



Nor-Cal Products

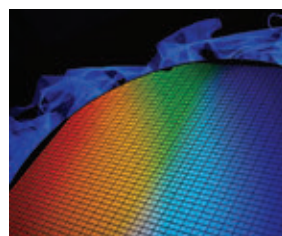
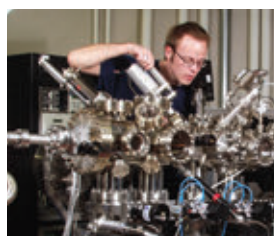
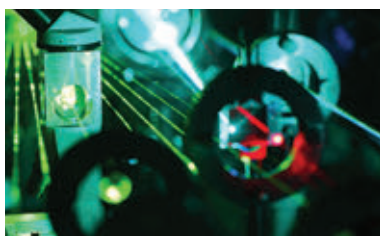


by PFEIFFER VACUUM



# Nor-Cal Products

*where technology takes shape*



*vacuum products catalog*

# Sample Transfer & Manipulation

## Section Nine



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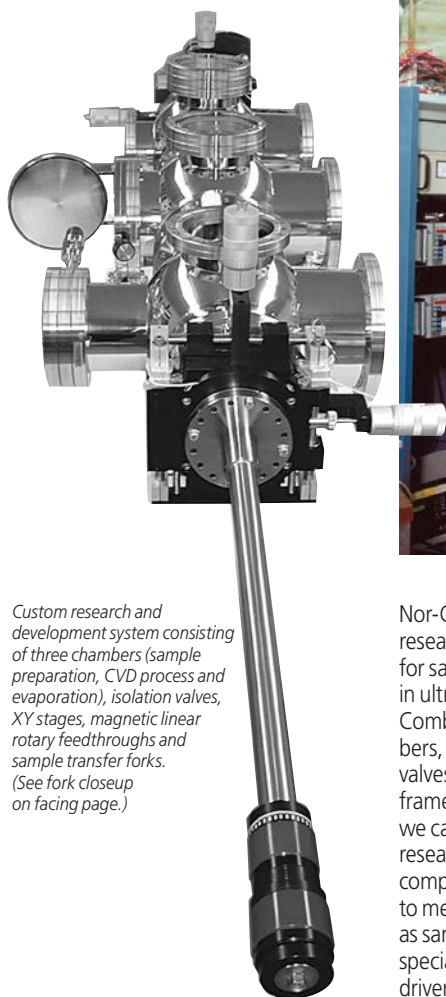
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# Sample Transfer & Manipulation

## General Information

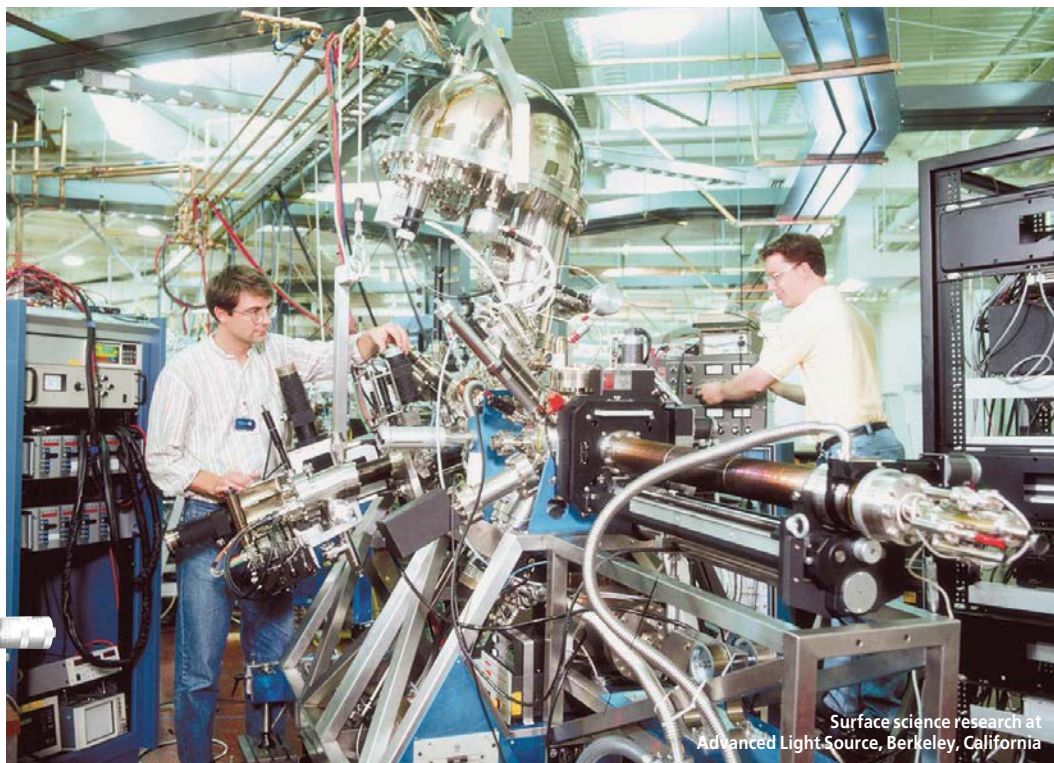


Custom research and development system consisting of three chambers (sample preparation, CVD process and evaporation), isolation valves, XY stages, magnetic linear rotary feedthroughs and sample transfer forks. (See fork closeup on facing page.)

Most sample transfer/manipulation devices include a 5 year warranty, depending on the specific product type. 5 year warranty not available in all territories.

Contact the factory for details.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



Surface science research at Advanced Light Source, Berkeley, California

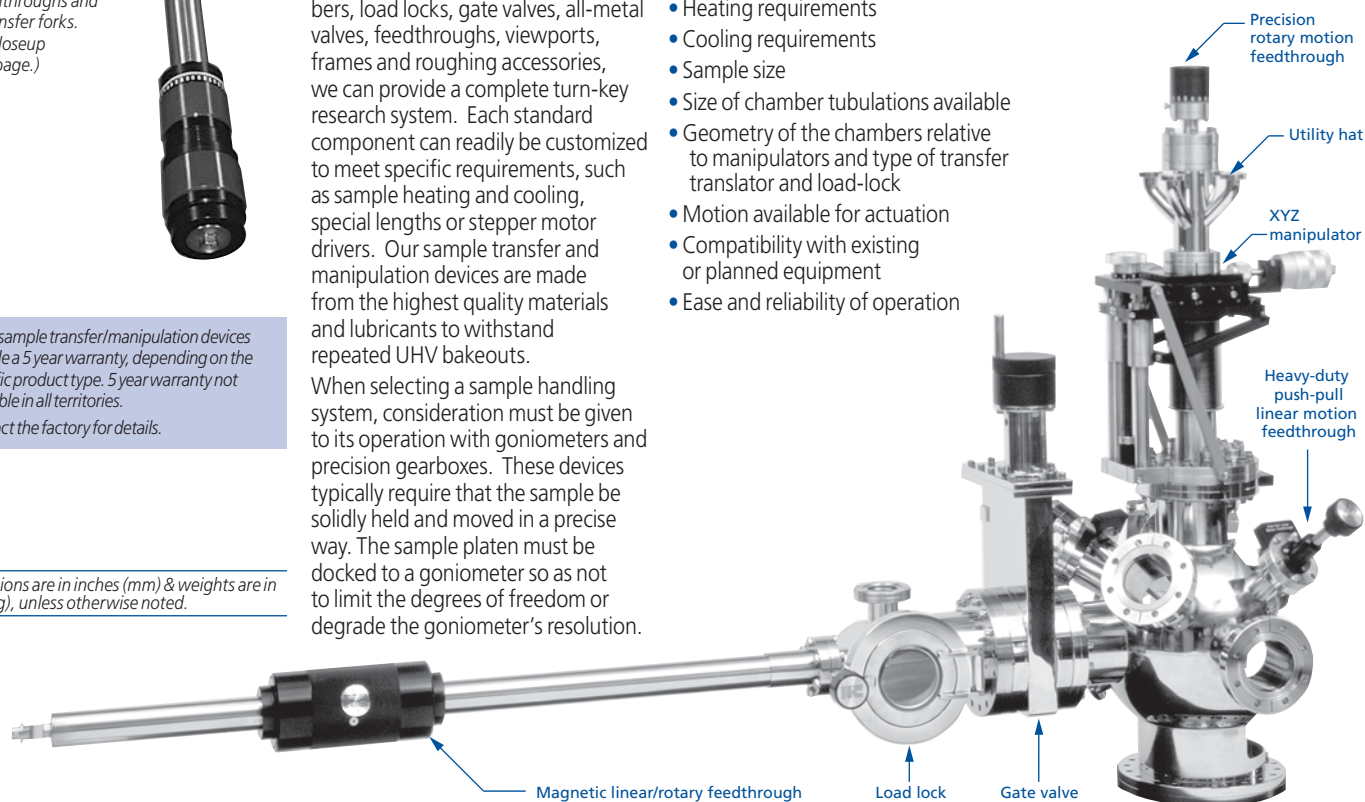
Nor-Cal Products offers the researcher complimentary devices for sample transfer and positioning in ultra-high vacuum systems. Combined with our vacuum chambers, load locks, gate valves, all-metal valves, feedthroughs, viewports, frames and roughing accessories, we can provide a complete turn-key research system. Each standard component can readily be customized to meet specific requirements, such as sample heating and cooling, special lengths or stepper motor drivers. Our sample transfer and manipulation devices are made from the highest quality materials and lubricants to withstand repeated UHV bakeouts.

When selecting a sample handling system, consideration must be given to its operation with goniometers and precision gearboxes. These devices typically require that the sample be solidly held and moved in a precise way. The sample platen must be docked to a goniometer so as not to limit the degrees of freedom or degrade the goniometer's resolution.

### Selecting a Sample Transfer System

The following list contains some of the many factors that influence the selection of a sample transfer system, which vary by application.

- Sample motion requirements
- Heating requirements
- Cooling requirements
- Sample size
- Size of chamber tubulations available
- Geometry of the chambers relative to manipulators and type of transfer translator and load-lock
- Motion available for actuation
- Compatibility with existing or planned equipment
- Ease and reliability of operation



## XYZ Manipulator

The XYZ manipulator is a 3-axis (X,Y,Z) positioning device which is typically mounted outside the vacuum chamber for most applications. A welded bellows provides a flexible vacuum curtain. The X axis passes in front of the vertical, mechanical structure, or "backframe," with the Y axis moving to and away from the backframe. The Z axis is perpendicular to the X and Y axes and moves up and down directly against the vacuum pressure differential. The polar axis is the same as the Z axis.

The limit of X and Y travel is normally a circular pattern with range indicated as a vector sum. This means a  $\pm .50$  inch (12.7mm) range of X and Y allows the polar axis to be moved anywhere inside a 1.00 inch (25.4mm) diameter circle. The sum of the X and Y vectors is limited to .50 inch (12.7mm). Square pattern XY stages are available as options on some models.

## Z Translator

A translator is a single axis positioning device, utilizing a bellows as a vacuum seal. Referred to as a "Z only" stage, this axis is normally perpendicular to the chamber. This causes the Z axis to work directly against the force from the pressure differential.

## XY Stage

The XY stage provides the X and Y axes only. No Z motion is available.

## Polar Rotation

The polar axis is the same as the Z axis. Rotation about the polar axis is commonly achieved by mounting a rotary feedthrough at the center of the traveling flange of a manipulator or translator. This degree of freedom can also be achieved with a differentially pumped rotary seal.

