

Intellisys™

ADAPTIVE PRESSURE CONTROL



Throttling Pendulum Valves and Adaptive Pressure Controllers

Intellisys throttling pendulum valves provide equipment manufacturers with unmatched pressure control performance and low particle generation. Other pendulum valves use one actuation method to move the gate and another method to seal, creating an “out of control” area near the closed position. To compensate for this, system designers often add secondary bypass lines with costly throttling butterfly valves for high pressure, high flow regimes, such as NF₃ cleans. Intellisys pendulum valves utilize exclusive closed-loop motor control and a patented Penduroll® actuator mechanism to move the sealing gate rapidly across the valve bore and transition to the axial direction. The result is precise pressure control over the entire valve stroke, most notably near the closed position. The Intellisys control system is the only choice for demanding 300mm Etch and CVD applications which require fast, accurate pressure control across the entire range of critical process flows and chamber pressures.

Nor-Cal Products' closed-loop motor control monitors and controls the exact position of the valve's gate mechanism. The adaptive pressure controller provides over eight million steps of addressable resolution to position the gate exactly where it needs to be to control pressure or to seal. In addition, the Nor-Cal control system's speed of actuation is unequalled in providing optimal transient response, pressure set-point stability, and overall process improvement. The APC's adaptive algorithm outperforms “learn modes” by optimizing phase and gain settings in real time during varying chamber pressure and flow conditions.

Isolation Pendulum Valves

Nor-Cal Products' pneumatically actuated isolation pendulum valves contain the same patented Penduroll™ mechanism that is found in the Intellisys™ throttling pendulum valves. These valves offer the user a compact and low cost alternative to competitive designs. In addition, the smooth actuation results in low particle generation and rapid open-to-close speeds.

In-situ serviceability of the valve is made possible through the incorporation of a removable bonnet cover. The entire gate assembly and sealing O-ring can be accessed without removing the valve from the system, making regular inspections, cleanings and O-ring replacements quick and easy.

Intellisys is a trademark of Nor-Cal Products, Inc.
Penduroll is a registered trademark of V-Tex Corporation

General Features and Benefits

- Space saving, low cost design
- Low particle generation
- High reliability
- Easy maintenance, split body allows O-ring replacement without removing valve from system
- Body can be heated to 150°C with optional heater jackets
- Available in ISO and JIS flange styles

General Specifications

Construction

Wetted Materials:

Body: Cast aluminum AC4CH

Valve plate: Aluminum A5052

Other parts: A 6061, A7075, SS304 and SS316, Viton®

Seals: Viton® standard, other materials available upon request

Body and plate surface treatment:

Bare aluminum standard, hard anodizing optional

Valve Design

Operating Pressure: 3.8 x 10⁻⁸ to 760 Torr (5 x 10⁻⁸ to 1000 mbar)

Maximum Differential Pressure

(while opening valve): 200mm - 20 Torr (26 mbar)

250mm - 24 Torr (32 mbar)

350mm - 29 Torr (38 mbar)

Heating or Bakeout Capabilities:

Body: 150°C max with optional heater jackets

Actuator: 60°C maximum

Ambient Operating Conditions: 0 to 60°C

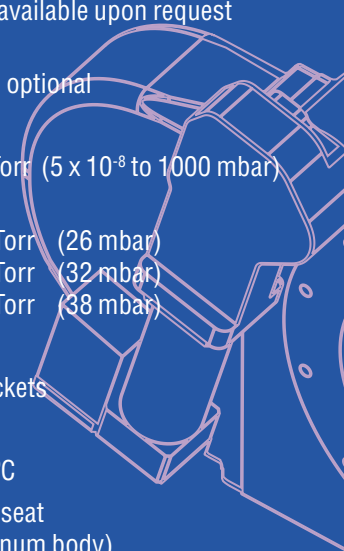
Leak Rate: 1 x 10⁻⁹ atm-cc/sec He across seat

and to atmosphere (bare aluminum body)

Service Life: 200,000 cycles - Open to Fully Closed (All valves)

1 million cycles - Open to Partially Closed (3-position valves)

1 million cycles - Open to Control Closed Position (TPV)





Intellisys Throttling Pendulum Valves

Nom. ID	Part Number	A	B	C	D	E	F	Weight
8.00	TPV-800-ISO-200	3.46	3.78	19.90	14.40	6.50	9.29	49 lbs. (22 Kg)
10.00	TPV-1000-ISO-250	3.94	3.78	23.80	16.60	8.46	9.49	62 lbs. (28 Kg)
12.00	TPV-1200-ISO-320	4.72	4.06	30.20	22.00	10.60	12.80	123 lbs. (56 Kg)
14.00	TPV-1400-JIS-350	4.92	4.06	32.30	22.00	12.20	12.80	143 lbs. (65 Kg)

Other sizes and flange configurations available. Call for details.

