03

Low-Frequency Air Spring Elements

PLM

Pneumatic Air Spring Elements
For an efficient isolation of measuring equipment, high-speed presses and machines.

PAL

Air Spring Elements with Automatic Level Controls
Isolation against disruptive vibrations and level-adjustment for test and measuring equipment. Isolating at extremely low-frequencies, these components are used in the automotive industry and in aerospace engineering.

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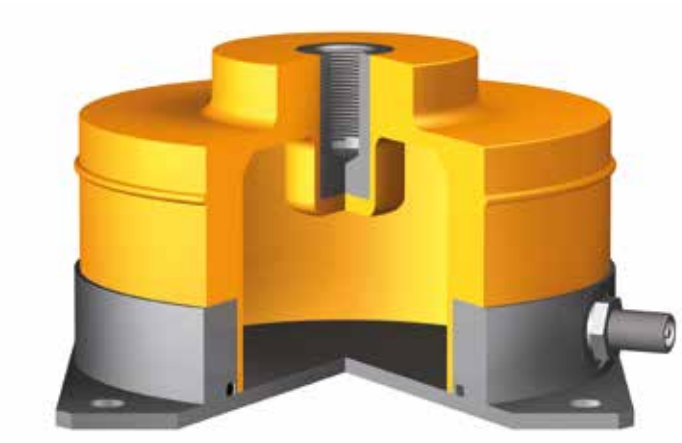

PLM
Air Spring Elements

PLM air spring elements offer low-frequency vibration and shock isolation for measuring stations, coordinate measuring machines, fans, air compressors, motor and generator units, high-speed presses and more.

The PLM air spring series comprises low-frequency vibration and shock isolators which reduce undesirable vibrations while simultaneously levelling the supported devices.

When used as a vibration damper, the internal air chamber already guarantees a significant isolating effect from 5 Hz upwards. In an optimally loaded condition, the natural frequency is 3.0 Hz. PLM air spring elements also isolate in a pressure-free state.

The vertical natural frequency of the elastomer body is approximately 10 Hz, meaning that disturbances above 14 Hz are isolated.
The ratio of vertical to horizontal natural frequency is roughly 1:1 with high horizontal stability.

For applications with shock or impact loads, the elastomer wall design of the PLM air springs offer high dynamic spring deflection. If one wishes simultaneously to retain the low natural frequency of 3 Hz, the use of external arrestors is recommended in order to prevent the air springs from breaking through.

The PLM design features a vulcanised thread insert, by means of which the air springs can be inflated either with a standard tyre valve or a pneumatic fitting. Special connections are not necessary.

The isolators are delivered with a valve. They are inflated and levelled manually with the aid of hand pumps or adaptors connected to an air supply. If a compressed air fitting is mounted on the air springs, they can be connected to the controlled air supply system. This facilitates the pressurisation and the level control. In the event that no level control valve is used, a control unit can be provided to regulate the pressure and the height of the air springs linked to each other.

In addition, the PLM air spring elements can be supplied with automatic level control valves for height regulation. Each master isolator has a built-in level control valve which functions as a load detector and position sensor.

Properties
- Low natural frequency of 3 Hz
- Easy level control via integrated valve
- Height regulation control on request
- Ratio of horizontal to vertical natural frequency 1:1

Areas of application
- Measuring tables
- Test benches
- High-speed presses
- Production plants

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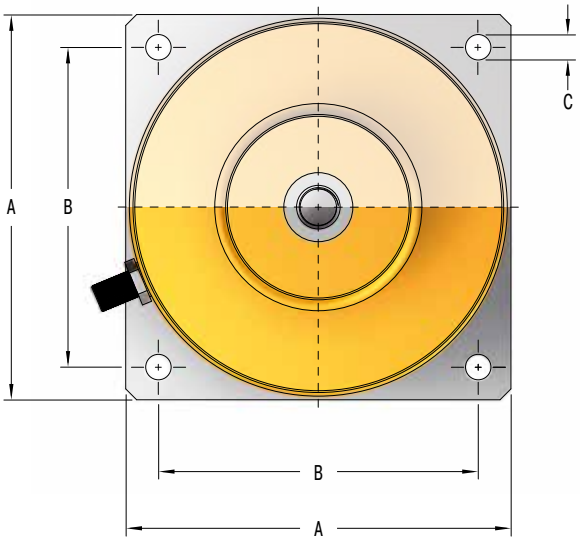