## Azimuthal Axis

The azimuthal axis is perpendicular to the polar axis. Sample azimuthal rotation refers to rotation of the sample about an axis normal to the sample face and perpendicular to the polar axis.

## Flip Motion

Flip motion is the changing of an axis normal to the sample face from parallel (or coaxial) to the polar axis to coaxial with the azimuthal axis. The range of this change of axis may be  $90^\circ$ ,  $180^\circ$  or full  $360^\circ$ .

## Tilt Motion

Tilt refers to changing the polar axis with respect to the X, Y and Z axes. This is usually done at the traveling flange of a 3-axis manipulator or other exterior mounting stage. Tilt range is often limited by the bellows ID and the OD of the probe passing through the bellows. The maximum angle practical is about  $\pm 7^\circ$ . When used in this manner, translation in X, Y and (slightly) Z will occur with adjustment of the tilt angle. Tilt stages are available in single or dual axis units.

## Sample Transfer & Heating

Sample transfer may reduce heating performance at high temperatures. The ideal transfer system for heating the sample to the highest temperatures should use thin sample plates made of appropriate material placed as close to the heater as possible. Thick, high mass, sample plates reduce thermal response and lower peak heating temperatures.

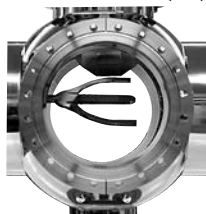
## Sample Transfer & Cooling

Sample transfer may reduce cooling performance at low temperatures. The ideal transfer system for cooling the sample to the lowest temperatures should use thin, highly conductive, sample plates that contact the dewar with a large surface area. Thick, high mass, sample plates reduce thermal response and reduce peak cooling performance.

## Transfer Components

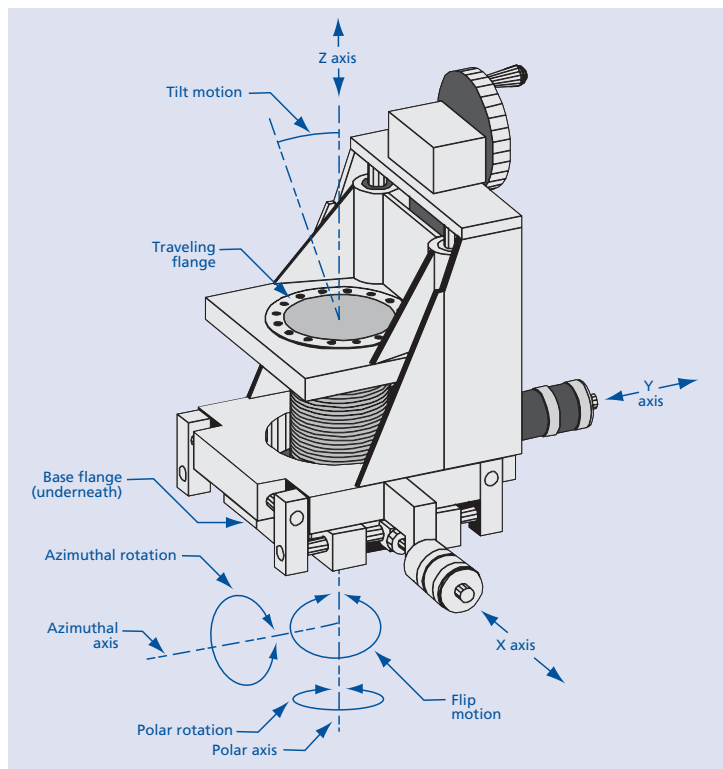
**Sample Platen** - the transferable plate that holds the sample

**Sample Fork** - attaches to a transfer arm from the load-lock and holds the sample platen



Sample transfer fork

**Sample Dock** - attaches to a work station (manipulator) and holds the platen for processing or positioning the sample



## Fork & Dock Configurations

**Axial Fork** - a sample fork with the plane of the sample platen face orthogonal to the axis of the transfer arm on which the fork is mounted

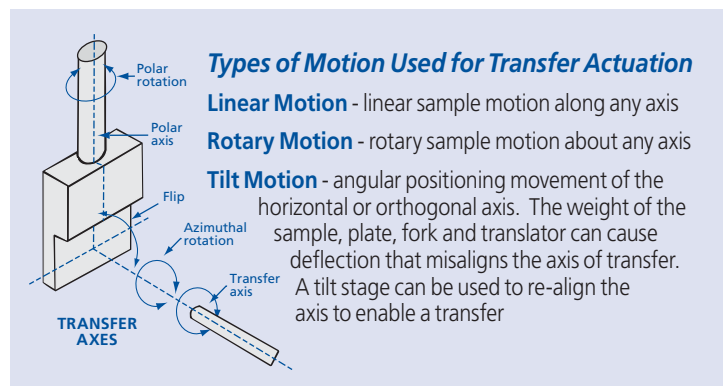
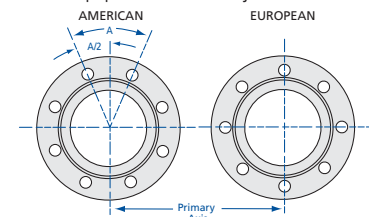
**Radial Fork** - a sample fork with the plane of the sample platen face parallel to the axis of the transfer arm on which the fork is mounted

**Axial Dock** - a sample dock with the plane of the sample platen face orthogonal to the axis of the manipulator on which the dock is mounted

**Radial Dock** - a sample dock with the plane of the sample platen face parallel to the axis of the manipulator to which the dock is mounted.

## Bolt Pattern Orientation

Our components are manufactured with the primary axis straddling adjacent bolt holes on the mounting flange (American standard). Most components can be furnished with the axis passing through a bolt hole axis (European standard) on request. Some equipment is field adjustable.



## Types of Motion Used for Transfer Actuation

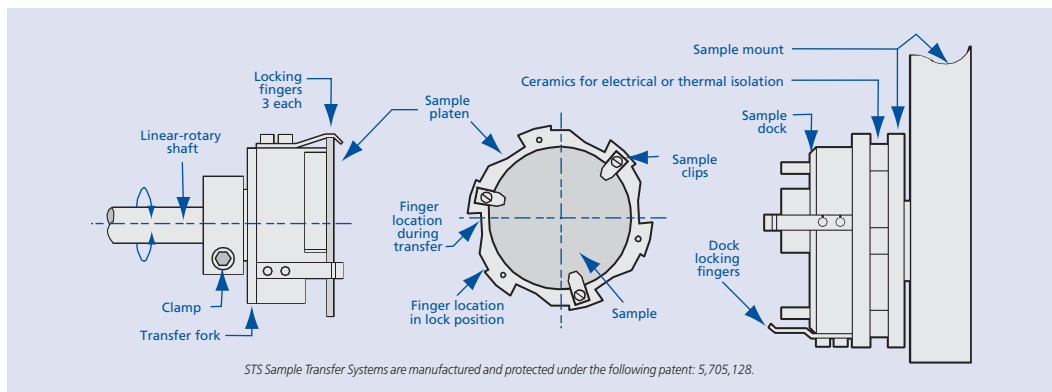
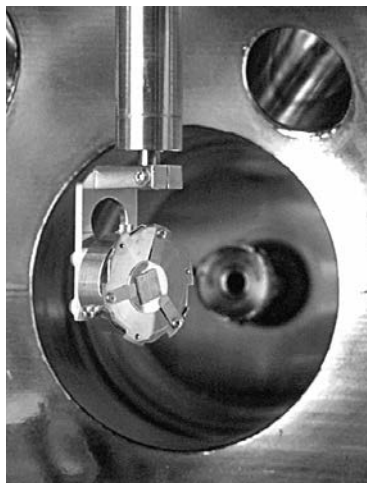
**Linear Motion** - linear sample motion along any axis

**Rotary Motion** - rotary sample motion about any axis

**Tilt Motion** - angular positioning movement of the horizontal or orthogonal axis. The weight of the sample, plate, fork and translator can cause deflection that misaligns the axis of transfer. A tilt stage can be used to re-align the axis to enable a transfer

# Sample Transfer & Manipulation

## Sample Transfer System & Load Lock Chamber



### Sample Transfer System

This sample transfer system uses thin (.040 inch) sample plates with six sawtooth shaped ramps, profiled on the plate's edge. The sample transfer probe is fitted with a fork consisting of three tab-shaped spring fingers positioned radially on a barrel. The sample plate locks on to the fork by rotating the fork's fingers over three of the six ramps. When the fork is rotated, the locking fingers slide up the ramps to stops. The plate is gripped by the spring fingers, holding it tight to the barrel of the fork.

Transferring the sample from the probe fork to a manipulator sample dock is done with a rotary motion. The dock has the same type of locking fingers as the fork. The plate is mated to the dock by orienting it so that the three unused ramps can receive the dock's fingers. Rotating the fork releases the plate at the same time the fingers on the dock grip and lock the plate to the manipulator. This rotary movement makes a smooth sample transfer from the fork to dock and back again.

Nor-Cal Products sample transfer system allows easy, forgiving sample transfer from a rotary/linear feedthrough to the sample dock mounted inside the chamber. Systems are available for sample sizes ranging from 1/2 inch (12.7mm) to 3 inches (76.2mm). Each system includes a dock assembly custom fitted to place the sample on target in your particular chamber, a transfer fork assembly which mounts to a rotary/linear device and two stainless steel sample plates. Molybdenum sample plates are also available. Call for details and pricing.

#### Features

- Fast thermal response and greater extremes
- Larger samples may be introduced through smaller ID plumbing
- Excellent sample plane repeatability
- Adapts to most goniometers and precision gearboxes
- Excellent performance for direct and indirect cooling
- Transferable thermocouple, optional
- Transferable intrinsic direct heating
- Five-year guarantee

MODEL NUMBER	SAMPLE OD	MINIMUM PORT OD
<b>STS-050</b>	1/2 (12.7)	1 1/2 (38.1)
<b>STS-100</b>	1 (25.4)	1 1/2 (38.1)
<b>STS-200</b>	2 (50.8)	2 1/2 (63.5)
<b>STS-300</b>	3 (76.2)	4 (101.6)

### Load Lock Chamber

Load lock chambers are an efficient means to introduce a sample into a vacuum chamber without impacting the main chamber vacuum. Load Locks are provided with a six inch CF flange for mounting to the gate valve, a six inch Add-A-Door with 7056 glass viewport, a 2 3/4 inch (70mm) CF flange for attachment of the linear feedthrough, and two 2 3/4 inch (70mm) CF flanges for pumping and gauges. Standard finish is electropolished. Custom sizes and configurations are readily available. Call for pricing.

