



Instruments That Advance The Art

Differential Pump

FEATURES

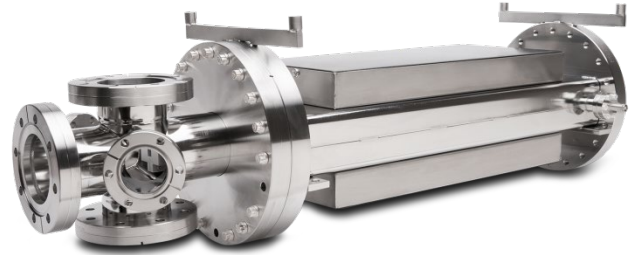
- Windowless HV to UHV vacuum isolation.
- Molecular line-of-sight pumping.
- Five orders (10^{-5} - 10^{-10} Torr) pressure isolation.
- Aperture to 10 mm H x 14 mm W.
- Standard overall length 34".

OVERVIEW

The XIA model DP-03 differential pump provides a cost effective, windowless, direct line-of-sight transition between ultra-high vacuum (UHV) ($< 10^{-9}$ Torr) and high-vacuum (HV) regions ($< 10^{-5}$ Torr). Differential pumps traditionally have a series of pumps separated from each other and from the UHV region by flow restricting throttles. The DP-03 does the same, consisting of a pair of throttles separated by an active pumping region. An adaptor nipple on one end facilitates connection to HV, while an adaptor cross on the other end makes the connection to the UHV system, as well as providing ports for pressure monitoring, viewing, and attaching the user supplied secondary pump which completes the system.

Innovative in design, the DP-03 provides large throttle apertures in an overall short pump length by placing distributed pumping close to the line of sight through the pump. This enhances effective pumping speed by up to 10x compared to conventional ion pumps of similar dimension. For most applications only a single stage DP-03 and a 30-60 l/sec exit pump will be required.

The DP-03 contains an XIA patented innovation which passes the line of sight directly through the active pumping region of a Penning style ion pump. The Penning electrons trapped by the magnetic field in this active pumping region have a substantial cross-section for "straight-through" molecules and are able to remove the vast majority of them. Tests using an RGA sensitive to 10^{-14} Torr, where unable to detect any straight through N_2 beam on the UHV side when the HV side was at 10^{-5} Torr. This design also offers better pumping speed, so that Eqn. 1 (overleaf) should be regarded as predicting an upper limit on performance.



Differential pumps are easy to configure to specific applications by optimizing the trade-off between throttle aperture dimensions and the amount of isolation provided. This is accomplished by adjusting the dimensions of the two throttles and by selecting the pumping speed of the user supplied exit pump. Throttle aperture dimensions are specified at time of order, but can easily be removed and altered later.

APPLICATIONS

Thin Window Elimination: Removes the operating complexities associated with fragile windows while transmitting full intensity in the soft x-ray range. Also offers a solution when high power loading on windows is a problem.

UHV Incompatible Materials: Allows experiments on materials with vapor pressures exceeding 10^{-9} Torr. With an additional stage of pumping the direct study of sputtering and low pressure CVD are possible.

Fast Sample Chamber Cycling: If UHV conditions are not an experimental necessity, then install a DP-03 and operate the sample chamber at 10^{-6} Torr, eliminating the need for bake-outs and reducing cycle times from days to minutes.

Remove Unwanted HV Restrictions: Complex precision mechanical devices (e.g. monochromators) are 10x more expensive at 10^{-9} Torr than 10^{-6} Torr. Using two DP-03s to isolate them from both the storage ring and the experiment can be very cost effective.

X-ray lithography and microscopy: Simplifies the design of alignment and exposure equipment and allows windows free exposure of resist materials at 10^{-6} Torr.

