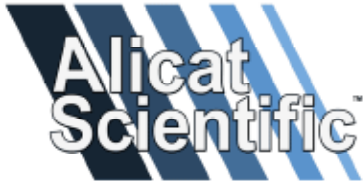


FINALLY, A FLOW INSTRUMENT THAT LASTS A LIFETIME!



It's time to get rid of those devices that cost a fortune to repair. All Alicat measurement and control products now come with a **LIFETIME WARRANTY!**

The versatility of multiple communications options is integrated into every single Alicat device. A graphical display, multi-drop RS-232 and the availability of multiple analog signals allow you to centralize control of up to 26 Alicat instruments, greatly simplifying the automation of your control processes.

All Alicat mass flow instruments come with 30 pre-set calibrations, allowing easy selection from 20 standard gases and 10 common gas mixtures.

Several mounting options are available, including standard and NeSSI styles.



Contact Alicat Scientific to learn more about our full line of flow products at (888) 290-6060 or on the web at www.AlicatScientific.com.



All Alicat products are calibrated with NIST traceable certification.

Alicat Scientific, Inc. is ISO 9001:2000 certified.



Alicat products in compliance with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) carry the CE Mark.

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Advantages & Benefits

Warm-Up Time < 1 second

Speed of Response & Control 10 milliseconds to read; 100ms to control

Gas Select

You can use your device with any of 30 precalibrated gases from the gas select menu on the display or via RS-232 communication. You no longer need to purchase a different meter for each gas.

Dynamic Digital Display w/ Push Button Interface

Our standard display gives you a multitude of information and precise control over the device via a simple push-button interface.

Stand Alone “Smart” Devices

No additional software or electronics are needed to read or control our product. All measurement and control functions can be performed through the standard local display via the push button interface, an analog set point provided to the mini-DIN connector, or via RS-232 communication.

Programmable Geometric Running Average

Many thermal flow meters have built in software that tries to enhance an inherently slow response time. Alicat flow instruments have software that allows you to slow down an inherently fast response time. This lets you easily read flows that might be rapidly fluctuating by taking samples and averaging them before updating the display and analog output.

Field Adjustable PID Loop Tuning

All controllers have a field adjustable PID loop which can be tuned via the push button interface on the display, or via RS-232 communication. The generic tune applied at the factory will run properly in most systems, but the ability to tweak the tuning to match a given system can make the difference between a system simply runs well and one that runs superbly.

Multiple Analog Outputs

All Alicat instruments have an analog output and RS-232 input/output. A second analog output can be ordered. It could be used either as a second output for the mass flow rate or it might be the volumetric flow rate, the absolute pressure or the temperature. In addition, analog outputs can be ordered independently as 0-5 Vdc, 0-10 Vdc, 1-5 Vdc, or 4-20 mA signals.

Tare Function: Automatic, Push Button or Remote

All flow meters with display include a push button tare you can use to zero the meter when no flow is present. On controllers, the tare is automatic when the set-point is at zero for longer than two seconds. A remote tare (ground to tare) is also included for meters in integrated applications.

Mass flow controllers may be used to control absolute pressure or volume flow

Field selectable loop closure allows a mass flow controller to control absolute pressure or volumetric flow rate. This saves in component and design costs, as the mass controller can be used as a pressure controller that also provides information on the actual mass and volumetric flow rates.

Customization

Alicat provides alternative units of measure, gas mixes, totalization, alternate STPs and more at low cost. Please see page 38.

Technology Comparison

SPECIFICATION	ALICAT PRODUCTS	COMPETITOR PRODUCTS
Sensor	Solid-State Silicon Based Differential Pressure (allows nearly instantaneous response times & eliminates hotwire drift)	RTD or Thermocouple
Response Speed	10 milliseconds (no software corrections required—reduces over & undershooting of flow)	0.5-3.0 seconds (no software), 500 milliseconds (software corrections predict flow)
Display	Standard, Integrated (no extra cost for stand alone abilities)	Optional if available, External Mount
Warm-up Time	< 1 Second (cycle times can be reduced)	8—30 minutes
Totalizer	Optional, Integrated (maintain stand alone functionality)	Optional if available, External Mount
Process Data	Integrated Display shows Mass Flow Rate, Volumetric Flow Rate, Line Temperature and Line Absolute Pressure (reduce system components)	Mass flow rate
Output Options	Standard integrated display, analog (either 0-5 Vdc, 0-10 Vdc, 1-5 Vdc, or 4-20mA), and Standard RS-232 (no special software required) Optional 2nd analog output for volumetric flow, temperature, or absolute pressure. (reduce system components & save integration time)	Standard analog, optional display if available, optional digital output if available
Digital Output	Standard output includes mass flow rate volumetric flow rate, line temperature, line absolute pressure, selected gas, AND total if ordered with Totalizer option. Multi-drop Rs-232 standard. (standard features reduce costs for everyone)	Digital output of mass flow if available. Multi-drop not available
Power	7-30 Vdc, 35mA. Standard AC/DC adapter jack AND cable connector pins. Can run off anything from a standard 9 Volt battery to 12 or 24 volt systems. (reduce current & power draw on the overall integrated system)	Special supply with + and – regulated 15 Vdc Higher supply current required
Fittings	Standard NPT or miniature pneumatic fittings. Optional SAE, BSPP, etc threads available. (inexpensive, adaptable to common components.)	Specialized Swagelok®, VCR, etc.
Multi-Gas Versatility	Standard 30+ gas select menu from integrated display. (reduce inventory requirements with 1 off the shelf device)	Single gas, conversion charts
Inherent Linearity	Yes (no additional data manipulations necessary for smooth operation)	No
Documentation	Integrated display with model number, serial number, date of manufacture, calibration technician, and software revision number. Identification label also standard. (device info is always with the device)	On paper included with unit, sticker
Flow Ranges	Ranges available from full scales of 0.5ml/minute to full scales of 1500 standard liters/min. (cover every required flow range with one manufacturer)	Ranges available from 10 ml/minute to 50 standard liters/min full scale.

Suitable Applications

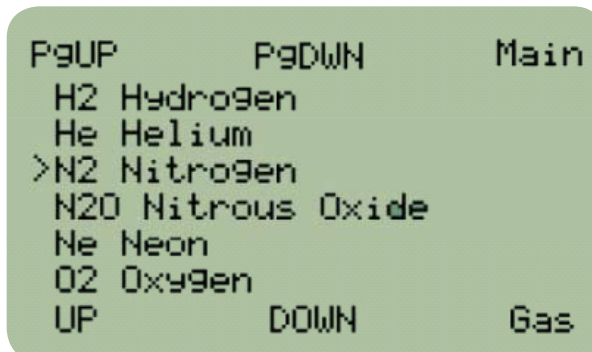
As part of our mission, we strive to provide the correct instrument for every application. Alicat flow devices are a good choice for applications that involve clean, dry gases, or that can install a filter upstream of the flow inlet (usually 20-50microns.) Typically Alicat's flow devices should be used with operating pressures below 145PSIG (100PSIG for liquids). Alicat flow devices are not recommended for dirty gases, solids or slurries. They are also not well suited for applications with temperatures above 50° Celsius. Customized products for ambient temperatures of up to 100° Celsius are available. In most instances, it is not recommended to place an Alicat flow device after a humidifier, though there are exceptions. Alicat engineers will be happy to discuss exceptions to the above limitations in detail.

THIRTY GAS SELECT STANDARD

**Alicat Scientific gas flow meters and controllers
are now even more versatile!**

**One device can now be used with any of
20 common gases and 10 gas mixtures!**

Air	75% Argon / 25% CO2
Argon	90% Argon / 10% CO2
Methane	92% Argon / 8% CO2
Carbon Monoxide	98% Argon / 2% CO2
Carbon Dioxide	75% CO2 / 25% Argon
Ethane	75% Argon / 25% Helium
Hydrogen	75% Helium / 25% Argon
Helium	90% Helium / 7.5% Argon / 2.5% CO2
Nitrogen	(Praxair - Helistar® A1025)
Nitrous Oxide	90% Argon / 8% CO2 / 2% Oxygen
Neon	(Praxair - Stargon® CS)
Oxygen	95% Argon / 5% Methane
Propane	
normal-Butane	
Acetylene	
Ethylene	
iso-Butane	
Krypton	
Xenon	
Sulfur Hexafluoride	



**Simply Scroll the Display
and Select a Gas!**

If your application calls for a gas or gas mixture not on this list, please let us know. We may be able to add it to your device. See the following page for details.

Gas Viscosities, Densities and Compressibilities at 25° and 0° C

Gas Number	Short Form	Long Form	Viscosity* 25 deg C 14.696 PSIA	Density** 25 deg C 14.696 PSIA	Compressibility 25 deg C 14.696 PSIA	Viscosity* 0 deg C 14.696 PSIA	Density** 0 deg C 14.696 PSIA	Compressibility 0 deg C 14.696 PSIA
0	Air	Air	184.918	1.1840	0.9997	172.588	1.2927	0.9994
1	Ar	Argon	225.593	1.6339	0.9994	209.566	1.7840	0.9991
2	CH4	Methane	111.852	0.6569	0.9982	103.657	0.7175	0.9976
3	CO	Carbon Monoxide	176.473	1.1453	0.9997	165.130	1.2505	0.9994
4	CO2	Carbon Dioxide	149.332	1.8080	0.9949	137.129	1.9768	0.9933
5	C2H6	Ethane	93.540	1.2385	0.9924	86.127	1.3551	0.9900
6	H2	Hydrogen	89.153	0.08235	1.0006	83.970	0.08988	1.0007
7	He	Helium	198.457	0.16353	1.0005	186.945	0.17849	1.0005
8	N2	Nitrogen	178.120	1.1453	0.9998	166.371	1.2504	0.9995
9	N2O	Nitrous Oxide	148.456	1.8088	0.9946	136.350	1.9778	0.9928
10	Ne	Neon	311.149	0.8246	1.0005	293.825	0.8999	1.0005
11	O2	Oxygen	204.591	1.3088	0.9994	190.555	1.4290	0.9990
12	C3H8	Propane	81.458	1.8316	0.9841	74.687	2.0101	0.9787
13	n-C4H10	normal-Butane	74.052	2.4494	0.9699	67.691	2.7048	0.9587
14	C2H2	Acetylene	104.448	1.0720	0.9928	97.374	1.1728	0.9905
15	C2H4	Ethylene	103.177	1.1533	0.9943	94.690	1.2611	0.9925
16	i-C4H10	iso-Butane	74.988	2.4403	0.9728	68.759	2.6893	0.9627
17	Kr	Krypton	251.342	3.4274	0.9994	232.175	3.7422	0.9991
18	Xe	Xenon	229.785	5.3954	0.9947	212.085	5.8988	0.9931
19	SF6	Sulfur Hexafluoride	153.532	6.0380	0.9887	140.890	6.6154	0.9850
20	C-25	75% Argon / 25% CO2	205.615	1.6766	0.9987	190.579	1.8309	0.9982
21	C-10	90% Argon / 10% CO2	217.529	1.6509	0.9991	201.897	1.8027	0.9987
22	C-8	92% Argon / 8% CO2	219.134	1.6475	0.9992	203.423	1.7989	0.9988
23	C-2	98% Argon / 2% CO2	223.973	1.6373	0.9993	208.022	1.7877	0.9990
24	C-75	75% CO2 / 25% Argon	167.451	1.7634	0.9966	154.328	1.9270	0.9954
25	A-75	75% Argon / 25% Helium	230.998	1.2660	0.9997	214.808	1.3821	0.9995
26	A-25	75% Helium / 25% Argon	234.306	0.5306	1.0002	218.962	0.5794	1.0002
27	A1025	90% Helium / 7.5% Argon / 2.5% CO2 (Praxair - Helistar® A1025)	214.840	0.3146	1.0003	201.284	0.3434	1.0002
28	Star29	90% Argon / 8% CO2 / 2% Oxygen (Praxair - Stargon® CS)	218.817	1.6410	0.9992	203.139	1.7918	0.9988
29	P-5	95% Argon / 5% Methane	223.483	1.5850	0.9993	207.633	1.7307	0.9990

*in micropoise (1 Poise = gram / (cm) (sec))

** Grams/Liter

(NIST REFPROP 7 database)

If your application calls for a gas or gas mixture not on this list, please let us know. Alicat Scientific can calibrate to a wide variety of complex gas mixtures involving up to four gas constituents. The percentage of each gas is required at the time of order for the calculation of the mixture's viscosity and temperature curve characteristics. The gas mixture will then be added to the device's gas calibration list. The mix can be selected via RS-232 or local display. Alternately, we can suppress the 30 gas selection and default a device to a specific gas mixture calibration.

COMMUNICATIONS

At Alicat we strive to offer communications options that fit your needs! Whether through our standard integrated display or your PC, digital or analog, a single device or multi-drop system, you can easily communicate with any Alicat instrument.

Interactive Local Display An easy to use local display is a standard feature on all Alicat units (a no-display option for OEMs is available). The display mode is changed via the membrane switches located on the front of the unit. Example displays are shown below.

All units in “Main Mode” provide information on their appropriate process parameters.

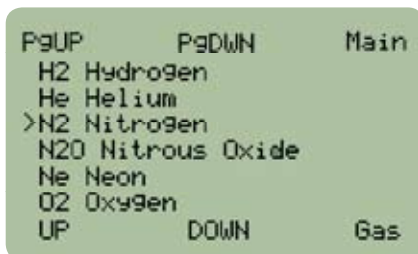
All gas units are provided with a “Gas Select Mode” that includes the standard 30 gas calibrations.

All units come with “Communication Select Mode”. This allows you to assign a Unit ID, select Baud and data rate.

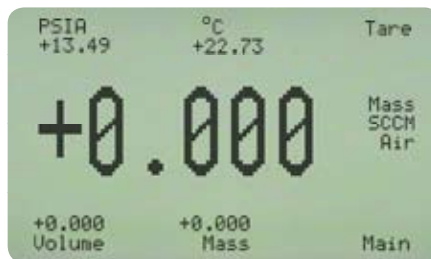
All controllers have a “Control Setup Mode” which allows you to field select to control one parameter such as volumetric flow or pressure, while still reading the unit’s other parameters like mass flow and temperature. You can also adjust the PID control algorithm specifically for your application requirements.

All units provide model number, serial number and manufacturer information in the “Manufacturer Data Mode”.

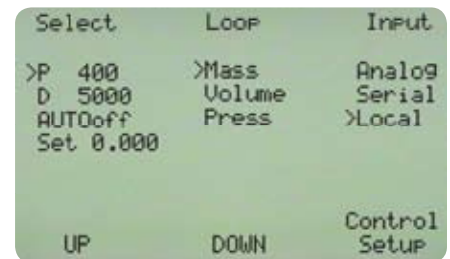
Any flow meter or flow controller may also be ordered with an integrated “Totalizer Mode”.



M and MC Series Gas Select Display
(Scrolls to display all gases)



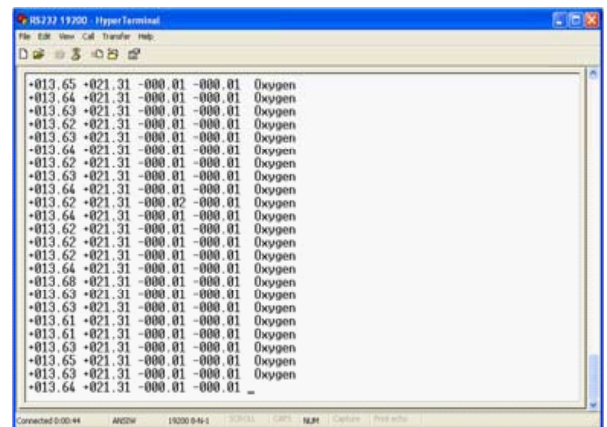
M Series Main Display



MC & MCR Control Setup Display

RS-232 Serial Output

The RS-232 Serial output is a standard feature on all Alicat products. The signals are accessed through the 8-pin circular mini-din connector or through the optional 6-pin industrial connector. No special software is required to use Alicat’s digital RS-232 input & output communication. Any device with a terminal program such as HyperTerminal® found on all Windows® operating systems will work with our devices. The RS-232 allows you to digitally perform all the same functions as are available through the local display (tare the unit, change gas calibration reference, etc). The process parameters displayed will be identical to the unit’s local display capabilities. All units are capable of field configuration to streaming or polling mode, depending on your preference.



M Series Streaming Mode Example:
PSIA, °C, Volumetric Flow, Mass Flow, Gas Selected

Multi-Drop Capable RS-232

Up to 26 units addressable, mix & match meters, controllers and pressure units!

While no additional software is required to use the RS-232 communication feature, Alicat Scientific offers the **Flow Vision™** application suite to improve the ease and efficiency of device monitoring and data capturing. You can also download the following drivers for Alicat’s meters and controllers: **LabVIEW VI driver**; **LabVIEW 6i.**; **LabVIEW 7.1.**

Analog Communication

All analog communication is also provided in conjunction with RS-232 through the 8-pin mini-din connector. The default analog value is 0-5Vdc, with optional 0-10Vdc or 4-20mA available. **An optional secondary independent analog signal of the pressure, temperature or volumetric flow may be added to most Alicat instruments.**

Alicat Mass Flow Meters (**M Series**) provide a 0-5Vdc output signal of the mass flow rate.

Our Mass Flow Controllers (**MC, MCR Series**) provide a 0-5Vdc output signal of the mass flow rate. An analog control set-point pin is also provided. Use the control setup display to select which control set-point method is referenced by the unit.

The Water Meters and Controllers (**L and LC, LCR Series**) provide a 0-5Vdc output signal of the volumetric flow rate .

For **LC**, and **LCR** models, you may choose to leave the secondary analog output pin with its default 5.12Vdc signal. This signal can be used with a potentiometer to provide the control set-point back to the **LC** or **LCR** model if control through the RS-232 or local display is not convenient and a source for an analog control signal is not available.

Pressure Gauges and Controllers (**PC, PCR and PCD Series**) provide a 0-5Vdc output signal of the process pressure. You may choose to leave the secondary analog output pin with its default 5.12Vdc signal. This signal can be used in other parts of the system, or may be used with a potentiometer to provide the control set-point back to the **PC** or **PCR** model.

The **PC** and **PCR** models also have an analog control set-point pin.

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



The **Model BB-9 Multi-Drop Box** makes it easy to connect multiple flow and/or pressure devices to a single RS-232 port. The Multi-Drop Box has nine 8 pin mini-DIN ports available. The ports are to be used with a standard double ended 8 pin mini-DIN (DC-62) style cable going from the box to each flow or pressure device.

A single DB9 D-SUB type connector (COM PORT) connects, using the included cable, to the serial connector on a PC or laptop. All of the flow and/or pressure devices are powered via a terminal block on the front of the box.

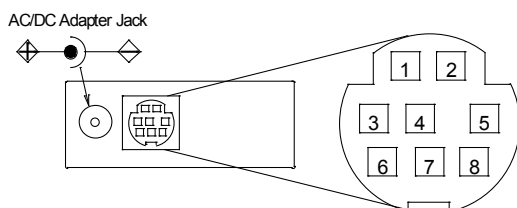
If more than nine devices will be required, additional Multi-Drop Boxes can be daisy chained together with a double ended 8 pin mini-DIN cable plugged into any receptacle on both boxes. (See page 36 for dimensions.)

Power and Signal Connections

Easy analog communications can be achieved as shown. All communications are through the 8 pin connector on top of the unit.

Power can be supplied to your Alicat instrument through the power jack or the 8 pin Mini-DIN connector as shown below.

An AC to DC adapter which converts line AC power to DC voltage is required to use the power jack. Refer to your device's specifications for correct DC voltage and adapter current requirements.



Pin	Function	Mini-DIN cable color
1	Inactive or <u>4-20mA Primary Output Signal</u>	Black
2	Static 5.12 Vdc or <u>Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm</u>	Brown
3	RS-232 Input Signal	Red
4	Analog Input Signal = Remote Tare (Meters) = Set-Point In (Controllers)	Orange
5	RS-232 Output Signal	Yellow
6	0-5 Vdc (or <u>0-10 Vdc</u>) Output Signal	Green
7	Power In (7-30 Vdc, 100mA) or (15-30Vdc for 4-20mA units)	Blue
8	Ground (common for power, communications and signals)	Purple

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

Underlined Items in the above table are optional configurations that are noted on your unit's calibration sheet.

FLOW VISION™

Flow Vision™ is an intuitive software interface to help your experimental test cycles run smoother and make your integration engineering time shorter!

This easy to use software features a simple graphical user interface, multiple device management capabilities and straightforward script building for controller command sequences.



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

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

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

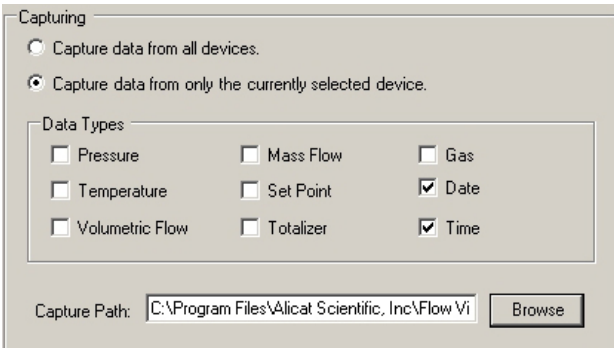
Script Building: Allows you to create scripts that change or sample your flow or pressure unit's setting at timed intervals.

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

Flow Vision™ supports multiple devices connected to the same RS-232 port.

Simply connect each device to a **BB-9 Multi-Drop Box** (see page 9), then using the device addressability, assign an identifier to each unit.

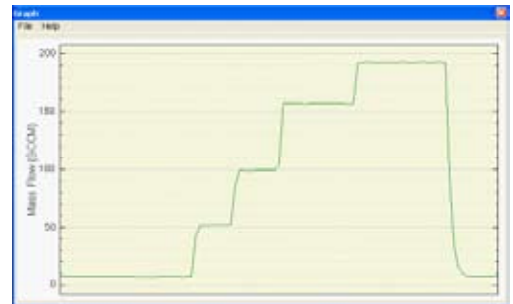
Now you can easily control and monitor varying flow rates for gas mixing, gas analysis, combined testing of multiple parts and other applications.



Flow Vision™'s Data Capture feature allows for measured data from the connected flow instrument to be captured to either a .csv file or a .txt file. Select the types of data you would like to capture by selecting measured parameters listed inside the 'Data Types' box. Simply click in the appropriate parameter's check box.

Note: Not all shown 'Data Types' parameters are applicable to all Alicat devices.

