

## Vibration and structure-borne noise isolation of research laboratory

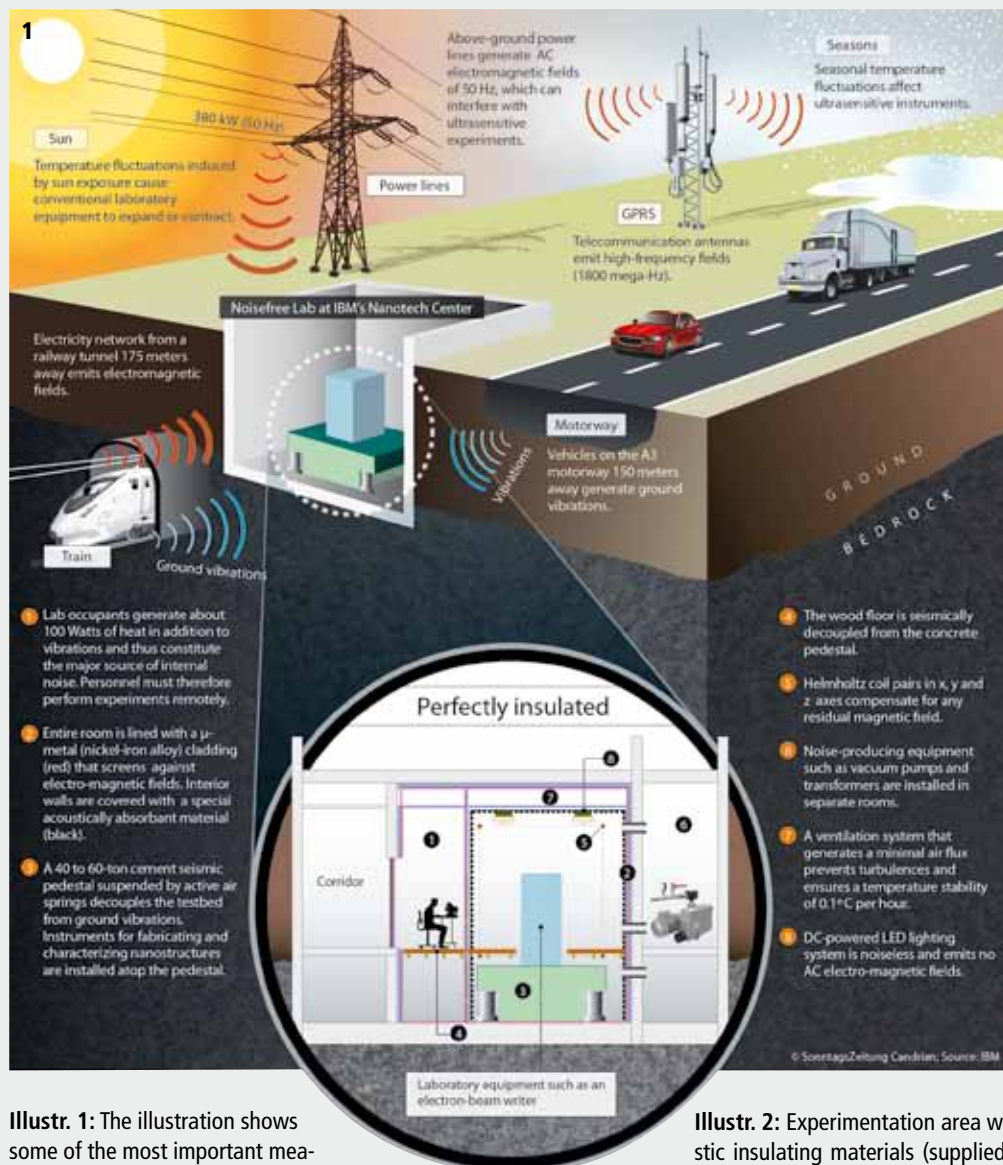
**AIS™**  
Active Isolation System

The manufacture and characterisation of ever smaller components, including structures consisting of just a few molecules or atoms, poses a huge challenge in terms of the vibration isolation required to protect the vibration-sensitive facilities.

