PDPCA

P-Series Dual-Zone EtherCAT® Pressure Controller

The P-Series Dual-Zone Pressure Controller (PDPCA) 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. The pressure control channels consist of two P-Series pressure controllers (PPCMA). Each PPCMA provides both pressure control and flow metering.

The PDPCA 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).

As shown in Figure 2, the PDPCA consists of four sections – an inlet subassembly, two PPCMA pressure control channels and an outlet subassembly. Pressurized gas (typically helium) is provided in the inlet subassembly. A pneumatic valve is then opened and the gas flow is split to two pressure control channels.

In the pressure control section, the PPCMA utilize MKS Baratron® capacitance manometers to 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 flow meters calibrated for helium, which is the typical gas used for backside wafer cooling.

Product Features

- Complete backside wafer cooling subsystem in a compact package
- Two independent channels of pressure control, each with mass flow metering
- With single package integration, size and complexity are reduced greatly
- Can be used in any application requiring independent pressure control and mass flow metering to two distinct volumes
- Tunable response for fast time to set point without pressure overshoot
- Control stability of ±0.1% of set point

Key Benefits

- Available with EtherCAT® communications
- Less plumbing and cabling required
- Pressure measurement accuracy of ±0.5% of set point

Description

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.

The controlled bleed is done using a fixed orifice based on device outlet pressure of <1 Torr. There is a choice of two orifice sizes for the controlled bleed. One is for a nominal flow of 13.5 sccm helium at a 14 Torr set point while the other is a nominal flow of 3.5 sccm of helium at a 9 Torr set point.

Communication and Control

The digital PDPCA features digital control electronics that are EtherCAT compliant communications. The PDPCA EtherCAT version is based on the SEMI ETG profile for EtherCAT pressure controllers.

To optimize pressure control performance, users may adjust gain, integral and differential (P, I, D) constants for each channel using the EtherCAT communications protocol. Control parameter adjustment may be required depending on system volume and pressure set points.