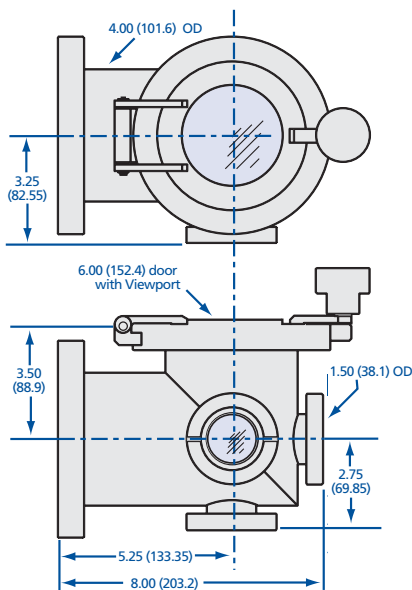
**MODEL NUMBER**  
**LL-600-ADV-150-3**

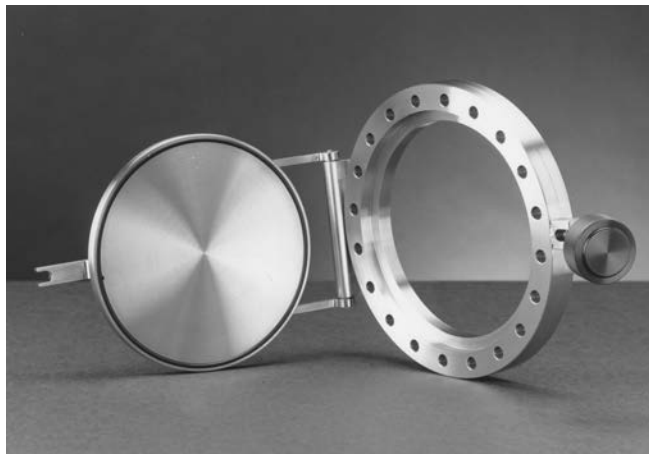
#### SPECIFICATIONS

**Construction**  
Flanges: 304 stainless steel  
Body: 304 stainless steel  
Viewport: 7056 glass  
O-ring: FKM

**Temperature range:** -20°C to 200°C

**Vacuum range:**  $\geq 10^{-8}$  mbar (High vacuum)





An Add-A-Door can provide easy access to a vacuum system when elastomer seals are acceptable. The hinged, FKM sealed door is quickly bolted to an existing CF (Conflat style) flanged chamber port. The door is opened easily by turning a knurled knob. These doors are available for 2<sup>3</sup>/<sub>4</sub> to 10 inch (70 to 254mm) OD flanges with a solid metal door or with a viewport. The standard finish is electropolish. Custom sizes can be supplied upon request.

### SPECIFICATIONS

#### Construction

Body: 304 stainless steel  
Flange: 2<sup>3</sup>/<sub>4</sub> to 10 inch (70 to 254mm) CF  
Door: Blank, 7056 glass, or fused silica  
O-ring: FKM standard

Temperature range: -20°C to 200°C

Vacuum range:  $\geq 10^{-8}$  mbar (High vacuum)

### Add-A-Doors

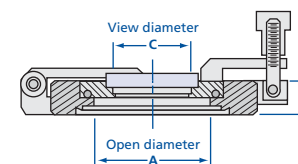
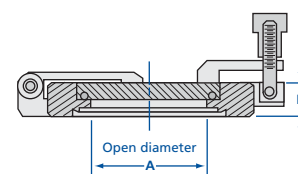
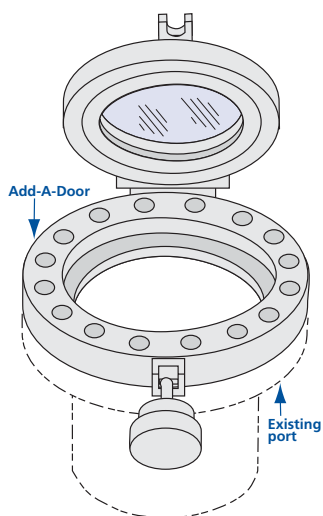
MODEL NUMBER	FLANGE TYPE	A	B
AD-275	2.75 CF	1.380 (35.05)	0.500 (12.70)
AD-450	4.50 CF	2.435 (61.85)	0.687 (17.45)
AD-600	6.00 CF	3.917 (99.49)	0.781 (19.84)
AD-800	8.00 CF	5.875 (149.23)	0.875 (22.23)
AD-1000	10.00 CF	7.875 (200.03)	0.968 (24.59)

### Add-A-Doors with Viewport – 7056 Glass

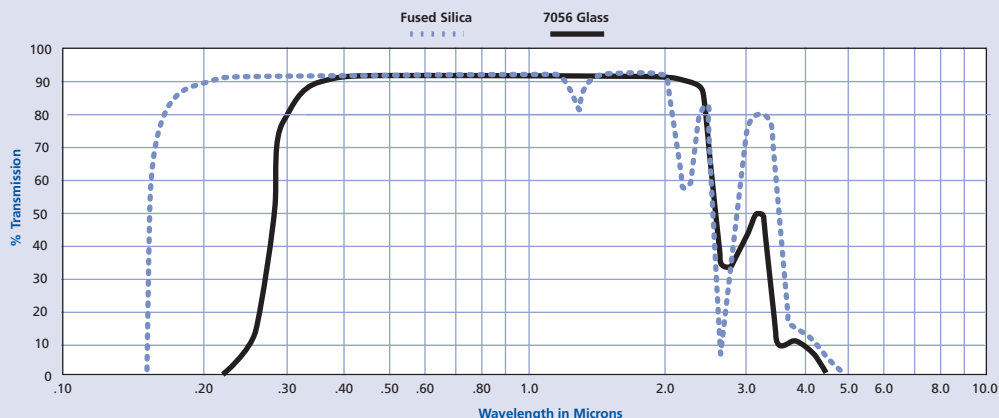
MODEL NUMBER	FLANGE TYPE	A	B	C
ADV-450	4.50 CF	2.435 (61.85)	0.687 (17.45)	1.49 (37.85)
ADV-600	6.00 CF	3.917 (99.49)	0.781 (19.84)	2.65 (67.31)
ADV-800	8.00 CF	5.875 (149.23)	0.875 (22.23)	3.88 (98.55)
ADV-1000	10.00 CF	7.875 (200.03)	0.968 (24.59)	5.60 (142.24)

### Add-A-Doors with Viewport – Fused Silica

MODEL NUMBER	FLANGE TYPE	A	B	C
ADVQ-450	4.50 CF	2.435 (61.85)	0.687 (17.45)	1.40 (35.56)
ADVQ-600	6.00 CF	3.917 (99.49)	0.781 (19.84)	2.69 (68.33)
ADVQ-800	8.00 CF	5.875 (149.23)	0.875 (22.23)	3.88 (98.55)
ADVQ-1000	10.00 CF	7.875 (200.03)	0.968 (24.59)	5.38 (136.65)



### Viewport Optical Transmission Curves



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Sample Transfer & Manipulation

## Manipulators, Stages & Translators

### SPECIFICATIONS

#### Construction

**Bellows:** 1 7/8 inch (47.63mm) ID  
**Base flange:** 6 inch (152.4mm) CF, clearance holes with 5 mini flanges  
**Traveling flange:** 2 3/4 inch (69.85mm) CF, tapped holes  
**Guide rods:** Dual 3/4 inch (19.05mm) OD hardened stainless steel  
**Stage:** Aluminum

#### Motion

**XY travel:** ± 1/2 inch (12.7mm), circular pattern, pre-loaded large drum micrometer stage coupling with .0001 inch (.003) divisions  
**Z travel:** 2 inch (50.8mm), Acme drive with 2 inch (50.8mm) diameter drive knob (0.10 inch (2.54mm) per turn)

**Operating orientation:** Any; maximum payload 10lbs (4.54mm) when horizontally mounted

#### Temperature

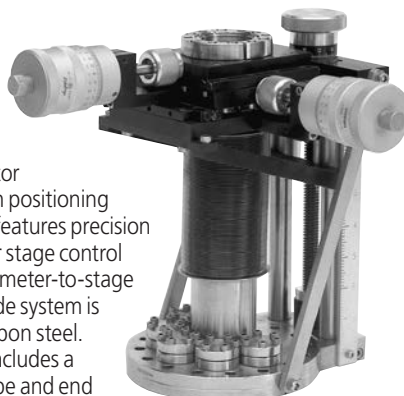
**Maximum bakeout:** 150°C, fully assembled  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Options:** Support tube

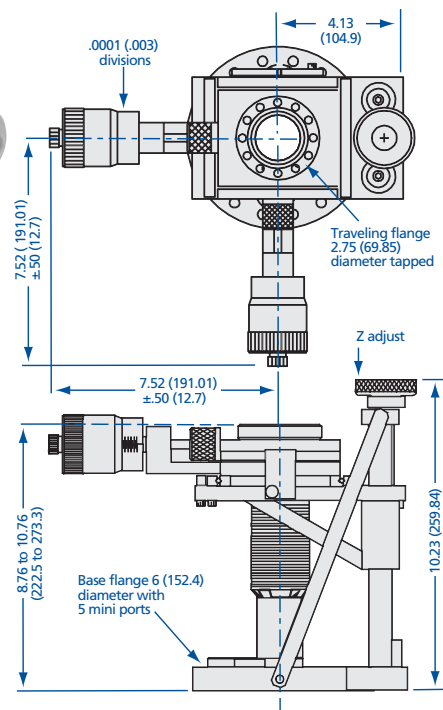
### XYZ Precision Manipulator

The PMXYZ manipulator provides high precision positioning at a minimum cost. It features precision pre-loaded cross-roller stage control with pre-loaded micrometer-to-stage coupling. The X-Y guide system is made of hardened carbon steel. Support tube option includes a 3/4 inch (19.05) OD tube and end bearing support. This increases rigidity on longer rotary shafts.



MODEL NUMBER	DESCRIPTION
PMXYZ-600-1.87-2	XYZ manipulator
-ST.25	1/4 inch (6.35) rotary shaft support tube*
-ST.38	3/8 inch (9.53) rotary shaft support tube*

\*Note: Add support tube option model number to the manipulator's model number. Example: PMXYZ-600-1.87-2-ST.38



### XY Stages with Bellows

XY stages are used to provide precise two-axis sample transfer positioning.

### SPECIFICATIONS

#### Construction

**Bellows:** Edge welded stainless steel  
**Base flange:** CF, clearance holes  
**Traveling flange:** CF, tapped holes  
**Way bearings:** Precision linear

#### Motion

**XY travel:** ± 1/2 to 1 inch (12.7 to 25.4mm), circular pattern, pre-loaded large drum micrometer stage coupling with 0.0001 inch (.003mm) divisions

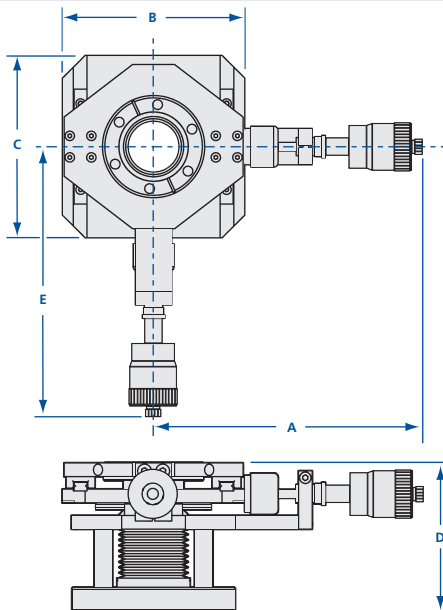
**Operating orientation:** Any; maximum payload 10 lbs (4.54kg) when horizontally mounted

#### Temperature

**Maximum bakeout:** 150°C, fully assembled  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

MODEL NUMBER	FLANGE TYPE	BELLOWS ID	XY TRAVEL	A	B	C	D	E
PMXY-275-139-1	2 3/4 CF	1.39 (35.31)	± 1/2 (12.07)	7.386 (187.60)	5.000 (127.00)	5.000 (127.00)	4.100 (104.14)	7.386 (187.60)
PMXY-450-200-1	4 1/2 CF	2.00 (50.80)	± 1/2 (12.07)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-450-250-1	4 1/2 CF	2.50 (63.50)	± 1/2 (12.07)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-450-250-2	4 1/2 CF	2.50 (63.50)	± 1 (25.40)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-600-300-1	6 CF	3.00 (76.20)	± 1/2 (12.07)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)
PMXY-600-300-2	6 CF	3.00 (76.20)	± 1 (25.40)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)
PMXY-600-400-1	6 CF	4.00 (101.60)	± 1/2 (12.07)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.85)	11.087 (281.61)
PMXY-600-400-2	6 CF	4.00 (101.60)	± 1 (25.40)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)

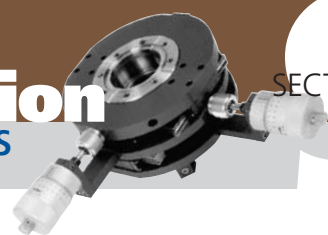


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Sample Transfer & Manipulation

## Manipulators, Stages & Translators

SECTION 9.4



### Z-Translators

Nor-Cal Products Z Translators feature a compact, yet stable, linear motion design suitable for a variety of applications including use with our differentially pumped rotary seals. Z Translators may also be used with feedthrough utility hats and rotary motion feedthroughs.