Dimensions in inches

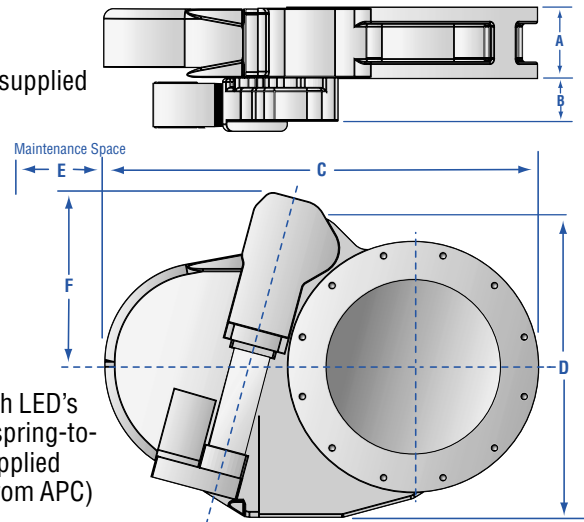
Specifications

Power Input: 36 VDC to valve supplied from APC. Customer supplied
4.5 to 16 VDC to optional position sensor

Performance: (when operated with an Intellisys APC Controller)
Control Range: From .5% to 100% of the vacuum gauge range
Accuracy: The greater of 5 mV or 0.25% of reading
Repeatability: Within 2.5 mV or 0.12% of reading
Maximum Speed: 1 to 3 seconds open-to-closed
Control resolution: 8 million to 20 million steps

Options:

- High Temperature:** Heated and insulated valve body with PID or thermostat controls
- Position Indicators:** Open/closed optical valve position indicator with LED's
- Safety Lock:** Closed position safety lock pin. Operated by a spring-to-close electric solenoid. (Requires customer supplied 24-76 VDC relay and power, relay logic signal from APC)
- Rough Pump Port:** NW-25 roughing port on main casting allows pump-down of chamber prior to opening pendulum valve



Isolation Pendulum Valves

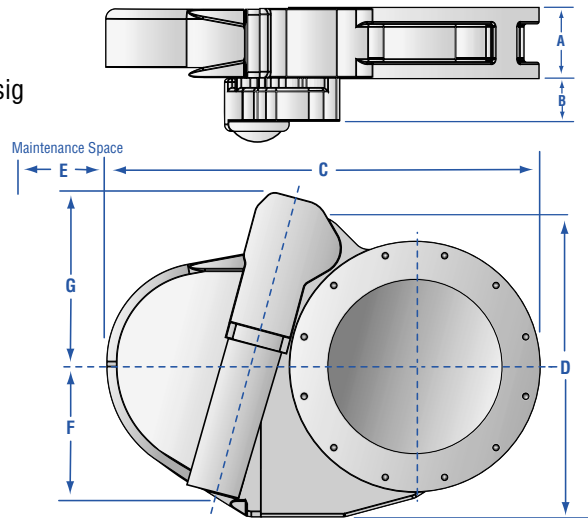
Nom. ID	Model Number	A	B	C	D	E	F	G	Weight
6.00	IPV-600-ISO-160	3.15	3.78	15.90	12.20	5.32	5.87	8.50	40 lbs. (18 Kg)
8.00	IPV-800-ISO-200	3.46	3.78	19.90	14.40	6.50	5.28	9.29	49 lbs. (22 Kg)
10.00	IPV-1000-ISO-250	3.94	3.78	23.80	16.60	8.46	5.47	9.49	62 lbs. (28 Kg)
12.00	IPV-1200-ISO-320	4.72	4.06	30.20	22.00	10.60	7.24	12.80	123 lbs. (56 Kg)
14.00	IPV-1400-JIS-350	4.92	4.06	32.30	22.00	12.20	7.64	12.80	143 lbs. (65 Kg)
16.00	IPV-1600-ISO-400	5.91	5.00	36.00	24.70	12.80	7.83	15.00	231 lbs. (115 Kg)

Other sizes and flange configurations available. Call for details.

Dimensions in inches

Specifications

Compressed air source: CDA or equivalent at 65 to 85 psig
Maximum speed: 3 seconds open to closed (250 mm size and below)



Call for Pricing. - International product pricing will vary.



