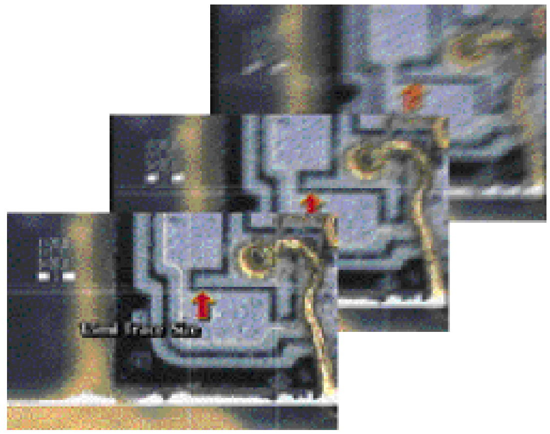
Boosting Yield Through Vibration Control

In an age of rapidly shrinking component geometries, your investment in vibration control today will be even more important tomorrow.

As manufacturers involved in lithography, surface profilometry, metrology, biotechnology, and other critical operations have found vibrations are a potentially disastrous threat to precision and throughput.

Vibrations are generated by traffic, footfall, air handling equipment, and other conditions that exist in the vicinity of virtually every manufacturing facility. Specifically, there are three types of vibration that can disturb a payload: ground vibration, acoustic noise and direct force disturbances.



Helps bring your images into focus!

Enhanced Performance Through Vibration Isolation

- ***High Resolution Microscopes***
- ***Scanning Electron Microscopes***
- ***Scanning Probe Microscopes—such as AFM's and STM's***
- ***Transmission Electron Microscopes***
- ***Commercial Interferometers***
- ***Surface Profilometers***
- ***Photolithography Exposure Illuminators***
- ***Metrology Inspection Systems***
- ***Ion Implanters***
- ***Probe Stations***

Ground or seismic vibrations exist in every environment on earth. These vibrations can be natural, emanating from tectonic shifts, waves crashing and wind blowing, or manmade, originating in vehicular or even foot traffic and even the whirring of HVAC equipment.

Acoustic noise comes from the same basic sources but is transmitted through air pressure waves. Even air currents coming from nearby ventilation systems can cause these waves, which can disturb a payload by acting as a differential pressure on the diaphragms of pneumatic isolators. Acoustic enclosures provide a nearly airtight, heavy, energy-absorbing cone over the process to combat this source of vibration. The final type of vibration, called direct force, is generated by the payload operation itself, such as vibration being transmitted to the payload through a hose or a laser water cooling line. It can also come from the payload itself. This is the case in semiconductor inspection equipment, where moving stages are used to position silicon wafers. The force used to accelerate the stage is also applied to the static portion of the payload in the form of a reaction force. Moving stages can also shift the payload's center of mass (COM).

Thus, there are invariably sources of vibration that can compromise your operations that require you to take steps to control the effects of seismic events, acoustic noise and direct force disturbances.

Disturbing Consequences!
In the most severe cases of environmental disturbance, high-precision operations become impossible. Without the ability to zero in on precise locations on a sample surface, an operator cannot complete critical functionality tests, obtain required resolution, or perform microinjections and other delicate procedures.

In other cases, momentary disturbances can compromise operations without the operator's knowledge. For example, a brief set of vibrations caused by unusually heavy street traffic can have disastrous consequences on an automated step-and-repeat lithographic exposure, involving hundreds of discrete parts that will have to be reworked or scrapped. To make matters worse, this damage may not be detected until after further processing operations have been completed—compounding an investment in degraded components.

Another consequence of environmental disturbances is felt on a more visceral level: they literally may be making your operators sick! Persistent viewing of blurred, shaking objects at high magnifications causes nausea, headaches, and fatigue, which take a heavy toll on performance and throughput.

Passive Vibration Isolation

The most common type of vibration isolator is the pneumatic isolator, which contains a sealed and pressurized air volume and movable piston. A rolling diaphragm membrane provides an airtight seal between the isolator and the piston.

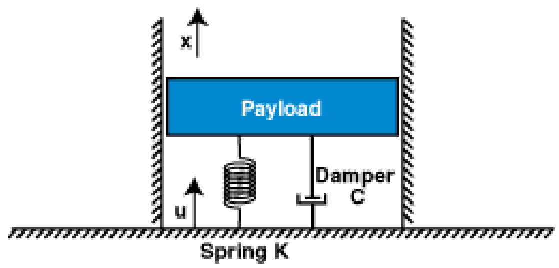
Compressed air pushes against the piston to support the system static load. Damping is provided by forcing air to move between chambers through one or more small orifices and/or a pendulum rod within a viscous damper.

