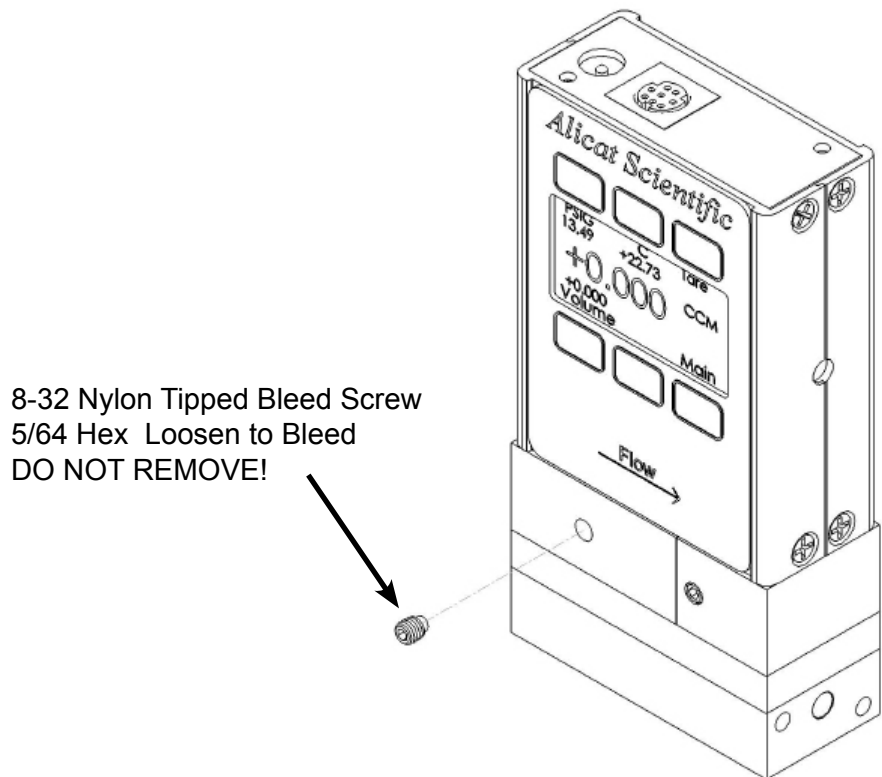


Figure 1. Bleed Ports

Power and Signal Connections

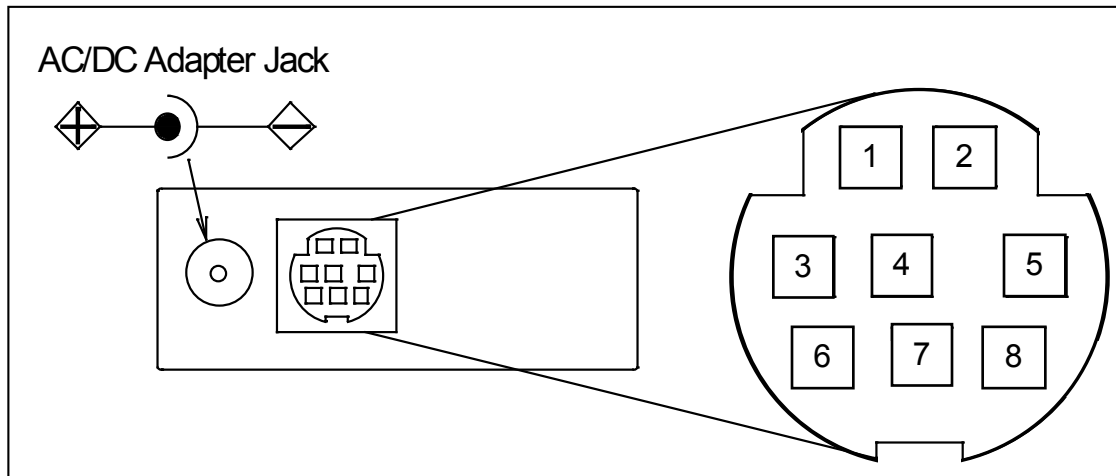
Power can be supplied to your meter or controller through either the AC/DC adapter jack or through the 8 pin Mini-DIN connector as shown in Figure 1.

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

A 2.1mm, positive center, 24-30 Vdc AC/DC adapter rated for at least 500 mA is required to use the adapter jack in a **LCR Series controller**.

Cables can be purchased from the manufacturer (see Accessories on page 40) or they are available from electronics suppliers. Alternatively, power can be supplied through the Mini-DIN connector as shown below:



Pin	Function	Mini-DIN cable color
1	Inactive or <u>4-20mA Primary Output Signal</u>	Black
2	Static 5.12 Vdc or <u>Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm</u>	Brown
3	RS-232 Input Signal	Red
4	Analog Input Signal = Remote Tare (Meters - see Figure 8) = Set-Point In (Controllers - see Figure 3)	Orange
5	RS-232 Output Signal	Yellow
6	0-5 Vdc (or <u>0-10 Vdc</u>) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, communications and signals)	Purple

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

Figure 2. 8 Pin Mini-DIN Connector

CAUTION: Do not connect power to pins 1 through 6 as permanent damage can occur!

Note: Upon initial review of the pin out diagram in Figure 2, 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 input signal. This allows the user in the field to run this output through a 50K ohm potentiometer and back into the analog set-point pin to create a 0-5 Vdc set-point source (see Figure 3).

Analog Input Signal

Apply analog input to Pin 4 as shown in Figure 2.

Unless ordered otherwise, 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. The 5.12 Vdc output on pin 2 can be wired through a 50K ohm potentiometer and back to the analog input on pin 4 to create an adjustable 0-5 Vdc input signal source as in Figure 3 below.

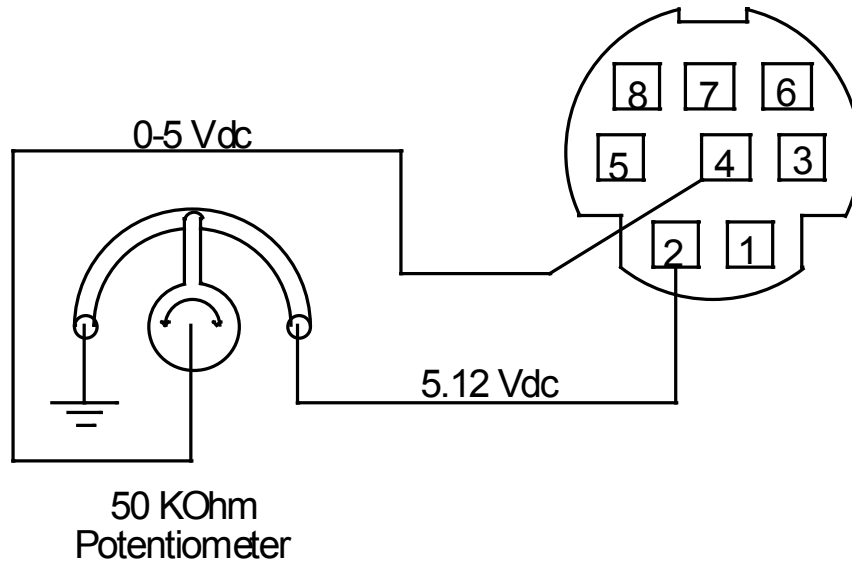


Figure 3. Simple Method for Providing Set-Point to Controllers

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.

RS-232 Digital Input Signal

If you will be using the RS-232 output signal, it is necessary to connect the RS-232 Output Signal (Pin 5), the RS-232 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown in Figure 4. *Adapter cables are available from Alicat (see Accessories page 40) or they can be constructed in the field with parts from a local electronic supply house. In Figure 4, note that the diagrams represent the “port” side of the connections, i.e. the connector on top of the meter and the physical DB-9 serial port on the back of the computer. The cable ends will be mirror images of the diagram shown in Figure 4. (See page 21 for details on accessing RS-232 output and input.)*

RS-232 Digital Output Signal

If you will be using the RS-232 output signal, it is necessary to connect the RS-232 Output Signal (Pin 5), the RS-232 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown in Figure 4. Adapter cables are available from the manufacturer or they can be constructed in the field with parts from an electronics supply house. In Figure 4, note that the diagrams represent the “port” side of the connections, i.e. the connector on top of the meter and the physical DB-9 serial port on the back of the computer. The cable ends will be mirror images of the diagram shown in Figure 4. (See page 21 for details on accessing RS-232 output.)

Standard Voltage (0-5 Vdc) Output Signal

All L and LC Series flow meters/controllers have a 0-5 Vdc (optional 0-10 Vdc) output signal available on Pin 6. This 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 device 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 device 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.)

Note: *This is a current sourcing device. Do not attempt to connect it to "loop powered " systems.*

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 device 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.

Note: *This is a current sourcing device. Do not attempt to connect it to "loop powered " systems.*

