UNIT

Pressure Controllers

User's Manual

CELERITY™

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Contents

Pressure Controllers User's Manual

1. GENERAL DESCRIPTION

The UPC Series pressure controllers are used to control the flow of gas in maintaining a preset pressure in a chamber. They offer the user precision pressure control over a wide pressure control range in pressure sensitive processes and applications.

The UPC-1630/8130 pressure controllers utilize the proven technology of Unit mass flow controllers in the control of pressure. The solenoid proportional control valve has a wide dynamic range with high reliability and only one moving part. The IsoSensor™ thermal mass flow sensor provides a stable indication of gas flow through the pressure controller.

The UPC-1630/8130 require ± 15 VDC for power and interface to most power supplies used for mass flow controllers. The UPC-1630/8130 with its wide dynamic control range can be used in many applications from 1 Torr to 50 psig when coupled to the appropriate pressure sensor. The user must select the appropriate sensor for their application. Most pressure sensors with a 0-1 Vdc to 0-10 Vdc output can be used with the UPC-1630/8130. Increased pressure resolution is achieved through increasing the voltage output or decreasing the pressure range of the sensor.

The UPC-8130 with Viton™ elastomer seals is appropriate for general pressure control and pump ballasting applications using inert and non-corrosive gases. The UPC-1630 with metal seals is used in applications flowing process or corrosive gases and where particle contamination is an issue. The UPC-1630 also offers better leak integrity with its all metal seal construction.

2. THEORY OF OPERATION

The UPC-1630/8130 operates in a downstream pressure control mode where downstream refers to pressure control on the exhaust side of the UPC. In this mode the pressure level and gas flow are in phase with each other. When the pressure requirement is higher the UPC flow will be higher. When the pressure requirement is lower the UPC flow will be lower. Applications requiring this type of pressure control include vacuum pump ballast gas control, wafer backside cooling, and downstream chamber pressure control. If your application requires the UPC to control pressure on its upstream side contact a Unit Instruments Applications Engineer.

The UPC-1630/8130 is composed of a high performance solenoid servo valve, a mass flow measurement meter, and a microprocessor-controlled PID valve control loop. The solenoid valve provides proportional control of the gas flow to maintain the required pressure. The flow meter provides direct measurement of the gas flow rate. The microprocessor compares the desired pressure setting with the actual pressure from the pressure transducer. The control valve is then driven further open or closed as directed by the PID algorithm to meet the desired response rate.

All input and output signal lines to the pressure controller are analog voltages. The voltage range for the setpoint and pressure signal is 0.1 to 10 VDC. This broad input range allows the use many

different pressure sensing technologies; thermocouple, ionization, strain gauge, capacitance manometers, and MEMS. The pressure sensor output voltage range determines the setpoint voltage range.

Important: *The pressure sensor output and the setpoint voltage input must be the same range.*

The microprocessor converts the setpoint and pressure voltages into 12 bit digital values. The PID algorithm then commands the servo valve to either open or close as needed to set and maintain the commanded pressure value.

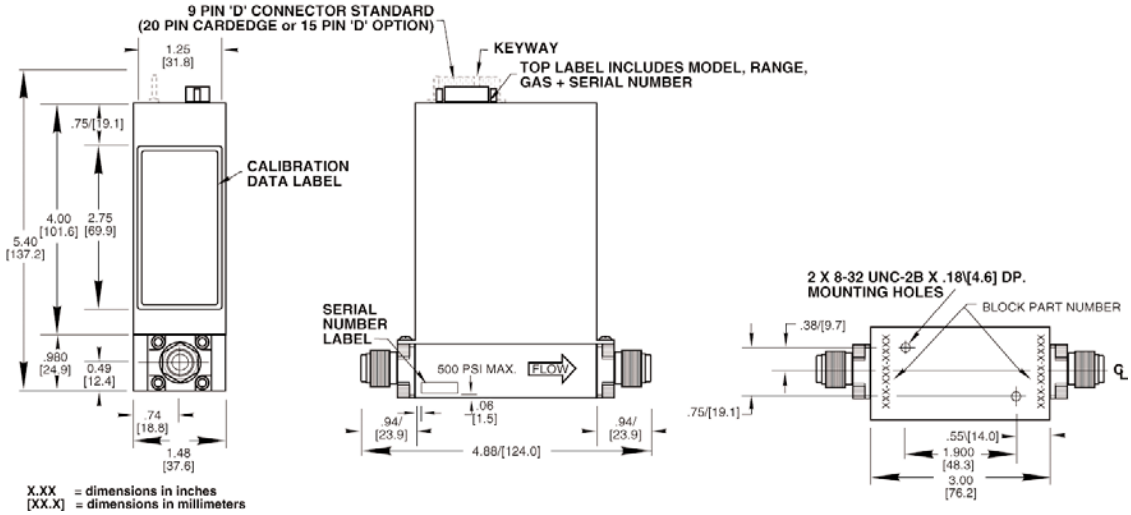
The flow meter monitors the flow rate through the UPC. The flow meter responds to changes in the control loop but does not control the flow as in a mass flow controller. The flow rate measurement is useful in determining process parameters, repeatability, trouble-shooting and changes in the control system. The gas flow rate cannot be directly related to pressure control. The position of the UPC valve is dependent on how much gas is required to produce the desired pressure condition.

