ADVANCED ENERGY®

Better technology. Better results.

Aera® Industrial MFC Product Guide

Innovative Control
at Work

contents

Advanced Energy's Aera® mass flow products have maintained a reputation for high quality products and superior worldwide sales, service, and support. Our pioneering developments helped us to emerge as a technology leader in industrial flow markets, including the industrial vacuum and coating industries. Today, Aera mass flow products integrate the latest in innovative technology to provide you with the ultimate in reliable, accurate, and cost-effective mass flow controllers (MFCs) and mass flow meters (MFMs) for advanced process control. Our promise to exceed expectations for quality, timeliness, and cost sets us apart from competition. We continue to deliver world-class products through dedicated research and a strong commitment to customer partnerships—giving you more security, more confidence, and more possibilities in mass flow control.

what is a mass flow controller (MFC)?

A mass flow controller is a closed-loop device that sets, measures, and controls the flow of a particular gas. Aera MFCs provide the most precise flow control at the most cost-effective price.

mass flow controller performance and reliability

MFC manufacturers go to great lengths to explain why their products should outperform others, often focusing on a few design features. But it is not enough to define MFC performance on the basis of a few parameters— today's critical processes demand MFCs that deliver outstanding performance and reliability. The primary factors include:

accuracy
The difference between the actual flow of an MFC and that of a primary standard at any set point

repeatability
Repeatability of actual flow for an MFC or from one MFC to another at any set point

linearity
Straightness of the curve of actual flow versus set point; in other words, accuracy over the entire flow range

calibration drift
The change in the curve of actual flow versus set point due to aging effects of some of the component parts that comprise an MFC

stability
The ability of an MFC to maintain stable flow levels through short-term effects, such as pressure and temperature changes, and through long-term effects, such as component-part degradation

response or settling time
The time it takes for actual flow to stabilize after a set point change

overshoot and undershoot control
Any spike or dip in the response curve of actual flow versus time

pressure change response
The time that it takes for actual flow to stabilize after a sudden change in gas input pressure

temperature change effects
The stability of flow during ambient temperature variations

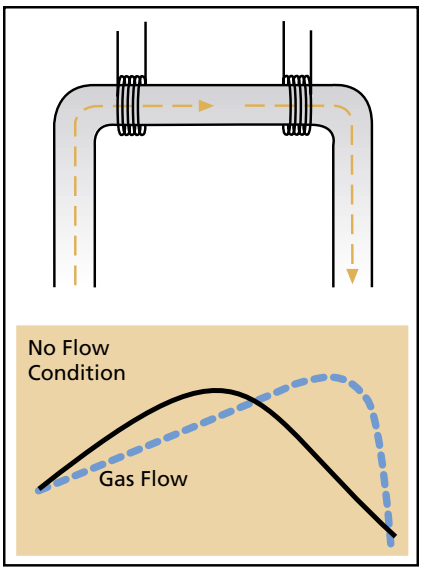
Aera MFCs offer state-of-the-art performance and reliability in *all* critical parameters.

- *Aera MFCs and MFMs have a zero drift of less than 0.5 percent of full scale over a period of one year and are guaranteed to have a zero drift of less than 1 percent of full scale over a period of one year.*
- *Aera MFCs and MFMs have the lowest return rates within one year of shipment (< 0.5 percent).*
- *Aera MFCs and MFMs are highly resistant to the effects from strong RF fields.*

fundamentals of mass flow measurement

The heart of a mass flow controller is a thermal mass flow sensor. It consists of a small bore tube with two resistance thermometer elements wound around the outside of the tube. The sensor tube is heated by applying an electric current to the elements. A constant proportion of gas flows through the sensor tube, and the cooling effect creates a temperature differential between the two elements. The temperature differential is measured as an electric signal.

The temperature differential created between the elements is dependent on the mass flow of the gas and is a function of its density, specific heat, and flow rate. Mass flow is normally calculated in terms of volume of the gas, either in standard cubic centimeters per minute (sccm) or in standard liters per minute (slm). The electronics of a mass flow controller convert mass flow into volume flow at standard conditions of 0°C (32°F) and 1 atmosphere. Because the volume of 1 mole of an ideal gas at 0°C and 1 atmosphere occupies 22.4 liters, a set point of 22.4 slm will cause 1 mole of gas to flow during 1 minute.