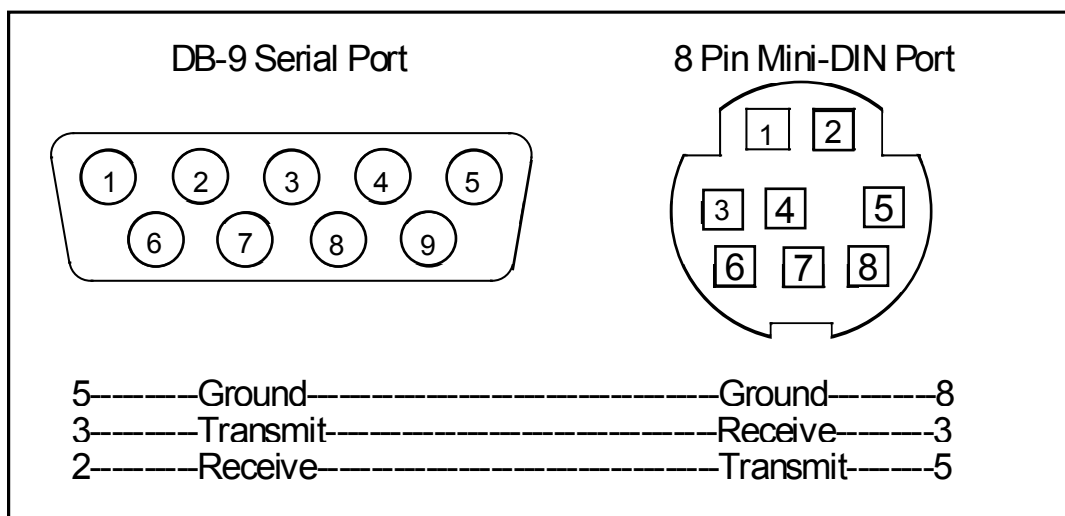


Figure 4. Mini-DIN to DB-9 Connection for RS-232 Signals

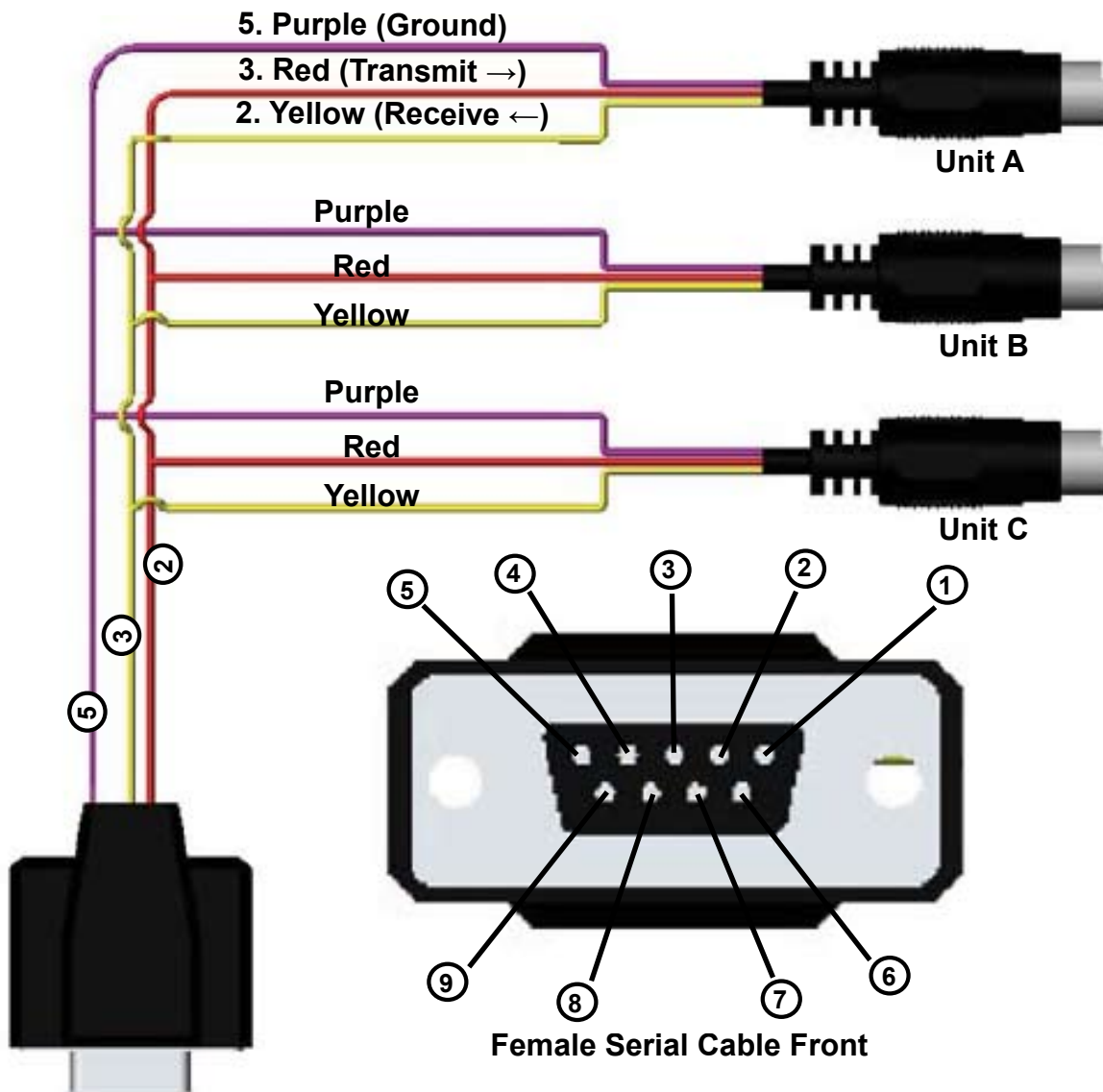


Figure 5. Typical Multiple Device (Addressable) Wiring Configuration

Note: The easiest way to connect multiple devices is with a Multi-Drop Box (see page 38).

An optional industrial connector is also available:

Pin	Function	Cable Color
1	Power In (+)	Red
2	RS-232 Output	Blue
3	RS-232 Input Signal	White
4	Remote Tare (Ground to Tare)	Green
5	Ground (common for power, communications and signals)	Black
6	Signal Out (Voltage or Current as ordered)	Brown

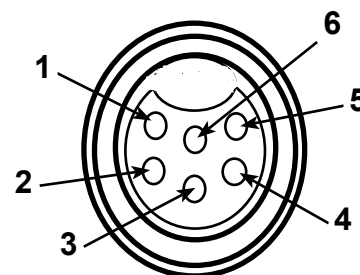


Figure 6. Optional Industrial Connector

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

L Series Water Flow Meter Operation

The L Series can have several screen “modes” depending on how the device is ordered. All L Series meters have a default Main Mode, Select Menu Mode, a Communication Select Mode, a Manufacturer Data Mode and a Miscellaneous Mode. (In addition, your meter may have been ordered with the Totalizing Mode option, see page 34.) The device defaults to Main Mode as soon as power is applied to the meter.

Note: L Series Flow Meters may also be powered with the 9 Volt Battery Pack described on page 35.

Main Mode

The main mode screen shows the flow in the units specified at time of order, the line pressure in PSIG, and the process temperature in degrees Celsius. The following parameters are displayed in the main mode as shown in Figure 7:

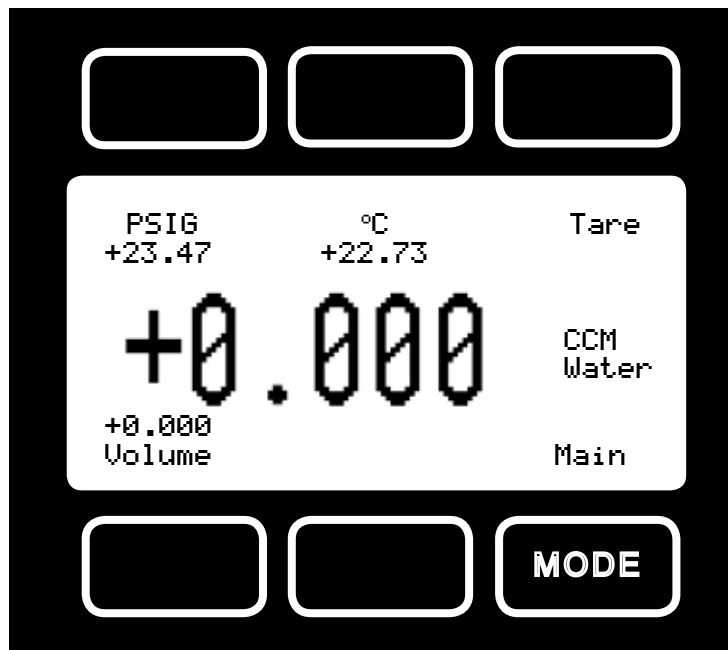


Figure 7. Main Mode Display, L Series Flow Meter

The “MODE” button in the lower right hand corner toggles the display between modes.

Tare – Pushing the dynamically labeled Tare button in the upper right hand corner tares the flow meter and provides it with a reference point for zero flow. *This is a very simple but important step in obtaining accurate measurements.* It is good practice to “zero” the flow meter each time it is powered up and whenever a known zero flow condition exists. 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, it is helpful to 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. It is not uncommon for a meter to read a small value when it is removed from the process line as water can “hang” in one or both of the differential pressure sensor ports. If the unit reads a significant negative value when removed from the line and blocked, it is a good indication that it was given a false zero.

Note: A remote tare can be achieved by momentarily grounding pin 4 to tare as shown in Figure 8 on page 14.

Line Pressure – Pressing the dynamically labeled PSIG button located in the upper left corner of the display will move the line gauge pressure to the primary display.

Line Temperature – Pressing the dynamically labeled °C button located in the upper middle of the display will move the process temperature to the primary display.

Volume – The volume flow rate is defaulted on the primary display. Pressing the dynamically labeled “Volume” button will move the volume flow rate to the primary display if another parameter is displayed there.

Flashing Error Message: 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.

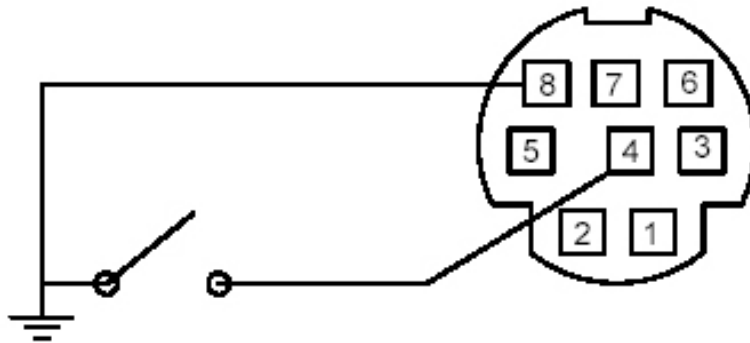


Figure 8. Proper Set Up for Remote Tare on Meters (Momentarily ground Pin 4 to Tare)

Select Menu Mode

Pushing “Mode” once will bring up the “Select Menu” display. Push the button nearest your selection to go to the corresponding screen. Push “Mode” again to return to the Main Mode display. **(Note: If your meter was ordered with Totalizing Mode option (page 34), pushing the “Mode” button once will bring up the “Totalizing Mode” display. Pushing “Mode” a second time will bring up the “Select Menu” display.)**

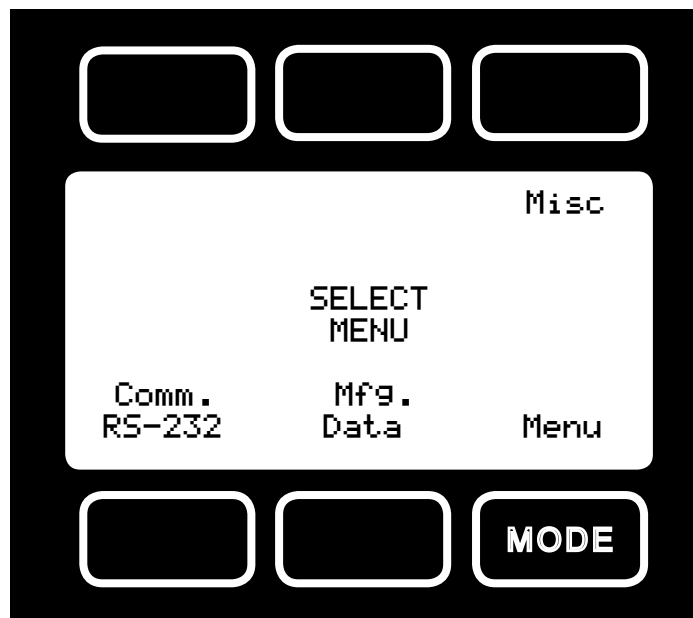


Figure 9. Select Menu Display

Communication Select Mode

The Communication Select mode is accessed by pressing the button below “Comm. RS-232” on the Select Menu display. The screen will appear as shown in Figure 10 below.

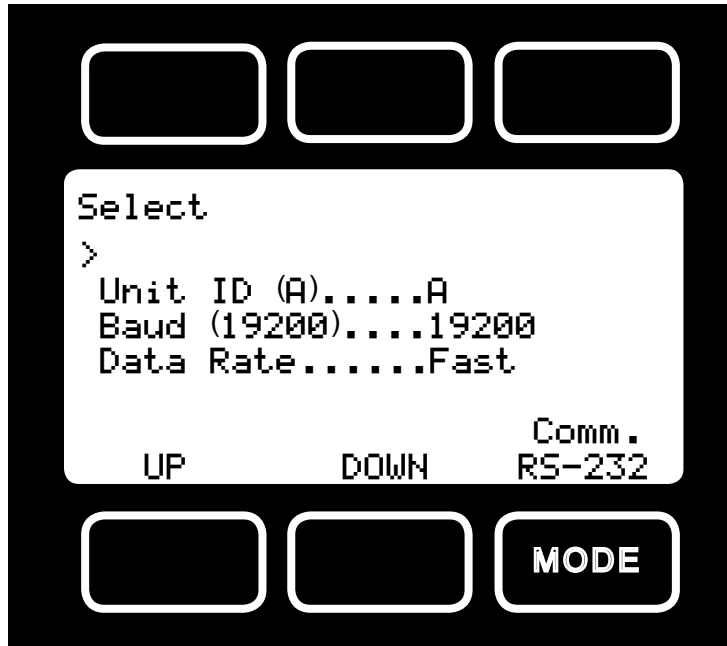


Figure 10. Communication Select Display

Unit ID – Valid unit identifiers are letters A-Z and @ (see **Note** below). This identifier allows the user to assign a unique address to each device so that multiple units can be connected to a single RS-232 port on a computer. The Communication Select Mode allows you to view and/or change a unit’s unique address. To change the unit ID address, press the “Select” button in the upper left corner of the display until the cursor arrow is in front of the word “Unit ID”. Then, using the UP and DOWN buttons at the bottom of the display, change the unit ID to the desired letter. **Any ID change will take effect when the Communication Select Screen is exited by pushing the MODE button.**

Note: When the symbol @ is selected as the unit ID, the device will go into streaming mode when the Communication Select Mode is exited by pushing the MODE button. See the RS-232 Communications chapter in this manual for information about the streaming mode.