In order to precisely carry out sensitive experiments and measurements on a scale of nanometres (1 nanometre = one millionth of a millimetre), external disturbances, such as fluctuations in temperature, humidity and air pressure, noise, electromagnetic fields and ground vibrations must be kept to a minimum. BILZ Vibration Technology AG has developed international expertise as a professional partner in providing solutions such as lab isolation (foundation block or platform isolation) or direct isolation of highly-sensitive machines (installation of isolation systems in facilities / equipment).

Passive membrane air springs, air bearings or active vibration isolation systems are used to provide high-quality vibration isolation. Depending on customer requirements, BILZ can also create the complete foundation block or platform design, or help with the layout and structural integration of the isolation system into the machine. We are very proud to have equipped the most modern research labs in the world with sound and vibration isolation, such as the "Präzisionslaboratorien MPI Stuttgart" (Precision Laboratories) and the "Noise-Free Labs" of the Binnig and Rohrer Nanotechnology Centre (IBM/ETH Zurich).

In the semiconductor industry, many famous companies such as Applied, Vistec and Zeiss number among our valued customers.



**Illustr. 1:** The illustration shows some of the most important measures for reducing external disturbances in the "Noise-Free Labs" of IBM and ETH Zurich's Binnig and Rohrer Nanotechnology Centre.



**Illustr. 2:** Experimentation area with 4.2 m of clearance and acoustic insulating materials (supplied and installed by BILZ). Source: Binnig and Rohrer Nanotechnology Centre (IBM Research – Zurich)



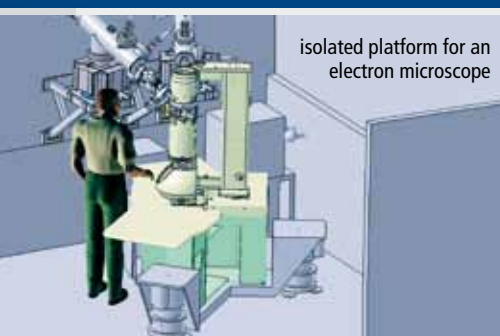
**Illustr. 3:** AIS™ active vibration isolation from BILZ, which suspends the 75-tonne foundation block, with glass-fibre plastic reinforcement, on an air cushion. Source: Binnig and Rohrer Nanotechnology Centre (IBM Research – Zurich)



ComPASS PRO Wafer inspection machine



Lab table with active isolation



isolated platform for an electron microscope



BILZ test facility

## Active Isolation System AIS™

- Active electro-pneumatic vibration isolation providing control in six degrees of freedom.
- Optimal vibration isolation performance without any amplification at resonance.
- Excellent level accuracy in both the vertical and horizontal plane.
- Minimal deflection and settling time after an acceleration or deceleration of a moving mass within the machine, shorter settling times equals greater machine throughput.
- Very efficient realtime control.
- PLC, CAN-Bus, one Controller and one High Speed electro-pneumatic servovalve for each degree of freedom.
- Each Controller consists of a microprocessor and integrated, high resolution sensors for position, air-pressure and acceleration.
- Easy-to-use, intelligent WinSNI-Software for setting up and optimizing the AIS™ and for providing system diagnostics.
- Two different modes of operation can be selected simply using a digital I/O. For example, scanning mode (during sensitive machine operations) to loading mode (during moving mass within the machine).
- Feedforward-signal is not required from the machine controller.
- No disturbing heat generation, magnetic variations or high electrical power consumption as by electromagnetic actuators / linear motors.

### Range of application

Optimal vibration isolation performance for machines with high dynamic forces that are performing sensitive measurements and inspections, lithography equipment, laser machines, high resolution electron microscopes and machinery for the semiconductor industry. The AIS™ is utilized when the efficiency of isolation and the settling time of conventional air-springs with electro-pneumatic leveling systems is insufficient.

### AIS™ has two primary functions:

One function is to protect the precision machine from floor vibration. The other primary function is to improve the performance of the machine by minimizing structure borne vibration created by the high dynamic forces produced during an acceleration or deceleration of a moving mass within the machine. In addition, settling time is reduced which minimizes the delay time before the machine can start performing its sensitive operation.

