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Valve Solutions

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649B

ELECTRONIC PRESSURE CONTROLLER WITH MASS-FLO® 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 down-stream 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.

Features & Benefits

Designed For The Most Demanding Processes

- Backside wafer cooling
- Fast response to set point with minimal overshoot
- Metal-sealed, cleanroom manufactured units meet critical high purity application needs

Reliable, Rugged, Repeatable

- Integral Baratron® Capacitance Manometer provides accuracy, reliability, and wide range
- Patented mass flow sensor* provides exceptional long-term accuracy and zero stability

Easily Integrated

- Integral pressure measurement and control with flow metering in a single package requires less space and reduces system cost
- Two alarm trip points for process limit control

US Patent 5461913. Foreign patent pending.

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 (250 Torr), with a maximum flow rate of 1000 sccm of N_2. The process connections are 4VCR and a Viton valve plug is specified. Your inlet pressure is 15 psig (30 psia) giving a differential pressure (delta P) of 25 psi. Approximating your differential pressure as 30 psi gives an Index Number of 175. Drawing a vertical line on the Orifice Selection Chart at 175 indicates that a #2 orifice would be the best choice for the application. The P/N for this model is 649B01313T13C2VR.

Inlet Pressure (psia)	Differential Pressure (psi) >50	50	30	15	8	4	2	1	0.5	Inlet Pressure (Torr)
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)

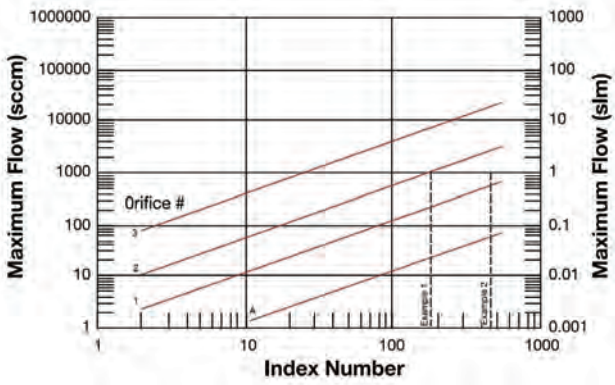

Figure 2 — Orifice Selection Graph (See Note)

Example 2

You want to control your process pressure at 5 Torr (0.1 psia), with a maximum flow rate of 100 sccm He. The process connections are 8VCR and a Viton valve plug is specified. Your inlet pressure is 15 psig (30 psia) giving a differential pressure (delta P) of 30 psi. Approximating your differential pressure as 30 psi again gives an uncorrected Index Number of 175. The density of N_2 is 1.25 and the density of He is 0.179 giving a Density Correction Factor of 2.6. Multiplying the uncorrected Index Number by the Density Correction Factor gives a density corrected Index Number of 455. Drawing a vertical line on the Orifice Selection Chart at 455 indicates that a size 1 orifice would be the best choice for the application. The P/N for this model is 649B00111T12C1VT.

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 Scales)	10, 20, 50, 100, 1000 mmHg (Torr)
Flow Ranges (Full Scales)	10, 20, 50, 100, 200, 500, 1000, 2000, 5000 sccm
Transducer Overpressure Limit	45 psia or 2x F.S., 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	±0.5% of Reading (includes linearity, hysteresis, and repeatability)
Temp. Coefficients	Zero: ±0.04% of F.S./°C Span: ±0.04% of Reading/°C
Time Response	<100 msec
Pressure Control	
Range	2 to 100% of F.S.
Accuracy	±0.2% of F.S.
Time Response	1.0 sec (excluding system time constant)
Flow Reading	
Measurement Range	1% to 100% of F.S.
Accuracy (including non-linearity, hysteresis, and non-repeatability referenced to 760 mmHg and 0°C)	±1.0% of F.S.
Repeatability	±0.2% of F.S.
Resolution	0.1% of F.S.
Temperature Coefficients	Zero: < 0.05% of F.S./°C Span: < 0.08% of Rdg./°C
Pressure Coefficient	<0.02% of Rdg./psi
Meter Warm-up Time (w/in 0.2% of F.S. steady state)	<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: 0-10 VDC default (user settable to 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 F.S.
Trip Points	
Pressure	Two open-collector transistors
Rated	250 mA @ 30 VDC
Adjustable	1 to 100% of F.S.
Hysteresis	3% of F.S.
Indicators	Green LED’s on when actuated
Compliance	CE
Materials Exposed to Gas	
Standard (metal sealed)	316L S.S., 316L/VAR S.S., Inconel®, Nickel
Optional (valve plug)	Viton®, Kalrez®, Kel-F®, or metal
Leak Integrity	
External	$< 10^{-9}$ scc/sec He
Internal (through closed valve)*	Elastomer valve: $< 10^{-3}$ scc/sec He Kel-F/metal valve: < 2% of F.S. (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 Information

