649B

Electronic Pressure Controller with Mass Flow Meter

The 649B provides both pressure control and flow metering. The 649 replaces multiple component subassemblies, for example pressure controllers with separate flow meters used in applications such as backside wafer cooling systems (BWCS). The compact 649 design allows for significant reduction in BWCS size and complexity.

The 649 Series Pressure Controller contains a capacitance manometer, mass flow meter, normally-closed proportioning control valve, and closed-loop control electronics. The 649 controls absolute pressure. The pressure transducer is a Baratron® Capacitance Manometer, with Full Scale pressure ranges from 10 Torr to 1000 Torr. Baratron Capacitance Manometers – well-known for their percent of Reading accuracy, stability, and resolution – provide precise measurements at lower pressures and over wider dynamic ranges than strain gage transducers. The patented mass flow sensor provides exceptional zero stability and accuracy of flow measurement. Full Scale ranges from 10 sccm to 5000 sccm nitrogen equivalent are available.

The 649 is powered by ±15 VDC at only 300 mA. The default pressure output and input control signals are 0-10 VDC. Two trip points are included in the 649, with LED status indicators, for use as simple on/off process limits. The 649's control loop tuning parameters are preset for typical installation conditions, but are field adjustable for different conditions and optimum performance. The Proportional and Integral Term adjustments are simple rotary switches, providing a wide dynamic control range.

In the 649, a pressure transducer monitors the pressure to be controlled at the downstream end of the controller. Actual pressure is compared in the electronics to the pressure set point signal. An appropriate signal is then generated to adjust the proportioning control valve to bring actual pressure into agreement with the desired set point. The internal control valve can be specified with one of four orifices allowing pressure control in systems with Full Scale flows from 10 sccm to 5 slm.

Product Features

- Backside wafer cooling
- Metal-sealed, cleanroom manufactured units meet critical high purity application needs
- Patented mass flow sensor* provides exceptional long-term accuracy and zero stability
- Integral pressure measurement and control with flow metering in a single package requires less space and reduces system cost

*US Patent 5461913. Foreign patent pending.

Key Benefits

- Integral Baratron capacitance manometer provides accuracy, reliability, and wide range
- Fast response to set point with minimal overshoot
- Two alarm trip points for process limit control

Inlet Pressure (psia)	Differential Pressure (psi)									Inlet Pressure (Torr)
	>50	50	30	15	8	4	2	1	0.5	
100	>585	585	480	355	265	190	135	95	65	5170
50	–	295	295	240	185	130	95	65	50	2585
30	–	–	175	175	140	100	75	50	40	1551
20	–	–	–	115	110	80	60	40	30	1034
15	–	–	–	90	90	70	50	35	25	776
10	–	–	–	–	60	55	40	30	20	517
5	–	–	–	–	–	30	25	20	15	259
2	–	–	–	–	–	–	10	10	9	103
1	–	–	–	–	–	–	–	6	6	51.7
	>2585	2585	1551	776	414	207	103	51.7	25.9	
	Differential Pressure (Torr)									

Figure 1 — Index Number Table (See Note)

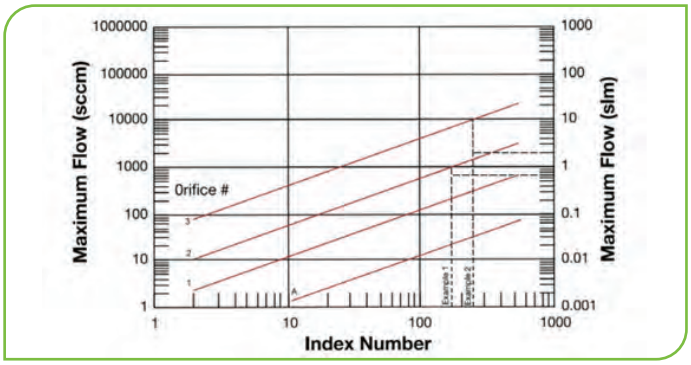


Figure 2 — Orifice Selection Graph (See Note)

Pressure Range

In the 649 Controller, the Baratron® Pressure Transducer measures absolute pressure. Full Scale ranges of 10, 100, or 1000 Torr are available. Each 649 can control pressure from Full Scale to less than 2% of Full Scale. Prudent design suggests choosing the lowest possible Full Scale for the application, taking into consideration the overpressure to which the sensor may be exposed (both normal and accidental).