### Controller SPC-LC

Acceleration sensor  
(resolution 8  $\mu\text{g}$ )

RS232 Diagnose und  
Updates

Sensor for position  
(resolution 0.2  $\mu\text{m}$ )





The AIS™ consists of a PLC, CAN-Bus, 16 bit-Controllers, High Speed electropneumatic servovalves and BiAir air springs and/or HAB™ horizontal air springs. A range of sizes are available for both the vertical and horizontal air springs. One 16 bit-controller and one High Speed electro-pneumatic servovalve is used for each air spring or group of air springs. The AIS™ works with a minimum of 3 groups (degrees of freedom) to a maximum of 6 groups (degrees of freedom).

The 16 bit-controller can be mounted directly to the air-spring itself or to the machine, in the same direction as the isolator motion. Located inside the 16 bit-controller is a microprocessor, a position sensor (resolution 0,2  $\mu\text{m}$ ), an acceleration sensor (resolution 8  $\mu\text{g}$ ) and an air-pressure sensor (resolution 0,2 mbar). The signals from each of these sensors will be sampled at the rate of 4 kHz.

Since each 16 bit-controller has a microprocessor with specially developed control algorithms along with a special high dynamic pneumatic servo valve, the resulting performance is a very efficient realtime control and no feedforward signal is required.

The 16 bit-controllers are connected by a CAN-BUS to the PLC.

The PLC can be connected to a PC by a standard RS-232 for initial set-up and diagnosis. The primary function of the PLC is to manage and watch over the 16-bit controllers. In addition, the PLC has digital Inputs and Outputs. For example, Ready, Motion Complete, Inspection of Position, Pressure and Power Supply, Switch over from Scanning Mode to Loading Mode, Emergency Stop.

The PLC also provides the possibility to switch from scanning mode to loading mode by using a digital I/O. The PLC takes care of downloading all of the necessary parameters to each 16 bit-controller to achieve the two different modes. The advantage of providing two different modes is the performance of the system can be optimized for each mode. For example, during scanning mode when machine is performing sensitive operations the system should be very soft and not be very aggressive otherwise forces created by the isolation system can affect the machine performance. During loading mode, level accuracy and shortest possible settling times are the most important factors and a very stiff, fast and aggressive system will provide the best performance.

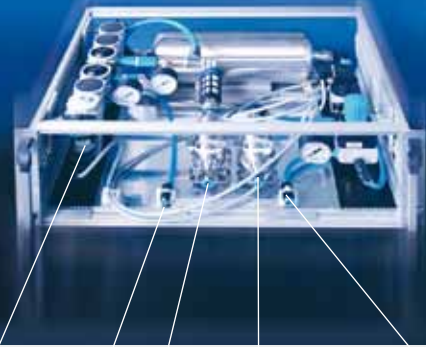


Controller 19" PLC-A1



Power Air-supply CAN Control WinSNI E/A Acknowledge error Control panel FED 50

Air-supply 19" AirBox-A1



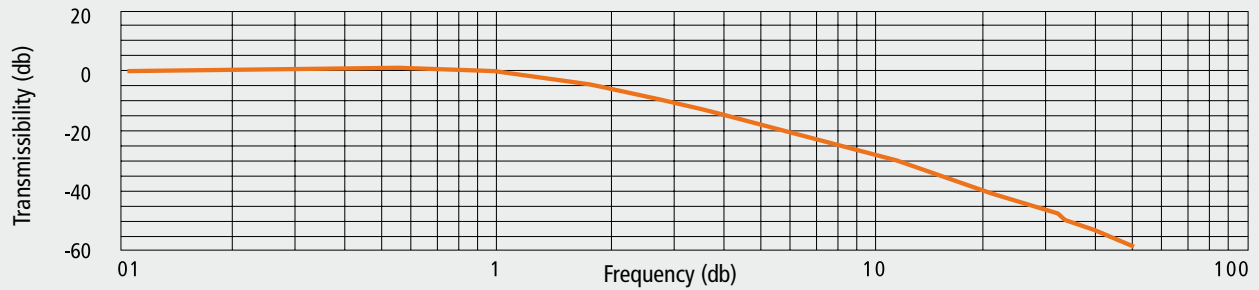
Air-supply Exhaust Valve horizontal Valve vertical Air-bearings