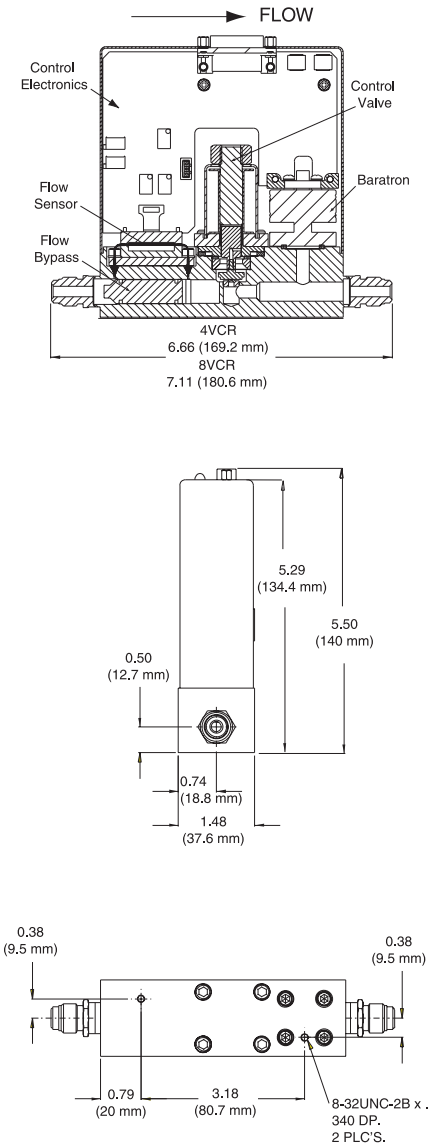

Figure 3 —

Cross section diagram.
Note: unless otherwise specified, dimensions are nominal values in inches (mm referenced).

Ordering Code Example: 649B00413T12C2VR	Code	Configuration
649 Electronic Pressure Controller with MFM	649B	649B
Gas		
Helium (He)	001	004
Argon (Ar)	004	
Hydrogen (H_2)	007	
Nitrogen (N_2)	013	
Pressure Range Full Scale		
10 Torr (mmHg)	11T	13T
20 Torr (mmHg)	21T	
50 Torr (mmHg)	51T	
100 Torr (mmHg)	12T	
1000 Torr (mmHg)	13T	
Flow Rate		
10 sccm	11C	12C
20 sccm	21C	
50 sccm	51C	
100 sccm	12C	
200 sccm	22C	
500 sccm	52C	
1000 sccm	13C	
2000 sccm	23C	
5000 sccm	53C	
Valve Orifice (nominal F.S. flow range for N_2 at 1 atm. DP)		
A (50 sccm)	A	2
#1 (200 sccm)	1	
#2 (1000 sccm)	2	
#3 (5000 sccm)	3	
Valve Plug Material		
Viton	V	V
Kalrez	D	
Metal*	M	
Kel-F	F	
Fittings (compatible with)		
Swagelok 4 VCR male	R	R
Swagelok 8 VCR male	T	
Optional Accessories		
246 single-channel power supply/readout/set point control		246C
247C four-channel power supply/readout/set point control		247D
649 Y cable		CB649-1-M1

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

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