3. INSTALLATION INSTRUCTIONS

3.1 Mounting

The UPC-1630/8130 pressure control valve is attitude insensitive. It can be mounted in any attitude. If you are using the flow meter section it is best to order the UPC-1630/8130 in one of two attitude configurations available. The HOV attitude configuration is applicable to most mounting positions of horizontal and vertical, Inlet Up and Inlet Down. The HOS attitude configuration also covers horizontal positions and where the UPC is mounted horizontally on its side. Using the UPC flow meter in an attitude other than what it is calibrated for will cause a small zero shift. Refer to the Flow Meter Zeroing section for further details.

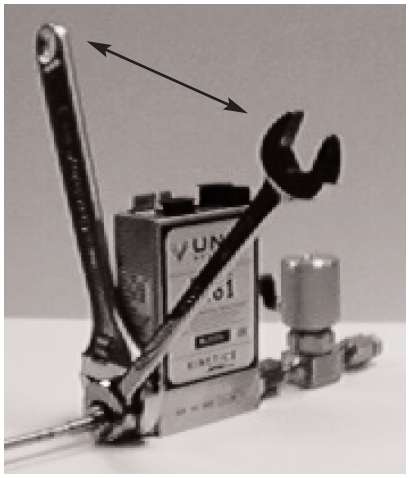
Two 8-32 threaded mounting holes are located on the bottom side of the UPC base block. It is recommended that these attachment points are used, especially in vertical mounted application. The UPC can also be held in place by the gas lines when stainless steel or other metal lines are used. When using plastic or other gas lines the threaded mounting holes must be used to hold the UPC in place.



3.2 Connecting Gas Lines

It is important to follow the proper installation procedure when attaching the gas lines to the fittings of the UPC. The available fittings on the UPC have different specifications for correct installation. Connection of all gas lines requires the use of two wrenches.

Important: *When attaching gas lines always use two wrenches. One wrench on the UPC fitting and the second on the tube side nut. Failure to follow the outlined procedure can result in fitting damage and gas leakage. After installation and prior to use, all gas lines and fittings should be thoroughly leak checked and purged.*



3.3 Fitting Tightening Specifications

Swagelok® and other ferrule type connections: Snug female nut finger tight. Then tighten with wrench an additional 1 1/4 turns. Hold UPC male fitting with second wrench to prevent torque transfer between fitting and UPC base block.

VCR®: Snug female nut finger tight. Then tighten with wrench an additional 1/8 to 1/4 turn. Hold UPC male fitting with second wrench to prevent torque transfer between fitting and UPC base block.

Downported: Downported UPC-1630 fittings do not require two wrenches. Follow seal manufactures recommended torque down procedure.

Electrical Connections:

UPC
20 PIN CARDEDGE
CONNECTOR PINOUT

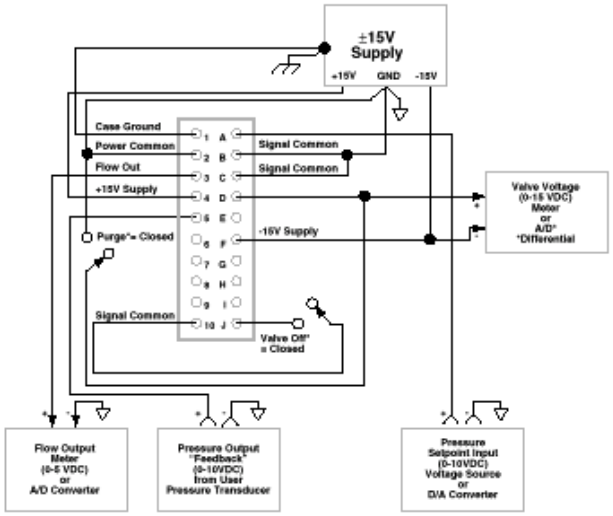
CASE GND	1	A	SET POINT (0-10 VDC)
POWER COMMON	2	B	SIGNAL COMMON
OUTPUT (0-5 VDC)	3	C	SIGNAL COMMON
+15 VDC	4	D	VALVE TEST PT.
PRESS.FDBK (0-10 VDC)	5	E	
	6	F	- 15 VDC
KEYWAY			
	8	H	
	9	I	
SIGNAL COMMON	10	J	

Pressure Signal Input: Voltage range 0-10 VDC. Typical ranges are 0-1 VDC, 0-5 VDC, and 0-10 VDC. Pressure sensors with full scale voltage outputs under one volt are not recommended. This would included most non-amplified pressure sensors. The pressure signal input range dictates what the pressure setpoint range must be.