Intellisys Pendulum Valve Controllers

The Intellisys Adaptive Pressure Controller (APC) merges closed loop motor control with adaptive pressure control to provide advanced control system performance. An advanced adaptive algorithm eliminates pressure overshoot or gradual ramps during pressure transition. A Digital Signal Processor (DSP) enables DeviceNet™ communications protocol and programming flexibility for customer or process specific requirements.



Features and Benefits

- Unique Preventative Maintenance Indicator (PMI™) reduces unscheduled maintenance and downtime
- Patented motor control technology senses increased torque in throttle gate for improved diagnostics
- Autosensing 90-240 VAC power supply
- Flexible analog and digital system interfacing
- Buried box model saves valuable rack space

Specifications

Power Input: 3-Pin 100-240VAC Input Connector

System Interface:

Serial Connector: DB-9 receptacle for RS-232 DCE or RS-485/ Modbus serial interface

TTL Connector: DB-37 receptacle contains all TTL and analog I/O

Analog Setpoint: 0-10 and 0-5 VDC linearly proportional to pressure or valve position

Pressure Output: 0-10 VDC analog output signals proportional to pressure, one for each vacuum gauge attached

Valve Angle Output: 0-10 and 0-5 VDC proportional to valve position, 0V is closed, 10V(5V) is open

Signal Interface: 9 digital (TTL) control input signals to operate the APC. 4 open collector status outputs, 2 process limit relays, Form C contacts

Device Interface:

Gauge Connector: Two DB-9 receptacles provide ±15VDC @ 800mA for 1 or 2 vacuum gauges with differential signal input for increased noise immunity

Pressure Input: 0-10 Volts DC linearly proportional to pressure

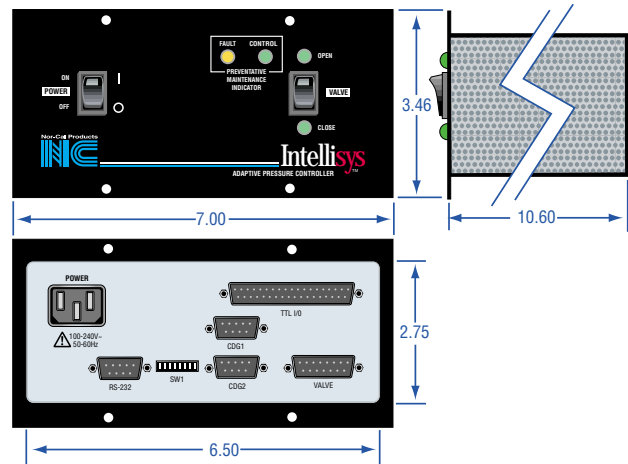
Valve Connector: DB-15 receptacle provides power to operate the high performance valve stepper motor

Approvals: CE (EMC and Low Voltage Directives)

Operating Range: 0 to 40°C @ 0-95% humidity noncondensing

Weight: 3 lbs. 8 oz. (1.7 Kg)

Model Number	Description
APC-001-PM.2	Full functionality including RS-485/ Modbus serial interface. Allows up to 16 controllers on one communications line.
APC-001-P.2	Full functionality including RS-232 DCE serial interface.

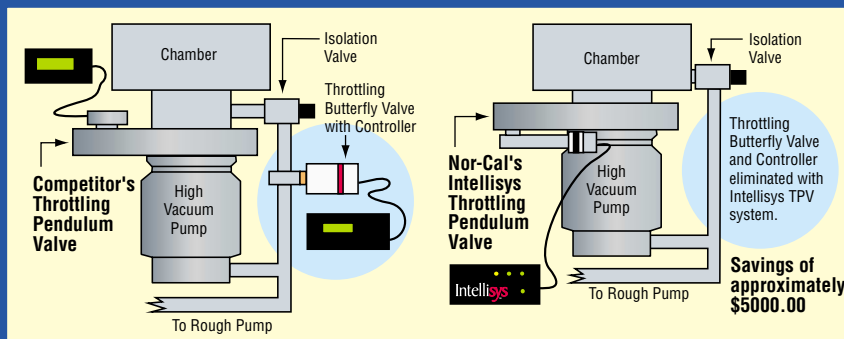


Call for Pricing. - International product pricing will vary.

Simplified System Design with Single Valve Approach

Most dry etch processes and many advanced CVD applications require the use of a wide range of operating pressures, including some low pressure conditions that are well into the molecular flow regime. That is, in part, driving OEM's to use large diameter pump stacks with high capacity turbo pumps. This means that the days of inserting a simple butterfly valve between the chamber and the pump are gone due to the limited control range and non-sealing nature of large diameter butterfly valves, as well as to the space they consume in the pump stack. To address these problems, OEM system designers turned their attention to the use of throttling gate or pendulum valves, thereby addressing the pressure control and isolation valve issue with a single solution. Until now, controlling the large, heavy gate proved slow and cumbersome. Metal-to-metal contact of structural parts often resulted in particle generation and mechanism failure causing havoc with process yields. Finally, existing valve designs are unable to provide the full range of pressure and mass flow requirements due to their inability to control pressure in the near closed position.

