ALICAT SCIENTIFIC

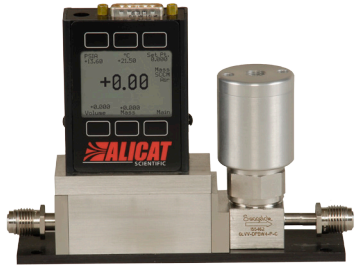
Operating Manual

MC-Series

WHISPER

MCS-Series

MCR-Series



MCV-Series

Precision Gas Mass Flow Controllers

The Fastest Flow Controller Company in the World!

CE NIST

RECALIBRATION

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

A yearly recalibration does a few things:

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

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

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

For more information regarding recalibration see page 51.

ACCESSORIES

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

Many of our customers also order:

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

See pages 55 - 58 for a complete description and list of Alicat accessories.

Thank you for purchasing an Alicat Gas Flow Controller.

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

MC and MCR-Series Mass Gas Flow Controllers

MCP-Series Mass Gas Flow Controllers

WHISPER Low Pressure Drop Mass Flow Controllers

MCS and MCRS-Series Mass Gas Flow Controllers

MCS and MCRS-Series Flow Controllers are for use with certain aggressive gases.

This includes MC and MCR-Series devices labeled as approved for CSA Class 1 Div 2 and ATEX Class 1 Zone 2 hazardous environments. See pages 95 and 96 for Special Conditions regarding the use of CSA/ATEX labeled devices.

MCV-Series Mass Gas Flow Controllers

MCV-Series Flow Controllers have an integrated shut-off valve and are built for use with applications that require tight shut-off.

MCE-Series Mass Gas Flow Controllers

MCE-Series Flow Controllers are built with a proportional valve positioned within the base of the unit.

MCD and MCRD-Series Dual Valve Mass Gas Flow Controllers

MCQ and MCRQ-Series High Pressure Mass Gas Flow Controllers

Unless otherwise noted, the instructions in this manual are applicable to all of the above instruments.

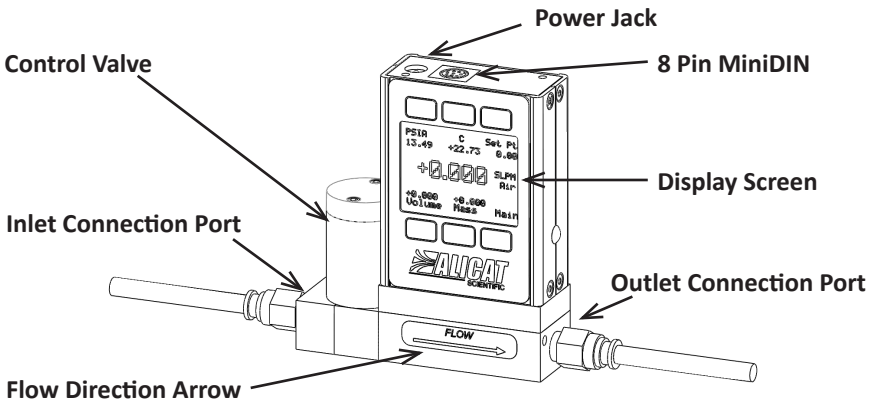
Please contact Alicat at 1-888-290-6060 or info@alicat.com if you have any questions regarding the use or operation of this device.

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

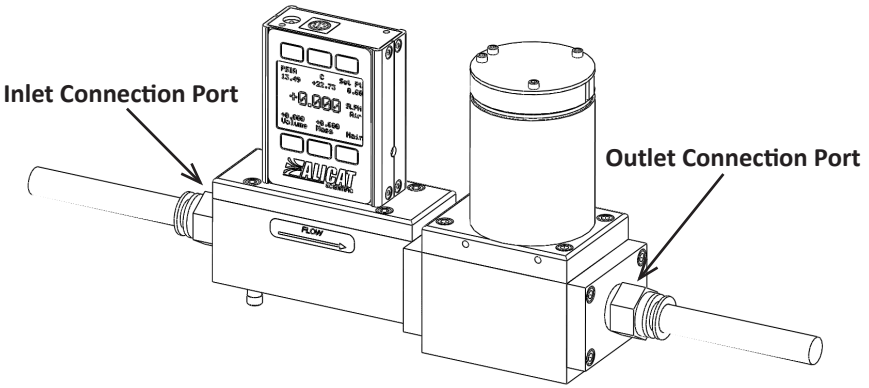
You can find a number of instructional videos related to the operation of this device by visiting the Alicat web site or scanning the QR code.

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

GETTING STARTED



Small Valve Mass Flow Controller shown with an upstream valve configuration and connection port fittings



Large Valve Mass Flow Controller shown with a downstream valve configuration and connection port fittings

MOUNTING

MC-Series Gas Flow Controllers have holes on the bottom for mounting to flat panels. See pages 59- 88.

Small valve controllers (MC-Series) can usually be mounted in any position.

Large valve controllers (MCR-Series) may be mounted in any orientation in fixed installations. ***For airborne installations, orient the axis of the valve parallel with the longitudinal axis of the aircraft. This will minimize inertial coupling to turbulent flight conditions.***

No straight runs of pipe are required upstream or downstream of the controller.

PLUMBING

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

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

Standard MC-Series Gas Flow Controllers have female inlet and outlet port connections. Welded VCR and other specialty fittings may have male ports.

The inlet and outlet port sizes (process connections) for different flow ranges are shown on pages 59 - 88.

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

For non M5 (10-32) ports use thread sealing Teflon® tape to prevent leakage around the port threads.
Do not wrap the first two threads. This will minimize the possibility of getting tape into the flow stream and flow body.

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

When changing fittings, carefully clean any tape or debris from the port threads.
We recommend the use of in-line sintered filters to prevent large particulates from entering the measurement head of the instrument. Suggested maximum particulate sizes are as follows:

5 microns for units with FS flow ranges of 0-1 sccm or less.
20 microns for units with FS flow ranges between 0-2 sccm and 0-1 slpm.
50 microns for units with FS flow ranges of 0-1 slpm or more.

Connecting Fittings and Filters
http://www.alicat.com/support/instructional-videos/

PRESSURE

Maximum operating line pressure is 145 psig (1 MPa).

If the line pressure is higher than 145 psig (1 MPa), use a pressure regulator upstream from the flow controller to reduce the pressure to 145 psig (1 MPa) or less.

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

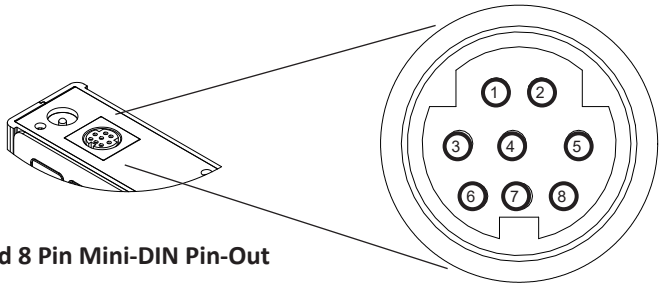
POWER AND SIGNAL CONNECTIONS

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

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

Small Valve controllers require a 12-30Vdc power supply with a 2.1 mm female positive center plug capable of supplying 250 mA. **NOTE:** 4-20mA analog output requires at least 15 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 750mA.



Standard 8 Pin Mini-DIN Pin-Out

Pin	Function	Mini-DIN cable color
1	Not Connected (or optional 4-20mA Primary Output Signal)	Black
2	Static 5.12 Vdc [or optional Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm]	Brown
3	Serial RS-232RX / RS-485(–) Input Signal (receive)	Red
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Setpoint Input	Orange
5	Serial RS-232TX / RS-485(+) Output Signal (send)	Yellow
6	0-5 Vdc (or optional 0-10 Vdc) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, communications and analog signals)	Purple
Note: The above pin-out is applicable to all the flow meters and controllers with the Mini-DIN connector. The availability of different output signals depends on the options ordered. Optional configurations are noted on the unit's calibration sheet.		

CAUTION! ***DO NOT CONNECT POWER TO PINS 1 THROUGH 6 AS PERMANENT DAMAGE CAN OCCUR!***

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

For 6 Pin Locking Industrial Connector, DB9 and DB15 pin-outs see pages 91 to 94. For PROFIBUS pin-outs see page 89.

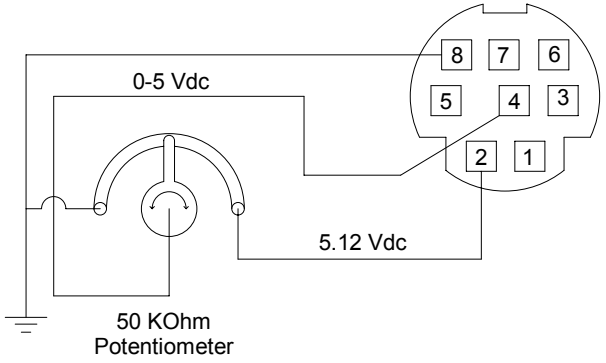
INPUT SIGNALS

Analog Input Signal

Apply analog input to Pin 4 as shown on page 8.

For 6 Pin Locking Industrial Connector, DB9 and DB15 pin-outs see pages 91 - 94. For PROFIBUS pin-outs see page 89.

Standard 0-5 Vdc is the standard analog input signal. Apply the 0-5 Vdc input signal to pin 4, with common ground on pin 8. The 5.12 Vdc output on pin 2 can be wired through a 50K ohm potentiometer and back to the analog input on pin 4 to create an adjustable 0-5 Vdc input signal source as shown below.



Simple method for providing setpoint to controllers

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

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

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

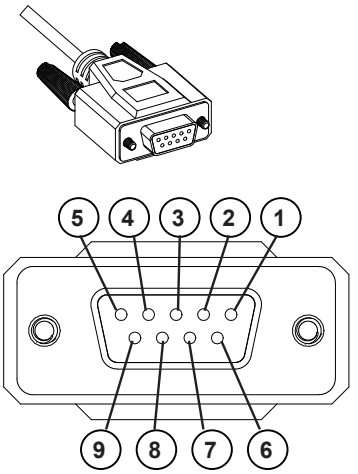
NOTE: 4-20mA output requires at least 15 Vdc power input.

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

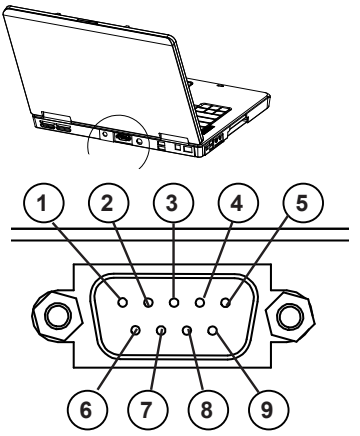
Electrical Connections and Basic Wiring
http://www.alicat.com/support/instructional-videos/

RS-232 / RS-485 Digital Input Signal

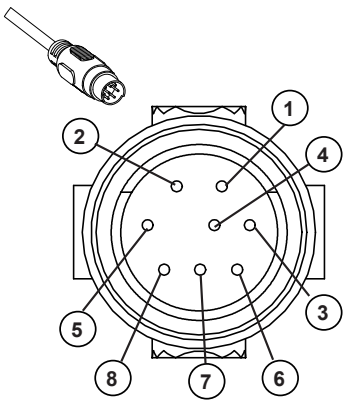
To use the RS-232 or RS-485 input signal, connect the RS-232 / RS-485 Output Signal (Pin 5), the RS-232 / RS-485 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown below. (See page 35 for details on accessing RS-232 / RS-485 input.)



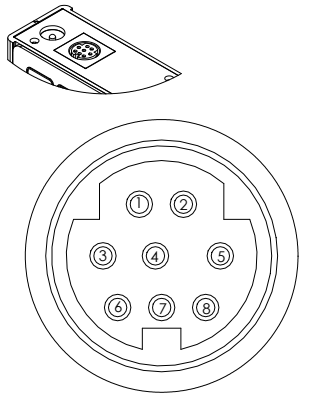
Serial Cable End



PC Serial Port



8 Pin MiniDIN Cable End



8 Pin MiniDIN Connector

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

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

Electrical Connections and Basic Wiring
http://www.alicat.com/support/instructional-videos/

OUTPUT SIGNALS

RS-232 / RS-485 Digital Output Signal

To use the RS-232 or RS-485 output signal, it is necessary to connect the RS-232 / RS-485 Output Signal (Pin 5), the RS-232 / RS-485 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown on page 8. (See page 35 for details on accessing RS-232 / RS-485 output.)

Standard Voltage (0-5 Vdc) Output Signal

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

Optional 0-10 Vdc Output Signal

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

Optional Current (4-20 mA) Output Signal

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

Optional 2nd Analog Output Signal

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

If your device is CSA/ATEX approved or equipped with the optional six pin industrial connector, please contact Alicat.

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

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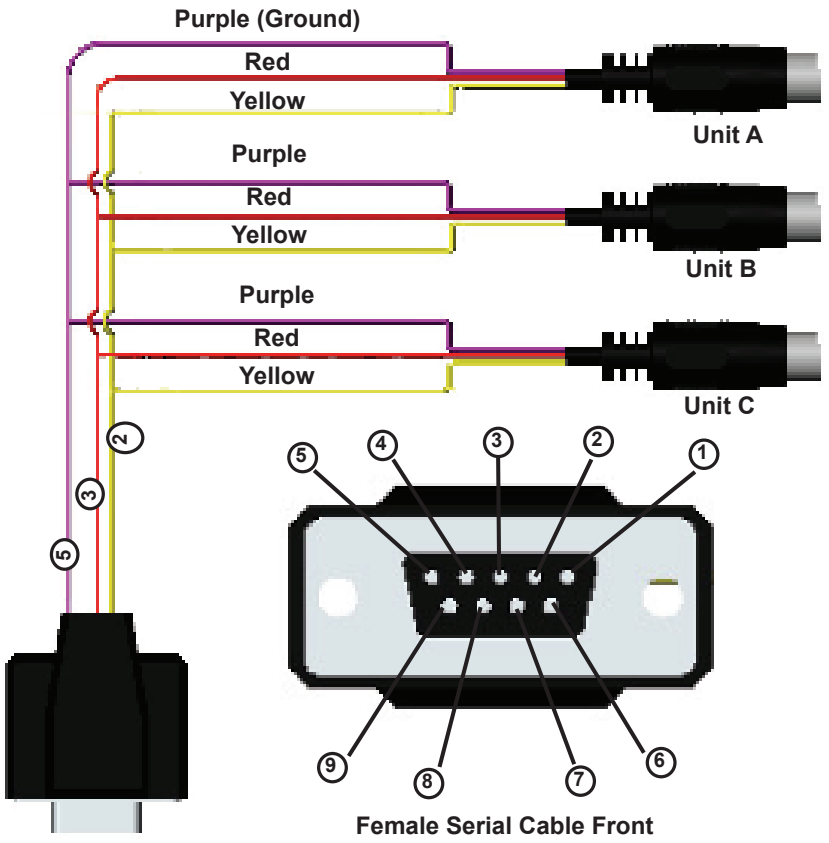


Typical Multiple Device (Addressable) Wiring Configuration

The easiest way to connect multiple devices is with a Multi-Drop Box (see page 55).

Information for Alicat TFT (Color Display) Instruments

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

Multi-Color Display Color Codes:

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

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

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

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

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

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

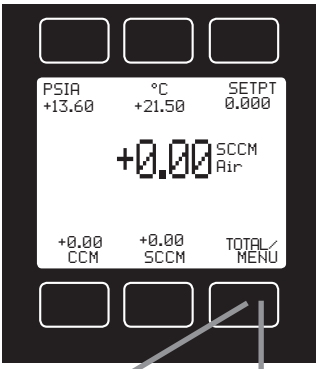
The following specifications are applicable to Alicat **TFT** (color display) meters, gauges and controllers only. All other operating specifications are shown in the Technical Data page for standard Alicat instruments. All standard device features and functions are available and operate in accordance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

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

DISPLAYS AND MENUS

The device screen defaults to **Main** display as soon as power is applied to the controller.
Note: See page 31 to rotate the display 180°.

Main

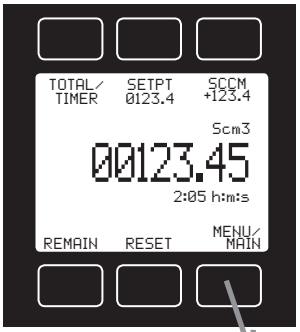


The **Main** display shows pressure, temperature, setpoint, volumetric flow and mass flow.

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

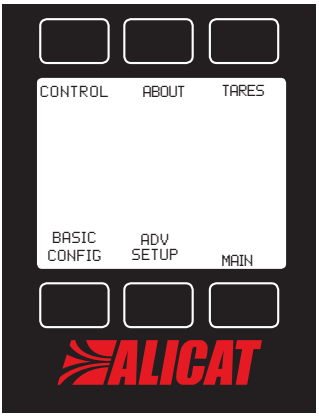
By hitting the **MENU** button at the bottom right of the screen you will enter the **Select Menu** display.

Totalizer (option only)



If your controller was ordered with the **Totalizer** option (page 52), pushing the **TOTAL/MENU** button once will bring up the **Totalizing Mode** display. Pushing **MENU/MAIN** will bring up the **Select Menu** display.

Select Menu



Select Menu

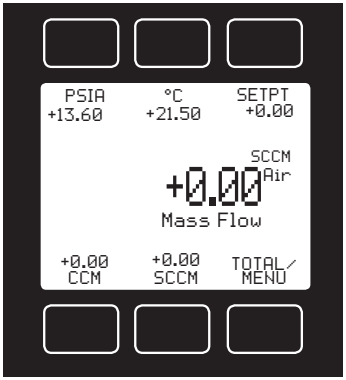
From **Select Menu** you can change the selected gas, interact with your RS-232 / RS-485 settings, read manufacturer's data or access the control set-up display.

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

Display On/Off:

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

MAIN



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

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

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

Press the button a second time to change the engineering unit associated with the device display (button units) and / or the data feed (device units). See page 16.

Gas Pressure: This sensor references hard vacuum and reads incoming pressure both above and below local atmospheric pressure. This parameter is moved to the primary display by pushing the button above **PSIA**. Pushing this button again will allow you to show Absolute Pressure, Gauge Pressure or Barometric Pressure in devices that have a barometer.

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

Pushing the button again allows you to select ºC (Celsius), K (Kelvin), ºF (Fahrenheit) or ºR (Rankine) for the temperature scale.

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

For information on changing the setpoint see SETPT SOURCE, page 18.

Volumetric Flow Rate: This parameter is located in the lower left of the display. It is moved to the primary display by pushing the button below **CCM** in this example. Your display may show a different unit of measure. Pushing this button again will access a list of selectable engineering units.

Mass Flow Rate: The mass flow rate is the volumetric flow rate corrected to a standard temperature and pressure (typically 14.696 psia and 25 °C).

This parameter is located in the lower middle of the display. It can be moved to the primary display by pushing the button below **SCCM** in this example. Your display may show a different unit of measure preceded by the letter **S, N** or a **True Mass Unit**. Pushing this button will access a list of selectable engineering units.

To get an accurate volumetric or mass flow rate, the gas being measured must be selected. See Gas Select, page 24.

Mass flow in units preceded by an S or N is impacted by the STP / NTP. See page 28.