Setpoint Input: Voltage range 0-10 VDC. The setpoint input and the pressure signal must be the same voltage range.

Flow Meter Output: 0-5 VDC output. The flow meter output is proportional to flow.

±15 VDC Power: Any low noise power supply with a minimum supply current of 250mA. Most MFC power supplies can be used to power the UPC.

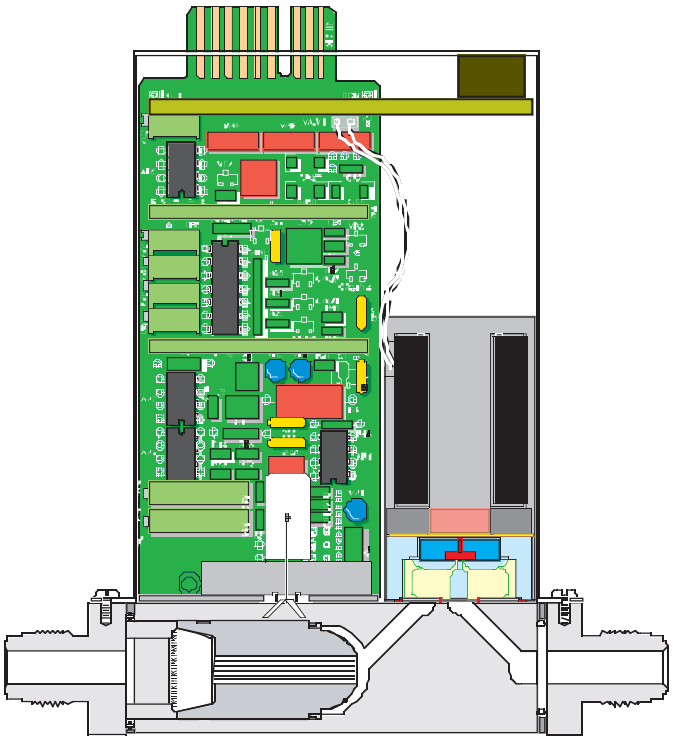


20 Pin Cardedge
UPC Pressure Controller

3.4 Flow Meter Zeroing

Zeroing of the flow meter is normally not necessary. Should the pressure controller be mounted in a different attitude than what it was calibrated for a small zero shift could occur. Before any zero adjustment is started power must be applied to the UPC for a minimum of 30 minutes. The UPC must be given a zero setpoint and where practical, gas flow to the UPC turned off.

The zero adjustment potentiometer is located at the top of the PCB cover can on the inlet fitting side. There is a label over the hole to the zero potentiometer indicating the proper location. Remove the center section of the zero label to reveal the hole and zero potentiometer. Using a small flat blade screw driver adjust the potentiometer until the flow reading is zero.



3.5 Purging

Purging of the UPC is necessary after installation and before removal. To force the UPC valve to its full open position for purging connect pin D, the Valve Test Point output, to either pin 2, Power Common, or pins B & C, Signal Common. Consult your company policy on purging of gas lines and equipment for specific purge times and procedures. Purge the UPC and gas lines with nitrogen or other inert gas for a minimum of 30 minutes before removal when toxic, corrosive, or reactive gases have been used.

3.6 Removal of the UPC

Purge the UPC and gas line as outlined in the Purging section. Close all gas supply line valves upstream of the UPC. Bleed off any residual pressure that might remain. Close any valves downstream of the UPC. Remove the card edge electrical connector.

Using the appropriate procedure outlined in the Connecting Gas Lines section, disconnect the gas lines to the UPC. If applicable, remove the two mounting screws used to mount the UPC. After removal cover the fittings with appropriate covers to prevent damage to the sealing surfaces.

Important: *Purging of the UPC and gas line is necessary before removal when toxic, corrosive, or reactive gases have been used.*

3.7 Tuning Procedure

The UPC-1630/8130 is an advanced pressure control instrument capable of very fast response over a wide operating range. The controller responds to input from a system pressure measurement device and adjusts flow of gas to increase or decrease the system pressure to the desired level. This system interaction requires tuning to adjust the response of the controller to match the response of the system. The basic tuning procedure is designed to allow the technician to tune the controller on the system for the best performance. Once the UPC-1630/8130 is tuned, operation is highly repeatable.

3.8 Recommended Test Equipment

A storage oscilloscope is preferable with dual channel capability.

