ALICAT SCIENTIFIC

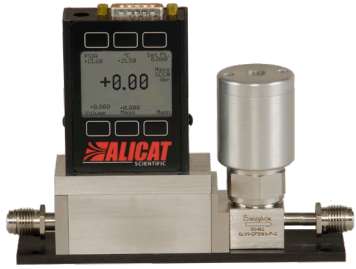
Operating Manual

MC-Series

WHISPER

MCS-Series

MCR-Series



MCV-Series

Precision Gas Mass Flow Controllers

The Fastest Flow Controller Company in the World!

CE NIST

Thank you for purchasing an Alicat flow controller.

We know you are going to love your new flow controller. If you have any questions about operating it, or if something is not working as expected, please let us know. We are eager to help you in any way possible.

Alicat Scientific, Inc.
info@alicat.com • alicat.com
7641 N Business Park Drive, Tucson, AZ 85743 USA
1-888-290-6060

Serial Number: _____

Next Calibration: _____

Recalibrate your flow controller every year.

Your calibration date is labeled on the back of the flow controller. Write that date in the space above. When it's time for your flow controller's annual recalibration, contact us by phone, email or live chat to set it up, or fill out the Service Request Form at alicat.com/service.

NIST This Alicat device comes with a NIST traceable calibration certificate.

RoHS This Alicat flow controller conforms to the European Union's Restriction of Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU.

CE This Alicat flow controller complies with the requirements of the Low Voltage Directive 2014/35/EU and the EMC Directive 2014/30/EU and carries the CE Marking accordingly.

This Alicat flow controller complies with the requirements of the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC.

07/31/2018 Rev.43 DOC-ALIMAN16C

Welcome to the Alicat way.

You're busy, and the last thing you want to do is waste time wrestling with your flow controller. We're here to make your life a little easier so you can do what you do best. It's our pleasure to introduce you to your new Alicat:

- **High-accuracy performance for all your gases.** Use your flow controller with any of the 98 or more gases that are part of Gas Select™, ***page 31.***
- **Control pressure while monitoring flow rate.** Set the closed loop control algorithm for pressure control, ***page 26.***
- **Backlit display with adjustable contrast** is easy to read in direct sunlight. In dimly lit areas, press the Alicat logo to turn on the backlight, ***page** 7.*
- **Change your STP** to match any standard temperature and pressure reference, ***page 35.***
- **Log data to your PC.** Talk to the flow controller serially to capture all flow data for logging and analysis, ***page 39.***

This manual covers the following Alicat Scientific instruments:

- **MC and MCR-Series Mass Gas Flow Controllers**
- **MCD and MCRD-Series Dual Valve Mass Gas Flow Controllers**
- **MCE-Series Mass Gas Flow Controllers**
- **MCP-Series Mass Gas Flow Controllers**
- **MCQ and MCRQ-Series High PressureMass Gas Flow Controllers**
- **MCS and MCRS-Series Mass Gas Flow Controllers**
- **MCV-Series Mass Gas Flow Controllers**
- **MCW (WHISPER) Low Pressure Drop Mass Flow Controllers**

This includes Alicat flow controllers labeled as approved for CSA Class 1 Div 2 and ATEX Class 1 Zone 2 hazardous environments. See page 98 for Special Conditions regarding the use of CSA/ATEX labeled devices.

Please contact Alicat at 1-888-290-6060 or info@alicat.com if you have any questions regarding the use or operation of this device.

Table of Contents

Setup

- **Tare your flow controller.** After you connect the flow controller, ensure that no air is flowing through the device, power it on and ensure it has a zero setpoint. After a few seconds, it will auto-tare.
- **Choose your engineering units.** Press the button above or below any parameter to enlarge it in the middle of the display. If you select that same item a second time, you can change the engineering unit for that parameter. You can chosse units for all of the parameters at once by selecting **MENU > BASIC CONFIG > DEVICE UNITS**.
- **Connect your flow controller.** Ensure that flow through your device will be in the same direction as the arrow on the flow body (usually left to right).

Operation: Flow Control

- **Choose your setpoint.** Select **SETPT** from the Main Display to select your flow rate. Press **SET**, and the controller immediately adjusts to the new setpoint.
- **Monitor live flow readings.** You can monitor live readings of flow, pressure and temperature by viewing the screen. Readings are updated in real time.
- **(Optional) Capture a totalized reading.** The totalizer option displays the total flow that has passed through the device since the last time the totalizer was reset. Press **TOTAL/MENU** to access the totalizer.

Operation: Pressure Control with Flow Monitoring

- **Switch the closed loop control to pressure.** Select **MENU > CONTROL > ADV CONTROL > LOOP SETUP > LOOP VAR**, and then choose **Absolute Pressure**. Your Alicat will now control absolute pressure while monitoring flow rate.
- **Choose your setpoint.** Select **SETPT** from the Main Display to select a pressure setpoint. Press **SET**, and the controller immediately adjusts to the new setpoint.

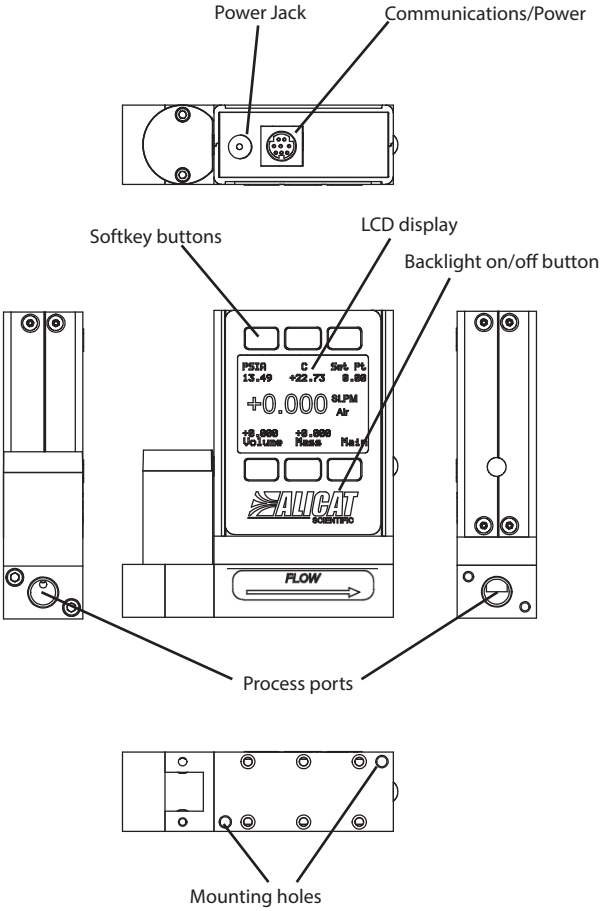
Maintenance and Care

- If your gas is clean, your flow controller will require no periodic cleaning.
- **Calibrate your flow controller annually.** Request an Alicat factory calibration at alicat.com/service or by calling Alicat at 1-888-290-6060.

Getting to Know Your Alicat

Connectors and Buttons

The drawings below represent the default configuration of a standard Alicat mass flow controller (MC series) with an upstream valve. Your flow controller's appearance and connections may differ, especially if it has been ordered with a large Rolamite valve or a downstream valve.

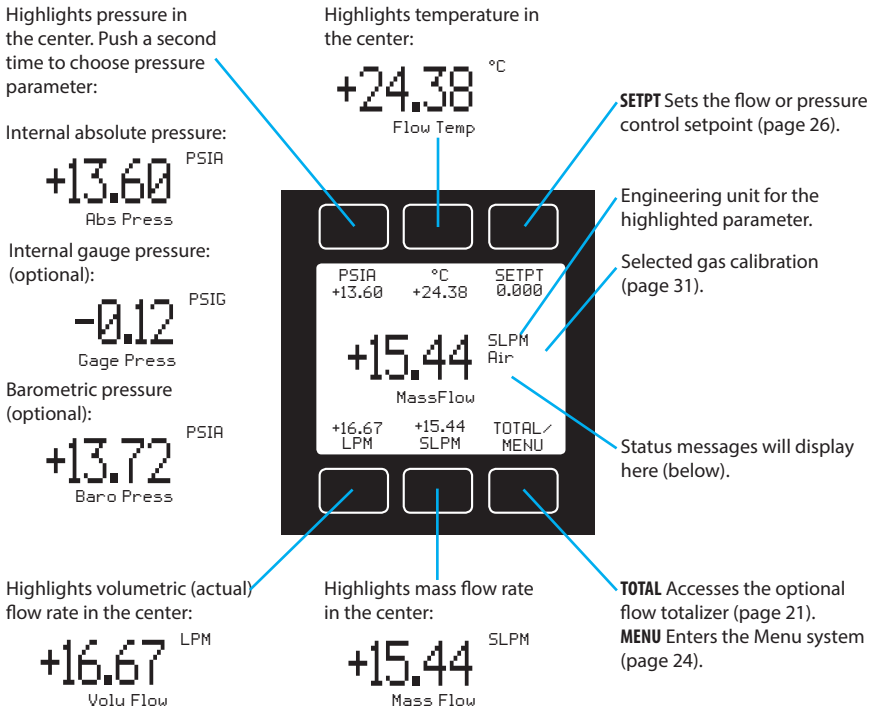


Getting Started

The Flow Controller Display

The figure below identifies the various features of the flow controller display. Press the large button with the Alicat logo to toggle the backlight on and off. For more details, see the Menu Map on page 18 and the menu-by-menu descriptions that follow it.

Main Display



Status Messages

Analog-digital converter error:	**ADC**
Valve exhaust is active:	**EXH**
Valve hold is active:	**HLD**
Front display is locked:	**LCK**
Mass flow over range of device:	**MOV**
Overpressure limit exceeded (optional):	**OPL**
Totalizer rolled over to 0:	**OVR**
Pressure over range of device:	**POV**
Totalizer missed out of range flow:	**TMF**
Temperature over range of device:	**TOV**
Volumetric flow over range of device:	**VOV**

Mounting

No straight runs of pipe are required upstream or downstream of the flow controller. Most Alicat flow controllers can be mounted in any position, including upside-down. (MCS/MCRS series flow controllers use media-isolated sensors that must be tared after changing orientation.)

> ***Caution: Flow controllers that use large Rolamite valves (MCR/MCRW/ MCRQ/MCRS) should be mounted with their valve oriented vertically (right-side up). If another orientation is desired, please contact Alicat.***

Plumbing

Your controller has been shipped with plastic plugs fitted into its ports. To lessen the chance of contaminating the flow stream, do not remove these plugs until you are ready to install the device.

Standard Alicat Gas Flow controllers have female inlet and outlet ports. Welded VCR and other specialty fittings may have male connections.

» If you are using a fitting that does not have a face seal, use thread-sealing Teflon tape to prevent leakage around the port threads, but do not wrap the first two threads. This will minimize the possibility of getting tape into the flow stream and clogging the laminar flow elements (LFE).

» If you are using a fitting that has a face seal, there is no need to apply Teflon tape to the threads.

> ***Warning: 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.***

Filters

When pressure drop is not an issue, use in-line sintered filters to prevent large particulates from entering the flow controller. Suggested maximum particulate sizes are as follows**:**

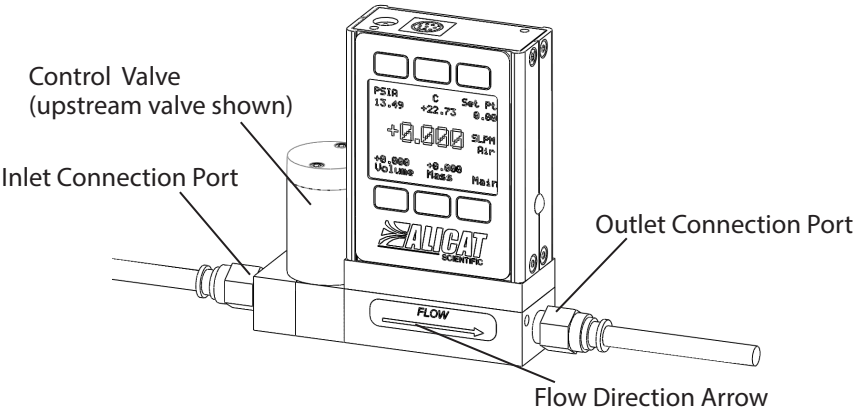
» 5 microns for units with flow ranges of 1 sccm or less.

» 20 microns for units with flow ranges between 2 sccm and 1 slpm.

» 50 microns for units with flow ranges of 1 slpm or more.

Connecting Your Gas Flow Controller

Your Alicat flow controller can measure and control flow generated by positive pressure and/or suction. Connect the controller so that the flow travels in the same direction as the flow arrow, usually from left to right as you look at the front of the device.



Warning: Using the flow controller above the maximum specified internal line pressure, or above the maximum recommended differential pressure between the inlet and outlet, will result in permanent damage to the internal pressure sensors.

A common cause of this problem is the instantaneous application of high-pressure gas, as from a snap-acting solenoid valve either upstream or downstream of the flow controller. If you suspect that your pressure sensor is damaged, please discontinue use of the device and contact Alicat.

See the chart below for pressure limits.

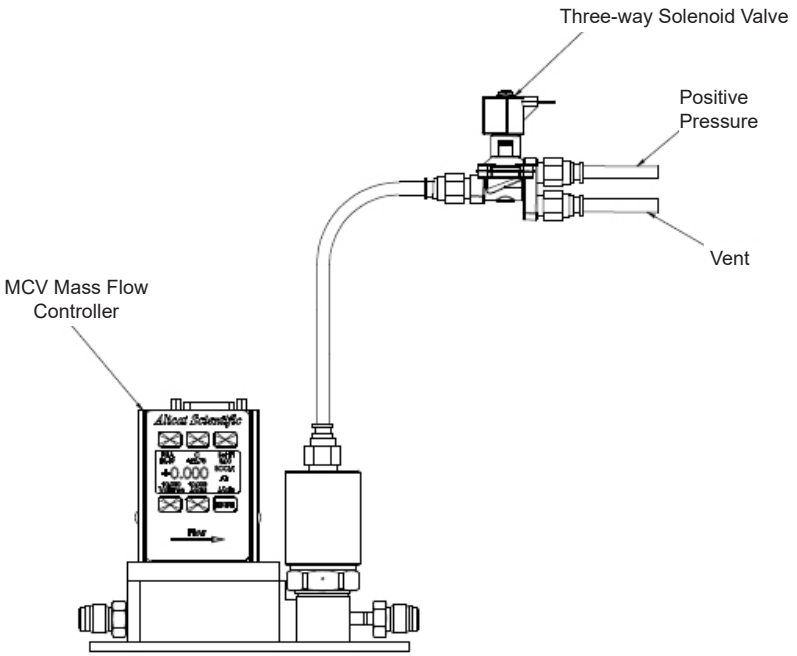
Model	Max Pressure at Sensor	Max Differential Pressure
MC//MCR/MCS	145 psig	75 psid
MCW/MCRW	45 psig	15 psid
MCQ/MCRQ	305 psig	100 psid

MCV Controller Operating Notes

Alicat's MCV mass flow controller is equipped with an integrated Swagelok® positive shutoff valve. The normally closed valve is actuated by a gas (typically air) and opens when supplied with 60-120 psig of pressure. The shut-off valve closes again when this pressure is removed.

A common method for actuating the shutoff valve incorporates a three-way solenoid valve (below). Pressure is applied to one side of the solenoid valve while the other side of the solenoid is left open to atmosphere. When the solenoid is energized, pressure is delivered to the shutoff valve, causing it to open. When the solenoid is returned to a relaxed state, the gas vents to atmosphere, allowing the shut-off valve to close.

✔ ***All standard MC-Series device features and functions are available on the MCV-Series and operate in accordance with the standard MC-Series operating instructions.***



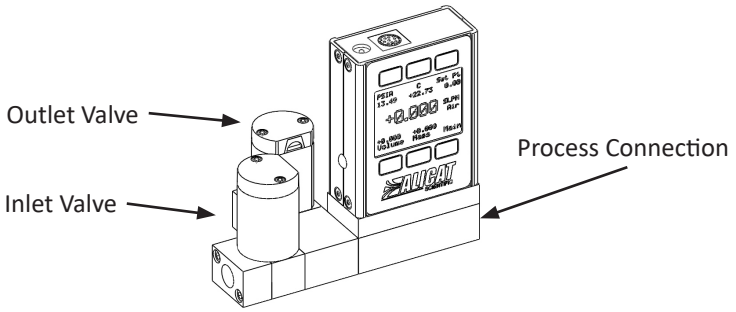
MCV mass flow controller and three-way solenoid valve.

MCD Dual Valve Mass Flow Controller Operating Notes

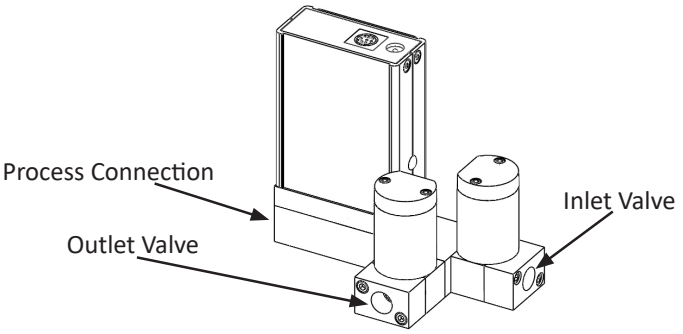
The MCD is a versatile Dual-Valve Mass Flow and Pressure Controller. It can be used to:

- Measure mass flow and volumetric flow in both directions, plus absolute pressure and temperature.
- Control mass or volumetric flow from a pressurized source or to vacuum.
- Control absolute pressure or back-pressure in a flowing process.
- Control absolute pressure in a closed volume with automatic venting.

Application examples are shown below and on the following page. Please contact Alicat if you have any questions regarding MCD use.

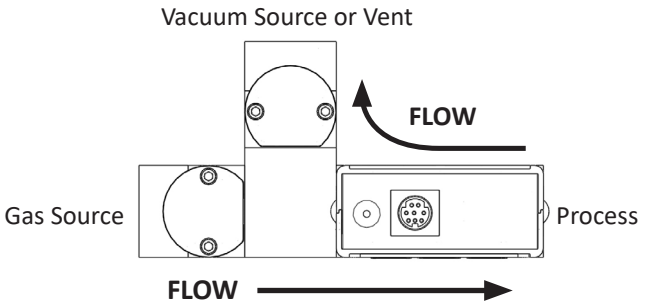


MCD front view

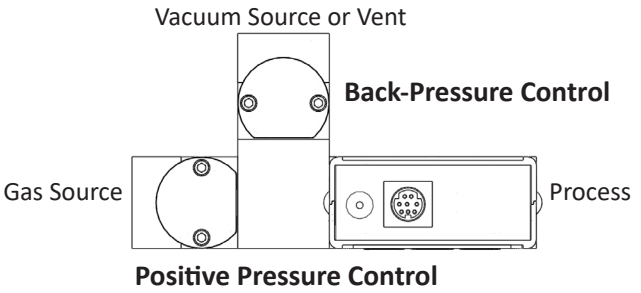


MCD rear view

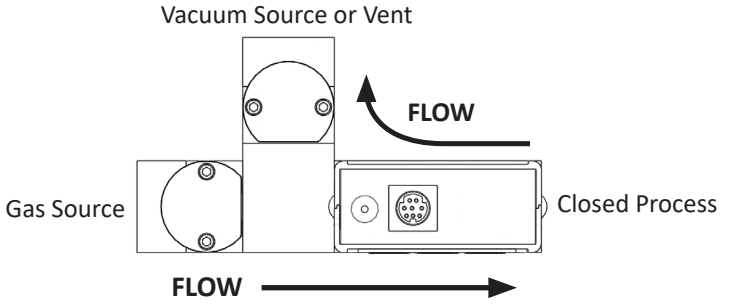
Bidirectional Mass or Volumetric Flow Control



Flowing Absolute Pressure Control



Dead-Ended Absolute Pressure Control

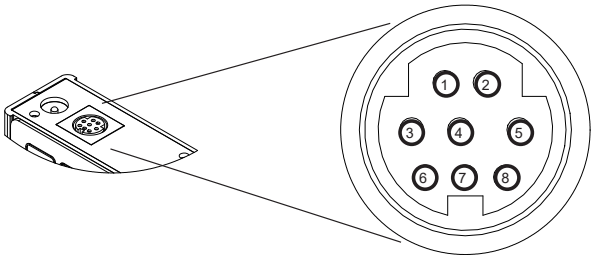


Power and Signal Connections

Power can be supplied to your controller through either the power jack or the multi-pin connector on top of your device.

Small valve controller power jacks require a 12-30 Vdc power supply with a 2.1 mm female positive center plug capable of supplying at least 250 mA. 4-20 mA analog signal outputs require at least 15 Vdc, , and 0-10 Vdc outputs require at least 10 Vdc..

Large valve controllers require a 24-30 Vdc power supply with a 2.1 mm female positive center plug capable of supplying at least 750 mA.



Standard 8-Pin Mini-DIN Pinout

Pin	Function	Mini-DIN cable color
1	Not Connected (or optional 4-20 mA Primary Output Signal)	Black
2	Static 5.12 Vdc (or optional Secondary Analog Output [4-20 mA, 0-5 Vdc, 1-5V dc, 0-10 Vdc] or Basic Alarm)	Brown
3	Serial RS-232RX / RS-485(–) Input Signal (receive)	Red
4	Analog Setpoint Input	Orange
5	Serial RS-232TX / RS-485(+) Output Signal (send)	Yellow
6	0-5 Vdc (or optional 1-5 Vdc or 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 pinout is applicable to all the flow controllers 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. Pin 2 is normally a constant 5.12 Vdc that reflects the system bus voltage.

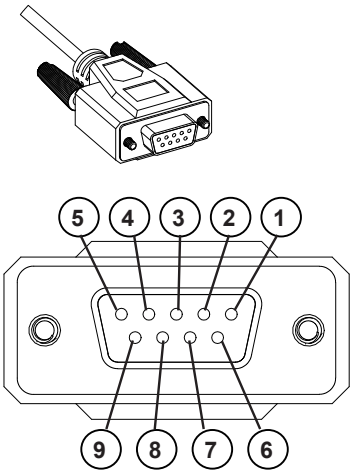
For 6-pin locking industrial connector, DB9 and DB15 pinouts, see page 92 to page 95 or visit alicat.com/pinout.

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

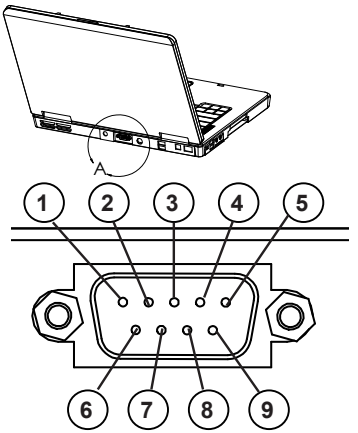
To use the RS-232 or RS-485 digital signal, connect the RS-232 / RS-485 Output Signal (Pin 5), the RS-232 / RS-485 Input Signal (Pin 3) and Ground (Pin 8) to your serial port as shown below. (See "Serial Communications" on page 39 for details)

DB9 to 8-Pin Mini-DIN Connection for RS-232 / RS-485 Signals

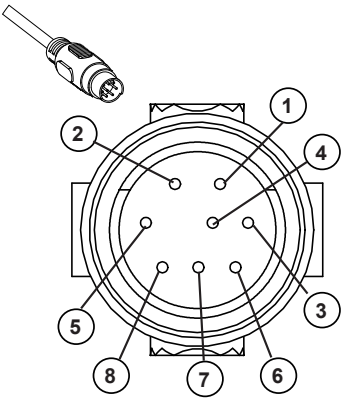
9 Pin Serial Connection		8 Pin Mini-DIN Connection	
Pin	**Function**	**Function**	**Pin**
5	Ground	Ground	8
3	Transmit	Receive	3
2	Receive	Transmit	5



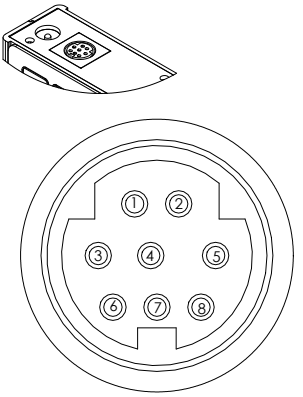
Serial Cable End



Serial Port



8 Pin Mini-DIN Cable End



8 Pin Mini-DIN Connector

Analog Signals

Primary Analog Output Signal

Most Alicat instruments include a primary analog output signal, which is linear over its entire range. For both standard 0-5 Vdc and optional 0-10 Vdc output signals, a zero flow condition is usually in the range of 0.010 Vdc. Zero flow for the optional 1-5 Vdc and 4-20 mA output signals is 1 Vdc and 4 mA, respectively. Full-scale flow is 5 Vdc for 0-5 Vdc and 1-5 Vdc signals, 10 Vdc for 0-10 Vdc signals and 20 mA for 4-20 mA signals.

Alicat's default 8-pin mini-DIN connector places the primary analog output on Pin 6 for voltage signals and Pin 1 for 4-20 mA current signals. Ground for these signals is common on Pin 8.

Option: Second Analog Output Signal

Alicat's default 8-pin mini-DIN connector places the secondary analog output on Pin 2 for both voltage and current signals. Your device's secondary analog signal may differ from its primary output signal.

✔ ***See the Calibration Sheet that shipped with your meter to determine which output signals were ordered.***

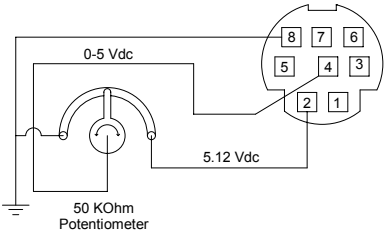
Option: 4-20 mA Current Output Signal

If your meter has a 4-20 mA current primary or secondary output signal, your flow meter will require 15-30 Vdc power.

! ***Caution: Do not connect 4-20 mA devices 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.***

Setpoint Analog Input Signal

Your mass flow controller may be a configured with a different analog inout signal than its output signal(s). One method for providing a remote setpoint to controllers with a 0-5 Vdc or 0-10 Vdc analog signal is shown below.



✔ ***Note: Devices with 4-20 mA input signalsare current sinking devices. The receiving circuit is essentially a 250 ohm resistor to ground.***

Option: Color TFT Display

Instruments ordered with a color display function the same as standard backlit monochrome instruments, but color is used to provide additional on-screen information.

Multi-Color Display Indicators

» **GREEN:** Parameter labels and adjustments associated with the button directly above or below the label are presented in green.

» **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 its value exceeds 128% of the device's specifications.

» **YELLOW:** Menu items that are ready to be selected appear in yellow. This color replaces the symbol (>) in selections on monochrome display.