Valve Orifice

The flow through any orifice depends on the size of the orifice, the inlet and outlet pressures, and gas density. To simplify 649 orifice selection, use the following procedure:

1. On the Index Number Table in Figure 1, choose your inlet pressure from the column of pressures on the left–the pressure that will be applied to the inlet of your 649. (Note that the values are absolute pressure.)

   Next, from the row of pressures at the top of that table, select your differential (delta) pressure – this is the inlet pressure minus your outlet pressure.

   Locate the Index Number – where your selected row and column intersect.

2. If you are using N_2, skip to step #3. For other gases, calculate the Density Correction Factor (DCF) by the following formula:

   $$DCF = \sqrt{\frac{N_2 \text{ Density}}{\text{User Gas Density}}}$$

   Multiply this Density Correction Factor times the Index Number found in step 3, to determine your density-corrected Index Number.

3. Go to the Orifice Selection Graph (Figure 2) and locate your Index Number along the bottom axis. Draw a vertical line at your Index Number. This line will intersect with the Max. Flow Rate lines for available valve orifices. Choose the orifice whose maximum flow rate exceeds your requirements.

Example 1

You want to control your process pressure at 5 psia, with a flow rate of 750 sccm of N_2. Your inlet pressure is 15 psig (30 psia), giving a differential pressure (delta P) of 25 psi. Your delta P of 25 psi gives an Index Number value of 175. Drawing a vertical line on the Orifice Selection Chart at 175 indicates that Orifice #2 would be the best choice.

Example 2

You want to control a vacuum process at a pressure of 0.5 psia, with a flow rate of 2000 sccm of He. Your inlet pressure is 15 psia, giving a differential pressure (delta P) of 15 psi, resulting in an uncorrected Index Number value of 90. The gas density correction for He is calculated as

$$\sqrt{N_2 \text{ density/He density}} = \sqrt{1.250/0.179} = 2.6.$$

Multiplying 2.6 by 90 gives a density-corrected Index Number of 234. Drawing a vertical line on the Orifice Selection Chart at 234 indicates Orifice #3 would be the best choice.

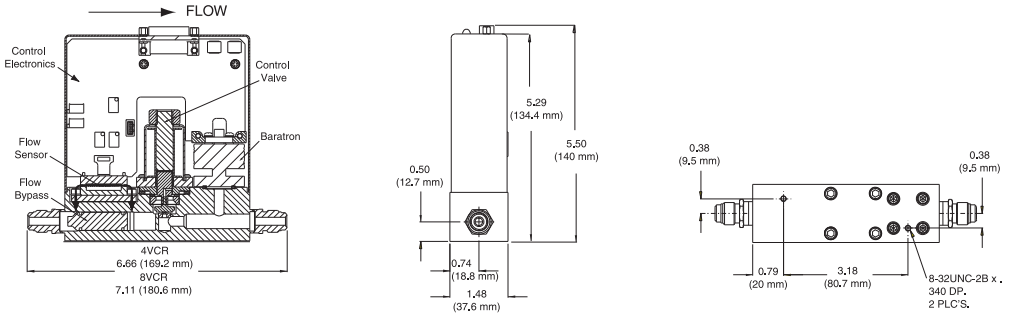
Note: The above procedure is provided as a reference guide to sizing the orifice for most typical applications. To assure proper orifice size selection for the specific application conditions, particularly those where the procedure results in an orifice selection near the limit lines in the graph, please contact our Applications Engineers for assistance in selecting the proper valve orifice.