MODEL NUMBER	DIAGRAM	TRAVELING FLANGE	BELLOWS ID	Z STROKE	BASE FLANGE	A	B	C	MIN.-MAX. D & E
MZ-275-153-2	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	2	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-153-4	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	4	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-153-6	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	6	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-2	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	2	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-4	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	4	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-6	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	6	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-2	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	2	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-4	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	4	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-6	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	6	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-600-300-2	B	6 (152.40)	3.00 (76.20)	2	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-300-4	B	6 (152.40)	3.00 (76.20)	4	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-300-6	B	6 (152.40)	3.00 (76.20)	6	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-2	B	6 (152.40)	4.00 (101.60)	2	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-4	B	6 (152.40)	4.00 (101.60)	4	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-6	B	6 (152.40)	4.00 (101.60)	6	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call

### SPECIFICATIONS

#### Construction

Bellows: 1.04 to 4 inch (26.42 to 101.6mm)  
ID edge welded stainless steel  
Base flange: 2<sup>3</sup>/<sub>4</sub> to 6 inch (70 to 152.4mm) CF, clearance holes  
Traveling flange: 2<sup>3</sup>/<sub>4</sub> to 6 inch (70 to 152.4mm) CF, tapped holes  
Guide rods: Dual 3/4 inch (19.05mm) OD hardened stainless steel  
Stage: Aluminum

**Motion:** 2 to 6 inches (50.8 to 152.4mm) Z travel, Acme drive with position indicator scale

**Operating orientation:** Any

#### Temperature

Maximum bakeout: 150°C, fully assembled  
Operating: 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

Diagram A

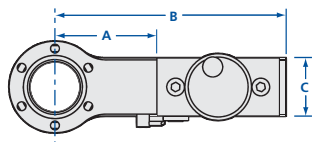
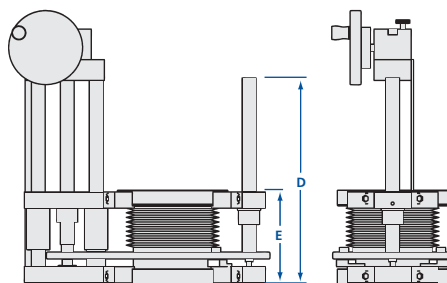
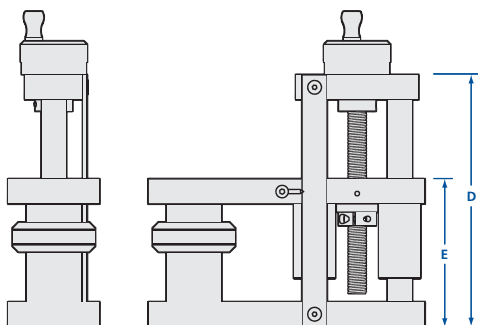
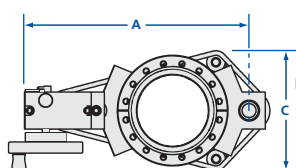
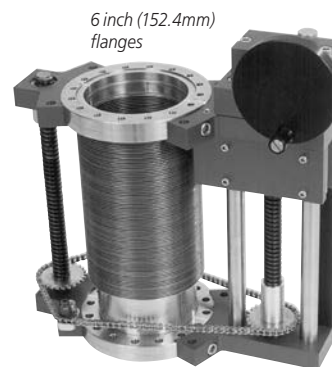


Diagram B



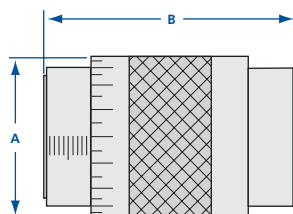
2<sup>3</sup>/<sub>4</sub> and 4 inch (70 and 101.6mm) flanges



### Linear Motion Thimbles

The compact design and reliable operation of these linear motion thimbles allows precision linear probe positioning to distances up to 2 inches (50.8mm). Features include a clear bore design with a stainless steel welded bellows. The anodized aluminum collar is threaded to perform linear movement.

MODEL NUMBER	NOMINAL OD A	MINIMUM - MAXIMUM B	ID
LMT-133	1 <sup>3</sup> / <sub>4</sub> (44.45)	1.800 - 2.800 (45.72 - 71.12)	0.54 (13.72)
LMT-275	3 <sup>1</sup> / <sub>4</sub> (82.55)	3.060 - 5.060 (77.72 - 128.52)	1.43 (36.32)



### SPECIFICATIONS

#### Construction

Bellows: 0.54 or 1.43 inch (13.72 or 36.32mm)  
ID stainless steel  
Flanges: 1<sup>1</sup>/<sub>3</sub> or 2<sup>3</sup>/<sub>4</sub> inch (34 or 70mm) CF, tapped holes  
Collar: Anodized aluminum

**Motion:** Up to 2 inches (50.8mm) linear movement, 360° graduations laser engraved on the collar

**Temperature range:** -20°C to 350°C

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)



# Sample Transfer & Manipulation

## Utility Hat & Alignment Gimbals

### SPECIFICATIONS

#### Construction

Material: 304 stainless steel  
Flanges: CF, tapped and clearance holes  
see diagram for details  
Finish: Electropolished

Operating orientation: Any

Temperature range: -200°C to 450°C

Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

### Utility Hat

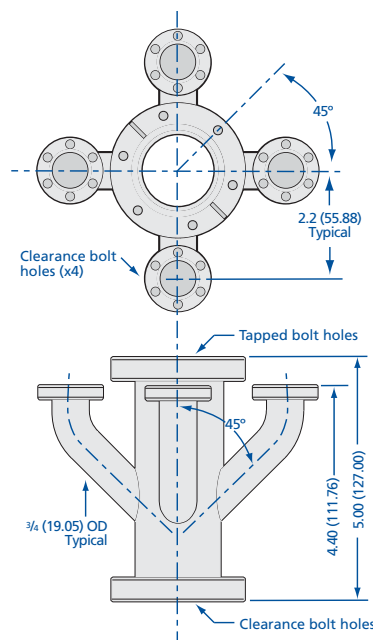
Feedthroughs can be mounted to the base flange of the XYZ Manipulator or to a utility hat.

A utility hat is the preferred method when X-Y movements of the sample will cause excessive flexing and abrading of utility lines in vacuum. The utility hat can be mounted between the precision rotary feedthrough and the traveling flange on top of the XYZ to provide X-Y movement of utility lines with the sample. Additionally, the utility hat can be used on top of a differentially pumped rotary seal to allow 360° polar rotation of utility lines along with the sample. (See photo next page.) The standard utility hat comes with a 1 $\frac{3}{4}$  inch (44.45mm) tube, two 2 $\frac{3}{4}$  inch (69.85mm) CF flanges and four 1 $\frac{1}{3}$  inch (34mm) CF ports for mounting feedthroughs.

Standard finish is electropolish. Custom sizes can be supplied upon request.

#### MODEL NUMBER

UH-175-2-133-4



### SPECIFICATIONS

#### Construction

Bellows: 1 $\frac{1}{2}$  inch (38.1mm) ID stainless steel  
Flanges: 2 $\frac{3}{4}$  inch (70mm) CF, tapped holes  
Pivots: Roller bearing

Motion:  $\pm 5^\circ$  XY adjustment range, knurled knob adjustment

Operating orientation: Any

#### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

Options: Micrometers "-M1" and "-M2"

### Alignment Gimbals

Alignment gimbals allow a precise angle alignment to be established (and repeated) between two flanges.

When the base flange of a gimbal is attached to the chamber flange (or traveling stage of a positioning device) and a probe is attached to the tilting flange, probe angle and tip position can be changed. Alignment gimbals were designed as an inexpensive method to align docking systems and actuate sample transfers. Gimbals cantilever the (horizontal) load when the linear feedthrough flange and the load lock are horizontally mounted and can also compensate for droop in long horizontal mounted linear feedthrough probes. Single axis alignment gimbals are also available. Call for pricing and availability.

#### MODEL NUMBER

AG-275-150

#### DESCRIPTION

Knurled knob adjustment on both axes

AG-275-150-M1

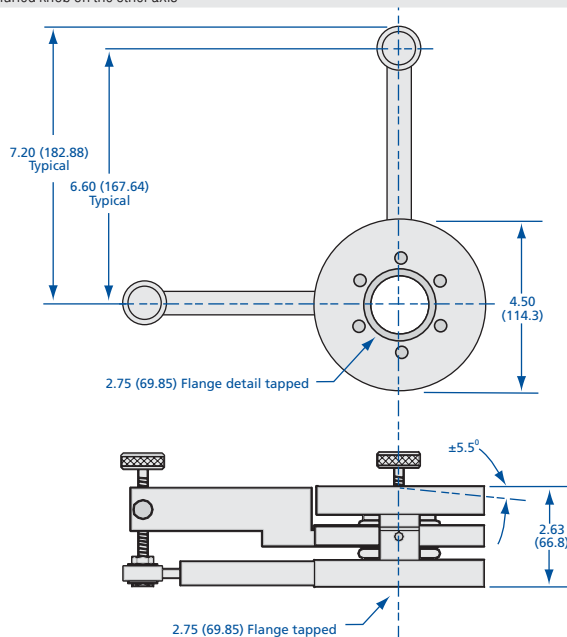
Micrometer adjustment on one axis, knurled knob on the other axis

AG-275-150-M2

Micrometer adjustment on both axes



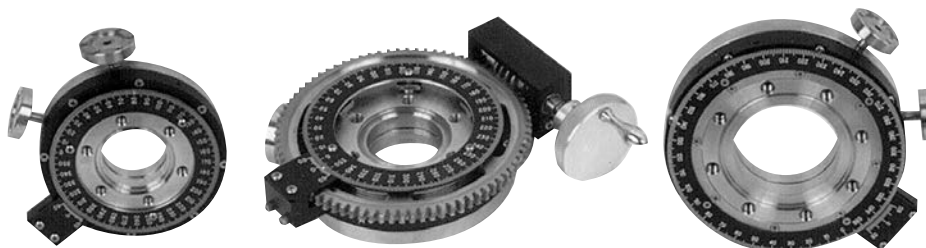
Shown with micrometer option "-M2"



# Sample Transfer & Manipulation

## Rotary Motion Feedthroughs

SECTION 9.6



### Differentially Pumped Rotary Seals

Differentially pumped rotary seals provide 360° of continuous rotation through the vacuum wall of a UHV system. They have two stages of differential pumping isolated by graphite-impregnated, expanded, PTFE seals on special sealing surfaces. A pre-loaded ball bearing set accurately controls the rotating stage position, allowing the unit to be successfully used with manipulators and other precision positioning devices. For easier and more accurate angle adjustment, a worm drive fine adjust option is available. Rotary seals are also available with an anti-backlash stepping or synchronous motor drive. Sizes up to 4 inch (101.6mm) ID are standard, while larger sizes are available on request.