3.9 Procedure Setup

1. Mechanically install the UPC-1630/8130 Pressure Controller into the system as it will be used.
2. Connect the electrical interface cable to the power supply and interface electronics. The interface electronics must have the ability to turn the controller ON and OFF (with a zero set point).
3. Connect the pressure transducer to the interfacing electronics or directly to Pins 5 and B or C on the pressure controller.
4. Connect the oscilloscope Channel One to the pressure transducer.
5. Connect the oscilloscope Channel Two to Pins D and F on the pressure controller.
6. Set up the oscilloscope:
   Channel One: 0-10 VDC
   Channel Two: 0-15 VDC
   Time Scale: 1-10 Seconds

3.10 Tuning

1. Adjust the inlet pressure to the normal operating pressure that will be used.
2. Switch the pressure controller to the off position.
3. Leaving the "Rotary" switch in the factory set position, test the response and stability of the controller by turning it ON and OFF, monitoring the oscilloscope. If the turn ON response shows large overshoot or oscillation, then slow down the response by turning the switch to a higher number. In turn, the response may be speeded up until overshoot or oscillation occurs by turning the switch to a lower number. Then, slow the response to leave some margin of safety. It is preferable to operate the pressure controller as fast as reasonably possible for best control capability. The response is adjusted by selecting the appropriate Rotary switch position. The Rotary switch selects the different parameters of a PID loop which determines the response of the pressure controller. Each time the switch position is changed, power to the UPC must be interrupted to reset the microprocessor and read the new setting of the switch. If the microprocessor is not reset the new switch setting will not take effect. The power cable to the UPC must be removed and reconnected each time a new switch position is selected.

4. Once the Rotary switch is set, test the control capability over the operating range desired. The system should operate for a long period without need of adjustment.

The UPC-1630/8130 has seven preset valve response curves that are user selectable through the Rotary switch. Most applications will use switch positions 3-6. Position 7 is used for digital communications and PID programming. Positions 8 & 9 are duplications of switch settings of 0 &1 respectively. Switch position 0 is the fastest valve response setting. Switch position 6 is the slowest valve response setting. If you are unable to tune the UPC to your application with the seven preset response curves, contact a Unit Applications Engineer for assistance.

Important: *Do not leave the Rotary switch in position 7. This switch setting is for digital communications and programming of PID values. Always interrupt power to force the microprocessor to read the Rotary switch during the tuning operation.*

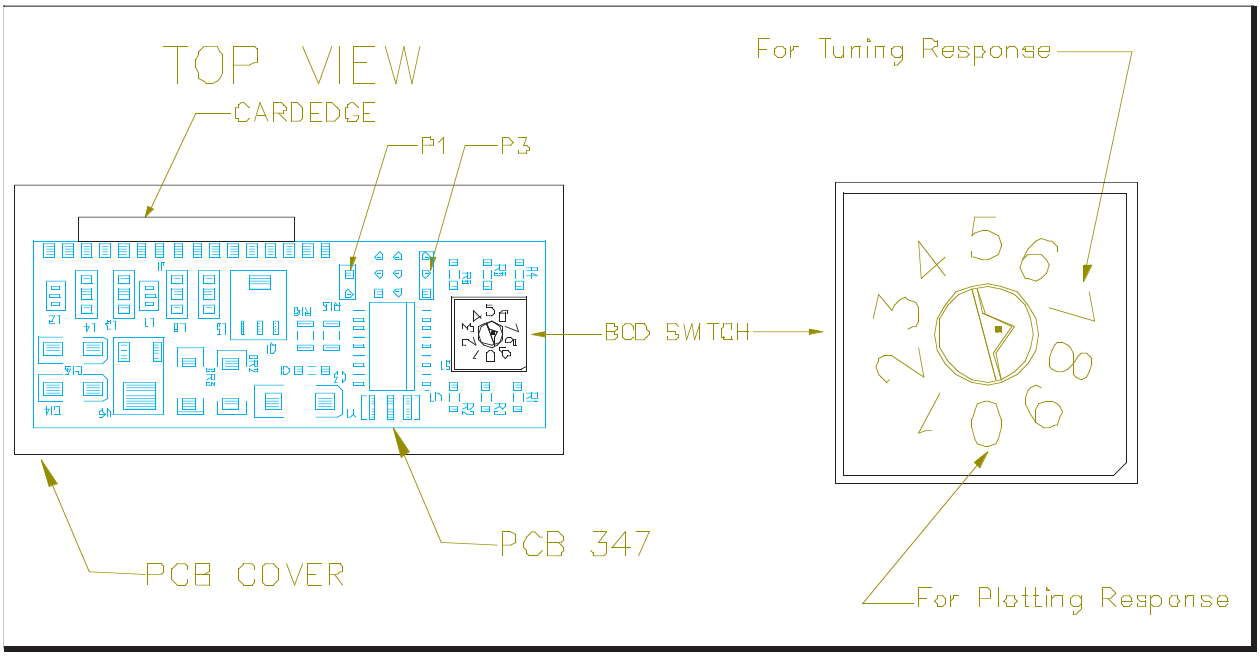


Figure 1. Using the BCD switch on the 347 PCB. Position 7 is for data communications

