

Mass Flow for Bioreactors

BUYER'S GUIDE



Introduction

Alicat Scientific mass flow meters and controllers are highly configurable – during our last count, we lost track at 10^{34} configurations. This gives our customers and partners the ability to customize their devices to meet specific application needs. For bioprocessing applications, this includes designing devices for mass flow for bioreactors with a focus on scalability and working within a highly controlled regulatory framework.

In this guide, we give an overview of how Alicats are used in bioprocessing, then compare three series of Alicats and recommend devices for various settings and applications – benchtop research, pilot facilities, and GMP commercial production.

As always, you can call, chat online, email, or fill out a form to describe your application in more depth and get a recommendation from our applications engineering team.

Alicats in bioprocessing

All Alicat devices calculate mass flow using differential pressure-based laminar flow technology – not thermal pressure-based technology. This provides some important advantages:

- <1 ms warmup time and <10 ms response times
- Environmental stability, not subject to fluctuations in ambient temperature or pressure (i.e. not subject to the air conditioning kicking on in the lab)
- Can handle small backsplashes (but don't flow liquid through a gas flow device)

Device comparison

There are three main product lines relevant to bioprocessing: the **M- and MC-Series** mass flow meters and controllers; the **MS- and MCS-Series** anti-corrosive mass flow meters and controllers; and the **Bio-Series** mass flow meters and controllers.

All Alicat devices and solutions come with a full lifetime warranty and support: calibration, servicing, and applications engineers ready to answer any questions you have.

Materials	M & MC Series	MS & MCS Series	Bio Series
316L stainless steel flow body	×	✓	✓
316L stainless steel sensors	×	✓	Available
316L stainless steel valve	×	Available	Available
USP Class VI elastomers	Available	Available	✓
Color	Black	Black	Silver

Specs*

Flow rate ranges	0–0.5 SCCM to 0–5000 SLPM	0–0.5 SCCM to 0–5000 SLPM	0–0.5 SCCM to 0–500 SLPM
Accuracy <i>High-accuracy calibration available</i>	10 SCCM–20 SLPM: Greater of ±0.6% of reading or ±0.1% of full scale 0.5–5 SCCM and 50–5000 SLPM: ±0.8% of reading and ±0.2% of full scale	±0.8% of reading and ±0.2% of full scale	Dependent on sensor: M(C)-Series specs with the standard sensor, and M(C)S-Series with the 316L stainless steel sensor.
Control range (turndown ratio)	0.01–100% of full scale (10,000:1)	1–100% of full scale (100:1)	Dependent on sensor (as above)

Additional features

Gas select	98 preloaded	128–130 preloaded	98–130 preloaded
Industrial communication and connectors	Available	Available	✓
ATEX/IP rating	IP40; ATEX or IP66 available	IP40; ATEX or IP66 available	IP40; ATEX or IP66 available
Oxygen cleaning	Available	Available	Available
Lead time	Standard	Standard	Extended

Differentiators

All Alicat devices have unparalleled flexibility and are fully configurable

Fast, low-cost, easy to work with, and fully configurable

Meet stringent material requirements, when you aren't planning for a full integration in an industrial setting

Compliant materials, industrial connectors, and industrial communication protocols, designed for integration with system components and controllers.

* Refer to the appropriate spec sheet for the most up-to-date information

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Notes on Scalability

Standard Alicat devices are repeatable down to 0.01% of full scale and are available for a wide range of flows. This means that only a small number of Alicats are needed for all flows from the low mL/min flows for 1 L bioreactors to the large (hundreds or thousands) L/min flows for 2,000 and 20,000 L bioreactors. As single-use bioreactors have brought unprecedented flexibility and scalability to culture growths, Alicats have been able to meet the new flow needs.

Regulatory Compliance

When flowing gases into a bioreactor, the flow controllers will sit upstream of the reactor and outside of the sterile envelope, meaning that material considerations are primarily a function of local SOP, rather than FDA guidance. Alicat devices can be built with 316L stainless steel flow paths and USP Class VI Viton elastomers to meet the standard for wetted material laid out in ASME BPE-2016. Alicat devices cannot be autoclaved or put through CIP/SIP. Alicats can be cleaned using ethanol, and we recommend employing filters to alleviate concerns about particulate buildups inside the device.

M-Series mass flow meters and MC-Series mass flow controllers

M(C)-Series devices are our standard set of meters and controllers. They're reliable, repeatable, accurate, precise, and highly configurable (see the table above and the spec sheets for details). These devices are used successfully across an incredibly broad range of applications – bioprocessing, ventilator testing, chemical vapor deposition, and fuel cells to name a few, as well as in labs and metrology groups.