Sensor Temperature Profile

nomenclature

base

The base provides the platform on which all other components of the MFC are mounted and contains the channels that form the main flow path of the gas. The base is constructed of type 316L stainless steel and is precision finished. Metal or elastomer seals, depending on the application, are provided between the base and other components.

sensor

The thermal sensor is designed for quick response, long-term stability, and high reliability. The sensor tube in Aera mass flow components has a very small diameter and mass to ensure the fastest response to any change in gas flow conditions.

bypass

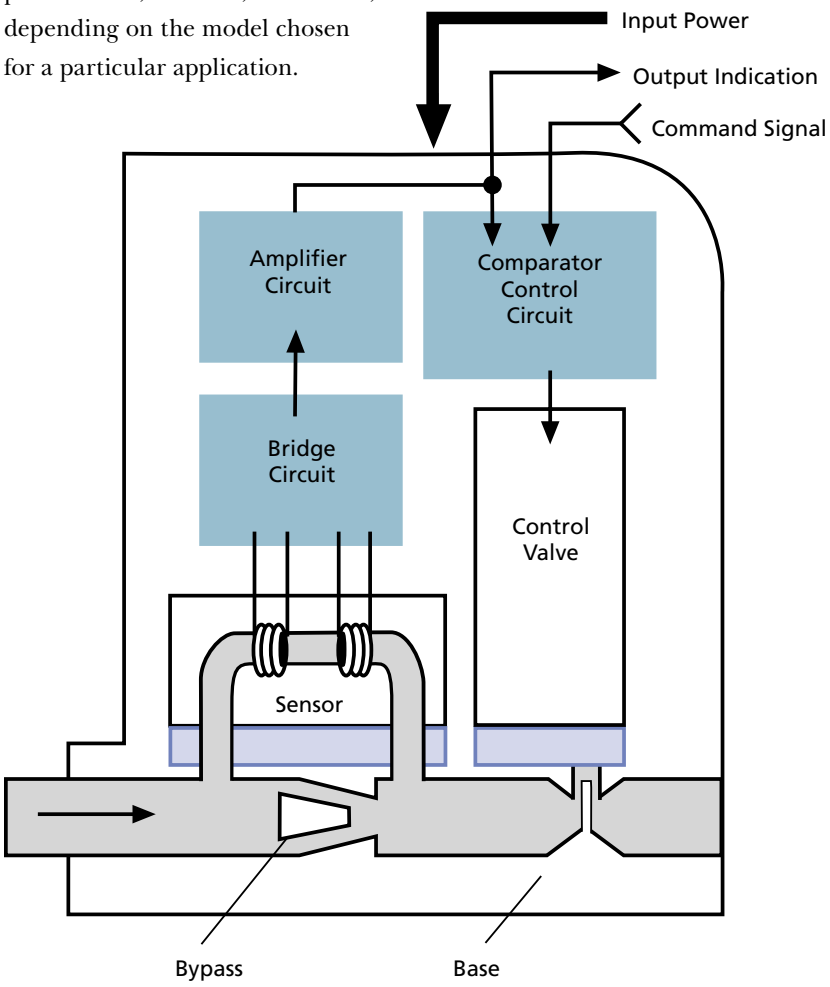
Also known as the flow splitter, the bypass maintains a constant ratio of gas flow through the sensor and main flow path, dividing the gas stream precisely over the entire calibrated flow range. As a result, the total flow can be determined by measuring just the portion of gas |that passes through the sensor.

control valve

The control valve establishes the flow of gas by responding to a signal that compares the actual flow with the set point. Actuators driving the control valve in Aera MFCs are piezoelectric, solenoid, or thermal, depending on the model chosen for a particular application.

printed circuit board

The printed circuit board is designed for optimum stability by mounting the minimum number of electronic components and using only the highest reliability components available.



operating principle

- *The bypass forces a constant proportion of the incoming gas to be fed into the sensor.*
- *The gas flow through the sensor tube causes heat to transfer from the upstream resistance-thermometer element to the downstream resistance-thermometer element.*
- *This temperature differential is linearized and amplified into a 0 to 5 volt flow output signal by a bridge circuit.*
- *The output signal is compared with the external set point signal to the mass flow controller.*
- *The error signal that results from comparing the output signal with the set point signal directs the control valve to open or close to maintain a constant flow at the set point level.*