XIA LLC

www.xia.com

sales@xia.com Tel: +1-510-401-5760

2744 East 11th St., Oakland, CA 94601 USA

PERFORMANCE

For many applications the DP-03 design is so efficient that only a single stage is needed when combined with a user supplied ion or turbomolecular exit pump. The output pressure P_3 for N_2 gas is then well described over 5 orders of magnitude in input pressure P_1 (10^{10} to 10^{-5} Torr) by

$$P_3 = 5 \times 10^{-5} \left(\frac{C_{12} \times C_{23}}{S_3} \right)^{0.5} P_1^{0.78} + P_{30} \quad (1)$$

where P_{30} is the output pressure for negligible input pressure P_1 . S_3 is the pumping speed in l/sec of the exit pump through the 400 l/sec connecting cross, and the throttle conductances may be computed for N_2 from the molecular flow formula

$$C_{N_2} = \frac{29 h^2 w^2}{(h + w) L} \quad (2)$$

in l/sec, where h and w are the width and height in cm of the throttle cross section, and L is its length in cm (15 standard).

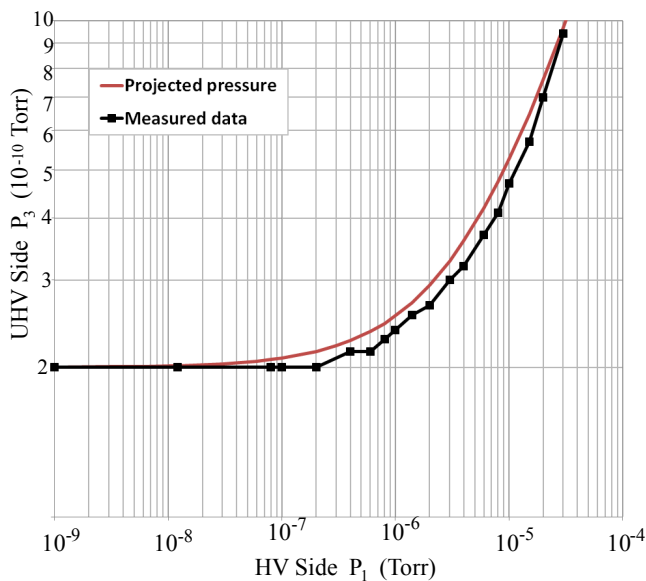
Figure 1 compares data from a pump with $h = 0.4$ cm, $w = 1.5$ cm and $L = 15$ cm, with $S_3 = 50$ l/s, to values from Eqn 1. Typically, as may be seen, the actual pressure is somewhat lower than the value projected from equation 1.

SPECIFICATIONS

Performance Specification: *Following an adequate bake-out cycle conducted according to good UHV vacuum practice and tested as described in the Users' Manual, a DP-03 will achieve the following:*

Background pressure: 3×10^{-10} Torr or better.

N_2 pressure isolation: Within a factor of 2 of Equation 1.



Overall Dimensions: Please see the pdf schematic on our website. At www.xia.com, go to “Products”, then under “Other Products” go to the Differential Pump and select the link to the mechanical drawing in pdf format.

Throttle Dimensions:

Length: 6” (15 cm).

Aperture: Specify at time of order.

Up to 14 mm wide x 10 mm high.

Materials:

Pump body, cross & nipple: Type 304 Stainless Steel.

Throttle and throttle plate: Type 6061 Aluminum.

Magnet: Ferrite.

High Voltage Connector: At time of order, specify Dunning HVFT-5143 (Varian 954-5143) or HVFT-5125 with interlock, or Gamma Vacuum 220005 (Old style SAFE-CONN).

Operating Voltage: DP-03 high voltage = -5.2 kV.

Mounting: 4 holes to attach to customer’s structure. See above referenced mechanical drawing in pdf format for details.

Alignment Aids: Tooling ball sockets: 0.250”, 4 provided.

Pump Life: 35,000 hours minimum for inlet pressures $\leq 1 \times 10^{-6}$ Torr.

Temperature Limits:

Pump: 375 °C. Magnet: 325 °C

CUSTOMER SUPPLIED ITEMS

Exit Pump: 50 l/s ion pump or equivalent.

High Voltage Supplies and Cables: For both the DP-03 and the Exit Pump (if required).

AVAILABLE DESIGNS

The standard design is the DP-03, with a 34” overall length, 4-point non-kinematic mounting, and throttle dimensions of up to 14 mm horizontal by 10 mm vertical. A pdf mechanical drawing is available on our website, (see above). Many simple design changes (e.g. flange dimensions, nipple length) can be accommodated without requiring custom design. Please discuss your requirements with us.

Custom designs for unusual applications may be possible. Please contact us to discuss your requirements.