DPC

Dual-Zone Pressure Controller

The Dual-Zone Pressure Controller (DPC) is a highly integrated closed-loop pressure control subsystem. It consists of an inlet pneumatic shut-off valve, two independent channels of pressure control with mass flow metering, and a vacuum outlet. Each pressure control channel consists of a pressure sensor, a control valve, and a mass flow meter, similar to the 649 Pressure Controller with Integral Mass Flow Meter.

The DPC has been designed to reduce the overall cost of ownership of pressure control subsystems for backside wafer cooling, specifically for the latest two-zone electrostatic chucks (Figure 1).

Product Features

- Two independent channels of pressure control, each with mass flow metering
- Available with Analog or DeviceNet™ communications
- Pressure measurement accuracy of ±0.5% of set point
- Control stability of ±0.1% of set point
- Complexity reduced with single package integration and size
- Reduced plumbing and cabling
- Can be used in any application requiring independent pressure control and mass flow metering to two distinct volumes

Key Benefits

- Complete backside wafer cooling subsystem in a compact package
- Tunable response for fast time to set point without overshoot

Operation

As shown in Figure 2, the DPC consists of three sections – an inlet subassembly, a pressure control/flow metering subassembly, and an outlet subassembly. Pressurized helium gas is fed into the inlet subassembly. A pneumatic valve is then opened and the gas flow is split to two channels.

In the pressure control section, MKS Baratron® Capacitance Manometers measure pressure for each of the two zones. These pressures are compared to the pressure set points and an appropriate signal adjusts the position of the solenoid control valve to bring actual pressures into agreement with the set points. At the same time, mass flow is monitored on each channel by MKS Mass-Flo® meters calibrated for helium, which is the typical gas used for backside wafer cooling.

Downstream of the pressure control section, the outlet subassembly directs flow to the electrostatic chuck and provides a controlled "bleed" to vacuum through fixed orifices.

The purpose of the bleed is to insure that the pressure control system is not "dead-ended". Since leak past the wafer is typically very low, the controlled bleed provides additional pressure relief for faster response to set point. Two different orifice sizes are used depending on the Full Scale range of the flow sensors. A smaller orifice size is used on units with 10 and 20 sccm FS flow sensors, and a larger orifice size is used on units with 50 and 100 sccm Full Scale flow sensors. The smaller orifice size delivers 3.5 ±1.5 sccm He at a control pressure of 9 Torr to the dump line. The larger orifice is sized to flow 13.0 ±3.0 sccm He at a control pressure of 14 Torr to the dump line.

Communication and Control

Both analog and DeviceNet™ versions of the DPC are available. For the analog version, power is supplied at ±15 VDC. The pressure set point and readout signals are 0-10 VDC and the flow sensor readout signal is 0-5 VDC. Ten-position gain and integral (P&I) term rotary switches provide a wide dynamic range for tuning pressure control performance. P&I switches are provided for each channel for independent tuning.

The digital DPC features digital control electronics and DeviceNet-compliant communication. The DPC DeviceNet profile for each channel basically adds an S-Analog Sensor object for mass flow sensing to the Process Control Valve object. Each channel has its own distinct MAC ID that is user-settable by two switches per DeviceNet specification. To optimize pressure control performance, users may adjust gain, integral and differential (P, I, D) constants for each channel using the DeviceNet communications protocol.