w / h / d / 483 x 133 x 348 mm

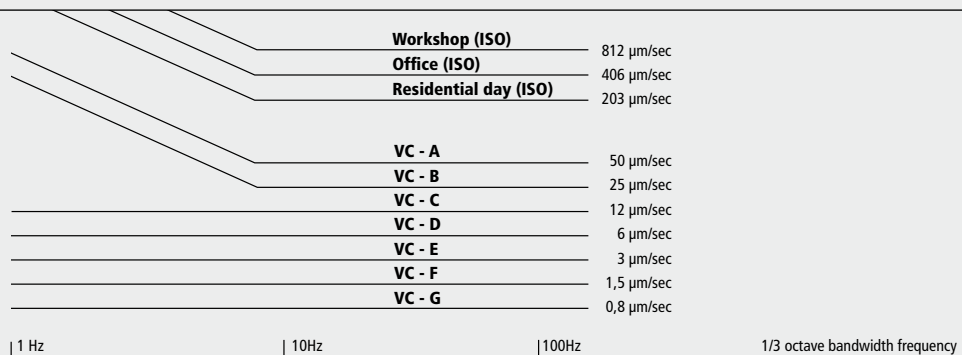
w / h / f / 483 x 177 x 348 mm

Transmissibility of new active BILZ controller at scanning mode with membrane air-springs **BiAir®/HE** and horizontal air-bearing **HAB™** with 6 controllers.

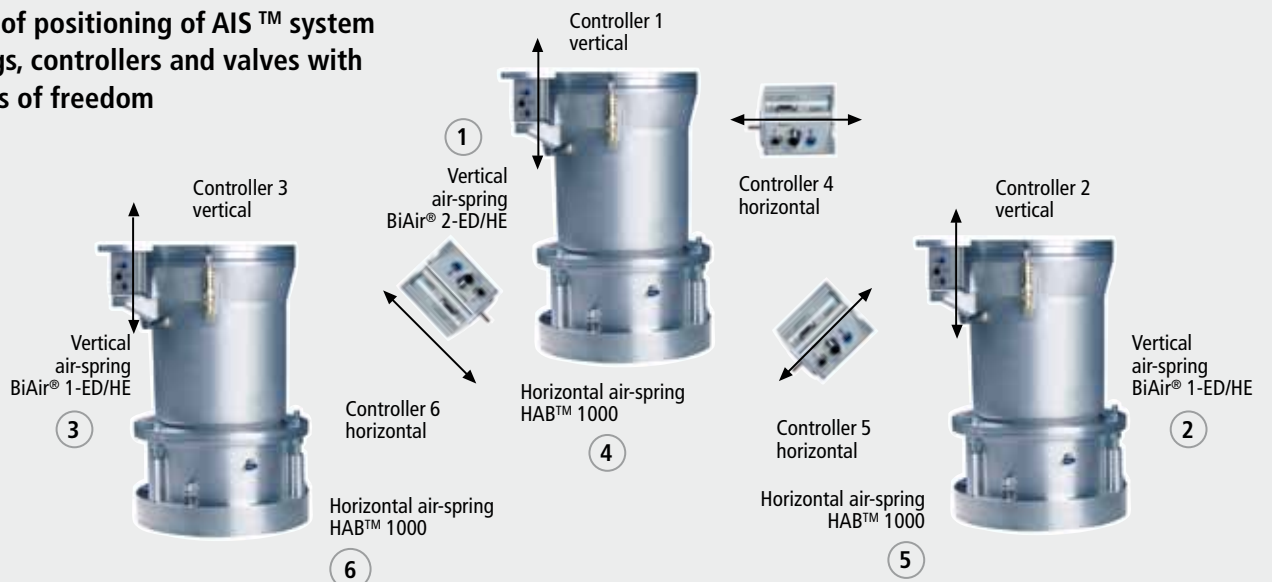
### Transmissibility of AIS™ with 6 degrees of freedom



### Vibrations criteria, VC



### Example of positioning of AIS™ system air-springs, controllers and valves with 6 degrees of freedom



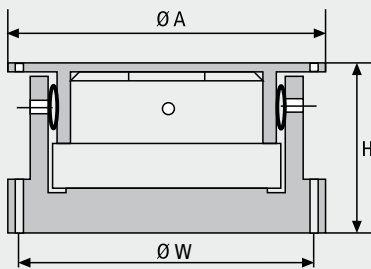


Patents: US 7,114,710 B2 - German Patent No. 102 49 647.1 - German Patent No. 102 49 647