✔ ***Press the Alicat logo button to turn off the color display backlight. The flow meter remains in operation while the backlight is off.***

LCD Contrast

LCD contrast is ranged from 0 to 11 on color displays, with 11 indicating the greatest contrast. See "Display Setup" on page 36.

Specifications for Instruments with Color Displays

The following specifications replace the standard power specifications when the instrument is equipped with a color display. All other specifications from your device's specification sheet remain in effect.

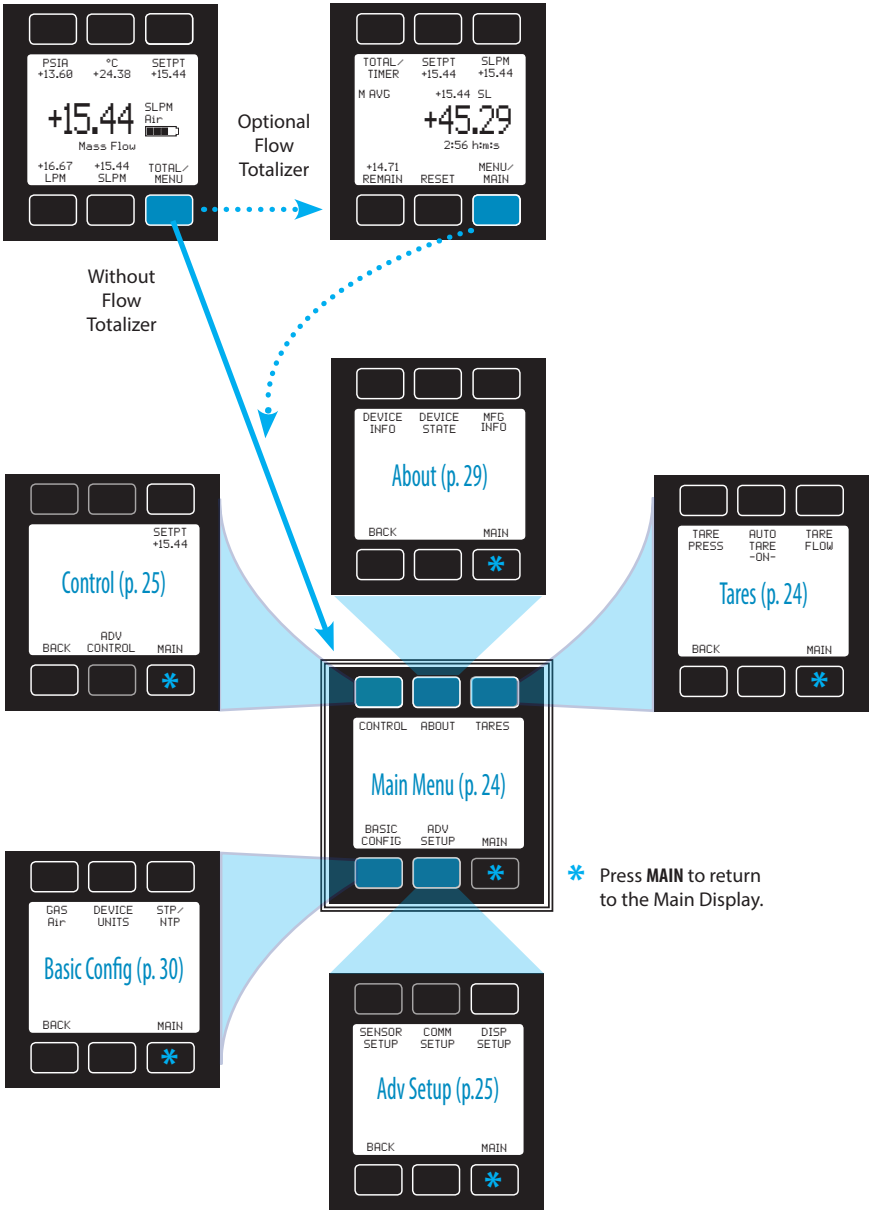
Specification	Small Valve Controller	Large Valve Controller
Supply Voltage	12 to 30 Vdc	24 to 30 Vdc
Supply Current	290 mA @ 12Vdc 200 mA @ 24Vdc	780 mA @ 24Vdc

Navigating and Customizing Your Flow Controller

Flow Controller Menu Map

Start Here

* Main Display



* Press **MAIN** to return to the Main Display.

Navigating and Customizing Your Flow Controller

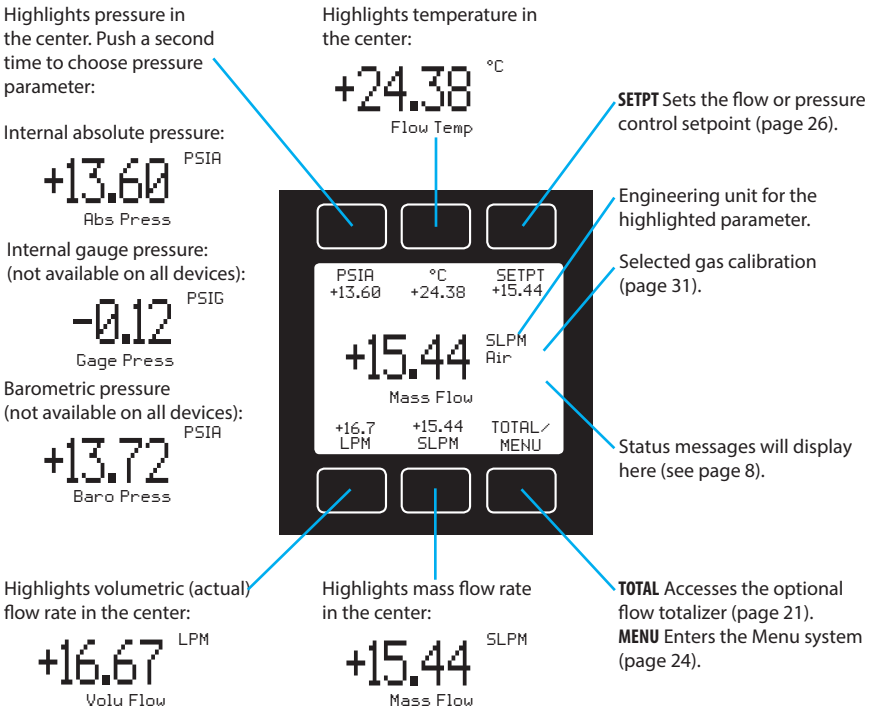
Collecting Live Flow Data

The Main Display has three primary functions:

- Collecting live temperature, pressure and flow data (see below)
- Changing engineering units for temperature, pressure and flow (page 20)
- Changing the flow or pressure control setpoint (page 26)

This screen displays live data for all flow parameters simultaneously. Live data is measured 1000 times every second but refreshed more slowly on the display. Press the button above or below any of the four flow parameters once to highlight its value in the center of the screen. Press the same button again to enter the engineering unit selection menu for that parameter (page 20).

Main Display



Choosing Engineering Units

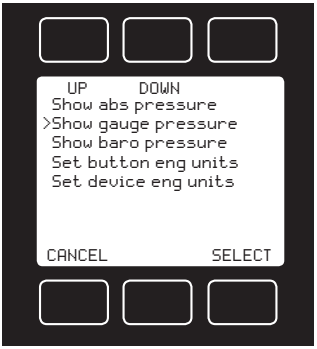
Press the button above or below any of the four flow parameters twice to enter its unit selection menu. You can change units in two ways:

Button engineering units alter the display only, not the serial data frame:

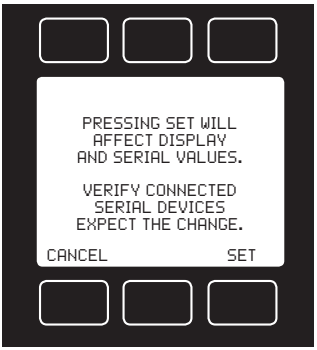
- Select **Set button eng units** and press **SELECT** to change the engineering unit on the display only. This does not alter the controller data frame.

Device engineering units alter both the display and the flow controller data frame:

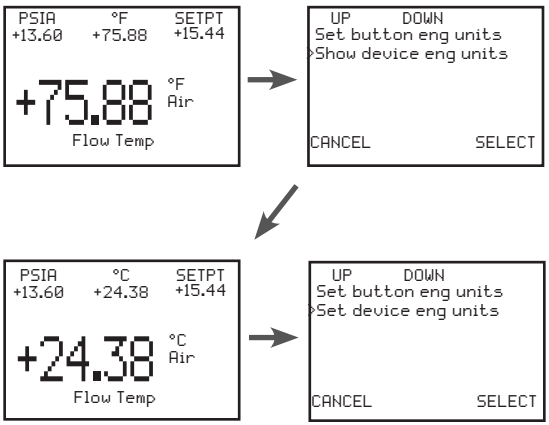
- Select **Set device eng units** and then choose the engineering unit as above. An additional confirmation screen asks you to confirm the serial change.
- If the button engineering unit is different than the device engineering unit, **Set device eng units** will not appear. First select **Show device eng units** to revert the button to the current device unit for that parameter. Enter the unit selection menu again to change the device engineering unit.



The example above shows the unit selection menu for a device that has the internal barometer option.



Examples of changing device engineering units:



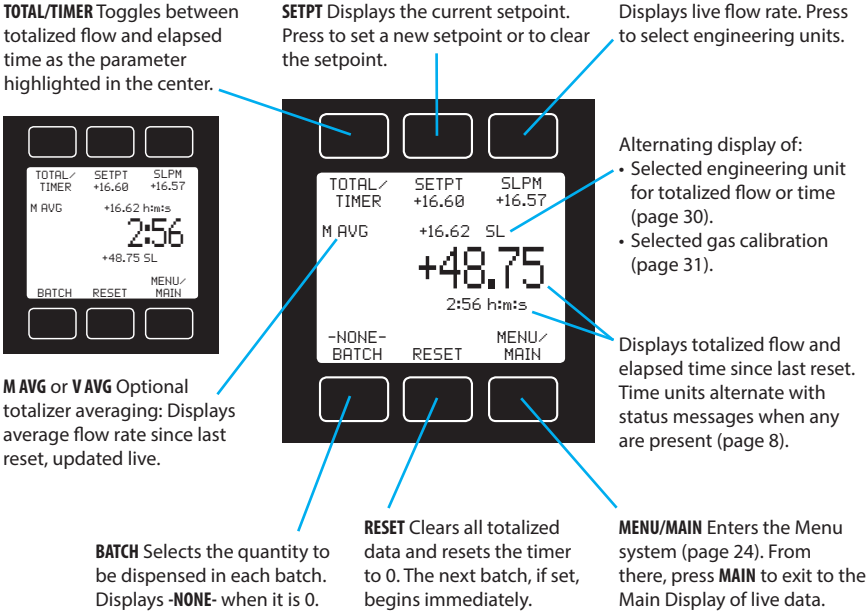
Changing device units:
°F is not the existing device engineering unit, so the unit selection menu displays **Show device eng units**. Select this to revert the button unit to the device unit for this parameter.

Changing device units:
°C is the existing device engineering unit, so the unit selection menu displays **Set device eng units**. Select this to choose a new unit.

Option: Collecting Totalized Flow Data and Batch Dispensing

Your flow controller may have an optional flow totalizer, which enables batch dispensing. The totalizer displays the total amount of mass or volume that has flowed through the instrument since its last reset, like a gasoline pump. Access the totalizer screen by pressing **TOTAL/MENU** on the Main Display.

Totalizer - Batch Off (Optional)



Totalizer Rollover Functions

Your flow totalizer has been configured to report a maximum of 7 digits. By default, the placement of the decimal is the same as the live flow rate. The totalizer can be configured at the time of order for the following behaviors. (By default, the totalizer rolls over and displays OVR.)

- **Rollover:** Totalizer resumes counting from 0 as soon as the maximum count has been reached.
- **Freeze:** Totalizer stops counting at max count, until it is reset manually.
- **Error:** Displays OVR status message when maximum count has been reached; compatible with Rollover and Freeze.

The elapsed time counter has a maximum value of 9999:59:59 (h:m:s). If flow is still being totalized at that point, the timer freezes, regardless of the behavior chosen above for the totalized flow readings.

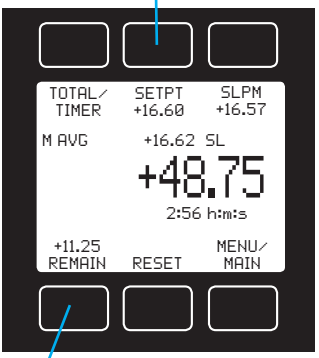
Dispensing Gas in Batches

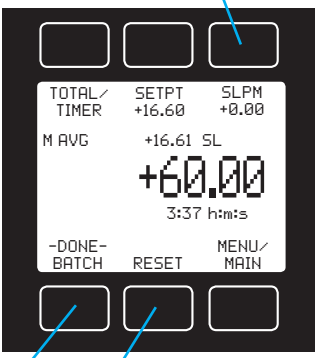
Batch dispensing allows you to choose a desired total quantity to flow, after which the valve closes. You can repeat batches with a single button press.

Totalizer - Batch On (Optional)

SETPT Displays the current setpoint. Batch dispensing can begin only when there is a non-zero setpoint.

Flow stops as soon as the batch completes.





REMAIN Displays the remaining quantity yet to be dispensed. Press to select a new quantity.

DONE BATCH Appears when the batch is complete. Press to select a new quantity to be dispensed.

RESET Clears all totalized data and resets the timer to 0. The next batch begins immediately.

How to start batch dispensing

1. From the totalizer screen, press **BATCH**. Choose the total quantity to be dispensed in each batch. Press **SET** to accept the new Batch Size.

2. From the totalizer screen, press **SETPT** to choose a non-zero setpoint. Flow begins as soon as you press **SET**.

Note: Batch dispensing requires an active Batch Size and a non-zero setpoint. If your controller already has a non-zero setpoint, flow begins as soon as you press* SET *from the Batch Size screen.

3. While a new batch is being dispensed, the **BATCH** button changes to show the quantity that remains to be dispensed. When the Batch Size has been achieved, the **BATCH** button displays -**DONE**- and flow stops automatically.

Dispensing Gas in Batches (continued)

The Batch Size can be changed while a batch is in progress. If the new Batch Size is larger than the current totalized flow, then flow continues until the new value is reached. If the new Batch Size is smaller than the current totalized flow, then the flow stops immediately. Press **RESET** to start the new batch.

How to repeat a batch

1. For a new batch of identical size, simply press **RESET**. Flow begins at once.

2. For a new batch of a different size, press **BATCH**, and then select the new Batch Size. Flow begins as soon as you press **SET**.

How to cancel a batch

1. To interrupt a batch in progress, clear the setpoint by pressing **SETPT > CLEAR > SET**.

2. To turn off batch dispensing altogether, first clear the setpoint by pressing **SETPT > CLEAR > SET**, press **BATCH** and then select a Batch Size of 0.

Caution: If your controller has a non-zero setpoint when batch dispensing is turned off, flow will resume immediately at the current setpoint.

Note: The Batch Size is retained in memory across power cycles of your flow controller. It must be manually cleared when no longer desired.

When batch mode is off, **-NONE-** appears above the **BATCH** button.

Using the Totalizer or Batch Dispensing while Controlling Pressure

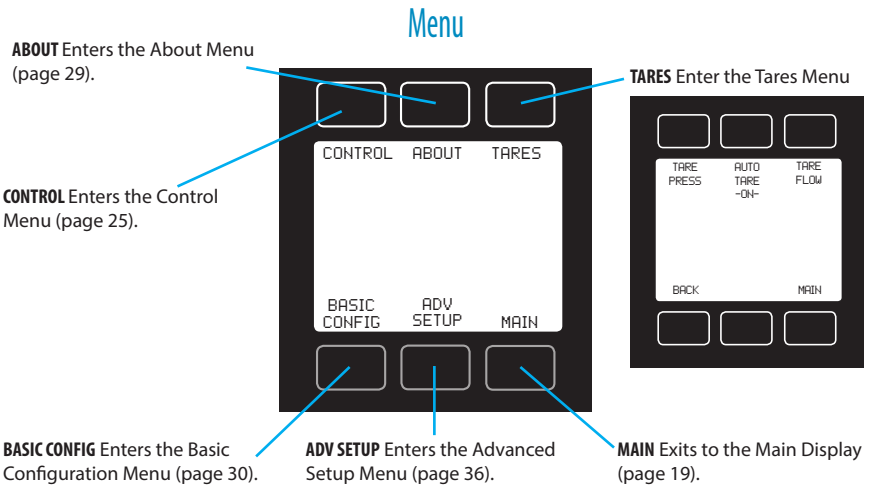
While using a mass flow controller in pressure control mode, it is possible for the flow rate to exceed the maximum measurable flow (128% of full scale) when making an abrupt pressure change. In this case, the totalized flow value will flash, and the controller will report a **TMF** message to indicate that the totalizer missed flow data. Please reset the totalizer to clear the incomplete data.

In certain situations, it is possible to exceed the desired Batch Size. For example, if the feed pressure is too low to achieve the flow setpoint and then pressure is suddenly increased, the Batch Size may be exceeded before the valve reacts to the sudden burst of pressure.

Navigating and Customizing Your Flow Controller

Menu

You can enter the menu system by pressing the **MENU** button from the Main Display.



Taring Your Flow Controller

Taring is an important practice that ensures that your flow controller is providing the most accurate measurements possible. This function gives the flow controller a good zero reference for flow measurements. For controllers with a barometer, taring can also be used to align the internal absolute pressure sensor with the barometric pressure reading.

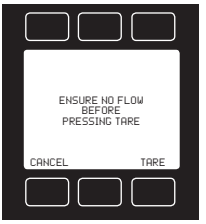
How to Tare

When auto tare is **-ON-** your flow controller automatically tares its flow rate whenever it has a zero setpoint for more than 1.2 seconds. For manual tares, follow these steps:

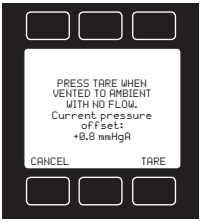
1. Ensure that nothing is flowing through the device, usually by giving the controller a zero setpoint.

2. **MENU > TARE> TARE FLOW**. Flow tares should occur at the expected process pressure, as long as there is no flow.

3. **MENU > TARE> TARE PRESS** Absolute pressure tares must be done with the controller open to atmosphere.



TARE FLOW



TARE PRESS

When to tare

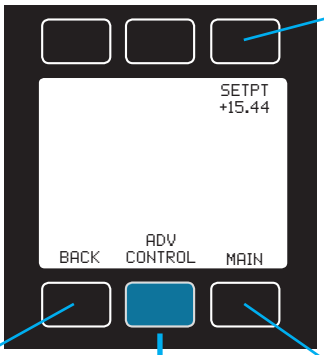
- After significant changes in temperature or pressure.
- After installing the controller in a different orientation.
- After dropping or bumping the flow controller.

Navigating and Customizing Your Flow Controller

Control Menus

The Control and Advanced Control menus allow you to command new setpoints, change the setpoint control loop and adjust PID settings, among other options.

Menu | Control



SETPT Displays the current setpoint. Press to command a new setpoint or clear the existing one.

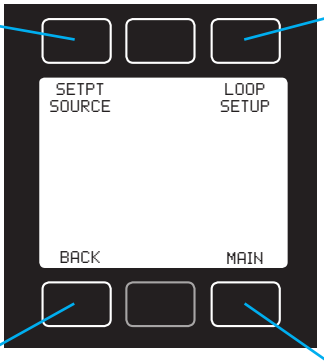
*Setpoints are not editable via the front panel if the setpoint source is **Analog**.

BACK Returns to the top-level Menu (page 24).

MAIN Exits to the Main Display (page 19).

Control | Advanced Control

SETPT SOURCE Toggles the setpoint input between serial and analog sources.



LOOP SETUP Selects the type of closed loop control and adjusts PID settings (page 27).

BACK Returns to the Control Menu (above).

MAIN Exits to the Main Display (page 19).

Commanding a new setpoint

Press the **SETPT** button from either the Main Display or the Control Menu (**MENU > CONTROL**) to choose a new setpoint. The setpoint selection screen indicates the maximum allowable setpoint (e.g., **SLPM 20.00 Max**). To cancel a setpoint, press **CLEAR**.

Changing the setpoint source

Unless your mass flow controller has been ordered with an industrial protocol, it will accept setpoints from the front panel, a serial connection or an analog signal. Change the setpoint source by selecting **MENU > CONTROL > ADV CONTROL > SETPT SOURCE**.

» When the source is set to **Serial/Front Panel**, the controller will accept input from either the front panel or an RS-232/RS-485 connection. Neither source is a slave of the other, so the controller will accept the most recent command from either source.

» When the source is set to **Analog**, the controller will ignore serial setpoint commands and will prevent input from the front panel.

Adjusting the setpoint with the optional IPC (Integrated Potentiometer Control)

If your controller has been ordered with a potentiometer control knob (IPC), the setpoint source must be set to **Analog** for the controller to accept setpoint commands from the IPC.

When using an analog setpoint signal with a controller that has an IPC, leave the IPC knob at the midpoint when it is not in use.

Changing the control loop variable

Your mass flow controller can control the flow rate or the pressure in your process. Change the control loop variable by selecting **MENU > CONTROL > ADV CONTROL > LOOP SETUP > LOOP VAR**. Loop variables include mass flow, volumetric flow and absolute pressure. Devices with internal barometers also allow control of gauge pressure.

Note: When pressure is selected as the control loop variable, flow controllers with upstream valves will control the outlet pressure. Those with downstream valves can control upstream backpressure, but these must be configured for this type of control.

When changing the control loop from mass or volumetric flow to absolute or gauge pressure, you may need to adjust the PID settings for optimal stability and speed of response. (See PID on page 27.)

Adjusting the PID controller

Your mass flow controller uses an electronic PID controller to determine how to actuate its valve(s) in order to achieve the commanded setpoint. We have tuned these settings for your specific operating conditions, but changes to your process sometimes require on-site adjustments to maintain optimal control performance. If you encounter issues with control stability, oscillation or speed of response, fine-tuning your PID control loop may help.

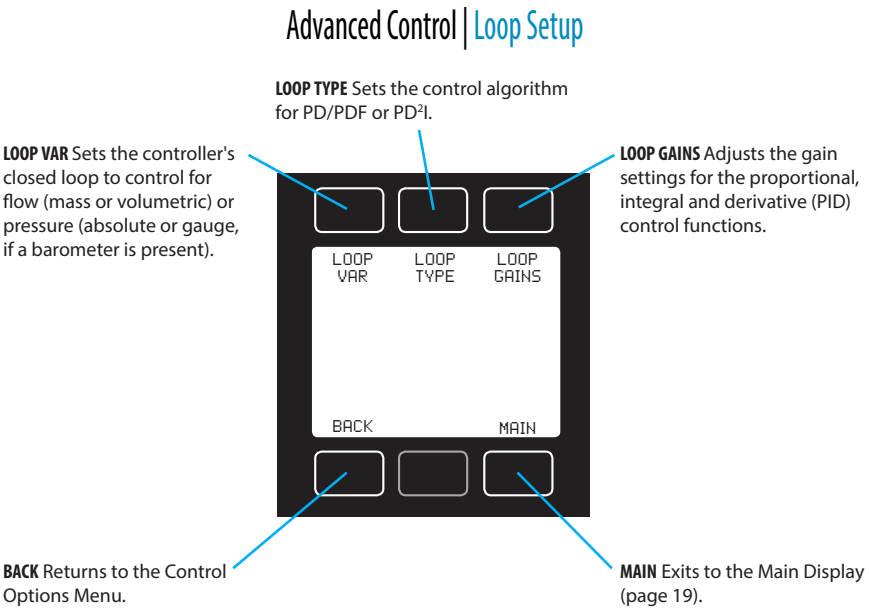
The Loop Setup menu (**MENU > CONTROL > ADV CONTROL > LOOP SETUP**) lets you choose the PID control loop algorithm and adjust the gain settings for the proportional, integral and derivative variables.

Tuning the PD/PDF control algorithm

Alicat's default control algorithm (PD) employs pseudo-derivative feedback (PDF) control, which uses just two variables:

- The larger the **D** gain, the slower the controller will correct errors between the commanded setpoint and the measured process value. This is equivalent to the P variable in common PDF controllers.
- The larger the **P** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred. This is equivalent to the I variable in common PDF controllers.

Note: The D and P variables in Alicat's PD/PDF control algorithm are more typically referred to as P and I, respectively, in PDF controllers.



Adjusting the PID controller (continued)

Tuning the PD²I control algorithm

Alicat's PD²I control algorithm (also called PDDI) is used in dual-valve flow and pressure controllers to provide faster response and reduce oscillations. This algorithm uses typical PI terms and adds a squared derivative term (D):

- The larger the **P** gain, the more aggressively the controller will correct errors between the commanded setpoint and the measured process value.
- The larger the **I** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred.
- The larger the **D** gain, the faster the controller will predict needed future corrections based on the current rate of change in the system. This often results in slowing the system down to minimize overshoot and oscillations.

Troubleshooting valve performance with PID tuning

The following issues can often be resolved by adjusting the PID gain values for your mass flow controller.

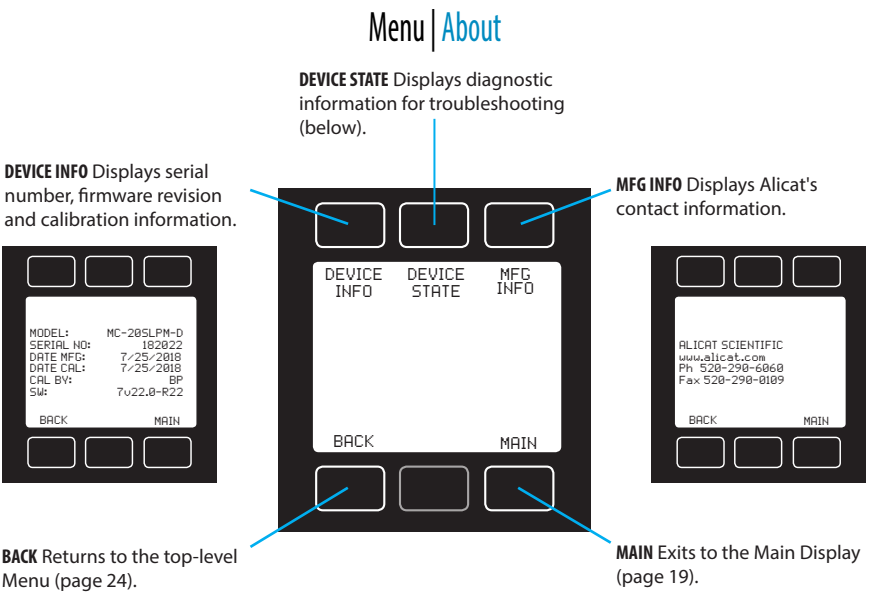
- Fast oscillation around the setpoint
  - » PD: Reduce the P gain in decrements of 10%.
  - » PD²I: Reduce the P gain in decrements of 10%, and then reduce the I gain to fine-tune.
- Overshot setpoint
  - » PD: Reduce the P gain in decrements of 10%.
  - » PD²I: If D is not 0, increase the P gain in decrements of 10%.
- Delayed or unattained setpoint
  - » PD: Increase the P gain in increments of 10%, and then decrease the D gain by small amounts to fine-tune.
  - » PD²I: Increase the P gain in increments of 10%, and then increase the I gain to fine-tune.