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

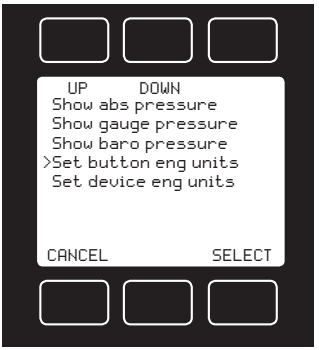
When using a mass flow controller as an absolute pressure controller, the mass flow rate may momentarily exceed the flow measurement capability (full scale + 28%) of the unit. This may occur when the unit is asked to make an abrupt pressure change. **If the optional totalizer is in use at that time**, the totalized value will necessarily become incorrect and a TMF error status will be displayed. Please reset the totalizer if such an 'over-flow' condition has occurred.

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

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

Choosing Engineering Units from Main Mode

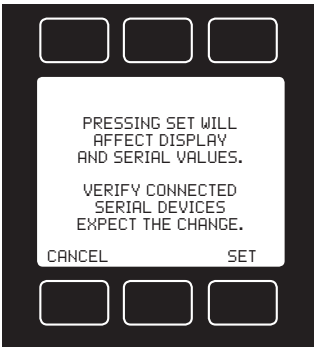
Press the button above or below any of the four flow parameters twice to enter its unit selection menu. You can change units in two ways:



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

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

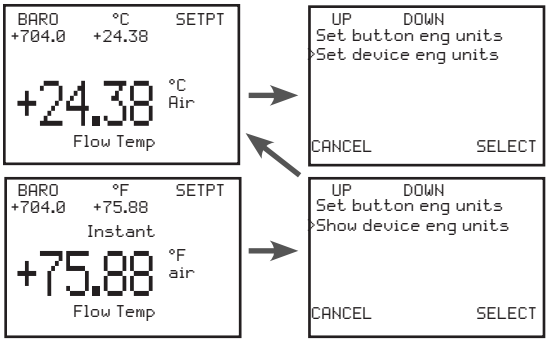
Device engineering units alter both the display and the data frame:



• Select Set device eng units and then choose the engineering unit as above. An additional confirmation screen asks you to confirm the RS-232 / RS-485 change.

• If the button engineering unit is different than the device engineering unit, Set device eng units will not appear. First select Show device eng units to return the button unit to the existing device unit, and then enter the unit selection menu again to change the device engineering unit.

Examples of changing device engineering units:



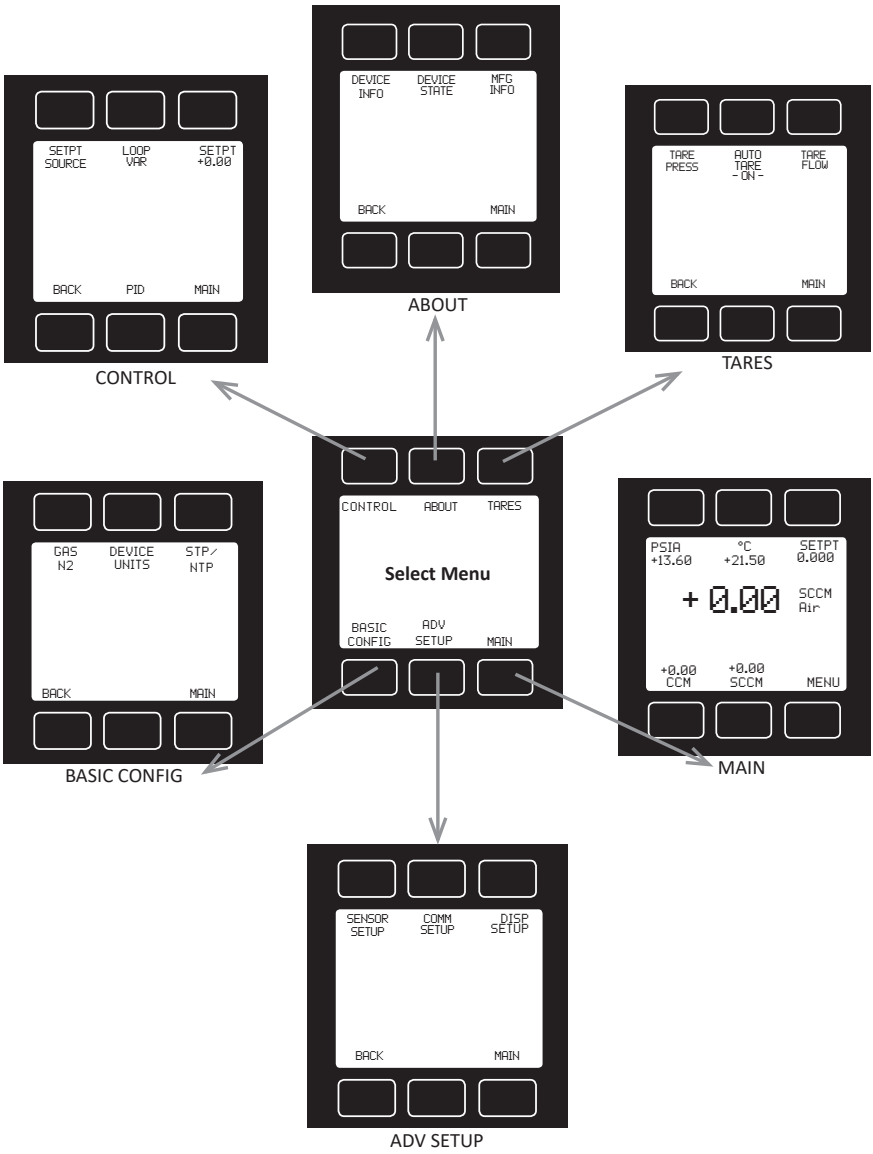
Changing device units:
°C is the existing device engineering unit, so the unit selection menu displays Set device eng units.

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

SELECT MENU

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

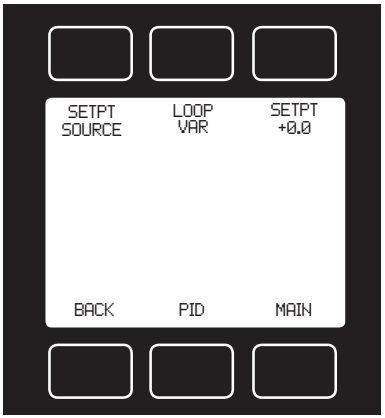
Press the button next to the desired operation to bring that function to the screen.



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

CONTROL

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



Press BACK to return to the Select Menu display.

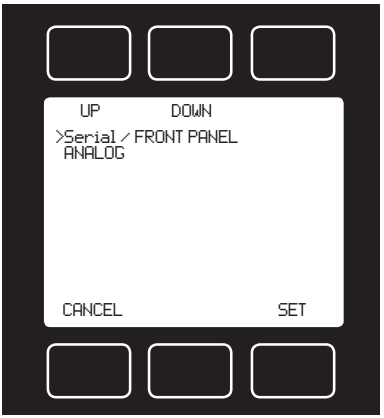
Press MAIN to return to the MAIN display

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

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

Press CANCEL to return to the previous display.

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



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

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

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

Analog refers to a remote analog setpoint applied to Pin 4 of the Mini-DIN connector as described in the installation section of this manual. ***The standard analog input is 0-5 Vdc.***

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

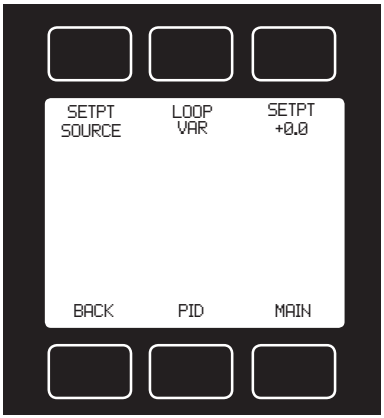
If nothing is connected to Pin 4, and the controller is set for analog control, the device will generate random setpoint values.

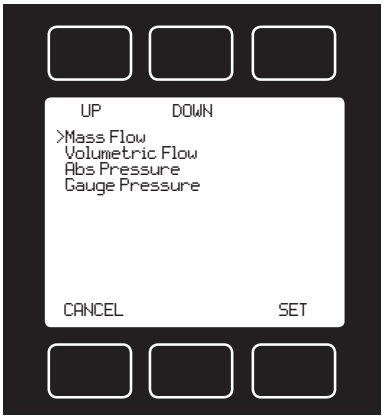
NOTE: If your controller has the **IPC** (Integrated Potentiometer Control) option, the IPC dial will operate with the ANALOG setpoint source selected.

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

CAUTION! ***Never leave a Controller with a non-zero setpoint if no pressure is available to make flow. The controller will apply full power to the valve in an attempt to reach the setpoint. When there is no flow, this can make the valve very HOT!***

CONTROL (continued)





LOOP VAR—The selection of what variable to close the loop on is a feature unique to Alicat mass flow controllers.

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

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

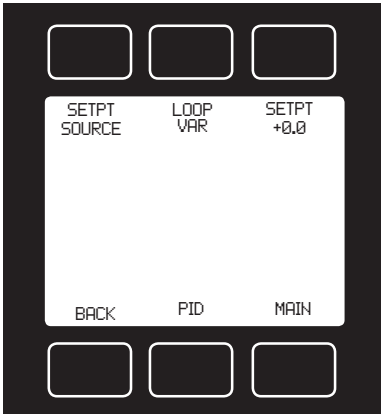
When the mass flow controller is supplied with the **control valve upstream** of the electronics portion of the system, the unit can be set to control on outlet pressure or volumetric flow rate, instead of mass flow rate.

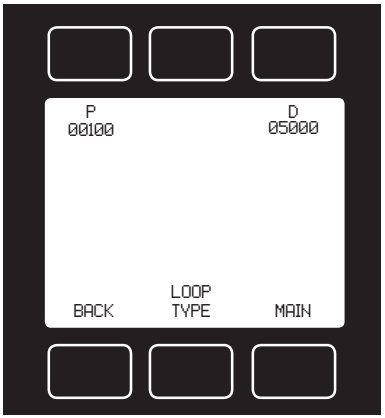
The change from mass to volume can usually be accomplished without much, if any, change in the P and D settings.

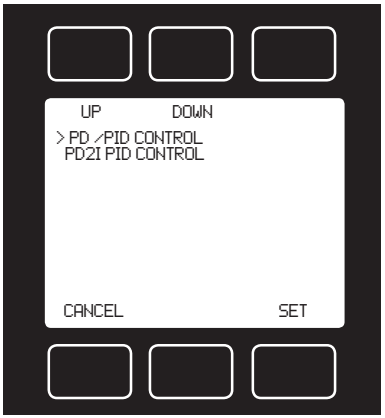
When you change from controlling flow to controlling pressure, sometimes fairly radical changes must be made to the P & D variables. *See page 20* – **PID TUNING**.

Contact Alicat if you are having difficulties with this procedure.

PID TUNING







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

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

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

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

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

P refers to the Proportional term of the PID loop.

I refers to the Integral term of the PID loop.

D refers to the Differential term of the PID loop.

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

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

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

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

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

It is divided into two segments:

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

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

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

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

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

The* PD2I *algorithm is a PID algorithm used primarily for high performance pressure and flow control applications.

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

1. Instead of applying a damping function based upon the rate of change of the process value, it applies a damping function based upon the square of the rate of change of the process value.

2. The damping function is applied directly to the proportional error term before that term is used in the proportional and integral functions of the algorithm. This provides a certain amount of 'look ahead' capability in the control loop.

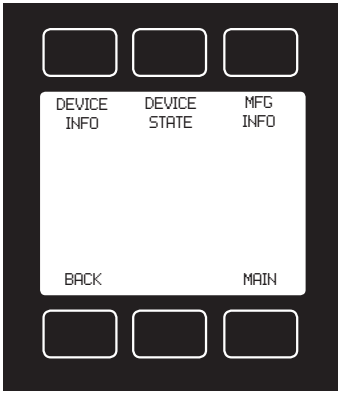
Because of these differences, you will note the following:

1. Increasing 'P' gain can be used to damp out overshoot and slow oscillations in pressure controllers. You will know that 'P' gain is too high, when the controller breaks into fast oscillations on step changes in setpoint. On flow controllers, too low a 'P' gain results in slower response times. Too high a 'P' gain results in overshoot and/or slow oscillation. A good starting value for 'P' gain is 200.

2. If the unit was originally shipped with the PD2I algorithm selected, the 'D' gain value should be left at or near the factory setting because it relates primarily to the system phase lags. If you are changing from the default algorithm to the PD2I algorithm, you should start with a 'D' gain value of 20.

3. The 'I' gain is used to control the rate at which the process converges to the setpoint, after the initial step change. Too low a value for 'I' gain shows up as a process value that jumps to near the setpoint and then takes awhile to converge the rest of the way. Too high a value for 'I' gain results in oscillation. A good starting value for the 'I' gain is 200.

ABOUT



ABOUT

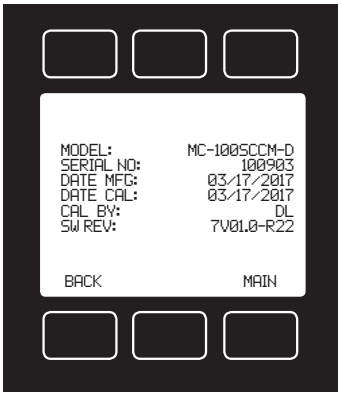
Press **DEVICE INFO** to show important information about your flow device including the model number, serial number, and date of manufacture.

Press BACK to return to the About display.

Push MAIN to return to the Main display.

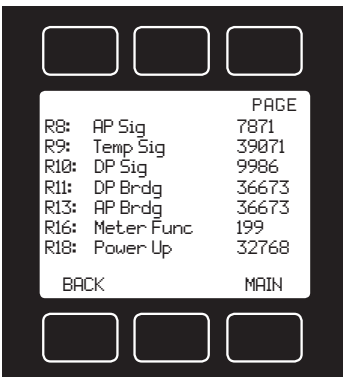
Manufacturer information is accessed by pressing the **MFG INFO** button on the About Menu display.

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



DEVICE INFO

MFG INFO



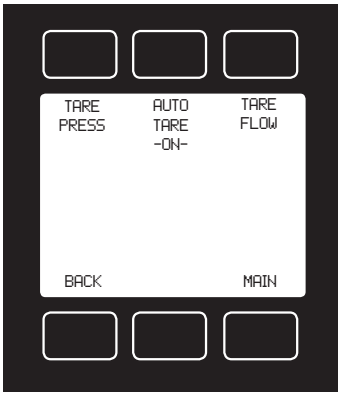
DEVICE STATE

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

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

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

TARES



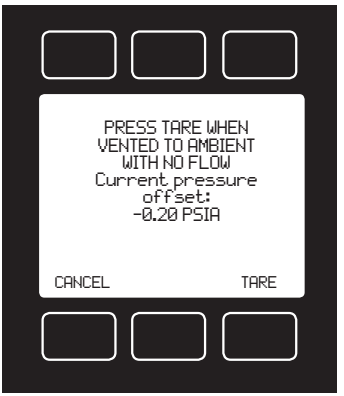
Press **TARES** to access **TARE PRESS** (Pressure Tare), **AUTO TARE** and **TARE FLOW**.
Press BACK to return to the Tares display.
Push MAIN to return to the Main display.

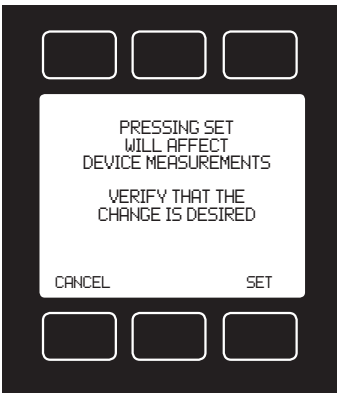
AUTO TARE ON/ OFF—refers to the standard auto-tare or “auto-zero” feature.

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

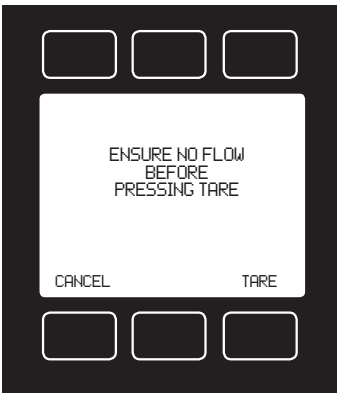
A zero setpoint results in the closing of the valve and a known “no flow” condition. This feature makes the device more accurate by periodically removing any cumulative errors associated with drift.

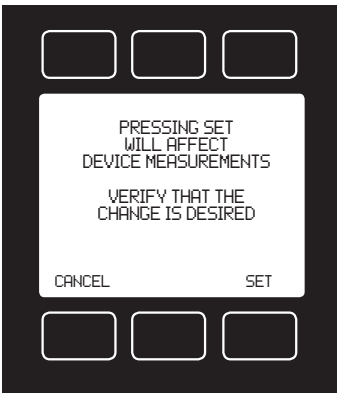
It is recommended that the controller be left in the default auto-tare ON mode unless your specific application requires that it be turned off.





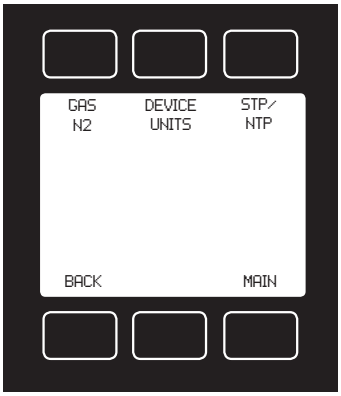
TARE PRESS





TARE FLOW

BASIC CONFIG



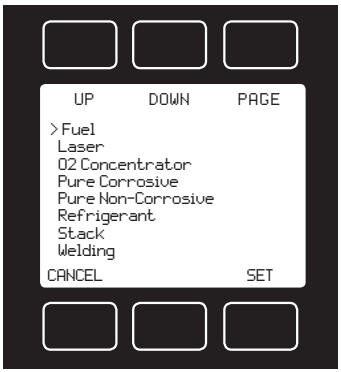
Press **BASIC CONFIG** to select gases, device units, and change STP and NTP references.
Press **BACK** to return to the Select Menu display. Push **MAIN** to return to the Main display.

Gas Select allows you to set your device to up to 150 gases and mixes. You can also use **COMPOSER** to program and store up to 20 gas mixes.

Gas Select is accessed by pressing the button above **GAS** on the **BASIC CONFIG** display.

To select a gas, use the UP and DOWN buttons to position the arrow in front of the desired gas category.

» Recent: Eight most recent selections
» Standard: Gases and mixes standard on earlier Alicat instruments (page 39)
» Factory Custom: Present only if customer requested gases were added at the factory
» COMPOSER User Mixes: Gas mixes programmed by the user (page 25)
» Bioreactor (page 43)
» Breathing (page 44)
» Chromatography (page 46)
» Fuel (page 45)
» Laser (page 45)
» O2 Concentrator (page 46)
» Pure Corrosive* (page 40)
» Pure Non-Corrosive (page 39)
» Refrigerant* (page 40)
» Stack (page 46)
» Welding (page 42)



Press PAGE to view a new page in the gas category list.