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



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



Flow Vision™ System Requirements:

- Microsoft® Windows® XP
- Microsoft® .NET Framework Version 1.1
- 2 MB hard disk space
- (A copy of Microsoft® .NET Framework can be downloaded at: <http://www.microsoft.com/downloads/details.aspx?FamilyId=262D25E3-F589-4842-8157-034D1E7CF3A3&displaylang=en>)
- Available COM port that supports 19200 baud communications*

* Note: Some laptops are not equipped with serial ports. A virtual serial port can be created using a USB to Serial adapter.

MASS FLOW METERS

Alicat
Scientific



- Alicat Scientific's M series mass flow meters can lower your process costs, increase your productivity and simplify your life.

The innovative features built into every **Alicat M series** meter are there to save you time and money and to make your job easier. Unlike traditional mass flow meters, Alicat MFMs utilize **laminar flow** and **differential pressure** technology. The result is an **extremely fast, accurate, economical MFM with no warm up time and unprecedented versatility**.

Do you work with more than one gas? All Alicat flow meters are calibrated and ready for use with 20 gases and 10 gas blends. You select the gas via the display or through the RS-232 interface. You don't need to buy separate meters for specific gases.

You can have accuracy as fine as \pm (0.4% of reading + 0.2% of full scale) even with full scale micro-flows of 0.5SCCM!

With a **turndown of 100:1**, it's easy to use a single Alicat meter to measure an operating flow range that would normally require two typical MFMs — and still maintain your required accuracy.

Does your application require monitoring gas temperature and pressure along with flow? Relax. **All Alicat M Series measure flow, pressure and temperature!** A unique feature that saves you money by eliminating extra transmitters and the cost of their installation.

This additional process information is invaluable for troubleshooting or to alert your operator of upsets before they become catastrophic. *(Monitoring of critical parameters can be further simplified with an optional alarm set-point for temperature, pressure or flow.)*

Is your meter used for process tuning or monitoring? Then you're aware of the necessity for instant on and fast response capability. **With a typical response of less than 10ms, the M series allows you to make process adjustments quickly before a production run is damaged or destroyed.**

In the case of a power outage, a thermal MFM may require as much as 30 minutes to stabilize, while **an M series meter is ready in less than a second after power up.** That can save you plenty when you consider how much 30 minutes of production is worth.

Are you aware that "Standard Conditions" aren't always standard? Have you ever tested two different meters on the same flow rate but get two different answers? That's probably because the meters were calibrated using different standard conditions. This can be quite a problem if you need both meters to read the same. With an Alicat meter, you can simply change the standard condition parameters through the RS-232 port using any computer and you're up and running. No need to send it

back to the factory for recalibration. How much time and money could that save you???

If you're concerned with power consumption, **Alicat's MFMs have the lowest power requirements in the industry.** Any M series meter can operate on 7 to 30 Vdc and consumes only 0.035Amps. This could allow for the use of a small solar panel for remote operation.

*Because the flow becomes laminar within the flow body, Alicat MFMs **do not** require any special plumbing or straight runs of pipe.*

"In the case of a power outage, a thermal device may require as much as 30 minutes to stabilize, while an M series meter is ready in less than a second after power up."

No special software is needed for communicating with Alicat products. They work with HyperTerminal®, free LabVIEW drivers or Alicat's low cost Flow Vision software.

All Alicat devices **provide "Stand Alone" operation**, along with multi-drop capability and a wide variety of digital and analog communications configurations at no extra charge.

Alicat not only brings you excellent products, **we back them with a lifetime warranty, engineering support, quick delivery and low cost recalibration.** Our delivery time is typically 2 weeks and recalibrations are normally on their way back to you within 3 days!

If you think this is impressive, wait until you talk to one of our application engineers. They have what it takes to answer your process questions concerning not only flow but pressure as well.

Give us a call at 888-290-6060 and let Alicat make your job easier.

M Series: Meters in any flow range from 0 to 0.5SCCM full scale through 0 to 1500SLPM full scale.

If you're looking for portability, turn to page 17 and see how the M series can meet that need as well!

www.AlicatScientific.com
Alicat Scientific is ISO 9001:2000 certified

LIFETIME WARRANTY CE NIST

Technical Data for Micro-Flow and Ultra-Low Flow Mass & Volumetric Flow Meters

0-0.5SCCM Full Scale through 0-50SCCM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Meters (V Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

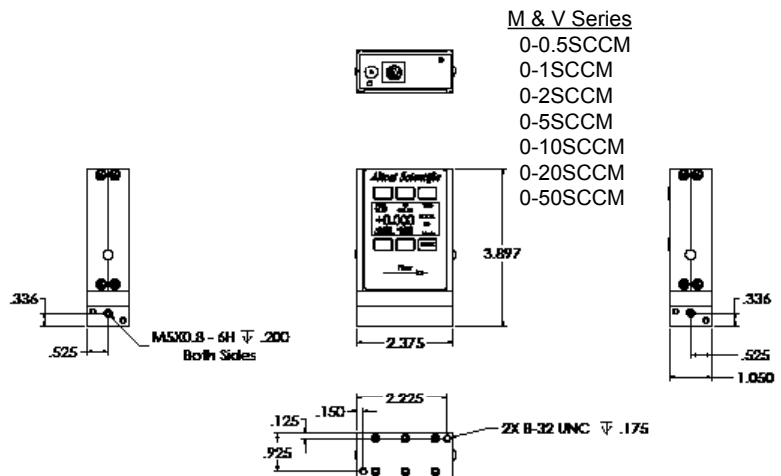
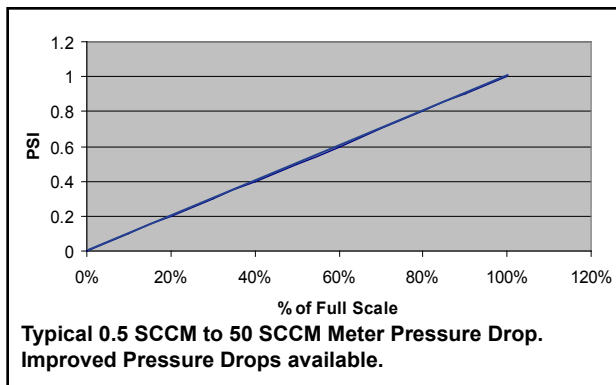
Specification	Mass Meter	Volumetric Meter	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure
Typical Response Time	10		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Measurable Flow Rate	128%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Output Signal Digital	Mass, Volume, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Output Signal Secondary Analog	Mass, Volumetric Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	7 to 30 Vdc (15-30Vdc for 4-20mA outputs)		
Supply Current	0.035Amp (+ output current on 4-20mA)		
Mounting Attitude Sensitivity	0%		Tare after installation
Warm-up Time	< 1		Second
Wetted Materials	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum.		

1. **Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
 2. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Meter	Full Scale Flow Volumetric Meter	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
0.5SCCM to 50SCCM	0.5SCCM to 50SCCM	3.9"H x 2.4"W x 1.1"D	M5 (10-32) Female Thread*	1.0

Units ≤50SCCM F.S. are shipped with M5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT adapters.
 These adapter fittings were selected for customer convenience in process connection. It should be noted that the 1/8" Female NPT introduces additional dead volume. To minimize dead volume, please see page 35 for M5 (10-32) compression fittings.
 1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings.
 2. Venting to atmosphere. Lower Pressure Drops Available, Please contact Application Assistance.



0.5SCCM to 50SCCM approximate shipping weight: 0.8lb

Technical Data for Low Flow Mass & Volumetric Flow Meters

0 to 100 SCCM Full Scale through 0 to 20 SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Meters (V Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

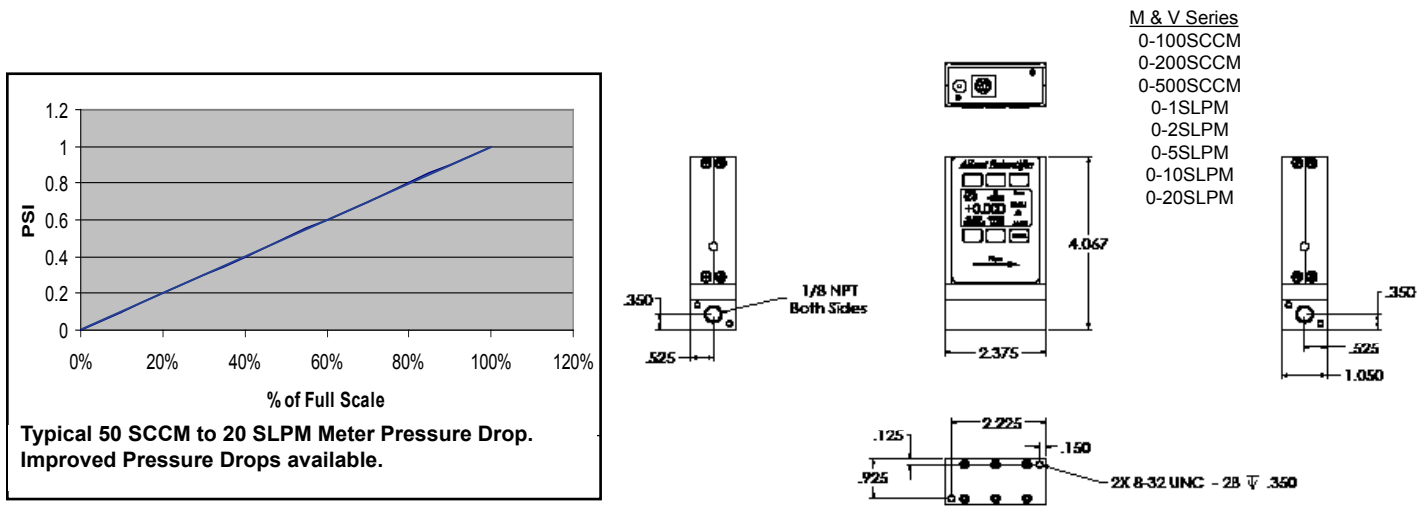
Specification	Mass Meter	Volumetric Meter	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure
Typical Response Time	10		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Measurable Flow Rate	128%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Output Signal Digital	Mass, Volume, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Output Signal Secondary Analog	Mass, Volumetric Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	7 to 30 Vdc (15-30Vdc for 4-20mA outputs)		
Supply Current	0.035Amp (+ output current on 4-20mA)		
Mounting Attitude Sensitivity	0%		Tare after installation
Warm-up Time	< 1		Second
Wetted Materials	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum.		

1. **Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
 2. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Meter	Full Scale Flow Volumetric Meter	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
100SCCM to 20SLPM	100CCM to 20LPM	4.1"H x 2.4"W x 1.1"D	1/8" NPT Female	1.0

1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.
 2. Venting to atmosphere. Lower Pressure Drops Available, Please contact Application Assistance.



100SCCM to 20SLPM approximate shipping weight: 1.0lb

Technical Data for Moderate Flow Mass & Volumetric Flow Meters

0 to 50 SLPM Full Scale through 0 to 250 SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Meters (V Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

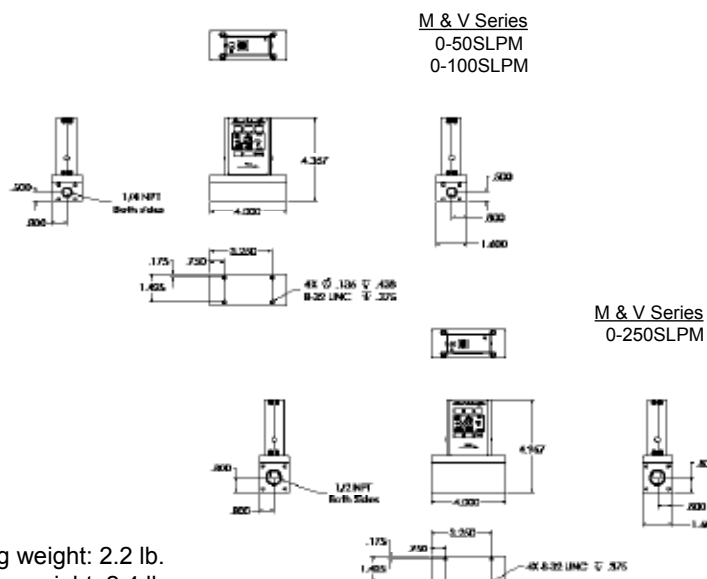
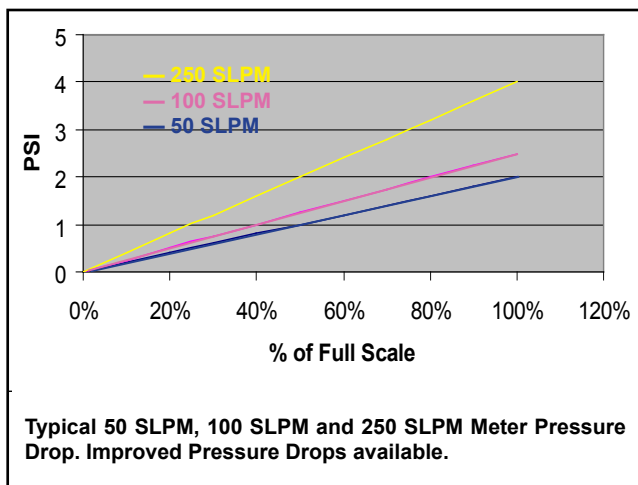
Specification	Mass Meter	Volumetric Meter	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure
Typical Response Time	10		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Measurable Flow Rate	128%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Output Signal Digital	Mass, Volume, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Output Signal Secondary Analog	Mass, Volumetric Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	7 to 30 Vdc (15-30Vdc for 4-20mA outputs)		
Supply Current	0.035Amp (+ output current on 4-20mA)		
Mounting Attitude Sensitivity	0%		Tare after installation
Warm-up Time	< 1		Second
Wetted Materials	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum.		

1. **Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
 2. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Meter	Full Scale Flow Volumetric Meter	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
50SLPM	50LPM	4.4"H x 4.0"W x 1.6"D	1/4" NPT Female	2.0
100SLPM	100LPM			2.5
250SLPM	250LPM	5.0"H x 4.0"W x 1.6"D	1/2" NPT Female	4.0

1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.
 2. Venting to atmosphere. Lower Pressure Drops Available, please contact Application Assistance.



50SLPM approximate shipping weight: 2.2 lb.
 100SLPM approximate shipping weight: 2.4 lb.
 250SLPM approximate shipping weight: 3.2 lb.

Technical Data for High Flow Mass & Volumetric Flow Meters

0 to 500 SLPM Full Scale through 0 to 1500 SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Meters (V Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

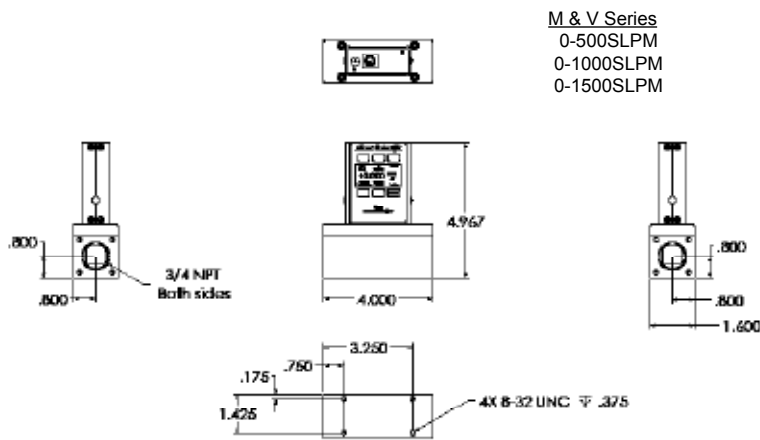
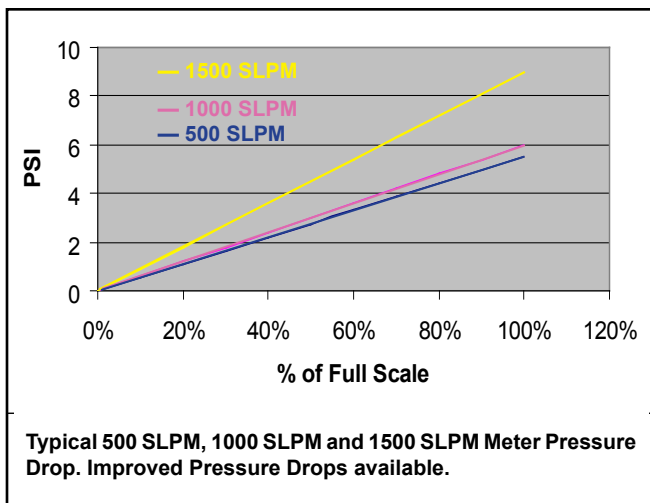
Specification	Mass Meter	Volumetric Meter	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure
Typical Response Time	10		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Measurable Flow Rate	128%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Output Signal Digital	Mass, Volume, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Output Signal Secondary Analog	Mass, Volumetric Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	7 to 30 Vdc (15-30Vdc for 4-20mA outputs)		
Supply Current	0.035Amp (+ output current on 4-20mA)		
Mounting Attitude Sensitivity	0%		Tare after installation
Warm-up Time	< 1		Second
Wetted Materials	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum.		

- Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
- If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Meter	Full Scale Flow Volumetric Meter	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
500SLPM	500LPM	5.0"H x 4.0"W x 1.6"D	3/4" NPT Female	5.5
1000SLPM	1000LPM			6.0
1500SLPM	1500LPM			9.0

- Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.
- Venting to atmosphere. Lower Pressure Drops Available, Please contact Application Assistance.



500SLPM to 1500SLPM approximate shipping weight: 3.0lb

PORTABLE FLOW METERS and PRESSURE GAUGES

Laboratories, industrial plants, process facilities and field technicians have all gained substantial advantages from Alicat portable flow meters and pressure gauges.

Instead of spending your time finding (or hard wiring) a power source you can utilize our portable meter with gas selection and multiple parameter measurement features to:

Verify proper operation of equipment, *including* other manufacturer's flow meters and flow controllers

Maintain proper equipment settings as components within the system wear down

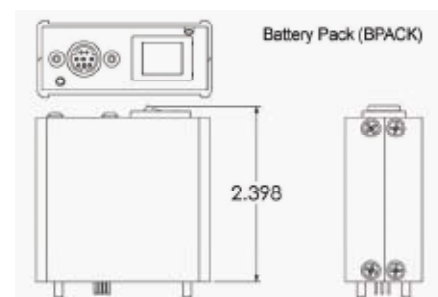
Search for leaks in the system utilizing the pressure reading or the flow reading

Install equipment and perform initial tuning and adjustments in the field

Perform periodic system checks for quality control and verification

Based on the Alicat advantage of low power consumption, we have developed the 9Vdc battery pack accessory (BPACK) for use with all standard Alicat meters and pressure gauges. Many of our customization features are compatible with our BPACK accessory, including:

- ◆ Alternate STPs to simplify comparisons to other flow devices
- ◆ High accuracy calibration
- ◆ Gas mixture calibrations or special gasses
- ◆ Integrated Totalizer for tests that require long term averaging.



Industrial Carrying Case



The industrial case is a rugged and attractive storage accessory that complements your portable meter or any Alicat device. These molded plastic cases are gasket sealed, providing an air and watertight closure. Alicat industrial cases have a barometric relief valve to prevent damage to the case or to the Alicat flow instrument inside when the air pressure in the environment changes.

Approximate case dimensions: 10.5" L x 9.5" W x 5" H

PORTABLE CALIBRATION UNIT

MOBILE SECONDARY CALIBRATION STANDARD

Alicat's **Portable Calibration Unit (PCU)** is a **self contained, portable secondary calibration standard** that is easy to transport and use.

You **don't have to waste engineering time or lose revenue for equipment downtime while verifying calibration on in-service flow equipment.**

Alicat PCUs are designed to operate in the field as secondary calibration standards without the need for hard power sources.

The Alicat PCU is built into an **industrial briefcase** and **can be taken anywhere in the world** to verify the operation of flow equipment.

Unlike typical secondary standards, the PCU is **fully self-contained and does not require any additional support equipment or line power.**

It is as simple as having your technician arrive on site, plug the unit into the system and take readings.

The PCU also has **on-board digital output** enabling it to send flow data to a laptop or other computer system.

The PCU is comprised of three Alicat M series flow meters powered by two common 9Vdc batteries or a 9-20Vdc wall outlet adaptor.

Like Alicat's standard line of flow devices the PCU has no mechanical parts to service or fail.

The ranges of the flow meters are specified by you when ordering the PCU.



Approximate case dimensions: 16" L x 13" W x 7" H

Approximate weight: 12 - 20 lb depending on configuration

MASS FLOW CONTROLLERS

Alicat
Scientific



Process Control Faster than the Process!

Alicat Scientific's MC and MCR Series mass flow controllers deliver improved Quality Control and reduced process costs.

Whether your gas control application involves sputtering, sparging, shaping or something else, Alicat Scientific's **MC** and **MCR** Series mass flow controllers will save you money in your system design and operation. Alicat's mass flow controllers incorporate **a fast dynamic piezo valve and PID loop control** resulting in unsurpassed flow control for even the smallest flow rate and low pressure processes.

Every Alicat mass flow controller gives you Volumetric Flow, Pressure and Temperature data – in addition to the Mass Flow reading! No extra gauges required. Plus, all MC & MCR units feature "Gas Select". "Gas Select" lets you use the device with any of 20 gases and 10 gas mixtures.

Typical flow controllers use directional valves which can only stop in either the on or off position. **Alicat MFCs use proportional control valves.** This allows the valve to stop in any position to maintain a constant flow. The resulting effect is a fast, smooth transition when you change the set-point.

Although the instruments come well-tuned from the factory, **you can optimize your Alicat MFCs performance in the field by adjusting the P or D via the front panel display.**

Alicat's larger MFCs use unique low drop valves (LRVs) to control flow or pressure. Their low-friction, fast-moving design **achieves set-point changes in 100ms or less.** This can be critical in gas blending or other processes where precise gas volumes are essential.

The nature of Alicat's design allows for **very low pressure drop** which increases cost savings by reducing the amount gas required to maintain flow.

Like all Alicat devices, **MC & MCR controllers provide "Stand Alone" operation.** You can provide a set-point via the display or RS-232, unplug communications and walk away. No need for complicated control boxes or expensive control software.

No special software is needed for communicating with Alicat products. They work with HyperTerminal® and LabVIEW drivers or Alicat's low cost Flow Vision™ software.

Alicat MFCs include both analog and digital inputs and outputs.

Are you working with Micro-Flows? Your accuracy can be as reliable as $\pm (0.4\%$ of reading + 0.2% of full scale) even with full scale flows of 0.5SCCM!

Laboratories and universities around the globe use Alicat MFCs for precision flow control in a wide variety of research projects including Micro-Electro-Mechanical Systems (MEMS) and Nanotechnology, Pharmaceuticals, Environmental and Atmospheric Testing, and Semiconductor development.

"Your Alicat MFC is not limited to control based on mass flow. Selectable control loops allow control on volumetric flow or on absolute pressure with the same device. A downstream MFC can act as a back pressure controller while monitoring mass flow, volumetric flow and temperature."