## ● HAB™ Horizontal Air Spring

Type	Ø A (mm)	Ø W (mm)	H (mm)	leveling screw	Max. vertical load at 5,5 bar (N)	Max. horizontal load at 1 bar (N)	Adjustable horizontal natural frequency (Hz)
HAB™ 280	200	180	101	M 10 x 1,5	3400	150	1,1–1,9
HAB™ 660	250	230	118	M 10 x 1,5	7200	380	1,1–1,9
HAB™ 1000	300	276	159	M 12 x 1,5	11000	490	1,1–1,9
HAB™ 1000-HL	300	276	159	M 12 x 1,5	14000	490	1,1–1,9
HAB™ 24 000	350	326	172	M 16 x 1,5	23500	700	1,1–1,9
HAB™ 38 000	422	398	187	M 16 x 1,5	38000	1100	1,1–1,9

Bigger sizes upon request !



Air-Bearing  
Leveling screw



Air-tube  
Transportation and centering screw

### Advantages of new HAB™ in comparison to conventional air-springs:

- Adjustable horizontal natural frequency.
- Adjustable horizontal dampening.
- Very low natural frequency / very efficient vibration isolation.
- Friction free operation, no stick-slip or hysteresis.
- When used as part of the AIS™ System no amplification at resonance
- Very high dampening,
- Minimum settling time,
- Excellent level accuracy.

### Design

The pneumatic horizontal vibration isolator HAB™ is constructed of a cylindrical top and bottom housing. Air tubes placed into the annular space between the two housings provide the horizontal force to counter any relative movement between the two housings.

The horizontal force or natural frequency of the HAB™ can be adjusted by changing the air pressure of these air tubes. A specially designed air bearing handles the vertical load and provides friction free smooth horizontal movement between the top and bottom housings.



**A. Base platform**



**B. Platform for integration in raised-/ cleanroom floor**



## ● Vibration isolated platforms

Our years of experience in the field of vibration isolation combined with our broad range of standard products guarantee the best technical and cost-effective solution.

### 1. Vibration Analysis

To optimize the design layout and achieve the best isolation results BILZ starts by conducting an on-site vibration analysis. BILZ uses high-end FFT-Analyzers along with the best seismic acceleration sensors and geophones on the market.

### 2. Engineering and Design

Complementing our broad range of products, BILZ offers customized systems and solutions that guarantee superior results. Engineering and design is part of our core business and our technical leadership is advanced through R&D and continuous improvement.

### 3. Production

Production, assembly and quality control is in-house and located within our headquarters in Stuttgart-Leonberg, Germany. Special requirements such as: Cleanroom packaging or special logistic solutions can also be offered. BILZ is ISO 9001 certified.

### 4. Installation

System installation can be conducted by BILZ field service engineers or by trained customer staff. The BILZ Active Electro-Pneumatic Isolation System can be installed and put into operation, including acceptance test, in one or two days. BILZ guarantees global service and support, with representatives in more than 20 countries.





**C. Platform for minimum working height and low center of gravity**



**D. Platform for minimum working height and very low center of gravity**

### Field of application

In many leading-edge industries the equipment and process requirements are becoming more demanding. Sub-micron, nano or even angstrom resolution is becoming a common customer requirement. Due to facility and on-site conditions, e.g. floor vibration, these resolutions are very hard to reach. High-end microscopes, metrology, inspection and repair equipment as well as other sensitive tools in the semiconductor industry, micro-biology and scientific research will not perform to specification without adequate vibration isolation. Isolated platforms are used when the equipment does not have an internal vibration isolation system or when the internal system is not effective enough in isolating the external vibration.

### System design

Based on customer requirements of isolation performance and on-site conditions, BILZ can design and build customized systems using cost-effective passive isolators with mechanical level control or for high-end requirements the cutting-edge active AIS™ isolation system in 6 degrees of freedom. The platforms are customized and optimized in terms of rigidity, weight, dimensions, center-of-gravity, and choice of isolators according to customer requirements.

### Results

Depending on the customer requirements, floor conditions and system design of the isolated platforms, BILZ will enable your machine to meet vibration criteria of VC-D ( $<6\mu\text{m/s}$ ) and VC-E ( $<3\mu\text{m/s}$ ). This allows our customers to reach specification from nano to sub-angstrom resolution.