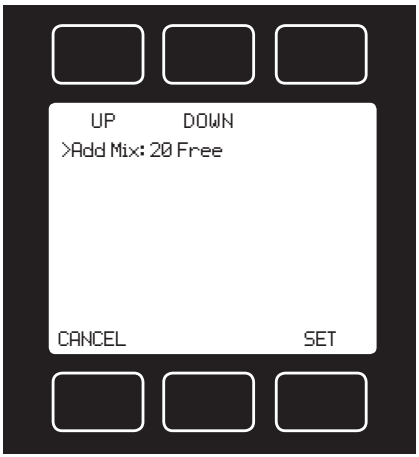
Press SELECT to view the gases in the selected category. Align the arrow with the desired gas. Press SET to record your selection and return to the MAIN display. The selected gas will be displayed on the screen.

***** Pure Corrosive and Refrigerant gases are only available on **S-Series** instruments that are compatible with these gases. Not all S-series instruments are compatible with all aggressive gases.

Note: Gas Select may not be available on units ordered with a custom gas or blend.

See pages 39 -46 for a full list of gases in each category.

COMPOSER

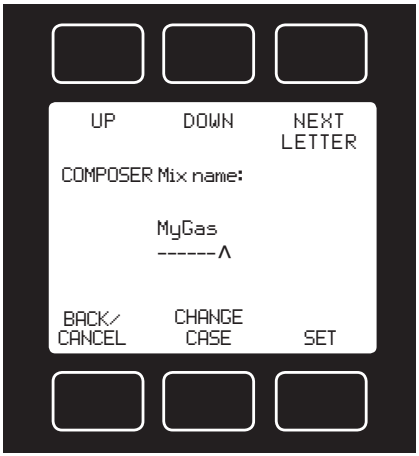


Composer allows you to program and save up to 20 custom gas mixes containing 2 to 5 component gases found in the gas lists (pages 39-46). The minimum resolution is 0.01%.

Composer is accessed by selecting **COMPOSER User Mixes** on the GAS SELECT display.

Press SET when the arrow is aligned with Add Mix.

Name the mix by pressing the UP and DOWN buttons for letters, numerals and symbols.

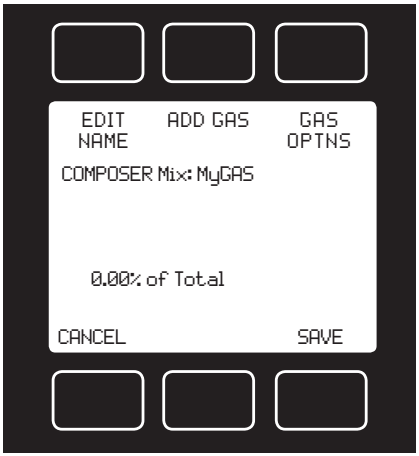


CHANGE CASE – Toggles the letter case. Letters remain in selected case until CHANGE CASE is pushed again.

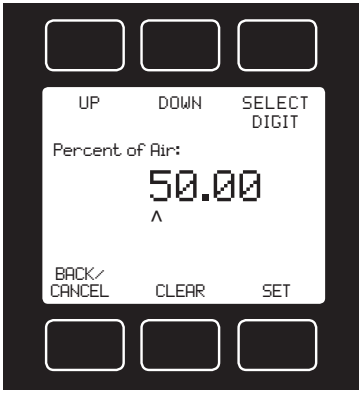
Press SET to save the name.

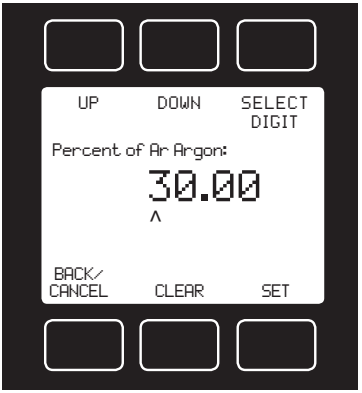
After naming the mix, press **ADD GAS** and select the gas category and the component gas.

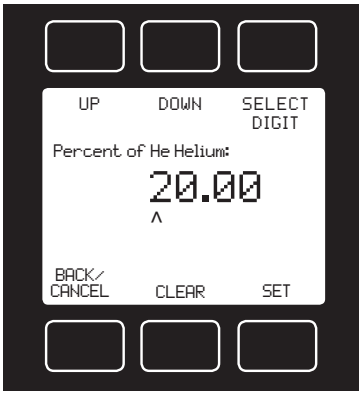
Select the digit with arrow and adjust the % with the UP and DOWN buttons. Press set to save. Add up to 4 more gases as needed. The total must equal 100% or an error message will appear.

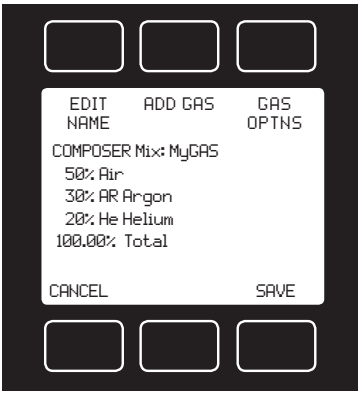


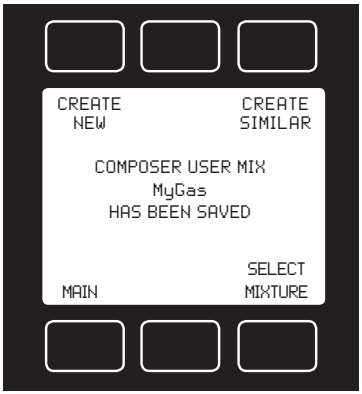
GAS OPTNS allows you to adjust the percentage of the constituents or delete a gas from the mix. Gas mixes cannot be adjusted after they have been saved.









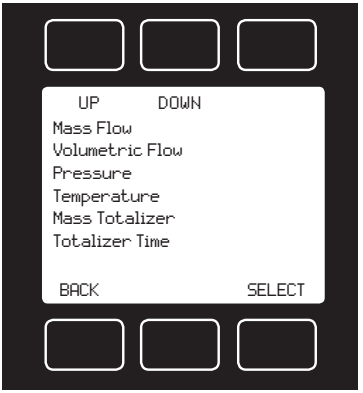


Once the mix has been saved, you may press **CREATE SIMILAR** to compose an additional mix based on the mix you have just saved. <u>This CREATE SIMILAR option is not available after leaving this screen.</u>

Press **CREATE NEW** to add a completely new mix.

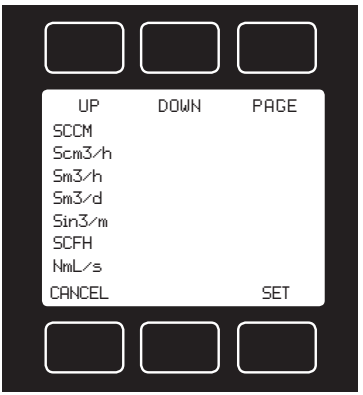
Press **SELECT MIXTURE** to select the custom mix as the current gas and return to the MAIN display.

DEVICE UNITS

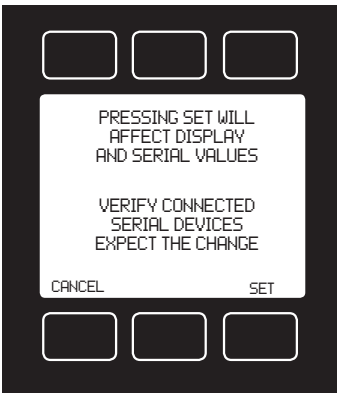


DEVICE UNITS

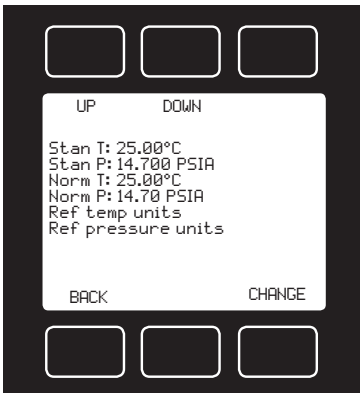
Press **DEVICE UNITS** to access menus of units of measure for each parameter (and totalizer if so equipped).
Scroll to the desired unit and press select. Once selected, you will see the message shown below. Verify that all connected devices expect the change.
See pages 47 and 48 for a full list of available units.



MASS FLOW UNITS



STP/NTP



STP/NTP allows selection of the temperature and pressure reference condition for mass flow. For standardardized flow (when using mass flow units that begin with S), Stan T and Stan P define the reference temperature and pressure. For normalized flow (when using mass flow units that begin with N), Norm T and Norm P define the reference temperature and pressure.

This feature is generally useful for comparing to other devices or systems that may be at a different temperature or pressure standard. The same flow, when referenced to different temperatures and/or pressures, will result in different reported values.

Standardized and normalized flow references define the temperature and pressure conditions for which the flow is calculated; this allows flows measured under different conditions to be compared by calculating them using a common set of conditions.

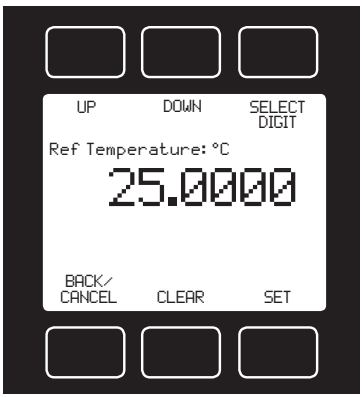
Use the UP/DOWN buttons to select a catagory from the displayed list as shown.

Press **CHANGE** to access the parameter's display. Now use the **SELECT DIGIT** and UP/DOWN buttons to make your changes and press **SET**.

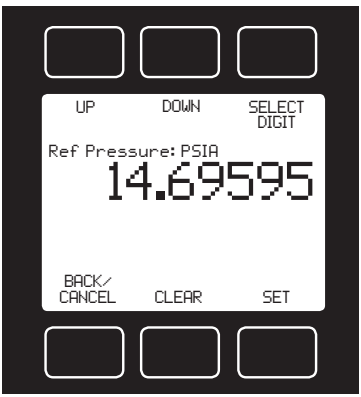
Once a selection has been made and recorded using the **SET** button, a change acknowledgement message will be displayed on screen.

Selecting "Ref temp units" or "Ref pressure units" will allow changing of the temperature or pressure unit for the reference.

Press **BACK** to return to the **BASIC CONFIG** screen.

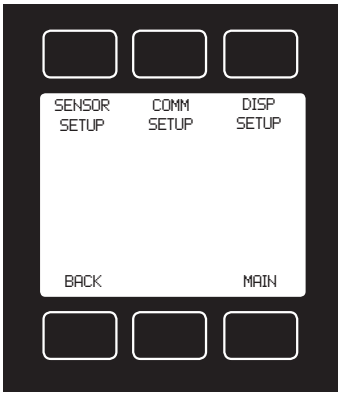


Std T



Std P

ADV SETUP



ADV SETUP

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

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

SENSOR SETUP

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

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

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

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

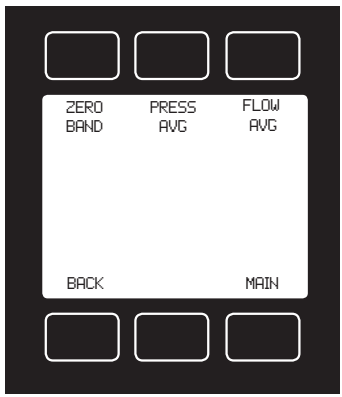
These are geometric running averages where the number between 1 and 255 can be considered roughly equivalent to the response time constant in milliseconds.

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

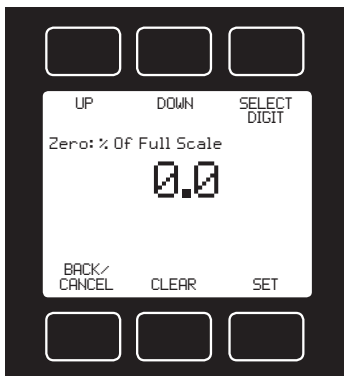
Press **PRESS AVG.** Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

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

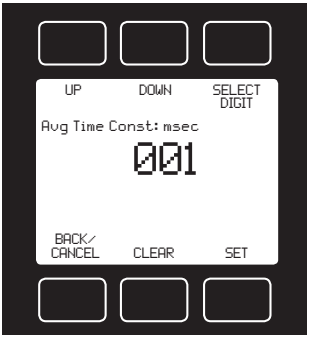
Setting a higher number will equal a smoother display.



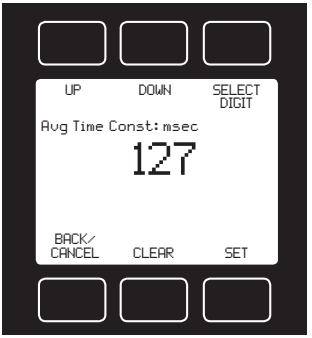
SENSOR SETUP



ZERO BAND



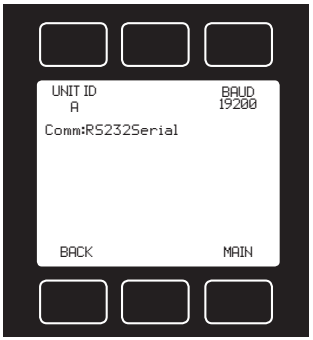
PRESS AVG



FLOW AVG

COMM SETUP

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



COMM SETUP

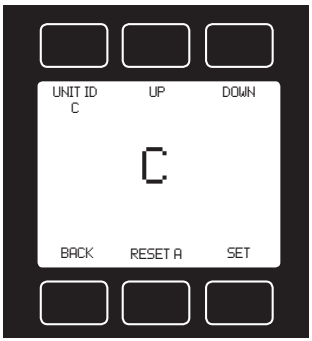
UNIT ID – Valid unit identifiers are the letters A-Z and @. The identifier allows you to assign a unique address to each device so that multiple units can be connected to a single RS-232 or RS-485 computer port.

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

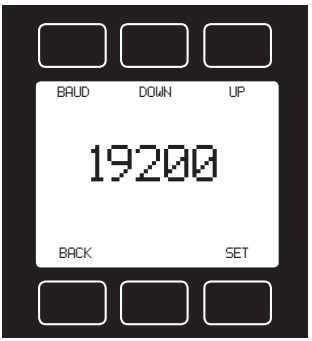
If the symbol @ is selected as the Unit ID, the device will enter streaming mode when SET is pressed. *See RS-232 Communications (page 36) for information about the streaming mode.*

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

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



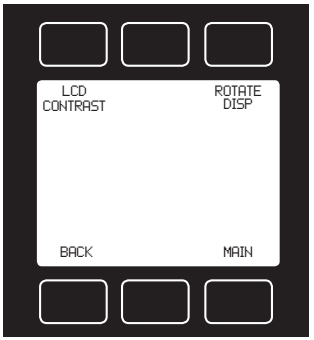
UNIT ID



BAUD

DISP SETUP

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

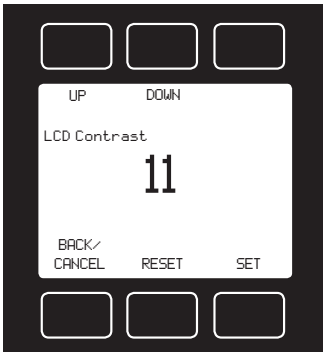


DISP SETUP

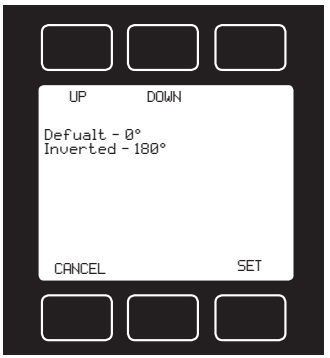
LCD CONTRAST: The display contrast can be adjusted between 0 and 28, with zero being the lightest and 28 being the darkest. Use the UP and DOWN buttons to adjust the contrast. Press SET when you are satisfied. Press BACK to return to DISP SETUP.

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

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



LCD CONTRAST



ROTATE DISPLAY

MCV Controller Operating Notes

Alicat's MCV mass flow controller is equipped with an integrated Swagelok® positive shutoff valve.

The normally closed valve is air actuated and will remain closed until it is connected to an air source supplying between 60 and 120 psig of air pressure.

Once the appropriate amount of air pressure is supplied to the shutoff valve, it will open, allowing flow through the mass controller. Air pressure must be removed from the shutoff valve in order for the valve to close.

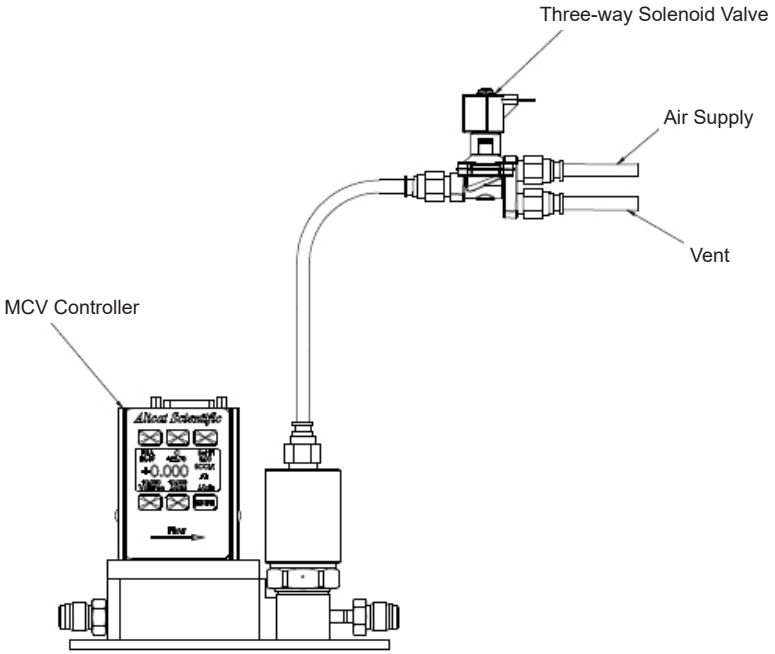
A common method for actuating the shutoff valve incorporates a three-way solenoid valve (below). See pages 70 and 71 for complete dimensions.

Air 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, air pressure is delivered to the shutoff valve, allowing it to open.

When the solenoid is returned to a relaxed state, air pressure is removed from the shutoff valve, allowing it to close. The air pressure is vented to atmosphere.

Note: 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.



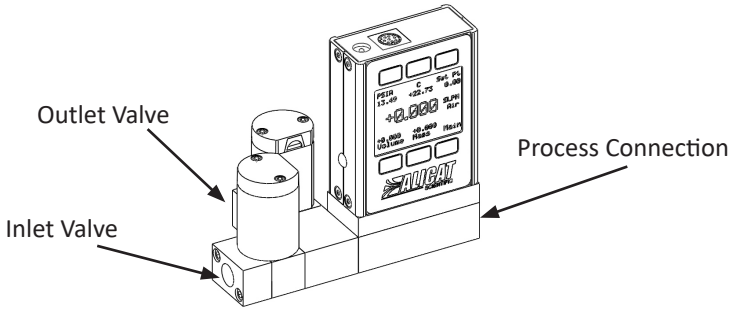
MCV controller and three-way solenoid valve.

