Fabreeka® supplies ultra-low vibration isolation for sub-nanometer measurement, inspection and manufacturing at the University of Huddersfield.

The University of Huddersfield has commissioned a state-of-the-art nano technology centre to become one of the largest ultra-precision metrology and teaching resources in Europe. The new laboratories include diamond turning, interferometry, inspection and microscopy equipment, which operate with atomic and sub-nanometer resolution.

Vibration control has taken on a new, more challenging dimension. While isolation systems used to be designed to isolate sensitive equipment from the environment, disturbing forces are now generated by the payload itself. Vibration control must contend with a multitude of diverse disturbances.

Fabreeka has supplied ultra low frequency pneumatic isolation systems including semi-active and active isolators with isolation control in all six (6) degrees of freedom. The isolation systems support and isolate large inertia masses (foundations) in the basement of the laboratory. The equipment with payload is installed on the masses through the laboratory floor above each mass.

A total of sixteen (16) semi-active isolators were provided for four (4) of the masses and four (4) active isolators for the fifth mass.

Specifications of the pneumatic isolators installed on this project are listed below, followed by acceptance test data taken on-site by Fabreeka during installation. The test data provides evidence of ultra low frequency isolation with large payload capacities.

PAL55-52P, 133-52P Isolation System
Technical Specifications

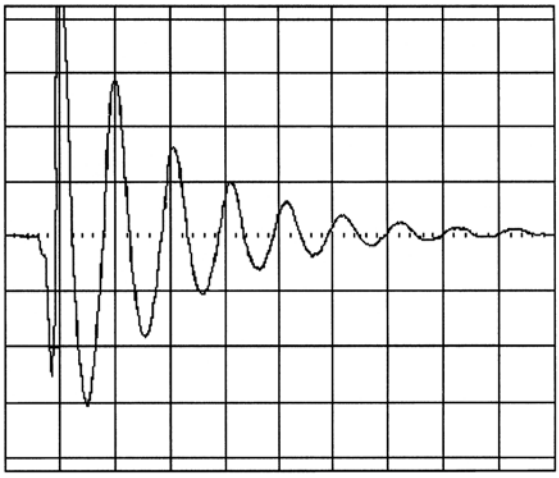
Vertical Characteristics	
Type of Isolation	Semi-Active Pneumatic
Natural Frequency	0.5 - 0.6 Hz.
Damping	10% of Critical Maximum
Isolation Rate (Roll-Off)	12 dB/octave (Theoretical)
Horizontal Characteristics	
Type of Isolation	Tuned Pendulum
Natural Frequency	0.4 - 0.5 Hz.
Damping	2% - 6% of Critical
Isolation Rate (Roll-Off)	6 dB/octave (Theoretical)
Vertical Control	
System Returnability	± 0.03 inch (± 0.8 mm)
Pneumatic Supply	Clean Dry Air
Source Pressure	100 psig Minimum

PAL55-52P, 133-52P

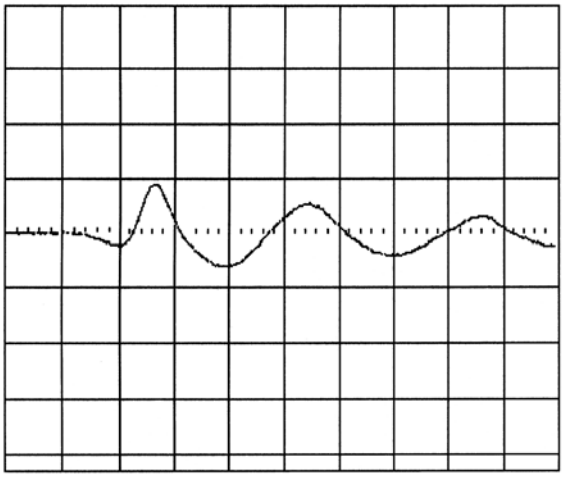
Each isolation system consists of four (4) semi-active pneumatic vibration isolators with low natural frequencies and automatic servo height control.

Masses "A", "B" and "D" are supported by four (4) PAL55-52P isolators. Each isolator is 52" in height and can support 5,500 lbs (2,500 Kg).

Four (4) PAL133-52P isolators support and isolate mass "G". Each isolator is 52" in height and can support 13,300 lbs (6,000 Kg).



Isolator response data – **horizontal** axis. Data indicates a horizontal natural frequency of 0.45 Hz with a damping ratio of 8.6% and an amplification at resonance of 5.8.



Isolator response data – **vertical** axis. Data indicates a vertical natural frequency of 0.63 Hz with a damping ratio of 6.4% and an amplification at resonance of 7.7.