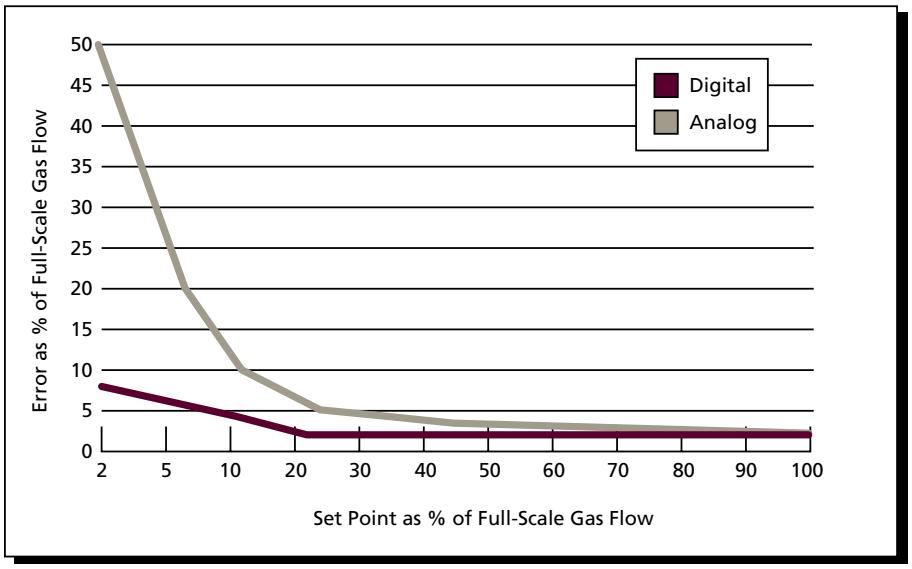
digital mass flow controller

A conventional analog mass flow controller contains an operational amplifier and an analog arithmetic control circuit. Digital MFCs convert the analog signal of the sensor output into a digital signal and have a digital CPU for subsequent data processing. Digitizing the circuitry improves response time and eliminates the drift and inaccuracies that are inherent with analog instrumentation.

set point accuracy

Analog MFC accuracy is a percentage of full-scale flow. Therefore, the flow error increases as the MFC is throttled down. The accuracy of a digital MFC is a percentage of set point from 100 percent down to 25 percent of the flow range. Digital MFCs are accurate to 1 percent of the set point down to 25 percent of the flow range and accurate to 0.25 percent of full scale below 25 percent of the flow range. Repeatability is 0.2 percent of full scale.

Aera digital MFCs (DMFCs) allow unlimited gas selection without recalibration. This capability is based on storing multiple surrogate gas calibration templates in memory, in contrast to competitive digital MFCs that store only one surrogate gas calibration curve in memory. Multiple surrogate gas calibration allows you to significantly reduce your inventory of spare MFCs since one DMFC can replace multiple MFCs.



fc-7700 series analog mass flow controller

The FC-7700 series has served as the industry standard for many applications. This series was designed for applications that require excellent performance but do not need the seal resistance of ultra-high leak integrity that metal seals provide. This series is also offered with a variety of electrical connectors that include Aera-exclusive designs, as well as other connectors that allow direct replacement of MFCs from other manufacturers.

- *Low-cost elastomer seal design*
- *High reliability*
- *Used in non-corrosive gas applications*
- *Flow ranges 10 sccm to 150 slm*

fc-7800 series analog mass flow controller

The FC-7800 series consists of metal-sealed MFCs with excellent performance that satisfies the majority of gas-control applications. This series is offered with a variety of electrical connectors, including Aera-exclusive designs as well as other connectors that allow direct replacement of MFCs from other manufacturers.

- *All-metal seal design*
- *High reliability*
- *Used in corrosive and inert gas applications*
- *Flow ranges 10 sccm to 150 slm*

3-digit series mass flow controller

The 3-digit series MFC, such as the 780/770, is based on the 7800/7700 series and has a flow control range of 2 to 100 percent of full scale. The 3-digit and 7800/7700 series are essentially identical in all other respects.

mach one™ digital mass flow controller

The revolutionary Mach One digital, pressure-based mass flow controller integrates advanced sonic nozzle technology with the ability to measure upstream line pressure and temperature.