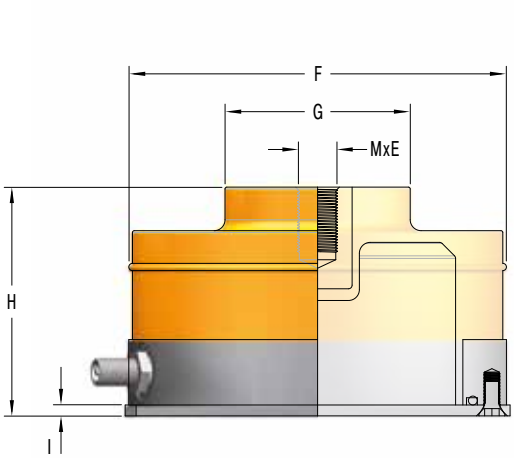

Type	A mm	B mm	C mm	M	E mm	F mm	G mm	H mm	I mm	Max. Load kg
PLM 1	76	60.5	6.9	M10	12.0	73	25	65	3.2	45
PLM 3	106	89	6.9	M12	13.5	105	56	65	3.2	135
PLM 6	130	108	7.4	M12	13.5	127	60	90	3.2	250
PLM 12	175	152	7.4	M12	13.5	171	100	90	3.2	550
PLM 24	254	216	14.2	M16	19.0	245	138	90	4.8	1100
PLM 48	343	305	14.2	M16	19.0	338	190	90	4.8	2200
PLM 96	470	406	20.6	M24	22.4	468	267	90	6.4	4400
PLM 192	610	508	20.6	M24	22.4	610	400	90	6.4	8800

Any number of parallel air springs can be added in order to increase the loading capacity of the overall system.

Our technicians are happy to assist you in the selection process and provide any support you require.

Selection and calculation

The best isolation values can be achieved for the use of PLM air springs when the maximum load of the individual air spring elements is utilised to the fullest extent possible.

In standard applications, it is sufficient to select PLM air spring elements on the basis of the weight of the machine or plant to be isolated. If the maximum isolation effect is to be realised, additional weights (steel or e.g. granite plates) may have to be added so as to achieve the maximum permitted load range and thus the ideal isolation effect.

Note

When commissioning, please ensure that pressure is first applied on the PLM air spring elements before they are filled to the desired operating pressure (max. 5 bar for sizes 1 and 3; max. 6 bar for the remaining sizes) using the valve.

A separate usable control unit can be used to check the operating condition and adjust to the desired amount.

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PAL

Air Spring Elements with Automatic Level Controls

Air spring elements of the PAL series offer superior low-frequency vibration isolation for measuring devices, electron microscopes, MRT equipment, coordinate measuring machines and precision manufacturing machines.

PAL air spring systems use level-controlled air springs. These isolators are ideal for conditions which require a constant level and vibration isolation at the same time. The PAL isolators meet all important requirements for measuring devices, electron microscopes, measuring stations and precision manufacturing machines.

Standard PAL isolators have a natural frequency of up to 1.7 Hz – depending on the height of the isolator. Even lower natural frequencies (up to 0.5 Hz) are possible for isolators manufactured according to customer specifications.

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Properties

- Height-adjustable
- Low-frequency isolation, natural frequencies of up to 0.5 Hz possible

Areas of application

- Test and measuring equipment
- Aircraft and automotive test benches
- Foundation bearing surfaces

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Extremely low-frequency-calibrated precision isolators for use in high-resolution measuring and testing systems.

A complete PAL system consists of at least three master isolators for a 3-point level control. Each isolator has a built-in level control valve which functions as a load detector and height control. Any number of slave isolators can be added in order to bear the overall weight of the equipment.

The scope of supply of a system contains a control unit, automatic level control valves, pneumatic lines and all the additional pneumatic accessories required for a complete system installation.

PAL air springs react quickly to changes in load or balance, with deviations from a preset position being automatically readjusted.

The performance of an air spring system is always a compromise between natural frequency (isolation), the resetting accuracy of the level control valve and the control setting time.

The control setting time is defined as the time required by the isolation system to reach a preset reference value again after a defined disturbance.

The disturbance can be caused by environmental factors or inherent machine forces, such as the movement of the measuring bridge of a measuring machine.