MCD Dual Valve Mass Controller Operating Notes

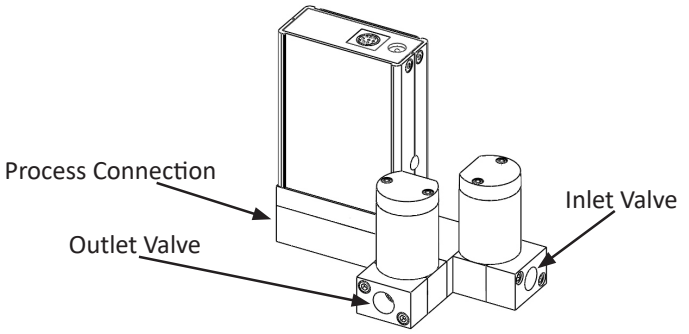
The MCD is a versatile Dual-Valve Mass Flow and Pressure Controller. It can be used to:

- 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.

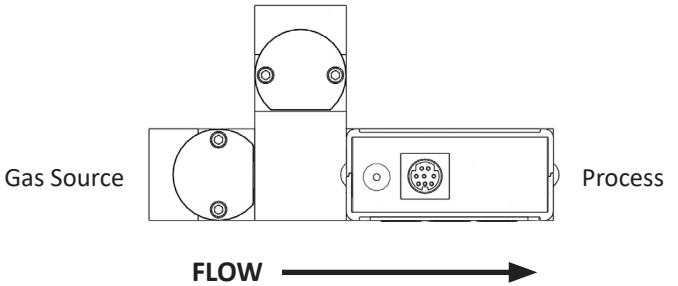


MCD front view



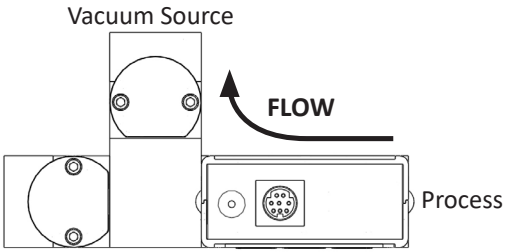
MCD rear view

Mass Flow (or Volumetric Flow) Control

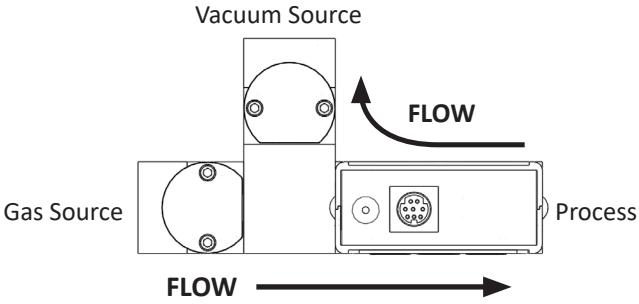


MCD top view

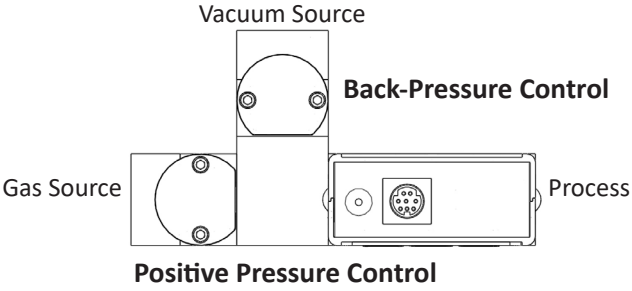
Inverse Mass Flow (or Volumetric Flow)Control with Vacuum



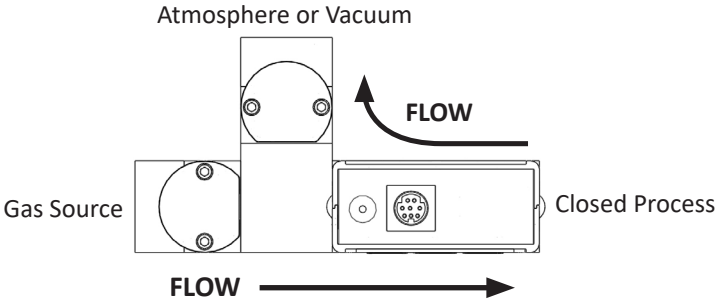
Bidirectional Mass Flow (or Volumetric Flow)Control



Flowing Absolute Pressure Control



Dead-Ended Absolute Pressure Control



RS-232 / RS-485 Output and Input

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

Alicat's Flow Vision Software

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

Flow Vision SC™ is for general use with up to 26 different Alicat devices, while Flow Vision MX™ is specifically designed for gas mixing applications.

Alicat's Free Serial Terminal Application

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

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

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

Additional Programs that are compatible with Alicat products

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

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

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

Alicat has written drivers specifically for LabVIEW which are available for download at ***alicat.com/support/software-drivers.***

Sending a Command

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

Parenthesis denote a value that must be filled in by the user. For example, (unit ID)<CR> should be changed to A<CR> when using a device with Unit ID "A". It may also be useful to note that commands are case insensitive. For example, A<CR> is equivalent to a<CR>.

Polling Mode

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

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

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

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

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

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

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

Data Format

The data frame represents the current measurements in the device in the "device units" selected on the unit. By default, mass flow controllers are configured to output seven columns of data.

Devices come standard with units of PSIA, °C, and either SLPM/LPM or SCCM/CCM, depending on the flow range of the device. Note that the "button units" available on portable units will not affect the serial output. The first column is the unit ID. This column will be excluded if the device is in streaming mode. The next columns are absolute pressure, temperature, volumetric flow rate, mass flow rate, setpoint value, and selected gas, respectively.

For example, suppose a controller with unit ID A was ordered with units of SCFM or the "device units" are currently selected as SCFM. If air is selected and the setpoint value is set to 2.004 SCFM, at atmospheric temperature, the data frame may read:

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

MC-Series Mass Flow Controller Data Format

On units with the totalizer function, the totalized flow will be displayed in column seven, with the selected gas moving to column eight. Additional columns, including status codes, may be present to the right of the gas selection column.

Changing the gas selection using Gas Select via RS-232 / RS-485

To change the selected gas, type `(unit ID)G(gas number)<CR>`. For a complete list of gas numbers available on the device, see "Gas Lists with Viscosities, Densities and Compressibilities" in this manual. This list is also available on the gas select menu on the unit. For example, Helium has a gas number of 7. To change the selected gas on unit "A" to Helium, type `AG7<CR>`.

Sending a Setpoint via RS-232 / RS-485

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

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

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

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

The formula for performing linear interpolation is as follows:

Value = (desired setpoint) X 64000 / (full Scale)

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

22400 = (35 SLPM) X 64000 / (100 SLPM)

Sending a Setpoint to a Bidirectional Controller via RS-232 / RS-485

For a bidirectional controller, the setpoint command may be sent in either of the above two methods with the following changes:
Using Method 1, a negative setpoint may be set using a negative sign in the command. For example, `AS-4.54<CR>` changes the setpoint for units "A" to -4.54 in the current device units.

Using Method 2, values between 0 and 64000 are acceptable which correspond linearly to -100% full scale flow and 100% full scale flow, respectively. The formula to perform linear interpolation for a bidirectional controller is as follows:

Value = (desired setpoint + full scale) X 64000 / (2 X full scale)

For example, when changing the setpoint on a 100 SLPM full scale bidirectional controller to -35 SLPM, the following value should be entered.

20800 = (-35 SLPM + 100 SLPM) X 64000 / (2 X 100 SLPM)

Additional Serial Commands

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

Operating Principle

All M-Series Gas Flow Meters (and MC-Series Gas Flow Controllers) are based on the accurate measurement of volumetric flow. The volumetric flow rate is determined by creating a pressure drop across a unique internal restriction, known as a Laminar Flow Element (LFE), and measuring differential pressure across it. The restriction is designed so that the gas molecules are forced to move in parallel paths along the entire length of the passage; hence laminar (streamline) flow is established for the entire range of operation of the device. Unlike other flow measuring devices, in laminar flow meters the relationship between pressure drop and flow is linear.

Please visit the Alicat web site for a detailed explanation this principle. alicat.com/technical-information/theory-of-operation/

STANDARD GAS DATA TABLES: Those of you who have older Alicat products may notice small discrepancies between the gas property tables of your old and new units. Alicat Scientific, Inc. has incorporated the latest data sets from NIST (including their REFPROP 9 data where available) in our products' built-in gas property models. Be aware that the calibrators that you may be using may be checking against older data sets such as the widely distributed Air Liquide data. This may generate apparent calibration discrepancies of up to 0.6% of reading on well behaved gases and as much as 3% of reading on some gases such as propane and butane, unless the standard was directly calibrated on the gas in question.

As the older standards are phased out, this difference in readings will cease to be a problem. If you see a difference between the Alicat meter and your in-house standard, in addition to calling Alicat Scientific at (520) 290-6060, call the manufacturer of your standard for clarification as to which data set they used in their calibration. This comparison will in all likelihood resolve the problem.

GAS SELECT > Standard:

MC Controllers will display: Acetylene, Air, Argon, Butane, Carbon Dioxide, Carbon Monoxide, Ethane, Ethylene (Ethene), Helium, Hydrogen, Iso-Butane, Krypton, Methane, Neon, Nitrogen, Nitrous Oxide, Oxygen, Propane, Sulfur Hexafluoride, Xenon, A-25, A-75, A1025, C-2, C-8, C-10, C-25, C-75, P-5, Star29.

MCS and **MCRS Controllers** add the following: Ammonia, Hydrogen Sulfide, Nitric Oxide, Nitrogen Triflouride, Propylene, Nitrogen Dioxide to 0.5% in an inert carrier, Refrigerant gases.

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

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. Gas numbers 33 and 35 are not available on controllers unless the unit is ordered with a specialized valve.**

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	Pentafluoroethane	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	R-142b	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	Difluoromonochloromethane	126.30390	3.58679	0.9853641	115.325	3.9360	0.9801128
111	R-23	Trifluoromethane	149.13160	2.88404	0.9922734	136.997	3.1568	0.9895204
112	R-32	Difluoromethane	126.13140	2.15314	0.9875960	115.303	2.3619	0.9827161
113	RC-318	Octafluorocyclobutane	115.04690	8.42917	0.9700156	104.785	9.3017	0.9594738
114	R-404A	44% R-125 / 4% R-134A / 52% R-143A	120.30982	4.18002	0.9836342	111.584	4.5932	0.9770889
115	R-407C	23% R-32 / 25% R-125 / 52% R-134A	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	4.23876	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

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

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

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

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

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

Pressure Units

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

Flow Units

Volumetric	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
	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
These can be used for mass flow on gas devices. These can also be used for volumetric flow on liquid devices calibrated in one of these units (liquid density is not yet supported).	

Totalizer Units

Volumetric	Standard	Normal	Notes
uL	SuL	NuL	microliter
mL	SmL	NmL	milliliter
L	SL	NL	liter
US GAL			US gallon
cm3	Scm3	Ncm3	cubic centimeter
m3	Sm3	Nm3	cubic meter
in3	Sin3		cubic inch
ft3	Sft3		cubic foot
	kSft3		1000 cubic feet
uP	micropoise, a measure of viscosity; no conversions are performed to or from other units		

Total Mass Units

Label	Notes
mg	milligram
g	gram
kg	kilogram
oz	ounce
lb	pound
These can be used for totalized mass on gas devices. These can also be used for totalized volume on liquid devices calibrated in one of these units (liquid density is not yet supported).	

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

Valve Drive Units

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

TROUBLESHOOTING

Display does not come on or is weak.
Check power and ground connections. Please reference the technical specifications (pages 59 - 88) to assure you have the proper power for your model.

Flow reading is approximately fixed either near zero or near full scale regardless of actual line flow.
Differential pressure sensor may be damaged. A common cause of this problem is instantaneous application of high-pressure gas as from a snap acting solenoid valve upstream of the meter. If you suspect that your pressure sensor is damaged please discontinue use of the controller and contact Alicat.

Displayed mass flow, volumetric flow, pressure or temperature is flashing and message MOV, VOV, POV or TOV is displayed:
Our flow meters and controllers display an error message (MOV = mass overrange, VOV = volumetric overrange, POV = pressure overrange, TOV = temperature overrange) when a measured parameter exceeds the range of the sensors in the device. When any item flashes on the display, the flashing parameter is not accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy. If the unit does not return to normal contact Alicat.

After installation, there is no flow.
Alicat MC controllers incorporate normally closed valves and require a set-point to operate. Check that your setpoint signal is present and supplied to the correct pin and that the correct setpoint source is selected under the SETPT SOURCE list in the control set up display. Also check that the unit is properly grounded.

The flow lags below the setpoint.
Be sure there is enough pressure available to make the desired flow rate. If either the setpoint signal line and/or the output signal line is relatively long, it may be necessary to provide heavier wires (especially ground wiring) to negate voltage drops due to line wire length. An inappropriate PID tuning can also cause this symptom if the D term is too large relative to the P term. See pages 20 and 21 for more information on PID tuning.

Controller is slow to react to a setpoint change or imparts an oscillation to the flow.
An inappropriate PID tuning can cause these symptoms. Use at conditions considerably different than those at which the device was originally set up can necessitate a re-tuning of the PID loop. See pages 20 and 21 for more information on PID tuning.

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

Meter does not agree with another meter I have in line.
Volumetric meters are affected by pressure drops. Volumetric flow meters should not be compared to mass flow meters. Mass flow meters can be compared against one another provided there are no leaks between the two meters and they are set to the same standard temperature and pressure. Both meters must also be calibrated (or set) for the gas being measured. M Series mass flow meters are normally set to Standard Temperature and Pressure conditions of 25 ° C and 14.696 psia. Note: it is possible to special order meters with a customer specified set of standard conditions. The calibration sheet provided with each meter lists its standard conditions.
When performing this comparison it is best to use the smallest plumbing volumes possible between the two devices. Using small plumbing volumes will minimize lag and dead volume.

RS-232 / RS-485 Serial Communications is not responding.
Check that your meter is powered and connected properly. Be sure that the port on the computer to which the meter is connected is active. Confirm that the port settings are correct per the RS-232 instructions in this manual (Check the RS-232 / RS-485 communications select screen for current meter readings). Reboot your PC. See pages 10, 11 and 33 for more information on RS-232 / RS-485 signals and communications.

Slower response than specified.
MC-Series Controllers feature a programmable Geometric Running Average (GRA). Depending on the full scale range of the meter, it may have the GRA set to enhance the stability/readability of the display, which would result in slower perceived response time. Please see “Pressure Averaging” and “Flow Averaging” on page 29.

Jumps to zero at low flow.
MC-Series Controllers feature a programmable zero deadband. The factory setting is usually 0.5% of full scale. This can be adjusted between NONE and 6.3% of full scale. See page 29.

Discrepancies between old and new units.
Please see “Standard Gas Data Tables” explanation on page 38.

Maintenance and Recalibration

General: MC-Series Flow Controllers require minimal maintenance. Other than the valve, they have no moving parts. The single most important thing that affects the life and accuracy of these devices is the quality of the gas being measured. The controller is designed to measure CLEAN, DRY, NON-CORROSIVE gases.

Moisture, oil and other contaminants can affect the laminar flow elements. We recommend the use of in-line sintered filters to prevent large particulates from entering the measurement head of the instrument. Suggested maximum particulate sizes are as follows:

5 microns for units with FS flow ranges of 0-1 sccm or less.
20 microns for units with FS flow ranges between 0-2 sccm and 0-1 slpm.
50 microns for units with FS flow ranges of 0-1 slpm or more.

Recalibration: The recommended period for recalibration is once every year. A label located on the back of the controller lists the most recent calibration date. The controller should be returned to the factory for recalibration within one year from the listed date. Before calling to schedule a recalibration, please note the serial number on the back of the instrument. The Serial Number, Model Number, and Date of Manufacture are also available on the Mfg Info display (page 22).

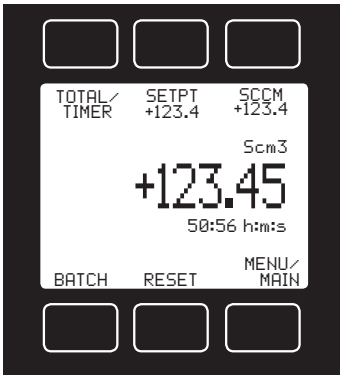
Cleaning: MC-Series Flow Controllers require no periodic cleaning. If necessary, the outside of the controller can be cleaned with a soft dry cloth. Avoid excess moisture or solvents.

For repair, recalibration or recycling of this product contact:

Alicat Scientific, Inc.
7641 N Business Park Drive
Tucson, Arizona 85743
USA
Ph. 520-290-6060
Fax 520-290-0109
e-mail: service@alicat.com
Web site: www.alicat.com

Option: Totalizing Mode - Controllers

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



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

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

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

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

Rollover with Notification – When the counter reaches the maximum count it automatically rolls over to zero, displays an overflow error, and continues counting until the counter is cleared.

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

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

SETPT: Pushing SETPT will allow you to change the controller's setpoint.

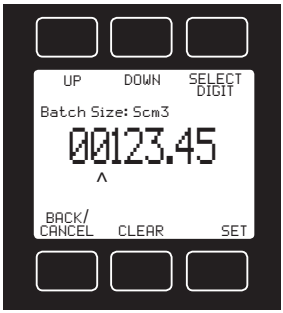
RESET – The counter can be reset to zero at any time by pushing the RESET button. To clear the counter via RS-232 or RS-485, establish serial communication with the meter or controller as described in the RS-232 or RS-485 section of the manual. To reset the counter, enter the following commands: `(unit ID)T <CR>` `(e.g. AT<CR>)`

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

IF THE TOTALIZER IS IN USE AT THAT TIME, THE TOTALIZED VALUE WILL NECESSARILY BECOME INCORRECT. A TIME ERROR WILL BE DISPLAYED AND THE TOTAL VALUE WILL BLINK. PLEASE RESET THE TOTALIZER IF SUCH AN 'OVER-FLOW' CONDITION HAS OCCURRED.

BATCH PROCESSING MODE

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



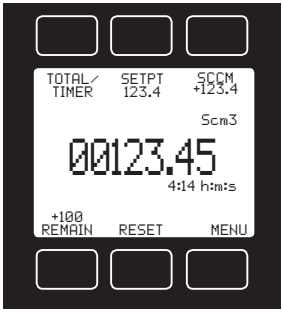
To activate Batch Mode: Press **BATCH**. Then use **SELECT DIGIT** to move the arrow to the desired digit, and the UP and DOWN buttons to change the value. Press **CLEAR** to return to zero. Press **SET** to record your value. If the controller has a non-zero Setpoint, flow will start immediately. If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

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

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

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

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



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

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

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

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

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

Option: Remote Electronics for High Line or Gas Temperatures

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

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

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

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

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

Option: Remote Panel Display

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

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

The Remote Display is ideal for:

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

Accessory: BB9 Multi-Drop Box

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

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

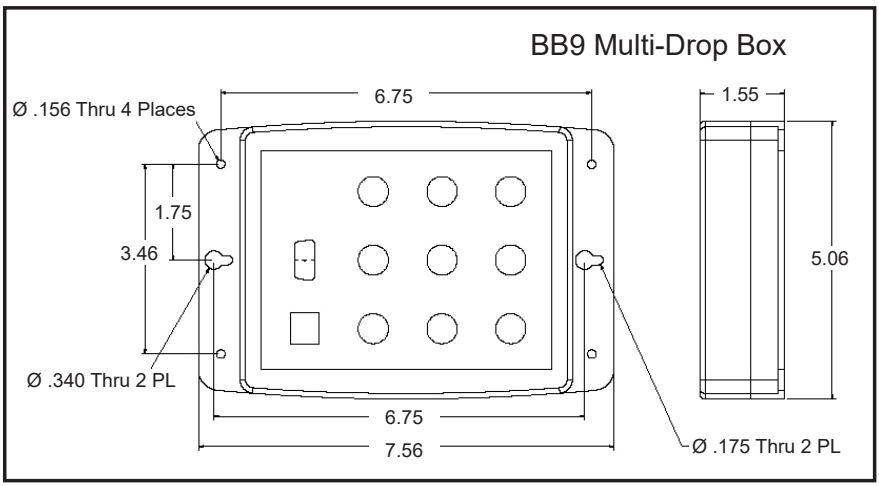
A single DB9 D-SUB type connector (COM PORT) connects, using the included cable, to the serial connector on a PC or laptop.