Baud – The baud rate (bits per second) determines the rate at which data is passed back and forth between the instrument and the computer. Both devices must send/receive at the same baud rate in order for the devices to communicate via RS-232. The default baud rate for these devices is 19200 baud, sometimes referred to as 19.2K baud. To change the baud rate in the Communication Select Mode, press the “Select” button in the upper left corner of the display until the cursor arrow is in front of the word “Baud”. Then, using the UP and DOWN buttons at the bottom of the display, select the required baud rate to match your computer or PLC. The choices are 38400, 19200, 9600, or 2400 baud. **Any baud rate change will not take effect until power to the unit is cycled.**

Data Rate – Changing the Data Rate affects the rate at which the instrument dumps its data. Slow is ½ the Fast rate. The speed of the Fast rate is determined by the selected baud rate. It is sometimes desirable to reduce the data rate if the communication speed bogs down the computer’s processor (as is not uncommon in older laptops), or to reduce the size of data files collected in the streaming mode. To change the data rate in the Communication Select Mode, press the “Select” button in the upper left corner of the display until the cursor arrow is in front of the word “Data Rate”. Then, using the UP and DOWN buttons at the bottom of the display, select either Fast or Slow. **Any data rate change will be effective immediately upon changing the value between Fast and Slow.**

Manufacturer Data Mode

“Manufacturer Data” is accessed by pressing the “Mfg. Data” button on the Select Menu display (Figure 7). The “Mfg 1” display shows the name and telephone number of the manufacturer. The “Mfg 2” display shows important information about your flow meter including the model number, serial number, and date of manufacture.

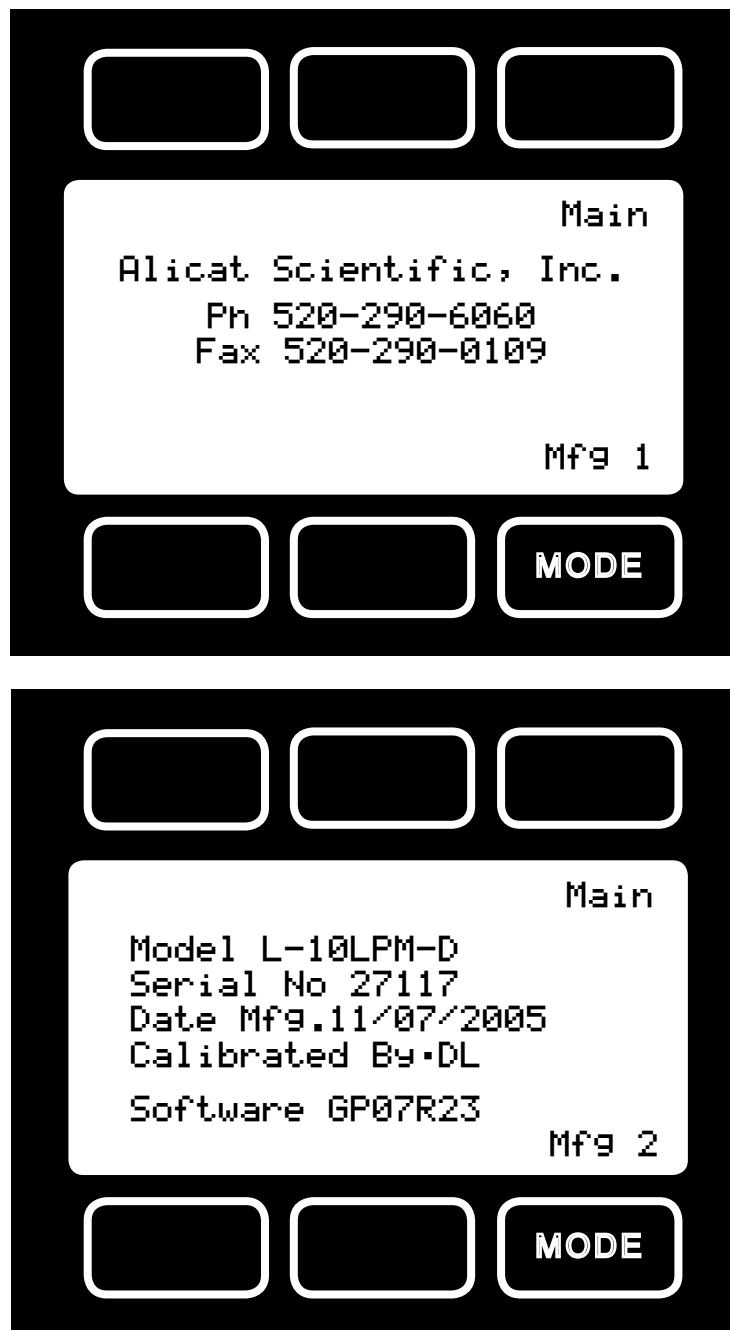


Figure 11. Manufacturer Data Displays

Miscellaneous Mode

The Miscellaneous mode is accessed by pressing the button above the “Misc” label in the upper right hand corner of the Select Menu display. The screen will appear as shown in Figure 12. Push the button above “Select” to move the cursor even with the item you wish to adjust. Then use the “UP” and “DOWN” buttons to make the adjustment.

NOTE: All Miscellaneous changes are recorded when you exit the Miscellaneous display.

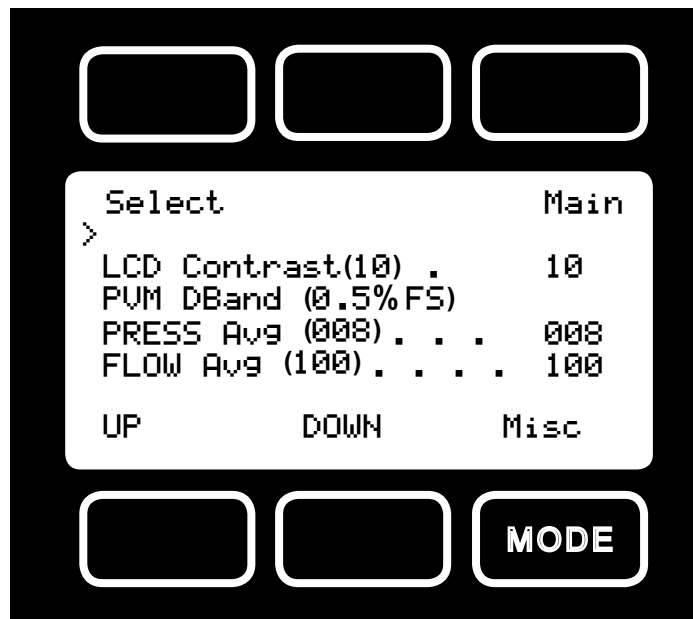


Figure 12. Miscellaneous Display

LCD Contrast: The Liquid Crystal Display Contrast can be adjusted between 0 and 30 with zero being the lightest contrast and 30 being the darkest contrast. To change the contrast, press the “Select” button in the upper left hand corner of the display until the cursor arrow is in front of the words “LCD Contrast (X)”. Then using the UP and DOWN buttons at the bottom of the display, change the contrast value as desired. The change is immediate and the effect can be monitored as the value is changed.

Display Zero Deadband: Zero deadband refers to a value below which the display simply 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 actually exist, especially in high noise (electrical) environments. This display deadband does not affect the analog or digital signal outputs — there is no zero deadband on the output signals. The display zero deadband can be adjusted between 0 and 3.2% of the Full Scale (FS) of the sensor. PVM refers to Pressure, Volumetric Flow, and Mass Flow, the three parameters to which the deadband applies. *Note: Only Pressure and Volumetric Flow are applicable to and adjustable in liquid devices.* To adjust the display zero deadband, press the “Select” button in the upper left hand corner of the display until the cursor arrow is in front of the words “PVM DBand (X %F.S.)”. Then using the UP and DOWN buttons at the bottom of the display, change the display zero deadband value as desired.

Pressure Averaging: It is sometimes advantageous to apply an averaging factor to the pressure output (and display) to make it easier to read and interpret rapidly fluctuating pressures. Pressure averaging can be adjusted between 1 (no averaging) and 256 (maximum averaging). This is a geometric running average where the number between 1 and 256 can be considered very roughly equivalent to the response time constant in milliseconds. This can be very effective at “smoothing” high frequency process oscillations such as those caused by diaphragm pumps. To adjust the pressure averaging, press the “Select” button in the upper left hand corner of the display until the cursor arrow is in front of the words “PRESS Avg (XXX)”. Then using the UP and DOWN buttons at the bottom of the display, change the pressure averaging value as desired.

Flow Averaging: It is sometimes advantageous to apply an averaging factor to the flow output (and display) to make it easier to read and interpret rapidly fluctuating flows. Flow averaging can be adjusted between 1 (no averaging) and 256 (maximum averaging). This is a geometric running average where the number between 1 and 256 can be considered very roughly equivalent to the response time constant in milliseconds. This can be very effective at “smoothing” high frequency process oscillations such as those caused by diaphragm pumps. To adjust the flow averaging, press the “Select” button in the upper left hand corner of the display until the cursor arrow is in front of the words “FLOW Avg (XXX)”. Then using the UP and DOWN buttons at the bottom of the display, change the flow averaging value as desired.

LC Series Water Flow Controller Operation

The LC Series can have several screen “modes” depending on how the device is ordered. All LC Series controllers have a default Main Mode, a Select Menu Mode, a Control Setup Mode, a Communication Select Mode, a Manufacturer Data Mode and a Miscellaneous Mode. (In addition, your controller may have been ordered with the Totalizing Mode option, see page 34.) The device defaults to Main Mode as soon as power is applied to the meter.

Main Mode

The main mode screen shows the flow in the units specified at time of order, the line pressure in PSIG, and the process temperature in degrees Celsius.

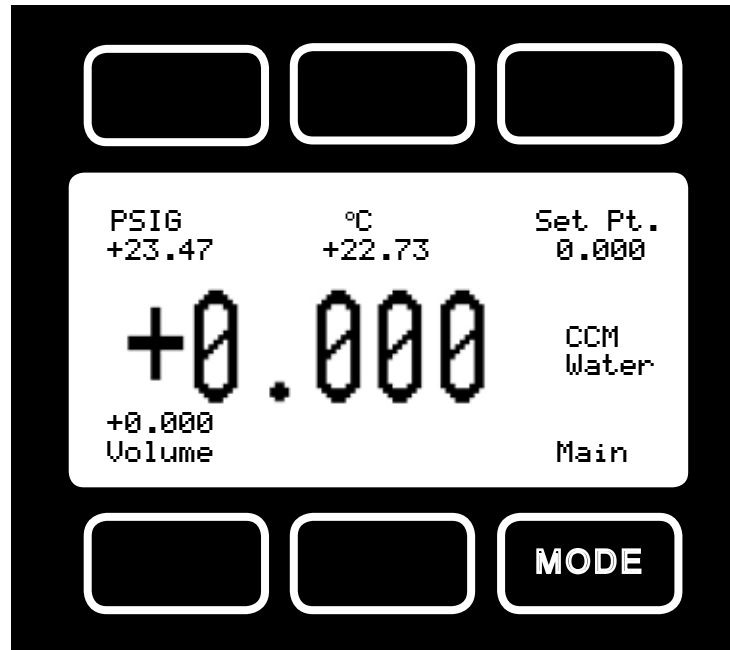


Figure 13. Main Mode Display, LC Series Water Flow Controller

The “MODE” button in the lower right hand corner toggles the display between the Main Display and the Select Menu Display.

Line Pressure – Pressing the dynamically labeled PSIG button located in the upper left corner of the display will move the line gauge pressure to the primary display.

Line Temperature – Pressing the dynamically labeled °C button located in the upper middle of the display will move the process temperature to the primary display.

Volume – The volume flow rate is defaulted on the primary display. Pressing the dynamically labeled “Volume” button will move the volume flow rate to the primary display if another parameter is displayed there.

Set Pt – The set-point is shown in the upper right corner of the display. The set-point cannot be adjusted from the main mode screen. (For information on changing the set-point, see the Control Set Up Mode below.)

Flashing Error Message: 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.