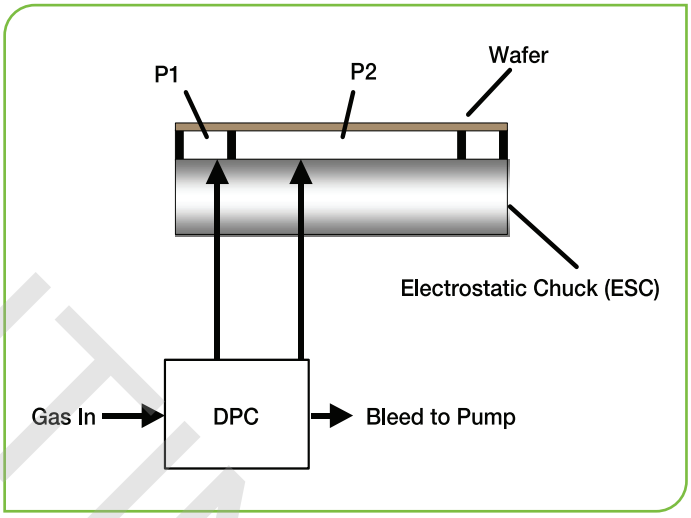


Figure 1 —
Two Zone Backside Wafer Cooling

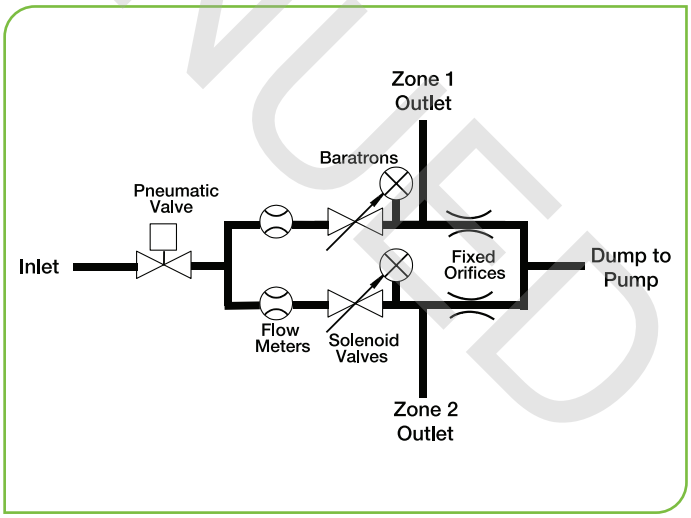


Figure 2 —
DPC Functional Schematic

Performance

Accuracy	**Pressure Transducer** **Mass Flow Meter**	• ±0.5% Reading[1] • ±1.0% Full Scale[2]
Leak Integrity	**Internal to External** **Through Closed Control Valve**	• $<10^{-9}$ scc/sec He • <1% Full Scale
Pressure Control	**Range** **Stability at Set Point** **Control Time to Set Point**	• 10-100% Full Scale • <0.1% set point • <2.0 seconds, typical
Temperature Coefficient		**Pressure** / **Flow** **Zero**: <0.02% Full Scale/°C / <0.05% Full Scale/°C **Span**: <0.04% Reading/°C / <0.08% Reading/°C
Warm Up Time		1 hour

Mechanical

Maximum Inlet Pressure		45 psia[3]
Dimensions (L x W x H)		10.46 in (incl. fittings) x 3.36 in x 5.35 in 26.56 cm (incl. fittings) x 8.53 cm x 13.59 cm
Fittings		Swagelok® 4 VCR® male compatible
Overpressure Limit		45 psia or 200% Full Scale, whichever is greater
Full Scale Ranges	**Pressure** **Flow**	• 10, 20, 50, 100 Torr • 10, 20, 50, 100 sccm
Pressure Transducer		Absolute pressure capacitance manometer
Surface Finish		Ra <10 µinches, electropolished
Weight		10.5 lbs. (4.8 Kg)
Wetted Materials		316L Stainless Steel, Inconel®, Nickel, Elgiloy®, Viton®

Electrical - Analog DPC

Input Power		±15 VDC ±5%, 500 mA, maximum during first five seconds at start up, 400 mA at steady state
Electrical Connectors		15 pin D male (one per channel)
Output Signals	**Flow** **Pressure**	• 0 to 5 VDC • 0 to 10 VDC
Pressure Set Point Input		0 to 10 VDC
Control Adjustments	**Integral** **Proportional**	• 10 positions (0 through 9) • 10 positions (0 through 9)
Maximum Cable Length		100 ft

Electrical - DeviceNet™ DPC

Input Power		11-25 VDC
Electrical Connector	**MAC ID's**	• 5-pin sealed microconnector with DeviceNet pin assignments • 2, one for each pressure control channel (4 MAC ID switches)
Baud Rate (user selectable)		• 125 Kbps (Network Length 500m) • 250 Kbps (Network Length 250m) • 500 Kbps (Network Length 100m) • PGM (Programmable over the network)
Digital Functions		• Read Pressure • Read Flow • Set Control Loop PID • Select Units • Set Zero
Visual Indicators		• LED Network Status (green/red) • LED Module Status (green/red)

Environmental

Ambient Operating Temperature	15° to 50°C (59° to 122°F)
RangeStorage Temperature RangeStorage	-20° to 80°C (-4° to 176°F)
Humidity Range	0 to 95% Relative Humidity, non-condensing

