

Precision-Aire™ Leveling Isolators (PAL)

PAL-type pneumatic isolators provide superior low frequency isolation for metrology instruments, electron microscopes, MRI units, coordinate measuring machines and precision manufacturing equipment.

Fabreeka's® Precision-Aire™ Leveling (PAL) model pneumatic vibration isolation systems use servo controlled air springs. These isolators are ideally suited for conditions where height control and vibration control must co-exist. Fabreeka PAL isolators meet the critical needs of metrology instruments, electron microscopes, inspection stations and precision manufacturing equipment.

PAL Isolators Description

The standard Fabreeka® PAL isolators have a natural frequency as low as 1.7 Hz, however, lower natural frequencies (0.5 Hz) can be obtained from custom designed isolators.

A complete Fabreeka® PAL system consists of a minimum of three master isolators for 3-point determinate leveling. Each isolator incorporates a leveling valve which is the load sensing and height controlling element. Any number of support isolators may be added to support the total weight of the equipment.

Systems are supplied with a control panel, automatic height control valves, tubing and all other pneumatic accessories necessary for complete system installation.



PAL isolators integrated into a coordinate measuring machine support frame.



PAL Isolator Performance

PAL isolators react quickly to changes in the supported load and to center of gravity shifts by automatically releveling to a preset position.

A pneumatic isolation system's performance is a compromise between natural frequency (isolation), valve leveling accuracy and settling time.

Settling time can be defined as the time it takes for an isolation system's motion to return to a predetermined reference with respect to a defined input disturbance. The disturbance can be an environmental input or machine induced, such as a gantry or stage movement.

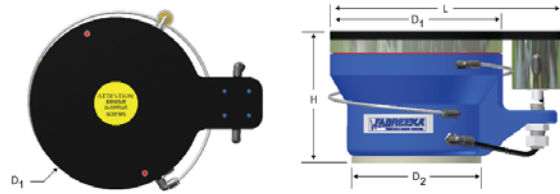
Settling time is minimal with optimum damping and corresponding valve flow. Long settling times using pneumatic isolators are unacceptable because precision measuring and positioning machines can suffer repeatability errors and throughput losses.

Fabreeka offers many leveling valve options depending on the application. Valve flow rate, stiffness and accuracy characteristics are key variables in the design of an acceptable solution. Leveling accuracies of +/- 0.006" (0.15 mm) or +/- 0.001" (0.025 mm) are available. The flow rate and stiffness of a valve are chosen based on the isolator design and damping.

Isolation Characteristics/Specifications

Natural Frequency	(-6)	(-12)
Vertical	2.5 - 2.7 Hz	1.5 - 1.7 Hz
Horizontal	2.0 - 4.5 Hz	2.0 - 4.5 Hz
Damping		
Vertical (Adjustable)	6% - 20%	6% - 20%
Horizontal	5% - 6%	5% - 6%

Isolator Dimensions*



*Verify actual dimensions with Fabreeka®. Dimensions subject to change.

Type	D1	D2	H		L	Max Lifting Capacity ¹	
			Deflated	Max. Lift		lbs	Kg
PAL 18-6	6.50 in 165 mm	6.00 in 152 mm	6.00 in 153 mm	6.25 in 160 mm	9.21 in 234 mm	1,800	800
PAL 21-6	7.87 in 200 mm	5.90 in 150 mm	6.00 in 153 mm	6.40 in 163 mm	10.60 in 270 mm	2,100	950
PAL 21-12	7.87 in 200 mm	7.87 in 200 mm	12.00 in 305 mm	12.40 in 315 mm	10.60 in 270 mm	2,100	950
PAL 36-6	8.65 in 220 mm	7.50 in 190 mm	6.00 in 153 mm	6.40 in 163 mm	11.40 in 290 mm	3,600	1,630
PAL 55-6	10.25 in 260 mm	9.00 in 230 mm	6.00 in 153 mm	6.40 in 163 mm	13.00 in 330 mm	5,500	2,500
PAL 55-12	10.25 in 260 mm	10.25 in 260 mm	12.00 in 305 mm	12.40 in 315 mm	13.00 in 330 mm	5,500	2,500
PAL 75-6	11.80 in 300 mm	10.45 in 265 mm	6.00 in 153 mm	6.40 in 163 mm	14.55 in 370 mm	7,500	3,400
PAL 133-6	15.00 in 380 mm	13.78 in 350 mm	6.00 in 153 mm	6.40 in 163 mm	17.70 in 450 mm	13,300	6,030
PAL 133-12	15.00 in 380 mm	15.00 in 380 mm	12.00 in 305 mm	12.40 in 315 mm	17.70 in 450 mm	13,300	6,030
PAL 255-6	20.87 in 530 mm	18.50 in 470 mm	6.00 in 153 mm	6.50 in 165 mm	23.60 in 600 mm	25,500	11,560
PAL 255-12	20.87 in 530 mm	18.10 in 460 mm	12.00 in 305 mm	12.50 in 317 mm	23.60 in 600 mm	25,500	11,560
PAL 416-8	25.20 in 640 mm	23.00 in 585 mm	8.00 in 203 mm	8.45 in 215 mm	28.00 in 710 mm	41,600	18,870
PAL 1000-6	37.40 in 950 mm	35.80 in 910 mm	6.00 in 153 mm	7.00 in 178 mm	40.15 in 1020 mm	100,000	45,360
PAL 1000-18	35.98 in 914 mm	35.98 in 914 mm	17.70 in 450 mm	18.70 in 475 mm	39.00 in 990 mm	100,000	45,360

¹At maximum working pressure of 100 psi (7 bar)