Select Menu Mode

Pushing “Mode” once will bring up the “Select Menu” display (Figure 9, page 14). Push the button nearest your selection to go to the corresponding screen. Push “Mode” again to return to the Main Mode display. (**Note:** *If your meter was ordered with Totalizing Mode option (page 34), pushing the “Mode” button once will bring up the “Totalizing Mode” display. Pushing “Mode” a second time will bring up the “Select Menu” display.*)

Control Setup Mode

The Control Setup Mode is accessed by pressing the button labeled “MODE” until the dynamic label over the button reads “Control Setup” as shown in Figure 11 below. This mode allows the user to set up most parameters commonly associated with PID control. LC Series flow controllers allow the user to select how the set-point is to be conveyed to the controller, what that set-point is if control is local, and what the Proportional and Differential terms of the PID control loop will be. The UP and DOWN buttons for adjusting variables can be held down for higher speed adjustment or pressed repeatedly for fine adjustment. *If your controller is difficult to reach or you prefer “dial up” set-point adjustment, please consider our Local Set-Point Module (LSPM) described on page 37.*

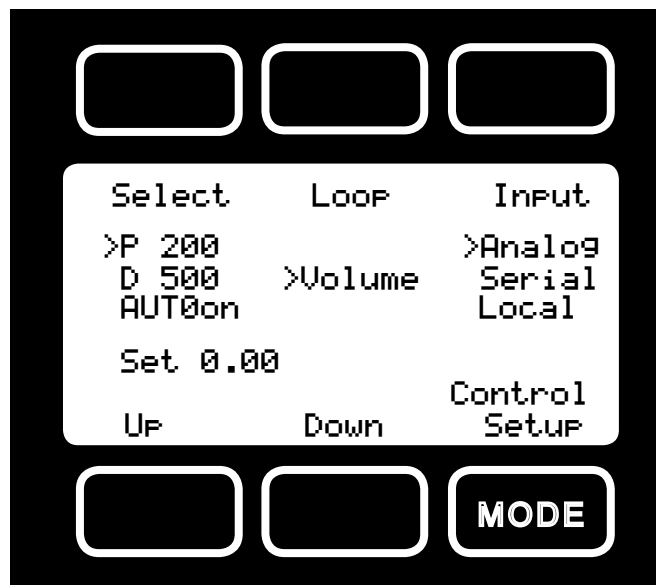


Figure 14. LC Series Control Setup Display

Input – LC Series Flow Controllers normally ship defaulted to analog control as indicated in Figure 14 above. To change how the set-point will be conveyed to the controller push the button in the upper right hand corner just above the dynamic label “Input” until the arrow is directly in front of the desired option. The controller will ignore any set-point except that of the selected input and it will remember which input is selected even if the power is disconnected.

Analog refers to a remote analog set-point applied to Pin 4 of the Mini-DIN connector as described in the installation section of this manual. To determine what type of analog set-point your controller was ordered with, refer to the Calibration Data Sheet that was included with your controller. 0-5 Vdc is standard unless ordered otherwise. Note that if nothing is connected to Pin 4, and the controller is set for analog control, the set-point will float. **CAUTION! NEVER LEAVE A CONTROLLER WITH ANY NON-ZERO SET-POINT IF NO PRESSURE IS AVAILABLE TO MAKE FLOW. THE CONTROLLER WILL APPLY FULL POWER TO THE VALVE IN AN ATTEMPT TO REACH THE SET-POINT. WHEN THERE IS NO FLOW, THIS CAN MAKE THE VALVE VERY HOT!**

Serial refers to a remote digital RS-232 set-point applied via a serial connection to a computer or PLC as described in the Installation and RS-232 sections of this manual. **CAUTION! NEVER LEAVE A CONTROLLER WITH ANY NON-ZERO SET-POINT IF NO PRESSURE IS AVAILABLE TO MAKE FLOW. THE CONTROLLER WILL APPLY FULL POWER TO THE VALVE IN AN ATTEMPT TO REACH THE SET-POINT. WHEN THERE IS NO FLOW, THIS CAN MAKE THE VALVE VERY HOT!**

Local refers to a set-point applied directly at the controller. For more information on changing the set-point locally refer to the heading “Select” below. Local input must be selected prior to attempting to change the set-point locally. **CAUTION! NEVER LEAVE A CONTROLLER WITH ANY NON-ZERO SET-POINT IF NO PRESSURE IS AVAILABLE TO MAKE FLOW. THE CONTROLLER WILL APPLY FULL POWER TO THE VALVE IN AN ATTEMPT TO REACH THE SET-POINT. WHEN THERE IS NO FLOW, THIS CAN MAKE THE VALVE VERY HOT!**

Loop – The LC is defaulted to volume flow.

Volume means that the controller is “closing the loop” on the volume flow rate. This means that when you give the controller a set-point, the controller compares that set-point to the measured volume flow rate and adjusts the valve to try to make the flow and the set-point match. For the volume flow rate, the input signal (e.g. 0-5 Vdc) corresponds to the full-scale flow rate for the device.

Select – To avoid accidental changing of the PID loop parameters or the set-point, the Control Setup mode defaults with the selector on a null position. To change the set-point or the P and D PID loop parameters, push the button in the upper left corner just above the dynamic label “Select” until the selection arrow is pointing to the parameter you wish to change. When the parameter you wish to change is selected, it may be adjusted up or down with the buttons under the display below the dynamic labels “UP” and “DOWN”. Press the buttons repeatedly to make slow adjustments or hold them down to make fast adjustments.

P refers to the Proportional term of the PID loop. Before changing this parameter, it is good practice to write down the initial value so that it can be returned to the factory settings if necessary.

D refers to the Differential term of the PID loop. Before changing this parameter, it is good practice to write down the initial value so that it can be returned to the factory settings if necessary.

AUT0on / AUT0off refers to the standard auto-tare or “auto-zero” feature. 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. The auto-tare feature automatically tares (takes the detected signal as zero) the unit when it receives a zero set-point for more than two seconds. A zero set-point results in the closing of the valve and a known “no flow” condition. This feature helps to make the device more accurate by periodically removing any cumulative errors associated with drift.

Set refers to the Set-point. This parameter may only be changed if “Local” is selected as the Input. See above for information on selecting the input. Using the UP and DOWN buttons, the set-point may be adjusted between zero and the full-scale range of the controller. **CAUTION! NEVER LEAVE A CONTROLLER WITH ANY NON-ZERO SET-POINT IF NO PRESSURE IS AVAILABLE TO MAKE FLOW. THE CONTROLLER WILL APPLY FULL POWER TO THE VALVE IN AN ATTEMPT TO REACH THE SET-POINT. WHEN THERE IS NO FLOW, THIS CAN MAKE THE VALVE VERY HOT!**

Communication Select Mode

The Communication Select mode is accessed by pressing the button below “Comm. RS-232” on the Select Menu display. Please see page 15 for Communication Select mode instructions.

Manufacturer Data Mode

“Manufacturer Data” is accessed by pressing the “Mfg. Data” button on the Select Menu display (Figure 9, page 14). The “Mfg 1” display shows the name and telephone number of the manufacturer. The “Mfg 2” display shows important information about your flow meter including the model number, serial number, and date of manufacture (Figure 11, page 16).

Miscellaneous Mode

The Miscellaneous mode is accessed by pressing the button above the “Misc” label in the upper right hand corner of the Select Menu display. The screen will appear as shown in Figure 12. Push the button above “Select” to move the cursor even with the item you wish to adjust. Then use the “UP” and “DOWN” buttons to make the adjustment. See pages 16 & 17.

NOTE: All Miscellaneous changes are recorded when you exit the Miscellaneous display.

RS-232 Output and Input

Configuring HyperTerminal®:

1. Open your HyperTerminal® RS-232 terminal program (installed under the “Accessories” menu on all Microsoft® Windows® operating systems).
2. Select “Properties” from the file menu.
3. Click on the “Configure” button under the “Connect To” tab. Be sure the program is set for: 19,200 baud (or matches the baud rate selected in the RS-232 communications menu on the meter) and an 8-N-1-None (8 Data Bits, No Parity, 1 Stop Bit, and no Flow Control) protocol.
4. Under the “Settings” tab, make sure the Terminal Emulation is set to ANSI or Auto Detect.
5. Click on the “ASCII Setup” button and be sure the “Send Line Ends with Line Feeds” box is not checked and the “Echo Typed Characters Locally” box and the “Append Line Feeds to Incoming Lines” boxes are checked. Those settings not mentioned here are normally okay in the default position.
6. Save the settings, close HyperTerminal® and reopen it.

In Polling Mode, the screen should be blank except the blinking cursor. In order to get the data streaming to the screen, hit the “Enter” key several times to clear any extraneous information. Type “*@=@” followed by “Enter” (or using the RS-232 communication select menu, select @ as identifier and exit the screen). If data still does not appear, check all the connections and com port assignments.

Changing From Streaming to Polling Mode:

When the meter is in the Streaming Mode, the screen is updated approximately 10-60 times per second (depending on the amount of data on each line) so that the user sees the data essentially in real time. It is sometimes desirable, and necessary when using more than one unit on a single RS-232 line, to be able to poll the unit.

In Polling Mode the unit measures the flow normally, but only sends a line of data when it is “polled”. Each unit can be given its own unique identifier or address. Unless otherwise specified each unit is shipped with a default address of capital A. Other valid addresses are B thru Z.

Once you have established communication with the unit and have a stream of information filling your screen:

1. Type `*@=A` followed by “Enter” (or using the RS-232 communication select menu, select A as identifier and exit the screen) to stop the streaming mode of information. Note that the flow of information will not stop while you are typing and you will not be able to read what you have typed. Also, the unit does not accept a backspace or delete in the line so it must be typed correctly. If in doubt, simply hit enter and start again. If the unit does not get exactly what it is expecting, it will ignore it. If the line has been typed correctly, the data will stop.
2. You may now poll the unit by typing A followed by “Enter”. This does an instantaneous poll of unit A and returns the values once. You may type A “Enter” as many times as you like. Alternately you could resume streaming mode by typing `*@=@` followed by “Enter”. Repeat step 1 to remove the unit from the streaming mode.
3. To assign the unit a new address, type `*@=New Address`, e.g. `*@=B`. Care should be taken not to assign an address to a unit if more than one unit is on the RS232 line as all of the addresses will be reassigned. Instead, each should be individually attached to the RS-232 line, given an address, and taken off. After each unit has been given a unique address, they can all be put back on the same line and polled individually.

Tareing via RS-232 (L Series only): Tareing (or zeroing) the flow meter provides it with a reference point for zero flow. *This is a very simple but important step in obtaining accurate measurements.* It is good practice 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, it is helpful to zero the unit near the expected operating pressure by positively blocking the flow downstream of the flow meter prior to entering the Tare command. Zeroing the unit while there is any flow will directly affect the accuracy by providing a false zero point. If in doubt about whether the flow is positively blocked, remove it from the line and positively block both ports before entering the Tare command. If the unit reads a significant negative value when removed from the line and blocked, it is a good indication that it was given a false zero. It is better to zero the unit at atmospheric pressure and a confirmed no flow conditions than to give it a false zero under line pressure. To send a Tare command via RS-232, enter the following strings:

In Streaming Mode: `$$V<Enter>`

In Polling Mode: `Address$$V<Enter>` (e.g. `B$$V<Enter>`)

Sending a Set-point via RS-232 (LC Series only): To send a set-point via RS-232, “Serial” must be selected under the “Input” list in the control set up mode. To give controllers a set-point, or change an existing point, simply type in a number between 0 and 65535 (2% over range), where 64000 denotes full-scale flow rate, and hit “Enter”. The set-point column and flow rates should change accordingly. If they do not, try hitting “Enter” a couple of times and repeating your command. The formula for performing a linear interpolation is as follows:

$$\text{Value} = (\text{Desired Set-point} \times 64000) / \text{Full Scale Flow Range}$$

For example, if your device is a 500 CCM full-scale unit and you wish to apply a set-point of 125 CCM you would enter the following value:

$$16000 = (125 \text{ CCM} \times 64000) / \text{Full Scale Flow Range}$$

If the controller is in polling mode as described in *Changing from Streaming Mode to Polling Mode*, the set-point must be preceded by the address of the controller. For example, if your controller has been given an address of D, the set-point above would be sent by typing:

D16000 followed by “Enter”

To adjust the Proportional and Differential (P&D) terms via RS-232 (LC Series only):

Type *@=A followed by “Enter” to stop the streaming mode of information.