#### SPECIFICATIONS

##### Construction

Flanges: CF, tapped holes, one rotational and one stationary  
T-wrench included for adjustment

**Motion:** 360° rotation, two stage, differentially pumped with 360° vernier scale

**Operating orientation:** Any

##### Temperature

Maximum bakeout: 150°C  
Operating: 20°C (ambient)

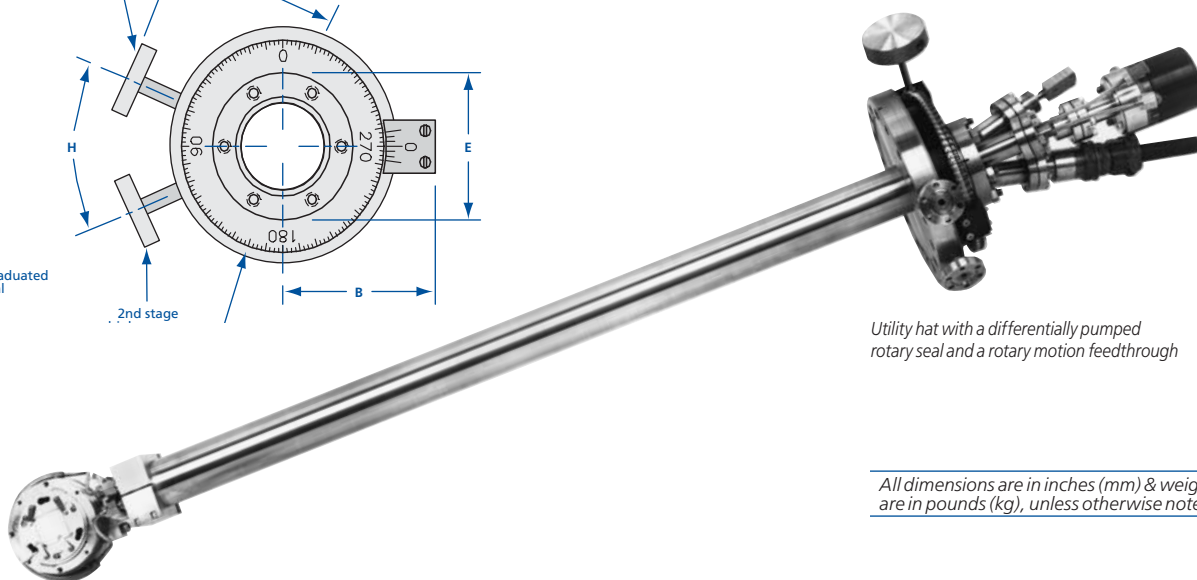
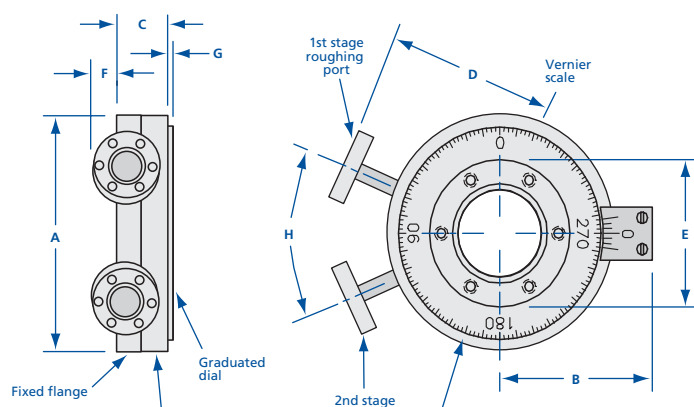
**Vacuum range:**  $\geq 10^{-11}$  mbar (UHV)

**Readability:** Standard scale 1.0°, mechanical counter 0.1°, micro stepped motor drive required for maximum resolution

**Options:** Fine adjust worm drive "-W", digital counters, stepper motors and other sizes available

MODEL NUMBER	ID	NOMINAL OD	A	B	C	D	E	F	G	H	VERTICAL PAYLOAD*	HORIZONTAL PAYLOAD*
<b>RS-150</b>	1.53 (38.86)	2 <sup>3</sup> / <sub>4</sub> (69.85)	4.50 (114.30)	2.99 (75.95)	1.00 (25.40)	3.18 (80.77)	2.75 (69.85)	0.49 (12.45)	0.13 (3.30)	60°	54 (24.3)	30 (13.5)
<b>RS-150-W</b>	1.53 (38.86)	2 <sup>3</sup> / <sub>4</sub> (69.85)	5.13 (130.30)	3.38 (85.85)	1.00 (25.40)	4.95 (125.73)	2.75 (69.85)	0.49 (12.45)	0.37 (9.40)	60°	54 (24.3)	30 (13.5)
<b>RS-250</b>	2.53 (64.26)	4 <sup>1</sup> / <sub>2</sub> (114.3)	5.75 (146.05)	3.64 (92.46)	1.36 (34.54)	3.58 (90.93)	4.50 (114.30)	0.49 (12.45)	0.03 (0.76)	45°	90 (40.5)	38 (17.1)
<b>RS-250-W</b>	2.53 (64.26)	4 <sup>1</sup> / <sub>2</sub> (114.30)	6.38 (162.05)	4.20 (106.68)	1.36 (34.54)	6.11 (155.19)	4.50 (114.30)	0.49 (12.45)	0.41 (10.41)	45°	90 (40.5)	38 (17.1)
<b>RS-400</b>	4.03 (102.36)	6 (152.40)	7.75 (196.85)	4.57 (116.08)	1.68 (42.67)	4.34 (110.24)	6.02 (152.91)	0.37 (9.40)	0.06 (1.52)	45°	144 (64.8)	66 (29.7)
<b>RS-400-W</b>	4.03 (102.36)	6 (152.40)	8.50 (215.90)	8.25 (209.55)	1.68 (42.67)	9.28 (235.71)	6.02 (152.91)	0.37 (9.40)	0.54 (13.72)	45°	144 (64.8)	66 (29.7)

\*Note: Standard maximum payloads with center of gravity within 10% of the RS ID from the RS centerline when vertical, within one ID of the RS from the RS flange face when horizontal, and certain other size restrictions are met – consult factory.



Utility hat with a differentially pumped rotary seal and a rotary motion feedthrough

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Sample Transfer & Manipulation

## Rotary Motion Feedthroughs

### Motorized Rare Earth Magnetic Rotary Motion Feedthrough

The rare earth magnetic series rotary drives are designed to provide exceptional, long life performance. They are UHV compatible and are an excellent option to conventional bellows sealed and other rotary devices. They can be adapted to pulsed laser deposition (PLD) target clocking and continuous rotation of targets and substrates, as well as applications that require small profiles and high performance. There are no sliding seals or magnets in vacuum and stray magnetic fields are virtually nonexistent. The in-vacuum armature is made of paramagnetic materials with stainless steel and silicon nitride bearings and is capable of repeated bake-out to 200°C with magnets removed. Out-of-vacuum bearings are accessible for lubrication and the magnet drive is easily removable.

#### SPECIFICATIONS

##### Construction

**Mounting flange:** 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
**Rotary probe:** 3/8 inch (9.53mm)  
**Drive:** Motor drive with controller, manual drive knob with position lock  
**Bearings:** 4,000,000 revolutions before service

**Motion:** 360° continuous with variable speed

**Operating orientation:** Any

##### Temperature

**Maximum bakeout:** 200°C, with drive removed  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

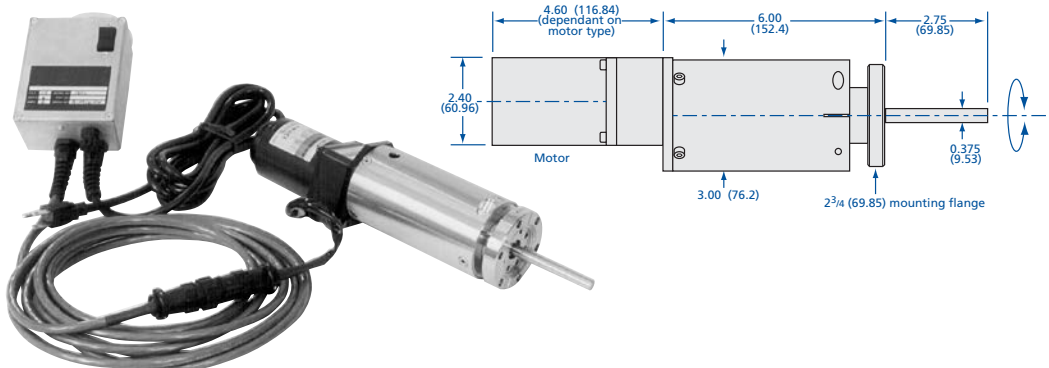
##### Torque

**Motor:** 50 ounce-inches (.353 Nm)  
**Feedthrough:** 150 ounce-inches (1.059 Nm)

**Speed:** 5 to 95 RPM

**Options:** Higher torque motors, different speed ranges

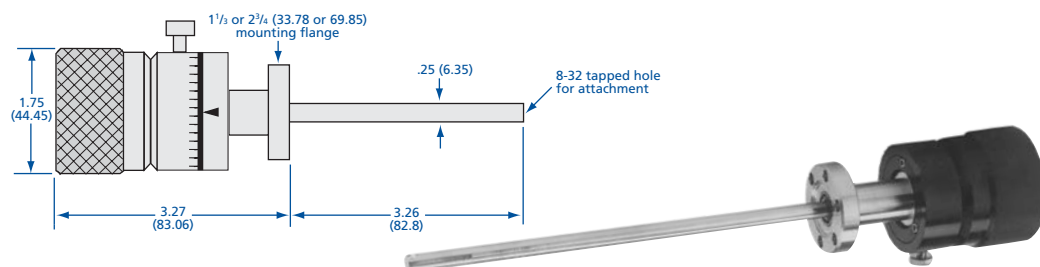
MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
MRRE-275-038	2.75 CF	0.375 (9.53)	2.75 (69.85)



### 1/4 Inch Precision Rotary Motion Feedthroughs

Precision rotary feedthroughs provide 360° continuous rotation and may be used to define a polar axis for a sample or probe or to actuate a mechanical device, such as a shutter, inside the vacuum chamber. Typically used for polar rotation on top of an XYZ manipulator.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
PRM-133	1.33 CF	0.25 (6.35)	3.26 (82.80)
PRM-275	2.75 CF	0.25 (6.35)	3.26 (82.80)



#### SPECIFICATIONS

##### Construction

**Bellows:** Welded stainless steel  
**Mounting flange:** 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
**Rotary shaft:** 3/8 inch (9.53mm)  
**Drive:** Manually actuated