Fuel cell designers are benefitting from the MFC's consistent control performance and easily customized design for both OEM placement into working energy systems and bench testing fuel cell components.

Industrial applications demanding precise control, such as nitrogen sputtering, nitrogen blanketing and air shaping in paint booths, regularly see overall process improvements and a reduction in down time with the integration of Alicat MFCs.

MC & MCR Series: Controllers in any flow range from 0 to 0.5SCCM full scale through 0 to 1500SLPM full scale.

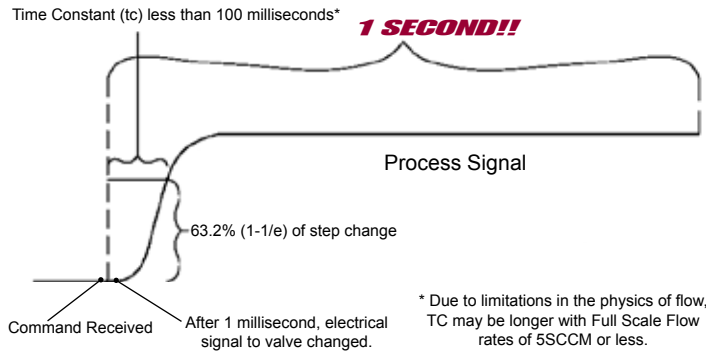
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Alicat Scientific is ISO 9001:2000 certified

LIFETIME WARRANTY CE NIST

Your Alicat MFC is not limited to control based on mass flow. Selectable control loops allow control on volumetric flow or on absolute pressure with the same device. A downstream MFC can act as a back pressure controller while monitoring mass flow, volumetric flow and temperature.

The standard MFC places the valve upstream but you may order a downstream configuration at no extra charge

While thermal units may require up to a half hour to warm up and stabilize, **your Alicat MFC is ready when you turn it on! No warm-up delays means you're in control immediately!**



You'll also benefit from the MFCs' low power requirements. Since Alicat MFCs use significantly less power than most other MFCs in the same flow range, Alicat MFCs are ideal for limited power applications. Low power consumption also saves money in multi-unit constant on situations and saves on facilities management via reduced heat output.

An integrated Totalizer option can be added to any MFC.

Does your system integrate multiple flow and pressure instruments? Use a **BB-9 Multi-Drop Box** to control and monitor up to 26 devices via a single RS-232 line. This simplifies wiring and cuts costs.

Alicat not only brings you excellent products, **we back them with a lifetime warranty, engineering support, quick delivery and low cost recalibration.** Our delivery time is typically 2 weeks and recalibrations are normally on their way back to you in less than a week!

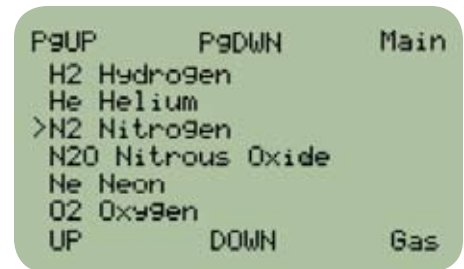
If you think this is impressive, wait until you talk to one of our application engineers. They have what it takes to answer your process questions concerning not only flow but pressure as well.

Give us a call at 888-290-6060 and let Alicat make your job easier.

Thirty Gas Select —

One device can be used with any of 20 common gases and 10 gas mixtures!

Air	Neon	75% Argon / 25% CO2
Argon	Oxygen	90% Argon / 10% CO2
Methane	Propane	92% Argon / 8% CO2
Carbon Monoxide	normal-Butane	98% Argon / 2% CO2
Carbon Dioxide	Acetylene	75% CO2 / 25% Argon
Ethane	Ethylene	75% Argon / 25% Helium
Hydrogen	iso-Butane	75% Helium / 25% Argon
Helium	Krypton	90% Helium / 7.5% Argon / 2.5% CO2 <i>(Praxair - Helistar® A1025)</i>
Nitrogen	Xenon	90% Argon / 8% CO2 / 2% Oxygen <i>(Praxair - Stargon® CS)</i>
Nitrous Oxide	Sulfur Hexafluoride	95% Argon / 5% Methane



Simply Scroll the Display and Select a Gas!

If your application calls for a gas or gas mixture not on this list, please let us know. We may be able to add it to your device.

Standard Features

- ▶ **Four instruments for the price of one!** Mass flow, Volumetric flow, Pressure & Temperature. Control pressure while monitoring mass flow!
- ▶ Fast: ≤ 100 millisecond response (typical). Accurate. No warm-up delays.
- ▶ 30 field selectable gas programming, No charts to reference.
- ▶ RS-232 & Analog Input/Output, Multiple drop capable RS-232. Stand-Alone control.
- ▶ Simple, position insensitive installation, No straight runs of pipe required!
- ▶ Low sensitivity to line or ambient pressure and temperature changes.
- ▶ Easy integration and bench top versatility.
- ▶ Support a wide range of options without extra software or components.

Technical Data for Micro-Flow and Ultra-Low Flow Mass & Volumetric Flow Controllers

0 to 0.5SCCM Full Scale through 0 to 50SCCM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Controllers (VC Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

Specification	Mass Controller	Volumetric Controller	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure and Control
Typical Response Time	100		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Controllable Flow Rate	102.4%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Input /Output Signal Digital	Mass, Volumetric, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Input / Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Input / Output Signal Secondary Analog	Mass, Volumetric, Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	12 to 30 Vdc (15-30Vdc for 4-20mA outputs) ²		
Supply Current	0.250Amp		
Mounting Attitude Sensitivity	0%		
Warm-up Time	< 1		Second
Wetted Materials ²	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, Brass, 410 Stainless Steel.		

- Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
- If your application demands a different material, please contact Application Assistance for available options.

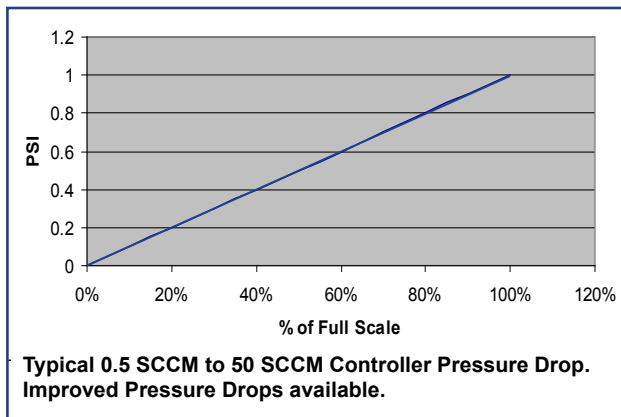
Mechanical Specifications

Full Scale Flow Mass Controller	Full Scale Flow Volumetric Controller	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
0.5SCCM to 50SCCM	0.5CCM to 50CCM	3.9"H x 3.4"W x 1.1"D	M5 (10-32) Female Thread*	1.0

Units ≤50SCCM F.S. are shipped with M5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT adapters.

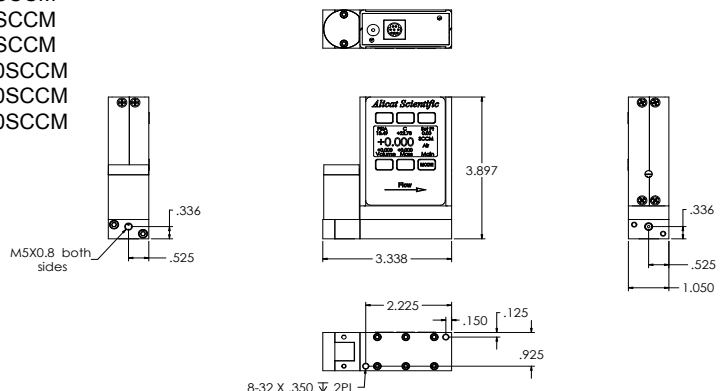
These adapter fittings were selected for customer convenience in process connection. It should be noted that the 1/8" Female NPT introduces additional dead volume. Please see page 35 for M5 (10-32) male compression fittings.

- Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings.
- Venting to atmosphere. Lower Pressure Drops Available, Please contact Application Assistance.



MC & VC Series

- 0-0.5SCCM
- 0-1SCCM
- 0-2SCCM
- 0-5SCCM
- 0-10SCCM
- 0-20SCCM
- 0-50SCCM



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

Technical Data for Low Flow Mass & Volumetric Flow Controllers

0 to 100SCCM Full Scale through 0 to 20SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Controllers (VC Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

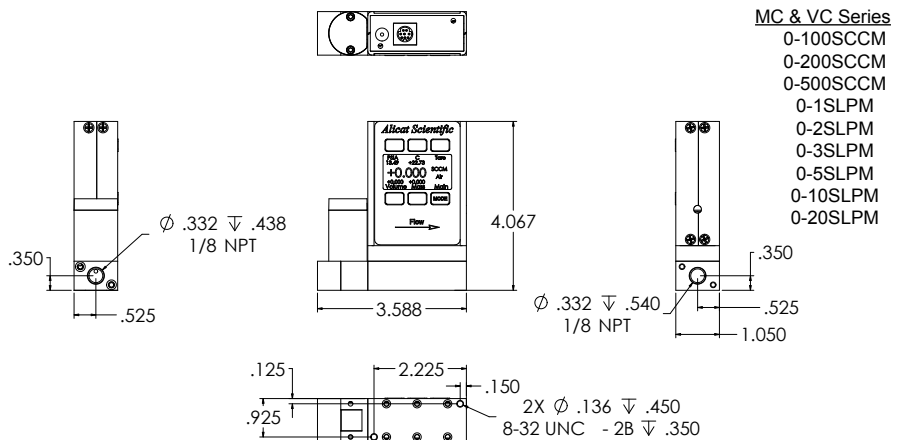
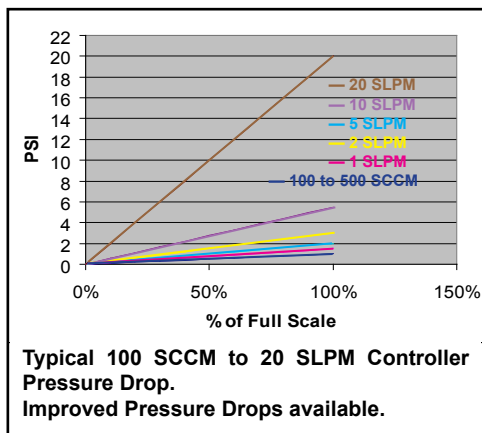
Specification	Mass Controller	Volumetric Controller	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure and Control
Typical Response Time	100		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Controllable Flow Rate	102.4%		Full Scale
Maximum Pressure	145	145'	PSIG
Input / Output Signal Digital	Mass, Volumetric, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Input / Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Input / Output Signal Secondary Analog	Mass, Volumetric, Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	12 to 30 Vdc (15-30Vdc for 4-20mA outputs)		
Supply Current	0.250Amp (at 12 Vdc, declining with increased supply voltage)		
Mounting Attitude Sensitivity	0%		
Warm-up Time	< 1		Second
Wetted Materials ²	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, Brass, 410 Stainless Steel.		

- Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
- If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Controller	Full Scale Flow Volumetric Controller	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
100SCCM to 500SCCM	100CCM to 500CCM	4.1"H x 3.6"W x 1.1"D	1/8" NPT Female	1.0
1SLPM	1LPM			1.5
2SLPM	2LPM			3.0
5SLPM	5LPM			2.0
10SLPM	10LPM			5.5
20SLPM	20LPM			20.0

- Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.
- Lower Pressure Drops Available, Please contact Application Assistance.



100SCCM to 20SLPM approximate weight: 1.2lb

Technical Data for Moderate Flow Mass & Volumetric Flow Controllers

0 to 50SLPM Full Scale through 0 to 100SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Controllers (VC Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

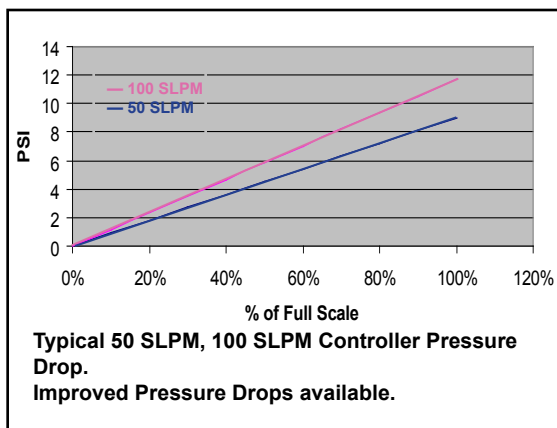
Specification	Mass Controller	Volumetric Controller	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure and Control
Typical Response Time	100		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Controllable Flow Rate	102.4%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Input /Output Signal Digital	Mass, Volumetric, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Input / Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Input / Output Signal Secondary Analog	Mass, Volumetric, Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	24 to 30 Vdc		
Supply Current	0.750Amp		
Mounting Attitude Sensitivity	Control response somewhat sensitive to inverted operation.		
Warm-up Time	< 1		Second
Wetted Materials ²	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, Brass, 410 & 416 Stainless Steel, Nickel.		

- Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.
- If your application demands a different material, please contact Application Assistance for available options.

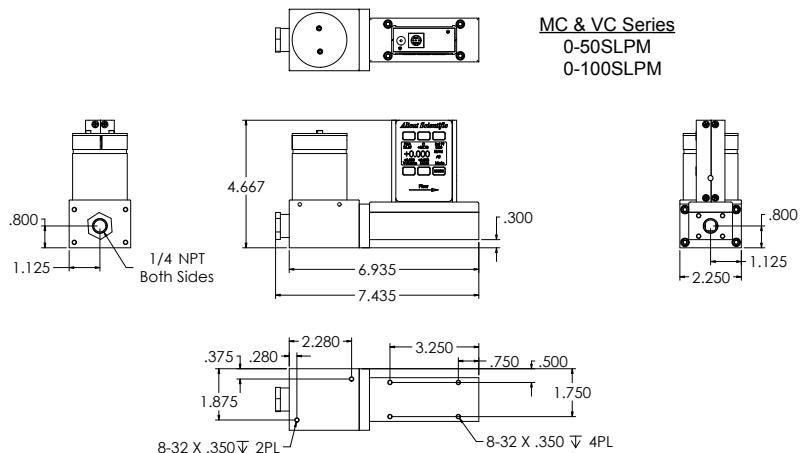
Mechanical Specifications

Full Scale Flow Mass Controller	Full Scale Flow Volumetric Controller	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
50SLPM	50LPM	4.7"H x 7.5"W x 2.3"D	1/4" NPT Female	9.0
100SLPM	100LPM			11.7

- Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.
- Lower Pressure Drops Available, Please contact Application Assistance.



50SLPM approximate weight: 6.4 lb.



100SLPM approximate weight: 6.4 lb.

Technical Data for High Flow Mass & Volumetric Flow Controllers

0 to 250SLPM Full Scale through 0 to 1500SLPM Full Scale

The following specifications are for the standard configuration of the Alicat product. There are many low-cost customization options available. Note: Alicat Volumetric Controllers (VC Series) provide information on the volumetric flow rate only and are designed for applications with no back pressure and low operating pressure.

Specification	Mass Controller	Volumetric Controller	Description
Accuracy	± (0.8% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
High Accuracy Option	± (0.4% of Reading + 0.2% of Full Scale)		At calibration conditions after tare
Repeatability	± 0.2%		Full Scale
Operating Range	1% to 100% Full Scale		Measure and Control
Typical Response Time	100		Milliseconds (Adjustable)
Standard Conditions (STP)	25°C & 14.696PSIA	Not Applicable	Mass Reference Conditions
Operating Temperature	-10 to +50		°Celsius
Zero Shift	0.02%		Full Scale / °Celsius / Atm
Span Shift	0.02%		Full Scale / °Celsius / Atm
Humidity Range	0 to 100%		Non-Condensing
Controllable Flow Rate	102.4%		Full Scale
Maximum Pressure	145	145 ¹	PSIG
Input / Output Signal Digital	Mass, Volumetric, Pressure & Temperature	Volumetric Flow	RS-232 Serial
Input / Output Signal Analog	Mass Flow	Volumetric Flow	0-5Vdc
Optional Input / Output Signal Secondary Analog	Mass, Volumetric, Pressure or Temperature	Volumetric Flow	0-5 Vdc or 0-10Vdc or 4-20mA
Electrical Connections	8 Pin		Mini-DIN
Supply Voltage	24 to 30 Vdc		
Supply Current	0.750Amp		
Mounting Attitude Sensitivity	Control response somewhat sensitive to inverted operation.		
Warm-up Time	< 1		Second
Wetted Materials ²	303 & 302 Stainless Steel, Viton®, Silicone RTV (Rubber), Glass Reinforced Nylon, Aluminum, Brass, 410 & 416 Stainless Steel, Nickel.		

1. **Volumetric meters only:** Operating pressure limitations determined by Reynolds number thresholds. For operating pressures >10PSIG, please contact Application Assistance for more details.

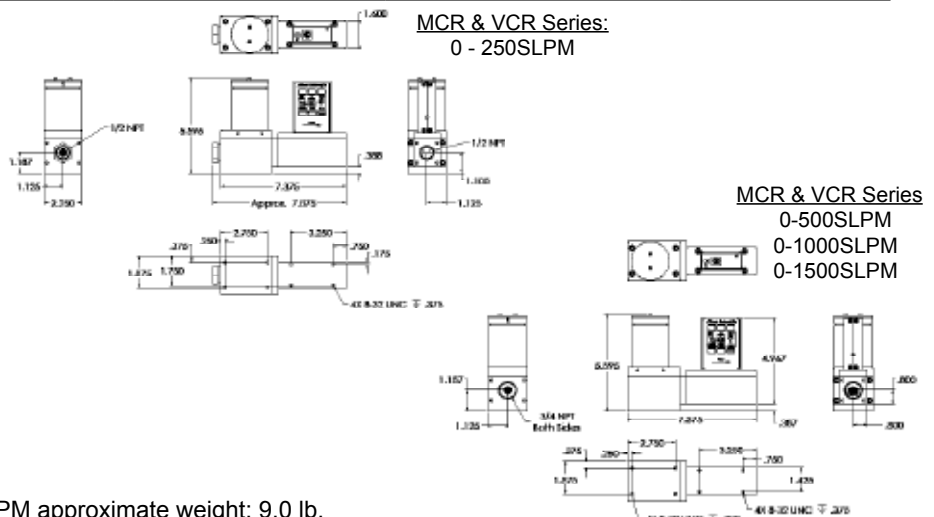
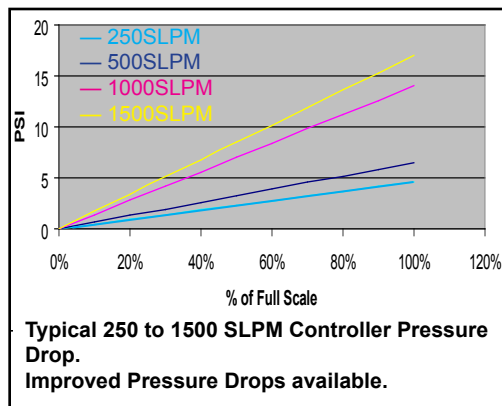
2. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow Mass Controller	Full Scale Flow Volumetric Controller	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
250SLPM	250LPM	5.6"H x 7.9"W x 2.3"D	1/2" NPT Female	4.6
500SLPM	500LPM	5.6"H x 7.4"W x 2.3"D	3/4" NPT Female	6.5
1000SLPM	1000LPM			14.0
1500SLPM	1500LPM			17.0

1. Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. See page 35 for fittings.

2. Venting to atmosphere. Lower Pressure Drops Available, Please contact Application Assistance.



MCR-250SLPM to 1500SLPM approximate weight: 9.0 lb.

DIGITAL PRESSURE CONTROLLERS and GAUGES



Finally, The Right Pressure Instrument For The Job!

Whatever your pressure dilemma, Alicat can help you choose the correct pressure controller or gauge for your application. **Do you want to pressurize a chamber and keep that pressure constant?** Our **PCD** Dual Valve Pressure Controller can serve that need and nearly eliminate your exhaust waste! **Are you leak checking a manifold, membrane, or even a hard drive?** Our **PC3** series with an external pressure port can speed up your process! **Are you concerned with flow through pressures for air sampling, product development, or process simulation?** A **PC** series single valve pressure controller could be precisely what you are looking for! **Do you need an accurate portable gauge with digital communication capabilities?** Check out the **P** series pressure gauge with an optional battery pack.

Alicat digital pressure devices utilize multiple configurations to perform and solve pressure needs in all types of applications. From controlling low vacuum, to measuring pressures up to 300 psi, working with closed volumes, flow through pressure, or performing as a back pressure controller, the versatility of Alicat pressure instruments means that one of our devices can be custom-tailored to fit your needs and answer your process concerns.

ACCURATE and REPEATABLE: Alicat pressure gauges and controllers outshine the competition with $\pm 0.25\%$ or $\pm 0.5\%$ accuracy (depending on range) and $\pm 0.1\%$ repeatability.

For applications like vacuum coating or leak testing, where accuracy and stability of pressure can mean the difference between a perfect or a ruined final product — **you can depend on Alicat pressure equipment.**

EFFICIENT: Digital Pressure Control gives you precise control while eliminating tedious and error-prone manual pressure controls. Alicat's impressive input/output options allow processes to be regulated with simple digital or analog signals.

Alicat pressure controllers use proportional control valves. This allows the valve to stop in any position to maintain a constant pressure. Their low-friction, fast-moving design **achieves set-point changes in 100ms or less.** This can be crucial in gas blending or other demanding processes where precise gas volumes are vital.

Although the instruments come well-tuned from the factory, **you can optimize your Alicat PCs performance in the field by adjusting the P or D via the front panel display.**

EASILY INTEGRATED: Alicat pressure devices can work in conjunction with both your vacuum or positive pressure systems. **Simple process connections and small footprints allow for easy integration into OEM settings.**

Your Alicat **PC** can be ordered with an external pressure sense port to enable a pressure controller to measure and control pressure at a point in your system further down the line from the installation point of the controller.

Separate sensor and valve configurations can overcome spatial restrictions in high flow pressure control applications.

Like all Alicat devices, **P, PC & PCR** instruments **provide "Stand Alone" operation.** You can provide a set-point via the display or RS-232, unplug communications and walk away. No need for complicated control boxes or expensive control software.

No special plumbing, straight runs of pipe or reference charts are required for set up or use!

Alicat pressure instruments include both standard analog and digital inputs and outputs.

No special software is needed for PC communication with Alicat products. They work with HyperTerminal® and LabVIEW or Alicat's low cost Flow Vision™ software.

Does your system integrate multiple flow and pressure instruments? Use a **BB-9 Multi-Drop Box** to control and monitor up to 26 devices via a single RS-232 line. For multiple gas applications consider a **PCM** pressure control manifold.