To adjust the “P” or proportional term of the PID controller, type *R21 followed by “Enter”.

The computer will respond by reading the current value for register 21 between 0-65535. It is good practice to write this value down so you can return to the factory settings if necessary. Enter the value you wish to try by writing the new value to register 21. For example, if you wished to try a “P” term of 220, you would type *W21=**220** followed by “Enter” where the bold number denotes the new value.

The computer will respond to the new value by confirming that 21=220. To see the effect of the change you may now poll the unit by typing A followed by “Enter”. This does an instantaneous poll and returns the values once. You may type A “Enter” as many times as you like. Alternately, you could resume streaming mode by typing *@=@ followed by “Enter”. Repeat step 3 to remove the unit from the streaming mode.

To adjust the “D” or proportional term of the PID controller, type *R22 followed by “Enter”.

The computer will respond by reading the current value for register 22 between 0-65535. It is good practice to write this value down so you can return to the factory settings if necessary. Enter the value you wish to try by writing the new value to register 22. For example, if you wished to try a “D” term of 25, you would type *W22=**25** followed by “Enter” where the bold number denotes the new value.

The computer will respond to the new value by confirming that 22=25. To see the effect of the change you may now poll the unit by typing A followed by “Enter”. This does an instantaneous poll and returns the values once. You may type A “Enter” as many times as you like. Alternately you could resume streaming mode by typing *@=@ followed by “Enter”. Repeat.

You may test your settings for a step change by changing the set-point. To do this type A32000 (A is the default single unit address, if you have multiple addressed units on your RS-232 line the letter preceding the value would change accordingly.) followed by “Enter” to give the unit a ½ full scale set-point. Monitor the unit’s response to the step change to ensure it is satisfactory for your needs. Recall that the “P” term controls how quickly the unit goes from one set-point to the next, and the “D” term controls how quickly the signal begins to “decelerate” as it approaches the new set-point (controls the overshoot).

Collecting Data:

The RS-232 output updates to the screen many times per second. Very short-term events can be captured simply by disconnecting (there are two telephone symbol icons at the top of the HyperTerminal® screen for disconnecting and connecting) immediately after the event in question. The scroll bar can be driven up to the event and all of the data associated with the event can be selected, copied, and pasted into Microsoft® Excel® or other spreadsheet program as described below.

For longer term data, it is useful to capture the data in a text file. With the desired data streaming to the screen, select “Capture Text” from the Transfer Menu. Type in the path and file name you wish to use. Push the start button. When the data collection period is complete, simply select “Capture Text” from the Transfer Menu and select “Stop” from the sub-menu that appears.

Data that is selected and copied, either directly from HyperTerminal® or from a text file can be pasted directly into Excel®. When the data is pasted it will all be in the selected column. Select “Text to Columns...” under the Data menu in Excel® and a Text to Columns Wizard (dialog box) will appear. Make sure that “Fixed Width” is selected under Original Data Type in the first dialog box and click “Next”. In the second dialog box, set the column widths as desired, but the default is usually acceptable. Click on “Next” again. In the third dialog box, make sure the column data format is set to “General”, and click “Finish”. This separates the data into columns for manipulation and removes symbols such as the plus signs from the numbers. Once the data is in this format, it can be graphed or manipulated as desired.

For extended term data capture see: “Sending a Simple Script to HyperTerminal®” on page 25.

Data Format:

The data stream on the screen represents the flow parameters of the main mode in the units shown on the display. For L Series Flow Meters, there are 3 columns of data. The first column is line pressure (normally in PSIG), the second column line temperature (normally in °C), and the third column is the volume flow rate in the units specified at time of order and shown on the display.

```
+014.70 +025.00 +4.123
+014.70 +025.00 +4.123
+014.70 +025.00 +4.123
+014.70 +025.00 +4.123
+014.70 +025.00 +4.124
+014.70 +025.00 +4.125
```

L Series Water Flow Meter Data Format

For LC Series Flow Controllers, there are 4 columns of data representing pressure, temperature, volume flow and set-point. The first column is line pressure (normally in PSIG), the second column is temperature (normally in °C), the third column is volume flow rate (in the units specified at time of order and shown on the display), and the fourth column is the set-point (also in the units specified at time of order and shown on the display). For instance, if the meter was ordered in units of CCM, the display on the meter would read 2.004 CCM and the last two columns of the output below would represent volume flow and set-point in CCM.

```
+014.70 +025.00 +02.004 +02.004
+014.70 +025.00 +02.005 +02.004
+014.70 +025.00 +02.006 +02.004
+014.70 +025.00 +02.005 +02.004
+014.70 +025.00 +02.004 +02.004
+014.70 +025.00 +02.004 +02.004
```

LC Series Water Flow Controller Data Format

Sending a Simple Script File to HyperTerminal®

It is sometimes desirable to capture data for an extended period of time. Standard streaming mode information is useful for short term events, however, when capturing data for an extended period of time, the amount of data and thus the file size can become too large very quickly. Without any special programming skills, the user can use HyperTerminal® and a text editing program such as Microsoft® Word® to capture text at user defined intervals.

1. Open your text editing program, MS Word for example.
2. Set the cap lock on so that you are typing in capital letters.
3. Beginning at the top of the page, type A<Enter> repeatedly. If you're using MS Word, you can tell how many lines you have by the line count at the bottom of the screen. The number of lines will correspond to the total number of times the flow device will be polled, and thus the total number of lines of data it will produce.

For example: A

A

A

A

A

A

will get a total of six lines of data from the flow meter, but you can enter as many as you like.

The time between each line will be set in HyperTerminal.

4. When you have as many lines as you wish, go to the File menu and select save. In the save dialog box, enter a path and file name as desired and in the "Save as Type" box, select the plain text (.txt) option. It is important that it be saved as a generic text file for HyperTerminal to work with it.
5. Click Save.
6. A file conversion box will appear. In the "End Lines With" drop down box, select CR Only. Everything else can be left as default.
7. Click O.K.
8. You have now created a "script" file to send to HyperTerminal. Close the file and exit the text editing program.
9. Open HyperTerminal and establish communication with your flow device as outlined in the manual.
10. Set the flow device to Polling Mode as described in the manual. Each time you type A<Enter>, the meter should return one line of data to the screen.
11. Go to the File menu in HyperTerminal and select "Properties".
12. Select the "Settings" tab.
13. Click on the "ASCII Setup" button.
14. The "Line Delay" box is defaulted to 0 milliseconds. This is where you will tell the program how often to read a line from the script file you've created. 1000 milliseconds is one second, so if you want a line of data every 30 seconds, you would enter 30000 into the box. If you want a line every 5 minutes, you would enter 300000 into the box.
15. When you have entered the value you want, click on OK and OK in the Properties dialog box.
16. Go the Transfer menu and select "Send **Text** File..." (NOT Send File...).
17. Browse and select the text "script" file you created.
18. Click Open.
19. The program will begin "executing" your script file, reading one line at a time with the line delay you specified and the flow device will respond by sending one line of data for each poll it receives, when it receives it.

You can also capture the data to another file as described in the manual under "Collecting Data". You will be simultaneously sending it a script file and capturing the output to a separate file for analysis.

TROUBLESHOOTING

Display does not come on or is weak.

Check power and ground connections and supply voltage.

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

Differential pressure sensor may be damaged. Avoid installations that can subject sensor to pressure drops in excess of 10 PSID. A common cause of this problem is instantaneous application of high pressure as from a snap acting solenoid valve upstream of the meter. Damage due to excessive pressure differential is not covered by warranty.

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.

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.

My controller does not respond to the set-point.

Check the control set up screen to be sure the Input parameter selection matches the set-point you are trying to use. Also, be sure that the unit was ordered for the type of analog signal you are trying to use.

After installation, there is no flow.

Alicat Scientific LC Series controllers incorporate normally closed valves and require a set-point to operate. Check that your set-point signal is present and supplied to the correct pin and that the correct input is selected under the Input list in the control set up mode screen. Also check that the unit is properly grounded.

The flow lags below the set-point.

Be sure there is enough pressure available to make the desired flow rate. If either the set-point 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.

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. 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 above).

Controller is slow to react to a set-point 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.

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 a Teflon tape shreds. Note: L & LC Series meters 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 17.

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 set-point 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 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 instructions in this manual (Check the RS-232 communications select screen for current meter readings). Close HyperTerminal® and reopen it. Reboot your PC.

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 17.

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 3.2% of full scale. See page 17.

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. Providing that the CLEAN, DRY, and NON-CORROSIVE mantra is observed, this periodic recalibration is sufficient. A label located on the back of the meter lists the recalibration due date. The meter should be returned to the factory for recalibration near the listed due 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 Manufacture Data 2 screen (page 16).

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

For repairs, recalibrations, or recycling of this product, contact:

Alicat Scientific, Inc.
2045 N Forbes Blvd. Bldg.103
Tucson, Arizona 85745
USA
Ph. 520-290-6060
Fax 520-290-0109
email: info@alicatscientific.com
Web site: www.alicatscientific.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

Technical Data for Water Flow Meters & Water Flow Controllers

Specification	L Series	LC Series	LCR Series	Description
Available Ranges	0.5CCM to 10LPM	5CCM to 500CCM	1LPM to 5LPM	Full Scale
Accuracy	$\pm 2\%$			Full Scale
Repeatability	$\pm 2\%$			Full Scale
Operating Range	2% to 100% Full Scale			Measure or Control
Typical Response Time	20	100		Milliseconds (Adjustable)
Operating Temperature	+10 to + 50			°Celsius
Zero Shift	0.02%			Full Scale / °Celsius / Atm
Span Shift	0.02%			Full Scale / °Celsius / Atm
Flow Rate	128% Measurable	102.4% Controllable		Full Scale
Common Mode Pressure	100			PSIG
Supply Current	0.035	0.250	0.750	Amp
Supply Voltage	7—30 ¹	12—30 ¹	24-30	Vdc
Input /Output Signal Digital	Pressure, Temperature and Flow			RS-232 Serial
Input /Output Signal Analog	Volumetric Flow			0-5Vdc
Optional Input / Output Signal Secondary Analog	Pressure, Temperature or Flow			0-5 Vdc; 0-10Vdc;4-20mA ¹
Electrical Connections	8 Pin			Mini-DIN
Mounting Attitude Sensitivity	None	Control response somewhat sensitive to inverted operation.		Tare after installation
Wetted Materials ²	303 & 302 Stainless Steel, Viton®, Polyetherimide, Silicon, Glass. LC and LCR Controllers Add: 400 Series Stainless Steel, Nickel. LC Controllers only also add Brass.			

1. 15 volts required for 4-20mA output.

2. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
L Series			
0.5CCM to 1CCM	4.4"H x 2.4"W x 1.1"D	M-5 (10-32) Female Thread*	2.0
2CCM to 500CCM	4.6"H x 2.4"W x 1.1"D	1/8" NPT Female	2.0
1LPM			4.0
2LPM	4.8"H x 2.7"W x 1.1"D	1/4" NPT Female	4.0
5LPM			10.0
10LPM			20.0
LC Series			
5CCM to 50CCM	4.6"H x 3.6"W x 1.1"D	1/8" NPT Female	5.0
100CCM			5.0
200CCM to 500CCM			7.5
LCR Series			
1LPM	5.5"H x 7.9"W x 2.3"D	1/8" & 1/4"NPT Female	4.0
2LPM	5.7"H x 6.7"W x 2.3"D	1/4" NPT Female	4.0
5LPM			10.0

*Units ≤ 1 CCM F.S. are shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

These adaptor fittings were selected for customer convenience in process connection. It should be noted that the 1/8" Female NPT introduces additional dead volume. To minimize dead volume, please see [Accessories](#) for the M-5 (10-32) Male to 1/8"OD compression fitting.

1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings.