✔ ***Note: Alicat configures PD²I algorithm gains for dual-valve controllers based on expected process conditions. If you are switching a PDF controller to PD²I for the first time, try gain settings of P=200, I=200 and D=20 as a starting point.***

✔ ***Valve tuning can be complex. Please give us a call, and we'll be happy to guide you through the process. Or, visit alicat.com/pid for more detailed instructions.***

About

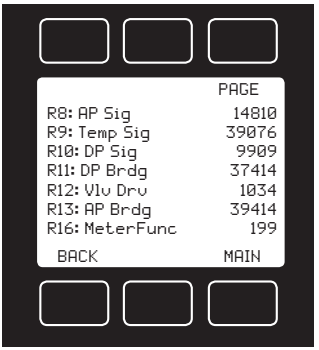
We hope you don't run into trouble using your flow controller, but if you do, the **ABOUT** menu contains information that can make the troubleshooting process easier. Select **MFG INFO** to look up Alicat's phone number and web address. **DEVICE INFO** shows you the serial number and firmware version (**SW:**) for your specific device. It also gives you the original manufacturing date and the last calibration date, as well as the initials of the Alicat calibraton technician.



Diagnostic Information

The **DEVICE STATE** screen displays live values for the internal device registers. Many of these values can help an Alicat applications engineer diagnose operational issues over the phone. Some register values clearly distinguish between hardware and operational problems, which speeds up the troubleshooting process.

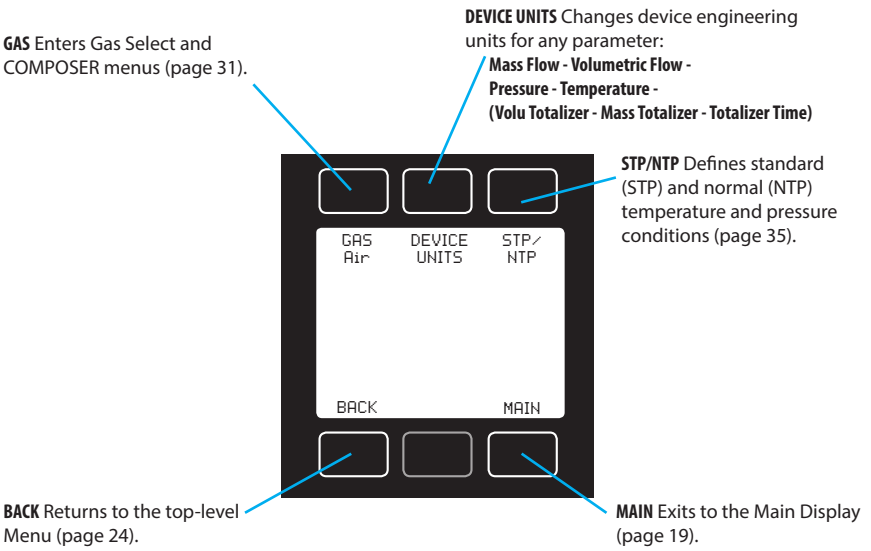
Within the **DEVICE STATE** screen, press **PAGE** to advance to the next page of register values.



Basic Configuration Menu

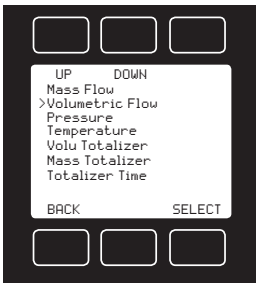
The Basic Configuration Menu contains options for choosing the gas calibration, device engineering units and STP/NTP mass flow references.

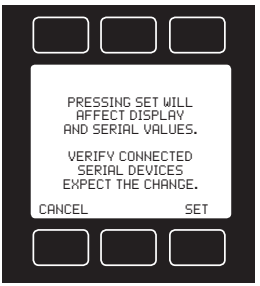
Menu | Basic Configuration



Choosing Device Engineering Units from the Basic Configuration Menu

Changing device engineering units alters both the display and the data frame. First choose the parameter whose unit you want to change, and then select your desired engineering unit, confirming the change on the last screen. If your controller has been configured with a flow totalizer, this screen will also include units for totalized volumetric and mass flow, plus elapsed time.



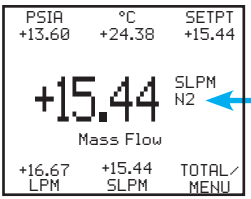


Gas Select™

In most cases, your flow controller was physically calibrated on air at Alicat's factory. Gas Select™ allows you to reconfigure the flow controller to flow a different gas without sending it back to Alicat for a physical recalibration.

To use Gas Select, simply choose a gas or gas mix from one of the listed categories. As soon as you press **SELECT** from the gas listing, your flow controller will reconfigure itself to flow your chosen gas. There is no need to restart the flow controller.

Your current gas selection appears just below the unit's indicator on the right side of the Main Display:

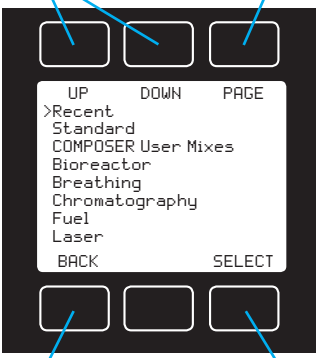


Gas Select set to nitrogen (**N2**).

Gas Select - Category Listing

UP/DOWN Moves the selection arrow up or down the listing of gas categories.

PAGE Advances the view to the next page of categories.



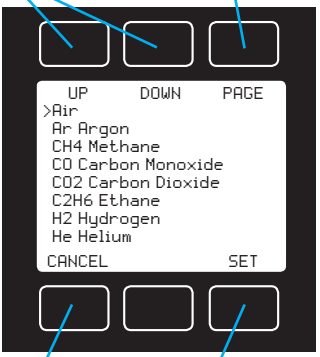
BACK Returns to the Basic Configuration Menu (page 30).

SELECT Opens the category to view its gases.

Gas Select - Gas Listing

UP/DOWN Moves the selection arrow up or down the listing of gases.

PAGE Advances the view to the next page of gases.



CANCEL Returns to the listing of gas categories.

SET Loads the gas properties data for the selected gas and exits to the Main Display (page 19).

Navigating and Customizing Your Flow Controller

Gas Select™ Gas List

Your Alicat is preloaded with gas properties data for the following gases. See page 49 for gas properties data (viscosity, density and compressibility).

Pure Non-Corrosive Gases

- **Acetylene** C2H2
- **Air**
- **Argon** Ar
- **iso-Butane** iC4H10
- **normal-Butane** nC4H10
- **Carbon dioxide** CO2
- **Carbon monoxide** CO
- **Deuterium** D2
- **Ethane** C2H6
- **Ethylene** (Ethene) C2H4
- **Helium** He
- **Hydrogen** H2
- **Krypton** Kr
- **Methane** CH4
- **Neon** Ne
- **Nitrogen** N2
- **Nitrous Oxide** N2O
- **Oxygen** O2
- **Propane** C3H8
- **Sulfur Hexafluoride** SF6
- **Xenon** Xe

Breathing Gas Mixes

- Metabolic Exhalant
- EAN-32
- EAN-36
- EAN-40
- EA-40
- EA-60
- EA-80
- Heliox-20
- Heliox-21
- Heliox-30
- Heliox-40
- Heliox-50
- Heliox-60
- Heliox-80
- Heliox-99

Bioreactor Gas Mixes

- 5% CH4
- 10% CH4
- 15% CH4
- 20% CH4
- 25% CH4
- 30% CH4
- 35% CH4
- 40% CH4
- 45% CH4
- 50% CH4
- 55% CH4
- 60% CH4
- 65% CH4
- 70% CH4
- 75% CH4
- 80% CH4
- 85% CH4
- 90% CH4
- 95% CH4

Refrigerants (*S-series only)

- R-11
- R-115
- R-116
- R-124
- R125
- R-134A
- R-14
- R-142b
- R-143a
- R-152a
- R-22
- R-23
- R-32
- RC-318
- RC-404A
- RC-407C
- R-410A
- R-507A

Welding Gas Mixes

- C-2
- C-8
- C-10
- C-15
- C-20
- C-25
- C-50
- C-75
- He-25
- He-50
- He-75
- He-90
- A1025
- Stargon CS

Stack/Flue Gas Mixes

- 2.5% O2+10.8% CO2+85.7% N2+1% Ar
- 2.9% O2+14% CO2+82.1% N2+1% Ar
- 3.7% O2+15% CO2+80.3% N2+1% Ar
- 7% O2+12% CO2+80% N2+1% Ar
- 10% O2+9.5% CO2+79.5% N2+1% Ar
- 13% O2+7% CO2+79% N2+1% Ar

Pure Corrosive Gases (*S-series only)

- **Ammonia** NH3
- **Butylene** 1Buten
- **Cis-Butene** cButen
- **iso-Butane** iButen
- **Trans-Butene** tButen
- **Carbonyl Sulfide** COS
- **Chlorine** Cl2
- **Dimethylether** DME
- **Hydrogen Sulfide** H2S
- **Nitrogen Trifluoride** NF3
- **Nitric Oxide** NO
- **Propylene** C3H6
- **Silane** SiH4
- **Sulfur Dioxide** SO2

Chromatography Gas Mixes

- P-5
- P-10

Laser Gas Mixes

- 4.5% CO2+13.5% N2+82% He
- 6% CO2+14% N2+80% He
- 7% CO2+14% N2+79% He
- 9% CO2+15% N2+76% He
- 9.4% CO2+19.25% N2+71.35% He
- 9% Ne+91% He

Oxygen Concentrator Gas Mixes

- 89% O_2+7% N_2+4% Ar
- 93% O_2+3% N_2+4% Ar
- 95% O_2+1% N_2+4% Ar

Fuel Gas Mixes

- **Coal Gas** 50% H2+35% CH4+10% CO+5% C2H4
- **Endothermic Gas** 75% H2+25% N2
- **HHO** 66.67% H2+33.33% O2
- **LPG HD-5** 96.1% C3H8+1.5% C2H6+0.4% C3H6 +1.9% n-C4H10
- **LPG HD-10** 85% C3H8+10% C3H6+ 5% n-C4H10

Natural Gases

- 93% CH4+3% C2H6+1% C3H8+2% N2+1% CO2
- 95% CH4+3% C2H6+1% N2+ 1% CO2
- 95.2% CH4+2.5% C2H6+0.2% C3H8+0.1% C4H10+1.3% N2+0.7% CO2

Synthesis Gases

- 40% H2+29% CO+20% CO2+11% CH4
- 64% H2+28% CO+1% CO2+7% CH4
- 70% H2+4% CO+25% CO2+1% CH4
- 83% H2+14% CO+3% CH4

Navigating and Customizing Your Flow Controller

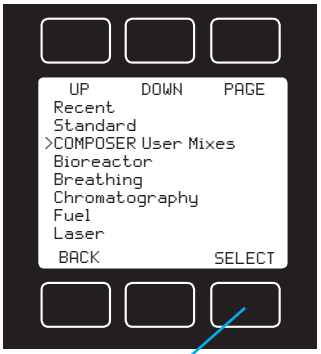
Using COMPOSER™ to Personalize Mixed Gas Compositions

To remain accurate, your flow controller needs to know the viscosity of the gas you are flowing through it. The more closely you can define your actual gas composition, the more accurate your flow readings will be. Alicat's COMPOSER is an included feature of Gas Select that lets you define new mixed gas compositions to reconfigure your flow controller on the fly.

COMPOSER uses the Wilke method to define a new gas mixture based on the molar (volumetric) ratios of the gases in the mixture. You can define these gas compositions to within 0.01% for each of up to five constituent gases in the mixture. Once you define and save a new COMPOSER gas mix, it becomes part of the Gas Select system and is accessible under the gas category **COMPOSER User Mixes**. You can store 20 COMPOSER gas mixes on your flow controller.

✔ ***Note: COMPOSER does not physically mix any gases for you. It reconfigures your flow controller to report flow readings more accurately based on the constituents of your defined gas mixture.***

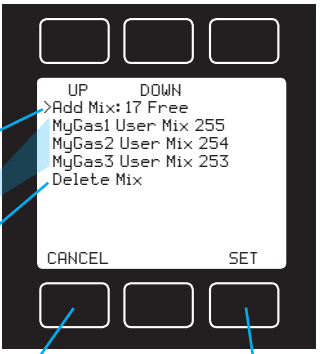
Gas Select - Category Listing



SELECT Enters the COMPOSER Menu.

To access COMPOSER, select **COMPOSER User Mixes** from the Gas Select category listing. Select any existing mix to reconfigure your flow controller to flow that gas mixture. Select **Delete Mix** to permanently remove a gas mix.

Gas Select | COMPOSER Menu



Add Mix Creates a new COMPOSER gas mix.

COMPOSER Mixes Selects an existing gas mix to use.

Delete Mix Deletes an existing gas mix. (Option appears if at least 1 mix exists.)

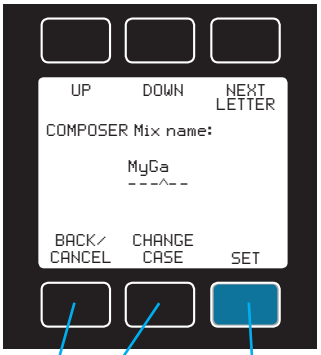
CANCEL Returns to the Gas Select Menu (page 31).

SET Confirms your selection and exits to the Main Display (page 19).

Navigating and Customizing Your Flow Controller

Adding a new mixed gas composition to COMPOSER

Generate and store a new COMPOSER mix in 3 easy steps.



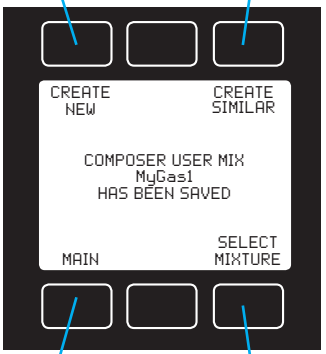
1 Name the mix.

CHANGE CASE Toggles upper/ lower case.

SET Accepts the name.

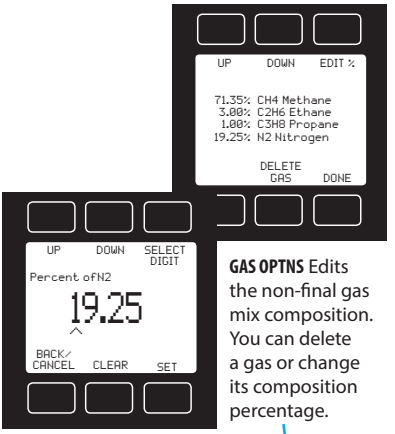
BACK/CANCEL Exits to the COMPOSER Menu.

CREATE NEW/SIMILAR Restarts at Step 1. After saving a name, **CREATE SIMILAR** duplicates the mix you just saved. ***Note:* CREATE SIMILAR *is not accessible after leaving this screen.***



3 Save the mix.

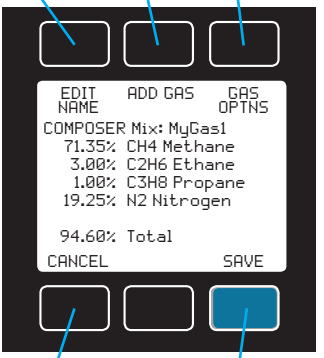
MAIN Exits to the Main Display and keeps your existing gas selection. **SELECT MIXTURE** also activates the new COMPOSER mix.



GAS OPTNS Edits the non-final gas mix composition. You can delete a gas or change its composition percentage.

ADD GAS Enters Gas Select listing to choose a gas, then asks you to set its composition percentage.

EDIT NAME Returns to Step 1.



2 Define the mix.

CANCEL Exits to the COMPOSER Menu.

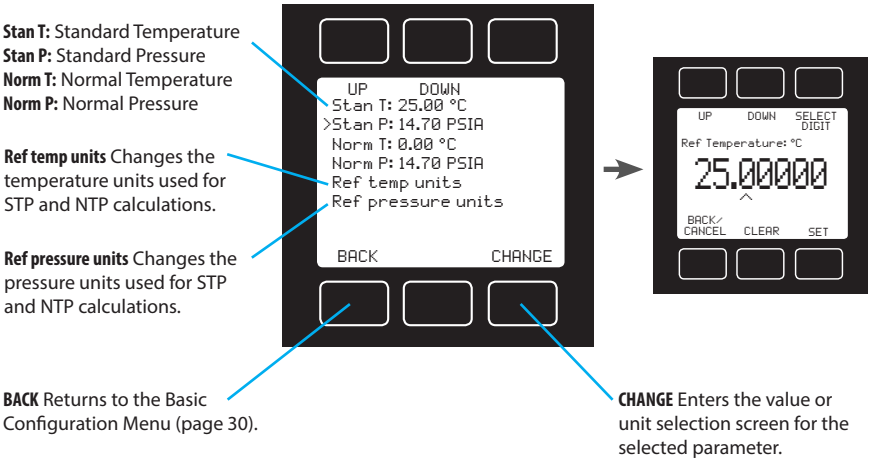
SAVE Adds the new mix to COMPOSER.

Note: You cannot save your mix until the total is 100%. Saved gas compositions cannot be changed.

Defining STP/NTP Reference Values

Standardized flow rates are reported in "standard" or "normal" volumetric flow units that reference a given temperature and pressure combination. This reference is called an STP (standard temperature and pressure) or, typically in Europe, an NTP (normal temperature and pressure).

Basic Configuration | STP/NTP



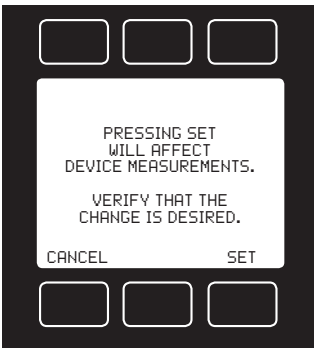
Using the **STP/NTP** menu, you can independently change the temperature or pressure references for STP and NTP. Your flow meter ships with Alicat default STP of 25°C and 1 atm (which affects flow units beginning with "S"), and an NTP of 0°C and 1 atm (which affects flow units beginning with "N").

To make changes, follow these steps:

1. Select the desired pressure or temperature reference engineering unit by selecting **Ref temp units** or **Ref pressure units** and pressing **CHANGE**. Both normal and standard references use the same engineering units.

2. Select the temperature or pressure value you wish to modify, and press **CHANGE**.

3. At the confirmation screen, press **SET** to confirm your desired change.



Caution: Changes to STP/NTP references will alter your mass flow readings.

Advanced Setup

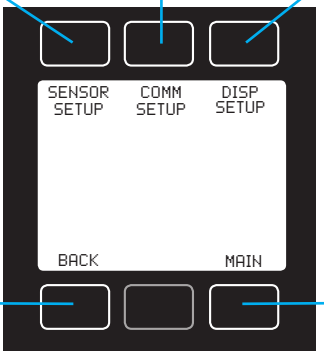
The Advanced Setup Menu lets you configure the display, deadband, averaging (for flow and pressure) and serial communications.

Menu | Advanced Setup

SENSOR SETUP Enters the Sensor Setup Menu (page 37).

COMM SETUP Enters the Communications Setup Menu (page 38).

DISP SETUP Enters the Display Setup Menu (below).



BACK Returns to the top-level Menu (page 24).

MAIN Exits to the Main Display (page 19).

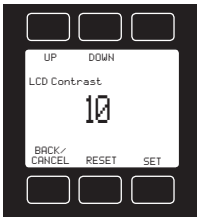
Display Setup

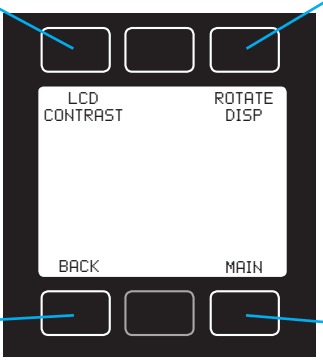
The options in the Display Setup Menu adjust the contrast of the display and enable screen rotation.

Advanced Setup | Display Setup

LCD CONTRAST Sets the contrast level of the display. Press reset to revert to the default contrast level.

ROTATE DISP Rotates the display and buttons 180° for inverted installations.





BACK Returns to the Setup Menu (above).

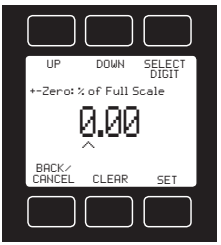
MAIN Exits to the Main Display (page 19).

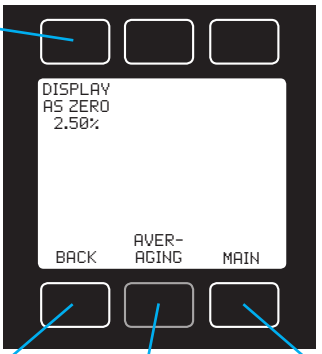
Sensor Setup

The Sensor Setup Menu contains advanced settings that govern how the flow and pressure sensors report their data.

Advanced Setup | Sensor Setup

DISPLAY AS ZERO Defines the deadband threshold under which flow values are displayed as 0. (Max: 6.38%)





BACK Returns to the Advanced Setup Menu (page 36).

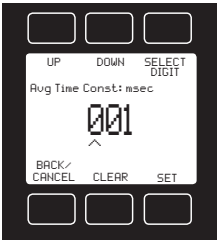
AVERAGING Adjusts the time constants of the geometric running averages for flow and pressure (1-255 ms).

MAIN Exits to the Main Display (page 19).

The deadband threshold (**DISPLAY AS ZERO**) is the value below which the flow controller displays all flow readings as "0" (no flow). This function also applies to gauge pressure readings when using the optional barometer. By default, flow controllers ship with a deadband value of 0.25%, so on a 20-slpm instrument, all readings below 0.05 slpm would display as 0 slpm.

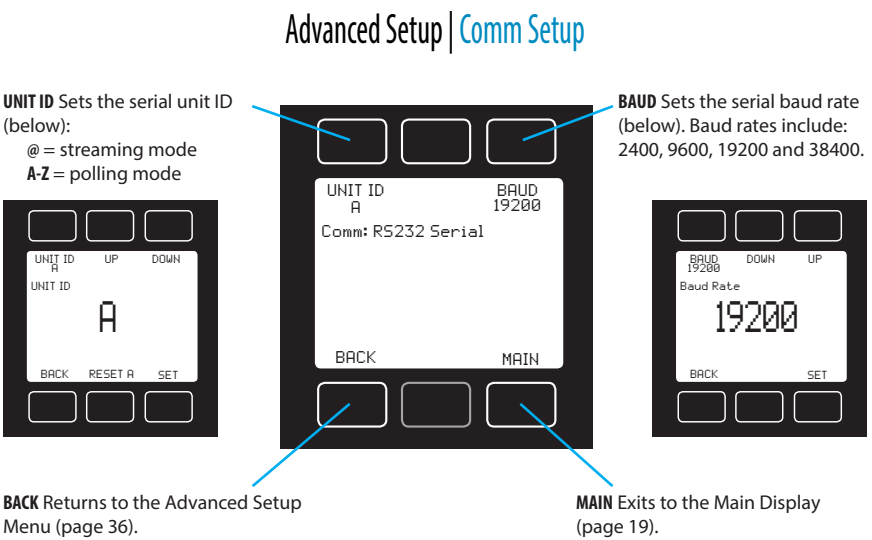
Note: Deadband settings do not affect the values reported in the serial data frame.

The **AVERAGING** button opens a submenu for adjusting the flow and pressure averaging, which are changed independently. Values roughly correspond to the time constant (in milliseconds) of the averaged values. Higher numbers generate a greater smoothing effect on rapidly fluctuating readings (max 255 ms).



Configuring Your Flow Controller for Serial Communications

You can operate the flow controller remotely via its top connector for easy streaming and logging of all data. Before connecting the flow controller to a computer, ensure that it is ready to communicate with your PC by checking the options in the **COMM SETUP** menu.



Unit ID

The unit ID is the identifier that a computer uses to distinguish your flow controller from other Alicat devices when it is connected to a network. Using the unit ID letters **A-Z**, you can connect up to 26 devices to a computer at the same time via a single COM port. This is called polling mode (page 40). Unit ID changes take effect when you select **SET**.

If you select @ as the Unit ID, the flow controller enters streaming mode when you exit the menu (see page 40).

Baud Rate

Baud rate is the speed at which digital devices transfer information. The flow controller has a default baud rate of 19200 baud (bits per second). If your computer or software uses a different baud rate, you must change the flow controller baud rate in the **BAUD** menu to match them both. Alternatively, you can change your PC's baud rate in Device Manager. Baud rate changes take effect once you press **SET**, but you may need to restart your software.

Serial Communications

Connecting your flow meter to a computer allows you to log the data that it generates. The flow meter communicates digitally through its communications connector and cable using a real or virtual COM port on your PC. This section of the manual shows you how to operate the flow meter using ASCII commands.

Establishing Serial Communications

After connecting your flow controller using a communications cable, you will need to establish serial communications through a real or virtual COM port on your computer or PLC.

- Confirm that your mass flow controller is ready to accept new setpoints serially by selecting **MENU > CONTROL > ADV CONTROL > SETPT SOURCE**. The setpoint source should be set to **Serial/Front Panel**.
- If you have connected your device to a serial port, note its COM port number. This can be found in Windows Device Manager.
- If you have used a USB cable to connect your device to your computer, the computer in most cases will recognize your Alicat as a virtual COM port. If it does not, download the appropriate USB device driver at alicat.com/drivers and note the COM port number as found in Windows Device Manager.

Serial Terminal Application

Alicat's Serial Terminal is a preconfigured program for serial communications that functions much like the older HyperTerminal program of Windows. Download Serial Terminal for free at alicat.com/drivers. Once downloaded, simply run SerialTerminal.exe. Enter the COM port number to which your device is connected and the baud rate of the flow controller. The default baud rate is 19200, but this is adjustable by entering the **SERIAL COMM** menu on your flow meter: **MENU > ADV SETUP > COMM SETUP > BAUD** (page 38)

Serial Streaming vs Polling

Note: In what follows, <CR> indicates an ASCII carriage return (decimal 13, hexadecimal D). Serial commands are not case-sensitive.