Alicat backs its products with a lifetime warranty, engineering support, quick delivery and low cost recalibration. Our delivery time is typically 2 weeks and recalibrations are normally on their way back to you in less than a week!

If you think this is impressive, wait until you talk to one of our application engineers. They have what it takes to answer your process questions.

Give us a call at 888-290-6060 and let Alicat make your job easier.

Alicat Pressure Devices Are Available In Any of Nine Different Units Of Measure!

PSIA	PSIG	mmHG	inHG	inH₂O	mBar	Atm	Torr	kPa
-------------	-------------	-------------	-------------	-------------------------	-------------	------------	-------------	------------

PRESSURE DEVICE CAPABILITIES		P	PC	PCR	PC3	PCR3	PCD	PCM	MC*	MCR*
Differential Pressure		◆	◆				◆	◆		
Vacuum		◆	◆	◆	◆	◆	◆			
Back Pressure			◆	◆					◆	◆
Gauge Pressure		◆	◆	◆	◆	◆	◆	◆		
Absolute Pressure		◆	◆	◆	◆	◆	◆	◆	◆	◆
Flow Through Pressure		◆	◆	◆	◆	◆		◆	◆	◆
Closed System — Pressure or Vacuum		◆					◆			
Remote Pressure (External Feedback)					◆	◆				
Portable Digital Gauging		◆								
High Flow >20LPM				◆		◆				◆

*Alicat's MC & MCR mass gas flow controllers can function as pressure controllers in applications where users are concerned with monitoring mass or volumetric flow rate while controlling pressure. Please see page 28.

**P Series
Digital Pressure Gauges**

Pressure measurements as low as -30inHG full scale to as high as 300PSIA.

Alicat **P** Series digital pressure gauges are used in laboratories to perform leak checks and equipment operation verification. They have an easy to read display with digital output that makes it simple to determine pressure and improve consistency in recorded measurements.

Our gauges are designed to seamlessly integrate with our flow products on one RS-232 line using the unit address feature. This decreases time and expense in applications that require flow and pressure measurement in different physical locations of the system, but with the same Programmable Logic Controller (PLC).

The gauges have low power requirements allowing for portable operation with our BPACK accessory.

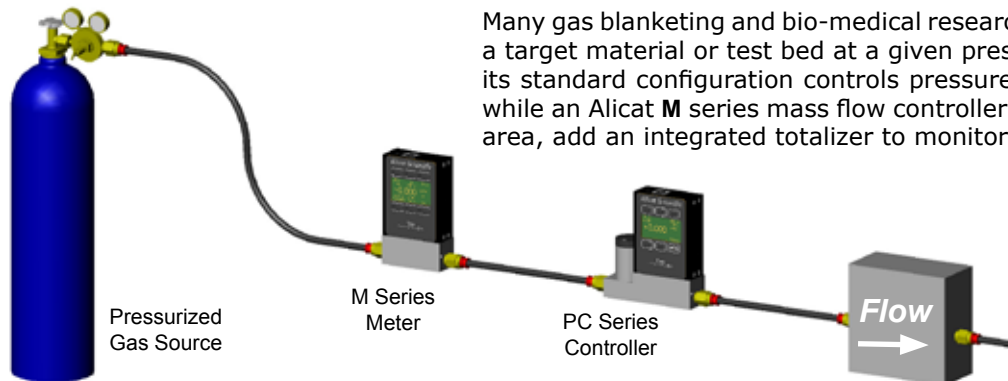


**PC Series
Single Valve Pressure Controllers**

Available in multiple configurations, the versatility of the **PC** Series allows you to control absolute pressures, gauge pressures, back pressures, and vacuum pressures.

Customization is often as simple as valve placement or sensor selection. The speed of response and stability of these digital devices offers many advantages over more common mechanical controllers.

With 1/8th inch female NPT connection ports, the **PC** performs in-line flow through pressure control with typical ±.25% or ±.5% full scale accuracy, depending on range.



Many gas blanketing and bio-medical research applications require gas flow over a target material or test bed at a given pressure. Alicat Scientific's **PC** series in its standard configuration controls pressure in the blanketing or test chamber while an Alicat **M** series mass flow controller monitors flow rate through the test area, add an integrated totalizer to monitor total gas usage.

P & PC Series: Differential Pressure Gauges and Controllers

The differential pressure gauge is designed to measure a pressure ratio between two points in the line, while the differential pressure controller is designed to change the flow to allow the control of a pressure ratio between two points in the line. There are a variety of applications for these devices. One of the most common is to measure or control the difference in pressure across some sort of element that changes resistance to flow over time, such as a filter or one that changes area with time as would happen with orifice testing. Please contact Applications Assistance for more differential pressure information.

PCR Series: High Flow Pressure Controllers

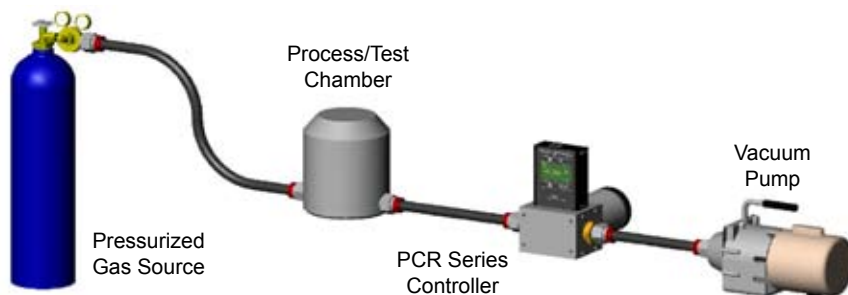
PCR Series single valve pressure controllers perform flow through pressure control in high flow applications (flows greater than 20 LPM).

The PCR series utilizes a large low pressure drop valve of Alicat design to allow for a positive pressure with high mass flow rate as well as vacuum applications with inflated volumetric flow rates.

With the same available configurations as the PC series, the PCR series is equipped to handle absolute pressures, gauge pressures, back pressures, and vacuum pressures.

pressures.

With 3/4 inch female npt connection ports, the PCR performs in-line flow through pressure control with typical $\pm .5\%$ full scale accuracy.



High Flow Vacuum & Positive Pressure Control with Alicat PCR Series

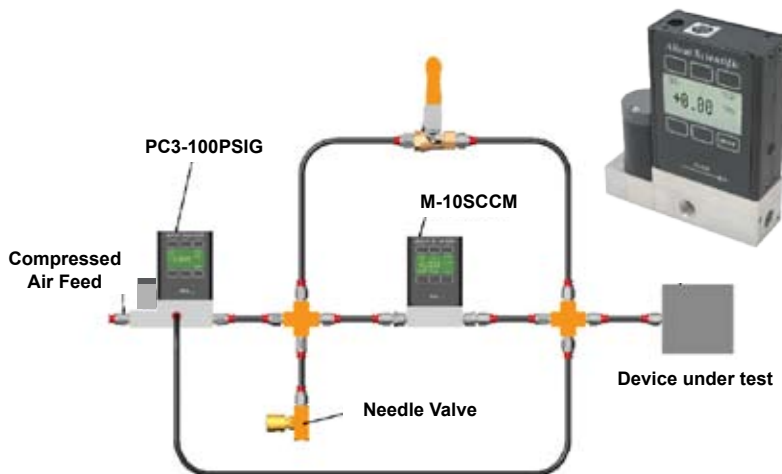
Downstream, large-valve controller, installed downstream of a vacuum chamber, upstream of a vacuum pump. Positive pressure feeds chamber, vacuum pump evacuates and brings down pressure in chamber.

PC3 & PCR3 Series: External Pressure Port Controllers

PC3 Series single valve pressure controllers have an external pressure pick up port for sensing and controlling pressures at a point in the system other than the installation point of the device.

Utilized in leak checking applications where maintaining a precise pressure at the testing orifice is critical, the PC3 is an example of a custom pressure controller which has evolved into widespread use as a standard device.

Other permutations of the PC3 have utilized multiple pressure sensors in various ranges, performing the functions of a vacuum gauge and a positive pressure controller in one device.



Leak Test with Alicat PC3 and M Series

PCM Series: Manifold Pressure Controllers

PCM Series manifold pressure controllers are custom-built for the most demanding multiple gas OEM applications.

The PCM manifold incorporates multiple dual-valve pressure controllers in arrays of up to 11 units. These arrays are used widely by bio-medical and semi-conductor researchers and equipment manufacturers to perform pressure based control of fluidic movement through micro-flow channels or chambers.

The mechanics of the PCM unifies all plumbing while the RS-232 communication protocol consolidates electronic communications into a single simple RS-232 transmit and receive connection that communicates with all of the individual pressure controllers simultaneously. Some configurations of PCM's incorporate pressure gauges in place of pressure controllers.

All units in a PCM can be suitably configured to the volumes being controlled and the pressure ranges required (as compatible with specs on PCD series: Dual Valve Pressure Controllers and P series: Pressure Gauges).



PCD Series: Dual Valve Pressure Controllers



Do you need to pressurize a chamber and keep that pressure constant? Or do you want to maintain precise and repeatable pressure on valves or fittings during leak tests? ***Our Dual Valve Pressure controller can serve that need and minimize your exhaust costs!***

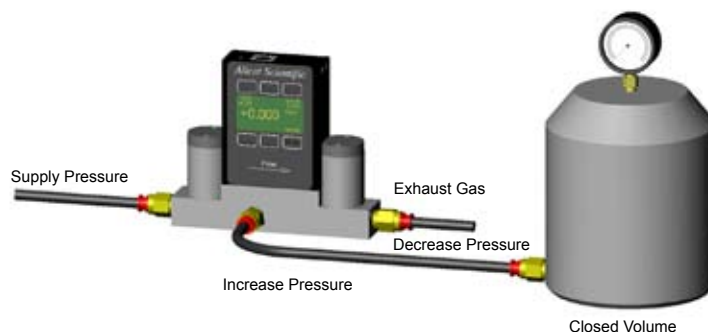
The PCD is ideal for applications with no in-line flow ("dead ended" processes) that require precise pressure control. For example, pressure loading fluid dispensers for manufacturing processes in paint and semi-conductor industries or processes that require precise application of forces for pressure controlled actuation. In addition, as all feed and exhaust valve adjustments are done internally, higher-level resources in the user's DCS or the PLC can be utilized for other functions, with the actual line pressure data available for data logging and maintenance reports.

This controller utilizes a modified PID closed loop control algorithm and proportional control valves on both the feed and the exhaust lines. Unlike controllers that use simple pressure switches and on/off valves, there is no built in dead-band. This leads to impressive increases in precision control of the process pressure in closed or nearly closed systems. As the line pressure increases, the drive to the feed valve is decreased, until the set-point is reached, allowing for the minimization of overshooting.

The exhaust valve opens to reduce pressure by allowing gas to flow out of the process. The drive to the exhaust valve is decreased as the set-point is reached, allowing for the minimization of undershooting the set-point. ***The reduction in gas usage translates directly into significant cost savings, especially in expensive bottled gas systems.***

PCD for Closed Volume Pressure Control

The dual valve pressure controller is maintaining a precise pressure of medical grade helium within the closed volume chamber. Product within the chamber is undergoing a coating process which requires a specific pressure set-point at different intervals. The PCD maintains the set-point while reducing the use of helium. The ability to reliably and consistently maintain specific pressures within the chamber increases yields.



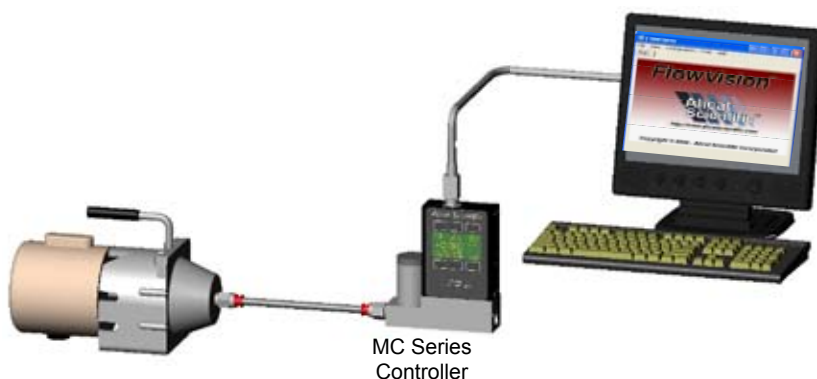
MC & MCR Series: Mass Flow Controllers for Pressure Control

Alicat MFCs (page 19) are not limited to control based on mass flow. Selectable control loops allow control on volumetric flow or on absolute pressure with the same device. A downstream MFC can act as a back pressure controller while monitoring mass flow, volumetric flow and temperature.

Pump and Compressor Flow Characterization under Back Pressure

In this application a mass flow controller is utilized as a back pressure controller. The mass flow controller performs a flow characterization on the air compressors under test, by reading mass flow and volumetric flow. The downstream valve and specific tuning allows the controller to perform a cycle of back pressure set-points, emulating different back pressure conditions that the air compressor will be operating under.

In other configurations (Control Valve Upstream of measurement head) similar tuning can be used to perform exit pressure control for a downstream process instead of back pressure control, typical applications include testing absorption, atomizers, and spray processes.



Technical Data for Pressure Gauges & Single Valve Pressure Controllers

The following specifications are for the standard configuration of the Alicat product as shipped from the factory. PCR Series high flow pressure controllers are available for applications with required flows above 20LPM. Please contact Application Assistance for PCR specifications.

Specification	P Series	PC & PCR Series	Description
Accuracy: Full scale pressure ≤ 0.04 PSIG		$\pm 0.5\%$	Full Scale
Accuracy: Full scale pressure > 0.04 PSIG		$\pm 0.25\%$ or $\pm 0.125\%$ HC ¹	Full Scale
Repeatability		$\pm 0.08\%$	Full Scale
Turndown Ratio		200:1	
Adjustable Response Time ²	5	100	Milliseconds
Operating Temperature		-10 to +50	Degree Celsius
Zero Shift		0.02%	Full Scale / °Celsius
Span Shift		0.02%	Full Scale / °Celsius
Excess Pressure	128% Measurable	102.4% Controllable	Full Scale
Burst Pressure		3X	Full Scale
Supply Current Peak	0.035	0.250 (PCR: 0.750)	Amp
Supply Voltage	7 – 30	12 – 30 (PCR Series = 24 – 30)	Volts dc
Input /Output Signal Standard	RS-232 Serial & 0-5Vdc		
Electrical Connections	8 Pin		
Wetted Materials ³	302 & 303 Stainless Steel, Viton®. Silicone RTV, Controllers add: Brass, 400 Series Stainless Steel		

1. HC (High Accuracy Calibration).
2. Volumes, feed pressures, exhaust pressures and line sizing will determine the limits of response times
3. If your application demands a different material, please contact Application Assistance for available options..

Select One of Nine Units of Measure				
PSIA	PSIG	mmHG	inHG	inH ₂ O
mBar	Atm	Torr	kPa	

Mechanical Specifications

Pressure Product	Mechanical Dimensions	Process Connections ¹
P Series Gauges	4.1"H x 2.4"W x 1.1"D	1/8" NPT Female
PC Series Controllers	4.1"H x 3.6"W x 1.1"D	1/8" NPT Female
PCR Series Controllers	5.3"H x 3.0"W x 5.6"D	3/4" NPT Female

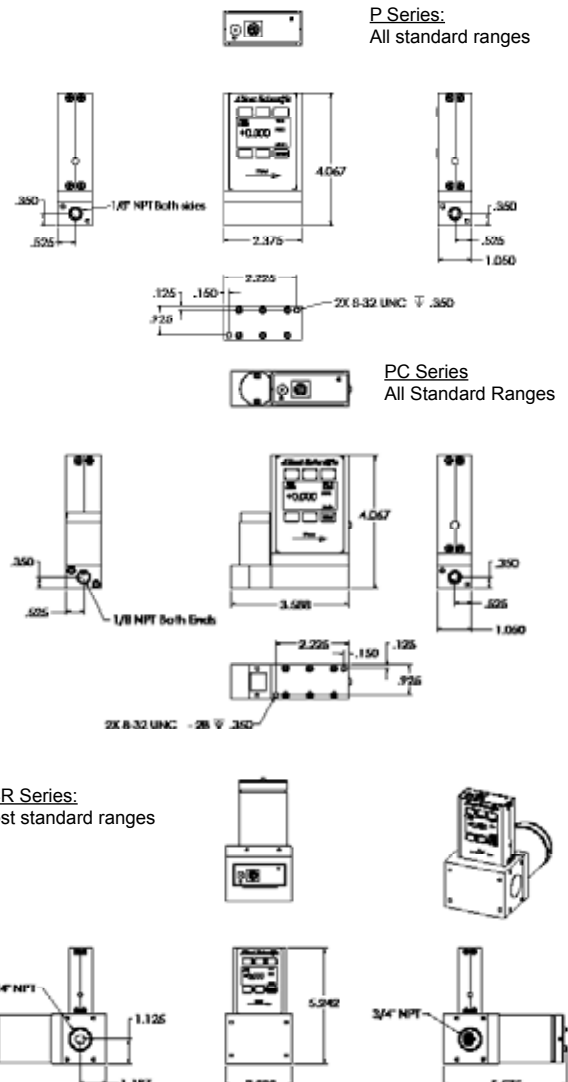
1) Compatible with Swagelok® tube, Parker®, face seal, push connect & compression fittings. Alternates available.

P Series Gauges			PC, PCR Series Controllers		
-15PSIG to 0PSIG			-15PSIG to 0PSIG		
4inH ₂ OD	4inH ₂ OG		4inH ₂ OD	4inH ₂ OG	
1PSID	1PSIG		1PSID	1PSIG	
5PSID	5PSIG		5PSID	5PSIG	
15PSID	15PSIG	15PSIA	15PSID	15PSIG	15PSIA
30PSID	30PSIG	30PSIA	30PSID	30PSIG	30PSIA
100PSID	100PSIG	100PSIA	100PSID	100PSIG	100PSIA
150PSID		300PSIA	150PSID		300PSIA
Other ranges available. Please contact Application Assistance.					

P Series Gauges All Standard Ranges approximate weight: 1.0 lb.

PC Series Controllers All Standard Ranges approximate weight: 1.2 lb.

PCR Series Controllers All Standard Ranges approximate weight: 4.8 lb.



Technical Data for Dual Valve Pressure Controllers

The following specifications are for the standard configuration of the Alicat product as shipped from the factory.

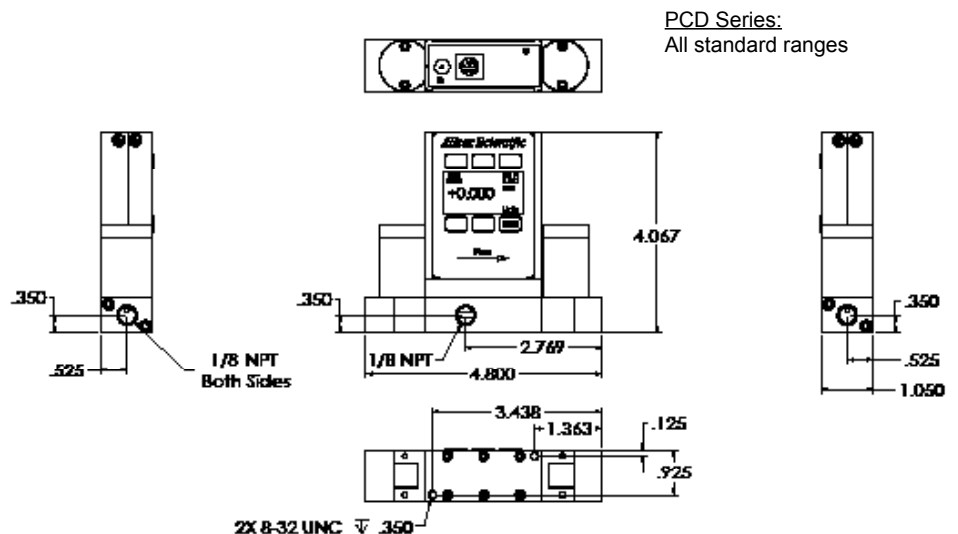
Specification	PCD Series	Description
Accuracy: Full scale pressure ≤ 0.04 PSIG	$\pm 0.5\%$	Full Scale
Accuracy: Full scale pressure > 0.04 PSIG	$\pm 0.25\%$ or $\pm 0.125\%$ HC ¹	Full Scale
Feed Valve Orifice	0.050	Inches
Exhaust Valve Orifice	0.050	Inches
Alternate Valve Orifices Available	0.010 or 0.030	Inches
Repeatability	$\pm 0.08\%$	Full Scale
Turndown Ratio	200:1	
Adjustable Response Time ²	≤ 100	Milliseconds
Operating Temperature	-10 to +50	Degree Celsius
Zero Shift	0.02%	Full Scale / °Celsius
Span Shift	0.02%	Full Scale / °Celsius
Excess Pressure	102.4% Controllable	Full Scale
Burst Pressure	$\geq 3X$	Full Scale
Supply Current Peak	0.250	Amp
Supply Current Average	0.050	Amp
Supply Voltage	12 – 30	Volts dc
Input /Output Signal Standard	RS-232 Serial & 0-5Vdc	
Electrical Connections	8 Pin	Mini-DIN
Wetted Materials ³	302 & 303 Stainless Steel, Viton®, Silicone RTV, Brass, 400 Series Stainless Steel (standard units are for non-corrosive gases)	

1. HC (High Accuracy Calibration).
2. Volumes, feed pressures, exhaust pressures and line sizing will determine the limits of response times
3. If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications	Mechanical Dimensions	Process Connections ¹
PCD Series Dual Valve Controller		
All Standard Ranges	4.1"H x 4.8"W x 1.1"D	1/8" NPT Female

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

PCD Series Pressure Controllers		
-15PSIG to 0PSIG		
4inH ₂ OD	4inH ₂ OG	
1PSID	1PSIG	
5PSID	5PSIG	
15PSID	15PSIG	15PSIA
30PSID	30PSIG	30PSIA
100PSID	100PSIG	100PSIA
150PSID		300PSIA
Other ranges available. Please contact Application Assistance.		



Select One of Nine Units of Measure		
PSIA	inHG	Atm
PSIG	inH ₂ O	Torr
mmHG	mBar	kPa

All Standard Ranges approximate weight: 1.4 lb.

WATER FLOW METERS and WATER FLOW CONTROLLERS



Alicat Scientific's L, LC and LCR water flow instruments are helping customers achieve higher levels of productivity from their existing process tooling.