Specifications		
Pressure Controller Type		649B
Pressure Ranges (Full Scale)		10, 20, 50, 100, 1000 mmHg (Torr)
Flow Ranges (Full Scale)		10, 20, 50, 100, 200, 500, 1000, 2000, 5000 sccm
Transducer Overpressure Limit		45 psia or 2x Full Scale, whichever is greater
Orifice Full Scale Ranges		50, 200, 1000, 5000 sccm (nominal F.S. flow rates for N_2 with 15 psig on inlet and atmospheric pressure on outlet)
Maximum Differential Pressure		150 psi (consistent with transducer overpressure limit)
Pressure Control Mode		Downstream
Pressure Reading	**Accuracy** **Temp. Coefficients** **Time Response**	• ±0.5% of Reading (includes linearity, hysteresis, and repeatability) • Zero: ±0.04% of Full Scale/°C • Span: ±0.04% of Reading/°C • <100 msec
Pressure Control	**Range** **Accuracy** **Time Response**	• 2 to 100% of Full Scale • ±0.2% of Full Scale • 1.0 sec (excluding system time constant)
Flow Reading	**Measurement Range** **Accuracy** **Repeatability** **Resolution** **Temperature Coefficients** **Pressure Coefficient**	• 1% to 100% of Full Scale • ±1.0% of Full Scale (including non-linearity, hysteresis, and non-repeatability referenced to 760 mmHg and 0°C) • ±0.2% of Full Scale • 0.1% of Full Scale • Zero: < 0.05% of Full Scale/°C • Span: < 0.08% of Reading./°C • <0.02% of Reading./psi
Meter Warm-up Time		<2 min
Meter Response Time		<100 msec
Operating Temperature		0° to 50°C (32° to 122°F)
Storage Temperature		-20° to 80°C (-4° to 176°F)
Power Required		±15 VDC ±5%, 300 mA max.
Input/Output Signals	**Pressure** **Flow**	• 0-10 VDC, standard (0-5 VDC optional) • 0-5 VDC
Connector		15-pin male Type “D”
Cable Length		100 ft. (30 m) max.
RFI Sensitivity		SAMA 33.1, 1-abc: <0.2% of Full Scale
Trip Points	**Pressure** **Rated** **Adjustable** **Hysteresis** **Indicators**	• Two open-collector transistors • 250 mA @ 30 VDC • 1 to 100% of Full Scale • 3% of Full Scale • Green LEDs on when actuated
Compliance		CE
Materials Exposed to Gas	**Standard (metal sealed)** **Optional (valve plug)**	• 316L S.S., 316L/VAR S.S., Inconel®, Nickel • Viton®, Kalrez®, Kel-F®, or metal
Leak Integrity	**External** **Internal (through closed valve)***	• $<10^{-9}$ scc/sec He • Elastomer valve: $<10^{-3}$ scc/sec He • Kel-F/metal valve: <2% of Full Scale (N_2 @ 25 psig to atm)
Fittings (compatible with)		Male Swagelok® 4 VCR®, 8 VCR
Dimensions		1.5'' (38.1 mm) x 6.66'' (169.2 mm) (4 VCR) x 5.50'' (140 mm) max.
Weight		3.5 lbs. (1.59 kg)

Note: The 649 Series controllers require flow to operate, but will not control pressure in “dead-ended” (zero flow) applications.
**649 Control Valves should not be used for positive shutoff. Where positive shutoff is required, a separate valve should be installed. When selecting the location of an external shutoff valve, consideration should be given to the maximum pressure rating of the internal transducer and to the possibility that leakage across the internal valve over time can build up and result in a sudden surge of gas.*

Ordering Code Example: 649B00413T12C2VR	Code	Configuration
Pressure Controller		
649 Electronic Pressure Controller with MFM	649B	649B
Gas		
Helium (He) Argon (Ar) Hydrogen (H_2) Nitrogen (N_2)	001 004 007 013	004
Pressure Range Full Scale		
10 Torr (mmHg) 20 Torr (mmHg) 50 Torr (mmHg) 100 Torr (mmHg) 1000 Torr (mmHg)	11T 21T 51T 12T 13T	13T
Flow Rate		
10 sccm 20 sccm 50 sccm 100 sccm 200 sccm 500 sccm 1000 sccm 2000 sccm 5000 sccm	11C 21C 51C 12C 22C 52C 13C 23C 53C	12C
Valve Orifice (nominal Full Scale flow range for N_2 at 1 atm DP)		
A (50 sccm) #1 (200 sccm) #2 (1000 sccm) #3 (5000 sccm)	A 1 2 3	2
Valve Plug Material		
Viton Kalrez Metal* Kel-F	V D M F	V
Fittings (compatible with)		
Swagelok 4 VCR male Swagelok 8 VCR male	R T	R

** Metal valve plug available on 200 sccm and larger valve orifice*



Dimensional Drawing — Note: Unless otherwise specified, dimensions are nominal values in inches (mm referenced).

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