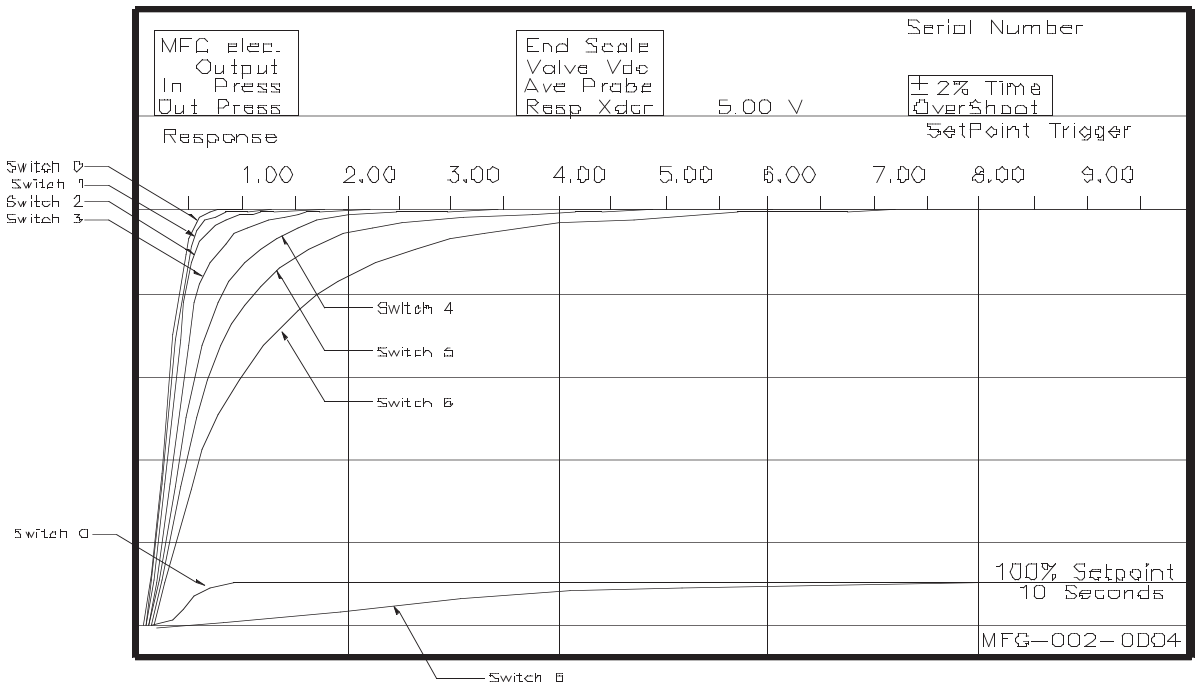


Figure 2. Response profiles. Responses for switch positions 0–6.

3.11 Tuning Using UPCTune Software

Should your application require resetting of the UPC PID tuning parameters you will require the UPCTune CD and programming cable p/n 955-001-0029.

1. Create a file folder on the hard drive of the computer being used called UPCTUNE.
2. Insert the UPCTUNE CD into CD drive.
3. Copy all of the files from the CD to the UPCTUNE file folder.
4. From the hard drive folder run Setup.exe and follow the instructions.
5. If you receive a “Version Conflict” warning it is best to keep your current file. To do this click on the “Yes” box.
6. After Setup is completed successfully click on the “OK” box to finish.

To place the UPCTune icon on the Windows Desktop.

1. Open Windows Explorer.
2. The UPCTune software is normally located at C:/Program Files/UPCTUNE
3. Right mouse click on the UPCTune.exe icon and highlight “Create Shortcut”.
4. Highlight the “Shortcut to UPCTune.exe” icon with your mouse and drag to your Windows Desktop.

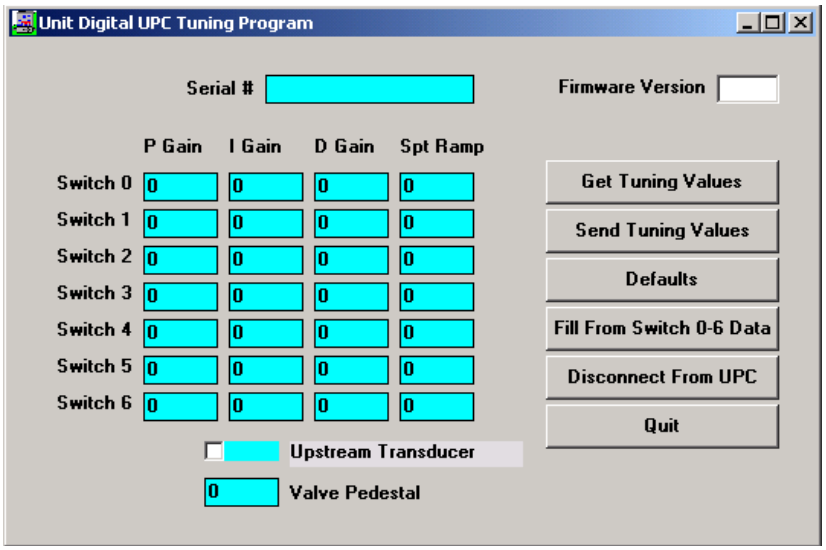
Double clicking on the UPCTune icon will start the program.