If your application demands accurate water flow measurement or control at very low flow rates – *Alicat's liquid flow instruments are designed for you.*

L meters and **LC** and **LCR** controllers use Alicat's *patented laminar differential pressure technology*, instead of the common heated wire/heat transfer principle. *Avoiding the inherent weakness of any heated wire system – heat.*

In a heated wire system, the heated elements of the instrument cause vaporization of liquids, especially at lower flow rates. This heat also promotes bubbling and cavitation. Erroneous readings result in poor yields and damage to sensitive equipment. In critical dispense operations, these *losses can easily amount to millions of dollars.*

If you avoid heat by using turbine meters you're up against other problems – Higher pressure drops; Parts that wear out; and Pulse signal conversion errors.

A turbine in the flow stream creates an obstruction and requires a certain amount of force for the fluid to pass. The pressure drop for turbine meters will vary, but it's always greater than that of a laminar flow device.

Turbine meters have moving parts – the turbine and the bearing. These parts wear, causing friction and imbalance – resulting in flow error.

The direct signal from a turbine is a pulse signal. It can be one pulse per revolution or several. This pulse signal is converted to an analog or digital signal using the internal diameter of the meter, number of pulses per second and the inverse square law equation. Each of these items introduces an inherent amount of error.

In large scale industrial applications, *differential pressure technology accounts for over 50% of liquid flow measurement.* Now, Alicat allows you to benefit from this proven method of measurement in your micro-flow processes.

Alicat instruments measure differential pressure within a laminar flow region to determine volumetric flow rate. A temperature sensor determines the viscosity of the water and an internal microprocessor calculates the actual volumetric flow.

You also get a discrete pressure sensor. This lets you read three independent pieces of information: *water flow, water temperature and water pressure — in one compact device.*

L series meters can measure flow rates as low as 0.5CCM full scale through flow rates as high as 10LPM full scale with a turndown ratio of 50:1 and 2% accuracy of full scale!

"In large scale industrial applications, differential pressure technology accounts for over 50% of liquid flow measurement. Now, Alicat allows you to benefit from this proven method of measurement in your micro-flow processes."

The **LC** and **LCR** lines of liquid flow controllers add *a fast dynamic piezo valve and PID loop control* to an L series meter. Giving you unsurpassed flow control for even the smallest flow rate and low pressure processes. And you can field tune the PID to your specific application!

The controller will accurately and repeatedly control liquid flows from 50CCM full scale through 5LPM full scale with a turndown ratio of 50:1 and 2% accuracy of full scale.

Both meters and controllers are *equipped with bleed ports* so that air may be easily removed.

No special plumbing, straight runs of pipe or reference charts are required for set up or use.

All Alicat devices *provide "Stand Alone" operation*, along with multi-drop capability and a wide variety of digital and analog communications configurations at no extra charge.

You can be confident that your Alicat instruments will provide you a lifetime of trouble free operation. In fact, *all Alicat flow instruments are backed by the industry's only lifetime warranty.*

Call Alicat Scientific today 888-290-6060 to order an L, LC or LCR liquid flow instrument or to discuss your specific needs with an Alicat applications engineer.

Technical Data for Water Flow Meters & Water Flow Controllers

The following specifications are for the standard configuration of the Alicat product as shipped from the factory. There are many low-cost customization options available.

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

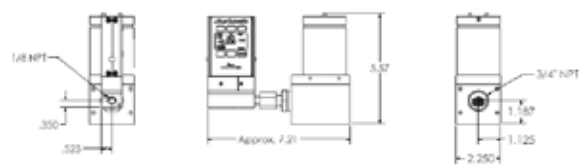
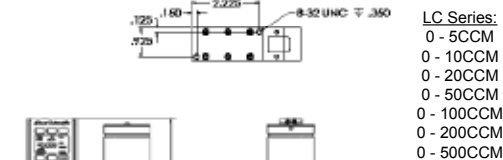
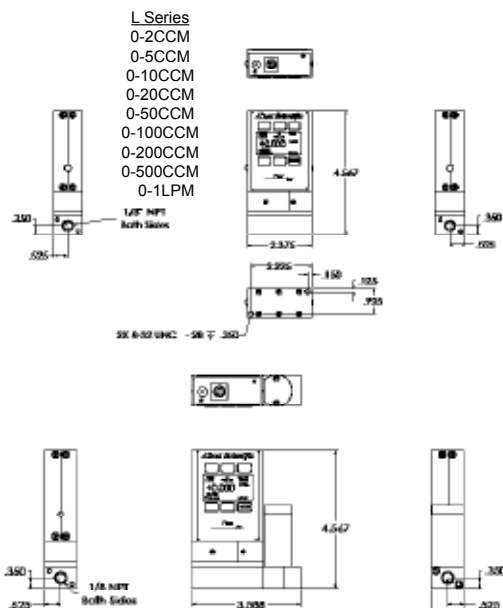
- 15 volts required for 4-20mA output.
- If your application demands a different material, please contact Application Assistance for available options.

Mechanical Specifications

Full Scale Flow	Mechanical Dimensions	Process Connections ¹	Pressure Drop ² (PSID)
L Series			
0.5CCM to 1CCM	4.4"H x 2.4"W x 1.1"D	M5 (10-32) Female*	2.0
2CCM to 500CCM	4.6"H x 2.4"W x 1.1"D	1/8" NPT Female	2.0
1LPM			4.0
2LPM			4.0
5LPM	4.8"H x 2.7"W x 1.1"D	1/4" NPT Female	10.0
10LPM			20.0
LC Series			
0.5CCM to 1CCM	4.4"H x 3.4"W x 1.1"D	M5 (10-32) Female*	5.0
5CCM to 50CCM	4.6"H x 3.6"W x 1.1"D	1/8" NPT Female	5.0
100CCM			5.0
200CCM to 500CCM			7.5
LCR Series			
1LPM	5.6"H x 7.3"W x 2.3"D	1/8" & 3/4" NPT Female	4.0
2LPM	5.8"H x 6.2"W x 2.3"D	1/4" & 3/4" NPT Female	4.0
5LPM			10.0

Units ≤1CCM F.S. are shipped with M5 (10-32) Male Buna-N O-ring face seal to 1/8" Female NPT adapters. To minimize dead volume, see page 35 for the M5 (10-32) Male to 1/8"OD compression fitting.

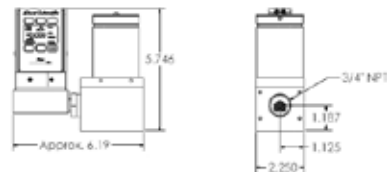
- Compatible with Beswick®, Swagelok® tube, Parker®, face seal, push connect and compression fittings.
- Lower Pressure Drops Available, Please contact Application Assistance.



LCR Series:
0 - 1LPM

LCR Series:
0 - 1LPM

LCR Series:
0 - 2LPM
0 - 5LPM



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

L Series Meters 0.5CCM to 1CCM approximate weight: 1.0 lb.

LC Series Controllers 0.500CCM to 500CCM ≈ 1.2 lb.

2CCM to 1LPM ≈ 1.3lb

LCR Series Controllers 1-5LPM ≈ 6.8 lb.

2LPM to 10LPM ≈ 2.2 lb.

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REMOTE ELECTRONICS

Some applications involve ambient and operating temperatures outside the standard Alicat device specifications. Our Remote Electronics option solves this dilemma.

Relocating the electronics allows for installation of the flow body in ambient temperatures as high as 85° Celsius with gas temperatures up to 100° Celsius. In these applications, we recommend our custom calibration at gas temperatures up to 70° Celsius. This will reduce zero shift errors that occur when actual gas flow temperatures deviate substantially from the gas calibration temperature.

Remote Electronics can also be useful in applications that require the installation of a compact flow package.

LOCAL SET-POINT MODULE

The Local Set-Point Module (LSPM) facilitates controller operation when you can't access the local display or provide a set-point through the standard RS-232 or analog pins. The set-point signal is set with the adjustment knob.

The displayed parameter may be changed from set-point to process measurement via the slide switch. Analog, RS-232 and power may be passed through the LSPM to/from the controller via the two female 8-pin electrical connectors. All standard LSPMs may be panel mounted. Each LSPM comes with a DC-62 connector cable for connecting the LSPM to the controller.

*This accessory is **not** required to use our controller products.*



REMOTE DISPLAY

Embed Alicat measurement technology without losing the functionality of our dynamic display!

Our Remote Display (RD) option is **designed to offer the flexibility of using Alicat's display with units that are embedded inside processes**. The RD retains all of the same features as our standard display.

The RD option is available for any Alicat flow or pressure device. A cable as long as 12 feet can be used between the flow body and the display. *(For applications requiring longer cables please contact Alicat)*



Our digital display allows you to monitor flow, temperature and pressure data in real time. The display also permits you to make functional changes to the unit such as — change the selected gas, control set-point and tare without the need for digital communication or special software.

The Remote Display is ideal for:

- ▶ OEMs Remote Panel mounting
- ▶ Gas panels
- ▶ Leak detection systems
- ▶ Embedded systems
- ▶ Fuel cell test stations
- ▶ Artificial environments

NeSSI COMPATIBLE

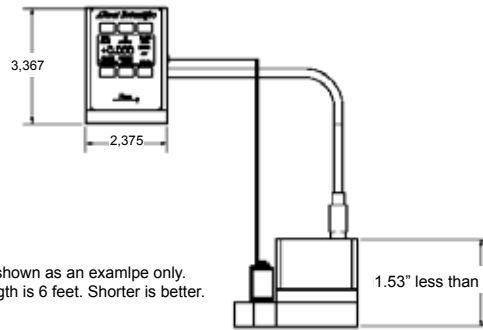
Alicat Scientific is a proud participant in **NeSSI (New Sampling/Sensor Initiative)**.

Many Alicat instruments are now available in a **NeSSI** compatible design. If your application calls for a **NeSSI** device, please let us know. We are committed to providing superior instruments that will meet your requirements.

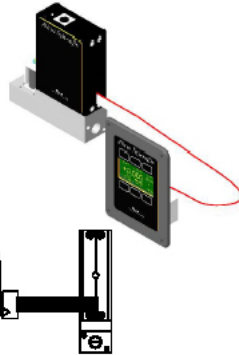
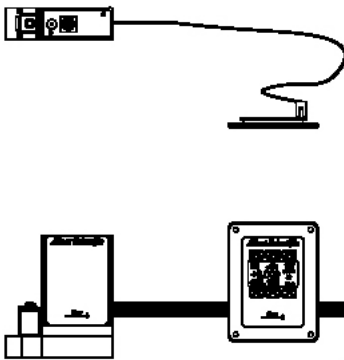
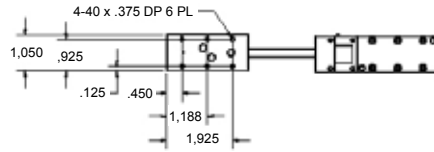


Remote Electronics

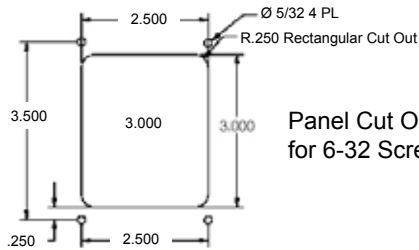
10SLPM Controller dimensions shown as an example only



- Notes:
 1. 10SLPM controller shown as an example only.
 2. Maximum cable length is 6 feet. Shorter is better.

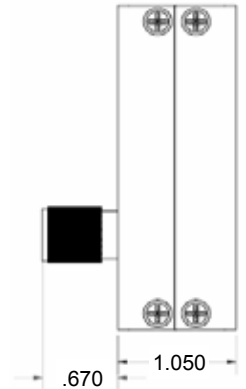
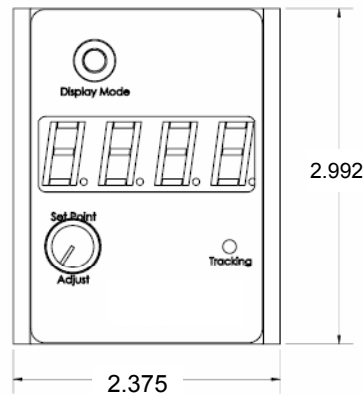
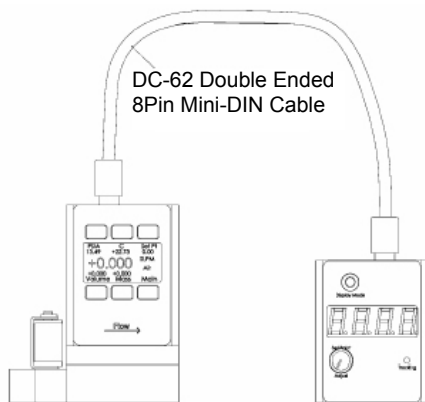


Remote Panel Display
(typical dimensions)



Panel Cut Out Template
for 6-32 Screws and Nuts

Local Set-Point Module (LSPM)
All Ranges



ACCESSORIES

Power Supplies

Power supplies are typically ordered to facilitate “out of box” use of Alicat devices when it is inconvenient or impossible to provide DC power to a device through the electrical connector.

PVPS: This is an unregulated 12 Vdc, 120VAC, US plug style wall adapter. It may be used with M, V, L, P Series devices or small valve controllers. If you have ordered a customized pressure drop or orifice sized unit, a 24Vdc power supply may be required.

PVPS24: This is an unregulated 24 Vdc, 120VAC, US plug style wall adapter. It may be used with MCR, VCR, LCR and PCR controllers. If you have ordered a customized pressure drop or orifice sized unit, a 24Vdc power supply may be required for other model types.

PVPSE: Same as PVPS, but 220VAC, European rounded plug style wall adapter.

PVPS24E: Same as PVPS24, but 220VAC, European rounded plug style wall adapter.



BB-9 Multi-Drop Box makes it convenient to wire multiple flow and/or pressure devices to a single RS-232 port. The Multi-Drop Box has nine 8 pin mini-DIN ports available. The ports are to be used with a standard double ended 8 pin mini-DIN (DC-62) style cable going from the box to each flow or pressure device. A single DB9 D-SUB type connector (COM PORT) connects, using the included cable, to the serial connector on a PC or laptop. All of the flow and/or pressure devices are powered via a terminal block on the front of the box. If more than nine devices will be required, additional Multi-Drop Boxes can be daisy chained together with a double ended 8 pin mini-DIN cable plugged into any receptacle on both boxes.



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

Fittings, Filters and Adapters

We carry a full line of Swagelock® compression fittings in 316 stainless steel. Other fittings and filters are available upon request.



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

*Our micro-flow devices (i.e. gases ≤ 50 SCCM full scale and water ≤ 1 CCM full scale) utilize an M5 (10-32) thread female process connection. This connection was chosen to make it possible for end users to minimize dead volume throughout their system by providing a thread that is compatible with miniature process connections.

Connecting Cables - Recommended Accessory

The electrical connector on all Alicat units is female. Male electrical connecting cables can be ordered for the following purposes:

- To provide power to the unit from a customer supplied dc voltage source
- To access output and input signals in communication
- To activate remote tare

DC-61: 8-pin circular mini-din connector cable. 6' long with one male mating connector. The opposite end is blunt cut with color-coded wires.

DC-251: Identical to DC-61, except 25' long cable.

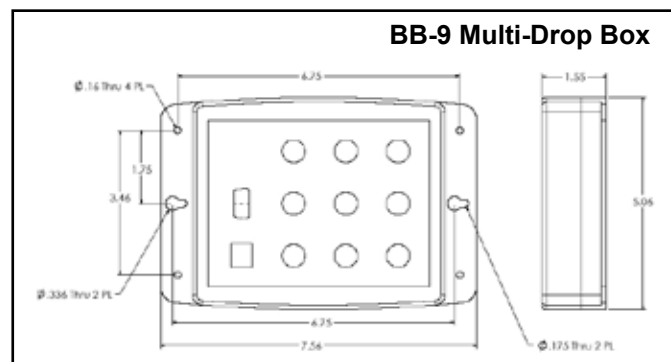
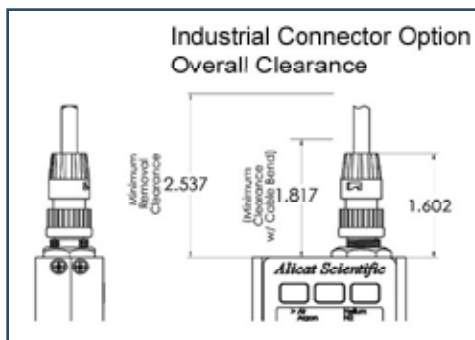
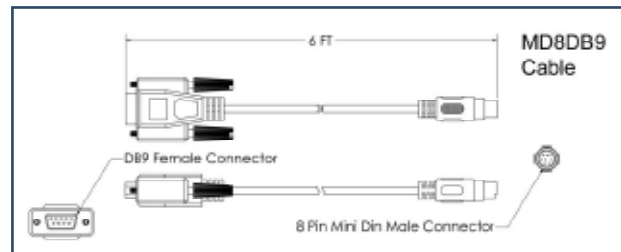
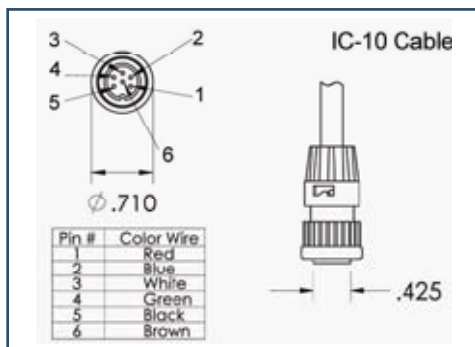
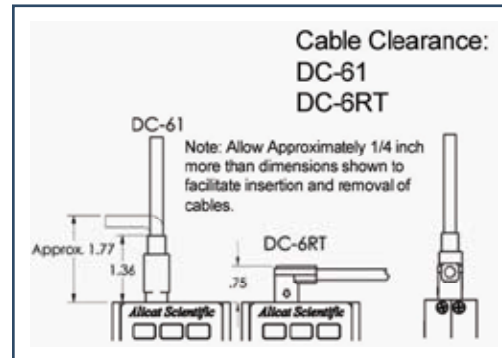
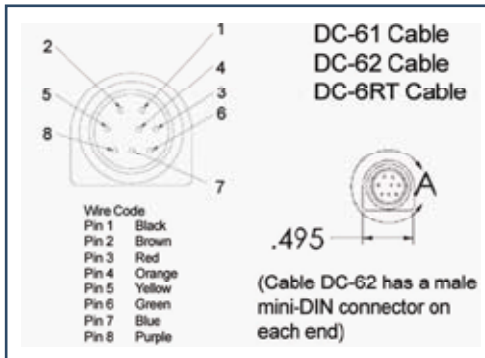
DC-6RT: Lower profile alternative. This is a right angle, 8-pin circular mini-din connector cable at 6' long with one male mating connector. The opposite end is blunt cut with color-coded wires.

DC-62: Double-ended male 8-pin circular mini-din connector cable in 6' length. It is a straight pin-to-pin cable. This cable is supplied with the LSPM.

DC-252: Identical to DC-62, except 25' long cable.

IC-10: 6-pin industrial style locking cable for use with the "I" industrial connection option, 10' long with one male mating connector. Opposite end is blunt cut with color-coded wires. Cable reduces variety of optional signal configurations.

MD8DB9: Male 8-pin circular din to female DB9 adapter cable, 6" long, typically used to simplify connection direct to a PC, but will not pass through power to the unit.



LRV SERIES

HIGH FLOW, LOW PRESSURE DROP VALVES

These high flow, low pressure drop LRV valves were originally designed for use with Alicat control products. Over the last few years, we have made the individual valves available for other applications. The LRV valves are proportional control valves, but they are “flow blind” devices that must receive continuous updates in control voltages.

These valves are designed for processes that can provide the loop closure (e.g. a process feedback driven PID controller). For integrated systems that can provide the closed-loop feed back system, these valves can bring substantial advantages through their flow versus pressure profile as seen below (air at 21° Celsius):

LRV Series Valve

Basic Operating Specifications

Orifice Diameter:

49 0.063” orifices

Power Requirements:

24-30Vdc, 1Amp

Control Signal:

0-2.5 Vdc

Max. Operating Temperature:

85° Celsius

Min. Operating Temperature:

-10° Celsius

Max. Operating Pressure:

200PSIG

Min. Forward Pressure to Assure Seal:

1PSI

Overall Dimensions:

5.5”H x 3.0”W x 2.25”D

Mechanical Connections:

3/4” NPT Female (SAE available)

Weight:

4.8lbs.

Valve Type:

Normally Closed Proportional

Response Time (Off-Full Open-Off):

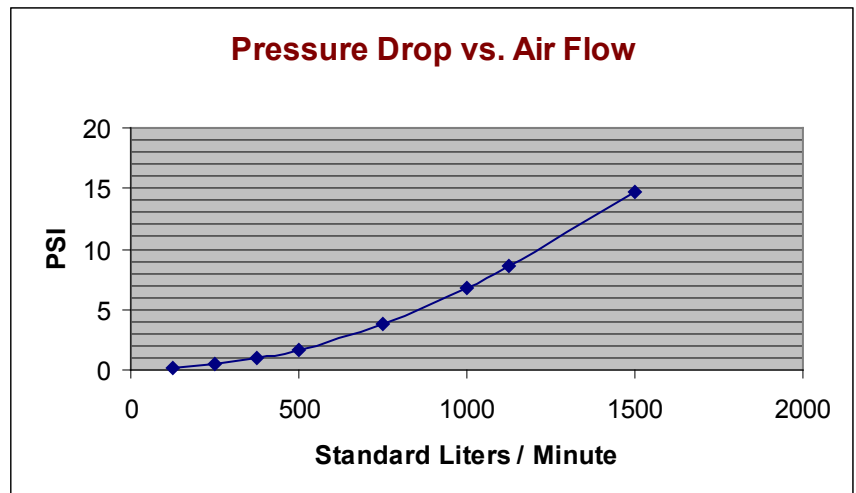
8Hz (operating pressure independent)

Acceptable Media:

All gases and liquids compatible with the wetted materials

Wetted Materials:

303 & 410 stainless steel, nickel, Viton®, Anodized Aluminum, Delrin®, 18-8 stainless steel



CUSTOMIZATION

There are many ways our units may be tailored to fit your specific application, typically for a low fee. Our engineers are available to assist you with any questions you may have regarding the optimal configuration for your application. Please call us or contact an engineer at info@alicatescientific.com for further information.

Gas Mixtures

Available on M, V, MC, VC, MCR and VCR units, Alicat Scientific can calibrate to a wide variety of complex gas mixtures involving up to four gas constituents. The percentage of each gas is required at the time of order for the calculation of the mixture's viscosity and temperature curve characteristics. The gas mixture will then be added to the device's gas calibration list. The mix can be selected via RS-232 or local display. Alternately, we can suppress the 30 gas selection and default a device to a specific gas mixture calibration. Please see page 53 for an alternate application involving real-time gas mixture ratio changes.