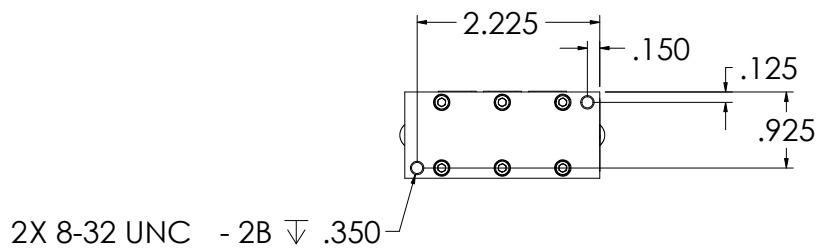
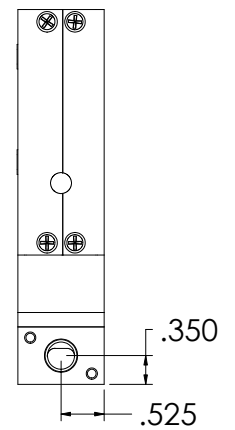
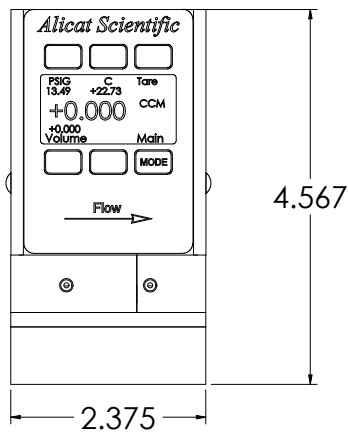
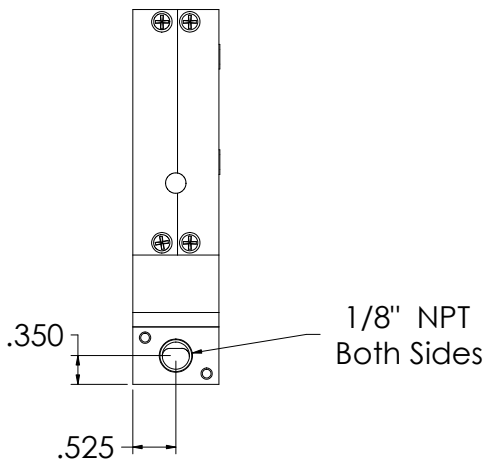
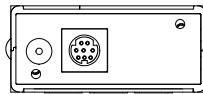
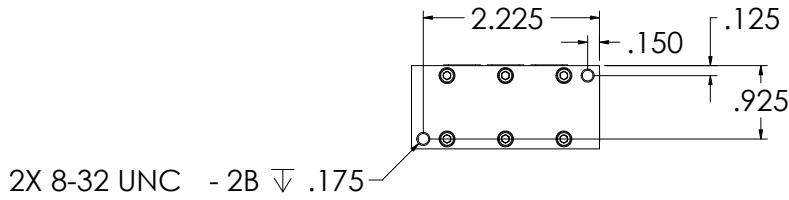
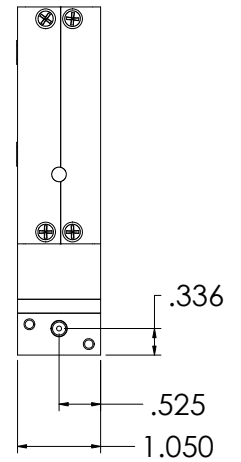
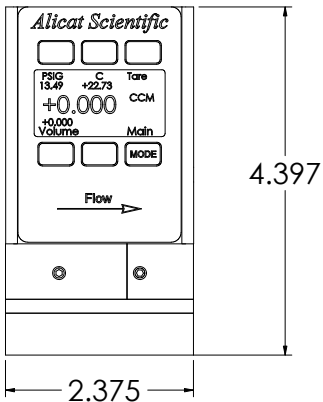
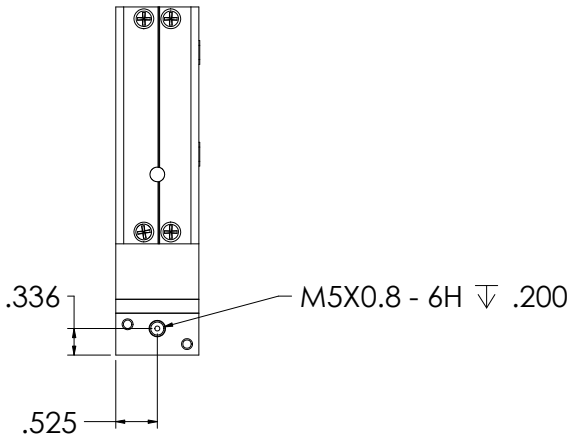
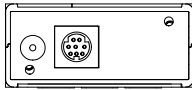
2. Lower Pressure Drops Available, Please contact the manufacturer.

Dimensional Drawings: pages 30-32

L Series:

0 - 0.5CCM

0 - 1CCM



L Series:

0 - 2CCM

0 - 5CCM

0 - 10CCM

0 - 20CCM

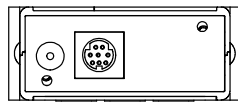
0 - 50CCM

0 - 100CCM

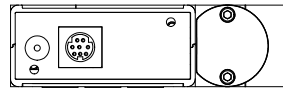
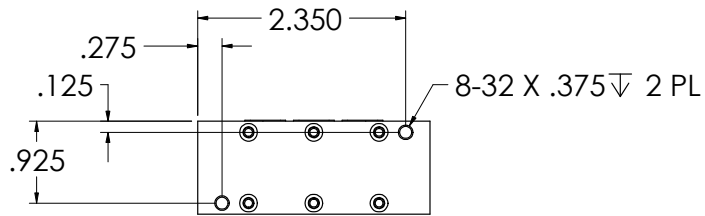
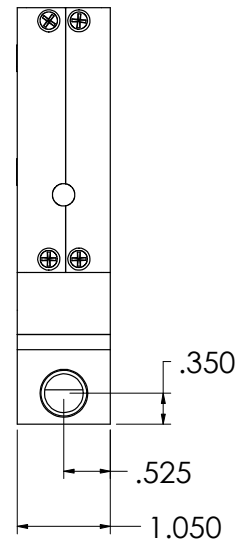
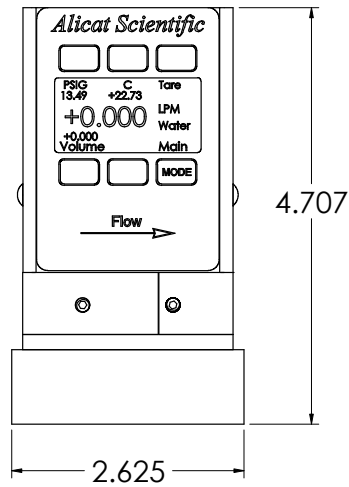
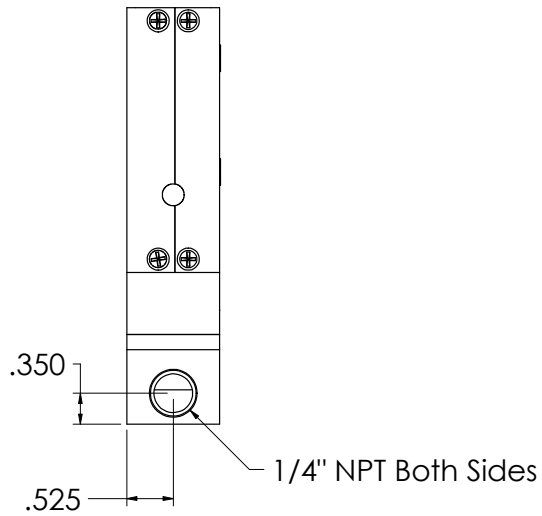
0 - 200CCM

0 - 500CCM

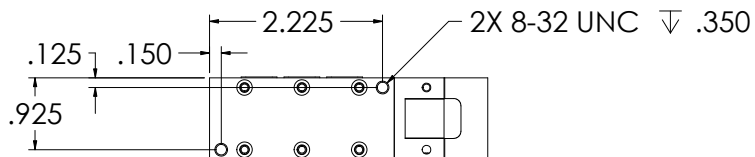
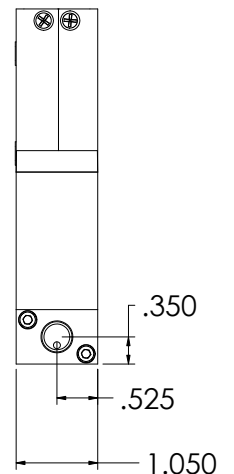
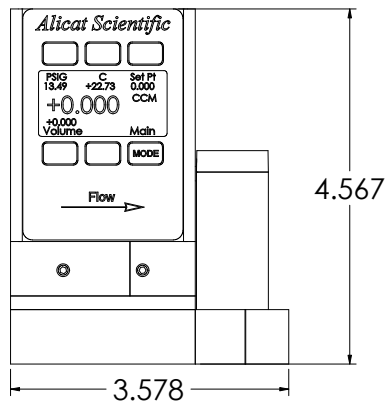
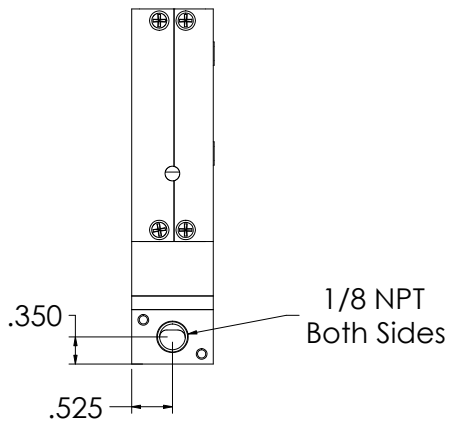
0 - 1LPM



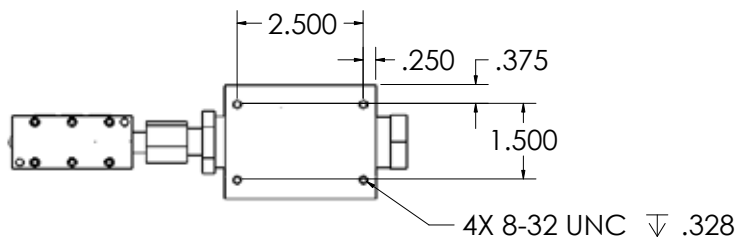
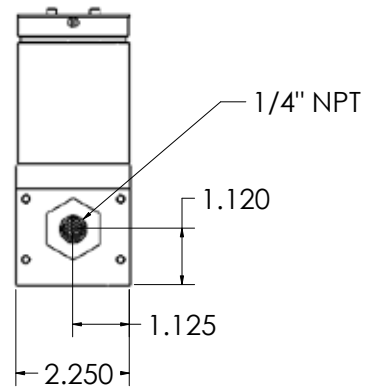
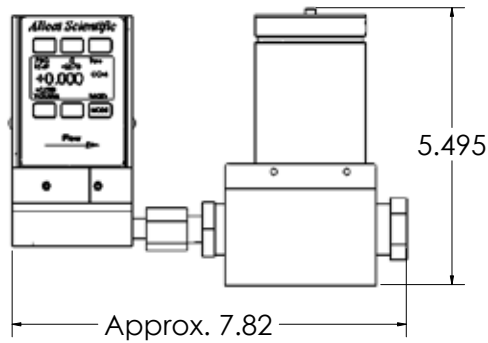
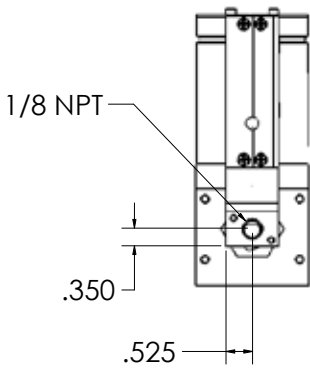
L Series:
 0 - 2LPM
 0 - 5LPM
 0 - 10 LPM