**Motion:** 360° continuous, 0.10° resolution (1° graduations on dial), maximum run-out 0.005 inches (.13mm)

**Operating orientation:** Any

##### Temperature

**Maximum bakeout:** 200°C  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

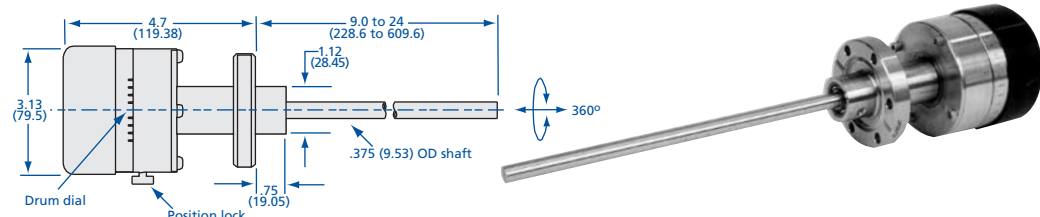
**Torque:** 1,100 ounce-inches (7.768 Nm)

**Options:** Custom shaft lengths: 9 to 23 inches (228.6 to 584.2mm). Change model number suffix "-24" Additional charges will apply. Example: PRM-275-038-12 (indicates 12 inch (304.8mm) shaft), field-mountable shaft extensions, fine adjust and motor drives

### 3/8 Inch Precision Rotary Motion Feedthrough

Precision rotary feedthroughs are commonly used to define a polar axis for a sample or probe. They provide 360° continuous rotation and are mounted on top of XYZ manipulators and other stages. They are also used separately where precision angular orientation is needed.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
PRM-275-038-24	2.75 CF	3/8 (9.53)	24.00 (609.60)



# Sample Transfer & Manipulation

## Linear Motion Feedthroughs

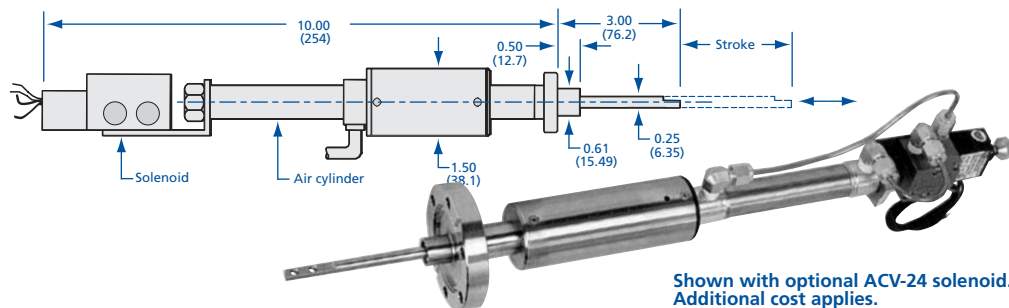
SECTION 9.6

### Pneumatically Actuated Linear Motion Feedthrough

Commonly used as positioning devices for shutters and beam stoppers.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	TRAVEL
ALM-133-2	1.33 CF	0.25 (6.35)	2 (50.80)
ALM-133-4	1.33 CF	0.25 (6.35)	4 (101.60)

ACV-24 Solenoid



Shown with optional ACV-24 solenoid. Additional cost applies.

#### SPECIFICATIONS

##### Construction

Bellows: Welded stainless steel, sealed  
Mounting flange: 1 1/3 (34mm) CF, clearance holes  
Linear probe: 1/4 inch (6.35mm) OD  
Cylinder: 3/4 inch (19.05mm) ID  
Bushing: Macor

##### Motion

Linear: 2 to 4 inch (50.8 to 101.6mm) travel, pneumatically actuated  
Operating air pressure: 50 to 150 psi

##### Operating orientation: Any

##### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

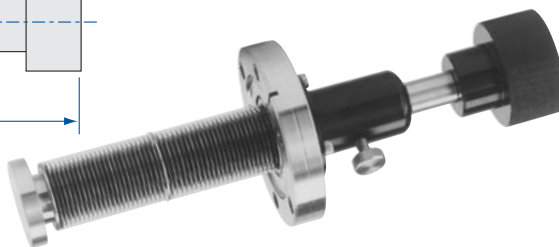
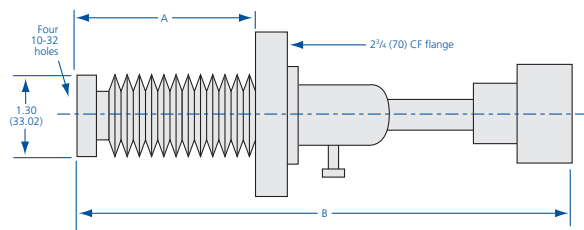
##### Vacuum range: $\geq 10^{-10}$ mbar (UHV)

Options: 2 3/4 inch (69.85) OD flange, solenoid 24VDC or per customer requirements

### Heavy-Duty Push-Pull Linear Motion Feedthroughs

Manually operated linear motion positioning device designed for UHV applications.

MODEL NUMBER	FLANGE TYPE	TRAVEL	MINIMUM – MAXIMUM A	B
HLM-275-2	2.75 CF	2 (50.80)	1.1 - 3.1 (27.94 - 78.74)	6.75 (171.45)
HLM-275-3	2.75 CF	3 (76.20)	1.4 - 4.4 (35.56 - 111.76)	8.07 (204.98)
HLM-275-4	2.75 CF	4 (101.60)	1.7 - 5.7 (43.18 - 144.78)	9.38 (238.25)



#### SPECIFICATIONS

##### Construction

Bellows: Welded stainless steel, sealed  
Mounting Flange: 2 3/4 (70mm) CF, clearance holes

Motion: 2, 3 and 4 inch (50.08, 76.2 and 101.6mm) linear travel with

##### Operating orientation: Any

##### Temperature range: -20°C to 250°C

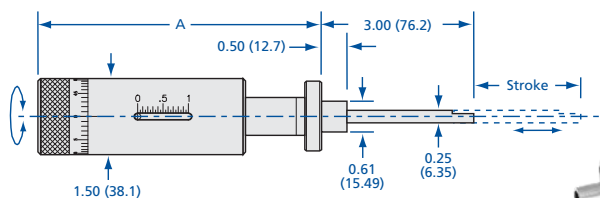
##### Vacuum range: $\geq 10^{-10}$ mbar (UHV)

##### Maximum lateral load: 20 pounds

### Linear Vacuum Feedthrough

Manually operated linear motion positioning device with rotary actuation.

MODEL NUMBER	FLANGE TYPE	LINEAR TRAVEL	SHAFT OD
RLM-133-2	1.33 CF	2 (50.80)	0.25 (6.35)
RLM-133-4	1.33 CF	4 (101.60)	0.25 (6.35)
RLM-275-2	2.75 CF	2 (50.80)	0.25 (6.35)
RLM-275-4	2.75 CF	4 (101.60)	0.25 (6.35)



#### SPECIFICATIONS

##### Construction

Bellows: Welded stainless steel, sealed  
Mounting flange: 1 1/3 or 2 3/4 (34 or 70mm) CF, clearance holes  
Linear shaft: 1/4 inch (6.35mm) OD  
Drive: All ball bearing

Motion: 2 or 4 inch (50.8 or 101.6mm) linear travel, 20 turns/inch (25.4) rotary actuation, position indicator

##### Operating orientation: Any

##### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

##### Vacuum range: $\geq 10^{-10}$ mbar (UHV)

##### Options: Longer strokes

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Sample Transfer & Manipulation

## Linear/Rotary Motion Feedthroughs

### SPECIFICATIONS

#### Construction

Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
 Probe: 1/2 inch (12.7mm) OD stainless steel tubular probe  
 Drive: Removable neodymium iron boron magnet  
 Bearings: 8 stainless steel

#### Motion

Linear: 24 and 36 inch (609.6 and 914.4mm), adjustable stops  
 Rotary: 360° continuous rotation, with 0° to 360° indication

Operating orientation: Horizontal

#### Maximum temperature:

200°C with drive removed

Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

Linear force: 4 pounds (1.8 kg)

Torque: 150 ounce-inches (1.059 Nm)

Options: Light-touch magnet (-LT)

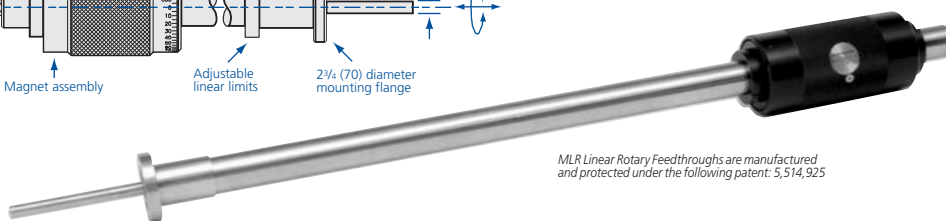
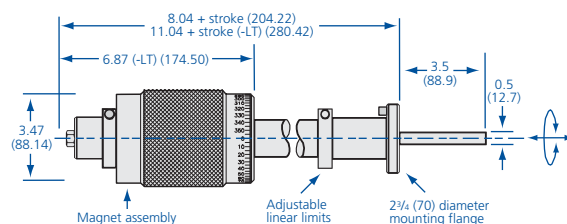
### Magnetic Linear/Rotary Feedthrough

Magnetically coupled feedthroughs offer exceptional linear/rotary motion for short to medium stroke sample introduction and transfer of light loads. The standard magnetic driver package provides more than 150 ounce-inches (1.059 Nm) of torque and four pounds of linear force. The inside traveler has no magnets, but it is made of magnetically permeable material.

#### LIGHT-TOUCH MAGNET ASSEMBLY OPTION (-LT)

- Utilizes dynamically loaded full-bearing support to increase tactile feedback
- Heavy-duty linear magnet driver increases linear force to 15 pounds (6.75 kg)

MODEL NUMBER	DESCRIPTION
MLR-275-050-24	24 inch (609.6) stroke
MLR-275-050-36	36 inch (914.4) stroke
-LT	Light-touch magnet assembly option (Add -LT to the model number)



MLR Linear Rotary Feedthroughs are manufactured and protected under the following patent: 5,514,925

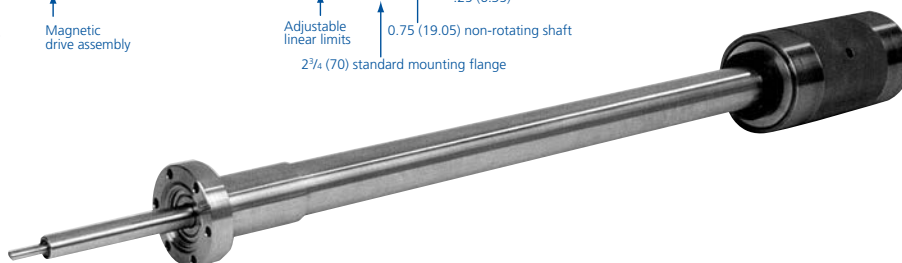
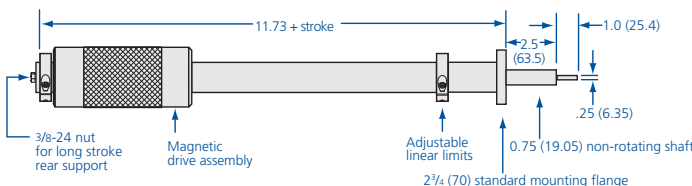
### Coaxial Magnetic Linear/Rotary Feedthrough

Magnetically-coupled linear/rotary feedthroughs offer unparalleled smooth rotary motion for medium to long stroke sample introduction and transfer of light loads. The coaxial design features a 3/4 inch (19.05mm) linear support tube with rotary bearing in the tip to guide the 1/4 inch (6.35mm) rotary probe. In addition to rotary motion, the design includes a linear driver, for additional axial force and tactile feedback.

#### SOFT-TOUCH MAGNET ASSEMBLY OPTION (-ST)

- Soft touch magnet assembly utilizes dynamically loaded full-bearing support to increase tactile feedback.