Industrial Connector, 6-pin locking

A locking 6-pin industrial connector can be added to any device. The industrial connector has a limited number of total output options in comparison to the standard 8-pin DIN connector.

Customized Pressure Drops

The M, V, MC, MCR, VC, VCR and LC units may be customized for lower pressure drops. Depending on the range, a 50% or greater reduction in pressure drop is obtainable. However, as the pressure drop decreases it is possible the accuracy of the device will also degrade by as much as $\pm 2\%$ of full scale. When low-drop device part numbers are provided, revised accuracy specifications are included.

Vacuum Applications

Standard Alicat M and V Series flow meters will work with vacuum applications down to 11.5 PSIA without changes to ordered part. Lower pressures (to 1.5 PSIA) are possible with customization. Please see page 46 for details.

Alicat MC, MCR and VC, VCR controllers can also be utilized for both positive and vacuum applications. It is strongly encouraged that at time of order you request a downstream valve for vacuum applications by indicating "DS" after the Gas in the part number. A downstream valve will help accommodate for expansion in the volumetric flow under vacuum. There is no charge for this service.

Alternate STPs (Standard Temperature and Pressure)

Alicat M, MC & MCR devices use a default STP of 25°C and 14.696PSIA in flow calibration. We have designed our units so that at no cost you may order an alternate STP. The device STP is stated on the calibration sheet. Common STPs include 0°C & 760mmHG; 0°C & 14.696PSIA; and 20°C & 14.696PSIA.

Alternate Units of Measure

All devices are listed in full-scale ranges of cubic centimeters/minute, liters/minute or pounds/square inch. Alternate units of measure are available at no additional cost. Alternate units of measure requested include SCFM, SCFH, mmHG, and inH₂O.

Bi-Directional Flow Readings

Alicat M or V Series gas meters can be ordered with a full scale calibration in both directions. Display and RS-232 mass flow outputs indicate direction of flow with "+" and "-" signs. Includes NIST traceable calibration in both directions. Note, device accuracy is based on total span; e.g. a 2SLPM meter with bi-directional flow @ $\pm 1\%$ full scale accuracy has a accuracy specification of ± 0.04 SLPM at +2SLPM or at -2SLPM. 0-5Vdc and 0-10Vdc analog bi-directional outputs available, for example:

5BDM	0-5Vdc bi-directional output of mass flow.	Zero flow point at 2.5Vdc
10BDM	0-10Vdc bi-directional output of mass flow.	Zero flow point at 5Vdc
CBDM	4-20mA bi-directional output of volumetric flow.	Zero flow point at 12mA

Totalizer

Flow meters and controllers can be ordered with the Totalizing option. This option adds an additional mode screen that displays the total flow (normally in the units of the main flow screen) that has passed through the meter or controller since the last time the Totalizer was cleared. The counter can have as many as six digits. At the time of order, the customer must specify the resolution of the count. For instance, if a resolution of 1/100ths of a liter is specified on a meter, which is totalizing in liters, the maximum count would be 9999.99 liters. If the same unit were specified with a 1 liter resolution, the maximum count would be 999999 liters. The customer can also specify what the Totalizer is to do when the maximum count is reached. The following options may be specified:



Mass Device Totalizer Display

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.

The display will show elapsed time since the last reset in 0.1 hour increments. The maximum measurable elapsed time is 6553.5 hours (about nine months). The hours count resets when the “clear” button is pushed, an RS-232 clear is executed or on loss of power (a battery back-up can help circumvent Totalizer clear when power is lost). The counter can be reset to zero at any time by pushing the dynamically labeled “Clear” button located above the upper right side of the display or via a RS-232 Serial Command.

Pulse Output (PUL: Flow): Available on M, V and L models. The pulse output option is a simplified totalizer. It is available on pin 2 of the 8-pin mini din connector and replaces the ability to have a static 5.12Vdc output, a secondary analog output or an alarm. The parameters for the pulse output are factory set and should be requested at time of order. This option will create a state change on pin 2 from 0Vdc to 5Vdc (or 5Vdc to 0Vdc on alternate periods) each time the total amount of predefined flow passes through the unit. For example:

M-10SLPM-D /5M, PUL:17SL

Every time a total flow of 17SL passes through the unit, Pin 2 will go from 0 to 5Vdc. The duration of the 5Vdc output signal is approximately 102 seconds.

Orifice Sizing

In many pressure control applications it is necessary to restrict or maximize the actual flow of gas through the device. We can increase or decrease the orifice size as necessary to accommodate this need. If pressure control is the goal, it may be more efficient in high flow applications to utilize a mass flow controller, which can be field configured to control the pressure while still providing flow rate data.

Alarms: Alicat M, V, L or P Series meters and gauges can be ordered with a simple alarm. You can program in the field the alarm set-point via the local display, RS-232 or analog input. There are two types of alarms available. Both types operate on pin 2 of the 8-pin mini-din connector (detailed diagram page 10). Units with the alarm function do not have the static 5.12Vdc output, the option for a secondary analog output or the pulse ability.

ALH: This alarm format, which is programmed by the factory, will cause pin 2 to go from a 0Vdc output directly to a 5Vdc output when the alarm set-point is exceed. For example, a 0-20SLPM mass meter (M) is programmed by the user with an alarm condition of 13.75SLPM. When the flow exceeds 13.75SLPM, pin 2 will change state to a 5Vdc output. For a pressure gauge (P) series, the alarm state change will occur when the pressure exceeds the set-point .

ALL: This alarm format is similar to the ALH option, except the state change to 5Vdc occurs when the process parameter (flow or pressure) is under the set-point .

Please consult the factory for additional customization options, including:

- Customized process connections
- Alternate materials of construction (e.g. aluminum bodies to reduce weight)
- Complete private label package (labels, software, manuals, etc)

QUICK GLOSSARY

- % of full scale:** A flow meter with a flow range of 0 to 100LPM and an accuracy of 1% full scale will read ± 1 LPM anywhere in its operating range.
- % of reading:** A flow meter with a flow range of 0 to 100LPM and an accuracy of 1% of reading will read $\pm 1\%$ of actual flow rate anywhere in the meter's operating range. As a result, at full scale on a 0-100LPM unit, the accuracy would be ± 1 LPM at 100LPM and ± 0.1 LPM and 10LPM.
- Accuracy:** Quantity defining the limit that errors will not exceed. When applied to flow meters, accuracy is specified in either % of full scale or % of reading.
Error as a percentage of full scale is established by multiplying the error percentage by the full scale flow. The less you flow through the device the less accurate the reading will be. Devices with error expressed as a percentage of full scale are most accurate when flowing at full scale.
Error expressed as a percentage of reading expresses error as a percentage of what the device is actually flowing. Simply, if a instrument's accuracy is rated to $\pm 1\%$ of reading an instrument will be accurate to $\pm 1\%$ of whatever the instrument is flowing. At 100SLPM the instrument will be accurate to within ± 1 SLPM, and at 10SLPM of flow the unit will be accurate to within ± 1 SLPM.
- Dead Band:** Dead band is defined as an area of a signal range or band where no action occurs. Dead band as it relates to a pressure switch is the band in between which the switch trips (the set-point) and where the switch resets.
- Differential Pressure:** The difference between two pressures. Differential pressure or Laminar flow meters use the pressure drop created within a laminar flow element to measure the mass flow rate of a fluid (see page 41).
- Mass Flow:** Also called normal flow or standard flow. The mass flow rate can be thought of as what the volume flow rate would be if the gas flowing through the line were at standard conditions. See pages 44 & 45 for more information.
- Pressure Coefficient (Pressure Sensitivity):** Indicates the effects of operating pressures on a flow device's overall accuracy. It is related to operating condition deviations from the calibration process pressure. This specification is additive to overall device accuracy specifications.
- Pressure Drop:** Pressure drop describes the loss of pressure as a gas or fluid travels through a pipe or channel.
- Repeatability:** Is the closeness of agreement between consecutive measurements of the same flow within a particular time frame. This can be specified as % of full scale or % of reading.
- Span Shift or Span Error:** Span shift or span error is defined as a shift in the slope of the calibration curve with zero not changing. The calibration curve of the device will be affected differently at different flow ranges. Span error is measured in %FS (or %reading)/degree change in temp (or psi change in pressure) Simply, for every change in degree temp or change in psi the calibration is offset by the percentage of error. Sometimes called "Zero Shift" or "Offset Error".
- Temperature Coefficient (Temperature Sensitivity):** Similar in effect as a pressure coefficient, but related to operating temperature deviations from gas temperature during device calibration. Also additive to overall device accuracy.
- Turndown:** Conveys the same information as rangeability and operating range but in a slightly different way. Turndown is the ratio of maximum flow to minimum flow. For example, a 100LPM flow meter, with a 100:1 (100 to 1) turndown, the maximum flow rate would be 100LPM and the minimum flow rate where you could reasonably use the unit would be 1LPM. All Alicat flow meters and controllers will read all the way down to zero flow.
- Volume Flow:** Indicates the actual volume of a gas. Since gases are compressible, the actual mass of the gas will be constant with temperature & pressure changes, but the volume will vary.

ALICAT TECHNOLOGY

Alicat Laminar Mass Flow devices address many of the historic drawbacks to classic orifice plate type volumetric flow measurement as a basis for mass flow calculations. They also address limitations of thermal flow technology in regards to hot-wire drift, micro-flow calculations and response time. Advancements in sensor and microprocessor technology have made these improvements possible. An Alicat mass flow meter or mass flow controller operates on the same principles as many larger, laminar transfer standards, but in a small, easily integrated package.

Principle Features and Benefits

- No straight runs of pipe required
- Micro-Flows as low as 0.5ml/minute full scale available for gas and liquids
- Pressure and temperature (density) compensations performed internally on mass products
- Less sensitivity to line or ambient pressure and temperature changes
- Simple, position insensitive installation
- Easy integration and bench top versatility
- Support a wide range of options without extra software packages or components

Theory of Operation: Volumetric Flow Base (V, VC, VCR and L, LC, LCR Series Units)

The operating principle of the volumetric unit is based on the physics of the Poiseuille Equation (Equation 1). The Poiseuille Equation quantifies the relationship between pressure drop and flow. In its simplified form (Equation 2), K is a constant factor determined by the geometry of the restriction. It shows the linear relationship between volumetric flow rate (Q), differential pressure (ΔP), and absolute viscosity (η).

To use the Poiseuille Equation, an internal restriction is created. This restriction is known as a Laminar Flow Element (LFE), represented by r and L in Equation 1. The LFE forces the gas molecules to move in parallel paths along the length of the passage, eliminating flow turbulence and creating a state of laminar gas flow beneath the Reynolds threshold of 2000. (The Reynolds number of 2000 is commonly accepted as the theoretical threshold. This number will vary depending on surface characteristics.) Next the differential pressure drop is measured within the laminar region. Finally, the viscosity of the gas (η) must be determined as affected by gas temperature. This procedure is performed internally by the microprocessor. Volumetric devices complete their calculations and loop.

Equation 1: $Q = (P_1 - P_2)\pi r^4/8\eta L$

Where:

Q = Volumetric Flow Rate

P_1 = Static Pressure at Inlet

P_2 = Static Pressure at Outlet

r = Hydraulic Radius of Restriction

η = (eta) Absolute Viscosity of Fluid

L = Length of Restriction

Equation 2: $Q = K(\Delta P/\eta)$

Where:

K = constant dependent upon the geometry of the LFE.

Theory of Operation: Mass Flow Conversion (M, MC, MCR Series Units)

Alicat mass flow devices start with the volumetric flow rate calculation as described above. Additional measurements and calculations are incorporated to determine the actual mass flow rate of the gas. Ideal gas laws show us that the density of a gas is affected by its temperature and absolute pressure. Using ideal gas laws requires a reference to a standard temperature and pressure (STP) condition for "normalizing" the mass flow calculation. Essentially this is a determination of the density of the gas at sea level and a predetermined temperature as related to the actual flow conditions. In order to determine the mass flow rate, two correction factors must be applied to volumetric flow rate: temperature effect on density and absolute pressure effect on density (Equation 3).

$$\text{Equation 3: } M = Q(T_s / T_a)(P_a / P_s)$$

Where:

M= Mass Flow

Q = Volumetric Flow (From Equation 2)

T_s = Absolute Temperature @ Standard Condition in Kelvin

T_a = Absolute Temperature @ Flow Condition in Kelvin

P_a = Flow Absolute Pressure

P_s = Absolute Pressure @ Standard Condition

In an Alicat mass flow meter a discrete absolute pressure sensor and temperature sensor are placed in the laminar region of the flow stream. This information is sent to the microprocessor and is utilized to determine mass flow. Due to advancements in microprocessor technology, this series of calculations can be performed and flow rate data updated (local display, analog output and digital outputs) an average of 1,200 times/second. This allows for extremely fast, real time measurements of flow that are sensitive enough to report pulsations in flow, as well as step changes.

At www.AlicatScientific.com there is a simple conversion calculator for changing normalized mass flow readings into true mass flow readings (e.g. grams/second). Alternate Units of Measure for flow readings are available at no charge when product is ordered. Page 45 explains the difference between *corrected* mass flow and *true* mass flow.

Accuracy Comparisons & Calibration Conditions

Alicat mass and volumetric flow devices have a standard accuracy of ± (0.8% of Reading + 0.2% of Full Scale) at calibration conditions after tare for gases and ±2% full scale for liquids. Optional tighter calibrations that improve accuracies by 50% are available. When comparing device accuracies across flow technologies, it is important to understand the accuracy shift effects as process conditions deviate from the calibration conditions used by the manufacturer during the calibration production process.

The two most common effects on accuracy in calibration conditions versus actual operating conditions are zero shift and span shift. Sometimes these are also referred to as temperature and pressure coefficients or temperature and pressure sensitivity. These two specifications are *additive* to the stated device accuracy (whether % of reading or % of full scale) and increase in effect as the actual operating conditions deviate from the calibration conditions. With Alicat's product, it is possible to reduce the zero shift by re-zeroing the unit at the expected operating temperature. The zero shift and span shift specifications from any vendor should be considered as part of the overall unit accuracy when estimating the overall meter error for the intended application.

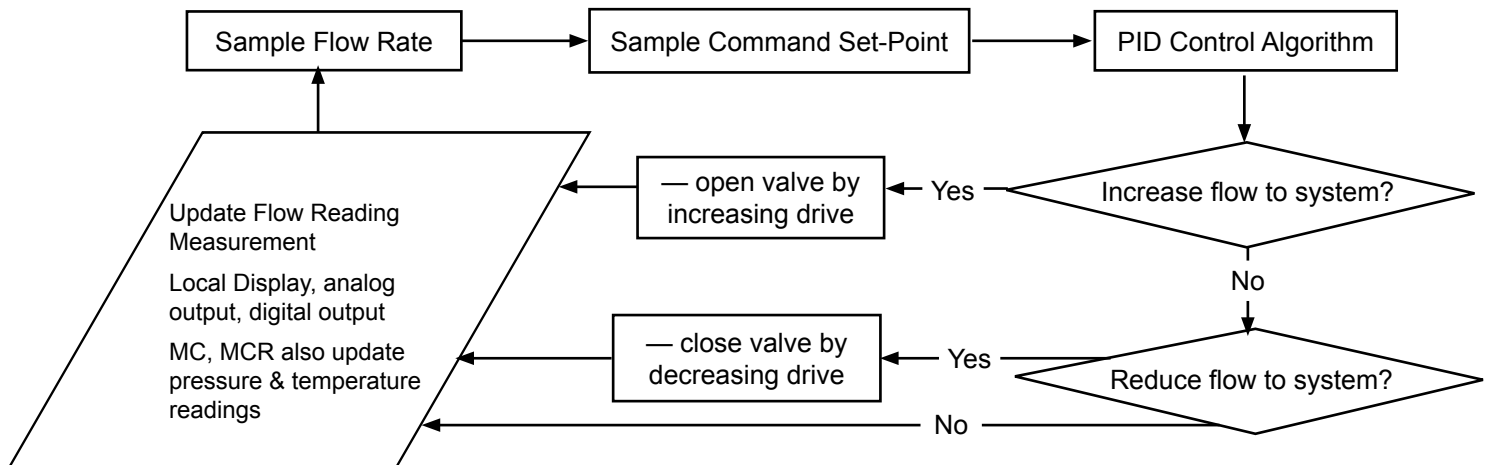
Flow & Pressure Controller Operation

MC, MCR, VC, VCR, LC, LCR, & PC, PCR, PCD Series Instruments

An Alicat flow controller (or pressure controller) takes the flow meter (or pressure gauge) and couples it to a proportional control valve. Alicat Scientific, Inc. was among the first companies to respond with a "smart" flow controller. Specific application parameters for each model are available in the detailed specifications section of this catalog. These models can be configured to accommodate vacuums as low as 27inHG depression full scale. Alternate valve orifice sizing can accommodate much lower pressure drops. The heart of the flow and pressure controller product line's ability to respond to multiple industry needs lies within the optimized control algorithms. The algorithms were developed over years of intensive research, both in the laboratory and in the field with semiconductor equipment, fuel cell integrators, automotive paint facilities and bio-pharm laboratories.

The Alicat controllers are designated a "smart" device because the advanced control algorithms are handled on the device's internal microprocessor. There is also no additional software or electronic components required. They are a stand alone device. The end-user simply sends a command flow, mass flow or pressure set-point (via local display, analog or RS-232 communication) to the flow or pressure controller. The controller handles the balance of the tasks in the microprocessor. This frees up any DCS (Distributed Control Systems) or PLC (Programmable Logic Controller) resources that were once used to control the basic analog system, for other higher level tasks. It also allows for easy installation and set-up and eliminates weeks or sometimes months of trial & error to determine set-point intervals. This reduction in initial installation time can be attributed to the advanced PID (Proportional Integral Differential) control algorithm.

The **PID algorithm** is a closed loop control formula used to actuate the proportional control valve. The flow controller's microprocessor continuously performs the following loop* approximately 1,000 times per second:



PID Control Algorithm Diagram

The actual drive applied to the control valve is determined by the PID control algorithm. The “P” or proportional effect on the overall system valve drive command is additive and is determined by calculating:

$$(\text{Actual Flow Rate} - \text{Command set-point}) \times \text{Proportional Gain Value}$$

The “D” or differential effect is a dampening effect that prevents oscillation in flow. The “D” effect on the overall system valve drive command is subtractive and is determined by calculating:

$$(\text{Current Flow Rate} - \text{Previous Flow Rate}) \times \text{Differential Gain Value}$$

An Alicat controller is calibrated with default PID algorithms that will provide performance within manufacturer’s specifications at the outlet side of the flow meter. The ability to adjust the PID terms in the field is provided for application specific tuning. For example, some automotive companies require critical control at the end of 50’ of tubing. These companies can tune the unit to provide relatively large jumps in valve drive changes that essentially “smooth out” by the time the air flow has entered the process 50’ away from the flow controller installation point. This allows significant improvements in response times at a distance from the flow controller. Response times in these types of applications are typically limited by the actual physics of the pneumatic system.

*** Pressure controllers perform the same loop on “pressure” parameters instead of “flow” parameters.**

References:

Flow Measurement Engineering Handbook, 3rd edition, Richard W. Miller, McGraw-Hill, 1983.
Fluid Mechanics, 2nd edition, Frank M. White, McGraw-Hill, 1986.
Respiratory Therapy Equipment, 4th edition, Steven P. McPherson, The C.V. Mosby Company, 1990.

Pressure Influence on Volumetric Flow

The Alicat V, VC and VCR Series volumetric flow devices are intended for use in low pressure applications. This is because accurate measurement of the volumetric flow rate, using differential pressure, requires that the flow at the DP sensor be in a laminar state. A laminar (or streamline) state of flow is quantified by what is known as the Reynolds number. If the Reynolds number gets above a certain point (nominally 2000) the flow will become non-laminar. The Reynolds number for a given Newtonian fluid flow is defined as:

$$Re = \rho VL/\mu$$

Where:

ρ = density

V = average velocity

L = constant determined by length and geometry of the passage

μ = viscosity

From this relationship we see that increasing the gas density or the velocity increases the Reynolds Number, and increasing the gas viscosity decreases the Reynolds number. For a given gas in a given meter at a given temperature, L and μ are roughly fixed constants.

For the purpose of illustration, let us put two flow meters in series with one another in a pipeline. They are identical in every way except that one is a volumetric flow meter (100LPM) and one is a mass flow meter (100SLPM). Now let us pass a small constant volume of air flow (20LPM) through the meters, thus fixing the velocity V through both meters. With the flow fixed, begin increasing the pressure, and thus the density. The mass flow meter, which is measuring the absolute pressure and compensating for the density change, registers this pressure increase as an increase in mass flow rate because the number of molecules of gas keeps going up in the fixed (20LPM) volume of flow. In addition, the Reynolds number has increased proportionately with the pressure increase because the density goes up with the pressure. If you increase the pressure high enough, the mass flow meter will max out at 100SLPM, the Reynolds number has increased fairly dramatically, and the volumetric meter still registers the small (20LPM) fixed flow rate.

Now if we maintain the higher pressure we can try to take the volumetric meter up to its published full scale flow of 100 LPM. Our density (because of high pressure) *and* our velocity V are now high, which often results in a high Reynolds number and non-laminar flow. When the flow is non-laminar, the Poiseuille Equation upon which we base our volumetric flow measurement is no longer valid and the meter reading is therefore no longer valid.

Any time there is flow in any line piping system there is always pressure drop. This pressure drop always causes a change in gas density, so that in general, no two points in a flowing system have the same gas density. Because volumetric flow meter readings are based on the gas density at their specific location, two meters placed in series can report somewhat different readings and both be correct. This makes it unwise to place any two volumetric flow meters (or one volumetric and one mass) in series in a system with the expectation of being able to compare the measurements.

Volumetric Flow versus Mass Flow

At room temperature and low pressures the volumetric and mass flow rate will be nearly identical, however, these rates can vary drastically with changes in temperature and/or pressure because the temperature and pressure of the gas directly affects the volume of the gas.

For example, assume a volumetric flow reading was used to fill balloons with 250 mL of helium, but the incoming line ran near a furnace that cycled on and off, intermittently heating the incoming helium. Because the volumetric meter simply measures the volume of gas flow, all of the balloons would initially be the same size. However, if all the balloons are placed in a room and allowed to come to an equilibrium temperature, they would generally all come out to be different sizes. If, on the other hand, a mass flow reading were used in the identical arrangement to fill the balloons with 250 *standard* mL of helium near a cycling furnace, the resulting balloons would initially be different sizes, but when allowed to come to an equilibrium temperature, they would all turn out to be the same size.

The flow reported by an Alicat mass flow device is called corrected "mass" flow because the resulting reading has been compensated for temperature and pressure effects and can therefore be tied to the mass of the gas. Without knowing the temperature and pressure of the gas and thus the density, the mass of the gas cannot be determined. Please see page 45 "Corrected Mass Flow versus True Mass Flow."