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

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

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

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



Accessory: Flow Vision™ SC Software

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

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

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

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

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

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

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

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

Accessory: Flow Vision™ MX Software

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

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

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

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

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

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

Accessories

Part Number	Description
FLOWVISIONSC	Flow Vision™ SC software for interface with all Alicat instruments
FLOWVISIONMX	Flow Vision™ MX software for gas blending
BB9-232	9 position Multi Drop Box with 9-pin serial port and USB to PC
BB9-I	9 position Multi-Drop Box, Industrial connectors
BB9-485	9 position Multi Drop Box with serial port only
BB9-I-485	9 position Multi-Drop Box, industrial connectors, serial port only
PVPS24U	Universal 100-240 VAC to 24 Volt DC Power Supply Adapter
PS24VHC	High current power supply for BB9 use with Large Valve Controllers
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
USB-RS232	RS-232 to USB Converter

Accessories

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

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

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

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

Technical Data for Alicat 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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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	**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)

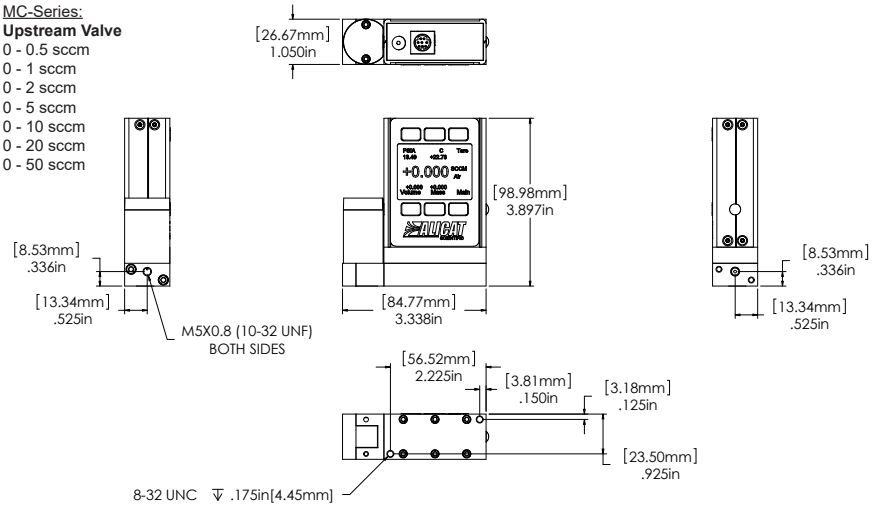
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature.

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

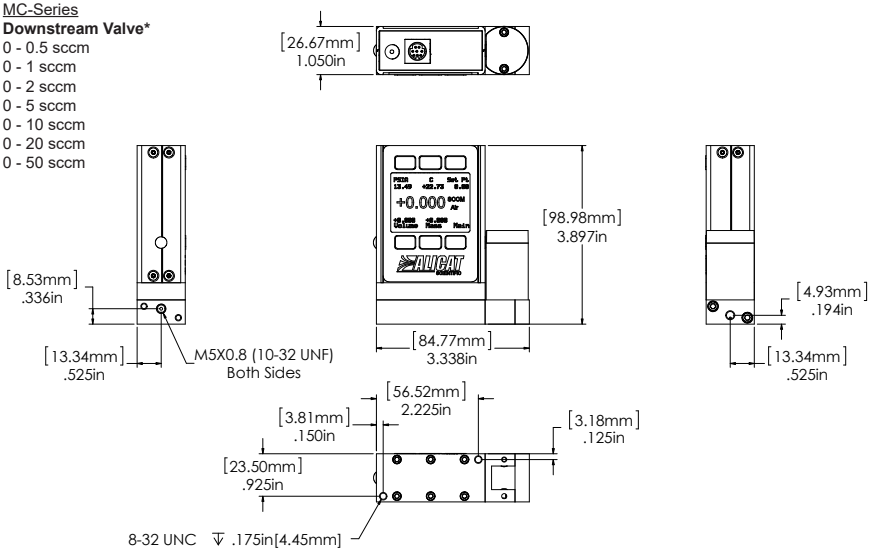
1. Lower Pressure Drops Available, please see our **WHISPER-Series** mass flow controllers at ***www.alicat.com/whisper***.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with M-5 (10-32) Male Buna-N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

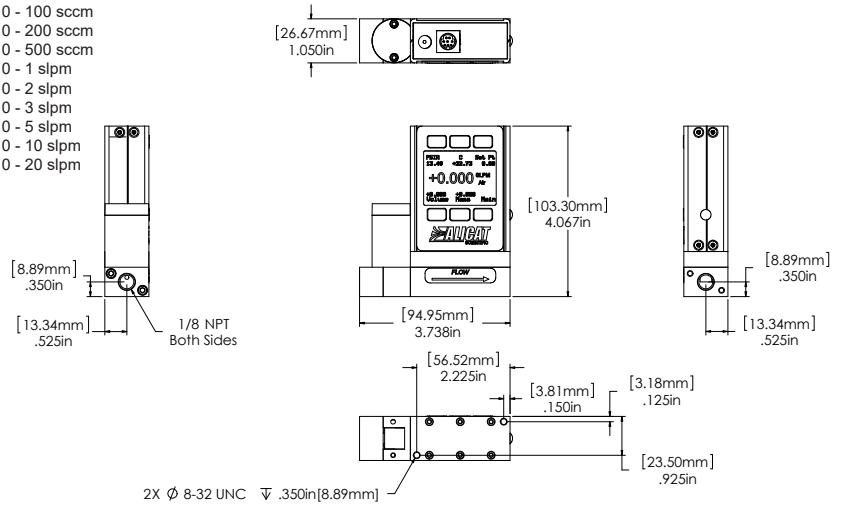
MC-Series
Downstream Valve*
0 - 0.5 sccm
0 - 1 sccm
0 - 2 sccm
0 - 5 sccm
0 - 10 sccm
0 - 20 sccm
0 - 50 sccm



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

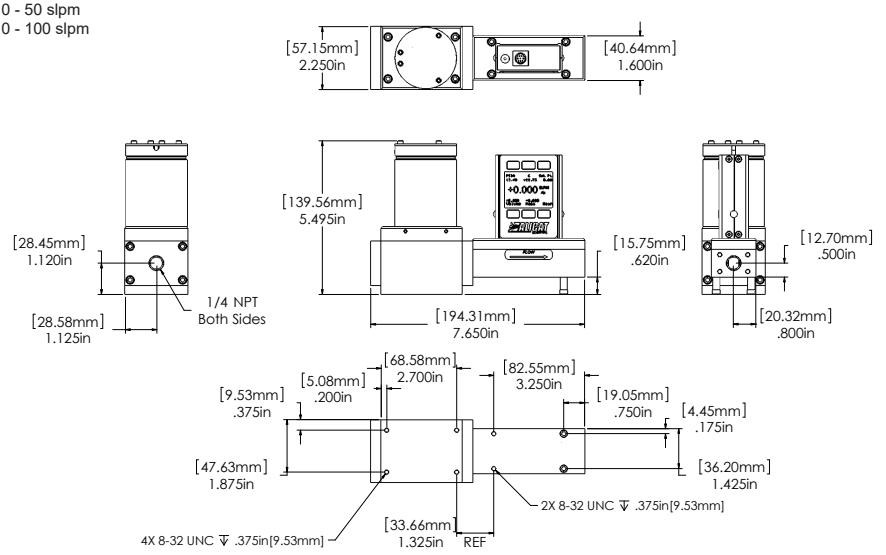
MC 0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

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



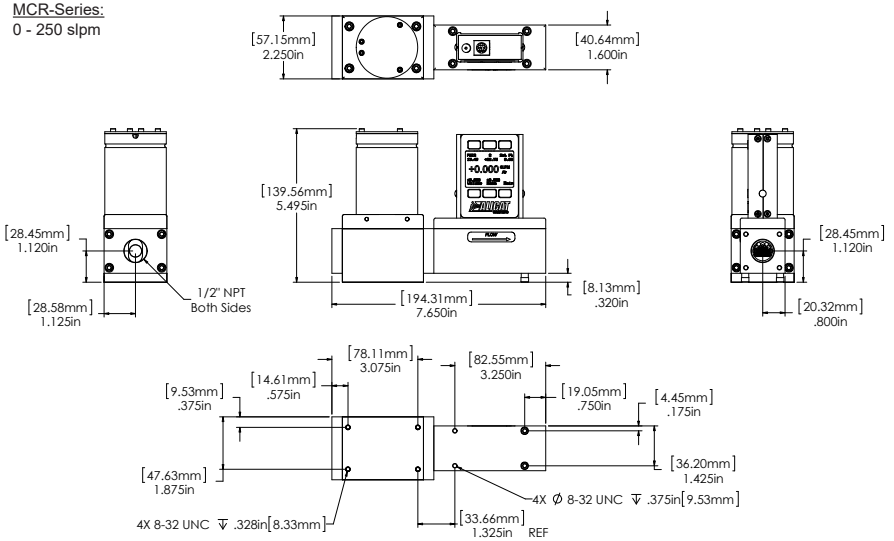
MC 100 sccm to 20 slpm approximate weight: 1.2lb

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



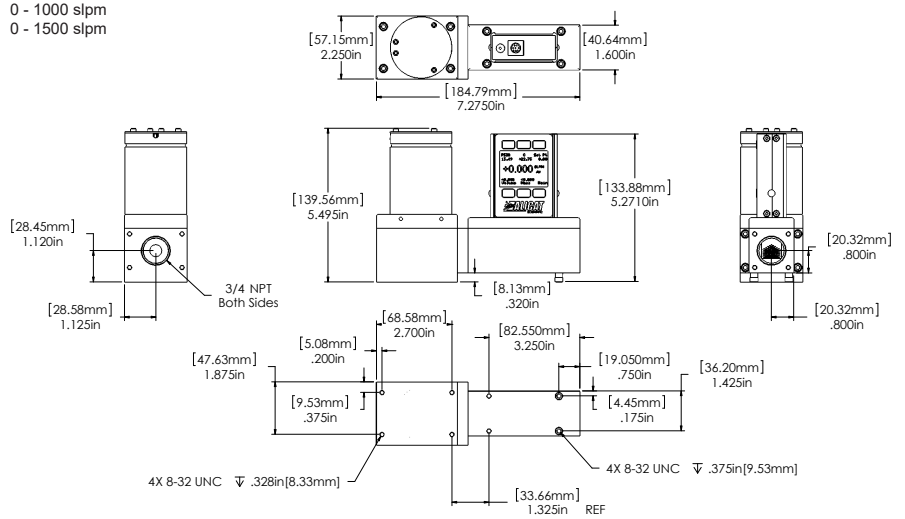
MCR 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCR-Series:
0 - 250 slpm



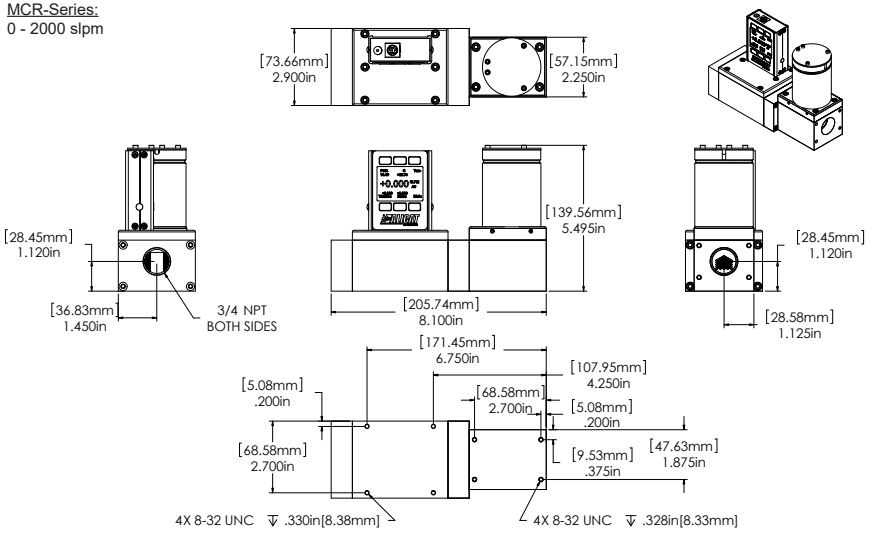
MCR 250 slpm approximate weight: 9.0 lb.

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



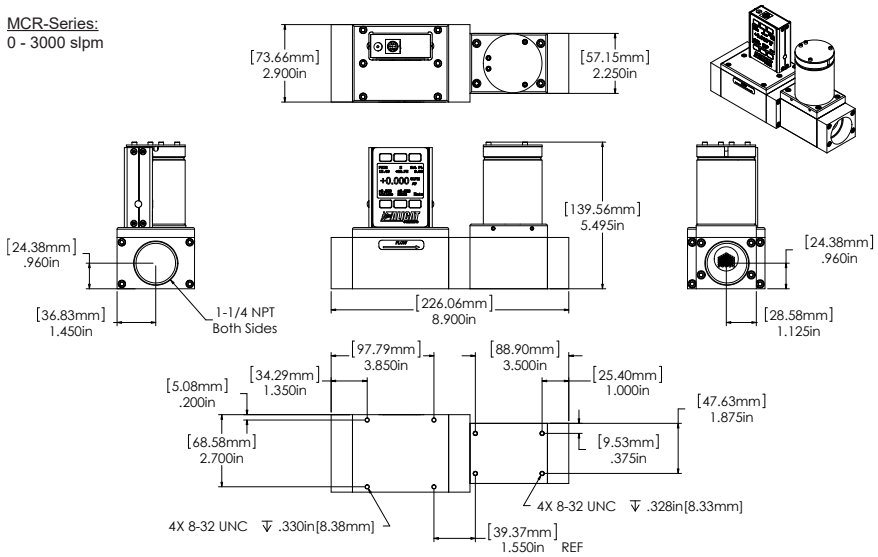
MCR 1500 slpm approximate weight: 9.0 lb.

MCR-Series:
0 - 2000 slpm



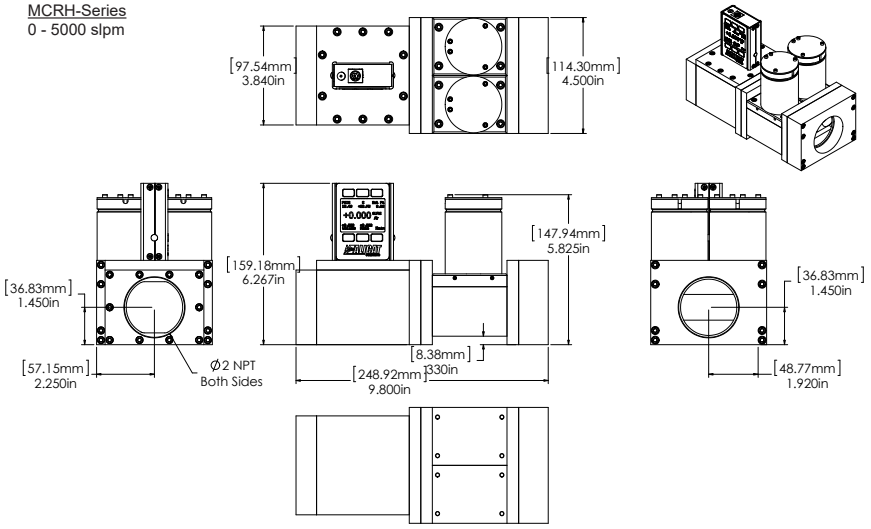
MCR 2000 slpm approximate weight: 12.0 lb.

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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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	**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

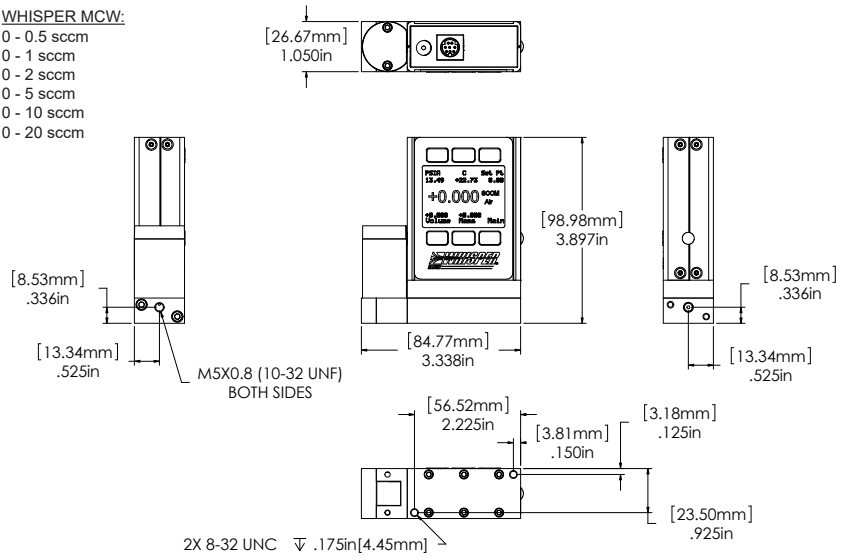
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

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

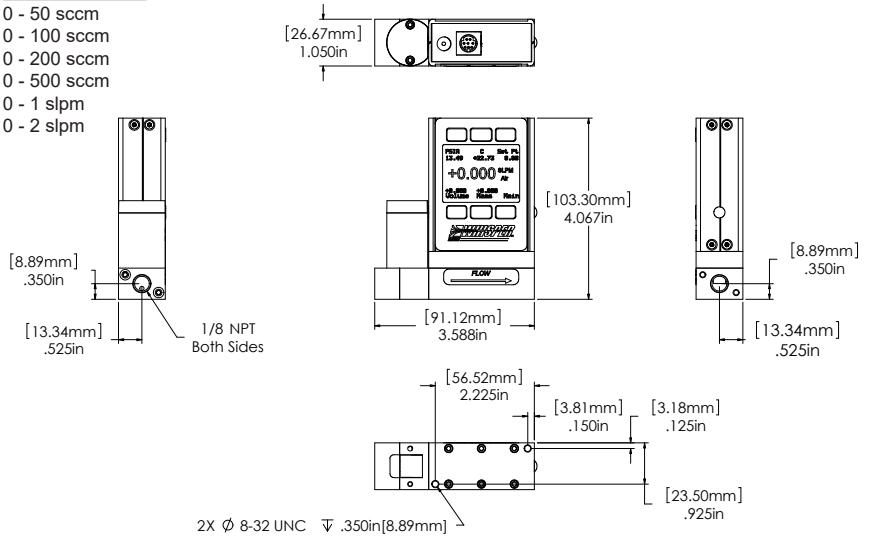
1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
2. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT fittings.