Polling Mode

Your flow controller was shipped to you in polling mode with a unit ID of A, unless requested otherwise. Polling the flow controller returns a single line of data each time you request it. To poll your flow controller, simply enter its unit ID.

Poll the device:	[unit ID]**<CR>**
Example:	**a<CR>** (polls unit A)

You can change the unit ID of a polling device by typing:

Change the unit ID:	[current unit ID]**@=**[desired unit ID]**<CR>**
Example:	**a@=b<CR>** (changes unit A to unit B)

You can also do this via the flow controller menu: **MENU > ADV SETUP > COMM SETUP > UNIT ID** (page 38). Valid unit IDs are letters A-Z, and up to 26 devices may be connected at any one time, as long as each unit ID is unique.

Streaming Mode

In streaming mode, your flow controller continuously sends a line of live data at regular intervals without your having to request the data each time. Only one unit on a given COM port may be in streaming mode at a time.

To put your flow controller into streaming mode, type:

Begin streaming:	[unit ID]**@=@<CR>**

This is equivalent to changing the unit ID to "@". To take the flow controller out of streaming mode, assign it a unit ID by typing:

Stop streaming:	**@@=**[desired unit ID]**<CR>**
Example:	**@@=a<CR>** (stops and assigns unit ID of A)

When sending a command to a flow controller in streaming mode, the flow of data will not stop while the user is typing. This may make the commands you type unreadable. If the device does not receive a valid command, it will ignore it. If in doubt, simply hit **<CR>** and start again.

Note: The default streaming interval is 50 ms, but this can be increased by changing Register 91 while the device is in polling mode:

Set streaming interval:	[unit ID] **w91=**[number of milliseconds]**<CR>**
Example:	**aw91=500<CR>** (streams new data every 500 ms)

Taring Serially

Before collecting flow data, be sure to tare your flow controller. This can be accomplished serially through two separate commands. Taring flow sets the zero flow reading and must be done when no flow is passing through the flow controller:

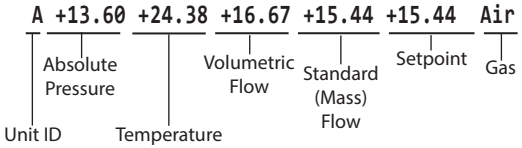
Tare flow: [unit ID]**v<CR>**
Example: **av<CR>** (sets flow reading to zero)

For devices equipped with a barometer, the second tare aligns the internal absolute pressure sensor with the current barometer reading and must be done with the flow meter open to atmosphere:

Tare absolute pressure: [unit ID]**pc<CR>**
Example: **apc<CR>** (aligns internal pressure to barometer)

Collecting Flow Data Serially

Collect live flow data by typing the [unit ID] **<CR>** command or by setting your flow controller to streaming. Each line of data for live flow measurements appears in the format below, but Unit ID is not present in streaming mode.



Single spaces separate each parameter, and each value is displayed in the chosen device engineering units, which may differ from the engineering units visible on the flow controller display (see "Choosing Engineering Units" on page 20). You can query the engineering units of the instant data frame by typing:

Query live data info: [unit ID]**??d*<CR>**
Example: **a??d*<CR>** (returns the data frame descriptions)

Additional columns, including status codes (see "Status Messages" on page 8), may be present to the right of the gas label column. The Unit ID appears in the data frame only when the flow controller is in polling mode.

Commanding a New Setpoint Serially

Before attempting to send setpoints to your mass flow controller serially, confirm that its setpoint source is set to **Serial/Front Panel** by selecting **MENU > CONTROL > ADV CONTROL > SETPT SOURCE**.

There are two ways to command a new setpoint over a serial connection, as described below. In either of these methods, the data frame returns the new setpoint value when it has been accepted as a valid setpoint.

Sending Serial Setpoints as Floating Point Numbers

In this method, you send the desired setpoint value as a floating point number:

Command new setpoint:	**as**[setpoint as floating point number]**<CR>**
Example:	**as15.44<CR>** (setpoint of +15.44 slpm)

When using a bidirectional mass flow controller, negative setpoints are sent by adding the minus sign (-):

Example:	**as-15.44<CR>** (setpoint of -15.44 slpm)

Sending Serial Setpoints as Integers in Reference to Full Scale

In this method, your controller's full scale range is represented by a value of 64000, and a zero setpoint is represented by 0. To calculate your intended setpoint, use the following formula:

Integer value = 64000 x [desired setpoint] / [device full scale]

A desired setpoint of +15.44 slpm on a 20-slpm mass flow controller is calculated as 64000 x 15.44 / 20.00 = 49408. The command to assign the setpoint based on this integer value is:

Command new setpoint:	**a**[setpoint as integer where 64000 is full scale]**<CR>**
Example:	**a49408<CR>** (setpoint of 15.44 slpm)

When using a bidirectional mass flow controller, 0 represents -100% of full scale, 32000 represents 0, and 64000 represents +100% of full scale. Use the following formule to calculate the integer value:

Integer value = 64000 x [desired setpoint + full scale] / [device full scale x 2]

A desired setpoint of +15.44 slpm on a 20-slpm bidirectional mass flow controller is calculated as 64000 x (15.44 + 20.00) / 40.00 = 56704. A desired setpoint of -15.44 slpm on the same mass flow controller is calculated as 64000 x (-15.44 + 20.00) / 40.00 = 7296.

Quick Serial Command Guide

Note: Serial commands are not case-sensitive. For simplicity, we assume that the unit ID of the flow controller is A in the listing that follows.

Change the unit ID:	[current unit ID]**@=**[desired unit ID]**<CR>**
Tare flow:	**av<CR>**
Tare abs. pressure with baro:	**apc<CR>** *(optional)*
Poll the live data frame:	**a<CR>**
Begin streaming data:	[unit ID]**@=@<CR>**
Stop streaming data:	**@@=**[desired unit ID]**<CR>**
Set streaming interval:	**aw91=**[number of milliseconds]**<CR>**
Command new setpoint:	**as**[setpoint as floating point number]**<CR>**
Command new setpoint:	**a**[setpoint as integer where 64000 is full scale]**<CR>**
Hold valve(s) at current pos.:	**ahp<CR>**
Hold valve(s) closed:	**ahc<CR>**
Cancel valve hold:	**ac<CR>**
Query gas list info:	**a??g*<CR>**
Choose a different gas:	**ag**[Gas Number]**<CR>**
Create a COMPOSER mix:	**agm** [Mix Name] [Mix Number] [Gas1 %] [Gas1 Number] [Gas2 %] [Gas2 Number]...**<CR>**
Delete a COMPOSER mix:	**agd** [Mix Number]**<CR>**
Query live data info:	**a??d*<CR>**
Query manufacturer info:	**a??m*<CR>**
Query firmware version:	**a??m9<CR>**
Lock the front display:	**al<CR>**
Unlock the front display:	**au<CR>**

If you have need of more advanced serial communication commands, please contact Alicat.

Using Gas Select and COMPOSER Serially

To reconfigure your flow controller to flow a different gas, look up its Gas Number (see "Numerical List of Gases" on page 57). Then type:

Choose a gas:	[unit ID]**g**[Gas Number]**<CR>**
Example1:	**ag8<CR>** (reconfigures to flow nitrogen)
Example2:	**ag206<CR>** (reconfigures to flow P-10)

COMPOSER user mixes are selected in the same way. All COMPOSER gas mixes have a Gas Number between 236 and 255.

Choose a user mix:	[unit ID]**g**[Gas Number]**<CR>**
Example:	**ag255<CR>** (reconfigures for user mix 255)

Defining a new COMPOSER gas mix is faster using serial commands than using the front panel. The basic formula for this is:

[unit ID]**gm** [Mix Name] [Mix Number] [Gas1 %] [Gas1 Number] [Gas2 %] [Gas2 Number]...**<CR>**

» [Mix Name] Use a maximum of 6 letters (upper case and/or lower case), numbers and symbols (space, period or hyphen only).

» [Mix Number] Choose a number from 236 to 255. If a user mix with that number already exists, it will be overwritten. Use the number 0 to assign the next available number to your new gas. ***Note: COMPOSER gas numbers are assigned in descending order from 255.***

» [Gas1 %] [Gas1 Number]... For each constituent gas, enter its molar percentage (using up to 2 decimal places) and then its Gas Number (page 57). You must have at least 2—but no more than 5—gases in your COMPOSER mix.

After creating your COMPOSER mix, your flow controller will confirm the new gas:

Example1: *Create a mix of 71.35% helium, 19.25% nitrogen and 9.4% carbon dioxide as Gas 252, called "MyGas1".*

agm MyGas1 252 71.35 7 19.25 8 9.4 4<CR>

Response: A 252 71.35% He 19.25% N2 9.40% CO2

Example2: *Create a mix of 93% methane, 3% ethane, 1% propane, 2% nitrogen and 1% carbon dioxide, using the next available gas number, called "MyGas2".*

agm MyGas2 0 93 2 3 5 1 12 2 8 1 4<CR>

Response: A 253 93.00% CH4 3.00% C2H6 1.00% C3H8 2.00% N2 1.00% CO2

Note: The sum of all gas constituent percentages must equal 100.00%.

Troubleshooting Your Flow Controller

If you run into any trouble with your Alicat's installation or operation, please get in touch with us by phone, chat or email. You'll also find help on our website alicat.com and in the pages that follow.

General Use

Issue: ***My Alicat does not turn on or is weak.***
Action: Check power and ground connections. Please reference the technical specifications to ensure you have the proper power for your model.

Issue: ***The buttons do not work, and the screen shows* LCK.**
Action: The flow controller buttons were locked out via a serial command. Press and hold all four outer buttons to unlock the interface.

Issue: ***I can't read the display easily.***
Action: During the day, you can increase the visibility of the display by increasing the contrast (**MENU > ADV SETUP > DISP SETUP > LCD CONTRAST**). If you are working under low-light conditions, push the large Alicat button (located below the display) to turn on the backlight.

Issue: ***How often do I need to calibrate my Alicat?***
Action: Alicat recommends annual recalibrations. Check your flow controller's last calibration date by selecting **MENU > ABOUT > DEVICE INFO**. If it is time to recalibrate, request a recalibration at alicat.com/service.

Issue: ***I dropped my Alicat. Is it ok? Do I need to recalibrate?***
Action: If it turns on and appears to respond normally, then it is probably ok. It may or may not need a recalibration. Compare it against a known-good flow standard. If it checks out, keep using it, but tell us about the drop at your next annual recalibration so we can check it out for you.

Temperature Readings

Issue: ***How can I see temperature in different units?***
Action: From the Main Display, press the button above the temperature reading twice, and then choose **Set button eng units**. Use the **UP**/**DOWN** keys to move the > cursor to the desired unit, and then press **SET**.

On portable decives, charging the device may also reslove the issue.

Pressure Readings

Issue: ***How can I see pressure in different units?***
Action: From the Main Display, press the button above the pressure reading twice, and then choose **Set button eng units**. Use the **UP**/**DOWN** keys to move the > cursor to the desired unit, and then press **SET**.

Troubleshooting Your Flow Controller

Flow Readings

Issue: ***How can I see flow in different units?***

Action: From the Main Display, press the button below the flow reading twice, and then choose **Set button eng units**. Use the **UP**/**DOWN** keys to move the > cursor to the desired unit, and then press **SET**.

Issue: ***The live flow readings won't settle down.***

Action: The flow controller is very fast, so it can detect subtle variations in flow that may go unnoticed by your other flow devices. This sensitivity can help detect problems with pumps or flow controllers. You can lessen this sensitivity by decreasing the flow averaging (press **MENU > ADV SETUP > SENSOR SETUP > FLOW AVG**

Issue: ***My flow readings are negative.***

Action: Command a zero setpoint to see if the flow returns to 0 after 1.2 seconds. Under conditions of no flow, a negative flow reading can indicate a poor tare. Ensure that the flow controller has no flow passing through it, and select **TARE FLOW** from the Main Display to give it a fresh tare.

Issue: ***Does the Alicat work if it is laying down? Will it be accurate?***

Action: Yes to both! The flow controller is internally compensated for any changes in orientation, so you can use it sideways, on its back, or upside-down. S and QS-series devices should be tared again after changing their orientation.

Issue: ***Can I put the Alicat on top of a vibrating device? Will it be accurate?***

Action: Yes, and yes! The flow controller is internally compensated for any changes in orientation, including rapid vibrations. Noise will increase if the flow meter/controller is vibrating.

Issue: ***My controller does not agree with another meter I have in line.***

Action: Check the STP or NTP settings (**MENU > BASIC CONFIG > STP/NTP**) to ensure that your standardized temperature and pressure references match those of your other flow calibrator. Also check that your device's Gas Select is set to the right gas or mixture.

Issue: ***My flow readings won't change when flow changes.***

Action: If your flow readings won't change regardless of actual flow, your flow sensor may be damaged. Please contact Alicat to troubleshoot.

Issue: ***Can I use the Alicat with other gases?***

Action: Yes! Your flow controller is designed specifically to work with many different gases. Gas Select (**MENU > BASIC CONFIG > GAS**) includes up to 130 preloaded gases and gas mixes, or you can define your own using COMPOSER. If your desired gas is not listed, please contact Alicat to ensure compatibility.

Serial Communications

Issue: ***I can't communicate to the Alicat when it is connected to my PC.***

Action: Make sure the COM number matches the one your software is using to connect to the flow controller. Check the flow controller unit ID (**MENU > ADV SETUP > COMM SETUP > UNIT ID**) to make sure you are addressing it properly with your serial commands. Make sure the baud rate your software and Com Port require is the one your flow controller is using (**MENU > ADV SETUP > COMM SETUP > BAUD**).

Still experiencing issues?

Issue: ***None of the above helped.***

Action: We're here to help! Give us a call (1-888-290-6060) during our normal business hours (8am-5pm Mountain Standard Time) to get help from a friendly and capable applications engineer. Or, go to alicat.com and start a live chat. Is it after hours? Send an email to info@alicat.com, and we'll get in touch with you as soon as we can.

Additionally, we our troubleshooting page online might be more up to date than the manual. Please visit alicat.com/support.

Maintenance and Recalibration

Cleaning

Your flow controller requires no periodic cleaning, provided that it has been flowing clean, dry gas. If necessary, the outside of the device can be cleaned with a soft dry cloth.

If you suspect that debris or other foreign material has entered your device, do not take apart the flow body to clean it, as this will negate its NIST-traceable calibration. Please contact Alicat for cleaning.

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. This date is also stored inside your flow controller and is visible by selecting **MENU > ABOUT > DEVICE INFO**.

When it is time for your flow controller's annual recalibration, contact us by phone or live chat to set it up. Or, send an email to service@alicat.com, or fill out the form at alicat.com/service. We'll ask for your device's serial number and your contact information and send you an email with instructions for returning the flow controller to us.

Replacement Accessories

Please contact Alicat to order replacements for any accessories listed on page 63:

For repair, recalibration or recycling of this product contact:

Alicat Scientific, Inc.
service@alicat.com • alicat.com
7641 N Business Park Drive Tucson, AZ 85743 USA
1-888-290-6060

PURE NON-CORROSIVE GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
14	C2H2	Acetylene	104.44800	1.07200	0.9928000	97.374	1.1728	0.9905
0	Air	Air	184.89890	1.18402	0.9996967	172.574	1.2930	0.9994
1	Ar	Argon	226.23990	1.63387	0.9993656	210.167	1.7840	0.9991
16	i-C4H10	i-Butane	74.97846	2.44028	0.9735331	68.759	2.6887	0.9645
13	n-C4H10	n-Butane	74.05358	2.44930	0.9699493	67.690	2.7037	0.9591
4	CO2	Carbon Dioxide	149.31840	1.80798	0.9949545	137.107	1.9768	0.9933
3	CO	Carbon Monoxide	176.49330	1.14530	0.9996406	165.151	1.2505	0.9993
60	D2	Deuterium	126.59836	0.16455	1.0005970	119.196	0.1796	1.0006
5	C2H6	Ethane	93.54117	1.23846	0.9923987	86.129	1.3550	0.9901
15	C2H4	Ethylene (Ethene)	103.18390	1.15329	0.9942550	94.697	1.2611	0.9925
7	He	Helium	198.45610	0.16353	1.0004720	186.945	0.1785	1.0005
6	H2	Hydrogen	89.15355	0.08235	1.0005940	83.969	0.0899	1.0006
17	Kr	Krypton	251.32490	3.43229	0.9979266	232.193	3.7490	0.9972
2	CH4	Methane	110.75950	0.65688	0.9982472	102.550	0.7175	0.9976
10	Ne	Neon	311.12640	0.82442	1.0004810	293.822	0.8999	1.0005
8	N2	Nitrogen	178.04740	1.14525	0.9998016	166.287	1.2504	0.9995
9	N2O	Nitrous Oxide	148.41240	1.80888	0.9945327	136.310	1.9779	0.9928
11	O2	Oxygen	205.50210	1.30879	0.9993530	191.433	1.4290	0.9990
12	C3H8	Propane	81.46309	1.83204	0.9838054	74.692	2.0105	0.9785
19	SF6	Sulfur Hexafluoride	153.53200	6.03832	0.9886681	140.890	6.6162	0.9849
18	Xe	Xenon	229.84830	5.39502	0.9947117	212.157	5.8980	0.9932

***in micropoise (1 Poise = gram / (cm) (sec))** ****Grams/Liter** **Reference: NIST REFPROP 9 Database**

PURE CORROSIVES*			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
32	NH3	Ammonia	100.92580	0.70352	0.9894555	91.930	0.7715	0.9848612
80	1Butene	Butylene (1-Butene)	81.62541	2.35906	0.9721251	74.354	2.6036	0.9614456
81	cButene	Cis-Butene (cis-2-butene)	79.96139	2.36608	0.9692405	Liquid	Liquid	Liquid
82	iButene	Iso-Butene	80.84175	2.35897	0.9721626	73.640	2.6038	0.9613501
83	tButene	Trans-Butene	80.28018	2.36596	0.9692902	Liquid	Liquid	Liquid
84	COS	Carbonyl Sulfide	124.09600	2.48322	0.9888443	113.127	2.7202	0.985328
33	Cl2	Chlorine	134.56600	2.93506	0.9874470	125.464	3.1635	0.98407
85	CH3OCH3	Dimethylether	90.99451	1.91822	0.9816453	82.865	2.1090	0.9745473
34	H2S	Hydrogen Sulfide (H2S)	123.86890	1.40376	0.9923556	112.982	1.5361	0.9898858
31	NF3	NF3 (Nitrogen Trifluoride)	175.42500	2.91339	0.9963859	162.426	3.1840	0.9951506
30	NO	NO (Nitric Oxide)	190.05950	1.22672	0.9997970	176.754	1.3394	0.9995317
36	C3H6	Propylene (Propylene)	85.59895	1.74509	0.9856064	78.129	1.9139	0.9809373
86	SiH4	Silane (SiH4)	115.94400	1.32003	0.9945000	107.053	1.4433	0.99282
35	SO2	Sulfur Dioxide	127.83100	2.66427	0.9828407	116.717	2.9312	0.9750866

***Pure Corrosive gases are only available on S-Series instruments that are compatible with these gases.**

***in micropoise (1 Poise = gram / (cm) (sec)) **Grams/Liter Reference: NIST REFPROP 9 Database**

REFRIGERANTS			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
100	R-11	Trichlorofluoromethane	101.60480	5.82358	0.9641448	Liquid	Liquid	Liquid
101	R-115	Chloropentafluoroethane	125.14780	6.43293	0.9814628	114.891	7.0666	0.9752287
102	R-116	Hexafluoroethane	137.81730	5.70097	0.9895011	126.635	6.2458	0.9858448
103	R-124	Chlorotetrafluoroethane	115.93110	5.72821	0.9738286	105.808	6.3175	0.963807
104	R-125	Pentafliuoroethane	129.61740	4.98169	0.9847599	118.793	5.4689	0.979137
105	R-134A	Tetrafluoroethane	118.18820	4.25784	0.9794810	108.311	4.6863	0.9713825
106	R-14	Tetrafluoromethane	172.44680	3.61084	0.9962553	159.688	3.9467	0.9948964
107	R142B	Chlorodifluoroethane	104.20190	4.21632	0.9742264	95.092	4.6509	0.9640371
108	R-143A	Trifluoroethane	110.86600	3.49451	0.9830011	101.344	3.8394	0.9765755
109	R-152A	Difluoroethane	100.81320	2.75903	0.9785245	91.952	3.0377	0.9701025
110	R-22	NO (Nitric Oxide)	190.05950	1.22672	0.9997970	176.754	1.3394	0.9995317
111	R-23	Propylene (Propylene)	85.59895	1.74509	0.9856064	78.129	1.9139	0.9809373
112	R-32	Silane (SiH4)	115.94400	1.32003	0.9945000	107.053	1.4433	0.99282
113	RC-318	Sulfur Dioxide	127.83100	2.66427	0.9828407	116.717	2.9312	0.9750866
114	R-404A	44% R-125/4% R-134A/ 52% R-143A	120.30982	4.18002	0.98336342	111.584	4.5932	0.9770889
115	R-407C	23% R-32/25% R-125/ 52% R-143A	123.55369	3.95268	0.9826672	112.698	4.3427	0.9762849
116	R-410A	50% R-32/50% R-125	130.24384	3.56538	0.9861780	122.417	3.9118	0.9811061
117	R-507A	50% R-125/50% R-143A	121.18202	4.23867	0.9838805	112.445	4.6573	0.9774207

***Refrigerant gases are only available on S-Series instruments that are compatible with these gases.**

WELDING GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
23	C-2	2% CO2 / 98% Ar	224.71480	1.63727	0.9993165	208.673	1.7877	0.998993
22	C-8	8% CO2 / 92% Ar	220.13520	1.64749	0.9991624	204.199	1.7989	0.9987964
21	C-10	10% CO2 / 90% Ar	218.60260	1.65091	0.9991086	202.706	1.8027	0.9987278
140	C-15	15% CO2 / 85% Ar	214.74960	1.65945	0.9989687	198.960	1.8121	0.9985493
141	C-20	20% CO2 / 80% Ar	210.86960	1.66800	0.9988210	195.198	1.8215	0.9983605
20	C-25	25% CO2 / 75% Ar	206.97630	1.67658	0.9986652	191.436	1.8309	0.9981609
142	C-50	50% CO2 / 50% Ar	187.53160	1.71972	0.9977484	172.843	1.8786	0.9969777
24	C-75	75% CO2 / 25% Ar	168.22500	1.76344	0.9965484	154.670	1.9271	0.995401
25	He-25	25% He / 75% Ar	231.60563	1.26598	0.9996422	216.008	1.3814	0.9999341
143	He-50	50% He / 50% Ar	236.15149	0.89829	0.9999188	220.464	0.9800	1.00039
26	He-75	75% He / 25% Ar	234.68601	0.53081	1.0001954	216.937	0.5792	1.000571
144	He-90	90% He / 10% Ar	222.14566	0.31041	1.0003614	205.813	0.3388	1.00057
27	A1025	90%He/7.5%Ar/2.5%CO2	214.97608	0.31460	1.0002511	201.175	0.3433	1.000556
28	Star29	Stargon CS 90% Ar / 8% CO2 / 2% O2	219.79340	1.64099	0.9991638	203.890	1.7918	0.998798

***in micropoise (1 Poise = gram / (cm) (sec))** ****Grams/Liter** **Reference: NIST REFPROP 9 Database**

BIOREACTOR GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
145	Bio-5M	5% CH4 / 95% CO2	148.46635	1.75026	0.9951191	136.268	1.9134	0.9935816
146	Bio-10M	10% CH4 / 90% CO2	147.54809	1.69254	0.9952838	135.383	1.8500	0.993893
147	Bio-15M	15% CH4 / 85% CO2	146.55859	1.63484	0.9954484	134.447	1.7867	0.9941932
148	Bio-20M	20% CH4 / 80% CO2	145.49238	1.57716	0.9956130	133.457	1.7235	0.994482
149	Bio-25M	25% CH4 / 75% CO2	144.34349	1.51950	0.9957777	132.407	1.6603	0.9947594
150	Bio-30M	30% CH4 / 70% CO2	143.10541	1.46186	0.9959423	131.290	1.5971	0.9950255
151	Bio-35M	35% CH4 / 65% CO2	141.77101	1.40424	0.9961069	130.102	1.5340	0.9952803
152	Bio-40M	40% CH4 / 60% CO2	140.33250	1.34664	0.9962716	128.834	1.4710	0.9955239
153	Bio-45M	45% CH4 / 55% CO2	138.78134	1.28905	0.9964362	127.478	1.4080	0.9957564
154	Bio-50M	50% CH4 / 50% CO2	137.10815	1.23149	0.9966009	126.025	1.3450	0.9959779
155	Bio-55M	55% CH4 / 45% CO2	135.30261	1.17394	0.9967655	124.462	1.2821	0.9961886
156	Bio-60M	60% CH4 /40% CO2	133.35338	1.11642	0.9969301	122.779	1.2193	0.9963885
157	Bio-65M	65% CH4 /35% CO2	131.24791	1.05891	0.9970948	120.959	1.1564	0.9965779
158	Bio-70M	70% CH4 / 30% CO2	128.97238	1.00142	0.9972594	118.987	1.0936	0.9967567
159	Bio-75M	75% CH4 / 25% CO2	126.51146	0.94395	0.9974240	116.842	1.0309	0.9969251
160	Bio-80M	80% CH4 / 20% CO2	123.84817	0.88650	0.9975887	114.501	0.9681	0.9970832
161	Bio-85M	85% CH4 / 15% CO2	120.96360	0.82907	0.9977533	111.938	0.9054	0.9972309
162	Bio-90M	90% CH4 / 10% CO2	117.83674	0.77166	0.9979179	109.119	0.8427	0.9973684
163	Bio-95M	95% CH4 / 5% CO2	114.44413	0.71426	0.9980826	106.005	0.7801	0.9974957