- *All-metal seal design*
- *New, pressure-based MFC technology*
- *Used in inert gas applications*
- *High-accuracy, digital electronics with RS-485 communications*
- *Fast response*
- *Flow ranges from 10 sccm to 10 slm*

primaera® digital mass flow controller

The PrimAera is a true digital mass flow controller, designed with Aera's field-proven MFC components that have delivered outstanding performance and reliability in the field. This solid foundation, along with 21st century electronics, provides the ultimate in control and communications capability.

- *All-metal seal design*
- *Fast response*
- *DeviceNet™ communications*
- *Used in corrosive and inert gas applications*
- *Available in VCR and IGS configurations*
- *flow ranges from 10 sccm to 50 slm*

Available as gas-specific or multi-gas models. Multi-gas models allow you to select unlimited gases without recalibration, providing a significant reduction in the number of spares required.

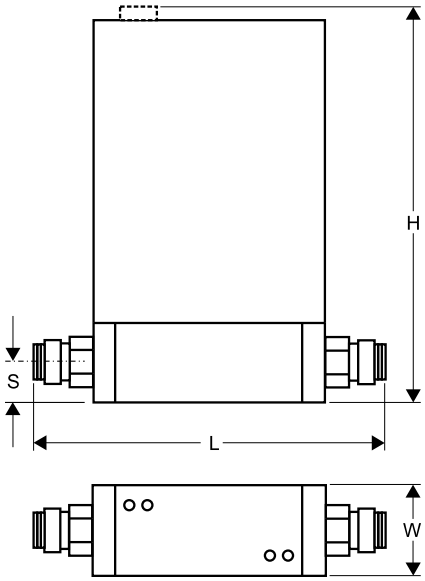
mass flow controller (MFC) product line

Model	Full-scale Flow ranges	Seals	Control Valves	Electrical Connectors	Comments	Dimensions
FC-770A/770AC	10 sccm – 5 slm	Elastomer	Solenoid	20-Pin Card Edge	All inert gases (e.g., N_2, O_2, Ar, etc.)	B
FC-7700CD	10 sccm – 5 slm	Elastomer	Solenoid	9-Pin D	All inert gases (e.g., N_2, O_2, Ar, etc.)	B
FC-771A/771C	6 slm – 30/50 slm	Elastomer	Solenoid	20-Pin Card Edge	All inert gases (e.g., N_2, O_2, Ar, etc.)	C
FC-7710CD	6 slm – 30/50 slm	Elastomer	Solenoid	9-Pin D	All inert gases (e.g., N_2, O_2, Ar, etc.)	C
FC-772/772C	35 slm –150 slm	Elastomer	Solenoid	20-Pin Aera Card Edge	All inert gases (e.g., N_2, O_2, Ar, etc.)	D
FC-780/780C	10 sccm – 5 slm	Metal	Solenoid	20-Pin Aera Card Edge	All inert & corrosive gases	B
FC-7800CD	10 sccm – 5 slm	Metal	Solenoid	9-Pin D	All inert & corrosive gases	B
FC-781/781C	6 slm – 30/50 slm	Metal	Solenoid	20-Pin Aera Card Edge	All inert & corrosive gases	C
FC-7810CD	10 sccm – 5 slm	Metal	Solenoid	9-Pin D	All inert & corrosive gases	B
FC-782/782C	35 slm – 150 slm	Metal	Solenoid	20-Pin Aera Card Edge	All inert & corrosive gases	D
FC-PN980/980C	10 sccm – 5 slm	Metal	Piezoelectric/ diaphragm	DeviceNet	Ultra-high purity applications; all inert and corrosive gasses	A
FC-PN981/981C	6 slm – 50 slm	Metal	Piezoelectric/ diaphragm	DeviceNet	Ultra-high purity applications; all inert and corrosive gasses	A
Mach One	10 sccm – 10 slm	Metal	Piezoelectric	15-Pin Sub D	All inert gases	E

C in the model code means normally closed

dimensions

	L	S	H	W
A	124 mm (4.9”)	12.7 mm (0.5”)	133 mm (5.2”)	28.6 mm (1.1”)
B	124 mm (4.9”)	12.7 mm (0.5”)	122 mm (4.8”)	32 mm (1.3”)
C	151 mm (5.9”)	19 mm (0.7”)	128 mm (5”)	38 mm (1.5”)
D	183.8 mm (7.2”)	15 mm (0.6”)	149 mm (5.9”)	38 mm (1.5”)
E	124 mm (4.9”)	12.7 mm (0.5”)	133 mm (5.2”)	38 mm (1.5”)



mass flow meter (MFM) product line

Mass flow meters differ from mass flow controllers in that they do not have a control valve or sensor output feedback circuitry. These devices are used in applications where there is a need for flow monitoring rather than flow control. Aera MFMs are available in models with elastomer or metal seals, analog or digital operation, surface-mount or VCR interfacing, and optional electropolished surfaces.