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



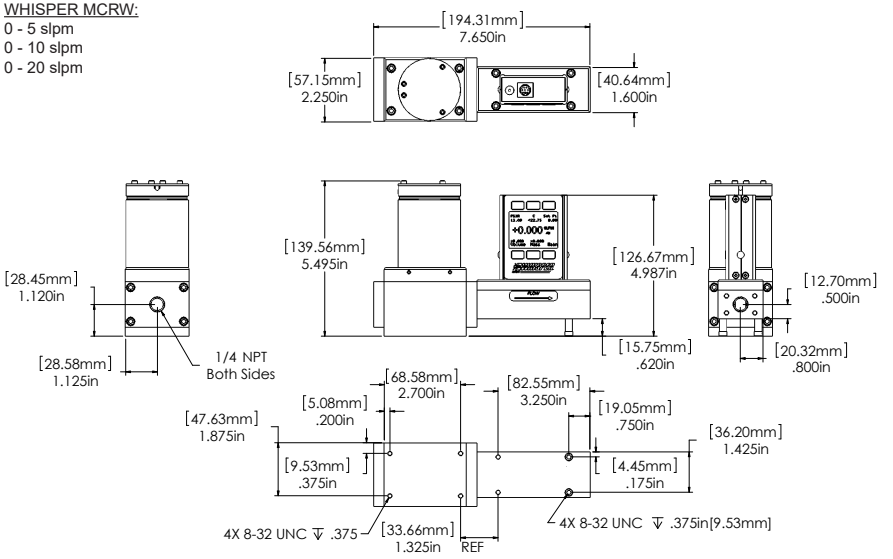
MCW 0.5 sccm to 20 sccm approximate shipping weight: 1.1 lb.

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



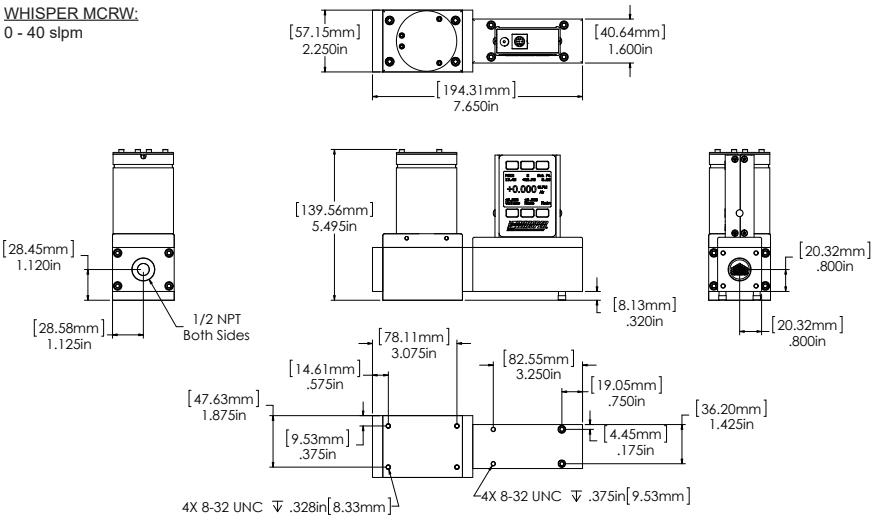
MCW 50 sccm to 2 slpm approximate weight: 1.2lb

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



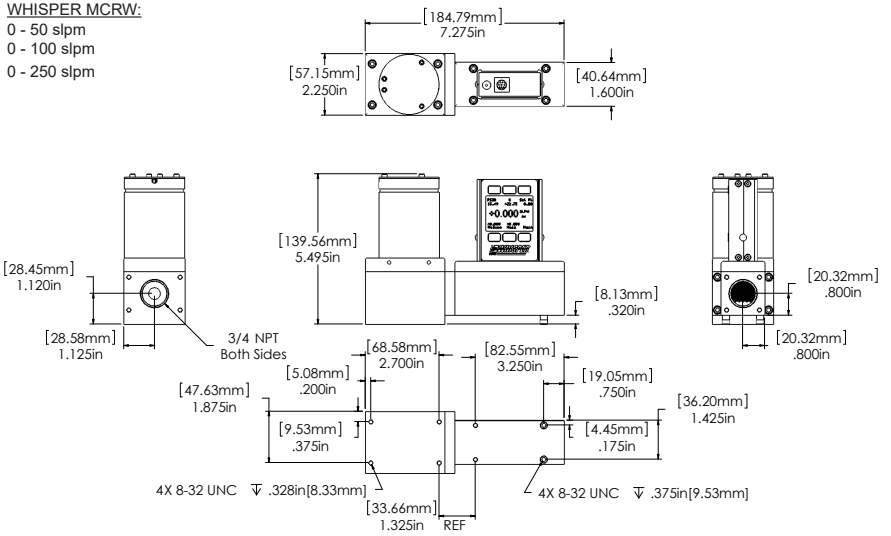
MCRW 5 slpm to 20 slpm approximate weight: 6.4 lb.

WHISPER MCRW:
0 - 40 slpm



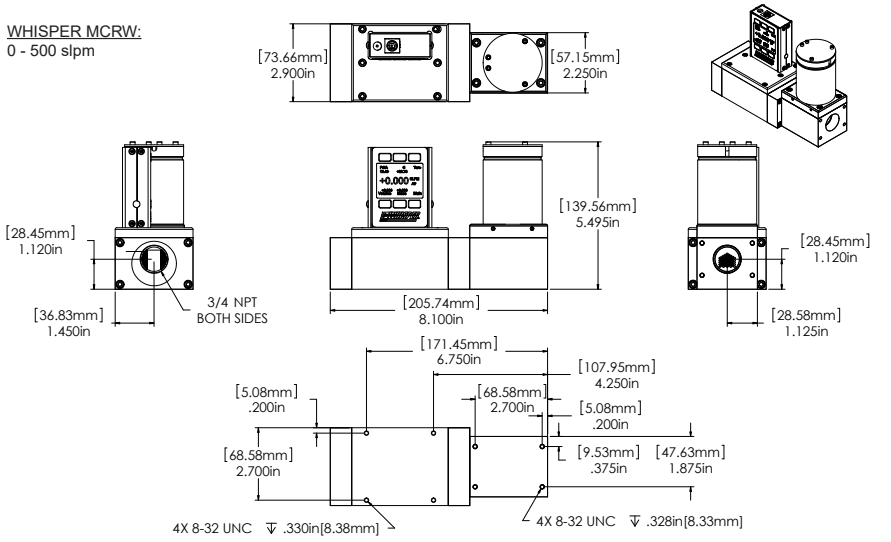
MCRW 40 slpm approximate weight: 9.0 lb.

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



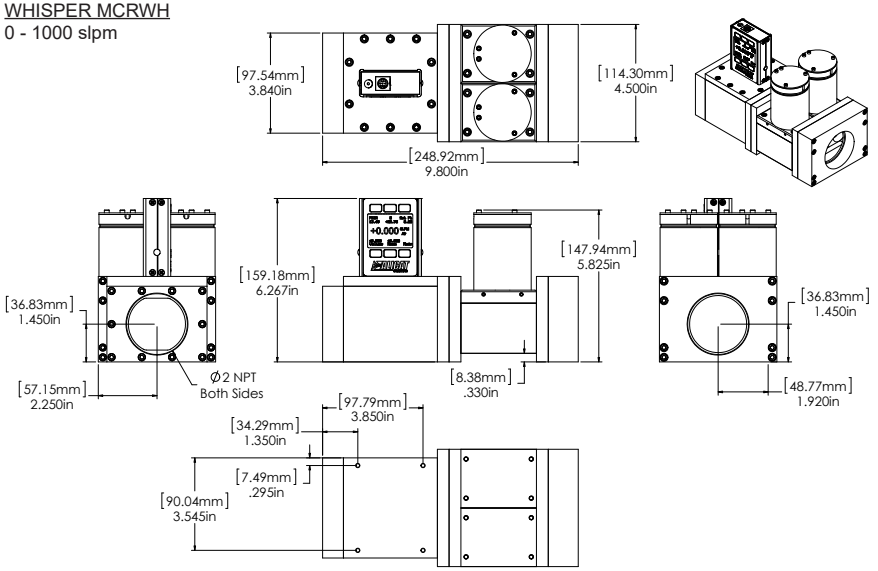
MCRW 50 slpm to 250 slpm approximate weight: 9.0 lb.

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 MCV & MCVS Mass Flow Controllers

0 to 0.5 sccm Full Scale through 0 to 20 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.	

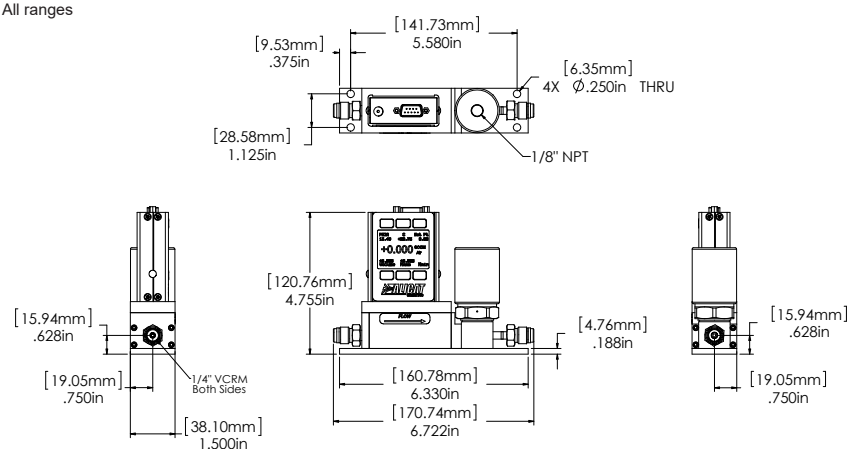
Communications / Power	Whisper MCV & MCVS Mass Flow Controller
Monochrome LCD or Color TFT Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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

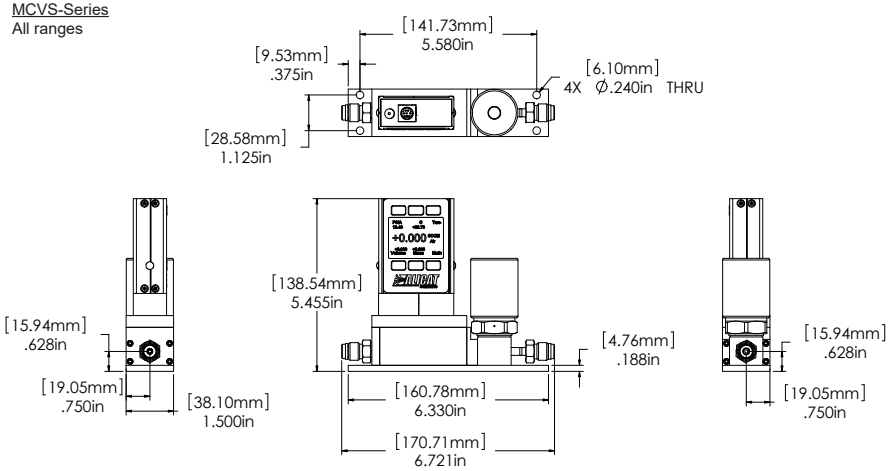
Full Scale Mass Flow Controller	Mechanical Dimensions	Process Connections
MCV 0.5SCCM to 20SLPM	4.8”H x 6.8”W x 1.5”D	1/4” VCR® Male
MCVS 0.5SCCM to 20SLPM	5.5”H x 6.8”W x 1.5”D	1/4” VCR® Male
Welded VCR® process connections are recommended for MCV and MCVS applications. Please contact Alicat.		

MCV-Series
All ranges



MCV approximate weight: 3.0 lb.

MCVS-Series
All ranges



MCVS approximate weight: 3.2 lb.

Technical Data for MCP Moderate Flow 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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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

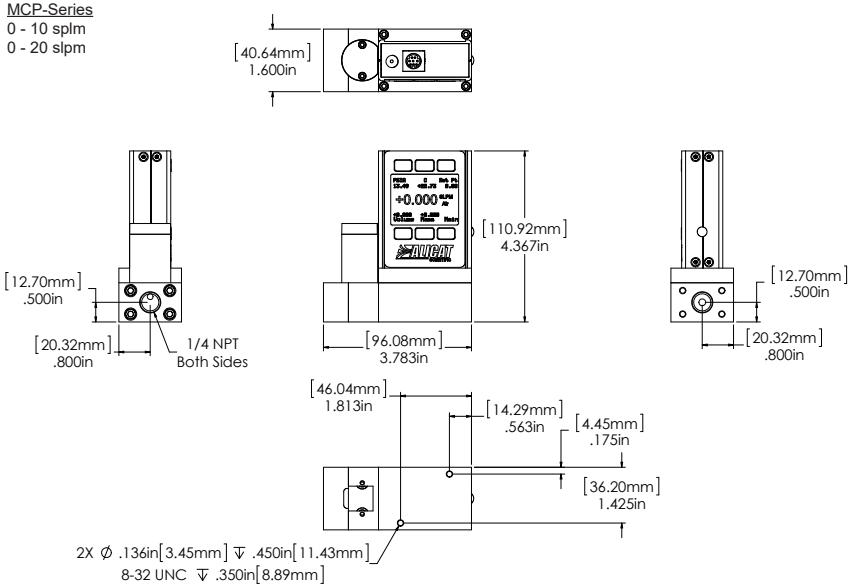
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[2]
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

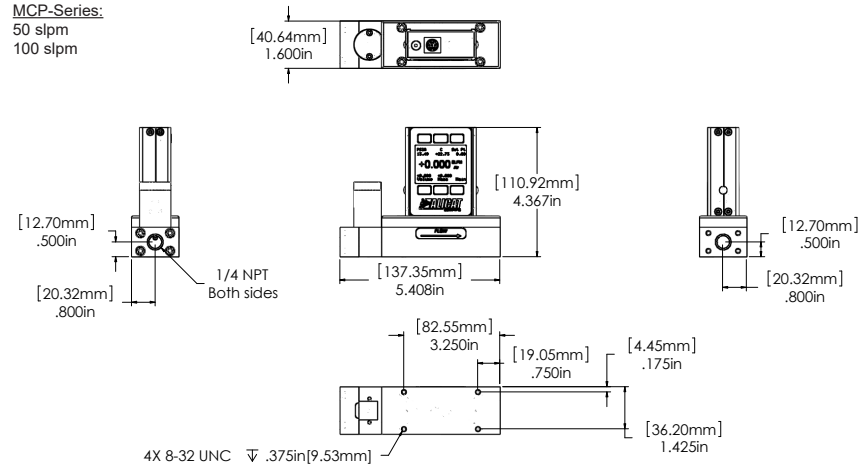
1. Lower Pressure Drops Available, please see our **WHISPER-Series** mass flow controllers at ***www.alicat.com/whisper***.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

MCP-Series
0 - 10 slpm
0 - 20 slpm



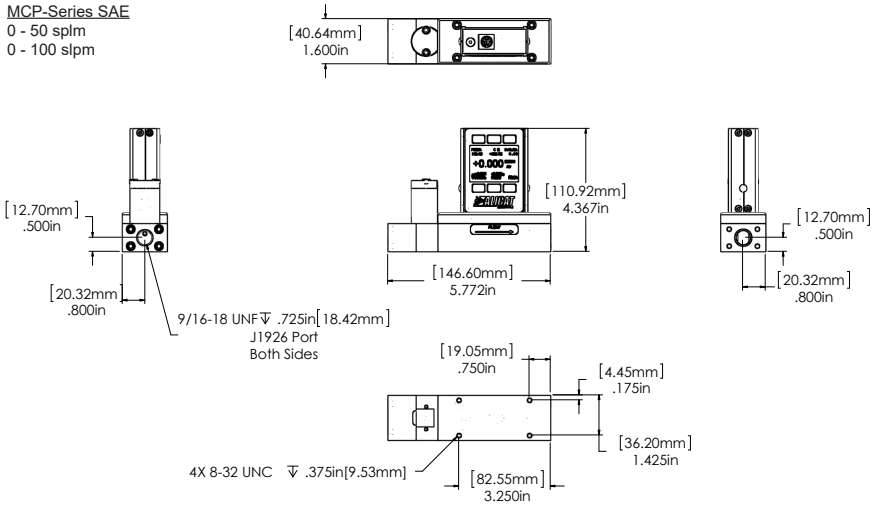
10 slpm to 20 slpm approximate shipping weight: 2.5 lb.

MCP-Series:
50 slpm
100 slpm



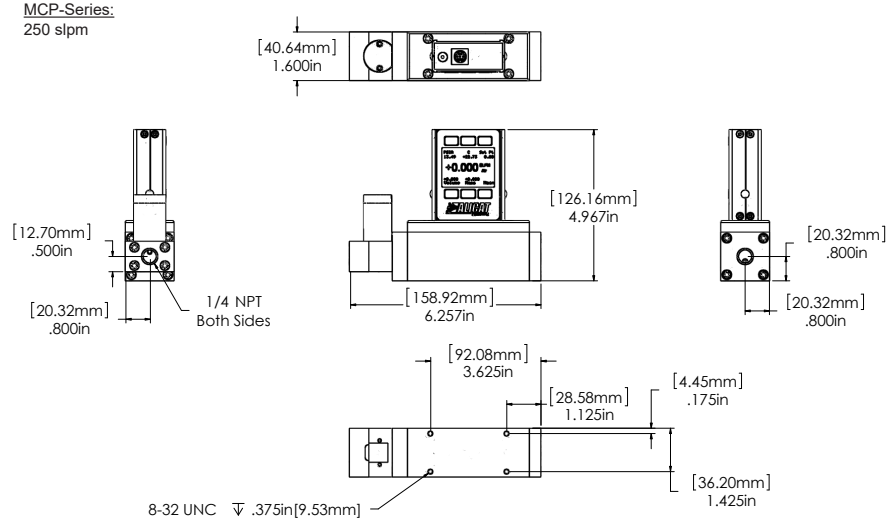
10 slpm to 50 slpm approximate shipping weight: 3.0 lb.