Warning for Windows 2000 users:
Windows 2000 users will have a window open attempting to install Microsoft Office 2000 Premium. Click the “Cancel” box each time it appears to start UPCTune. This is a bug with Visual Basic programs written under Win98.

3.12 Programming the UPC

1. Remove the two screws holding the cover can to the inlet and out fittings.
2. Remove the Warranty sticker and cover can.
3. Connect the UPC programming cable, 955-001-0029, between the computer serial port and the P3 programming pins located on the 347 PCB. See Figure 1.
4. Set the rotary switch to position #7.
5. Make sure that there is no pressure setpoint voltage being applied to pin A.
6. Click on “Disconnect from UPC” 3 or 4 times or remove power from UPC momentarily.
7. Click on “Get Tuning Value” to upload the current PID values in the UPC.

	Range	Typical Values
P-gain	0-65000	28000 – 65000
I-gain	0-65000	1000- 10000
D-gain	0-255	1-16
Spt Ramp	0-4095	8-50



Caution: Do not change Serial number or Valve Pedestal settings.

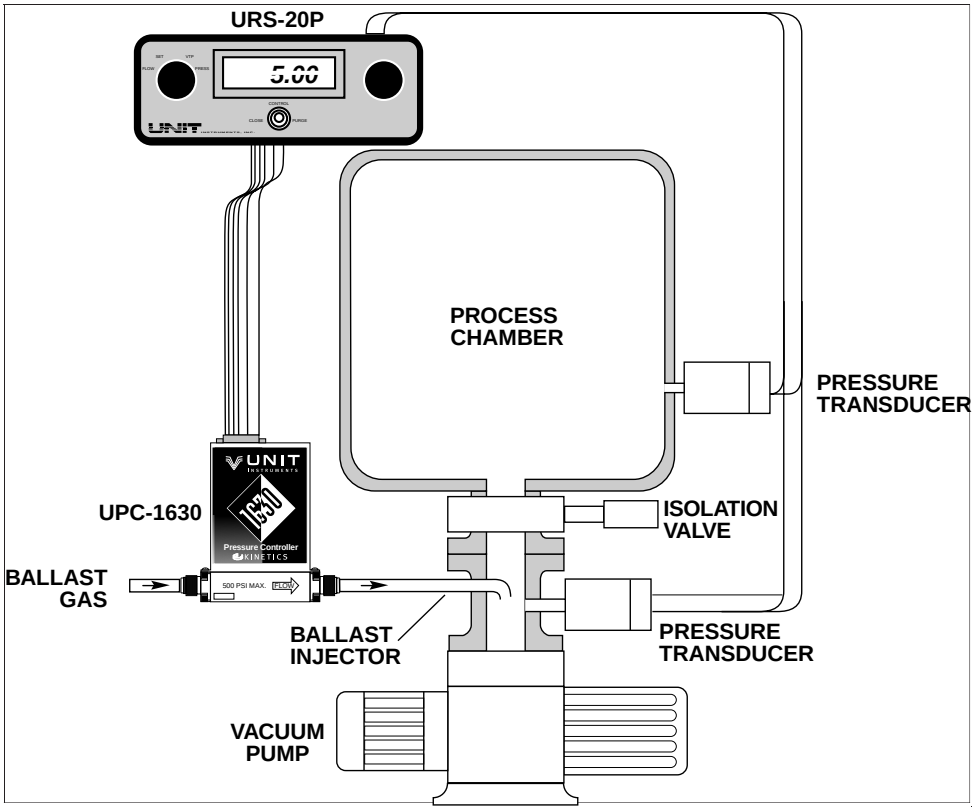
Tuning Functions	
Decrease response time	Increase I-gain
Oscillations	Decrease D-gain
Ramp Setpoint	Increase Spt Ramp