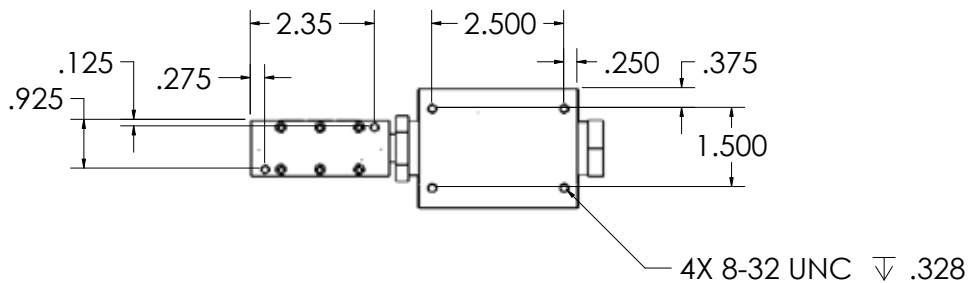
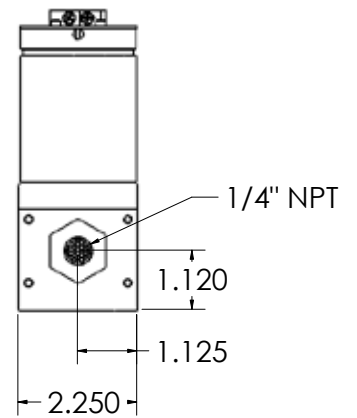
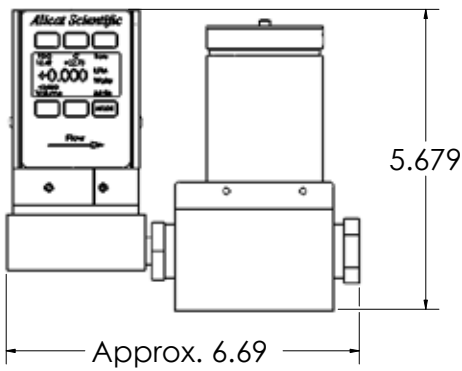
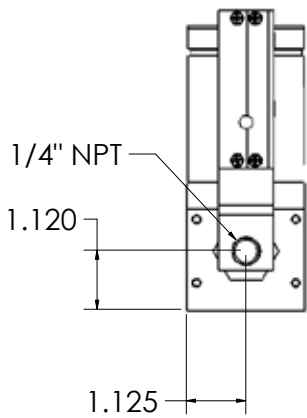
LC Series:
 0 - 5CCM
 0 - 10CCM
 0 - 20CCM
 0 - 50CCM
 0 - 100CCM
 0 - 200CCM
 0 - 500CCM



**LCR Series:
0 - 1LPM**



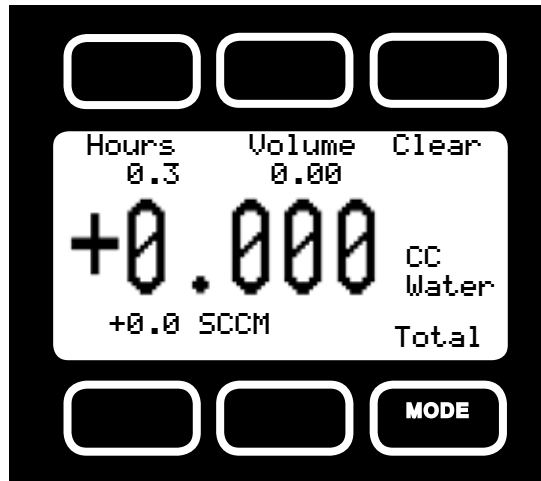
**LCR Series:
0 - 2LPM
0 - 5LPM**



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Option: Totalizing Mode

L and LC Series Flow Meters and Controllers can be purchased with the Totalizing Mode option. 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 meter or controller since the last time the totalizer was cleared. The Totalizing Mode screen shown below is accessed by pushing the “MODE” button until the label over it reads “Total”. *If your meter is ordered with Totalizing Mode option, pushing the “Mode” button once will bring up the “Totalizing Mode” display. Pushing “Mode” a second time will bring up the “Select Menu” display. Pushing it a third time will return you to the Main Mode Sreen.*



Counter – The counter can have as many as six digits. At the time of order, the customer must specify the resolution of the count. This directly affects the maximum count. For instance, if a resolution of 1/100ths of a liter is specified on a meter which is totalizing in liters, the maximum count would be 9999.99 liters. If the same unit were specified with a 1 liter resolution, the maximum count would be 999999 liters.

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.

Hours – The display will show elapsed time since the last reset in 0.1 hour increments. The maximum measurable elapsed time is 6553.5 hours (about nine months). The hours count resets when the “clear” button is pushed, an RS-232 clear is executed or on loss of power

Clear – The counter can be reset to zero at any time by pushing the dynamically labeled “Clear” button located above the upper right side of the display. To clear the counter via RS-232, establish serial communication with the meter or controller as described in the RS-232 section of the manual. To reset the counter, enter the following commands:

In Streaming Mode: \$\$T <Enter>

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

Option: 9 Volt Battery Pack

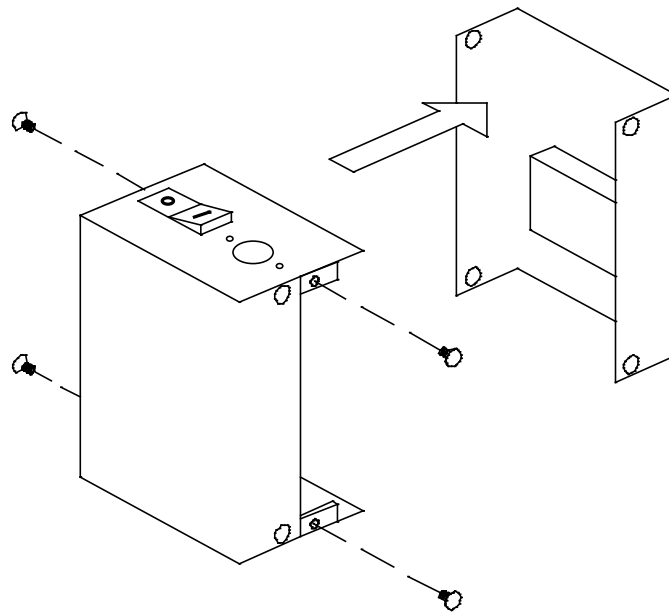
A Battery Pack that uses a common 9 Volt battery can be mounted to the top of your L Series Flow Meter. Power is passed from the battery to the flow meter through the 8 pin Mini-DIN connector. Output signals from the flow meter or pressure guage are passed through the male connector on the bottom of the battery pack to the female connector on top of the battery pack so the signals can be accessed normally. Turn the switch on top of the battery pack off when the meter is not in use. (**Note: The Battery Pack cannot be used with Flow or Pressure Controllers**)

Normal (9V alkaline) battery life is approximately 8 hours (30-40 hours with a 9V-lithium battery), however many factors can affect this. Replace the battery as often as required. A common indicator that the battery may be approaching the end of its life is a sharp increase in the temperature indicated on the meter. This false signal can result when the voltage drops below its normally regulated level. This can affect the accuracy of the meter so it is good practice to check that the temperature is approximately correct (25°C is about room temperature) or use a fresh battery especially if the measurement is critical.

Replacing the Battery:

The battery can be replaced with the battery pack installed on the flow meter.

1. Remove the four Phillips head screws from the back cover and gently remove it as shown in Figure 9.
2. Remove the 9V battery, pulling the top of the battery out first.
3. Remove the old battery from the harness and replace it with a new battery.
4. Install the new battery bottom end first and replace the back cover so that the cushioning pad presses directly down on the battery.
5. Replace the four Phillips head screws.

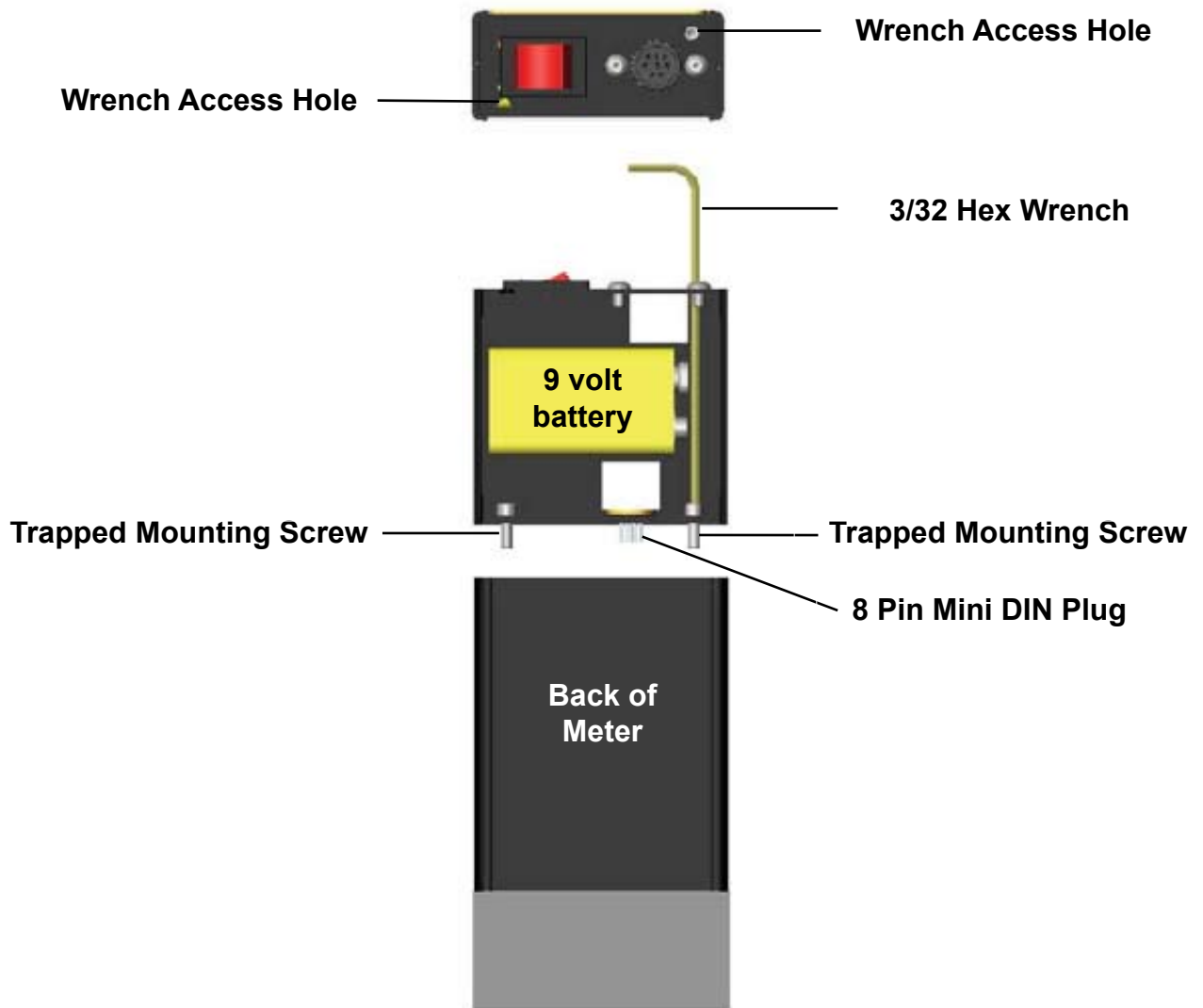


Battery Pack Back Cover Removal

Battery Pack Installation and Removal:

The battery must be removed before the battery pack can be installed or removed.

1. Remove the back cover of the battery pack and remove the battery if installed (see “Replacing the Battery”).
2. Carefully place the battery pack on top of the flow meter, being especially careful that the pins in the 8 pin Mini-DIN plug are inserted properly into the 8 pin Mini-DIN socket on top of the flow meter. The two screws trapped in the bottom of the battery pack will not allow the plug to be completely inserted into the socket until they are screwed into place.
3. Slip the included hex wrench into either of the two holes on the top of the battery pack as shown in Figure 10 and start the screw into the corresponding threaded hole in the top of the meter.
4. Before the screw is tightened down all the way, move the hex wrench to the other hole and tighten the other screw gently down. Avoid over tightening the screw.
5. Return the hex wrench to the first hole and tighten the first screw gently down. Avoid over tightening the screw.
6. Install the battery and replace the back cover as described above.
7. Removal is the reverse of the installation.