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 MCE and MCES Flow 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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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

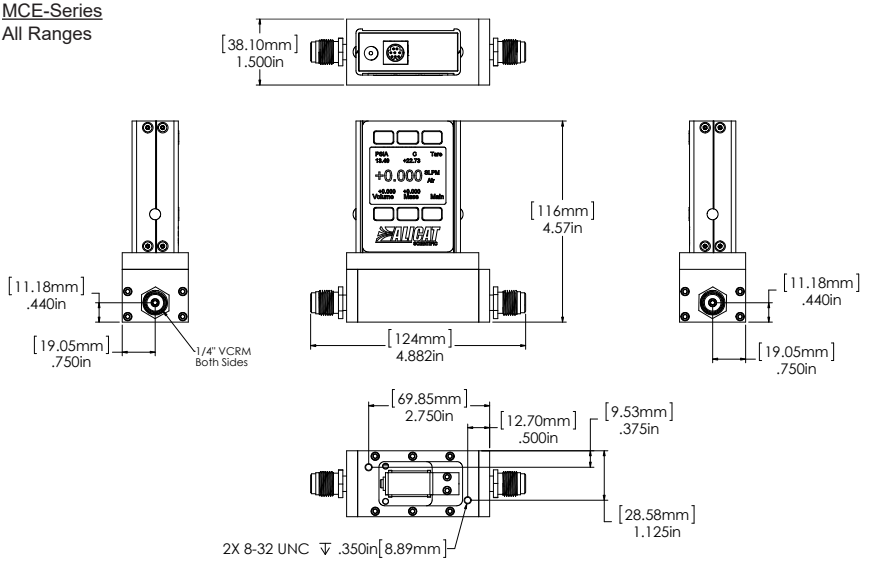
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

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		

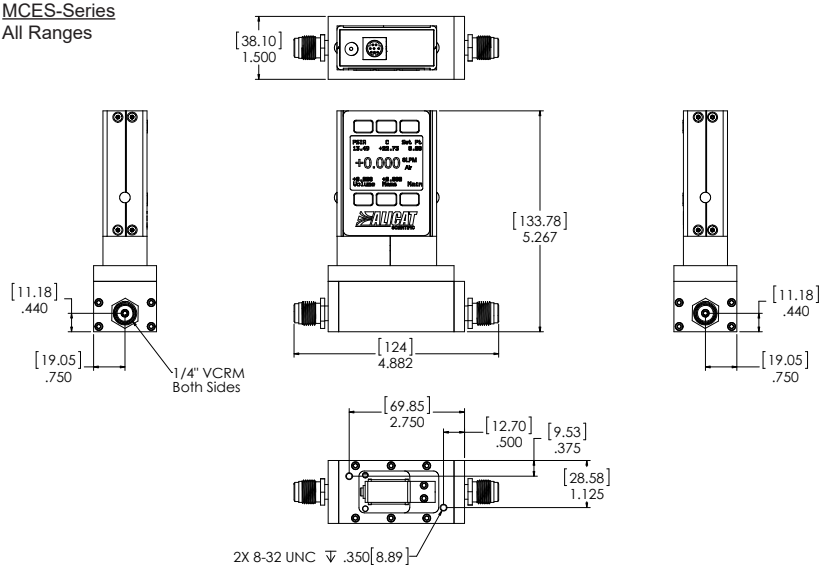
1. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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)	24 to 30 Vdc
Supply Current	0.250 Amp	0.750 Amp

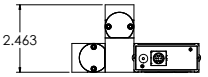
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

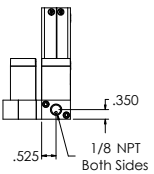
Range Specific Specifications

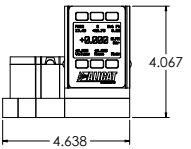
Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[2]
MCD 0.5 sccm to 50 sccm	1.0	Dimensions will vary with valve choice.	M-5 (10-32) Female Thread[3]
MCD 100 sccm to 500 sccm	1.0		1/8" NPT Female
MCD 1 slpm	1.5		
MCD 2 slpm	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

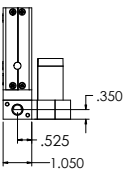
1. Lower Pressure Drops Available, please see our **WHISPER-Series** mass flow controllers at ***www.alicat.com/whisper***.
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with M-5 (10-32) Male Buna-N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

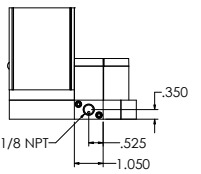
MCD-Series
0 - 20 slpm shown

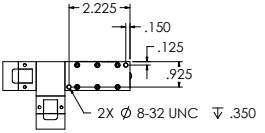




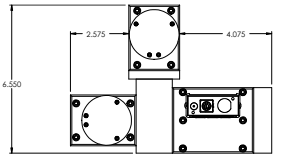


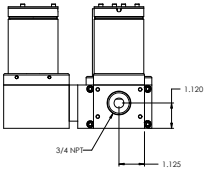


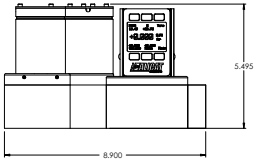


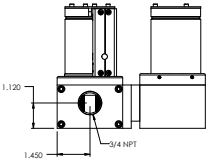


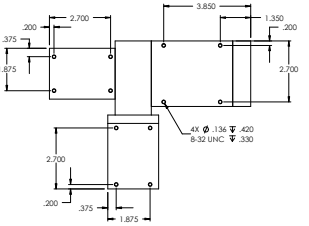
MCRD-Series
0 - 2000 slpm shown











Technical Data for Alicat MCS and MCRS-Series Mass Flow Controllers

Alicat MCS and MCRS instruments are built for use with aggressive gases. For the most part, these instruments maintain the specifications of equivalently ranged MC and MCR-Series devices.

Standard Compatible Gas List for MCS and MCRS Controllers

0	Air	Air
1	Argon	Ar
2	Methane	CH4
3	Carbon Monoxide	CO
4	Carbon Dioxide	CO2
5	Ethane	C2H6
6	Hydrogen	H2
7	Helium	He
8	Nitrogen	N2
9	Nitrous Oxide	N2O
10	Neon	Ne
11	Oxygen	O2
12	Propane	C3H8
13	normal-Butane	n-C4H10
14	Acetylene	C2H2
15	Ethylene	C2H4
16	iso-Butane	i-C4H10
17	Krypton	Kr
18	Xenon	Xe
19	Sulfur Hexafluoride	SF6
20	75%Ar / 25% CO2	C-25
21	90% Ar / 10% CO2	C-10
22	92% Ar / 8% CO2	C-8
23	98% Ar / 2% CO2	C-2
24	75% CO2 / 25% Ar	C-75
25	75% Ar / 25% He	HE-75
26	75% He / 25% Ar	HE-25
27	90% He / 7.5% Ar / 2.5% CO2 Helistar® A1025	A1025
28	90% Ar / 8% CO2 / 2% O2 Stargon® CS	Star29
29	95% Ar / 5% CH4	P-5
30	Nitric Oxide	NO
31	Nitrogen Triflouride	NF3
32	Ammonia	NH3
34	Hydrogen Sulfide	H2S
36	Propylene	C3H6
In addition, the following gases are available upon request:		
Nitrogen Dioxide to 0.5% in an inert carrier		NO2
Refrigerant gases to 100%		
Other gases to 1000 ppm in an inert carrier		
SO2 and Cl2: must be ordered with a specialized valve		

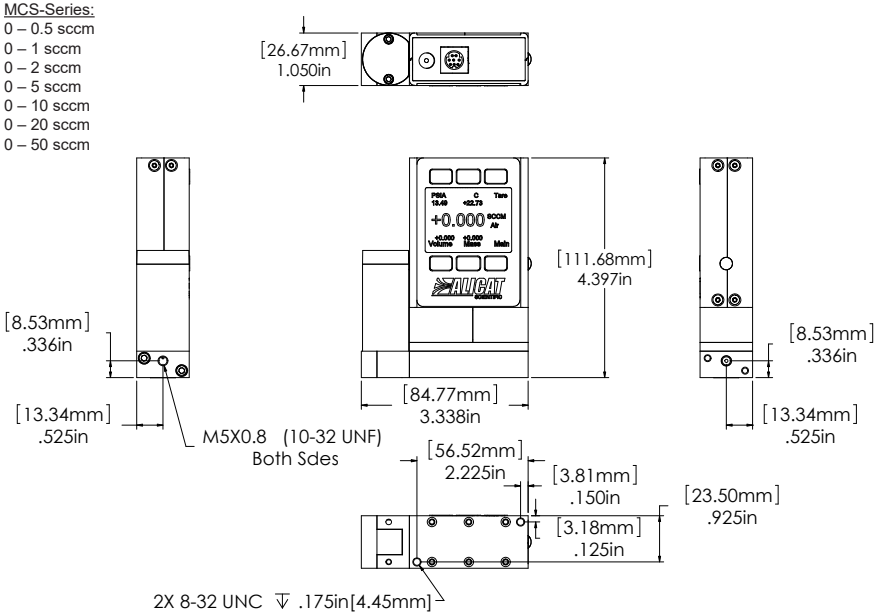
If your application requires another gas or gas mixture, please contact Info@alicat.com or call 888-290-6060.

Please refer to Alicat's Technical Data and Specifications for the equivalently ranged MC and MCR-Series instrument for all operating specifications except:

Operating Range	1% to 100% Full Scale
Turndown Ratio	100 : 1
Wetted Materials	316LSS, 303SS, 430FRSS, FFKM (Kalrez) standard, Viton, EPDM as needed for some gases.

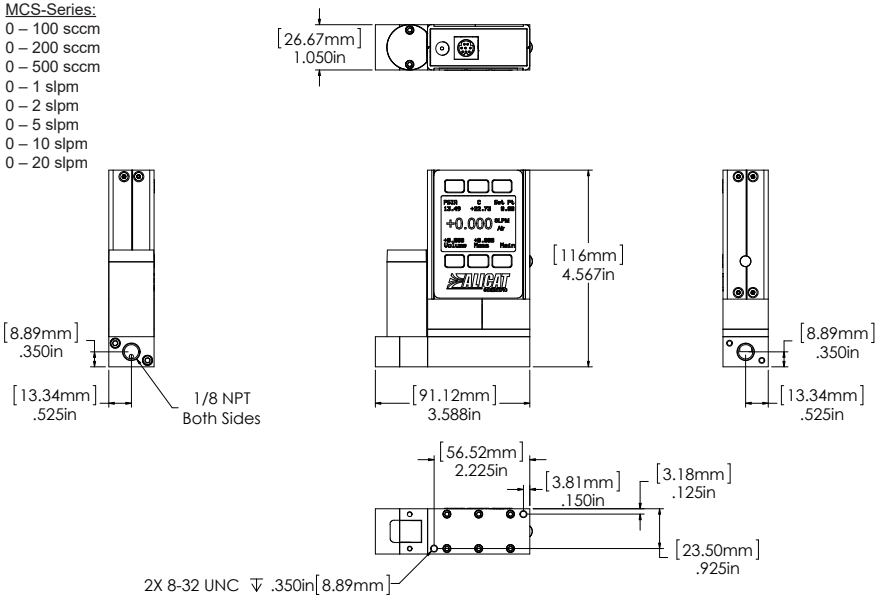
The dimensions of MCS and MCRS instruments may vary from their standard MC and MCR-Series counterparts. Dimensional drawings for MCS and MCRS instruments are shown on pages 80 -83

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



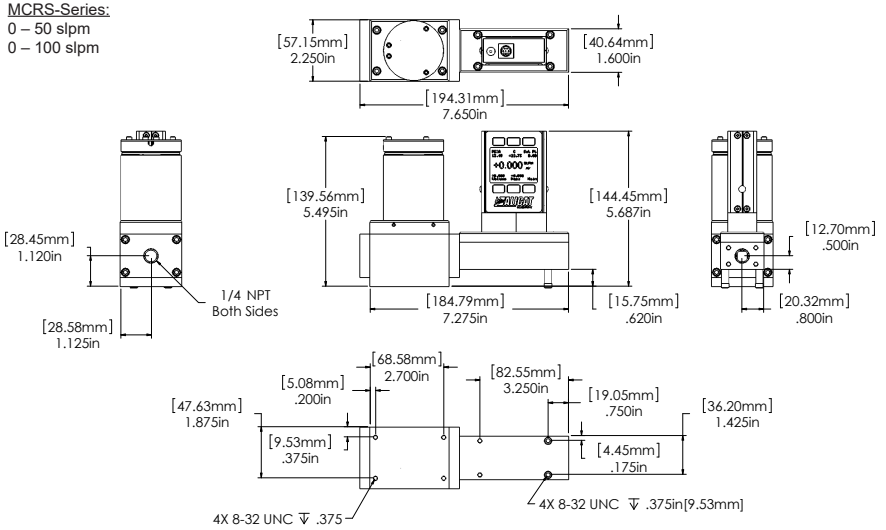
0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

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



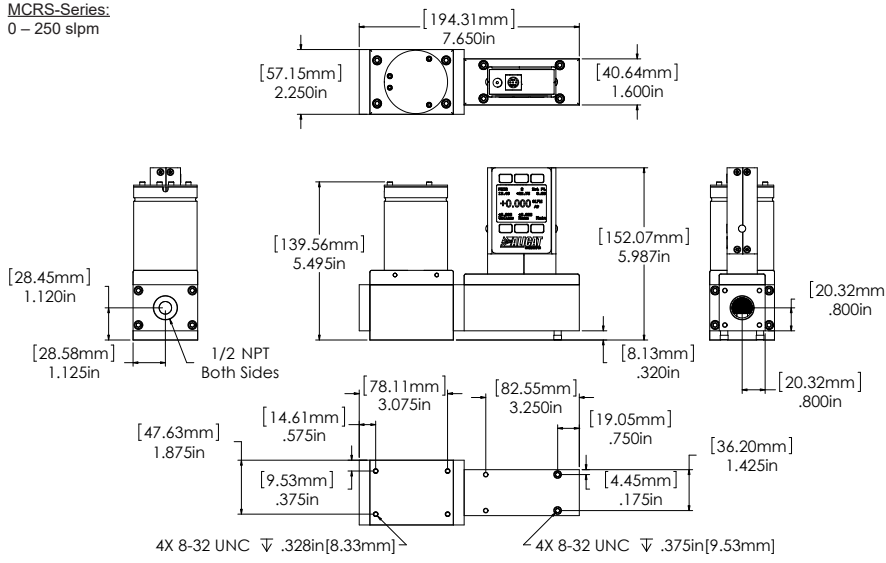
100 sccm to 20 slpm approximate weight: 1.2 lb

MCRS-Series:
0 – 50 slpm
0 – 100 slpm



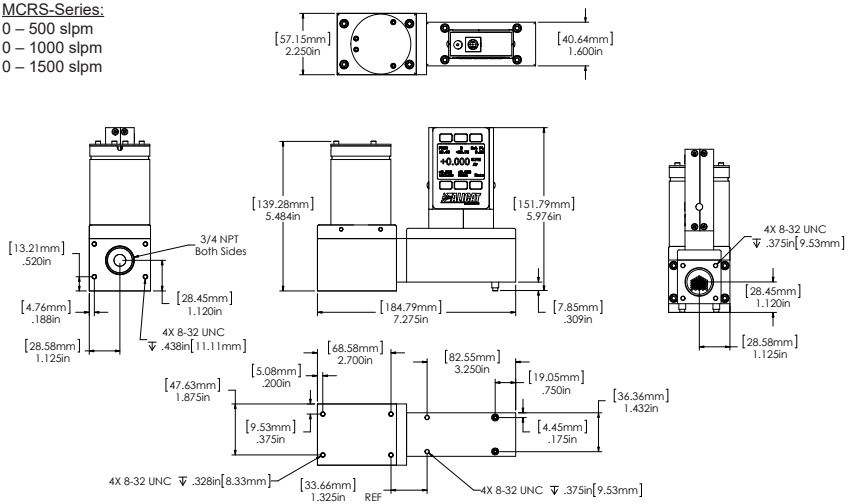
MCRS 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCRS-Series:
0 – 250 slpm



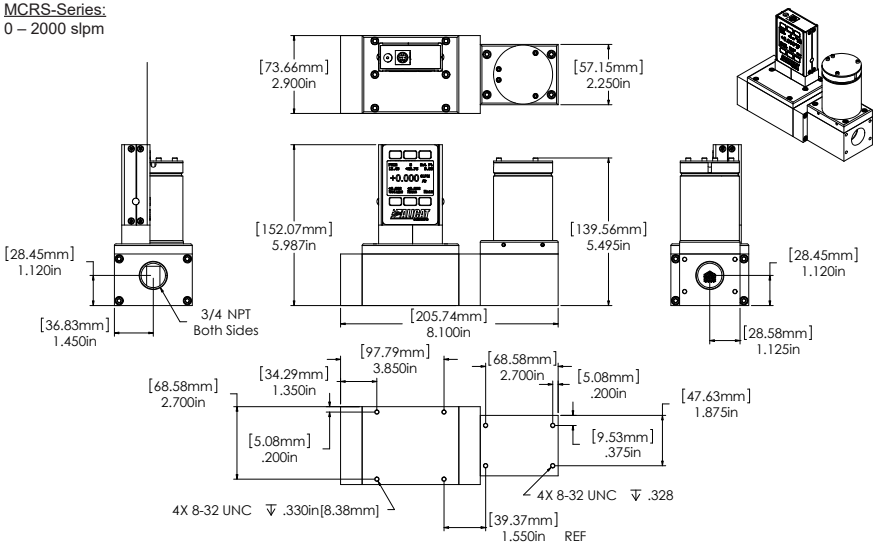
MCRS 250 slpm approximate weight: 9.0 lb.

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



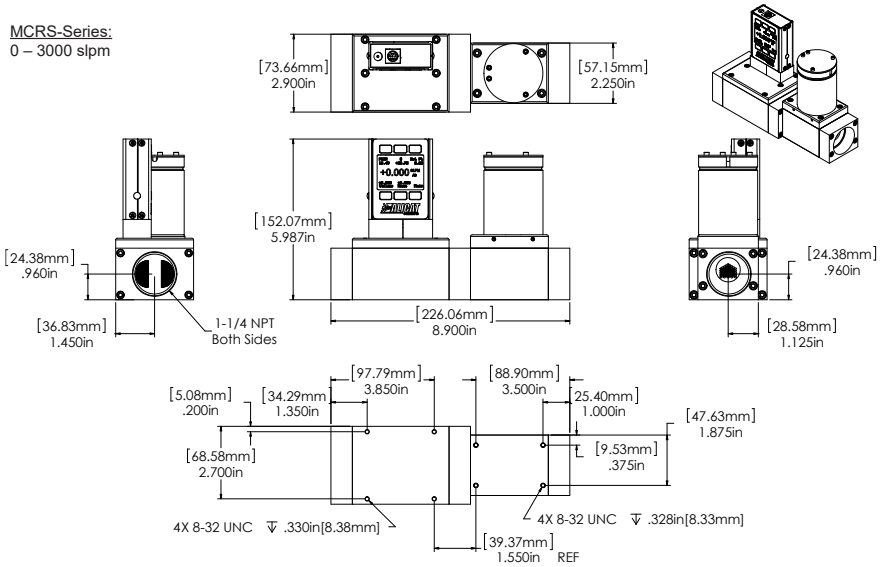
MCRS 500 slpm to 1500 slpm approximate weight: 9.0 lb.