MODEL NUMBER	DESCRIPTION
MLRC-275-36	36 inch (914.4) stroke
MLRC-275-42	42 inch (1066.8) stroke
MLRC-275-48	48 inch (1219.2) stroke
-ST	Soft-touch magnet assembly option (Add -ST to model number)

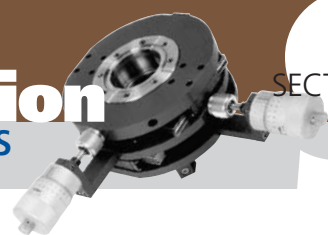


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Sample Transfer & Manipulation

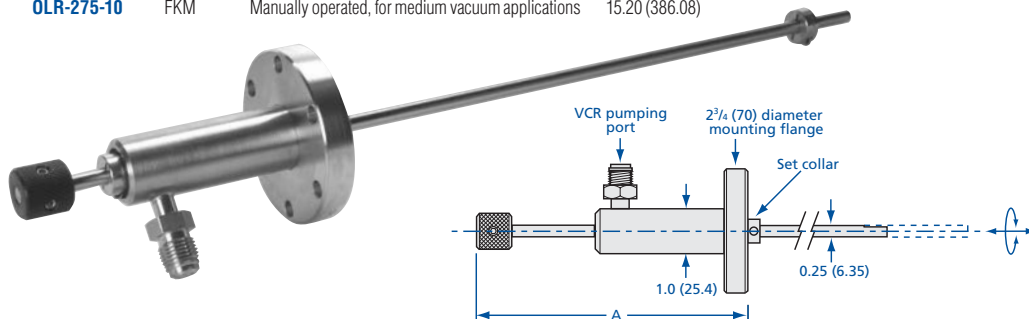
## Linear/Rotary Motion Feedthroughs

SECTION 9.6



### Differentially Pumped Linear/Rotary Motion Feedthrough

MODEL NUMBER	SEAL	DESCRIPTION	MAXIMUM A
OLR-275-10	FKM	Manually operated, for medium vacuum applications	15.20 (386.08)



#### SPECIFICATIONS

##### Construction

Feedthrough: stainless steel  
Mounting flange: 2 3/4 (70mm) CF, clearance holes  
Probe: 1/4 inch (6.35mm) OD  
Seal: Differentially pumped FKM O-ring  
Body insert: PTFE

##### Motion

Linear: 10 inch (254mm), clamp type stop collar  
Other lengths available on request.  
Rotary: 360° continuous rotation

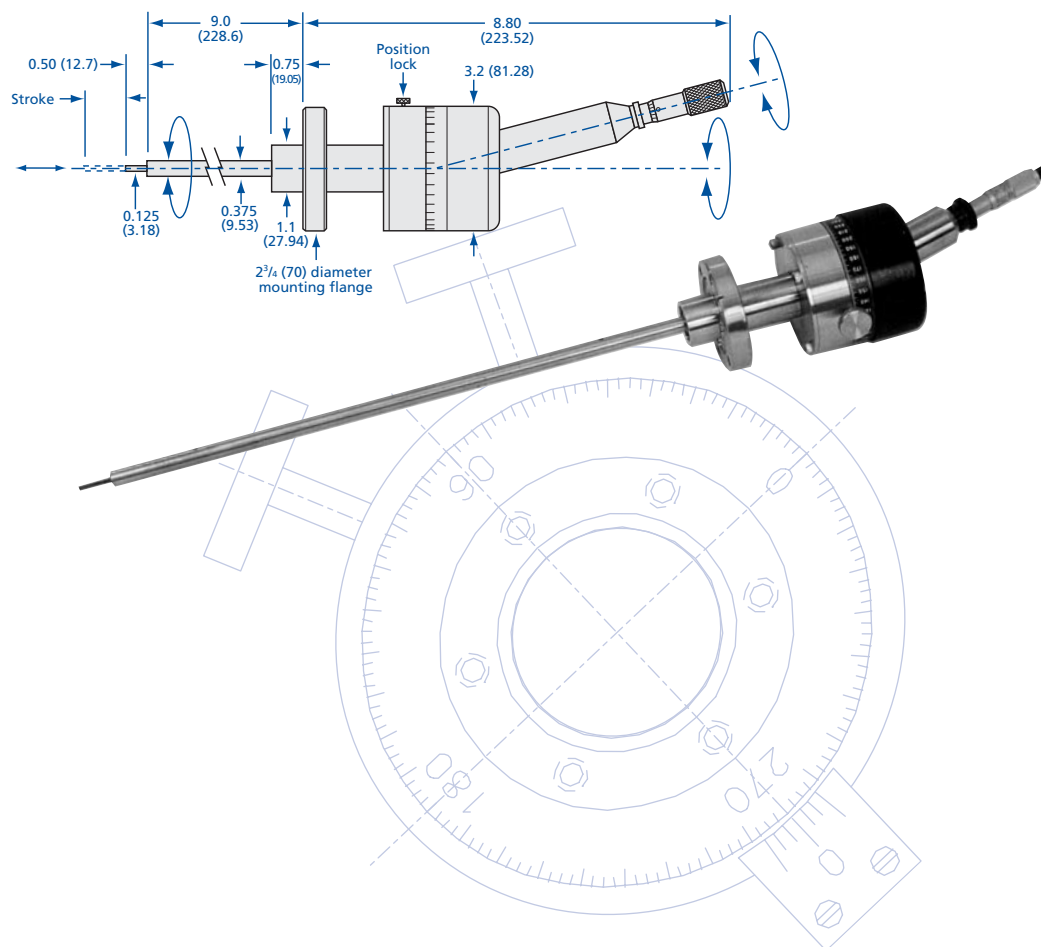
##### Operating orientation: Any

Temperature range: -20°C to 150°C

Vacuum range:  $\geq 10^{-5}$  mbar (Medium vacuum)

### Precision Linear/Rotary Motion Feedthrough

MODEL NUMBER	DESCRIPTION	STROKE
PLR-275-050	Stand-alone device or used when coupled with a gearbox to control polar and azimuthal rotation of a sample	1/2 (12.70)



#### SPECIFICATIONS

##### Construction

Mounting flange: 2 3/4 (70mm) CF, clearance holes  
Linear probe: 1/8 inch (3.18mm) OD  
Rotary tube: 3/8 inch (9.53mm) OD, 9 inch (228.6mm) length  
Bearings: Precision internal guide

##### Motion

Linear: 1/2 inch (12.7mm), micrometer adjusted  
Rotary: 360° continuous, 0.1° resolution in 1.0° graduations with position lock

##### Operating orientation: Any

##### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

Vacuum range:  $\geq 10^{-8}$  mbar (UHV)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Sample Transfer & Manipulation

## Wobble Sticks

### SPECIFICATIONS

#### Construction

Bellows: Welded stainless steel  
Mounting flange: CF or NW  
Shaft OD: 1/8 or 1/4 inch (3.18 or 6.35mm)  
Drive: Manually actuated

**Motion:**  $\pm 22^\circ$  or  $\pm 30^\circ$  tilt

**Operating orientation:** Any

#### Temperature range

Metal seal: 450°C  
Elastomer seal: 200°C

#### Vacuum range

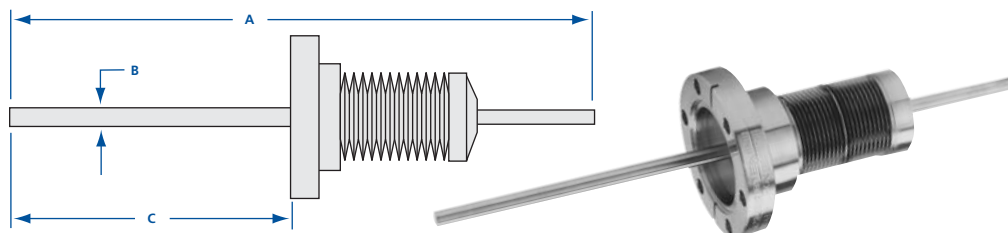
Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
Elastomer seal:  $\geq 10^{-8}$  mbar (High Vacuum)

### Wobble Sticks

WBL wobble sticks offer a simple means of positioning samples in vacuum by permitting Z-axis and tilt movements. All stainless steel construction designed for use in high vacuum or UHV environments.

MODEL NUMBER	FLANGE TYPE	FLEX ANGLE*	A	B	MIN. - MAX. C
<b>WBL-133</b>	1.33 CF	$\pm 22^\circ$	6 (152.40)	0.12 (3.05)	3 - 3 1/2 (76.20 - 88.90)
<b>WBL-275</b>	2.75 CF	$\pm 30^\circ$	10 (254.00)	0.25 (6.35)	3 3/4 - 6 (95.25 - 152.40)
<b>WBL-NW-16</b>	NW-16	$\pm 22^\circ$	6 (152.40)	0.12 (3.05)	3 - 3 1/2 (76.20 - 88.90)
<b>WBL-NW-40</b>	NW-40	$\pm 30^\circ$	10 (254.00)	0.25 (6.35)	3 3/4 - 6 (95.25 - 152.40)

\* Mating flange may restrict flexible angle



### SPECIFICATIONS

#### Construction

Bellows: Welded stainless steel, independent for Z and theta  
Mounting flange: 2 3/4 (70mm) CF, clearance holes  
Tip: Pre-fitted with hook  
Drive: Manually actuated

#### Motion

Rotary: 360° probe rotation via rotary motion feedthrough  
Linear: 4 or 8 inch (101.6 or 203.2mm) stroke  
Tilt:  $\pm 22^\circ$