Simply stated, the key to isolating vibration is to develop vibration isolators that attain the lowest possible natural frequency with the best isolation possible. The lower the natural frequency, the greater the ability of the isolation table to resist a disturbing frequency (resulting from loud noises, traffic, falling objects, etc.).

Natural frequency is the rate of movement (in cycles per second) at which a mass-spring system will vibrate if it is disturbed. The damping mechanism in the system will eventually damp out these oscillations.

As long as the disturbing frequency is higher than the natural frequency, the surface will isolate the vibration. When disturbing frequencies approach and then fall below the natural frequency, however, the isolators in the vibration table will amplify the disturbing frequency, increasing the vibration of the work surface.

Vibration isolation effectiveness is demonstrated graphically by a transmissibility curve which plots the ratio of system motions to ground motion as a function of frequency. In the transmissibility curve shown, the crossover frequency is the frequency at which the motion of the isolated system is the same as the floor motion (transmissibility = 1).

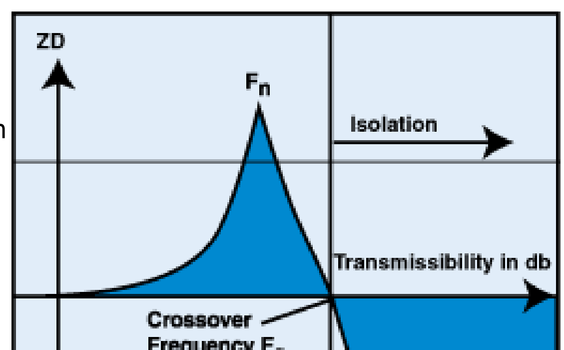


Passive Isolation System

x Frequency of vibration at work surface

u Frequency of vibration at floor

T (Transmissibility) = x/u



Transmissibility Curve

fn - Natural Frequency

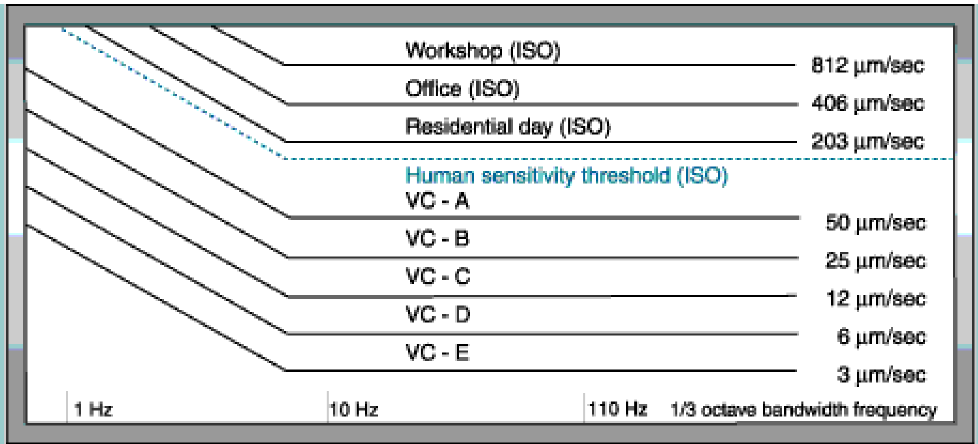
fg - Crossover Frequency

For optimal results, then, the desirable characteristics of a pneumatic isolator are a low natural frequency, a low amplification at resonance, and a fast roll-off of vibration transmission at higher frequencies. These are precisely the characteristics engineered into our line of passive vibration isolation tables and platforms.

Any disturbing force with a higher frequency will be isolated; the pneumatic isolator will transmit only a small fraction of the floor vibration to the isolated system. This isolation efficiency approaches 99.9%, depending on the load and the disturbing frequency.

How Does Your Facility Shake Down?

Allowable vibration in semiconductor facilities (in μm/sec rms)



Maximum permissible amplitudes in the following vibration categories (VC):

- VC-A Adequate in most instances for optical microscopes to 400X
- VC-B An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment to 3 micron line widths
- VC-C A good standard for most lithography and inspection equipment to 1 micron line widths.
- VC-D Suitable for electron microscopes (SEMs, TEMs) and E-Beam systems, operating to the limit of their capacity.
- VC-E Assumed to be adequate for the most demanding of sensitive systems

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