Corrected “Mass” Flow versus True Mass Flow

Most mass flow meter and mass flow controller manufacturers (including Alicat) report the mass flow rate in *standard* liters per minute (SLPM), *standard* cubic feet per hour (SCFH), *normal* liters per minute (nLPM), etc. This is an industry norm that often results in some confusion. The “standard” and “normal” in these units of measure refers to a volumetric flow rate that has been normalized (corrected) to standard gas temperature and pressure (STP) conditions.

Normalizing the volumetric flow to a specific STP (e.g. 25°C & 1 atmosphere or 0°C and 760mmHG) is done to account for pressure and temperature influences on volumetric flow of a gas versus the actual mass of the gas (see page 44), “Volumetric versus Mass Flow”). Strictly speaking, SLPM, SCFH, nLPM, etc units of measure (UOM) are not actual mass flow measurements. In physics, mass is a base quantity that will remain the same regardless of the conditions where it is measured (unless you are approaching the speed of light). True mass flow measurements are done in UOM such as grams/second or kilograms/hour.

After the corrected (normalized) mass flow rate has been determined, a true mass flow reading can be calculated. This requires knowledge of the gas density at the standard conditions. Common gas densities at specific standard conditions are well documented. Density tables for determining the actual mass flow from the normalized mass flow measurement are available on page 7. Alicat devices use a default STP of 25°C and 14.696PSIA, though alternate STPs can be requested at time of order. Please see the device’s calibration sheet to determine which STP to reference.

Once the density at standard conditions is known a true mass flow can be calculated as in the following example:

Gas	= Helium
Mass Flow Meter Reading (STP 25°C & 14.696PSIA)	= 250 SCCM (standard Cubic Centimeters/min)
Gas Density at 25°C & 14.696 PSIA	= 0.1636 grams/Liter
True Mass Flow	= (Mass Flow Meter Reading) X (Gas Density)
True Mass Flow	= (250 CC/min) X (1 Liter/1000 CC) X (.1636 grams/Liter)
True Mass Flow	= 0.0409 grams/min of Helium

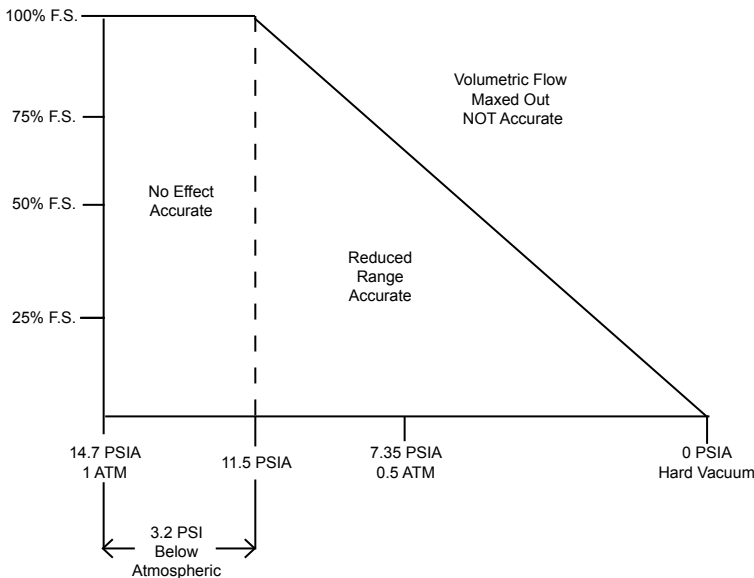
Simple conversion calculators are also available online at www.AlicatScientific.com.

Alicat Mass Flow Devices operating under Vacuum

The volume of a gas will expand under vacuum conditions. The Alicat mass flow devices utilize volumetric flow as their base calculation. The graph below demonstrates how expanding volumetric flow will effect the full scale mass flow operating range when the vacuum is greater than 11.5 PSIA. This same affect may be described as:

$$\text{Max. Accurate Mass Flow} = (\text{Actual Absolute Pressure} / 11.5) \times (\text{Flow Meter Full Scale})$$

E.g., a 10SLPM mass flow meter @ 5.8PSIA: 5.04 SLPM = (5.8 PSIA/11.5 PSIA) X (10 SLPM)



If Alicat knows the amount of vacuum the meter will be under, and the required flow rate, it is common practice to oversize the meter to compensate. For instance, if we know the customer will be using the meter at 5 PSIA, and they need to accurately measure up to 10 SLPM of flow, we would size the meter for 20 SLPM so that it could handle the expanded volumetric flow.

For mass controllers, we prefer to mount the valves downstream so the drop is taken across the valve and the meter portion remains closer to atmospheric pressures.

$$\text{Max Accurate Flow} = (\text{Actual Absolute Pressure} / 11.5) \times (\text{Flow Meter Full Scale})$$

Application Assistance Guide

Application assistance is available on-line at www.AlicatScientific.com. Please use this guide to help us better understand your application and operating parameters. It isn't necessary to answer all questions. You can either complete the application assistance form on-line or copy this page and fax it to "Application Support" at (520) 290-0109. Or, you may use it as a guide when speaking to our engineers at (520) 290-6060 (toll free U.S. 888 290-6060).

How should we contact you?

Name: _____

Company: _____

Phone: _____

Email: _____

Fax: _____

What industry are you in or does your company work with? We'll have the in-house expert contact you.

Are you trying to cross reference another device? Make & Model #: _____

Basic Operating Information Gas or Liquid? _____ Specific Gas or Liquid? _____

≈ Temperature: _____ ≈ Feed Pressure: _____ ≈ Back Pressure (if any): _____

≈ Max. Flow: _____ ≈ Min. Flow: _____ Need help with rates?: _____

Would you like to power the unit through the communication cable or with a power supply? _____

What do you need the device to do? Check as many as apply. We'll let you know if we can do it in one device.

Measure Flow? _____ Measure Pressure? _____ Measure Temperature? _____

Control Flow? _____ Control Pressure? _____ Control Back Pressure? _____

Would you like to incorporate any of these abilities? Check as many as apply.

Gas blend calibrations? ____ Multiple gas calibrations in 1 device? ____ Totalize flow? ____

Bi-Directional flow measurement? ____ Compare devices in series? ____ Alarm? ____

Require specific fittings? ____ Other needs? _____

Could you tell us about your process or application? This way, if we have provided a solution to a similar process, we can bring that knowledge to your application needs.

Example: I need to automate QC checks for fittings we manufacture. Currently we use pressure decay.

Example: I'm designing a process and we want to know how flow affects throughput. We use 5 gases.

What challenges are you encountering in the current process or search for a flow or pressure solution?

Example: There is a lot of electrical noise in my environment - it's interfering with device communication.

Example: I'm new to this process / industry and wouldn't mind some help getting up to speed.

Is there anything else you would like us to know about the process or application?

SELECTING THE BEST PRODUCT FOR YOUR APPLICATION

This is a brief guide designed to help you determine which Alicat device is appropriate for your application.

Gas Meters and Controllers: M, MC, MCR, V, VC, VCR

The gas is clean (20 -50 micron filter), non-corrosive, and dry (non-condensing).

The pressure available is greater than the minimum full scale pressure drop.

The operating temperature of the gas is between -10°C and 50°C.

Mass Gas Measurement & Control: M, MC & MCR Series

Using a mass flow meter or controller is recommended in most applications. These devices measure and display temperature, absolute pressure, and volumetric flow rate in addition to the mass flow rate. Mass devices add versatility with their additional pressure and temperature readings available via the local display and RS-232. They are appropriate for applications where the following conditions exist:

Comparison of other devices in series is required. Operating pressures and temperatures will fluctuate.

Back pressure (which effects density) will exist on the device, or pressures as high as 145PSIG.

Vacuum operation as low as 11.5PSIA (for deeper vacuums, please consult the factory for FS sizing).

Molar delivery quantification is critical.

Volumetric Gas Measurement & Control: V, VC and VCR Series

There are occasional applications where the non-corrected volume of flow is preferred. Volumetric devices are appropriate for applications where the following conditions exist:

Gas line conditions near to atmospheric conditions (10 – 15PSIG maximum recommended).

Venting to atmosphere or very low backpressure. Relatively consistent temperature.

Flow quantification is not critical. Comparison with other devices in series is not required.

Pressure Gauges and Controllers: P, PC, PCR, PCD

The gas is clean (20 -50 micron filter), non-corrosive and dry (non-condensing).

The operating temperature of the gas is between -10°C and 50°C.

Pressure Measurement: P Series

These devices are appropriate for applications involving pressure measurement with the general characteristics:

Pressures measurement as low as -30inHG full scale to as high as 1,000PSIG.

Pressure Control: PC & PCR Series

These devices are appropriate for applications involving pressure control with the general characteristics:

There is in-line flow. (These devices have no bleed ports to reduce pressure—please see PCD Series.)

Pressures as low as -30inHG to as high as 100PSIG full scale (excess pressure 2xFS).

Valve orifice sizing to accommodate high flows (e.g. 1500SLPM) at low pressures (e.g. 10PSI) — PCR model.

Pressure Control: PCD Series

These devices are appropriate for applications involving pressure control with the general characteristics:

Closed or “dead headed” processes. (A digital device actuated exhaust valve is incorporated into the PCD.)

Pressures as low as -30inHG to as high as 100PSIG full scale (excess pressure 2 x FS).

Valve orifice sizing to accomplish high flows at low pressure—please consult the factory.

Liquid Measurement & Control: L, LC & LCR Series

These devices measure and display temperature, gauge pressure and volumetric flow rate. They are designed for DI water, but can be calibrated for other media. These devices are appropriate for applications:

Comparison of other devices in series is required. Operating pressures and temperatures will fluctuate.

The operating temperature of the liquid is between 10°C and 50°C. The operating pressure is less than 100PSIG.

Alicat has verified device usage (material compatibility and calibration ability) for liquids other than DI water.

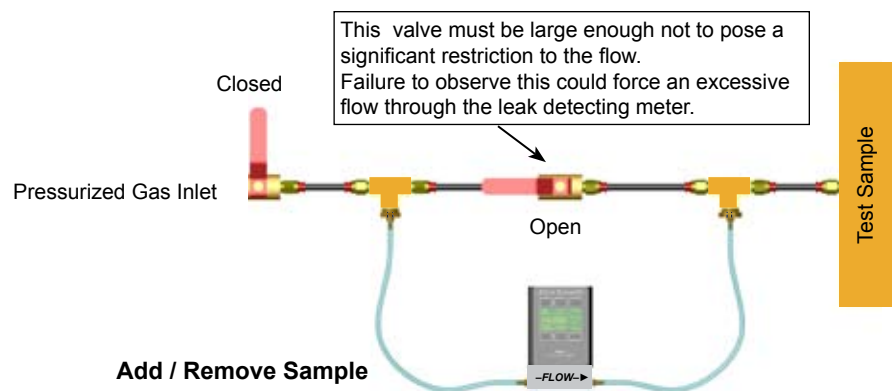
The pressure available is greater than the minimum full scale pressure drop.

Faster Leak Checking

In many manufacturing firms it is necessary to have a fast, accurate and reliable method for leak checking components. Alicat's measurement principle can help these applications run even faster. Because our mass flow meters are measuring the pressures and the temperatures of the gas, we are constantly compensating for the effects of pressure and temperature. At low flow rates this relationship between pressure and flow can become relatively strong, so we also can assist in reducing the errors normally associated with pressure decay leak testing.

There are many ways to establish a leak test system and the standard Alicat product line assists in several designs from fully automated to bench-top lot checking.

We can also help in systems where mass spectrometry appears to be the only solution. Use our 0.5SCCM full scale devices with helium gas to mimic high pressure, low flow test conditions. This is possible because helium has a small molecular size compared to air or nitrogen.

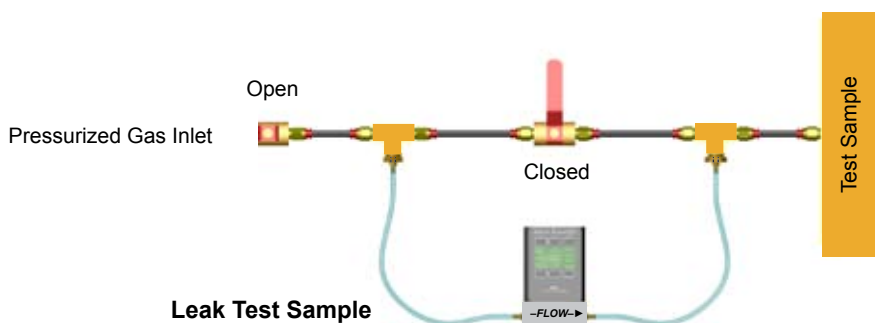
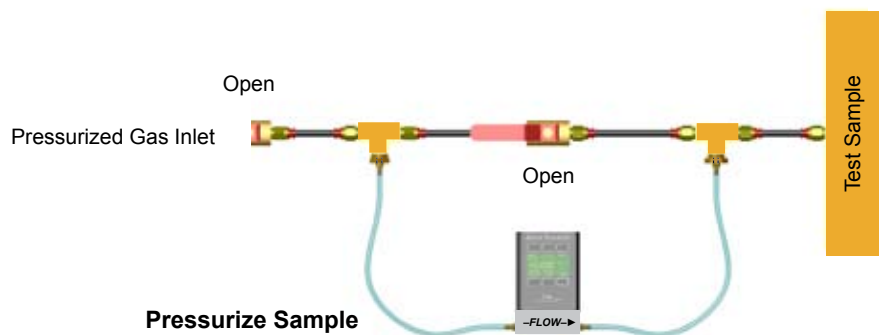


The most popular models for this application are:

- M Series Meters:
 M-0.5SCCM-D /5M
 M-500SCCM-D /5M



M-1SCCM-D
 Shown with opt. fittings



Sputtering Flow Control

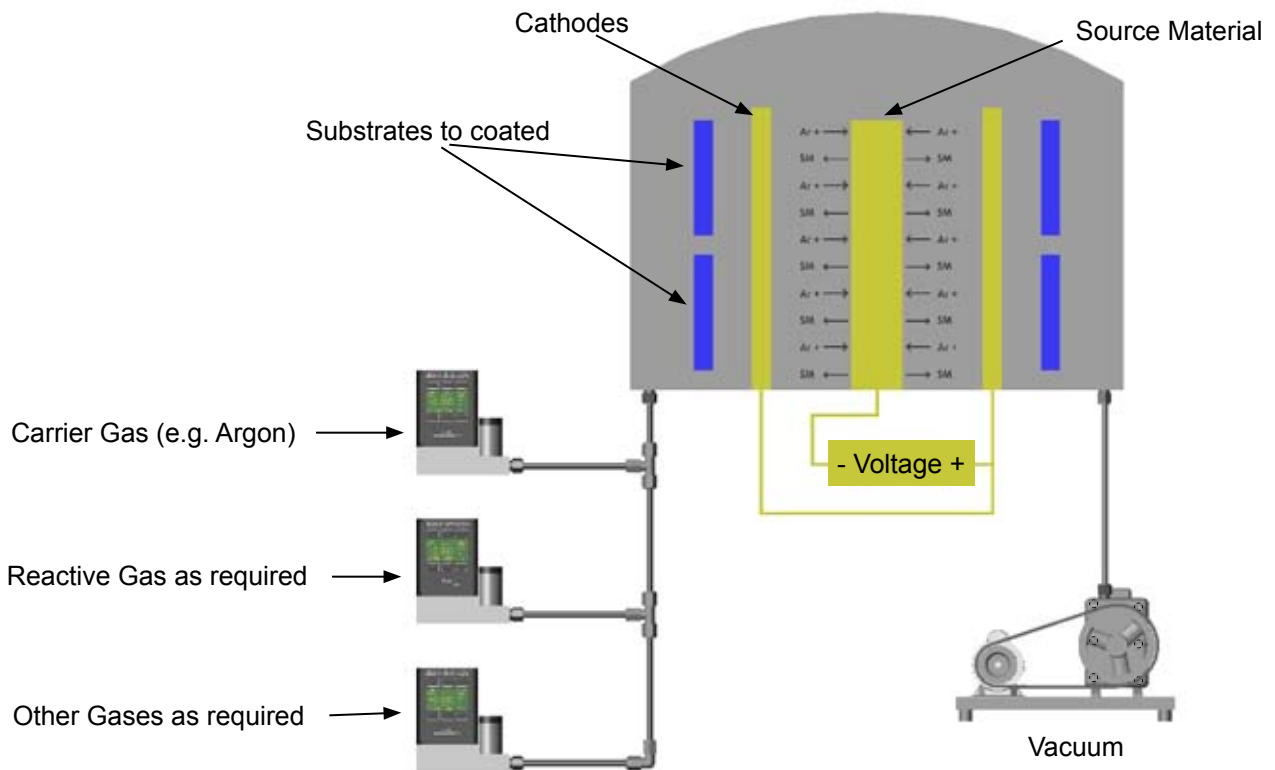
In the process of sputtering, a plasma gas (typically argon) is used to fill a vacuum chamber which contains a target lattice and a substrate. The amount of plasma gas within the chamber is critical to control of the number of atoms released from the target lattice.

In reactive sputtering, reactive gasses like oxygen and nitrogen are added to the chamber (usually for coating substrates with compound atoms like titanium oxide).

Proper partial pressures of reactive gasses must be maintained within the chamber to prevent target poisoning.

Fast response times and low flow resolution are crucial to this application.

For longer cathode arrays and sputtering applications using multiple gas sources, multiple mass flow controllers can be controlled from one serial connection or through analog input/output.



Alicat Advantages:

Relative Insensitivity to Process & Ambient Temperature and Pressures Changes.

Downstream Valves provide full compatibility with High Vacuum Process Chambers.

25-100 millisecond control times. Tune the PID in the field for your specific application.

Selectable Loop controls allow you to control Mass Flow, Volumetric flow, or Absolute Pressure with the same device, while simultaneously measuring Mass Flow, Temperature, Volumetric Flow, and Absolute Pressure.

Multi-Drop RS-232 communications allows communication and set-point control with up to 26 Alicat devices from a single computer serial port.

Every Alicat MFC comes preset with 20 selectable gas calibrations and 10 gas-mix calibrations.

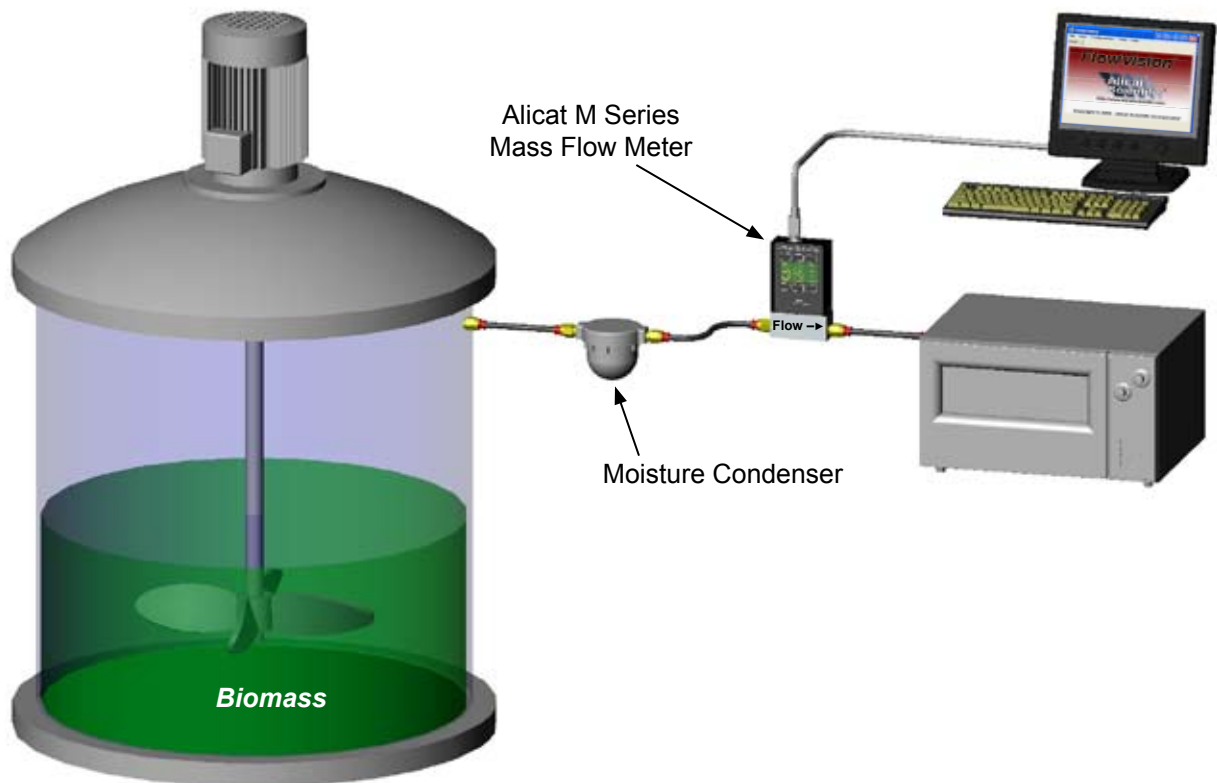
Bioreactor Outgassing Rotometer Replacement

Research projects involving isolated chambers with decomposing organic components often use rotometers. The gas is released from the chamber and metered into a gas analyzer to determine the actual gas constituents.

The diagram demonstrates how an Alicat micro-flow mass meter (MFM) can be used instead of a rotometer to gain substantial improvements in device accuracy and automation.

The Alicat MFM is set for methane gas calibration. The MFM reports the totalized gas flow to the PC, which incorporates this data with the analyzer's calculations.

The actual gas being released from the chamber is not pure methane, but a number of gases mixed with methane. Viscosity calculations have indicated that the total flow accuracy will not exceed $\pm 2\%$ full scale. The MFMs high operating range of 1 – 100% and digital communication ability, results in a test solution that is highly repeatable with simplified data collection.