The control setting time is minimised with an optimal damping effect and an adequate flow through the valve. Long control setting times are not acceptable for air springs, as this can induce errors in repeat accuracy in the case of precision measuring devices and positioning machines as well as lower part throughput rates.

Depending on the application, ACE offers many different level control valves. The decisive variables for designing an acceptable solution are the valve flow-through and rigidity, as well as accuracy characteristics. Reset accuracies of +/- 0.15 mm or +/ 0.025 mm are available. The valve flow-through and rigidity are selected on the basis of the air spring design and the damping.

PAL-3 to PAL-9
Small size

PAL-18 to PAL-1000
Large size

PAL-5.5-2.5
with level control valve PALV 5-5

The figures are not to the same scale.

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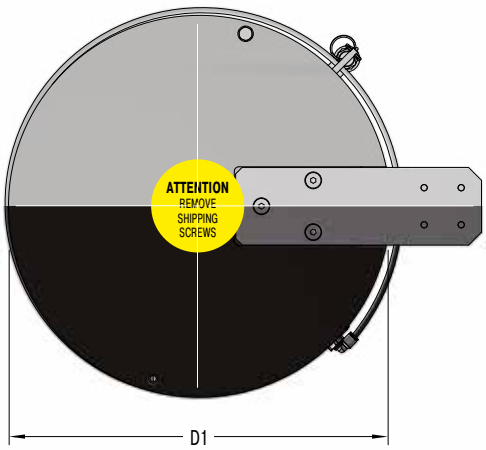
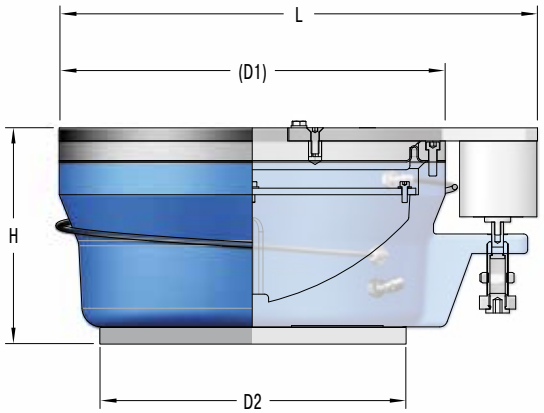
PAL





Type	D1 mm	D2 mm	H (pressureless) mm	H (Max. Stroke) mm	L mm	Max. Load* kg	Special design only on request
PAL 18-6	165	152	153	160	234	800	■
PAL 21-6	200	150	153	163	270	950	
PAL 21-12	200	200	305	315	270	950	■
PAL 36-6	220	190	153	163	290	1630	
PAL 55-6	260	230	153	163	330	2500	
PAL 55-12	260	260	305	315	330	2500	■
PAL 75-6	300	265	153	163	370	3400	
PAL 133-6	380	350	153	163	450	6030	
PAL 133-12	380	380	305	315	450	6030	■
PAL 255-6	530	470	153	165	600	11 560	
PAL 255-12	530	460	305	317	600	11 560	
PAL 416-8	640	585	203	215	710	18 200	
PAL 1000-6	950	910	153	178	1020	42 000	■
PAL 1000-18	914	914	450	475	990	42 000	■
PAL 3-2.5	80	80	64	70	157	126	
PAL 5.5-2.5	100	100	64	70	177	238	
PAL 9-4	130	130	94	98	207	385	
PAL 9-6	130	130	153	159	221	385	

* At a maximum operating pressure of 7 bar

Note

The maximum permissible horizontal movement of the PAL air spring elements can be limited to 3 mm, if necessary.

Isolation properties

Natural frequency	PAL xx-6 Hz	Pal xx-12 Hz
vertical	2.5 - 2.7	1.5 - 1.7
horizontal	2.0 - 4.5	2.0 - 4.5

Damping	PAL xx-6 %	Pal xx-12 %
vertical (adjustable)	6 - 20	6 - 20
horizontal	5 - 6	5 - 6

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Design service and analysis

Low-frequency vibrations and strong shocks and force peaks influence the accuracy, production quality and productivity of high-performance and precision machinery.

The specifications for the maximum permissible accelerations and vibrations are often prescribed by the manufacturers of testing, measuring and production machines. Our expert team is happy to assist you with analysing the site conditions and selecting the right isolators for complying with the required system parameters.