***in micropoise (1 Poise = gram / (cm) (sec))** ****Grams/Liter** **Reference: NIST REFPROP 9 Database**

BREATHING GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
164	EAN-32	32% O2 / 68% N2	186.86315	1.19757	0.9996580	174.925	1.3075	0.9993715
165	EAN	36% O2 / 64% N2	187.96313	1.20411	0.9996401	175.963	1.3147	0.9993508
166	EAN-40	40% O2 / 60% N2	189.06268	1.21065	0.9996222	176.993	1.3218	0.9993302
167	HeOx-20	20% O2 / 80% He	217.88794	0.39237	1.0002482	204.175	0.4281	1.000593
168	HeOx-21	21% O2 / 79% He	218.15984	0.40382	1.0002370	204.395	0.4406	1.000591
169	HeOx-30	30% O2 / 70% He	219.24536	0.50683	1.0001363	205.140	0.5530	1.000565
170	HeOx-40	40% O2 / 60% He	218.59913	0.62132	1.0000244	204.307	0.6779	1.000502
171	HeOx-50	50% O2 / 50% He	216.95310	0.73583	0.9999125	202.592	0.8028	1.000401
172	HeOx-60	60% O2 / 40% He	214.82626	0.85037	0.9998006	200.467	0.9278	1.000257
173	HeOx-80	80% O2 / 20% He	210.11726	1.07952	0.9995768	195.872	1.1781	0.9998019
174	HeOx-99	99% O2 / 1% He	205.72469	1.29731	0.9993642	191.646	1.4165	0.9990796
175	EA-40	Enriched Air-40% O2	189.42518	1.21429	0.9996177	177.396	1.3258	0.9993261
176	EA-60	Enriched Air-60% O2	194.79159	1.24578	0.9995295	182.261	1.3602	0.9992266
177	EA-80	Enriched Air-80% O2	200.15060	1.27727	0.9994412	186.937	1.3946	0.9991288
178	Metabol	Metabolic Exhalant (16% O2 / 78.04% N2 / 5% CO2 / 0.96% Ar)	180.95936	1.20909	0.9994833	170.051	1.3200	0.9992587

***in micropoise (1 Poise = gram / (cm) (sec))** ****Grams/Liter** **Reference: NIST REFPROP 9 Database**

FUEL GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
185	Syn Gas-1	40% H2 + 29% CO + 20% CO2 + 11% CH4	155.64744	0.79774	0.9989315	144.565	0.8704	0.9992763
186	Syn Gas-2	64% H2 + 28% CO + 1% CO2 + 7% CH4	151.98915	0.43715	1.0001064	142.249	0.4771	1.000263
187	Syn Gas-3	70% H2 + 4% CO + 25% CO2 + 1% CH4	147.33686	0.56024	0.9991225	136.493	0.6111	0.9997559
188	Syn Gas-4	83% H2 + 14% CO + 3% CH4	133.63682	0.24825	1.0003901	125.388	0.2709	1.000509
189	Nat Gas-1	93% CH4 / 3% C2H6 / 1% C3H8 / 2% N2 / 1% CO2	111.77027	0.70709	0.9979255	103.189	0.7722	0.9973965
190	Nat Gas-2	95% CH4 / 3% C2H6 / 1% N2 / 1% CO2	111.55570	0.69061	0.9980544	103.027	0.7543	0.9974642
191	Nat Gas-3	95.2% CH4 / 2.5% C2H6 / 0.2% C3H8 / 0.1% C4H10 / 1.3% N2 / 0.7% CO2	111.49608	0.68980	0.9980410	102.980	0.7534	0.9974725
192	Coal Gas	50% H2 / 35% CH4 / 10% CO / 5% C2H4	123.68517	0.44281	0.9993603	115.045	0.6589	0.996387
193	Endo	75% H2 + 25% N2	141.72100	0.34787	1.0005210	133.088	0.3797	1.000511
194	HHO	66.67% H2 / 33.33% O2	180.46190	0.49078	1.0001804	168.664	0.5356	1.000396
195	HD-5	LPG 96.1% C3H8 / 1.5% C2H6 / 0.4% C3H6 / 1.9% n-C4H10	81.45829	1.83428	0.9836781	74.933	2.0128	0.9784565
196	HD-10	LPG 85% C3H8 / 10% C3H6 / 5% n-C4H10	81.41997	1.85378	0.9832927	74.934	2.0343	0.9780499

LASER GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
179	LG-4.5	4.5% CO2 / 13.5% N2 / 82% He	199.24300	0.36963	1.0001332	187.438	0.4033	1.000551
180	LG-6	6% CO2 / 14% N2 / 80% He	197.87765	0.39910	1.0000471	186.670	0.4354	1.00053
181	LG-7	7% CO2 / 14% N2 / 79% He	197.00519	0.41548	0.9999919	186.204	0.4533	1.000514
182	LG-9	9% CO2 / 15% N2 / 76% He	195.06655	0.45805	0.9998749	184.835	0.4997	1.000478
183	HeNe-9	9% Ne / 91% He	224.68017	0.22301	1.0004728	211.756	0.2276	1.000516
184	LG-9.4	9.4% CO2 / 19.25% N2 / 71.35% He	193.78311	0.50633	0.9998243	183.261	0.5523	1.000458

*in micropoise (1 Poise = gram / (cm) (sec)) **Grams/Liter Reference: NIST REFPROP 9 Database

O2 CONCENTRATOR GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
197	OCG-89	89% O2 / 7% N2 / 4% Ar	204.53313	1.31033	0.9993849	190.897	1.4307	0.9990695
198	OCG-93	93% O2 / 3% N2 / 4% Ar	205.62114	1.31687	0.9993670	191.795	1.4379	0.9990499
199	OCG-95	95% O2 / 1% N2 / 4% Ar	206.16497	1.32014	0.9993580	192.241	1.4414	0.99904

STACK GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
200	FG-1	2.5% O2 / 10.8% CO2 / 85.7% N2 / 1% Ar	175.22575	1.22550	0.9992625	165.222	1.3379	0.9990842
201	FG-2	2.9% O2 / 14% CO2 / 82.1% N2 / 1% Ar	174.18002	1.24729	0.9991056	164.501	1.3617	0.9989417
202	FG-3	3.7% O2 / 15% CO2 / 80.3% N2 / 1% Ar	174.02840	1.25520	0.9990536	164.426	1.3703	0.9988933
203	FG-4	7% O2 / 12% CO2 / 80% N2 / 1% Ar	175.95200	1.24078	0.9991842	166.012	1.3546	0.9990116
204	FG-5	10% O2 / 9.5% CO2 / 79.5% N2 / 1% Ar	177.65729	1.22918	0.9992919	167.401	1.3419	0.9991044
205	FG-6	13% O2 / 7% CO2 / 79% N2 / 1% Ar	179.39914	1.21759	0.9993996	168.799	1.3293	0.9991932

CHROMATOGRAPHY GASES			25°C			0°C		
Gas Number	Short Name	Long Name	Absolute Viscosity*	Density** 14.696 PSIA	Compressibilty 14.696 PSIA	Absolute Viscosity	Density 14.696 PSIA	Compressibilty 14.696 PSIA
29	P-5	5% CH4 / 95% Ar	223.91060	1.58505	0.9993265	207.988	1.7307	0.9990036
206	P-10	10% CH4 90% Ar	221.41810	1.53622	0.9992857	205.657	1.6774	0.99895

***in micropoise (1 Poise = gram / (cm) (sec))** ****Grams/Liter** **Reference: NIST REFPROP 9 Database**

Numerical List of Gases

Number	Short Name	Long Name
0	Air	Air
1	Ar	Argon
2	CH4	Methane
3	CO	Carbon Monoxide
4	CO2	Carbon Dioxide
5	C2H6	Ethane
6	H2	Hydrogen
7	He	Helium
8	N2	Nitrogen
9	N2O	Nitrous Oxide
10	Ne	Neon
11	O2	Oxygen
12	C3H8	Propane
13	n-C4H10	n-Butane
14	C2H2	Acetylene
15	C2H4	Ethylene (Ethene)
16	i-C4H10	i-Butane
17	Kr	Krypton
18	Xe	Xenon
19	SF6	Sulfur Hexafluoride
20	C-25	25% CO2 / 75% Ar
21	C-10	10% CO2 / 90% Ar
22	C-8	8% CO2 / 92% Ar
23	C-2	2% CO2 / 98% Ar
24	C-75	75% CO2 / 25% Ar
25	He-25	25% He / 75% Ar
26	He-75	75% He / 25% Ar
27	A1025	90% He / 7.5% Ar / 2.5% CO2
28	Star29	Stargon CS 90% Ar / 8% CO2 / 2% O2
29	P-5	5% CH4 / 95% Ar
30	NO	NO (Nitric Oxide)
31	NF3	NF3 (Nitrogen Trifluoride)
32	NH3	Ammonia
33	Cl2	Chlorine
34	H2S	Hydrogen Sulfide (H2S)
35	SO2	Sulfur Dioxide
36	C3H6	Propylene (Propylene)
60	D2	Deuterium
80	1Butene	Butylene (1-Butene)
81	cButene	Cis-Butene (cis-2-butene)
82	iButene	Iso-Butene
83	tButene	Trans-Butene
84	COS	Carbonyl Sulfide
85	CH3OCH3	Dimethylether
86	SiH4	Silane (SiH4)
140	C-15	15% CO2 / 85% Ar
141	C-20	20% CO2 / 80% Ar

Number	Short Name	Long Name
142	C-50	50% CO2 / 50% Ar
143	He-50	50% He / 50% Ar
144	He-90	90% He / 10% Ar
145	Bio-5M	5% CH4 / 95% CO2
146	Bio-10M	10% CH4 / 90% CO2
147	Bio-15M	15% CH4 / 85% CO2
148	Bio-20M	20% CH4 / 80% CO2
149	Bio-25M	25% CH4 / 75% CO2
150	Bio-30M	30% CH4 / 70% CO2
151	Bio-35M	35% CH4 / 65% CO2
152	Bio-40M	40% CH4 / 60% CO2
153	Bio-45M	45% CH4 / 55% CO2
154	Bio-50M	50% CH4 / 50% CO2
155	Bio-55M	55% CH4 / 45% CO2
156	Bio-60M	60% CH4 /40% CO2
157	Bio-65M	65% CH4 /35% CO2
158	Bio-70M	70% CH4 / 30% CO2
159	Bio-75M	75% CH4 / 25% CO2
160	Bio-80M	80% CH4 / 20% CO2
161	Bio-85M	85% CH4 / 15% CO2
162	Bio-90M	90% CH4 / 10% CO2
163	Bio-95M	95% CH4 / 5% CO2
164	EAN-32	32% O2 / 68% N2
165	EAN	36% O2 / 64% N2
166	EAN-40	40% O2 / 60% N2
167	HeOx-20	20% O2 / 80% He
168	HeOx-21	21% O2 / 79% He
169	HeOx-30	30% O2 / 70% He
170	HeOx-40	40% O2 / 60% He
171	HeOx-50	50% O2 / 50% He
172	HeOx-60	60% O2 / 40% He
173	HeOx-80	80% O2 / 20% He
174	HeOx-99	99% O2 / 1% He
175	EA-40	Enriched Air-40% O2
176	EA-60	Enriched Air-60% O2
177	EA-80	Enriched Air-80% O2
178	Metabol	Metabolic Exhalant (16% O2 / 78.04% N2 / 5% CO2 / 0.96% Ar)
179	LG-4.5	4.5% CO2 / 13.5% N2 / 82% He
180	LG-6	6% CO2 / 14% N2 / 80% He
181	LG-7	7% CO2 / 14% N2 / 79% He
182	LG-9	9% CO2 / 15% N2 / 76% He
183	HeNe-9	9% Ne / 91% He
184	LG-9.4	9.4% CO2 / 19.25% N2 / 71.35% He
185	Syn Gas-1	40% H2 + 29% CO + 20% CO2 + 11% CH4
186	Syn Gas-2	64% H2 + 28% CO + 1% CO2 + 7% CH4

Number	Short Name	Long Name
187	Syn Gas-3	70% H2 + 4% CO + 25% CO2 + 1% CH4
188	Syn Gas-4	83%H2+14%CO+3%CH4
189	Nat Gas-1	93% CH4 / 3% C2H6 / 1% C3H8 / 2% N2 / 1% CO2
190	Nat Gas-2	95% CH4 / 3% C2H6 / 1% N2 / 1% CO2
191	Nat Gas-3	95.2% CH4 / 2.5% C2H6 / 0.2% C3H8 / 0.1% C4H10 / 1.3% N2 / 0.7% CO2
192	Coal Gas	50% H2 / 35% CH4 / 10% CO / 5% C2H4
193	Endo	75% H2 + 25% N2
194	HHO	66.67% H2 / 33.33% O2
195	HD-5	LPG 96.1% C3H8 / 1.5% C2H6 / 0.4% C3H6 / 1.9% n-C4H10
196	HD-10	LPG 85% C3H8 / 10% C3H6 / 5% n-C4H10
197	OCG-89	89% O2 / 7% N2 / 4% Ar
198	OCG-93	93% O2 / 3% N2 / 4% Ar
199	OCG-95	95% O2 / 1% N2 / 4% Ar
200	FG-1	2.5% O2 / 10.8% CO2 / 85.7% N2 / 1% Ar
201	FG-2	2.9% O2 / 14% CO2 / 82.1% N2 / 1% Ar
202	FG-3	3.7% O2 / 15% CO2 / 80.3% N2 / 1% Ar
203	FG-4	7% O2 / 12% CO2 / 80% N2 / 1% Ar
204	FG-5	10% O2 / 9.5% CO2 / 79.5% N2 / 1% Ar
205	FG-6	13% O2 / 7% CO2 / 79% N2 / 1% Ar
206	P-10	10% CH4 90% Ar

Device Units

Your device can display data in various engineering units. The most current listing of engineering units is available at alicat.com/units. You can change units from the Main Display (page 20) or from the Basic Configuration menu (page 30). Only the units appropriate to your flow controller are available for selection.

Flow Units

Volumetric	Standard	Normal	Notes
uL/m	SuL/m	NuL/m	microliter per minute
mL/s	SmL/s	NmL/s	milliliter per second
mL/m	SmL/m	NmL/m	milliliter per minute
mL/h	Sml/h	NmL/h	milliliter per hour
L/s	SL/s	NL/s	liter per second
LPM	SLPM	NLPM	liter per minute
L/h	SL/h	NL/h	liter per hour
US GPM			US gallon per minute
US GPH			US gallon per hour
CCS	SCCS	NCCS	cubic centimeter per second
CCM	SCCM	NCCM	cubic centimeter per minute
cm3/h	Scm3/h	Ncm3/h	cubic centimeter per hour
m3/m	Sm3/m	Nm3/m	cubic meter per minute
m3/h	Sm3/h	Nm3/h	cubic meter per hour
m3/d	Sm3/d	Nm3/d	cubic meter per day
in3/m	Sin3/m		cubic inch per minute
CFM	SCFM		cubic foot per minute
CFH	SCFH		cubic foot per hour
CFD	SCFD		cubic foot per day
	kSCFM		1000 cubic feet per minute
count	count	count	setpoint count, 0 – 64000
%	%	%	percent of full scale

True Mass Flow Units

Label	Notes
mg/s	milligram per second
mg/m	milligram per minute
g/s	gram per second
g/m	gram per minute
g/h	gram per hour
kg/m	kilogram per minute
kg/h	kilogram per hour
oz/s	ounce per second
oz/m	ounce per minute
lb/m	pound per minute
lb/h	pound per hour

Device Units

Pressure Units

Absolute/Barometric	Gauge	Notes
PaA	PaG	pascal
hPaA	hPaG	hectopascal
kPaA	kPaG	kilopascal
MPaA	MPaG	megapascal
mbarA	mbarG	millibar
barA	barG	bar
g/cm2A	g/cm2G	gram force per square centimeter
kg/cmA	kg/cmG	kilogram force per square centimeter
PSIA	PSIG	pound force per square inch
PSFA	PSFG	pound force per square foot
mTorrA	mTorrG	millitorr
torrA	torrG	torr
mmHgA	mmHgG	millimeter of mercury at 0 C
inHgA	inHgG	inch of mercury at 0 C
mmH2OA	mmH2OG	millimeter of water at 4 C (NIST conventional)
mmH2OA	mmH2OG	millimeter of water at 60 C
cmH2OA	cmH2OG	centimeter of water at 4 C (NIST conventional)
cmH2OA	cmH2OG	centimeter of water at 60 C
inH2OA	inH2OG	inch of water at 4 C (NIST conventional)
inH2OA	inH2OG	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	setpoint count, 0 – 64000
%	%	percent of full scale

Temperature Units

Label	Notes
°C	degree Celsius
°F	degree Farenheit
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

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
PVPS24U	Universal 100-240 VAC to 24 Volt DC Power Supply Adapter
PS24VHC	High current power supply for BB9 use with Large Valve Controllers
PVPS5USBU	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

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 MC and MCR Mass Flow Controllers

0 to 0.5 sccm Full Scale through 0 to 5000 slpm Full Scale

Standard Operating Specifications (Contact Alicat for available options)

Performance	MC & MCR Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale) High Accuracy option not available for units ranged under 5 sccm or over 500 slpm.
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	MC & MCR Mass Flow Controller	
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	145 psig	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	**MC:** None	**MCR:** Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	**MC:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. **MCR:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, 416 Stainless Steel, Silicon, Glass. If your application demands a different material, please contact Alicat.	

Communications / Power	MC & MCR Mass Flow Controller	
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature	
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS	
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Optional Secondary Analog Input/Output Signal[2]	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, 8 pin M12	
Supply Voltage	**MC:** 12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)	**MCR:** 24 to 30 Vdc
Supply Current	**MC**: 0.250 Amp	**MCR**: 0.750 Amp (**MCRH**: 2.0 Amp)

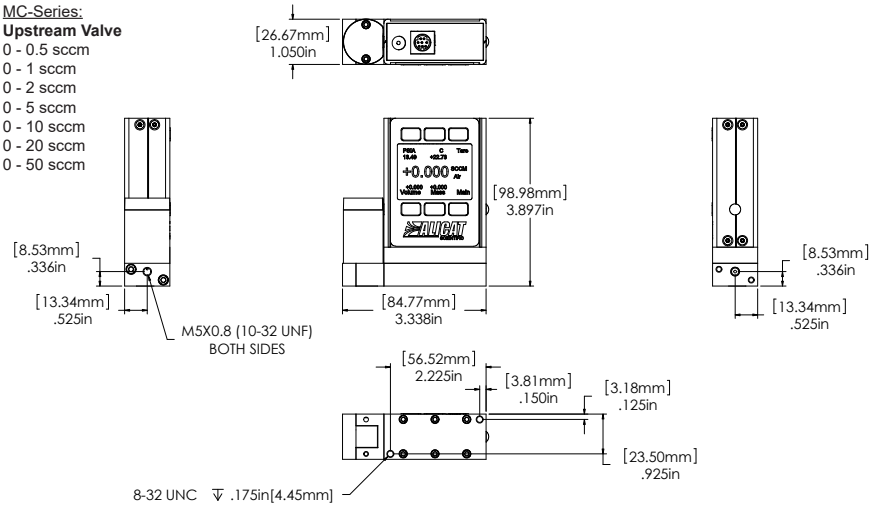
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature.

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[2]
MC 0.5 sccm to 50 sccm	1.0	3.9"H x 3.4"W x 1.1"D	M-5 (10-32) Female Thread[3]
MC 100 sccm to 500 sccm	1.0	4.1"H x 3.6"W x 1.1"D	1/8" NPT Female
MC 1 slpm	1.5		
MC 2 slpm	3.0		
MC 5 slpm	2.0		
MC 10 slpm	5.5		
MC 20 slpm	20.0		
MCR 50 slpm	2.0	5.5"H x 7.7"W x 2.3"D	1/4" NPT Female
MCR 100 slpm	3.2		
MCR 250 slpm	2.4	5.5"H x 7.7"W x 2.3"D	1/2" NPT Female
MCR 500 slpm	6.5	5.5"H x 7.4"W x 2.3"D	3/4" NPT Female (A 1-1/4" NPT Female process connection is available for 2000 slpm controllers.)
MCR 1000 slpm	14.0		
MCR 1500 slpm	17.0		
MCR 2000 slpm	28.6	5.5"H x 8.1" W x 2.9" D	
MCR 3000 slpm	16.8	5.5"H x 8.9" W x 2.9" D	1-1/4" NPT Female
MCRH 5000 slpm	14.1	6.3"H x 9.8"W x 4.5"D	2" NPT Female

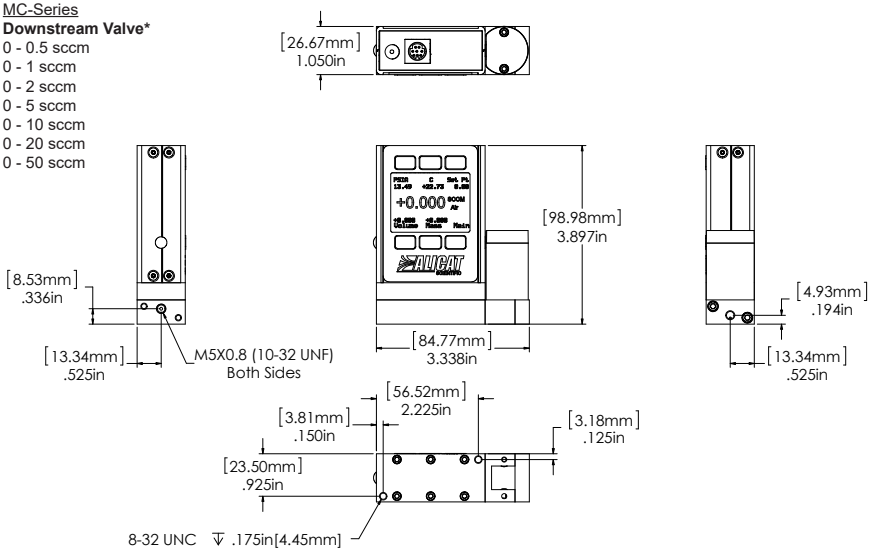
1. Lower Pressure Drops Available, please see our **WHISPER-Series** mass flow controllers at ***www.alicat.com/whisper***.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

MC-Series:
Upstream Valve
0 - 0.5 sccm
0 - 1 sccm
0 - 2 sccm
0 - 5 sccm
0 - 10 sccm
0 - 20 sccm
0 - 50 sccm



MC 0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

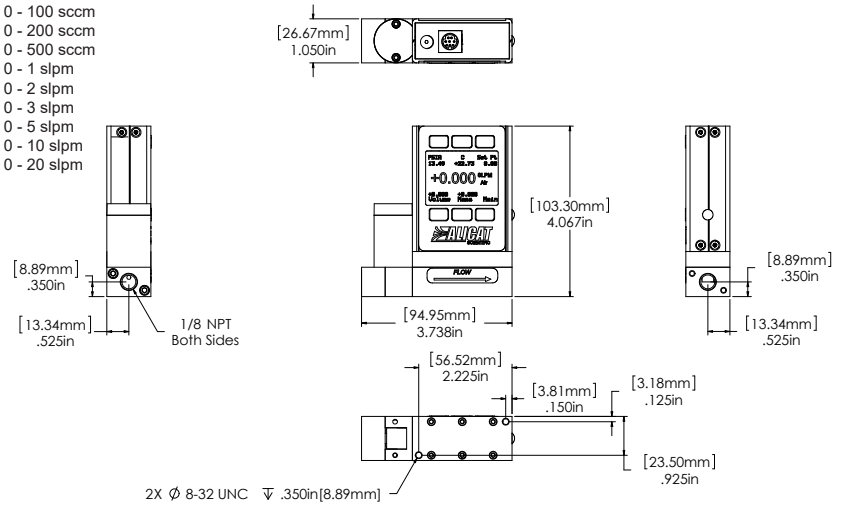
MC-Series
Downstream Valve*
0 - 0.5 sccm
0 - 1 sccm
0 - 2 sccm
0 - 5 sccm
0 - 10 sccm
0 - 20 sccm
0 - 50 sccm



* Note process connection port locations for downstream valve in this flow range.