4. APPLICATIONS

4.1 Pump Ballasting

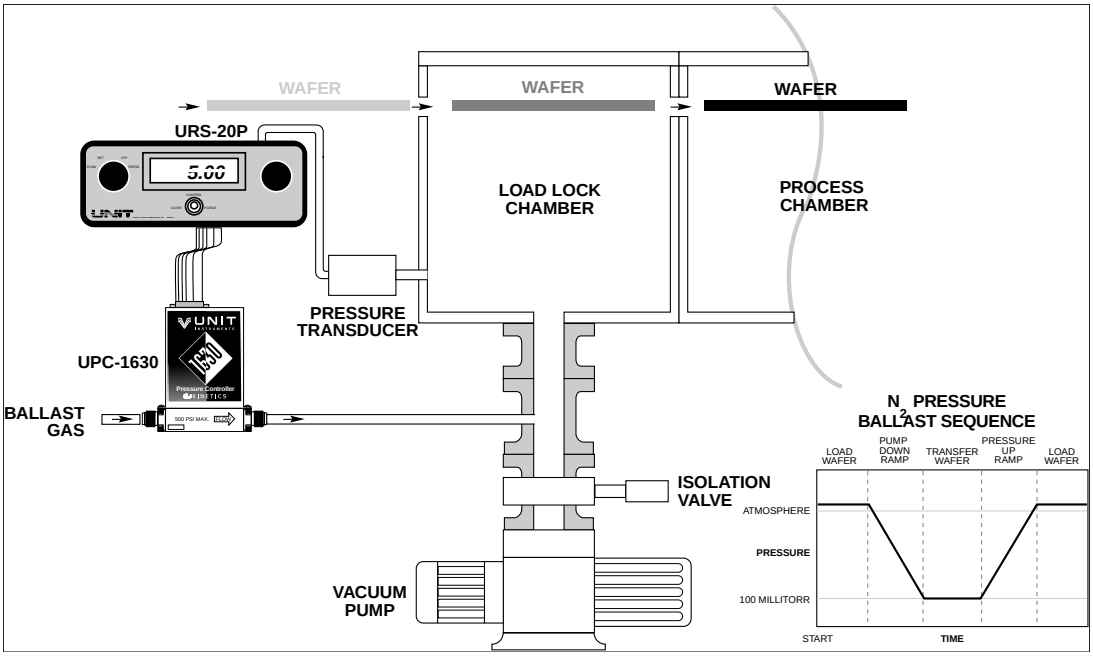
The Pump Ballast application replaces slower mechanical servo valve systems in controlling chamber pressure. The pressure can be controlled at any level above the base pressure of the vacuum pump. The ballast gas provides a buffer zone preventing back-streaming of contaminants into the process chamber.

Measurement of the ballast gas flow rate provides a monitor of the performance of the vacuum pump. A decrease in the flow rate relates to a reduction in pump speed indicating a possible need for service.



4.2 Load Lock

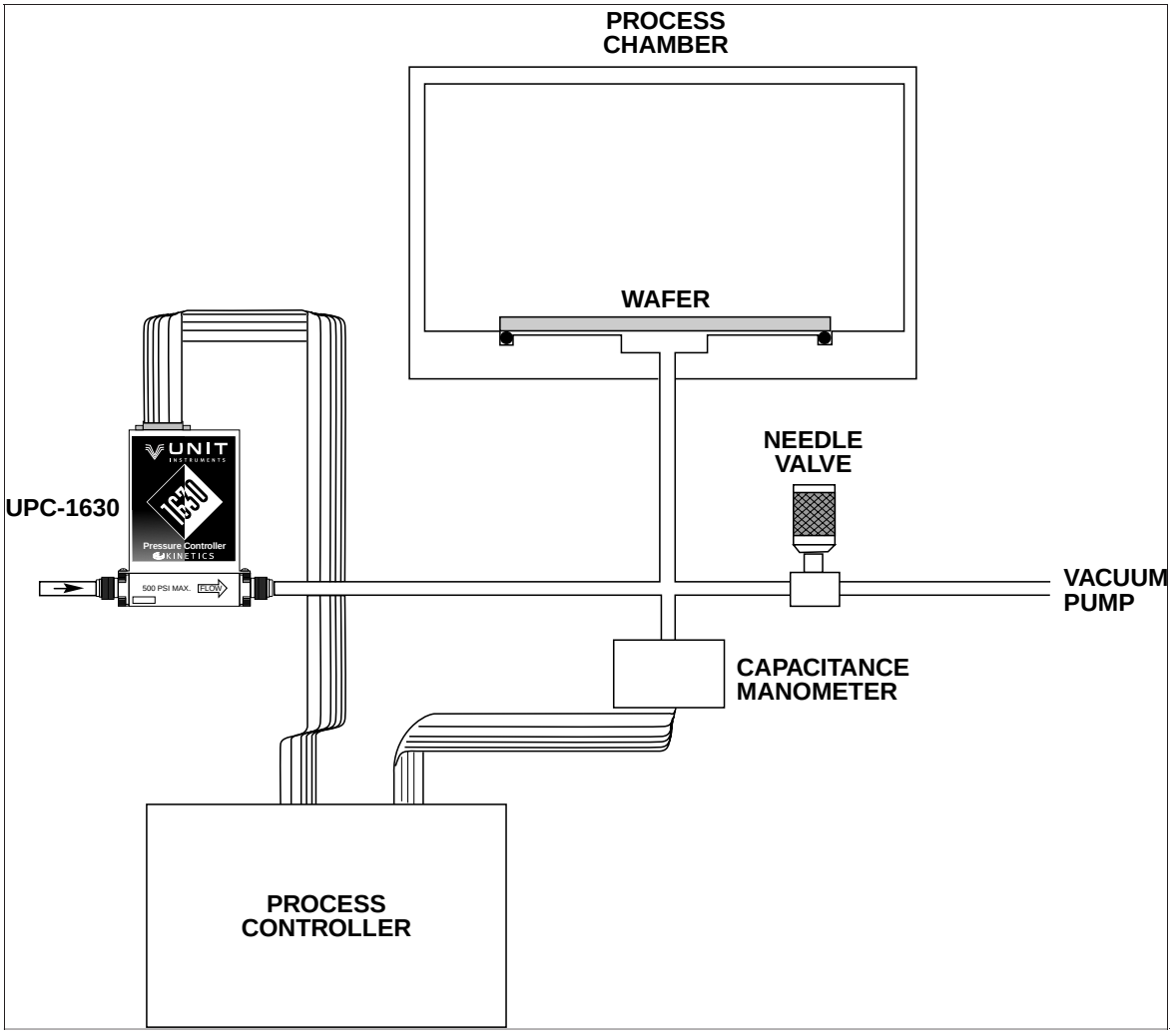
This application uses ballast gas to ramp up and down the load lock chamber pressure to prevent the disturbance of particles. This application does require the pressure setpoint of the UPC to ramp up and down from an external control source.