**Operating orientation:** Any

#### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

**Vacuum range:**  $\geq 10^{-10}$  mbar (UHV)

**Options:** Single-jaw pincer (add "-PS" to model number), double-jaw and other pincers upon request

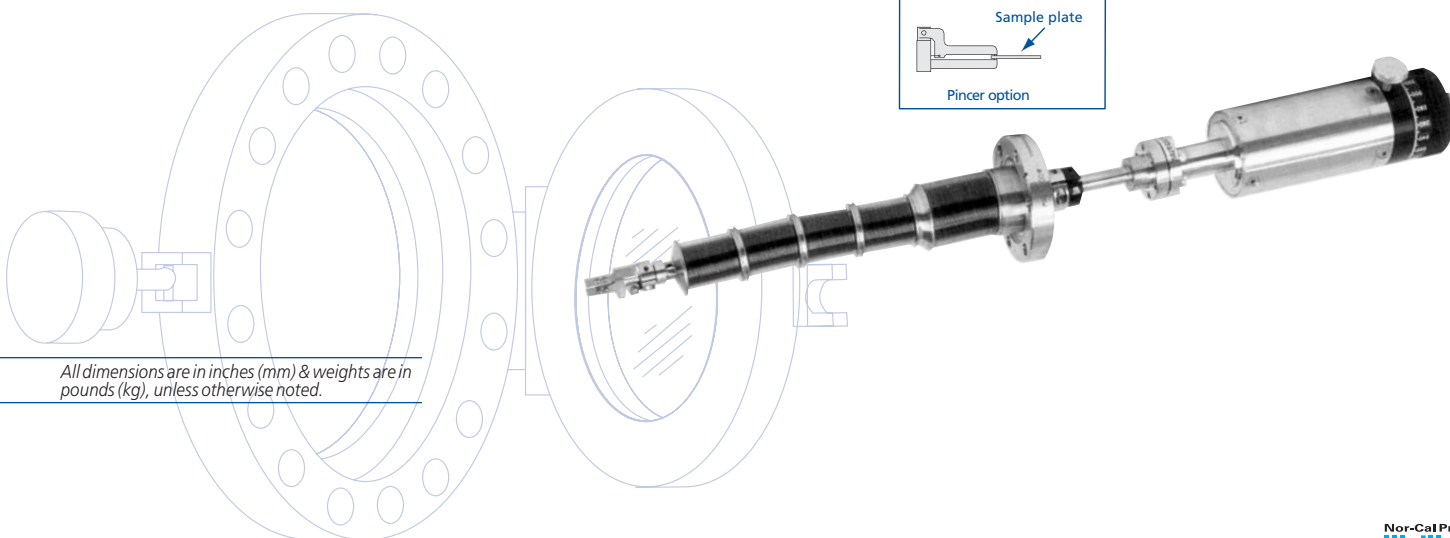
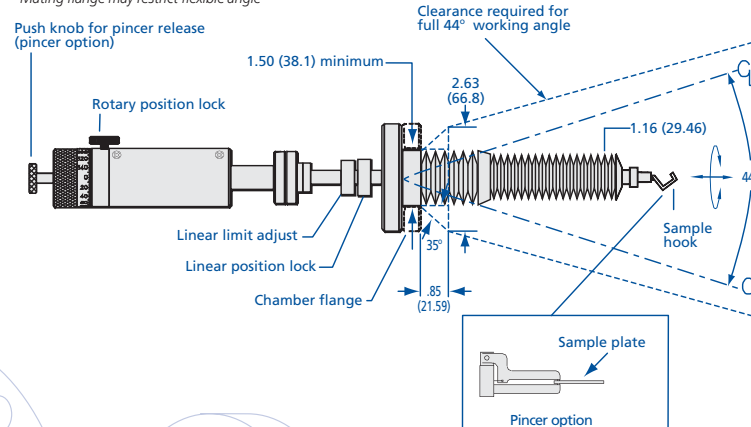
### Rotary Wobble Sticks

RWS wobble sticks provide Z-axis, polar rotation, and polar axis tilt to allow tip positioning inside a vacuum chamber. They offer an inexpensive alternative for sample introduction and manipulation.

MODEL NUMBER	FLANGE TYPE	FLEX ANGLE*	Z STROKE
<b>RWS-275-4</b>	2.75 CF	$\pm 22^\circ$	4 (101.60)
<b>RWS-275-8</b>	2.75 CF	$\pm 22^\circ$	8 (203.20)

**-PS** Single Jaw Pincer Option Add **-PS** to model number

\* Mating flange may restrict flexible angle



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Order Information

## Regional Sales Contacts

### Nor-Cal Products



by PFEIFFER VACUUM

#### Manufacturing & Corporate Global Headquarters

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at

[www.n-c.com/sales](http://www.n-c.com/sales)

or call

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Republic of Korea

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Fax: +82-31-8003-1342



### Terms & Conditions of Sale

Payment terms are net 30 days from the date of the invoice once credit has been approved. Otherwise, C.O.D. Most major credit cards are accepted.

If payment in full is not received within 30 days, a 1.5% per month late charge may be added to the unpaid balance. Discounts may be revoked if an account is not paid within these terms.

**MINIMUM ORDERS:** The minimum domestic order is \$40. The minimum international order is \$100.00.

#### QUANTITY PRICING:

Quantity pricing is valid on single shipments only.

**AVAILABILITY:** Our inventory is updated automatically, but there is always a possibility that an item may be unavailable or sold-out. If this occurs, customers are notified as soon as possible and alternative options are offered if available.

**PACKAGING:** The factory will determine the most cost effective method to package items for shipment. A \$5.00 USD per cardboard box charge will be applied to all orders with a maximum charge of \$25.00 USD per shipment. Large products requiring a wooden crate will be charged an amount consistent with the fabrication of the necessary crate.

**FOB POINT:** All orders ship FOB Yreka from 1967 S. Oregon, Yreka, California, 96097, USA unless quoted otherwise.

**LOST OR DAMAGED ITEMS:** Nor-Cal does not assume responsibility for items lost or damaged in transit, or for any direct or indirect damages incurred. Shipping damages are to be handled by the customer. Nor-Cal will provide the tracking number and contact information for the shipping company as needed. All items are purchased at the customer's risk.

**EXPORTED COMMODITIES:** US Export administration Regulations must be followed. Diversion contrary to US Law is prohibited.

### Pricing & Dimensions

In order to meet the changing needs of our customers we periodically make design revisions in our standard product line. As a result, the dimensions, pricing and specifications are subject to change without notice. International pricing may also vary.

**SPECIAL TOOLING:** Products ordered to non-standard specifications should state specification requirements in detail. Fee for special tooling may apply. On request, test report(s) and/or certification(s) can be supplied at additional cost.

### Discounts

OEM and quantity discounts are available to qualified customers.

### Return Policy

An RMA (Return Materials Authorization) number must be obtained from Nor-Cal Products before returning any merchandise. The RMA form can be found under SUPPORT in the footer of pages at [www.n-c.com](http://www.n-c.com). To expedite the assignment of an RMA number, complete the form online and submit online. You may also print and email the completed form to [rma@n-c.com](mailto:rma@n-c.com) or fax to the attention of the RMA Coordinator at 866-640-9012.

- Nor-Cal Products reserves the right to refuse the return of non-stocked items. A twenty-five (25) percent restocking fee may be charged.
- Nor-Cal Products shall incur no liability for damage, shortages or other cause alleged to have occurred at, or prior to, delivery to the carrier unless buyer shall have entered full details thereof on its receipt to the carrier. Products over 60 days old from the date of shipment will not be accepted for return.
- Nor-Cal Products must be allowed time to investigate all returns.

### Cancellations & Rescheduling

Any request by customers to reschedule or cancel in total or part of any purchase order must be approved at the sole discretion of Nor-Cal Products and shall be subject to the following conditions. Nor-Cal must receive written notice of Request for Cancellation or Reschedule, stating the reasons therefore.

#### Customer shall be liable for payment of the following charges to Nor-Cal in the event of Cancellation or Reschedule.

- For all charges incurred (including overhead, G&A, and profit) prior to the date that notice of cancellation is received by Nor-Cal for all parts peculiar to customer's requirements. Upon payment by the customer of these charges, such parts become the property of customer, Nor-Cal will store said parts for a reasonable period of time pending the receipt of customer's instructions for disposition. Such storage is at customer's risk and may be subject to storage charges if stored by Nor-Cal for longer than 30 days from the cancellation date; plus
- Charges to convert modified standard parts for return to Nor-Cal's inventory; plus
- A restocking charge of twenty (25) percent of the purchase price of the cancelled item.

**Warranty** Products manufactured by Nor-Cal Products are warranted against defects in material and workmanship for a period of twelve (12) months from the date of shipment from Nor-Cal Products to the buyer. Any modification to the product by the buyer or their agent voids this warranty. Liability under this warranty is expressly limited to the replacement or repair (at Nor-Cal Products' option) of defective parts. Nor-Cal Products may at any time discharge its warranty as to any of its products by refunding the purchase price and taking back the products. This warranty applies only to parts manufactured and labor provided by Nor-Cal Products under valid warranty claims received by Nor-Cal Products within the applicable warranty period and shall be subject to the terms and conditions hereof.

- Expendable items such as tubes, heaters, sources, bellows, etc., by their nature, may not function for one year; if such items fail to give reasonable service for a reasonable period of time, as determined solely by Nor-Cal Products, they will be repaired or replaced by Nor-Cal Products at its election.
- All warranty replacement or repair of parts shall be limited to equipment malfunctions which, in the sole opinion of Nor-Cal Products, are due or traceable to defects in original materials or workmanship. Malfunctions caused by abuse or neglect of the equipment are expressly not covered by this warranty. Nor-Cal Products expressly disclaims responsibility for any loss or damage caused by the use of its products other than in accordance with proper operating and safety procedures. Reasonable care must be taken by the user to avoid hazards.
- The buyer shall give Nor-Cal Products prompt notice of any claim under this warranty. If Nor-Cal Products, in its sole discretion, determines that the product does not conform to this warranty, Nor-Cal Products shall replace or repair the product free of charge. If such replacement or repair is not feasible, Nor-Cal Products may, at its sole option, refund the purchase price.
- In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the parts which have been repaired or replaced.
- After the expiration of the applicable warranty period, the buyer shall be charged at Nor-Cal Products' then current prices for parts and labor plus transportation.
- Except as stated herein, Nor-Cal Products makes no warranty, expressed or implied (either in fact or operation of law), statutory or otherwise: and, except as stated herein, Nor-Cal Products shall have no liability for special or consequential damages of any kind or from any cause arising out of the sale, installation, or use of any of its products. Statements made by any person, including representatives of Nor-Cal Products, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Nor-Cal unless reduced to writing and approved by an officer of Nor-Cal Products.
- This warranty shall not extend to any product, that in Nor-Cal Products' judgment, has been affected by damage or wear resulting from operations performed after the sale, or misuse, abrasion, negligence, accident, tampering, faulty installation, inadequate maintenance, damage or casualty.

**DISCLAIMER OF WARRANTY:** NOR-CAL MAKES NO WARRANTIES WITH RESPECT TO THIS SALE, WHETHER EXPRESSED OR IMPLIED, EXCEPT AS STATED HEREIN, NOR-CAL PRODUCTS MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

**LIMITATION OF REMEDY AND DAMAGES:** THE EXCLUSIVE REMEDY OF THE BUYER WITH RESPECT TO THE TRANSACTIONS CONTEMPLATED HEREIN SHALL BE THE REPLACEMENT OR REPAIR OF SAID PRODUCTS, OR THE RETURN OF THE PURCHASE PRICE, AS SET FORTH UNDER "WARRANTY".

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# Order Information

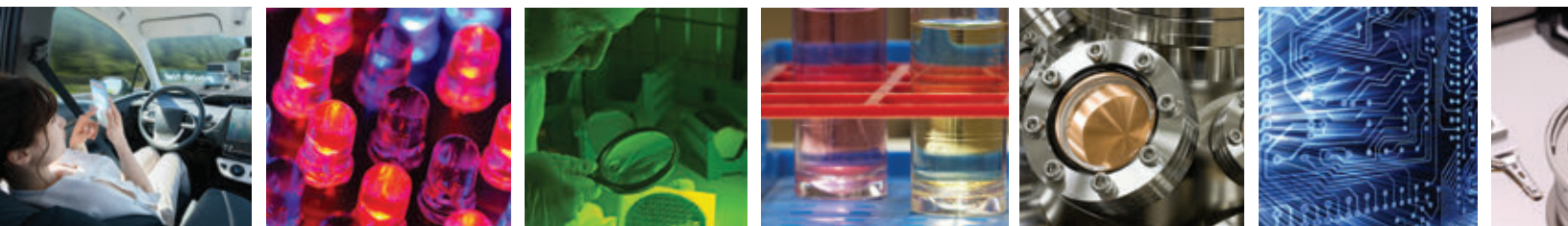
## Patents & Trademarks

### Nor-Cal Products, Inc. patents and trademarks:

Genesis Modular Valves are manufactured under patent number 6289932  
 Intellisys Pressure Control Products are manufactured under patent number 6612331  
 Genesis is a trademark of Nor-Cal Products, Inc.  
 Intellisys is a registered trademark of Nor-Cal Products, Inc.

### Other registered patents and trademarks:

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 Sample Transfer Systems are manufactured under patent number 5705128  
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