On request, we execute highly precise measurements on site and document the respective target and actual conditions or develop suitable system solutions with our customers. Requirements and solution models may vary widely from case to case.

Our technicians are happy to assist you in the selection process and provide any support you require.

Application examples

Measuring tables, example: coordinate measuring machine

Test benches, example: street simulation test bench

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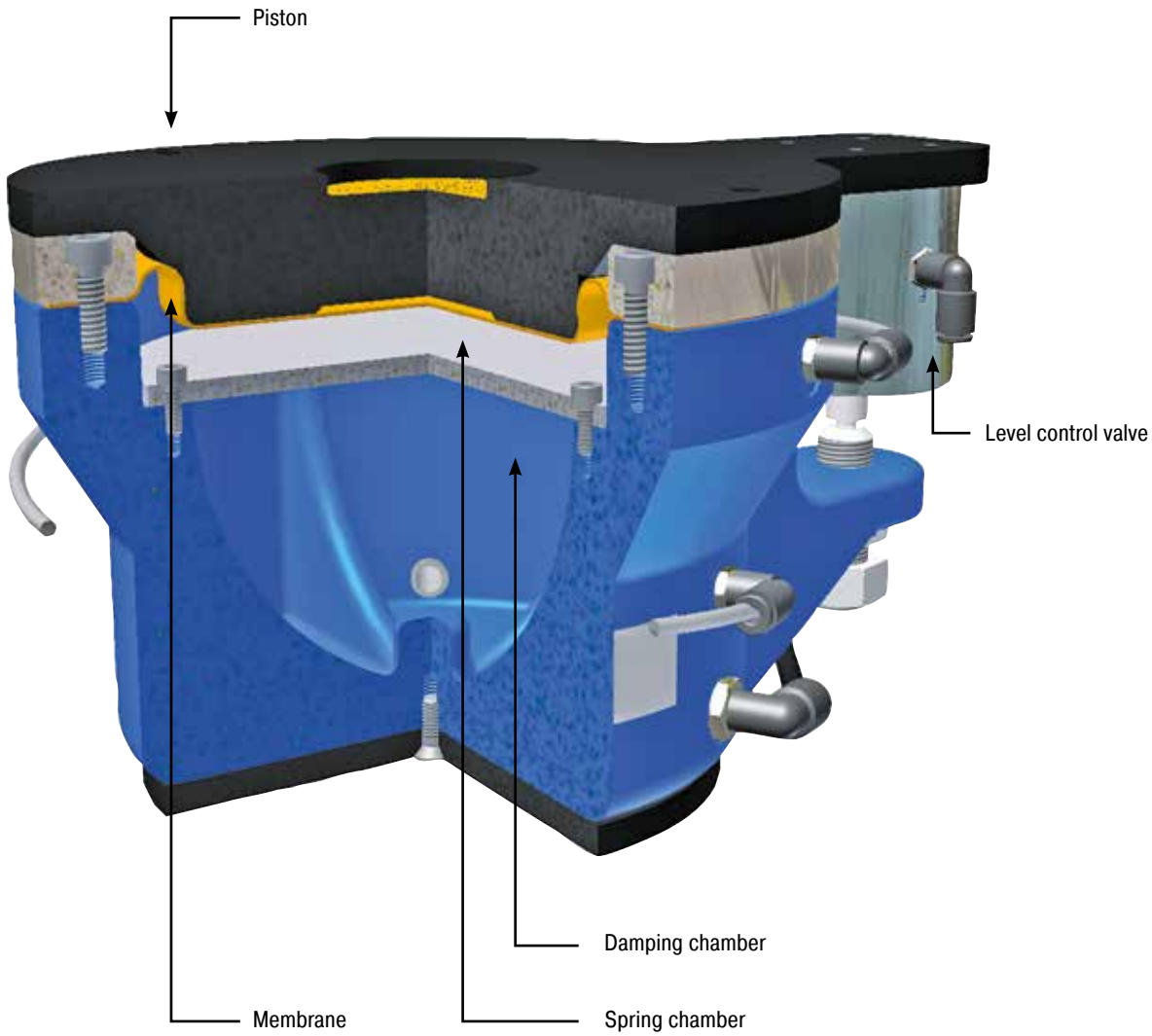
PAL

Air Spring Elements with Automatic Level Control

Structure



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