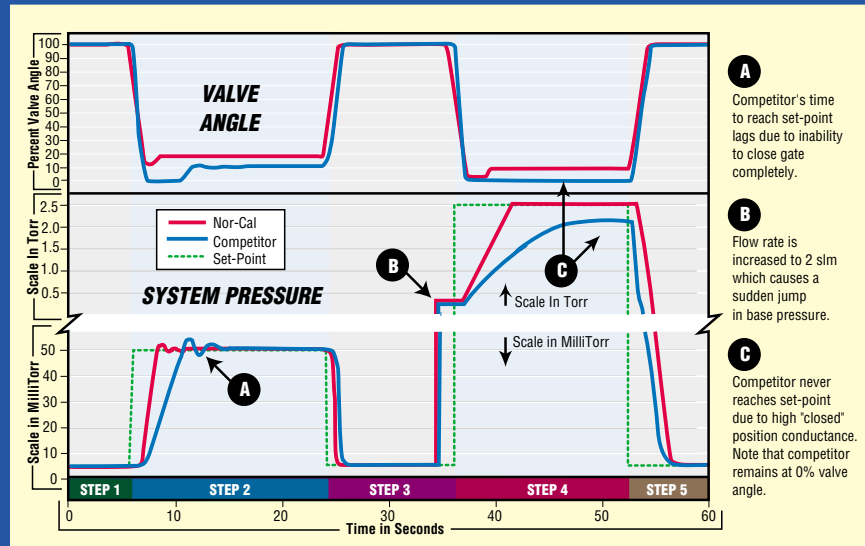
Specifically, designers have had to counteract the "low controllable conductance" limitation by inserting an additional throttle valve in the by-pass line around the throttling gate valve. (See illustration below.) In other cases, forcing the system through time consuming control learn algorithms for every new process condition has become necessary. In either case, a compromise involving valuable space, cost or process performance has often been the only solution until now.



The high speed, ultra-high resolution and exclusive actuation method of Intellisys throttling pendulum valves eliminate the previous products' shortcomings. Using a simulated semiconductor process, the Intellisys pendulum valve system was compared with a similar system from, historically, the sole manufacturer of such valves. (See chart above) In both cases, the test used the following abbreviated process recipe with a 40 liter chamber connected to an 1800 lps, ISO-250 turbo pump.

- Step 1** Pump system to base pressure
- Step 2** Flow 80 sccm N₂ & command system to a process set-point of 50 mTorr
- Step 3** Evacuate system to base pressure
- Step 4** Flow 2 slm N₂ and command system to a cleaning step pressure of 2.5 Torr
- Step 5** Evacuate system to base pressure

The graph clearly illustrates significant performance differences between the two valves. During the initial ramp from base pressure to 50 mTorr, the Intellisys system drives the pendulum gate to a point where the sealing O-ring is just



- A** Competitor's time to reach set-point lags due to inability to close gate completely.
- B** Flow rate is increased to 2 slm which causes a sudden jump in base pressure.
- C** Competitor never reaches set-point due to high "closed" position conductance. Note that competitor remains at 0% valve angle.

in contact with the sealing surface, whereas the competitive valve cannot and exhibits a significant leak-by in the closed position. (See Step 2.) As a result, the rate of pressure change was compromised and the time taken to reach set-point more than doubled. Furthermore, using the competitive valve led to pressure oscillations that measured $\pm 8\%$ of set-point lasting 3 to 4 seconds.

Another noteworthy observation occurred in the cleaning step. (See Step 4.) The Intellisys valve efficiently reached the target pressure of 2.5 Torr in approximately 3 seconds. However, even though the competitive valve traveled completely closed and remained closed for the duration of the process step, the maximum achievable pressure leveled out at just over 2 Torr. This phenomenon is, again, attributable to the high leak rate of the competitive valve when in the closed position.

Inherent valve design and pressure control performance limitations, such as these, have a direct effect on vacuum system design complexity. In the past, processes that required operation over a wide range of flow rates and pressures essentially dictated that the tool vacuum foreline be complex. Even though it was only for use during certain operations the added control valve bypass took up space and could add up to \$5,000 in system cost for every chamber. In contrast, the Intellisys pendulum valve system enables full command of all control applications with just one valve and associated pressure controller, thereby saving extra space, cost and integration efforts.