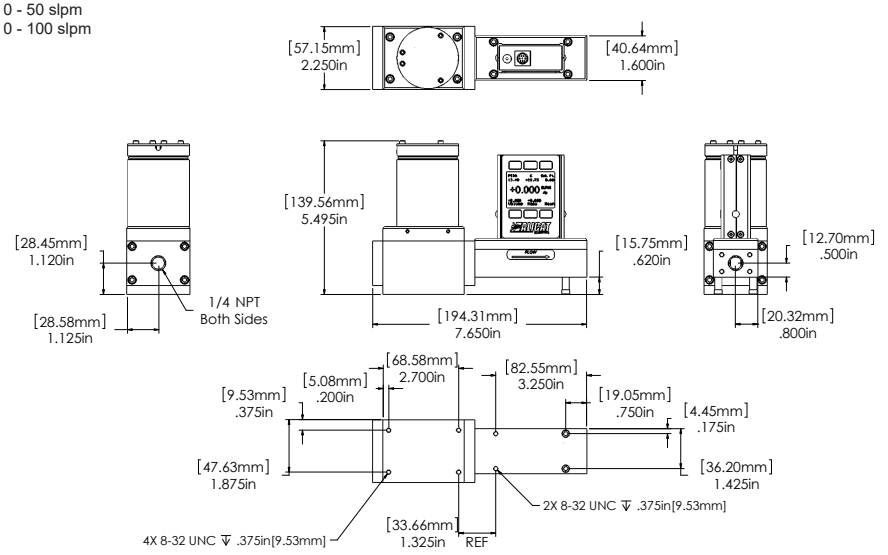
MC 0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

MC-Series:
0 - 100 sccm
0 - 200 sccm
0 - 500 sccm
0 - 1 slpm
0 - 2 slpm
0 - 3 slpm
0 - 5 slpm
0 - 10 slpm
0 - 20 slpm



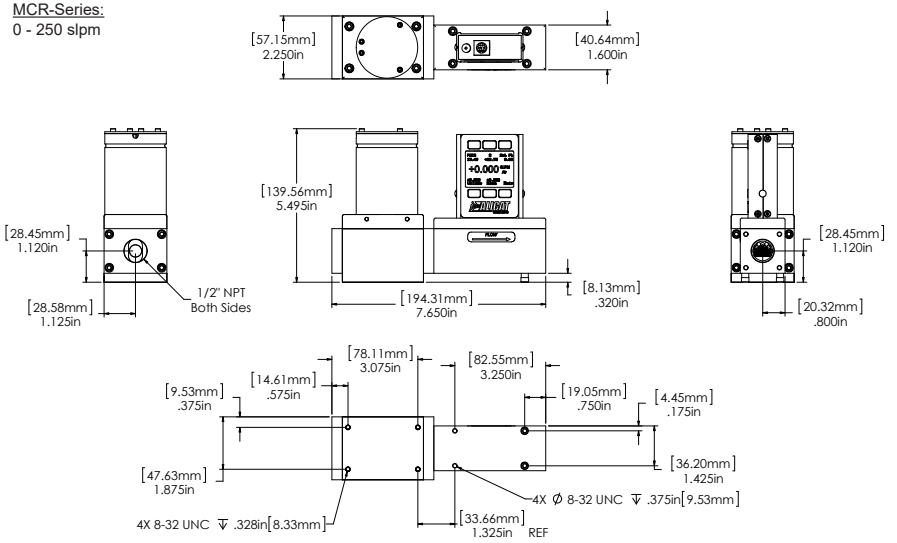
MC 100 sccm to 20 slpm approximate weight: 1.2lb

MCR-Series:
0 - 50 slpm
0 - 100 slpm



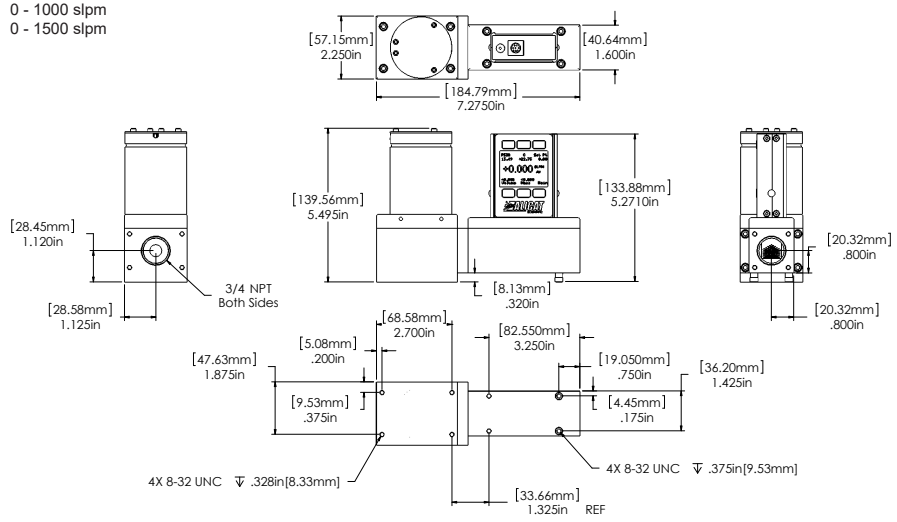
MCR 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCR-Series:
0 - 250 slpm



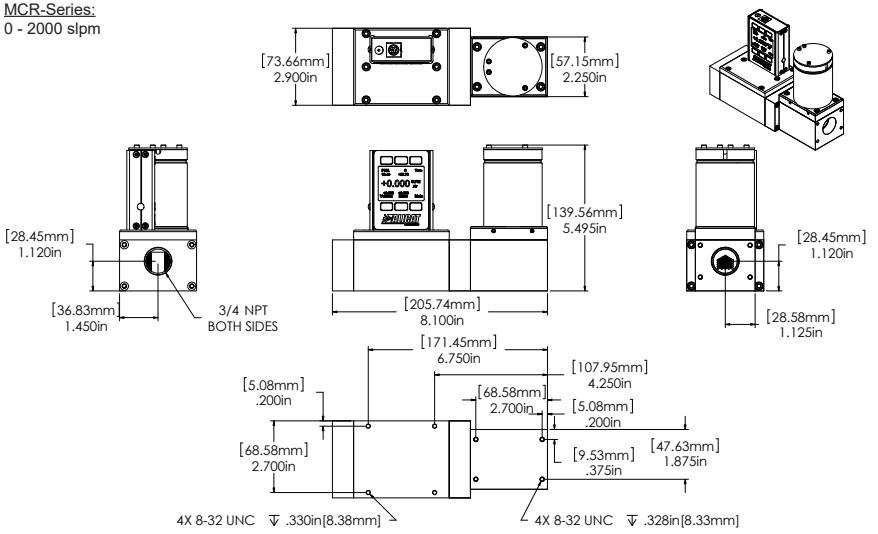
MCR 250 slpm approximate weight: 9.0 lb.

MCR-Series:
0 - 500 slpm
0 - 1000 slpm
0 - 1500 slpm



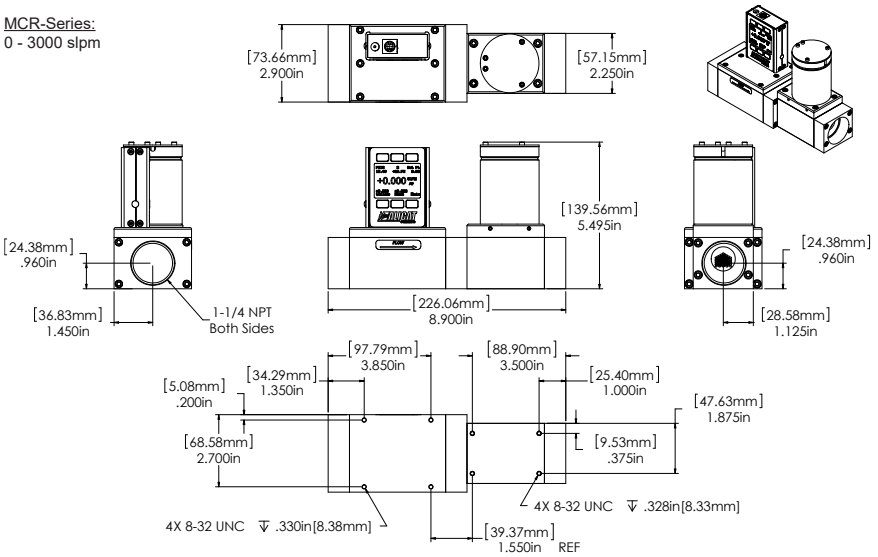
MCR 1500 slpm approximate weight: 9.0 lb.

MCR-Series:
0 - 2000 slpm



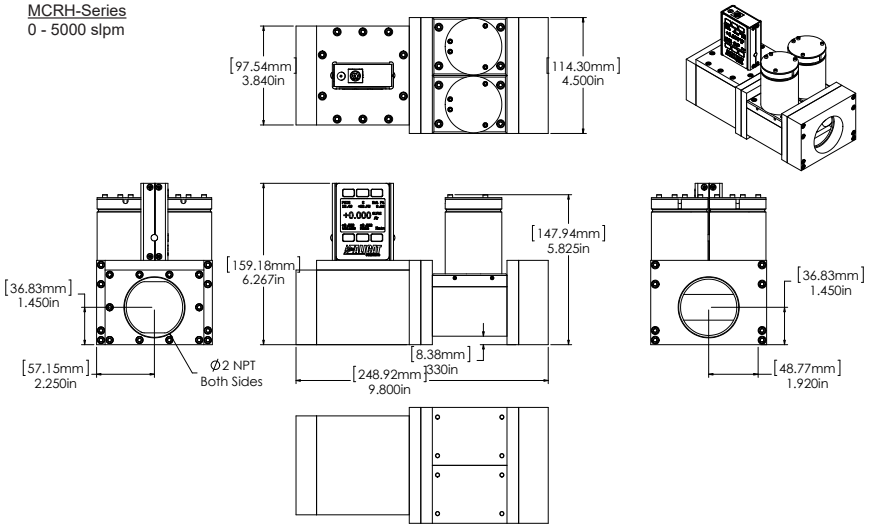
MCR 2000 slpm approximate weight: 12.0 lb.

MCR-Series:
0 - 3000 slpm



MCR 3000 slpm approximate weight: 12.0 lb.

MCRH-Series
0 - 5000 slpm



MCRH 5000 slpm approximate weight: 28.0 lb.

Technical Data for WHISPER Low Pressure Drop Mass Flow Controllers
0 to 0.5 sccm Full Scale through 0 to 1000 slpm Full Scale

Standard Specifications (Contact Alicat for available options.)

Performance	Whisper MCW & MCRW Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale) High Accuracy option not available for units ranged under 5 sccm or over 500 slpm.
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	Whisper MCW & MCRW Mass Flow Controller	
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	45 psig Higher line pressures available, please contact Alicat.	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	**MCW:** None	**MCRW:** Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	**MCW:** 303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, Brass, 430FR Stainless Steel, Silicon, Glass. **MCRW:** 303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, 416 Stainless Steel, Nickel, Silicon, Glass. If your application demands a different material, please contact Alicat.	

Communications / Power	Whisper MCW & MCRW Mass Flow Controller		
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature		
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS		
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA		
Optional Secondary Analog Input/Output Signal[2]	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, 8 pin M12		
Supply Voltage	**MCW:** 12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)		**MCRW:** 24 to 30 Vdc
Supply Current	**MCW**: 0.250 Amp	**MCRW:** 0.750 Amp	**MCRWH:** 2.0 Amp

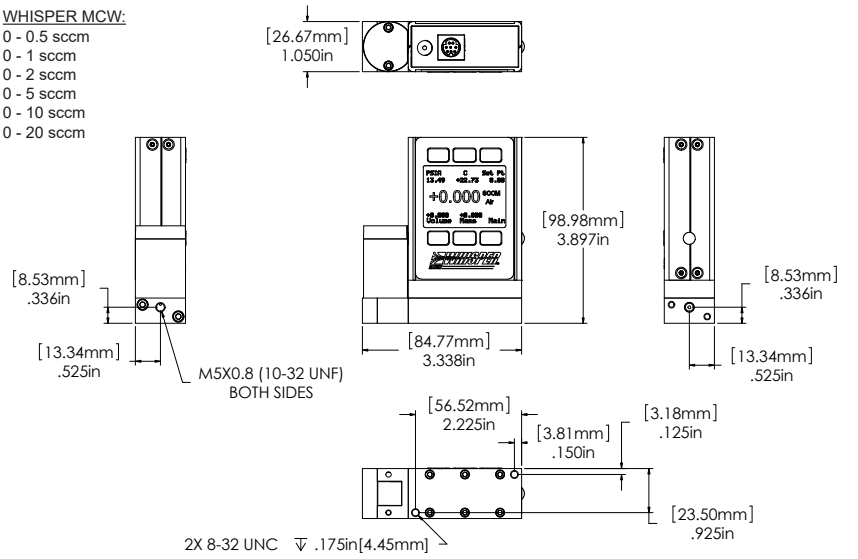
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[1]
MCW 0.5 sccm to 2 sccm	0.06	3.9"H x 3.4"W x 1.1"D	**M-5 (10-32) Female Thread[2]**
MCW 5 sccm to 10 sccm	0.08		
MCW 20 sccm	0.07		
MCW 50 sccm to 200 sccm	0.07	4.1"H x 3.6"W x 1.1"D	1/8" NPT Female
MCW 500 sccm	0.08		
MCW 1 slpm	0.10		
MCW 2 slpm	0.18		
MCRW 5 slpm	0.10	5.5"H x 7.7"W x 2.3"D	1/4" NPT Female
MCRW 10 slpm	0.12		
MCRW 20 slpm	0.26		
MCRW 40 slpm	0.14	5.5"H x 7.7"W x 2.3"D	1/2" NPT Female
MCRW 50 slpm	0.17	5.5"H x 7.3"W x 2.3"D	3/4" NPT Female
MCRW 100 slpm	0.30		
MCRW 250 slpm	0.69		
MCRW 500 slpm	0.69	5.5"H x 8.1"W x 2.7"D	3/4" NPT Female
MCRWH 1000 slpm	1.65	6.3"H x 9.8"W x 4.5"D	2" NPT Female

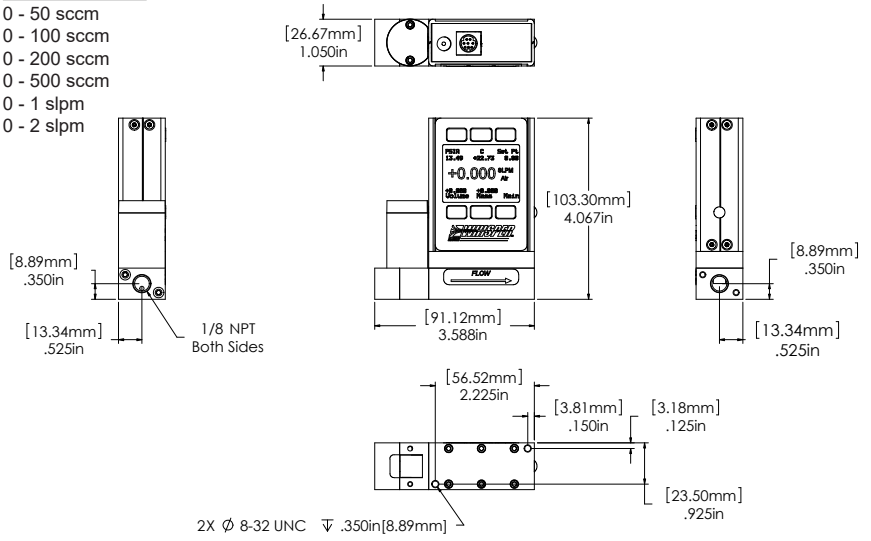
1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request. 2. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

WHISPER MCW:
0 - 0.5 sccm
0 - 1 sccm
0 - 2 sccm
0 - 5 sccm
0 - 10 sccm
0 - 20 sccm



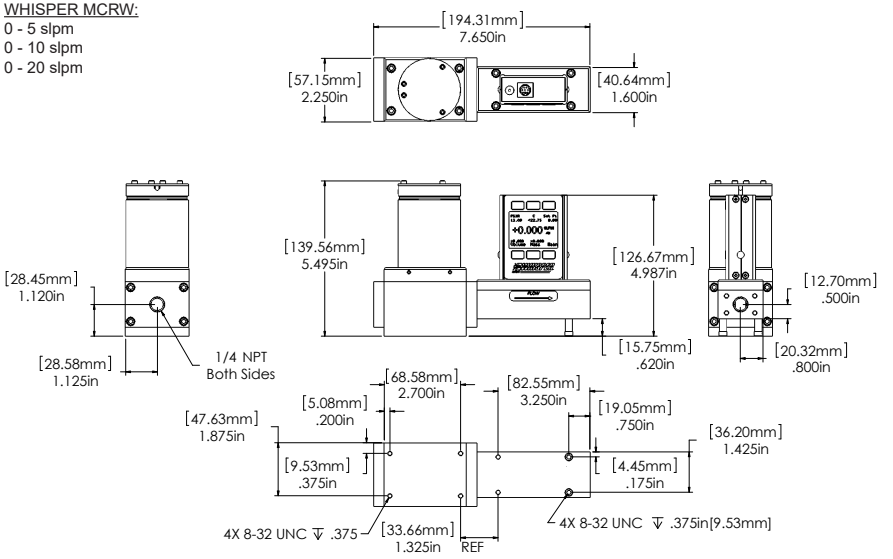
MCW 0.5 sccm to 20 sccm approximate shipping weight: 1.1 lb.

WHISPER MCW:
0 - 50 sccm
0 - 100 sccm
0 - 200 sccm
0 - 500 sccm
0 - 1 slpm
0 - 2 slpm



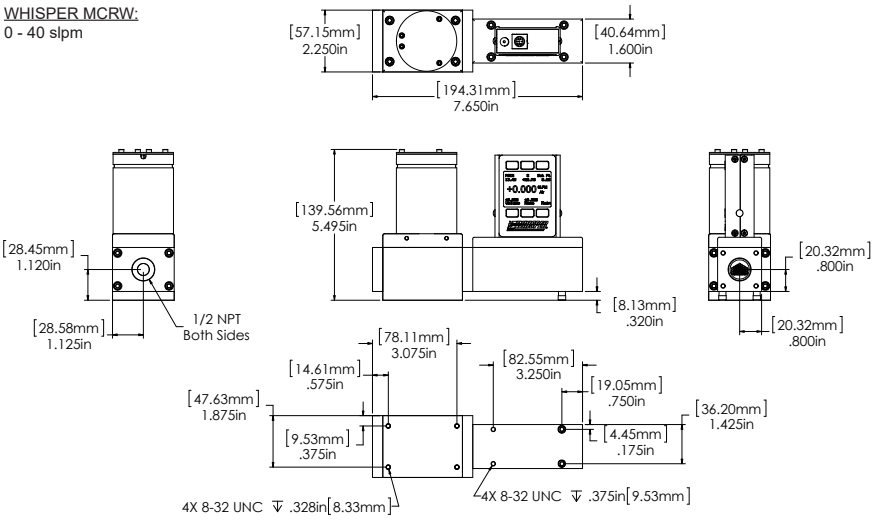
MCW 50 sccm to 2 slpm approximate weight: 1.2lb

WHISPER MCRW:
0 - 5 slpm
0 - 10 slpm
0 - 20 slpm



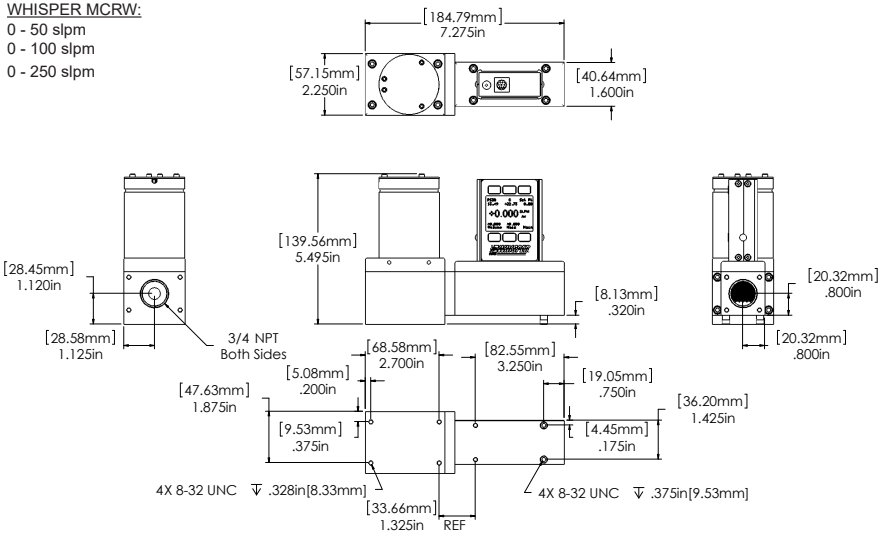
MCRW 5 slpm to 20 slpm approximate weight: 6.4 lb.

WHISPER MCRW:
0 - 40 slpm



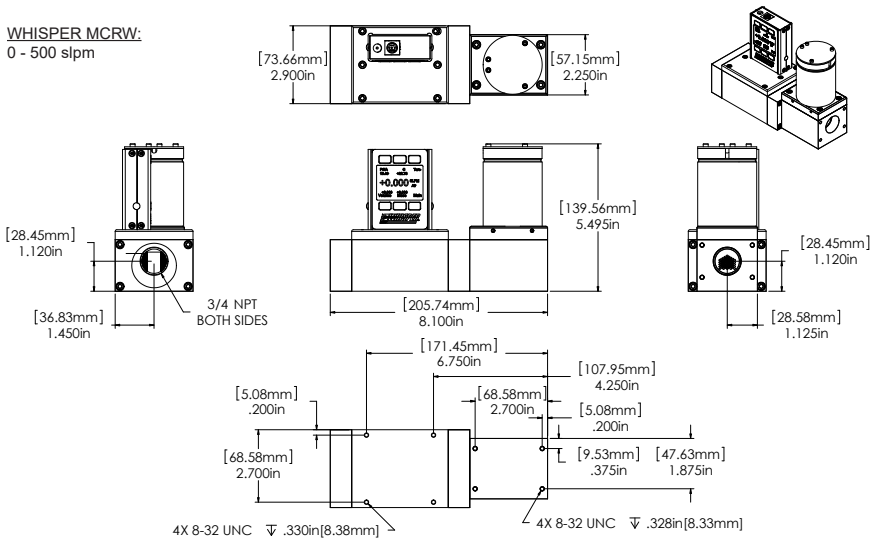
MCRW 40 slpm approximate weight: 9.0 lb.

WHISPER MCRW:
0 - 50 slpm
0 - 100 slpm
0 - 250 slpm



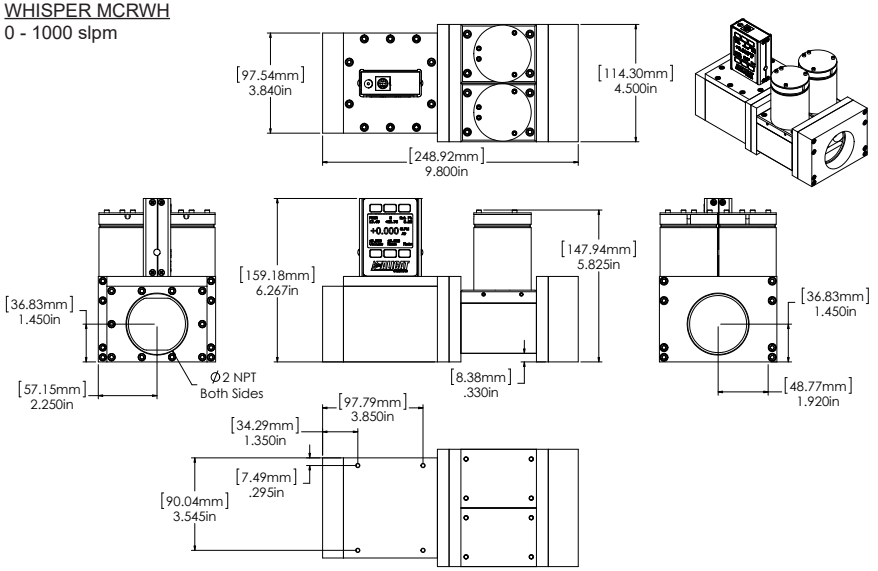
MCRW 50 slpm to 250 slpm approximate weight: 9.0 lb.

WHISPER MCRW:
0 - 500 slpm



MCRW 500 slpm approximate weight: 11.0 lb.

WHISPER MCRWH
0 - 1000 slpm



MCRHW 1000 slpm approximate weight: 28.0 lb.

Technical Data for Alicat MCV & MCVSMass Flow controllers

0 – 0.5 sccm Full Scale through 0 – 5000 slpm Full Scale

The Alicat **MCV** mass flow controller is designed for applications that require tight shut-off such as vacuum coating and sputtering processes. An integrated pneumatic shut-off valve is normally closed and provides positive shut-off of 1 x 10^{-9} atm scc/sec Helium max.
MCVS controllers are for use with aggressive gases.

Standard Specifications (Contact Alicat for available options.)

Performance	MCV Mass Flow Controller	MCVS Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)	
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale) High Accuracy option not available for units ranged under 5 sccm.	
Repeatability	± 0.2% Full Scale	
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm	
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown	1% to 100% Full Scale / 100:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale	
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)	
Typical Response Time	100 ms (Adjustable)	
Warm-up Time	< 1 Second	
Integrated Valve Leak Integrity	1 x 10^{-9} atm scc/sec Helium max	

Operating Conditions	MCV Mass Flow Controller	MCVS Mass Flow Controller
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	145 psig	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	None	
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	**MCV:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. **MCVS:** 316LSS, 303SS, 430FRSS, FFKM (Kalrez) standard, Viton, EPDM, Buna, Neoprene as needed for some gases. If your application demands a different material, please contact Alicat.	

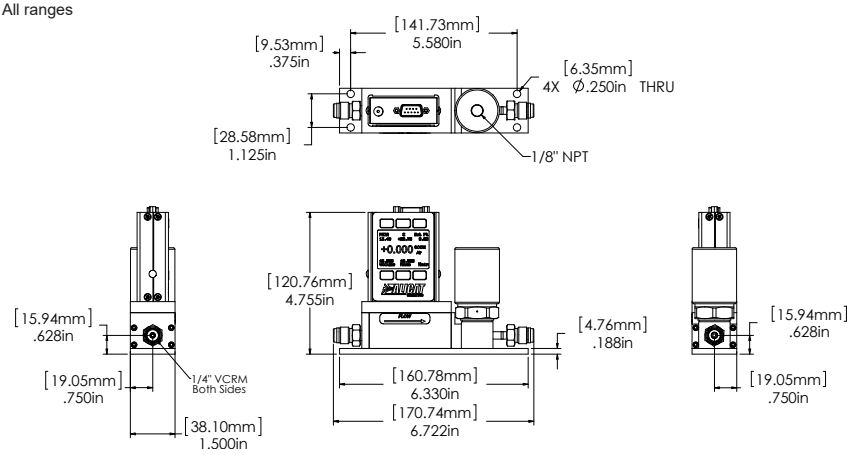
Communications / Power	Whisper MCV & MCVS Mass Flow Controller
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA
Optional Secondary Analog Input/ Output Signal[2]	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, 8 pin M12
Supply Voltage	12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)
Supply Current	0.250 Amp

1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

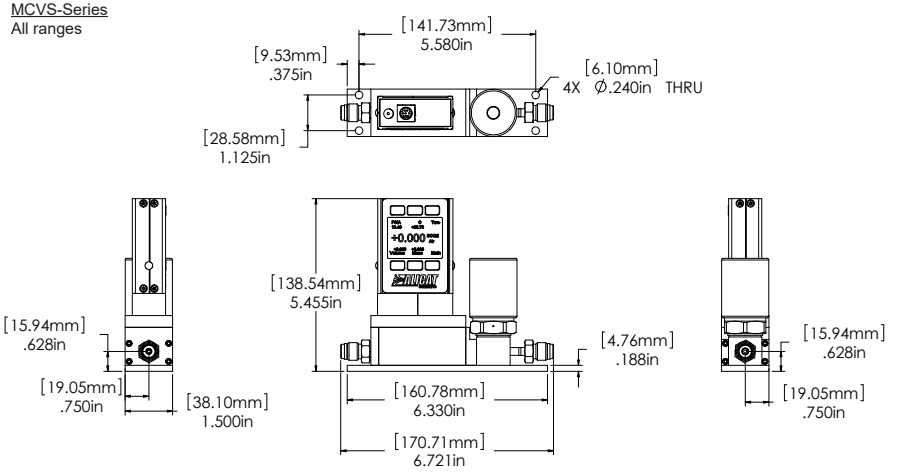
Full Scale Mass Flow Controller	Mechanical Dimensions	Process Connections
MCV 0.5SCCM to 20SLPM	4.8”H x 6.8”W x 1.5”D	1/4” VCR® Male
MCVS 0.5SCCM to 20SLPM	5.5”H x 6.8”W x 1.5”D	1/4” VCR® Male
Welded VCR® process connections are recommended for MCV and MCVS applications. Please contact Alicat.		

MCV-Series
All ranges



MCV approximate weight: 3.0 lb.

MCVS-Series
All ranges



MCVS approximate weight: 3.2 lb.

Technical Data for Alicat MCP Moderate Mass Flow controllers
0 to 10 slpm Full Scale through 0 to 250 slpm Full Scale

Alicat MCP mass flow controllers are fitted with a high performance valve for low pressure applications. The following specifications are applicable to Alicat MCP-Series Mass Flow Controllers only.