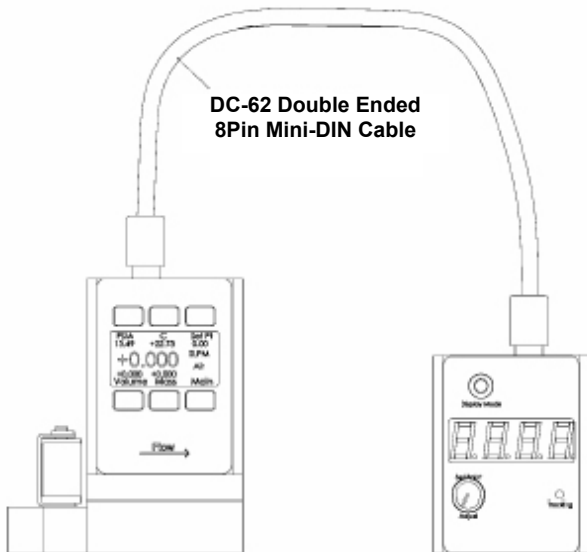


Battery Pack Installation/Removal

An industrial carry case (PCASE) is available for storing and transporting your portable device.

Option: Local Set-Point Module

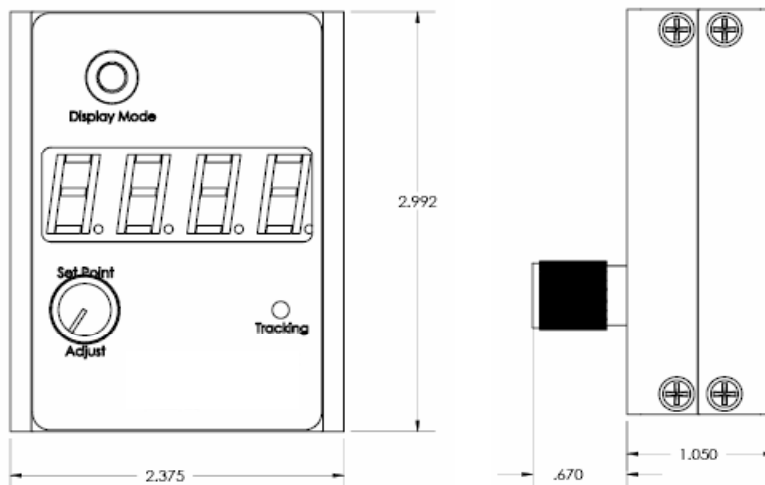
The Local Set-Point Module (**LSPM**) is designed to provide the user with a simple “turn of the dial” method of changing a flow or pressure controller set-point.



The LSPM features a set-point control dial, a digital LED display which can be set to show either the set-point or the actual process measurement, and a tracking alarm LED which glows red whenever the actual process measurement deviates from the set-point by more than 2% of full scale. This device is handy as a remote control/display device where the controller is out of convenient reach or view. It is supplied with a 6' double ended cable to run between the controller and the LSPM. There is an additional 8 pin Mini-DIN port on the LSPM that allows access to normal signal/power functions of the controller's Mini-DIN port.

- 8 Pin Mini-DIN connector connects to controller or to external device for power or output signal recording
- LCD Display can display either the set-point or the process measurement.
- Set-point Adjustment Knob provides simple “dial it in” process changes.
- Display button switches display between actual set-point and measured flow parameter.
- LED indicator switches from green to red when the measured parameter deviates from the set-point by more than 2% of full scale.

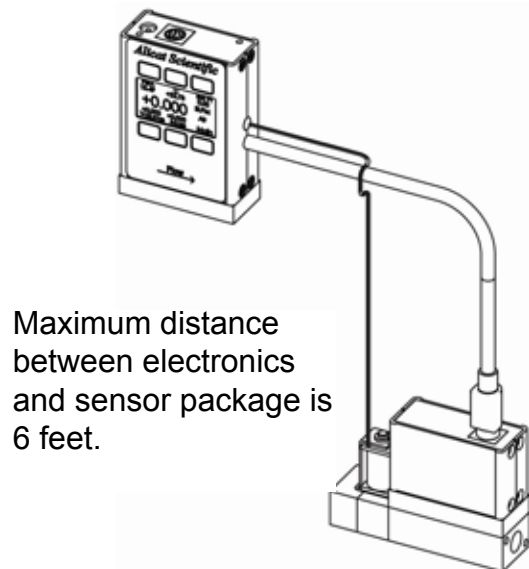
Operation Notes: The LSPM requires a double ended DC-62 8 Pin Mini-DIN cable connected between either the top or bottom connector socket of the LSPM to the connector socket on top of the controller. The two connector sockets on the LSPM are “pass through” connected so that the unused socket can be connected to a DC-61 single ended cable for connection of output signals and/or power. Appropriate power can be connected to either the LSPM or the controller, whichever is more convenient. Unless specially ordered otherwise, the LSPM utilizes the 5.12 Vdc output pin on the controller (pin 2) as a source. The 5.12 volts is connected through the potentiometer and returned to the controller on the set-point pin (pin 4) as a 0 though 5.12 Vdc input signal depending on the position of the adjustment knob.



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 to 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, including the LCD, 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.

Accessory: BB-9 Multi-Drop Box



The **BB-9 Multi-Drop Box** makes it convenient to wire multiple flow and/or pressure devices to a single RS-232 port.

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

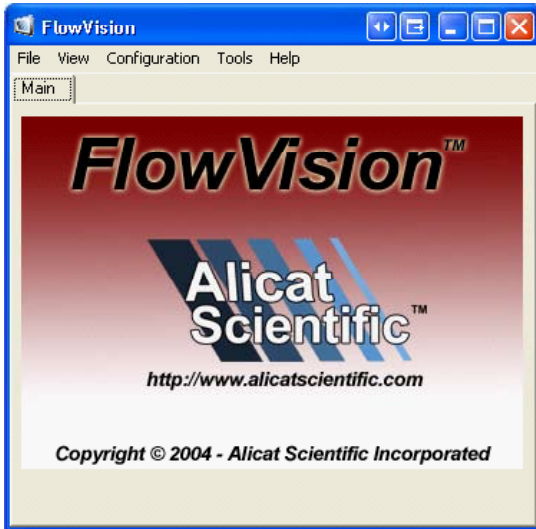
All of the flow and/or pressure devices are powered via a terminal block on the front of the box.

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.

Accessory: RS-232 to RS-485 Converter

Since most computers have RS-232 communication onboard, Alicat has chosen RS-232 as the digital standard on all of its flow instruments. For those using RS-485 as their primary standard, our **RS-232 to RS-485** converter will allow interface between an RS-485 system and Alicat's flow instrumentation.

Accessory: Flow Vision™ Software



Flow Vision™ is an intuitive software interface to help your experimental test cycles run smoother and make your integration engineering time shorter! This easy to use software features a simple graphical user interface, multiple device management capabilities and straightforward script building for controller command sequences.

Automatic Configuration: Automatically finds and configures Alicat devices connected to your computer.

Session Saving: Your current configuration data can be saved and reloaded for ease of experiment repetition.

Data Capturing & Logging: Captures data from your flow or pressure units and logs it in a Microsoft® Excel® file or plain text file – making it easy to graph and track your test data.

Script Building: Allows you to create scripts that change or sample your flow or pressure unit's setting at timed intervals.

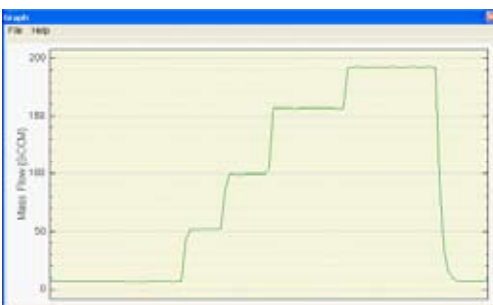
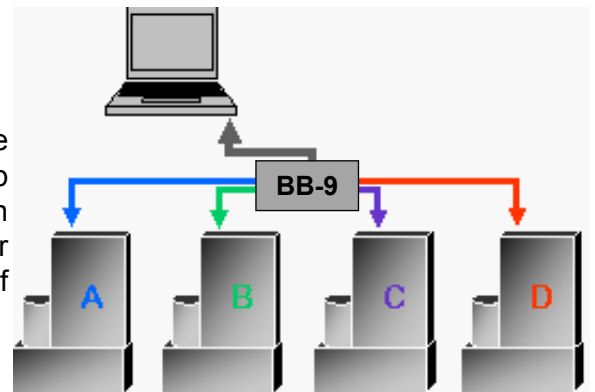
Flow Vision™ supports all RS-232 Serial Communications, including quick selection of the calibration for individual **gas selectability** and our popular end user access to the terms of the **PID loop tuning**



Flow Vision™ mimics Alicat's Standard Dynamic Displays on your PC. Use your mouse to execute all membrane switch functions and more!



Flow Vision™ supports multiple devices connected to the same RS232 port. Simply connect each device to a BB-9 Multi-Drop Box (see page 34), then using the device addressability, assign an identifier to each unit. Now you can easily control and monitor varying flow rates for gas mixing, gas analysis, combined testing of multiple parts and other applications.



Flow Vision™'s Graphing Utility continuously displays the data points of the main parameter selected. The graph auto scales the Y-axis for the range of the selected parameter. Includes easy pause, run, stop and print features.

Flow Vision™ System Requirements:

Microsoft® Windows® 2000 or Windows® XP ♦ 2MB hard disk space
Available serial port (Some laptop computers are not equipped with serial ports. A virtual serial port can be created using a USB to Serial adapter)

Accessories

Part Number	Description
FVISION	Flow Vision™ software for interface with all Alicat instruments
BB-9	Multi-Drop Box
REMOTE	Remote electronics with display
LSPM	Local Set-Point Module (Controllers Only)
BPACK	9 volt battery pack (Meters and Gauges Only)
PCASE	Industrial carry and storage case for portable meters/gauges
DC-61	8 Pin Male Mini-DIN connector cable, single ended, 6 foot length
DC-62	8 Pin Male Mini-DIN connector cable, double ended, 6 foot length
DC-251	8 Pin Male Mini-DIN connector cable, single ended, 25 foot length
DC-252	8 Pin Male Mini-DIN connector cable, double ended, 25 foot length
DC-6RT	8 Pin Male Right Angle Mini-Din Cable, single ended, 6 foot length
MD8DB9	8 Pin Male Mini-DIN to DB9 Female Adapter, 6 foot length
IC-10	Industrial cable, 6 Pin, single ended, 10 foot length
PVPS	AC to DC 12 Volt Power Supply Adapter
PVPS24	AC to DC 24 Volt Power Supply Adapter
PVPSE	AC to DC 12 Volt European Power Supply Adapter
PVPSE24	AC to DC 24 Volt European Power Supply Adapter
RS485-KIT	RS-232 to RS-485 Converter
RD	Remote Panel Mount Display

	ALICAT DEVICE PROCESS CONNECTION				
	M5 (10-32)	1/8"	1/4"	1/2"	3/4"
COMPRESSION FITTING					
1/8"	SS-200-1-0157	SS-200-1-2	SS-200-1-4	SS-200-1-8	
1/4"	SS-400-1-0256	SS-400-1-2	SS-400-1-4	SS-400-1-8	SS-400-1-12
1/2"		SS-810-1-2	SS-810-1-4	SS-810-1-8	SS-810-1-12
3/4"				SS-1210-1-8	SS-1210-1-12
3mm		SS-3M0-1-2	SS-3M0-1-4		
4mm		SS-4M0-1-2	SS-4M0-1-4		
6mm		SS-6M0-1-2	SS-6M0-1-4	SS-6M0-1-8	
8mm		SS-8M0-1-2	SS-8M0-1-4	SS-8M0-1-8	
12mm		SS-12M0-1-2	SS-12M0-1-4	SS-12M0-1-8	SS-12M0-1-12
16mm				SS-16M0-1-8	SS-16M0-1-12
FILTER					
10 micron		2F-F2L-10-B			
20 micron	CF-303-20-316				
50 micron		2F-F2L-50-B	4F-F4L-50-B	8F-F8L-50-B	12F-F12L-50-B
Adapter	410133	Male M5 (10-32) Buna-N O-ring face seal to 1/8" Female NPT			