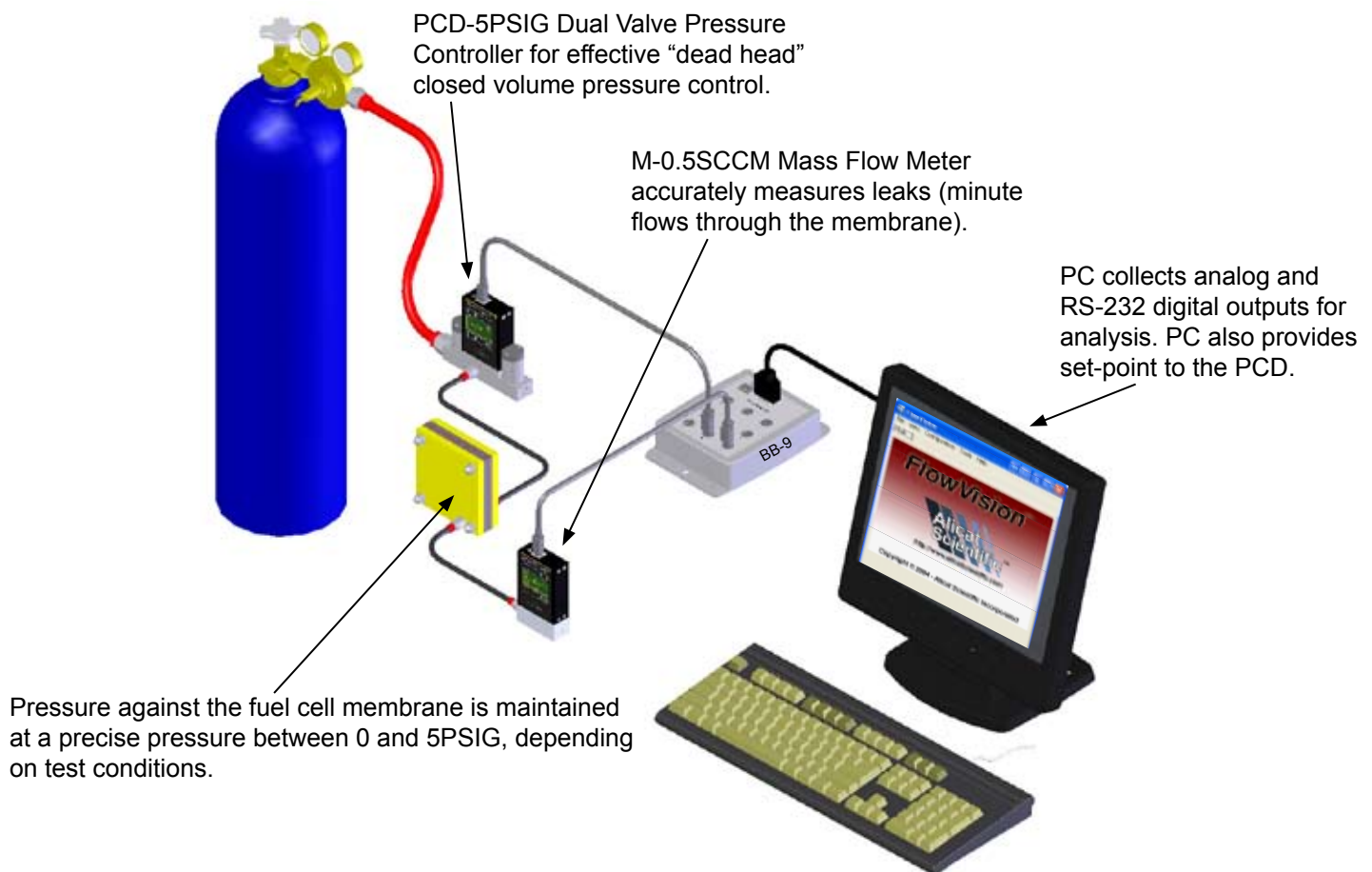
Fuel Cell SOFC Testing

This system is used to increase reliability, repeatability and speed of leak tests on Solid Oxide Fuel Cell (SOFC) membranes. The membrane is for use with Hydrogen but the test is performed with safer helium gas.

The dual valve pressure controller (PCD) replaces the manual pressure regulator. With the automatic adjustments for line pressure changes, the PCD introduced precise pressure control that is highly repeatable between facilities.

The micro flow mass flow meter (MFM) was installed in place of a bubble meter. Using a MFM allows for automatic compensation for density effects due to line pressure and temperature changes which isn't possible with bubble meters. The fast 10ms response also allows for significant time savings over the bubble meter system for determining and isolating leak size.

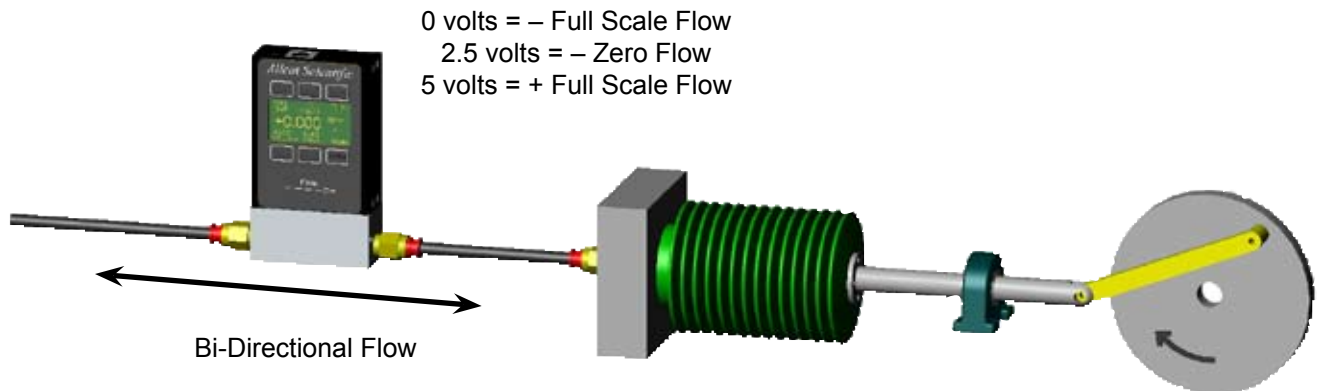
Data communication for the PCD and MFM with a single PC allows for easy automation. This customer uses intuitive Flow Vision™ software to design automated set-point tests and to automatically store the test data for later reference.



Bi-Directional Mass Flow Meters

Bi-Directional Flow — Bellows Application

The flow meter is measuring the air flow to and from a contained furnace to help in maintaining consistent temperatures. Using the bi-directional meter allows for the replacement of two individual flow meters and all the associated plumbing. The temperature and pressure signals are also incorporated as safety checks.



COMMON APPLICATIONS

Respiration Modeling:

Determining healthy lung volumes for research base lines

Veterinary Drug Research:

Providing a humane solution by allowing for dose recommendations based on lung volume x animal weight

Gas Mask Quality Checks:

Assuring capacity and throughput of protective masks for chemicals, pollution and high altitude uses

Order any Alicat M Series Mass Flow Meter with Bi-Directional Calibration and Receive:

- ▶ RS-232 Digital Output for Flow with a “-” to indicate reverse flow and “+” to indicate forward flow
- ▶ 0-5Vdc Analog Output of Flow with Direction Indication
- ▶ Local LCD with “-” and “+” Flow Direction Indication
- ▶ NIST Traceable Calibration to Full Scale Flow, Each Direction from 0.00 flow



20SLPM FS Mass Flow Meter
(shown with opt. fittings)

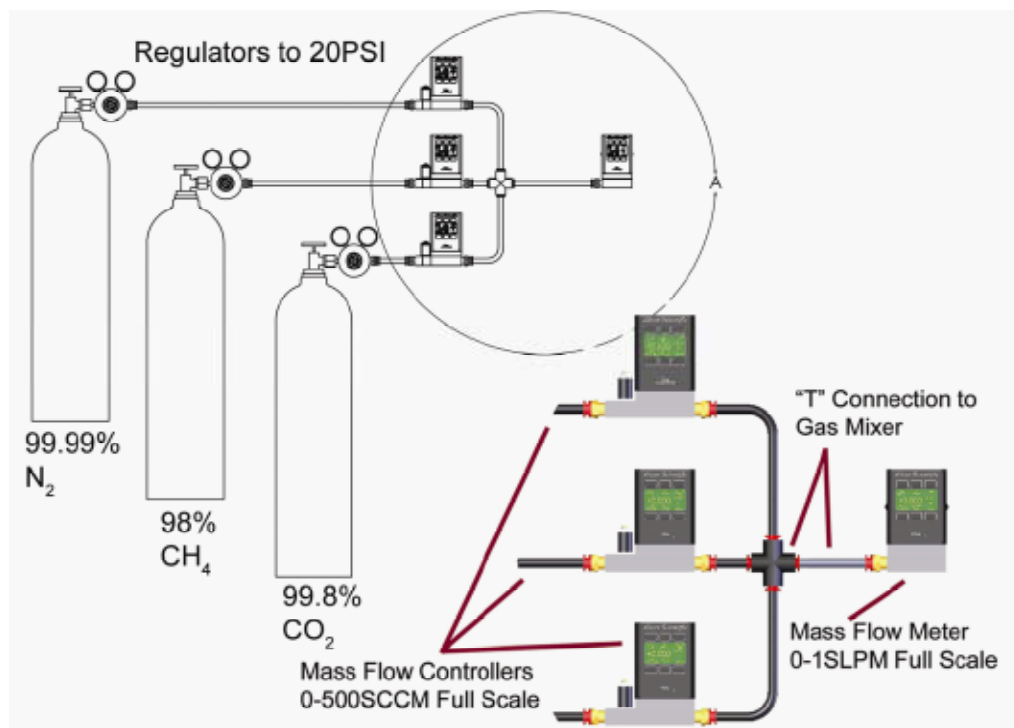
Mixed Gas Re-Metering

Some production processes gain substantial quality and yield improvements through mixed gas re-metering. Historically, there have been few technologies that can support mixed gas re-metering, particularly in flows below 20SLPM or operating at low pressures. One solution uses Alicat's mass flow meters in combination with the Wilke Semi-empirical method for mixed gas viscosity calculations. Mixed gas re-metering is different from a gas mixture calibration. In gas mixture calibrations sufficient accuracies ($\pm 1\%$ f.s.) can be obtained by using the actual gas mix in the calibration. In mixed gas re-metering the actual gas mixture is constantly changing as part of the production process.

The diagram demonstrates three mass flow controllers (MFCs) regulating gases from individual tanks into a simple mixing tube. Next a mass flow meter (MFM) re-meters the gas mix. Each MFC has been set to the appropriate pure gas calibration using the gas select screen. The MFCs are receiving their fluctuating flow control ratios by the PC. The MFM is set for N₂ as a calibration reference point. The PC reads the MFM's indicated flow and performs some simple ratio corrections to determine the actual gas flow for the mixture.

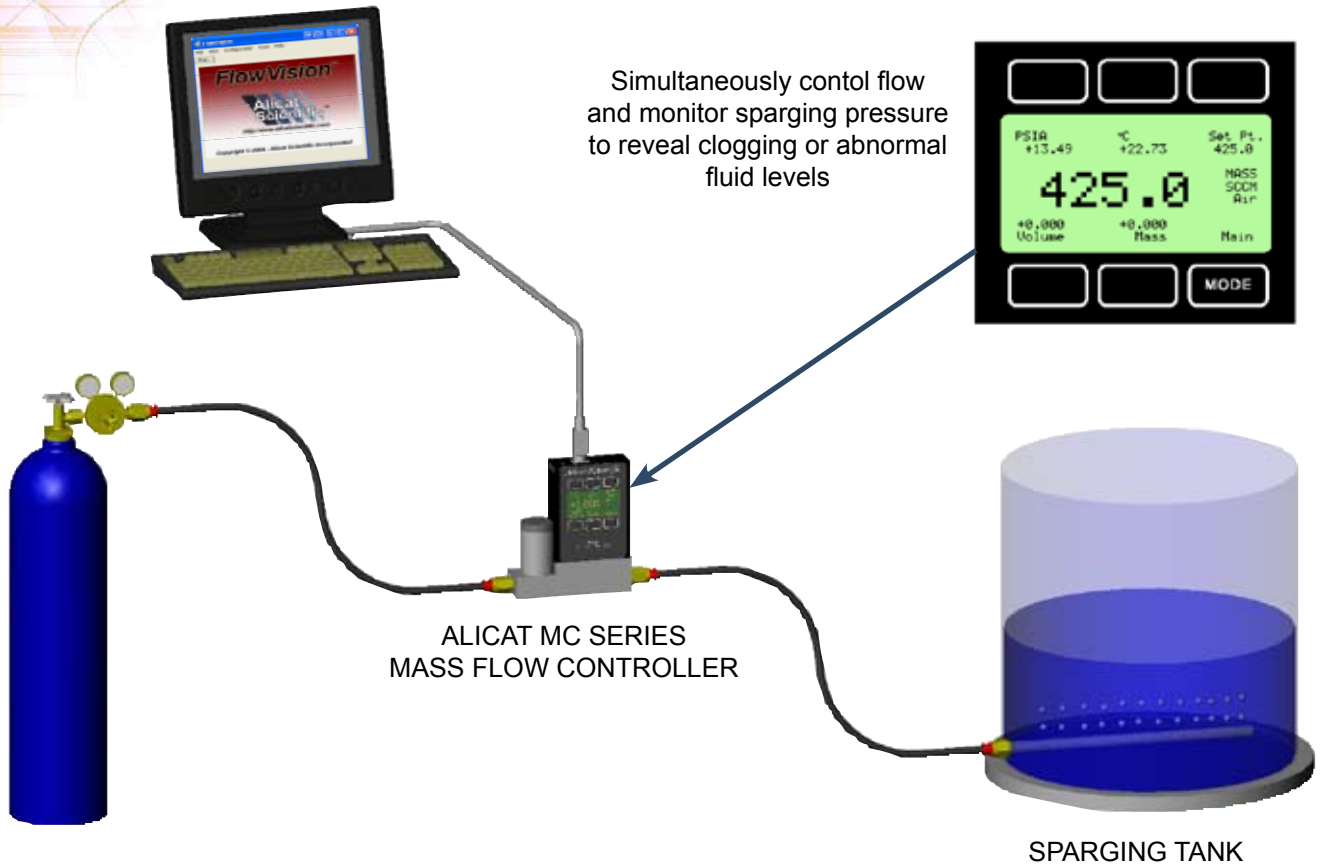
To perform the ratio corrections, the PC uses the MFC's set-points to determine the percent of each gas in the resulting mixture. Next, the computer calculates the theoretical gas mixture viscosity using Wilke's equation. Finally, the PC determines the actual gas flow by performing a simple viscosity ratio correction on the indicated flow:

Actual Flow = Indicated Flow at N₂ Viscosity / Calculated Mix Viscosity



Laboratory tests have demonstrated an overall $\pm 3\%$ of reading accuracy for this technique. The engineers at Alicat Scientific have spreadsheets with the appropriate Wilke's calculations and viscosity look-up tables to simplify incorporating this method into an existing field PC. It should be noted that Wilke's method works best on gases operating below 125PSIG and 50°Celsius. It is possible to use methods other than the Wilke's equation for a re-metering system. When incorporating Alicat mass flow devices, it is crucial that the alternate mathematical model solves for viscosity, not thermal coefficients.

Product Sparging



Sparging is a process where a gas is placed in contact with a product to achieve a variety of results. The sparging bar has many fine holes through which the gas is transferred into the product in the sparging tank. Maintaining a constant flow rate is crucial in order to obtain the desired results. A mass flow controller can insure a constant flow rate as the level of product changes or the sparging bar becomes clogged, allowing a high level of quality to be maintained.

Sparging is done with many different gases in applications such as:

- Air (to increase volume)
- Nitrogen (to remove water)
- Carbon Dioxide (to carbonate or decrease Ph)
- Hydrogen (to hydrogenate)
- Oxygen (to oxidize)

Alicat's MC Series Mass Flow Controllers are highly suitable for each of these purposes. The MCs provide local control and read out or they can interface directly with recording or control hardware via RS-232.

Product Sparging – (MC100SLPM-D-5M,RIN)

Reliable Air Delivery for Automated Liquid Paint Application

Robotic painting, one of the sectors within the Coatings Industry, has several applications in which mass flow is critical to paint application and control. In a typical application, paint is dispensed at the end of a robotic painting arm that articulates close to the surface, following the contours of the paint target (e.g. truck or car bodies). Spinning bells and pressurized guns are the final step in dispensing of the paint.

The liquid paint is atomized using a jet of air. The ratio of air to paint affects the atomization of the spray pattern, its consistency in application and the overall finish. The control of shaping air is critical to control of the pattern. Maintaining accurate, repeatable and fast response control over the air flow is essential to the overall paint job quality and minimizing over painting, thereby reducing costs on every part painted.

Alicat Scientific has developed several products for use in robotics applications, and as field tools when installing or trouble shooting an existing system. The multiple parameter outputs, either via RS-232 or secondary analog, are available for integration into the PLC operating parameters. This information can be used within the PLC to provide additional functions and to eliminate the cost of additional components. For example, line pressure can be critical to proper operation of the robots and for an early indication of a failure in the delivery systems. The Alicat mass flow meter's pressure signal eliminates the initial cost and maintenance of a separate pressure gauge. To further facilitate the use of these units as a replacement component, it may also be configured to provide a secondary parameter via an independent, digital or analog output signal.

The most popular models for this use are:

M Series Meters:

Guns: M-250SLPM-D-I /5M

M-500SLPM-D-I /5M

Bells: M-500SLPM-D-I /5M

M-1000SLPM-D-I /5M



MC Series Controllers:

MC-250SLPM-D-I /5M

MC-1000SLPM-D-I /5M

In-House Check of Gas Chromatograph Operation

In gas chromatographs (GCs) materials are detected at molecular level by preparing a sample of the material that is “carried” on a gas stream into the GC. The carrier gas flow stream is sent into small capillary flow tubes and then into detectors to sense and quantify the suspected materials. These carrier and capillary flow rates are critical to the correct performance of the gas chromatograph. The flow rates and pressures through the various gas flow paths vary by manufacturer’s specifications.

Alicat Scientific has recognized the need for an accurate and versatile device that is capable of verifying these critical aspects of a GC’s performance, for multiple gases, and pressures. The Alicat mass meter M series with optional battery pack creates a portable flow measurement device for each of these parameters. The multifunctional graphical display is the heart of Alicat’s ideal fit for this application.

The display features combine to provide multiple benefits in one compact device:

- Calibration for more than 20 of the most common gases
- Verification of mass measurement on the input and vent of the GC
- Verification of volumetric measurement on the vent of the GC
- Verification of the pressure on the inlet and vent of the GC

The application of the Alicat meter as a tool to verify correct operation of a GC is further augmented by the attributes of Alicat gas flow products, including:

- \pm (0.8% of Reading + 0.2% of Full Scale) Accuracy for precise measurements
- \pm 0.2% Full Scale Repeatability for consistent measurements
- 10mS or faster response to changes in flow, pressure or temperature
- 100:1 Turndown Ratio allows one unit to cover both the capillary and carrier gas flow ranges
- RS-232 Serial Output of all four parameters and selected gas for data logging to any PC, PDA or other device with HyperTerminal® capacity.

With the multiple features built into one, compact, portable device, the Alicat can be an invaluable tool in the verification of demanding and critical GC analysis.

The most popular models for this use are:

M Series Meters: M-20SCCM-D /5M with BPACK
M-500SCCM-D /5M with BPACK



**M-20SCCM-D
w/ optional fittings and BPACK**

Approximate Weights

For approximate shipping weight add 0.2lb to each unit for packaging.

Description	Weight	Description	Weight
M & V Series Meters		P Series Gauges	
0.5SCCM to 50SCCM	0.8lb	All Standard Ranges	1.0lb
100SCCM to 20SLPM	1.0lb	PC Series Controllers	
50SLPM	2.2lb	All Standard Ranges	1.2lb
100SLPM	2.4lb	PCR Series Controllers	
250SLPM	3.2lb	All Standard Ranges	4.8lb
500SLPM to 1500SLPM	3.0lb	PCD Series Controllers	
MC & VC Series Controllers		All Standard Ranges	1.4
0.5SCCM to 50SCCM	1.1lb	Accessories	
100SCCM to 20SLPM	1.2lb	ac to 12Vdc power supply PVPS	0.6lb
50SLPM	6.4lb	ac to 24Vdc power supply PVPS24	1.8lb
100SLPM	6.4lb	European 12Vdc power supply PVPSE	1.0lb
250SLPM	8.3lb	European 24Vdc power supply PVPSE24	2.4lb
MCR - 500SLPM to 1500SLPM	9.0lb	Cables DC-61, DC-62, DC-6RT	0.2lb
L Series Meters		Cables DC-251, DC-252	0.6lb
0.5CCM to 1CCM	1.0lb	Cable MD8DB9	0.1lb
2CCM to 1LPM	1.3lb	Industrial Connector Cable IC10	0.2lb
2LPM to 10LPM	2.2lb	Local Set-Point Module LSPM	0.2lb
LC Series Controllers		Battery Pack BPACK	0.2lb
50CCM to 500CCM	1.2lb	RS-232 to RS-485 Converter	0.2lb
LCR - 1LPM to 5LPM	6.8lb.	BB-9 Multi-Drop Box	1.0LB

Flow Conversions:

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

Pressure Conversions:

PSI	1.00	=	51.7150	mmHg
PSI	1.00	=	2.0360	inHg
PSI	1.00	=	27.7080	inH2O
PSI	1.00	=	68.9480	mbar
PSI	100.00	=	6.8046	atm
PSI	1.00	=	51.7150	torr
PSI	1.00	=	6.8948	kPa
mmHg	100.00	=	3.9370	inHg
mmHg	100	=	1.9337	PSI
inHg	100	=	49.1159	PSI
inH2O	100	=	3.6091	PSI
mbar	100	=	1.4504	PSI
atm	1	=	14.6959	PSI
torr	100	=	1.9337	PSI
kPa	100	=	14.5037	PSI
inHg	1	=	25.4000	mmHg

Conversion Calculators
available at
www.alicatscientific.com "Support"

Have You Considered Cost of Ownership?

Before purchasing anything you need to be concerned about the cost of ownership along with the cost of the product itself.

If two different MFCs from two different manufacturers have similar technological attributes, you might be persuaded to purchase the less expensive of the two. But is that always the right choice? **How long do you expect to use the product and how much support will it require to maintain?**

All we ask at Alicat is that you consider the whole package before making a decision.

Alicat products are affordable **with quick delivery (2 weeks or less)**. We are well known for our **excellent technical support**. But you may not be aware of our **low cost recalibration (\$175) and short turnaround (repairs usually shipped within 3-5 days of receipt)**. How much will that save you over the life of your instrument? Combine that with unparalleled standard features and you have an impressive package.

And we back our products with the industry's first lifetime warranty!

Call us today so we can help you choose the right product that will work for you now and into the future.



Alicat Scientific, Inc. is ISO 9001/2000 certified.



All Alicat products are calibrated with NIST traceable certification.



Alicat products in compliance with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) carry the CE Mark.

Alicat Scientific, Inc.'s Wide-Range Laminar Flow Element Patent:

The wide-range laminar flow element and products using the wide-range laminar flow element are covered by U.S. Patent Number: 5,511,416. Manufacture or use of the wide-range laminar flow element in products other than Alicat Scientific products or other products licensed under such patents will be deemed an infringement.