Standard Operating Specifications (Contact Alicat for available options)

Performance	MCP Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale)
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	MCP Mass Flow Controller
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)
Operating Temperature	−10 to +60 ºCelsius
Humidity Range (Non–Condensing)	0 to 100%
Max. Internal Pressure (Static)	145 psig
Proof Pressure	175 psig
Mounting Attitude Sensitivity	None
Valve Type	Normally Closed
Ingress Protection	IP40
Wetted Materials	303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. If your application demands a different material, please contact Alicat.

Communications / Power	MCP Mass Flow Controller
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA
Optional Secondary Analog Input/Output Signal[2]	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, 8 pin M12
Supply Voltage	12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)
Supply Current	0.250 Amp

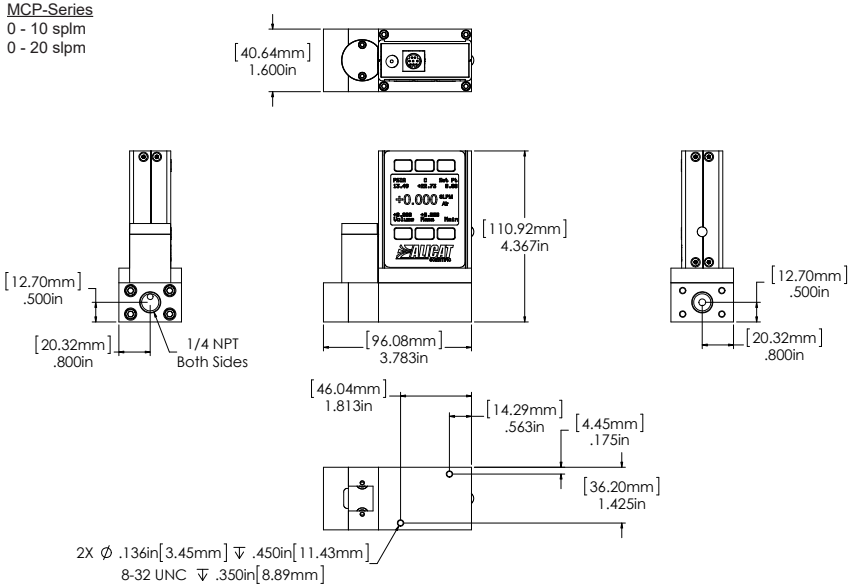
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[1]
MCP 10 slpm	1.1	4.4"H x 3.8"W x 1.6"D	1/4" NPT Female
MCP 20 slpm	1.5		
MCP 50 slpm	7	4.4"H x 5.4"W x 1.6"D	
MCP 100 slpm	20		
MCP 250 slpm	60	5.0"H x 6.3"W x 1.6"D	1/2" NPT Female

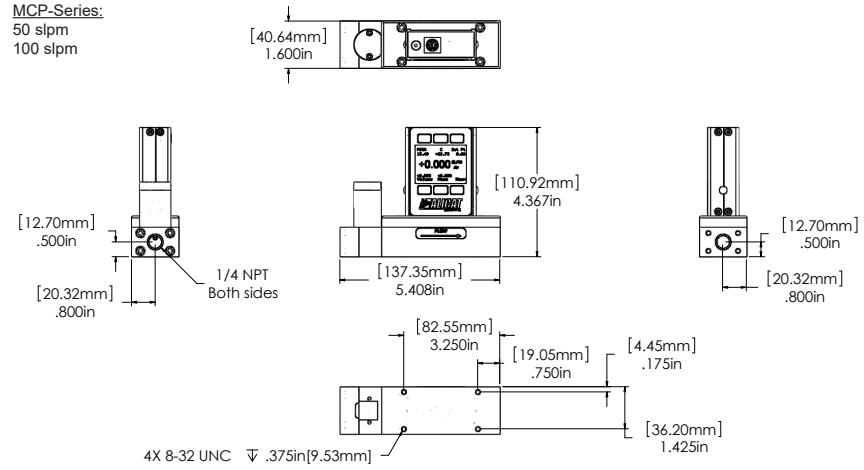
1. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

MCP-Series
0 - 10 slpm
0 - 20 slpm



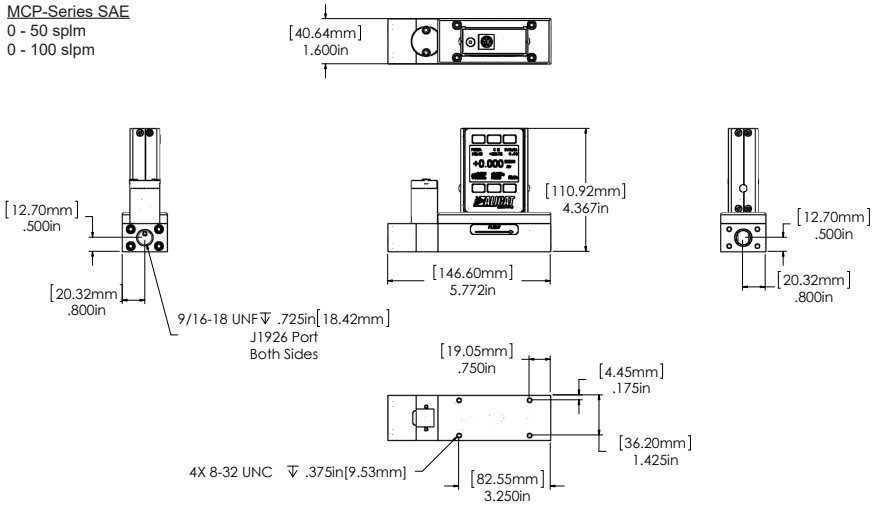
10 slpm to 20 slpm approximate shipping weight: 2.5 lb.

MCP-Series:
50 slpm
100 slpm



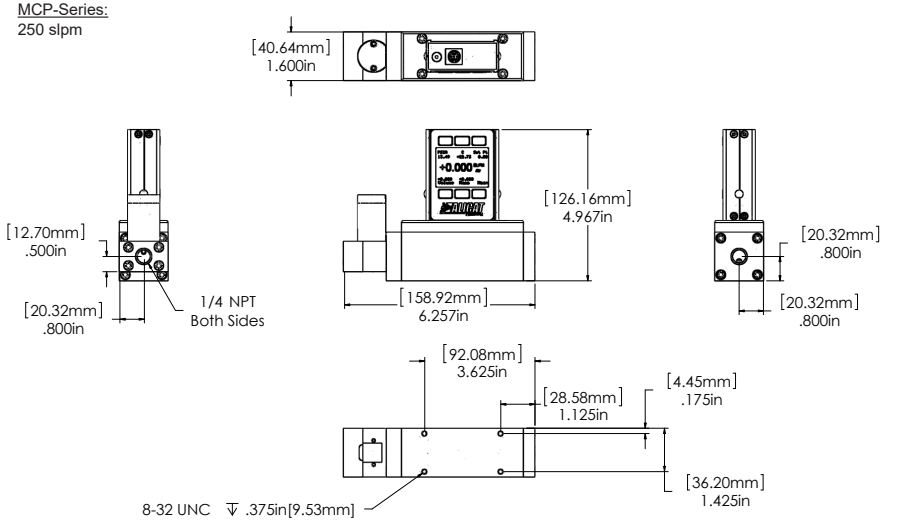
10 slpm to 50 slpm approximate shipping weight: 3.0 lb.

MCP-Series SAE
0 - 50 slpm
0 - 100 slpm



50 slpm to 100 slpm approximate shipping weight: 3.2 lb.

MCP-Series:
250 slpm



100 slpm to 250 slpm approximate shipping weight: 4.4 lb.

Technical Data for Alicat MCE and MCES Mass Flow controllers
0 – 0.5 sccm Full Scale through 0 – 20 slpm Full Scale

MCE mass flow controllers are built with a proportional valve positioned within the base of the unit. Please contact Alicat for MCE controller application information.
MCES controllers are for use with aggressive gases.

Standard Operating Specifications (Contact Alicat for available options)

Performance	MCE & MCES Mass Flow Controller	
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)	
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale)	
Repeatability	± 0.2% Full Scale	
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm	
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown	1% to 100% Full Scale / 100:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale	
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)	
Typical Response Time	100 ms (Adjustable)	
Warm-up Time	< 1 Second	

Operating Conditions	MCE & MCES Mass Flow Controller
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)
Operating Temperature	−10 to +60 ºCelsius
Humidity Range (Non–Condensing)	0 to 100%
Max. Internal Pressure (Static)	145 psig
Proof Pressure	175 psig
Mounting Attitude Sensitivity	None
Valve Type	Normally Closed
Ingress Protection	IP40
Wetted Materials	**MCE**: 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. **MCES**: 316LSS, 303SS, 430FRSS, FFKM (Kalrez) standard, Viton, EPDM, Buna, Neoprene as needed for some gases. If your application demands a different material, please contact Alicat.

Communications / Power	MCE & MCES Mass Flow Controller
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA
Optional Secondary Analog Input/Output Signal[2]	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 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)
Supply Current	0.250 Amp

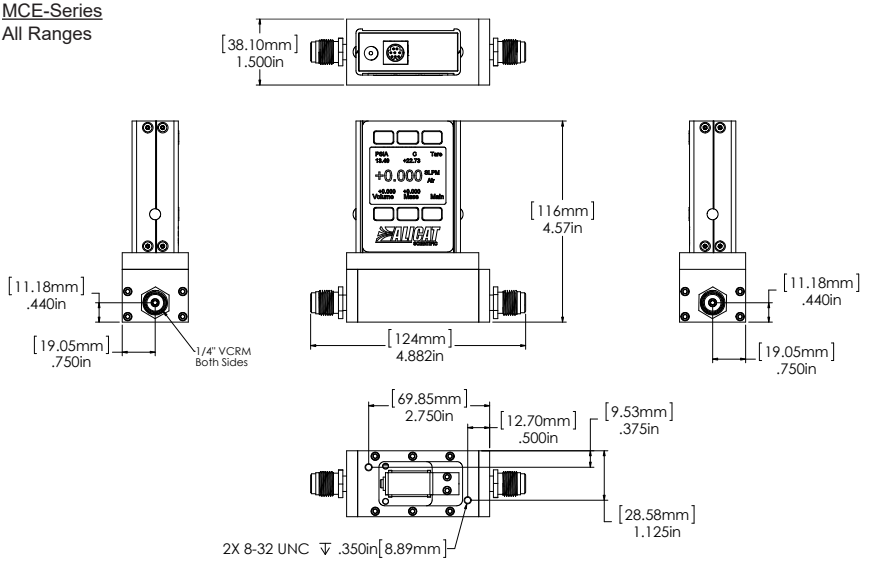
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[1]
MCE 0.5 sccm to 50 sccm	1.0	4.6"H x 4.9"W x 1.5"D	1/4" VCR® Male
MCE 100 sccm to 500 sccm	1.0		
MCE 1 slpm	1.5		
MCE 2 slpm	3.0		
MCE 5 slpm	2.0		
MCE 10 slpm	5.5		
MCE 20 slpm	20.0		

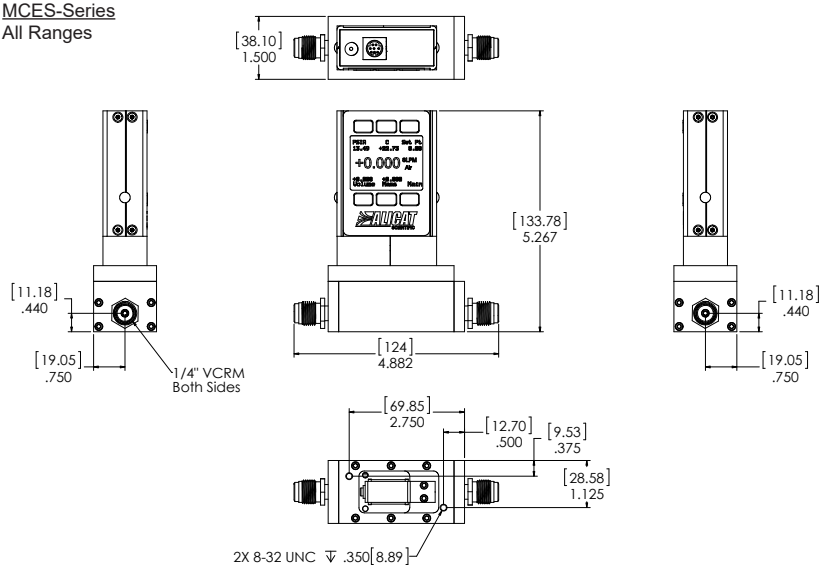
1. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

MCE-Series
All Ranges



MCE approximate weight: 3.0 lb.

MCES-Series
All Ranges



MCES approximate weight: 3.3 lb.

Technical Data for Alicat MCD and MCRD Dual Valve Mass Flow controllers

0 to 0.5 sccm Full Scale through 0 to 3000 slpm Full Scale

Standard Operating Specifications (Contact Alicat for available options)

Performance	MCD Mass Flow Controller	MCRD Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of reading + 0.2% of total span from positive full scale to negative full scale)	
High Accuracy at calibration conditions after tare	± (0.4% of total span from positive full scale to negative full scale) High Accuracy option not available for units ranged under 5 sccm or over 500 slpm.	
Repeatability	± 0.2% Full Scale	
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm	
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown	
Maximum Controllable Flow Rate	102.4% Full Scale	
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)	
Typical Response Time	100 ms (Adjustable)	
Warm-up Time	< 1 Second	

Operating Conditions	MCD Mass Flow Controller	MCRD Mass Flow Controller
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	145 psig	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	None	Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	**MCD:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass.. **MCRD:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, 416 Stainless Steel, Silicon, Glass. If your application demands a different material, please contact Alicat.	

Communications / Power	MCD Mass Flow Controller	MCRD Mass Flow Controller
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature	
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS	
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Optional Secondary Analog Input/Output Signal[2]	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, 8 pin M12	
Supply Voltage	12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)	24 to 30 Vdc
Supply Current	0.250 Amp	0.750 Amp

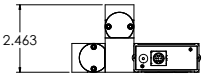
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

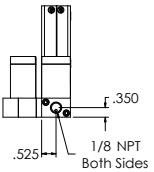
Range Specific Specifications

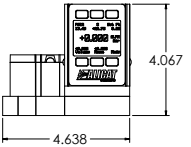
Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[2]
MCD 0.5 sccm to 50 sccm	1.0	Dimensions will vary with valve choice.	M-5 (10-32) Female Thread[3]
MCD 100 sccm to 500 sccm	1.0		1/8" NPT Female
MCD 1 slpm	1.5		
MCD 2 slpm	3.0		
MCD 5 slpm	2.0		
MCD 10 slpm	5.5		
MCD 20 slpm	20.0		
MCRD 50 slpm	2.0		1/4" NPT Female
MCRD 100 slpm	3.2		
MCRD 250 slpm	2.4		1/2" NPT Female
MCRD 500 slpm	6.5		3/4" NPT Female (A 1-1/4" NPT Female process connection is available for 2000 slpm controllers.)
MCRD 1000 slpm	14.0		
MCRD 1500 slpm	17.0		
MCRD 2000 slpm	28.6		
MCRD 3000 slpm	16.8		1-1/4" NPT Female

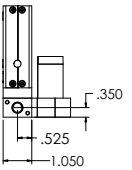
1. Lower Pressure Drops Available, please see our **WHISPER-Series** mass flow controllers at ***www.alicat.com/whisper***.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

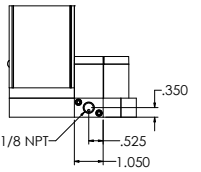
MCD-Series
0 - 20 slpm shown

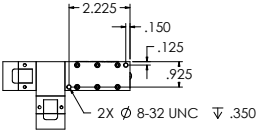




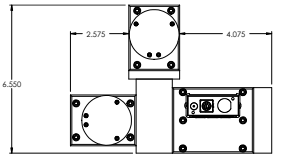


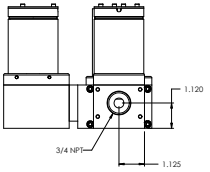


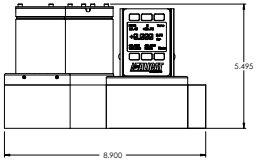


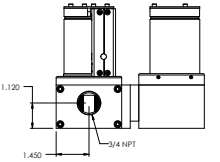


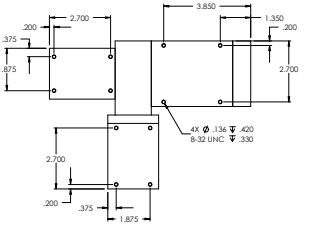
MCRD-Series
0 - 2000 slpm shown











Technical Data for Alicat MCS and MCRS Mass Flow controllers
0 – 0.5 sccm Full Scale through 0 – 5000 slpm Full Scale

Alicat MCS and MCRS instruments are built for use with certain aggressive gases.

Standard Operating Specifications (Contact Alicat for available options)

Performance	MCS & MCRS Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale) High Accuracy option not available for units ranged under 5 sccm or over 500 slpm.
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	1% to 100% Full Scale / 100:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	MCS & MCRS Mass Flow Controller	
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	145 psig	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	None	Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	316LSS, 303SS, 430FRSS, FFKM (Kalrez) standard, Viton, EPDM, Buna, Neoprene as needed for some gases. If your application demands a different material, please contact Alicat.	

Communications / Power	MCS & MCRS Mass Flow Controller	
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature	
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS	
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Optional Secondary Output Signal[2]	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 / 8-pin M12	
Supply Voltage	MCS: 12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)	MCRS / MCRHS: 24 to 30 Vdcc
Supply Current	MCS: 0.250 Amp	MCR; 0.750 Amp (MCRHS: 2.0 Amp)

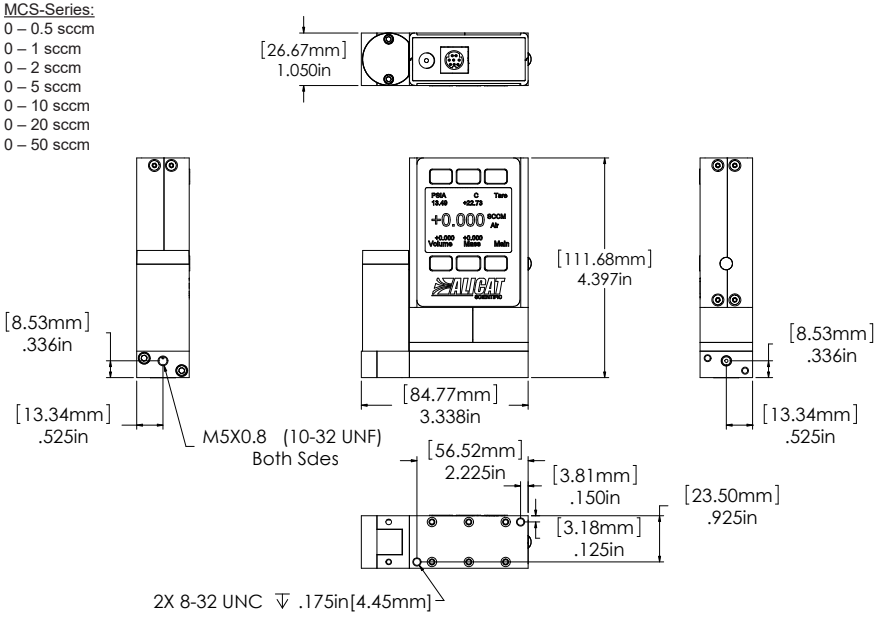
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[2]
MCS 0.5 sccm to 50 sccm	1.0	4.4"H x 3.4"W x 1.1"D	M-5 (10-32) Female Thread[3]
MCS 100 sccm to 500 sccm	1.0	4.6"H x 3.6"W x 1.1"D	1/8" NPT Female
MCS 1 slpm	1.5		
MCS 2 slpm	3.0		
MCS 5 slpm	2.0		
MCS 10 slpm	5.5		
MCS 20 slpm	20.0		
MCRS 50 slpm	2.0	5.7"H x 7.7"W x 2.3"D	1/4" NPT Female
MCRS 100 slpm	3.2		
MCRS 250 slpm	2.4	6.0"H x 7.7"W x 2.3"D	1/2" NPT Female
MCRS 500 slpm	6.5	6.0"H x 7.3"W x 2.3"D	3/4" NPT Female (A 1-1/4" NPT Female process connection is available for 2000 slpm controllers.)
MCRS 1000 slpm	14.0		
MCRS 1500 slpm	17.0		
MCRS 2000 slpm	28.6	6.0"H x 8.1"W x 2.9"D	
MCRS 3000 slpm	16.8	6.0"H x 8.9"W x 2.9"D	1-1/4" NPT Female
MCRHS 5000 slpm	14.1	7.0"H x 9.8"W x 4.5"D	

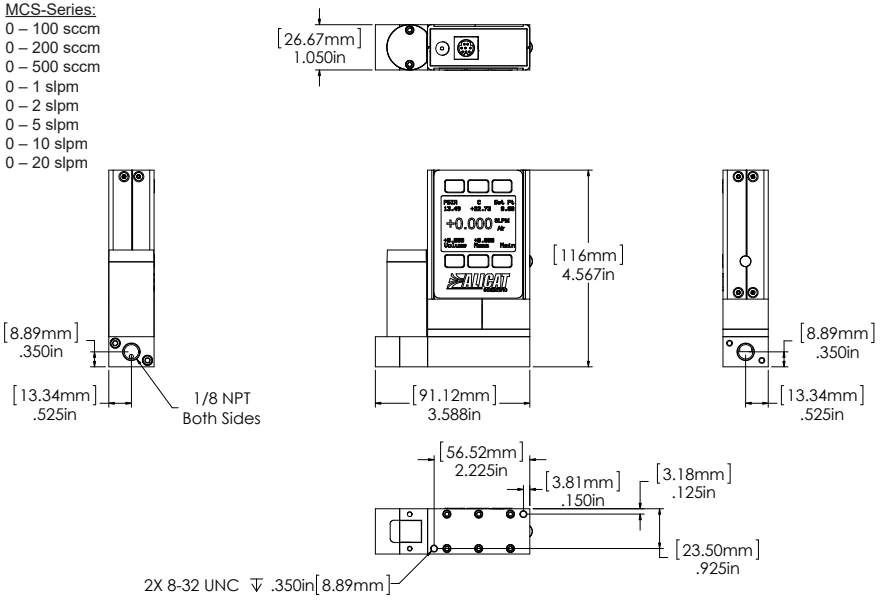
1. Lower Pressure Drops Available, please see our WHISPER-Series mass flow controllers at www.alicat.com/whisper.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with 316SS M-5 (10-32) Male Chemraz O-ring face seal to 1/8" Female NPT fittings

MCS-Series:
0 – 0.5 sccm
0 – 1 sccm
0 – 2 sccm
0 – 5 sccm
0 – 10 sccm
0 – 20 sccm
0 – 50 sccm



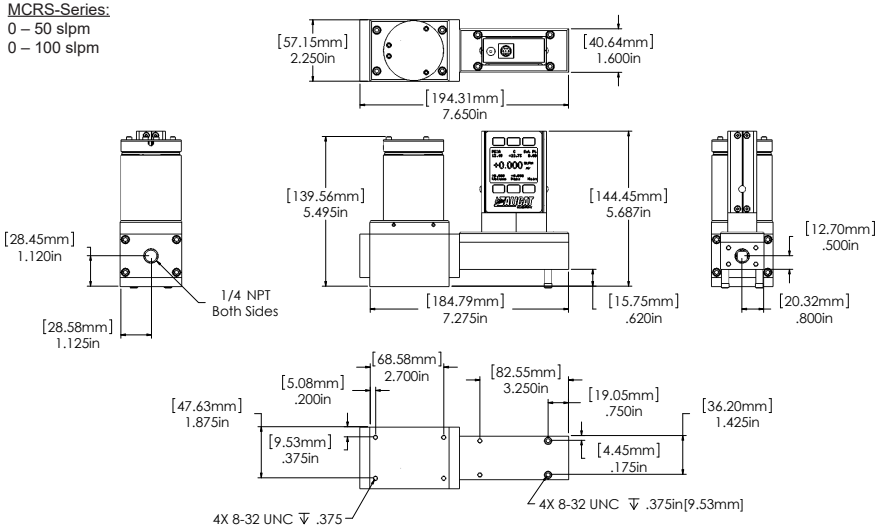
0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

MCS-Series:
0 – 100 sccm
0 – 200 sccm
0 – 500 sccm
0 – 1 slpm
0 – 2 slpm
0 – 5 slpm
0 – 10 slpm
0 – 20 slpm



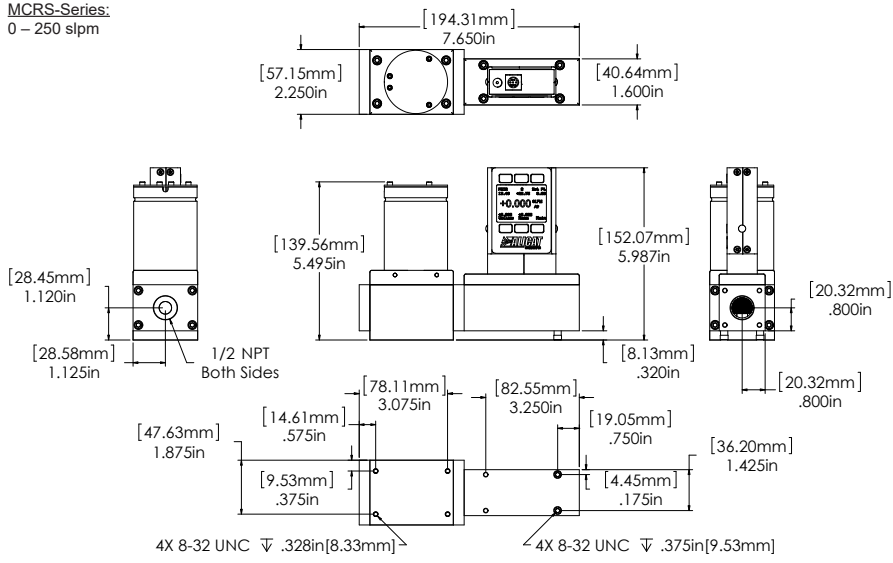
100 sccm to 20 slpm approximate weight: 1.2 lb

MCRS-Series:
0 – 50 slpm
0 – 100 slpm



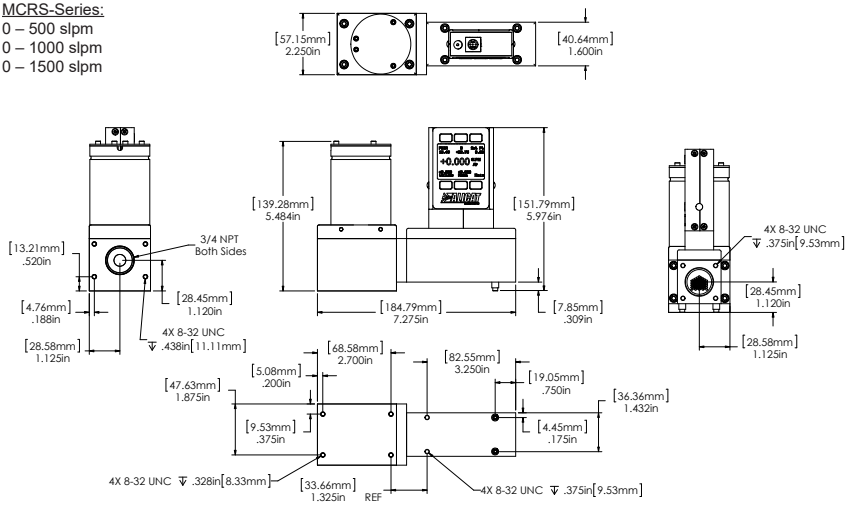
MCRS 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCRS-Series:
0 – 250 slpm



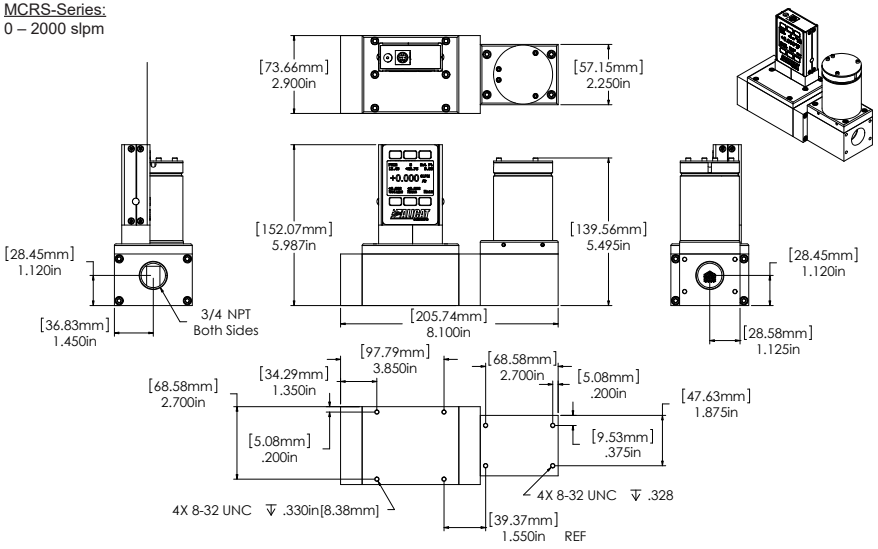
MCRS 250 slpm approximate weight: 9.0 lb.