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 Input/Output Signal[1] Options	RS-232 Serial / RS-485 Serial / Modbus / EtherNet IP / DeviceNet / 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	**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)

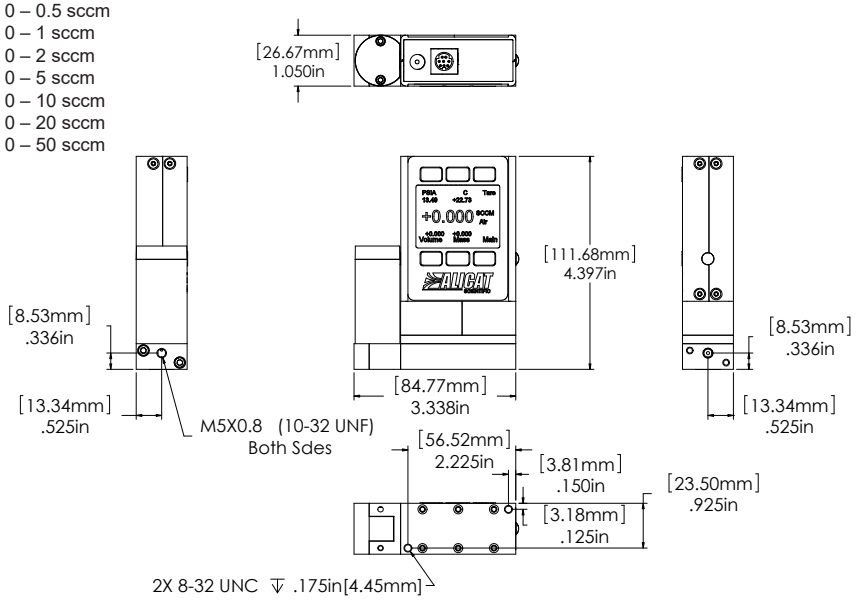
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** and **Optional Secondary Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop[1] at FS Flow (psid) venting to atmosphere	Mechanical Dimensions[1]	Process Connections[2]
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[3]
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

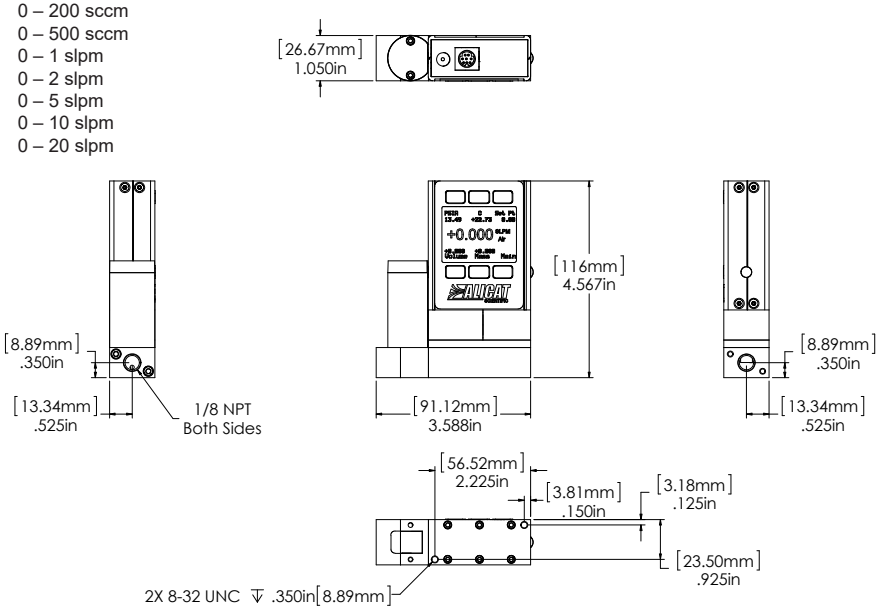
2. Compatible with Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.
3. Shipped with M-5 (10-32) Male Buna-N O-ring face seal to 1/8” Female NPT fittings.

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



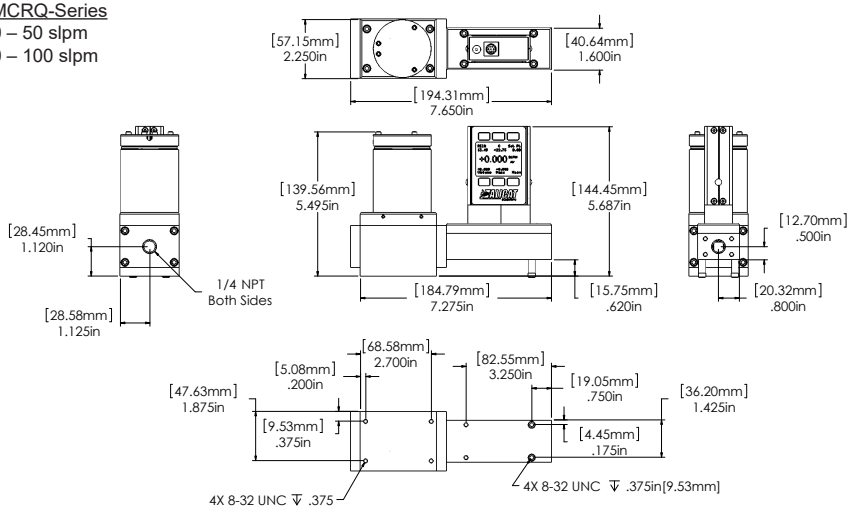
0.5 sccm to 50 sccm approximate shipping weight: 1.1 lb.

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



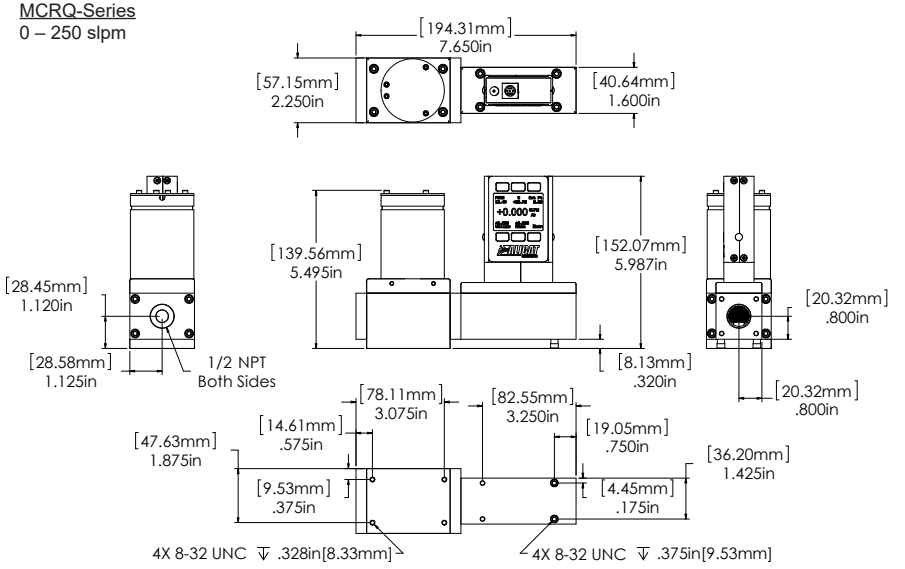
100 sccm to 20 slpm approximate weight: 1.2 lb

MCRQ-Series
0 – 50 slpm
0 – 100 slpm



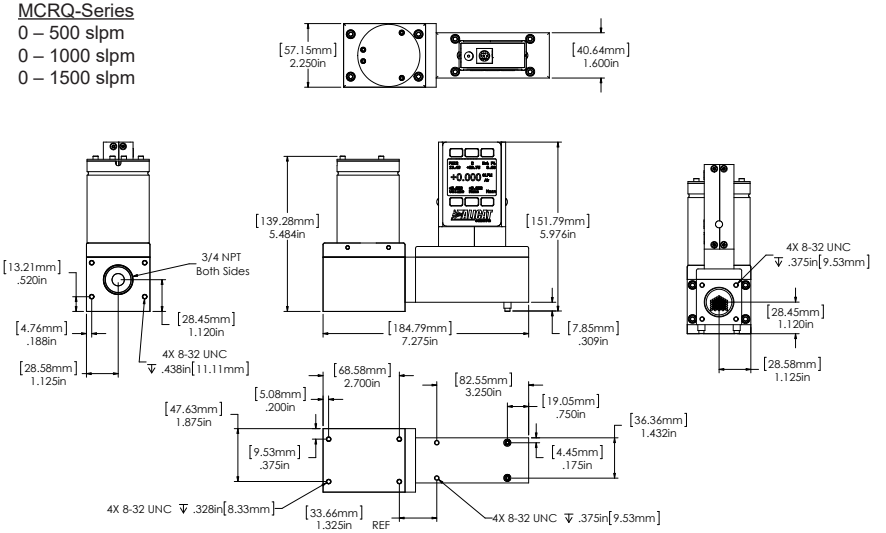
MCRQ 50 slpm to 100 slpm approximate weight: 9.0 lb.

MCRQ-Series
0 – 250 slpm



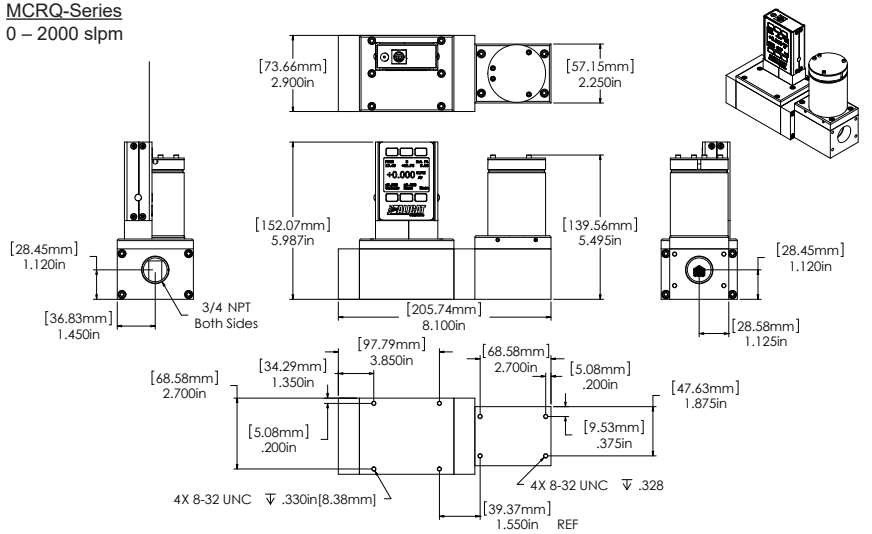
MCRQ 250 slpm approximate weight: 9.0 lb.

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



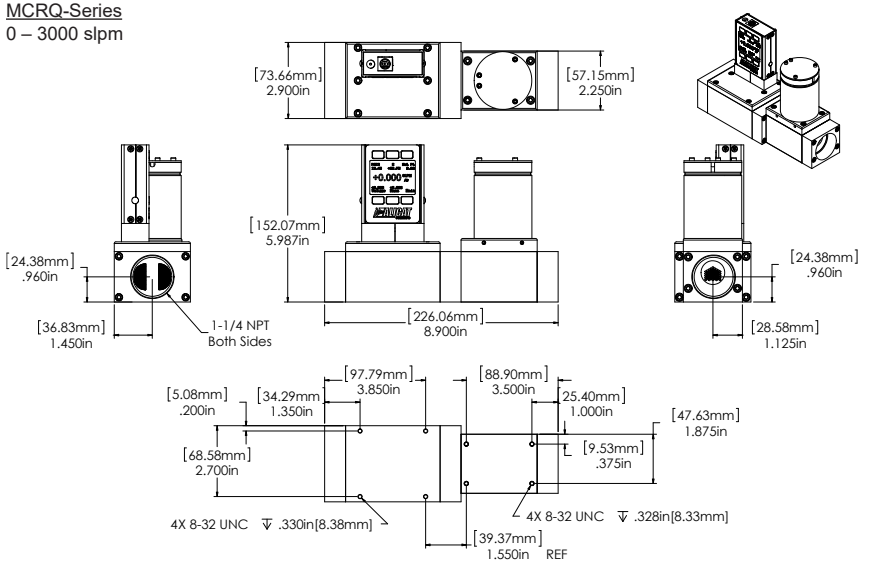
MCRQ 500 slpm to 1500 slpm approximate weight: 9.0 lb.

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.

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

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

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

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

Power and Signal Connections:

Connect to the device using two DB9 connectors.

The female top connection is PROFIBUS.

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

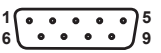
Pin out diagrams for all PROFIBUS enabled Alicat devices are shown:

TOP

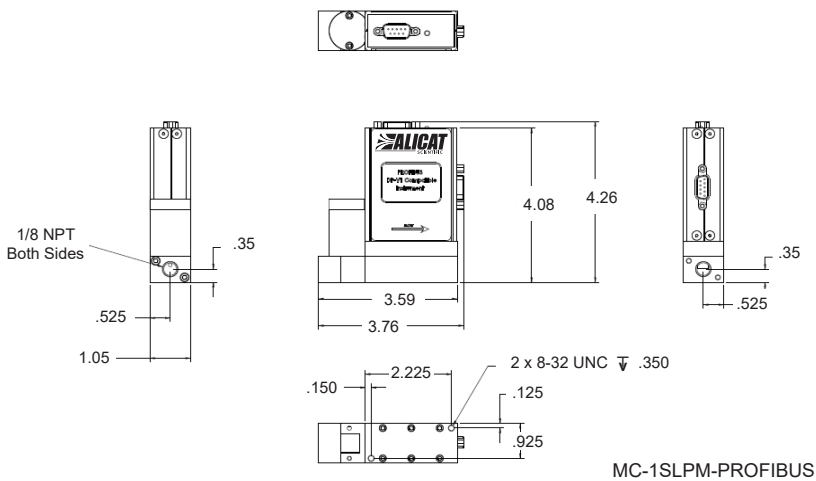
1. Not Connected
2. PoP Ground (Power over Profibus option)
3. Rx/Tx Data-P
4. Request To Send
5. Data Ground
6. Voltage Plus
7. PoP 7 to 30VDC
8. Rx/Tx Data-N
9. Not Connected

TOP: Pins 3, 5 & 8 are required. All other pin connections are optional.

SIDE



1. Not Connected
2. RS-232 RX
3. RS-232 TX
4. Not Connected
5. Ground
6. No Connected
7. 7 to 30VDC
8. Ground
9. Not Connected



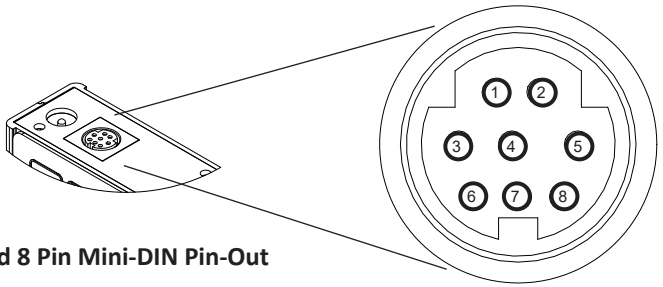
MC-1SLPM-PROFIBUS

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

PROFIBUS units do not have a display screen.

Eight Pin Mini-DIN Connector Pin-Outs

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

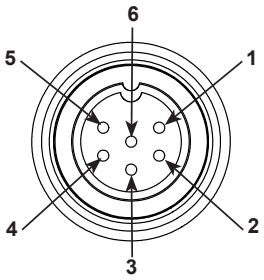


Standard 8 Pin Mini-DIN Pin-Out

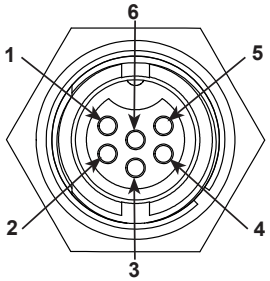
Pin	Function	Mini-DIN cable color
1	Inactive (or optional 4-20mA Primary Output Signal)	Black
2	Static 5.12 Vdc [or optional Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm]	Brown
3	Serial RS-232RX / RS-485(–) Input Signal (receive)	Red
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Setpoint Input	Orange
5	Serial RS-232TX / RS-485(+) Output Signal (send)	Yellow
6	0-5 Vdc (or optional 0-10 Vdc) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, digital communications, analog signals and alarms)	Purple
Note: The above pin-out is applicable to all the flow meters and controllers with the Mini-DIN connector. The availability of different output signals depends on the options ordered. Optional configurations are noted on the unit's calibration sheet.		

Locking Industrial Connector Pin-Outs

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



Male Connector: Cable



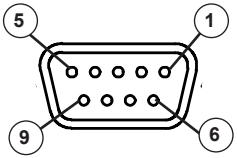
Female Connector: Device

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

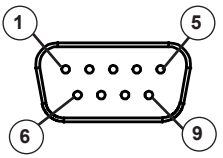
The above pin-out is applicable to all the flow meters and controllers ordered with the industrial connector. The availability of different output signals depends on the flow meter options ordered.

9 pin D-Sub Common Pinouts

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



Female Connector Front View



Male Connector Front View

Common Pinouts

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

Current Out = Not Connected or optional 4-20mA analog output signal
Analog In = setpoint for controllers or remote tare function for meters
Analog Out = 0-5 Vdc Output Signal (or 0-10 Vdc optional)
Analog Out 2 = 5.12Vdc or Optional Secondary Analog Output
TX (+) = Serial RS-232TX or RS-485(+)
RX (-) = Serial RS-232RX or RS-485(-)
NC = Not Connected
Power In = (+Vdc)
Ground = Common for power, digital communications, analog signals and alarms

Additional Pinouts

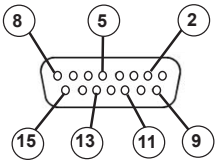
Pin	DB9B	DB9G	DB9H	DB9I	DB9N
1	Analog Out 2	RX (-)	TX (+)	NC	Power In
2	Analog Out	Analog Out	Analog Out	Analog Out	Analog In
3	Power In	Ground	Analog In	Power In	Analog Out
4	Ground	Power In	RX (-)	Ground	NC
5	Ground	Ground	Analog Out 2	NC	Ground
6	Analog In	TX (+)	NC	Analog In	Ground
7	Ground	Analog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

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

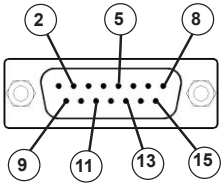
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

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

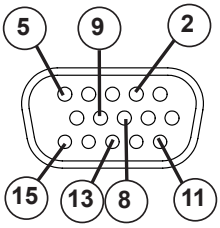
Analog In = setpoint for controllers or remote tare function for meters
Analog Out = 0-5 Vdc Output Signal (or 0-10 Vdc optional)
Analog Out 2 = 5.12Vdc or Optional Secondary Analog Output
TX (+) = Serial RS-232TX or RS-485(+)
RX (-) = Serial RS-232RX or RS-485(-)
NC = Not Connected
Power In = (+Vdc)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

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

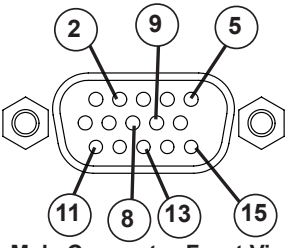
Due to variance in cable manufacturing, please identify proper wiring/pins via continuity check & color when using blunt cut multi-strand cables.

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 pages 91 - 94 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.

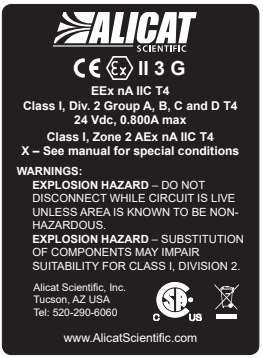
CSA certifies the use of this product for general use as well as use in hazardous locations as defined by Class 1 Division 2 Group A, B, C and D T4.

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

Serial Number: _____

Model Number: _____

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

Limited Lifetime Warranty

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

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

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

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

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

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

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

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

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

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

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

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

Accessories purchased from Alicat are not covered by this warranty.

Conformity / Supplemental Information:

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

Gas Viscosity, Density and Compressibility:

#	Gas		Absolute Viscosity* 25°C	Density ** 25°C 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

#	Gas		Absolute Viscosity* 25°C	Density ** 25°C 14.696PSIA	Compressibility 25°C 14.696PSIA
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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