4.3 Backside Wafer Cooling

This application uses helium gas to transfer thermal energy from the wafer to the wafer chuck reducing the wafer temperature during process. Precise pressure control and valve tuning are critical in this application. Over pressurizing the backside of the wafer may dislodge it from the chuck.

Caution should be used when applying the UPC to pressure control systems where the pressure can build up and become static requiring no further gas flow to maintain the desired pressure condition. This type of system is called a “dead-head”. The addition of a needle valve or other type of bypass makes the tuning of this type of system easier. Once the UPC valve tuning is complete the bypass flow can be reduced or eliminated depending on the leakage around the wafer in the chuck. Test the pressure control tuning during each step of the bypass flow reduction.



5. SPECIFICATIONS

Performance (Pressure Control)

Response 0.5 to 8 sec, user-selectable with a manual 8-position rotary switch
Performance (Flow Meter Output)
- Accuracy: ±1% Full scale
- Repeatability: ±0.15% Full scale
- Linearity: ±0.9% (Full scale/Cal. gas)

Inlet Pressure Coefficient: 0.0025% Full scale/psi (N_2)
Amb. Temp. Coef.:
- Zero: 0.05% Full scale/°C
- Span: 0.05% Full scale/°C

Leak Integrity:
- Model 1630: 1 x 10^{-10} Atm-cc/sec (He)
- Model 8130: 1 x 10^{-9} Atm-cc/sec (He)

Zero Drift: <0.6% per year

Specifications

Gases: He, N_2, Ar
Standard Flow Range: 10 sccm to 30 slm (He equivalent)
Flow Measurement Range: 2–100% (Full scale)
Pressure Control Range: 1 to 100 Torr
Valve Leak Rate: <1% Full scale
Ambient Temperature Range: 0–50°C (32–122°F)
Max. Operating Pressure: 2.45 kg/cm^2 (35 psi)
Max. Overrange Pressure: 35 kg/cm^2 (500 psi)
Proof Pressure: 105 kg/cm^2 (1500 psi)
Pressure Differential Range: 7 to 50 psid
Warm-up Period: 30 minutes
Mounting Position: HOV
Valve: Normally Closed

Electrical Characteristics

Input/Output Signal:
- Setpoint Input: 100 mV to 10 Vdc or 5Vdc standard corresponding to the range of the external pressure transducer
- Pressure Transducer Input: 0–10 Vdc or 0–5 Vdc proportional to pressure
- Output Monitor: 0–5 Vdc linearly proportional to required flow rate

Valve Off: External TTL signal
Auto Shut-off: Setpoint <0.9% full scale commands off. Standard. No disable option.
Power input:
- +15 Vdc (250 mA max.)
- -15 Vdc (250 mA max.)

Power Consumption: 5 watts
Mating Connector: 20 contact cardedge

Mechanical Characteristics

Surface Finish:
- Model 1630: 16µ inch Ra (10µ inch Ra optional)
- Model 8130: 32µ inch Ra

Fittings: 1/4" VCR (8130 and 1630), downported B, C, W or Z (1630 only)
Materials: Wetted Components 316L SS/K-M45/Nickel/304
Valve Position: Normally Closed
Weight: 1.4 Kg (3.08 lbs.)

Calibration

Traceability: National Institute of Standards and Technology (N.I.S.T.)
Standard Temperature and Pressure: 0°C and vacuum exhaust

Specifications subject to change without notice.

6. WARRANTY

Model 1630: 3 years
Model 8130: 2 years

7. MANUFACTURING, SALES, AND SERVICE LOCATIONS

UNITED STATES

Austin, TX (Sales & Service)
Celerity
200-C Parker Drive, #600
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