MCRS-Series:
0 – 500 slpm
0 – 1000 slpm
0 – 1500 slpm



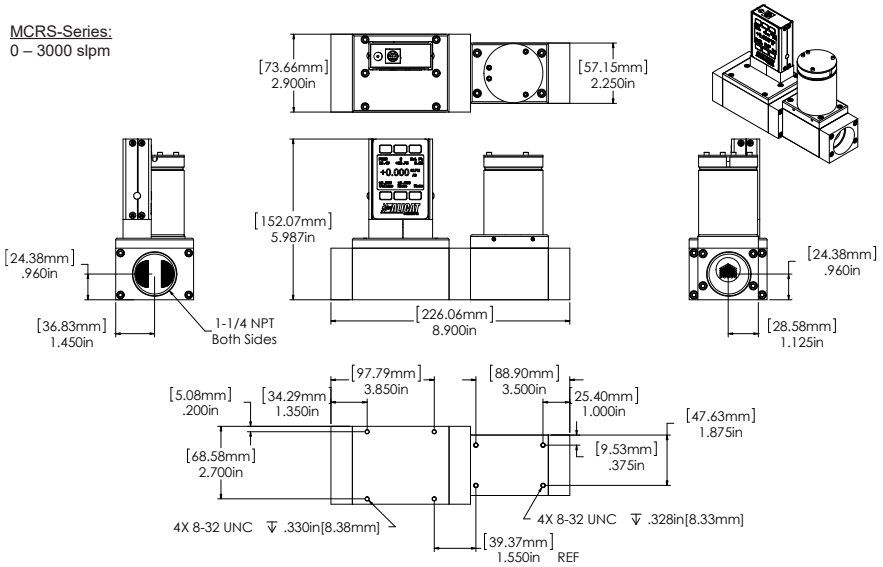
MCRS 500 slpm to 1500 slpm approximate weight: 9.0 lb.

MCRS-Series:
0 – 2000 slpm



MCRS 2000 slpm approximate weight: 12.0 lb.

MCRS-Series:
0 – 3000 slpm



MCRS 3000 slpm approximate weight: 12.0 lb.

Technical Data for Alicat MCQ and MCRQ Mass Flow Controllers

0 to 0.5 sccm Full Scale through 0 to 3000 slpm Full Scale

Alicat MCQ and MCRQ units are for high pressure applications. The flow rate is dependent on the pressure in that lower pressures will yield lower flow rates. The Q series should only be ordered after consulting Alicat. MCQ units are calibrated for operation at high pressure. Optimal performance is achieved at higher operating pressures.

Minimum Operating Pressure – 30 psia Maximum Operating Pressure – 320 psia

Standard Operating Specifications (Contact Alicat for available options)

Performance	MCQ & MCRQ Mass Flow Controller
Accuracy at calibration conditions after tare	± 2% of Full Scale
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	2% to 100% Full Scale / 50:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Maximum Measurable Flow Rate	up to 128% Full Scale (Gas Dependent)
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	MCQ & MCRQ QMass Flow Controller	
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)	
Operating Temperature	−10 to +60 ºCelsius	
Humidity Range (Non–Condensing)	0 to 100%	
Max. Internal Pressure (Static)	145 psig	
Proof Pressure	175 psig	
Mounting Attitude Sensitivity	**MCQ:** None	**MCRQ:** Mount with valve cylinder vertical & upright
Valve Type	Normally Closed	
Ingress Protection	IP40	
Wetted Materials	**MC:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. **MCR:** 303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, 416 Stainless Steel, Silicon, Glass. If your application demands a different material, please contact Alicat.	

Communications / Power	MCQ & MCRQ Mass Flow Controller	
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature	
Digital Communications Options[1]	RS-232 Serial, RS-485 Serial, DeviceNet, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP/IP, PROFIBUS	
Analog Input/Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 0-10 Vdc / 4-20 mA	
Optional Secondary Analog Input/Output Signal[2]	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, 8 pin M12	
Supply Voltage	**MCQ:** 12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)	**MCRQ:** 24 to 30 Vdc
Supply Current	**MCQ**: 0.250 Amp	**MCR**:Q 0.750 Amp (**MCRQH**: 2.0 Amp)

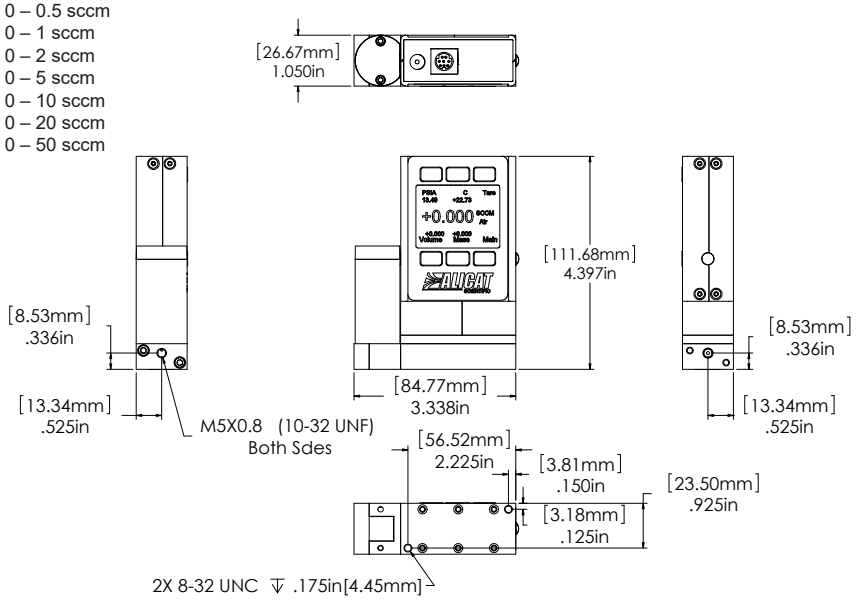
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[1]
MCQ 0.5 sccm to 50 sccm	1.0	4.4”H x 3.4”W x 1.1”D	M-5 (10-32) Female Thread[2]
MCQ 100 sccm to 500 sccm	1.0	4.6”H x 3.6”W x 1.1”D	1/8” NPT Female
MCQ 1 slpm	1.5		
MCQ 2 slpm	3.0		
MCQ 5 slpm	2.0		
MCQ 10 slpm	5.5		
MCQ 20 slpm	20.0		
MCRQ 50 slpm	2.0	5.7”H x 7.7”W x 2.3”D	1/4” NPT Female
MCRQ 100 slpm	3.2		
MCRQ 250 slpm	2.4	6.0”H x 7.7”W x 2.3”D	1/2” NPT Female
MCRQ 500 slpm	6.5	6.0”H x 7.3”W x 2.3”D	3/4” NPT Female (A 1-1/4” NPT Female process connection is available for 2000 slpm controllers.)
MCRQ 1000 slpm	14.0		
MCRQ 1500 slpm	17.0		
MCRQ 2000 slpm	28.6	6.0”H x 8.1”W x 2.9”D	
MCRQH 3000 slpm	16.8	6.0”H x 8.9”W x 2.9”D	1-1/4” NPT Female

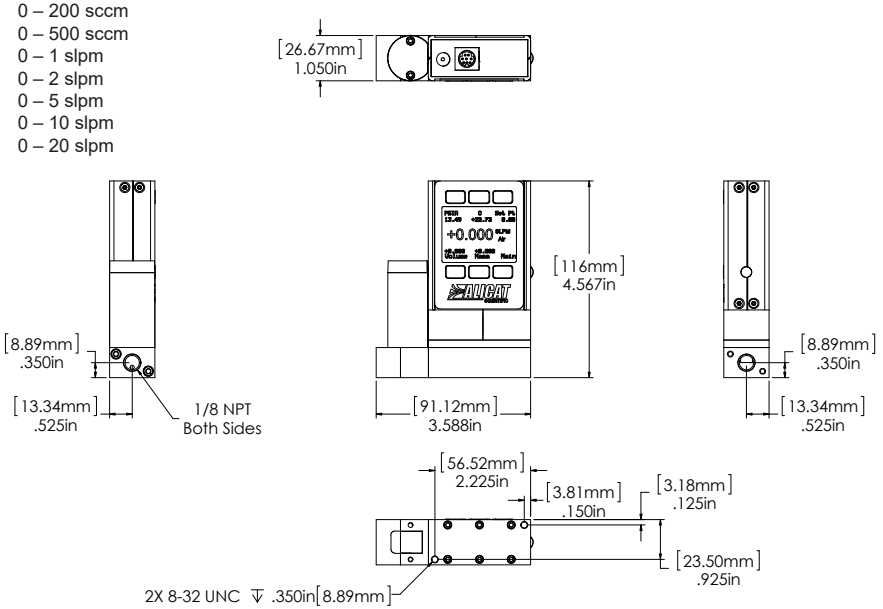
1. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
2. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8” Female NPT fittings.

MCQ-Series
0 – 0.5 sccm
0 – 1 sccm
0 – 2 sccm
0 – 5 sccm
0 – 10 sccm
0 – 20 sccm
0 – 50 sccm



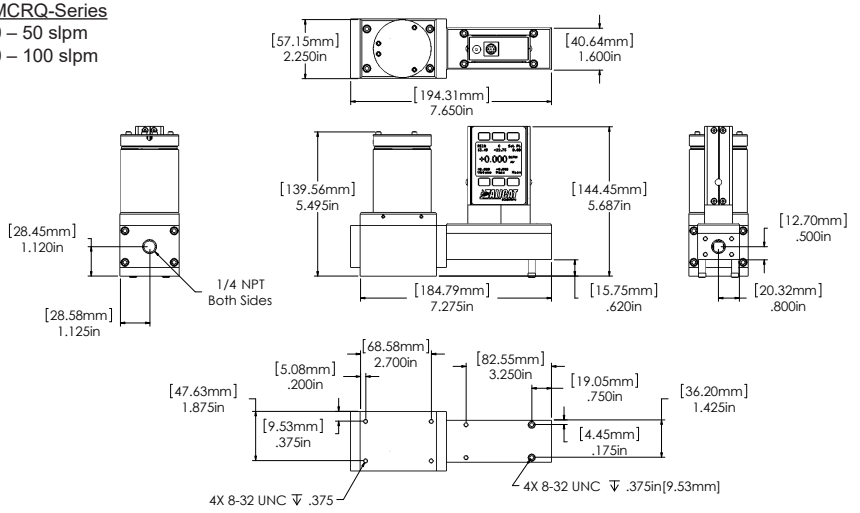
0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

MCQ-Series
0 – 100 sccm
0 – 200 sccm
0 – 500 sccm
0 – 1 slpm
0 – 2 slpm
0 – 5 slpm
0 – 10 slpm
0 – 20 slpm



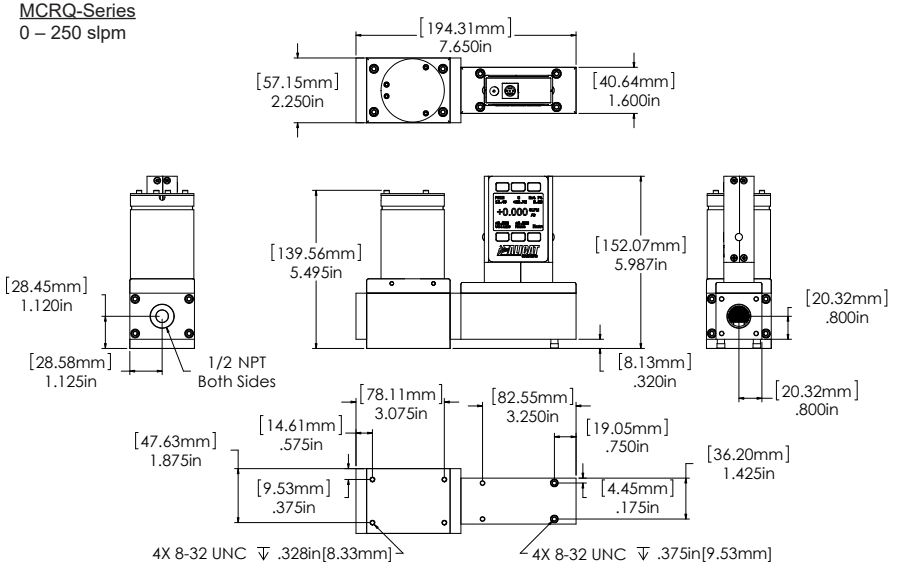
100 sccm to 20 slpm approximate weight: 1.2 lb

MCRQ-Series
0 – 50 slpm
0 – 100 slpm



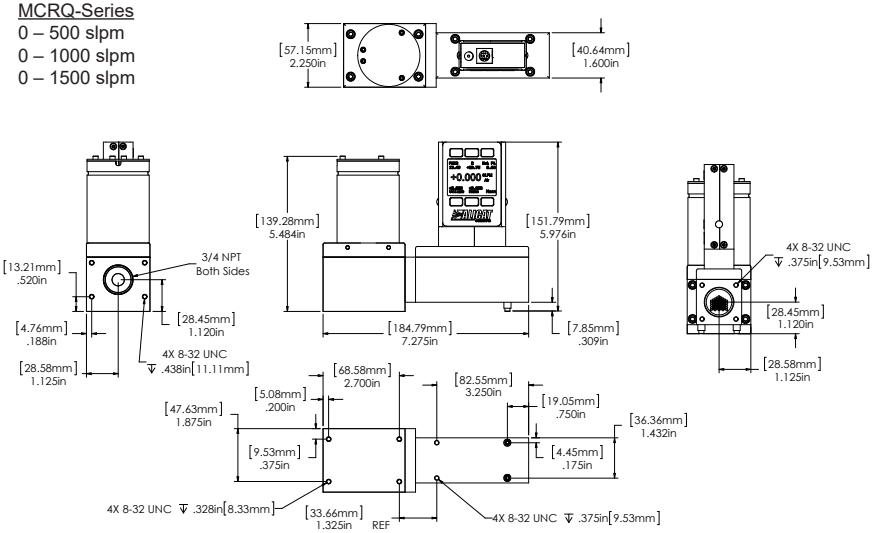
MCRQ 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCRQ-Series
0 – 250 slpm



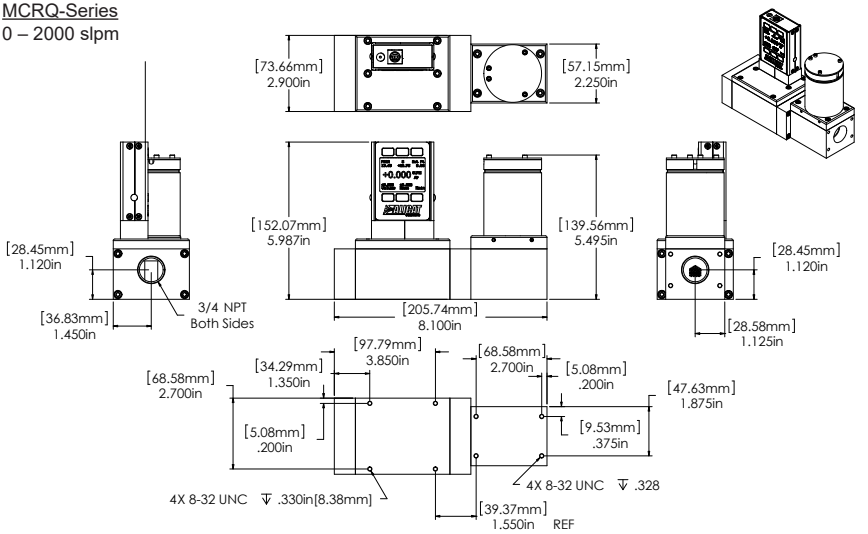
MCRQ 250 slpm approximate weight: 9.0 lb.

MCRQ-Series
0 – 500 slpm
0 – 1000 slpm
0 – 1500 slpm



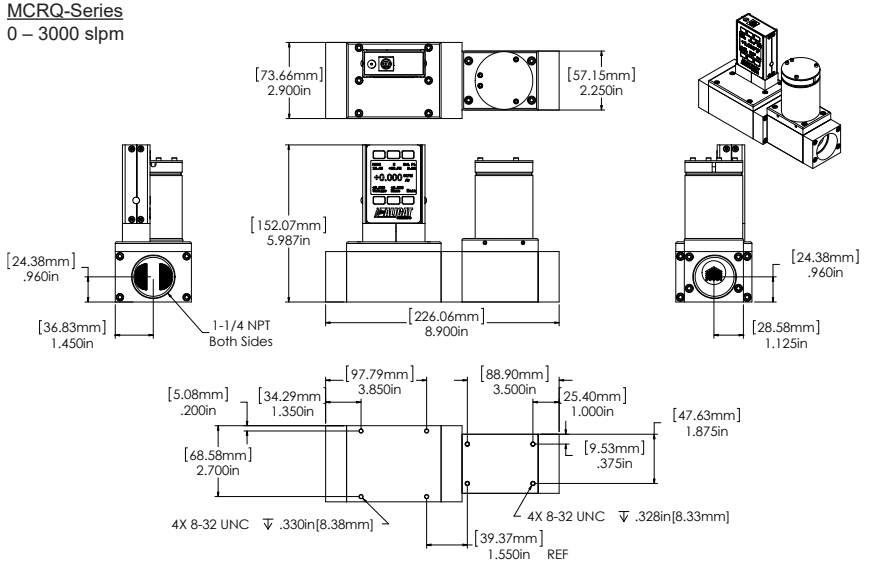
MCRQ 500 slpm to 1500 slpm approximate weight: 9.0 lb.

MCRQ-Series
0 – 2000 slpm



MCRQ 2000 slpm approximate weight: 12.0 lb.

MCRQ-Series
0 – 3000 slpm

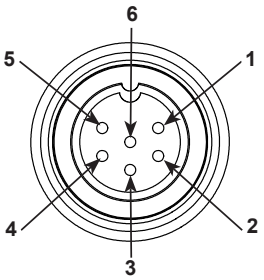


MCRQ 3000 slpm approximate weight: 12.0 lb.

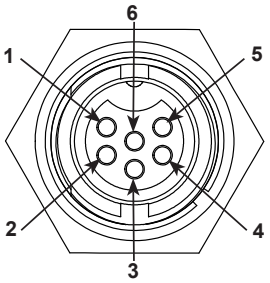
Optional Pinouts

Locking Industrial Connector Pinouts

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



Male Connector: Cable



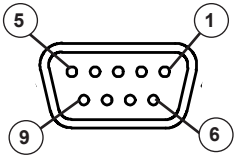
Female Connector: Device

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)

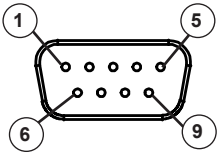
The above pinout is applicable to all the flow controllers and controllers ordered with the industrial connector. The availability of different output signals depends on the flow controller options ordered.

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 4-20 mA 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

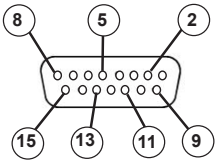
Pin	DB9B	DB9G	DB9H	DB9I	DB9N
1	Analog Out 2	RX (-)	TX (+)	NC	Power In
2	Analog Out	Analog Out	Analog Out	Analog Out	Analog In
3	Power In	Ground	Analog In	Power In	Analog Out
4	Ground	Power In	RX (-)	Ground	NC
5	Ground	Ground	Analog Out 2	NC	Ground
6	Analog In	TX (+)	NC	Analog In	Ground
7	Ground	Analog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

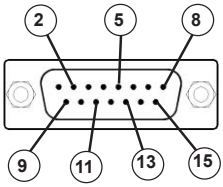
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

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[5]	Analog In
9	Ground	Ground	Ground	NC	Analog Out 2	Ground	Ground
10	Ground	NC	Ground	Analog Out 2	NC	Ground	Ground
11	Analog Out 2	NC	Analog Out 2	Power In	Ground	Analog Out 2	Analog Out 2
12	NC	Analog Out 2	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

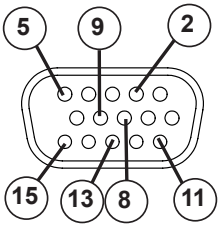
Analog In = setpoint for controllers or remote tare function for meters
Analog Out = 0-5 Vdc Output Signal (or 0-10 Vdc optional)
Analog Out 2 = 5.12Vdc or Optional Secondary Analog Output
TX (+) = Serial RS-232TX or RS-485(+)
RX (-) = Serial RS-232RX or RS-485(-)
NC = Not Connected
Power In = (+Vdc)
Ground = Common for power, digital communications, analog signals and alarms

Individual pinouts available at *www.alicat.com/pinout*

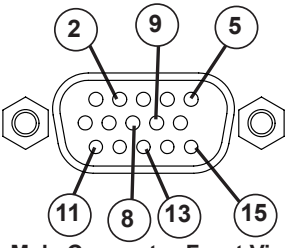
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

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*

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 page 94 to page 97 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.

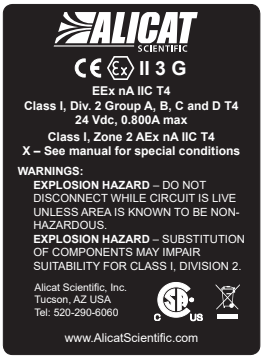
CSA certifies the use of this product for general use as well as use in hazardous locations as defined by Class 1 Division 2 Group A, B, C and D T4.

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:

II 3 G 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

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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.

Notice: Alicat Scientific, Inc. reserves the right to make any changes and improvements to the products described in this manual at any time and without notice. This manual is copyrighted. This document may not, in whole or in part, be copied, reproduced, translated, or converted to any electronic medium or machine readable form, for commercial purposes, without prior written consent from the copyright holder.

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.

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 14.696PSIA	Compressibility 25°C 14.696PSIA
0	Air	Air	184.8989	1.1840	0.9997
1	Argon	Ar	226.2399	1.6339	0.9994
2	Methane	CH4	110.7595	0.6569	0.9982
3	Carbon Monoxide	CO	176.4933	1.1453	0.9996
4	Carbon Dioxide	CO2	149.3184	1.8080	0.9950
5	Ethane	C2H6	93.5412	1.2385	0.9924
6	Hydrogen	H2	89.1535	0.08235	1.0006
7	Helium	He	198.4561	0.16353	1.0005
8	Nitrogen	N2	178.0474	1.1453	0.9998
9	Nitrous Oxide	N2O	148.4124	1.8089	0.9945
10	Neon	Ne	311.1264	0.8244	1.0005
11	Oxygen	O2	205.5021	1.3088	0.9994
12	Propane	C3H8	81.4631	1.8320	0.9838
13	normal-Butane	n-C4H10	74.0536	2.4493	0.9699
14	Acetylene	C2H2	104.4480	1.0720	0.9928
15	Ethylene	C2H4	103.1839	1.1533	0.9943
16	iso-Butane	i-C4H10	74.7846	2.4403	0.9735
17	Krypton	Kr	251.3249	3.4323	0.9979
18	Xenon	Xe	229.8483	5.3950	0.9947
19	Sulfur Hexafluoride	SF6	153.5320	6.0383	0.9887
20	75%Ar / 25% CO2	C-25	206.9763	1.6766	0.9987
21	90% Ar / 10% CO2	C-10	218.6026	1.6509	0.9991
22	92% Ar / 8% CO2	C-8	220.1352	1.6475	0.9992
23	98% Ar / 2% CO2	C-2	224.7148	1.6373	0.9993
24	75% CO2 / 25% Ar	C-75	168.2250	1.7634	0.9966
25	75% Ar / 25% He	HE-75	231.6056	1.2660	0.9997
26	75% He / 25% Ar	HE-25	234.6860	0.5308	1.0002
27	90% He / 7.5% Ar / 2.5% CO2 Helistar® A1025	A1025	214.9760	0.3146	1.0003
28	90% Ar / 8% CO2 / 2% O2 Stargon® CS	Star29	219.7934	1.6410	0.9992
29	95% Ar / 5% CH4	P-5	223.9106	1.5850	0.9993

*in micropoise (1 Poise = gram / (cm) (sec)) **Grams/Liter
Reference: NIST REFPROP 9 Database

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

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