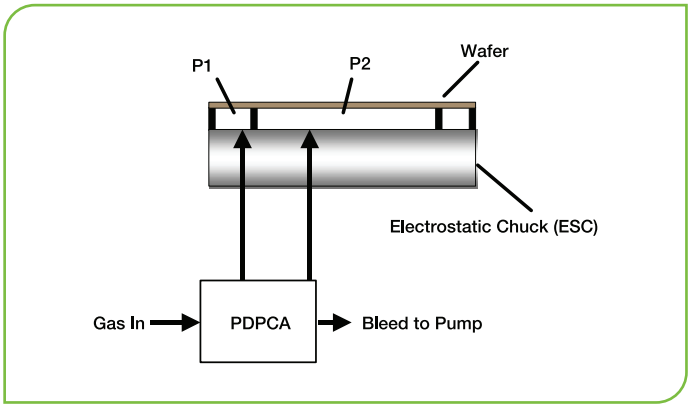


Figure 1 — Two Zone Backside Wafer Cooling

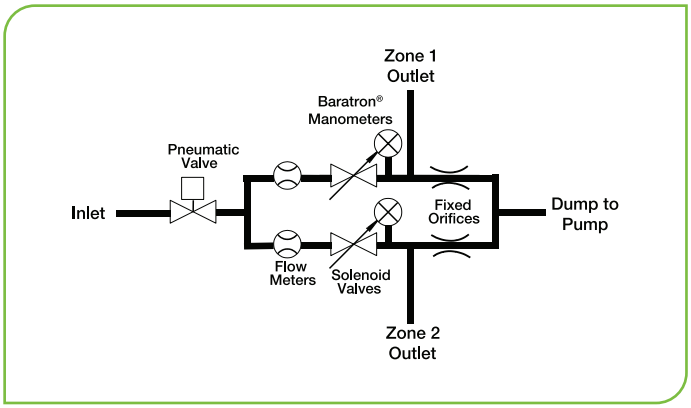


Figure 2 — PDPCA Functional Schematic

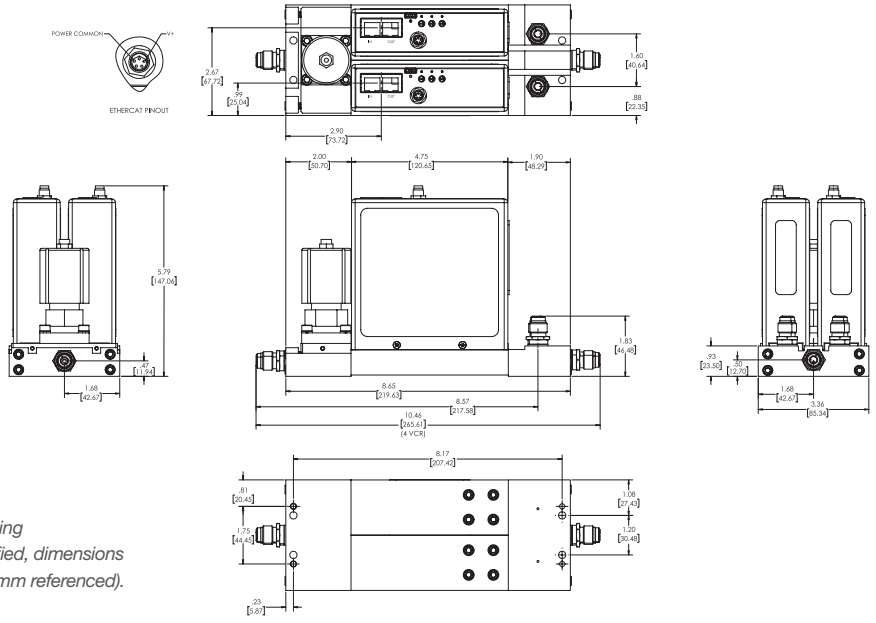
Specifications

Performance		
Accuracy	**Pressure Control Accuracy** **Pressure Transducer** **Mass Flow Meter**	• ±1.0% set point[1] • ±0.5% Reading • ±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[3]**	• 10-100% Full Scale • <0.1% set point • <2.0 seconds, typical - dependent on system configuration and control settings
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[4]
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 Range	**Pressure** **Flow**	• 20, 50, or 100 Torr • 20, 50 or 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		**EtherCAT®**
Input Power Required		+24 VDC (<5 watts)
Connector		2 x RJ-45 (comm.) male, M8 male, 5 pin (power)
Data Rate Switch/Selection		No switch
Comm. Rate(s)		100 Mbps
Mac ID Switches/Addresses		3 switches, 16 positions
Network Size		Up to 4095 nodes
Visual Indicators		• LED Power (green) • LED Error (red) • LED Run (green) • LED Comm (green)
Compliance		CE
Environmental		
Ambient Operating Temperature Range		15° to 50°C (59° to 122°F)
Storage Temperature Range		-20° to 80°C (-4° to 176°F)
Storage Humidity Range		0 to 95% Relative Humidity, non-condensing

[1] *Includes controller error, linearity, hysteresis and repeatability.*
[2] *Includes linearity, hysteresis and repeatability.*
[3] *Control tuning required for optimum performance.*
[4] *Consistent with the overpressure limit of the transducer.*

Ordering Information

Contact MKS Applications Engineering for ordering code.	Code
Model	
P Series Dual-Zone Pressure Controller	PDPCA
Full Scale Pressure Range	
20 Torr 50 Torr 100 Torr	21T 51T 12T
Full Scale Flow Rate (He equivalent)	
20 sccm 50 sccm 100 sccm	21C 51C 12C
Unit Configuration	
EtherCAT	8
Firmware	
EtherCAT Firmware	10
Gas and Bleed Flow Rate (Consult Applications Engineering)	



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

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