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MS-Series anti-corrosive mass flow meters and MCS-Series anti-corrosive mass flow controllers

M(C)S-Series devices are anti-corrosive. The flow body is made entirely of 316L stainless steel and elastomers which withstand corrosive gases. The sensors are slightly less sensitive than the standard sensors, so the operating range decreases to 100:1.

Bio-Series mass flow meters and controllers

Bio-Series meters and controllers were designed specifically for biopharmaceutical production settings. They use the core hardware and software of the M(C)- or M(C)S-Series devices, and bundle it with industrial connectors and communication protocols, so you can easily integrate the devices into your existing control systems. The Bio-Series devices come with USP Class VI elastomers and 316L stainless steel flow bodies (with various materials options for the sensors and valves), for compliance with the standard laid out in ASME BPE-2016.



Device recommendations

Benchtop research & development:

M(C)-Series

Alicat started out as a company designing lab instruments. We know that cost matters here, as does benchtop space. Maybe you're integrating the flow device with a larger control system – or maybe a USB cable is sufficient.

M(C)-Series devices enable research to move quickly and easily.

- **Accuracy, precision, and repeatability:** Alicats are accurate to $\pm 0.6\%$ of reading or $\pm 0.1\%$ of full scale (whichever is greater), and can read flows to 0.01 mL/min – ensuring the integrity of your experiments.
- **Flexibility:** Two key features set Alicats apart. Gas Select allows you to switch the device between 98 pre-loaded gases without recalibrating. The high turndown ratio and repeatability down to 0.01% of full scale means that a single flow meter or controller can handle a very wide range of flows. These two features together mean that a single Alicat flow controller can accomplish what would otherwise require multiple controllers.
- **Speed:** Get the equipment you need, when you need it. Standard Alicat devices are shipped in days or weeks, never months. We're ready for your experiment whenever you are.
- **Expertise:** You're the fermentation expert, or the biochemist, or the cell biologist, or the automation engineer. Let us handle the flows. When you call us, an engineer will answer the phone to provide the flow science expertise you need, so you can focus on your experiments.

What about material compatibility?

Any of our devices can be built with USP Class VI elastomers. If you want 316L stainless steel as well, we'd recommend M(C)S-Series devices. Although in our experience, this isn't often necessary at benchtop.

I want to integrate this into a controller, analyzer, or other existing system – does that change your recommendation?

It depends! The M(C) and M(C)S devices can easily be connected to a computer via USB, or you can use blunt-end cables with flying leads to integrate the device into your system. If you're looking for industrial protocols, we can add them on – but it also may make sense to upgrade to the Bio-Series, which comes standard with industrial communication protocols, industrial connectors, 316L stainless steel flow body, USP Class VI elastomers, and a nicer display.

Scaling, pilot phases, & small-scale production: M(C)-Series or Bio-Series

M(C)-Series devices are quite robust and can easily be configured with your choice of connectors and communications protocols. This often makes them the ideal mass flow devices, even outside of laboratory settings.

The choice between M(C)-Series and Bio-Series therefore often comes down to materials: if your process has less stringent materials requirements, if you only need USP Class VI elastomers, or if you are not looking for a full-system integration, the M(C)-Series will work for you. If you are operating in an environment in which you need USP Class VI elastomers and 316L stainless steel, the Bio-Series is likely your best option.

There are some other key differentiators: integration, aesthetics, and pricing model. Bio-Series devices come ready for integration into industrial production environments, and are likely a strong device choice if you are looking to integrate them with a full control system or even a SCADA; they are silver, while M(C)-Series devices are black; and they have bundled pricing with connectors, display, and industrial communication protocols included, while M(C)-Series devices will be priced for your specific configuration.

Large-scale, GMP manufacturing and production environments: Bio-Series

The Bio-Series uses the Alicat hardware and software cores, with a design specifically meant for bioprocessing applications. The various industrial communication protocols available mean that it will integrate smoothly with your controller system. The color display is easily readable, and includes the valve drive percentage as a redundant check on the overall system health. The wetted materials were chosen per the ASME BPE standards, and the device has industrial connectors.

None of these are quite what I need

Alicat custom and turnkey solutions can help. Nothing will excite our engineers more than the opportunity to dive into a new application and work with you to design the exact solution you need:

<https://www.alicat.com/about-us/contact-us/>

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