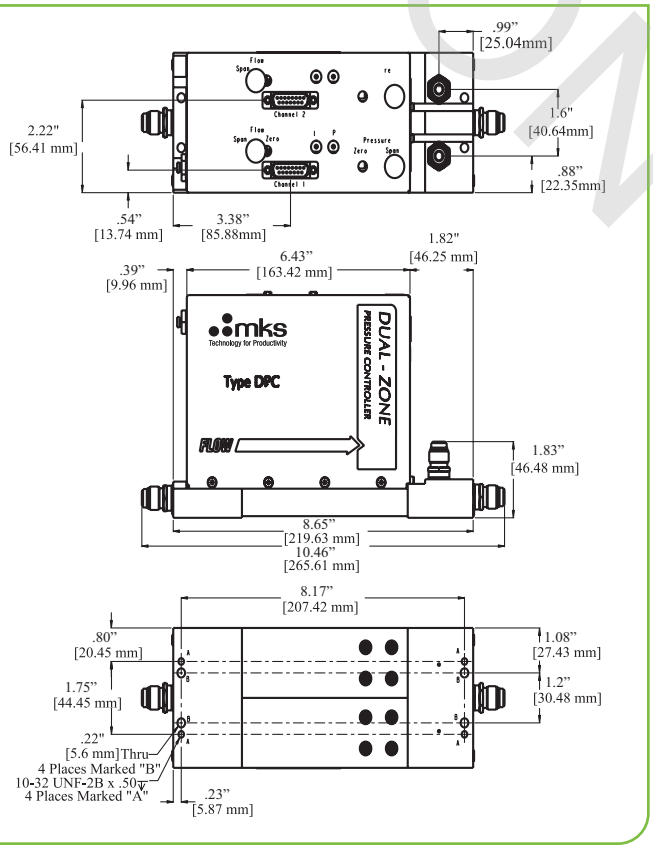
[1] Includes controller error, linearity, hysteresis and repeatability

[2] Includes linearity, hysteresis and repeatability

[3] Consistent with the overpressure limit of the transducer

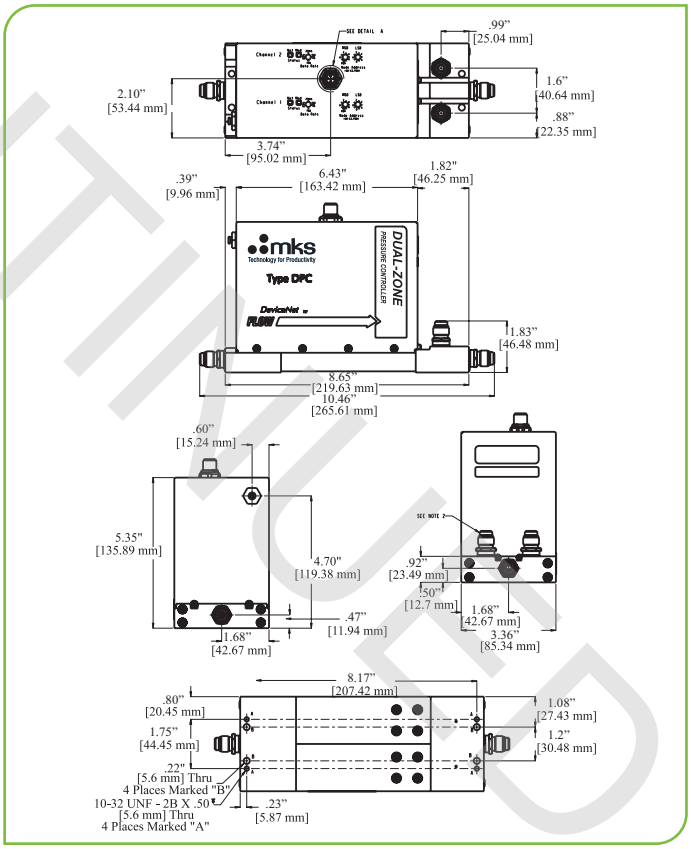
Ordering Code: DPCA12T51CB00	Code	Configuration
Model		
DPC Dual-Zone Pressure Controller	DPCA	DPCA
Full Scale Pressure Range (XXT)		
10 Torr* 20 Torr 50 Torr 100 Torr	11T 21T 51T 12T	12T
Full Scale Flow Rate (He equivalent) (YYC)		
10 sccm 20 sccm 50 sccm 100 sccm	11C 21C 51C 12C	51C
Unit Configuration (Z)		
15 pin D Analog 5 pin DeviceNet Digital	B 6	B
Firmware Revision (AA)		
Analog Version DeviceNet Version (Current firmware revision is 1.82)	00 13	00

*(*10 Torr/50 sccm combination not available - consult factory)*



Analog Dimensional Drawing

Unless otherwise specified, dimensions are nominal values in inches (mm referenced).



DeviceNet™ Dimensional Drawing

Unless otherwise specified, dimensions are nominal values in inches (mm referenced).

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