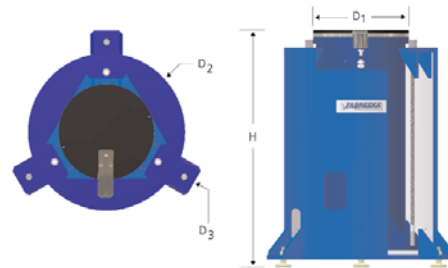


Isolation Characteristics/Specifications Pendulum Isolators

Natural Frequency	(-15/-19)	(-36)	(-52/-60)
Vertical	1.3 - 1.5 Hz	0.9 - 1.0 Hz	0.7 - 0.9 Hz
Horizontal	1.3 - 1.5 Hz	0.6 - 0.7 Hz	0.4 - 0.5 Hz

Damping			
Vertical (Adj)	6% - 20%	6% - 20%	6% - 20%
Horizontal (Adj)	3% - 6%	3% - 6%	3% - 6%

Isolator Dimensions*



*Verify actual dimensions with Fabreeka®. Dimensions subject to change.

Type	D1	D2	H		D3	Max Lifting Capacity ¹	
			Deflated	Max. Lift		lbs	Kg
PAL 21-15P	7.87 in 200 mm	11.00 in 279 mm	15.00 in 381 mm	15.40 in 391 mm	N/A	2,100	950
PAL 55-15P	10.25 in 260 mm	18.50 in 470 mm	15.00 in 381 mm	15.40 in 391 mm	23.75 in 603 mm	5,500	2,500
PAL 55-52P	10.25 in 260 mm	18.50 in 470 mm	52.00 in 1321 mm	52.40 in 1331 mm	23.75 in 603 mm	5,500	2,500
PAL 75-19P	11.63 in 295 mm	14.88 in 378 mm	19.00 in 483 mm	19.40 in 493 mm	N/A	7,500	3,400
PAL 133-36P	15.00 in 380 mm	24.50 in 622 mm	36.00 in 914 mm	36.40 in 924 mm	31.50 in 800 mm	13,300	6,030
PAL 133-60P	15.00 in 380 mm	24.50 in 622 mm	60.00 in 1524 mm	60.40 in 1534 mm	31.50 in 800 mm	13,300	6,030
PAL 255-36P	20.87 in 530 mm	30.50 in 775 mm	36.00 in 914 mm	36.45 in 926 mm	37.50 in 953 mm	25,500	11,560
PAL 255-60P	20.87 in 530 mm	30.50 in 775 mm	60.00 in 1524 mm	60.45 in 1536 mm	37.50 in 953 mm	25,500	11,560
PAL 416-36P	25.20 in 640 mm	36.50 in 927 mm	36.00 in 914 mm	36.45 in 926 mm	45.00 in 1143 mm	41,600	18,870
PAL 416-60P	25.20 in 640 mm	36.50 in 927 mm	60.00 in 1524 mm	60.45 in 1536 mm	45.00 in 1143 mm	41,600	18,870

¹At maximum working pressure of 100 psi (7 bar)

Pendulum Isolators

Specially designed diaphragms may be used to lower the horizontal natural frequency of an isolator to approach 1.5 Hz. Alternatively, natural frequencies as low as 0.4 Hz can be achieved using pendulums. The pendulum natural frequency is given by Eq 6, where L is equal to the length of the pendulum.

$$F_n = \frac{1}{2\pi} \sqrt{\frac{g}{L}} \quad \text{Eq 6}$$

At right, PAL 133-36P pneumatic isolators support a 80,000 lb reaction mass for a large NMR magnet. The vertical and horizontal natural frequencies are 1.0 Hz and 0.7 Hz.



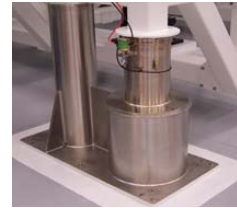
Custom/OEM Isolators

Isolators for OEM applications or having custom requirements are available for easy integration into machine designs. For cleanroom applications, the exhaust air from the leveling valves is vented and the isolators are made using cleanroom compatible materials, cleaned and packaged. Isolators can also be made using non-magnetic materials.



Type	D1	D2	H		L	Max Lifting Capacity ¹	
			Deflated	Max. Lift		lbs	Kg
PAL 3-2.5	3.20 in 80 mm	3.20 in 80 mm	2.50 in 64 mm	2.75 in 70 mm	6.20 in 157 mm	260	115
PAL 4-3.5	6.00 in 152 mm	4.00 in 102 mm	3.50 in 89 mm	3.75 in 95 mm	8.00 in 203 mm	295	130
PAL 5.5-2.5	3.95 in 100 mm	3.95 in 100 mm	2.50 in 64 mm	2.75 in 70 mm	6.95 in 177 mm	480	210
PAL 9-4	5.10 in 130 mm	5.10 in 130 mm	3.65 in 94 mm	3.95 in 100 mm	8.15 in 207 mm	735	330
PAL 9-6	5.10 in 130 mm	5.10 in 130 mm	6.00 in 153 mm	6.25 in 159 mm	8.71 in 221 mm	735	330

¹At maximum working pressure of 100 psi (7 bar)



Class 100,000 cleanroom compatible isolator.

Leveling Valves

A wide range of leveling valves are available. Leveling valves have accuracies from +/- 0.006" (0.15 mm) to +/- 0.001" (0.025 mm)* with adjustable flow rates to accommodate application requirements. Valve stiffness, flow rate and accuracy are important variables to optimum isolator settling time and isolation efficiency.

*Lever arm will change accuracy; however will increase stroke.