PALTCN-500 Isolation System
Technical Specifications

- Active, electronic vibration control in six (6) degrees of freedom
- Optimal vibration isolation from 0.1 Hz and above
- Adaptive, self-tuning control algorithm
- Minimal settling time after transient excitation
- Feedforward feature for onboard inertial force cancellation
- Digital control based upon DSP-CPU

• Transient settling time	<50 msec
• Force output per actuator	80N
• Degrees of freedom (DOF)	6
• System noise floor	100 nm/√Hz at 0.1 Hz 10 nm/√Hz at 1 Hz 1 nm/√Hz at 10 Hz <1 nm/√Hz for f>10 Hz
• Maximum deflection	±1 mm (0.03 in.)
• Vertical leveling accuracy	±300 µm
• EMI emission	<5 mG/√Hz (P-P)
• Air supply (min/max)	5/8 bar (75/120 psi)
• Air consumption	<100 Nltr./min;>1 scfm
• Power consumption (max.)	0.85 kW
• Power consumption (typ.)	0.4 kW

PALTCN

A TCN Series system is usually comprised of three or more isolators, a digital controller, interconnecting cables and a triaxial sensor unit for the measurement of floor vibration. Each individual isolator includes a passive pneumatic isolator with a horizontal pendulum, two electrodynamic force actuators, as well as highly sensitive microseismic vibration sensors for measuring the absolute vertical motion of a given payload.

Additionally, each standard isolator contains a mechanical leveling system (pressure control) and a pre-amplifier for the signal conditioning of the vibration sensors.

During normal operation, floor and payload vibrations are monitored simultaneously. The knowledge of the total system transfer function and all levels of vibration enable the controller to compute correctional forces in amplitude and phase which never amplify at any given frequency and guarantee optimum stability. If the characteristics of the payload change, reinitializing updates the stored transfer function automatically.

This superior isolation performance is vital not only in electron beam microscopes in tall buildings, but also in wafer inspection and lithography equipment. PALTCN Series isolators are used to eliminate vibration in complex and sensitive research laboratory experiments.

PALTCN 500 isolators located at specified points under reaction mass "C".

PALTCN Digital Control Panel

The PALTCN series isolators suppress "on board" disturbances. This eliminates the long settling time requirements of passive isolators in conjunction with moving X-Y staging arrangements that are being accelerated or decelerated. PALTCN series isolators offer control over these inertial forces either by feedback reactive mode or by electronically interfacing with the machine controller in a feedforward configuration. This results in higher resolution and improved settling time.

A standard RS-232 C connector offers and easy-to-use interface from any terminal. A simple menu guides the system operator through different layers in the interface hierarchy and allows for custom filter design, diagnostics, and many other features. An optional software package from Fabreeka can upgrade a controller to a multi-channel vibration analyzer.

For improved position control and for faster leveling response after center-of-gravity shifting, the PALTCN series controllers can be upgraded with electro-pneumatic servo valves. They are controlled in conjunction with the other servo algorithms and, therefore, never interfere or cause instability. All parameters can be adjusted by the system operator via the RS-232 C.

X-Y motion arrangements generate large inertial forces as a result of acceleration and deceleration. When X-Y driving signals are available, they can be fed into the PALTCN digital controller. A feedforward control algorithm can be applied to counteract the forces before they can actually cause motion. A stage motion feedforward kit is available with a software upgrade on 3-1/2" disk. The electrical interface to the machine controller can be accommodated with both analog and digital interfaces.

Contrary to conventional active feedback systems, the PALTCN series concept uses additional floor vibration sensors. Pure feedback systems need an error signal in order to generate correcting forces. This implies that these systems act after the fact. Furthermore, they cannot differentiate between the structural resonances of the payload and floor induced vibration. This will result in amplification at specific frequencies. In order to avoid this, Fabreeka's PALTCN Series isolation modules can be upgraded with a Floor Motion Sensor Kit. These additional sensors deliver critical information about present magnitude, which is important for the adaptive turning, as well as for improved isolation. This provides data on the magnitude and phase of the disturbance signal.

Immediately upon powering up the controller, a software routine for system initialization is started. This entails inducing white noise vibration into the payload and obtaining the system's transfer function.

As an alternative to using the self-tuning routine contained in the PALTCN series, the system operator may choose to interface with the controller via its RS-232 C interface and custom-design the unit's rejection characteristics.

By using either an external signal analyzer or the Fabreeka FFT multichanging signal analyzer package, the nature of the disturbance spectrum can be examined and frequencies of particular interest can be identified. The general broadband rejection characteristics can then be altered by selecting narrowband rejection at the selected frequencies in the software menu. The more individual frequencies selected, the smaller the rejection capability in comparison to the broadband default setup. Selecting narrowband rejection provides typically 30 dB of additional attenuation.

Please contact Fabreeka® with any questions or to discuss your application.

Fabreeka® International, Inc.
1023 Turnpike Street
PO Box 210
Stoughton, MA 02072
T: 1-800-322-7352 or 781-341-3655
F: 781-341-3983
E: info@fabreeka.com
www.fabreeka.com