Model	Full-Scale Flow	Seals	Electrical Connectors	Distinquishing Features
FM-3700 D	10 sccm – 5 slm	Elastomer	Standard 9-Pin D	All inert gases (e.g., N_2, O_2, Ar, H_2O, etc.)
FM-3710 D	6 slm – 20 slm	Elastomer	Standard 9-Pin D	All inert gases (e.g., N_2, O_2, Ar, H_2O, etc.)
FM-390	10 sccm – 5 slm	Elastomer	Aera 20-Pin Card Edge	All inert gases (e.g., N_2, O_2, Ar, H_2O, etc.)
FM-391	6 slm – 50 slm	Elastomer	Aera 20-Pin Card Edge	All inert gases (e.g., N_2, O_2, Ar, H_2O, etc.)
FM-362J	20 slm – 400 slm	Elastomer	Aera 20-Pin Card Edge	All inert gases (e.g., N_2, O_2, Ar, H_2O, etc.)
FM-860	10 sccm – 5 slm	Metal	Aera 20-Pin Card Edge	All inert & corrosive gases
FM-861	6 slm – 20 slm	Metal	Aera 20-Pin Card Edge	All inert & corrosive gases
FM-862	20 slm – 400 slm	Metal	Aera 20-Pin Card Edge	All inert & corrosive gases
FM-8700D	10 sccm – 5 slm	Metal	Standard 9-Pin D	All inert & corrosive gases
FM-8710D	6 slm – 20 slm	Metal	Standard 9-Pin D	All inert & corrosive gases
FM-880	10 sccm – 5 slm	Metal	Aera 20-Pin D	Electropolished surfaces standard; all inert & corrosive gases
FM-D880	10 sccm – 5 slm	Metal	Aera 20-Pin D	Digital; electropolished surfaces standard; all inert & corrosive gases
FM-881	6 slm – 20 slm	Metal	Aera 20-Pin D	Electropolished surfaces standard; all inert & corrosive gases
FM-D881	6 slm – 20 slm	Metal	Aera 20-Pin D	Digital; electropolished surfaces standard; all inert & corrosive gases
FM-1000	1 sccm	Metal	Aera 20-Pin Card Edge	Ultra-low flow; all inert & corrosive gases

product configurator

Example part number	FC 980 C 4V N2 200 sccm
Example part number	FC 7800 4V 02 1000 sccm

XXXX - Full-Scale Flow Range (0 to 5000 sccm)

XX- Gas (Example: N2)

4V - 1/4'' VCR

B - (Consult Representative for Surface-Mount Availability)

C - Normally-Closed Control Valve

X - Normally-Open Control Valve

Model Number (Refer to Product Line Chart on Pages 9 and 10)

FC - Mass Flow Controller

FM - Mass Flow Meter

electrical connectors

15-Pin Sub D		
1		CHASSIS GROUND
2		-15 VDC INPUT
3		SET POINT (+) INPUT
4		FLOW RETURN
5		POWER GROUND
6		PURGE INPUT
7		POWER GROUND
8	A	RS-485
9		+15 VDC INPUT
10		POWER GROUND
11		SET POINT (-) INPUT
12		FLOW OUTPUT
13		SHUT DOWN
14		FAULT OUTPUT
15	B	RS-485

20-Pin Aera Card Edge			
1	A	1. CASE GROUND	A. CONTROL 0-5 VDC
2	B	2. COMMON	B. COMMON
3	C	3. OUTPUT 0-5 VDC	C. COMMON
4	D	4. +15 VDC	D. SOFT START
5	E	5. —	E. —
6	F	6. VALVE TEST POINT	F. 15 VDC
8	J	8. —	J. —
9	K	9. —	K. —
10	L	10. —	L. —

20-Pin Card Edge			
1	A	1. CASE GROUND	A. CONTROL 0-5 VDC
2	B	2. COMMON	B. COMMON
3	C	3. OUTPUT 0-5 VDC	C. COMMON
4	D	4. +15 VDC	D. VALVE TEST POINT
5	E	5. —	E. —
6	F	6. VALVE TEST POINT	F. 15 VDC
8	J	8. —	J. —
9	K	9. —	K. —
10	L	10. COMMON	L. VALVE CLOSE

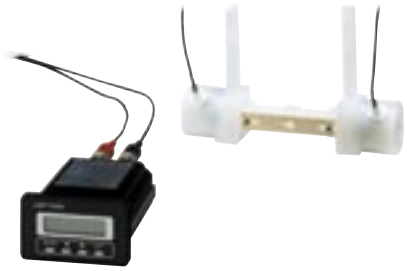
9-Pin D			
	1		1. VALVE OPEN/CLOSE
6		6. CONTROL 0-5 VDC	
	2		2. OUTPUT 0-5 VDC
7		7. COMMON	
	3		3. +15 VDC
8		8. COMMON	
	4		4. COMMON (VALVE RETURN)
9		9. VALVE TEST POINT (0-13 VDC)	
	5		5. -15 VDC

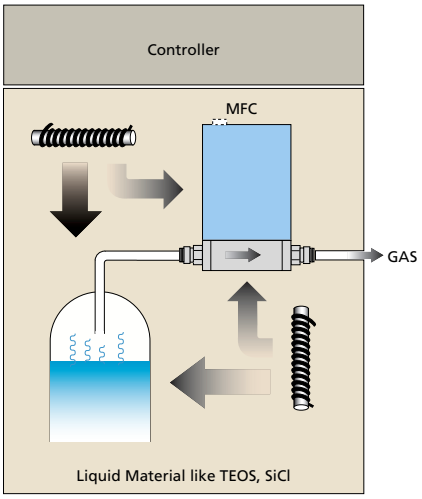
lx-1200 series liquid mass flow controller

Liquid MFCs are used in applications where the source material is a liquid but where you prefer to control the flow of the liquid rather than the flow of its heated vapor. The LX-1200 and LX-1200C do not exhibit bubble problems common to other liquid MFCs. The flow components and the flow paths are designed to prevent bubble formation or bubble retention. Typical liquids that can be delivered with the LX-1200 include TEOS, TMP, and TMB.

usf ultrasonic flow meter

The USF flow meter is ideal for monitoring the flow of high-purity liquids. All liquid-wetted areas are made of Teflon® to prevent contamination. The liquid flow is measured by ultrasound, offering a complete non-contact flow measurement in real time. Flow meters are available for flow ranges from 50 milliliters up to 50 liters per minute.





aera thermal vaporizer system

Aera thermal vaporizer systems are suitable for supplying a precise flow of liquid vapor to a process chamber. This is achieved by vaporizing the liquid source in a tank. The vaporized liquid is then controlled by an accurate, high-temperature mass flow controller. The chamber of the thermal vaporizer is heated to prevent liquid re-condensation in the piping. Liquids to be used with systems include TEOS, $SiCl_4$, WF_6, HDMSO, and H_2O.

as-70/71, as-60a compact thermal vaporizer systems

The AS-70/71 series systems were designed as compact vaporizers to be assembled into equipment. Miniaturization was achieved by eliminating the operation panel and other parts and by supplying only the basic functions. All gas-wetted surfaces in the AS-70/71 are electropolished and ultra-cleaned. An optional control panel, the AL-70 is also available. The AL-70 indicates temperature, prescribes and indicates flow rate, and controls the system's alarms. The AS-60A is available for vapor delivery of H_2O.

The AL-70 is a separate purchase option.

gs-440a large-capacity thermal vaporizer systems

The GS-440A was designed as a thermal vaporizer system for processes that require large quantities of vaporized liquids, such as in the optical fiber and synthetic silica industries. Although the basic technology is similar to that of smaller-capacity systems, the GS-440 can supply vapor for up to six lines simultaneously at 90 g/min. each. The vaporizer enclosure is designed for easy maintenance and is gold plated to prevent corrosion.

pr 100/200 pressure controller (regulator)

The PR-100/200 series consists of pressure controllers that regulate the pressure of a gas in gas lines leading to or from a process chamber. The pressure controllers consist of a servo valve, pressure sensor, and control electronics. They are available in various configurations that include normally-open, normally-closed, upstream pressure control, downstream pressure control, absolute pressure control, gauge pressure control, internal pressure sensor control, and external pressure sensor control.

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