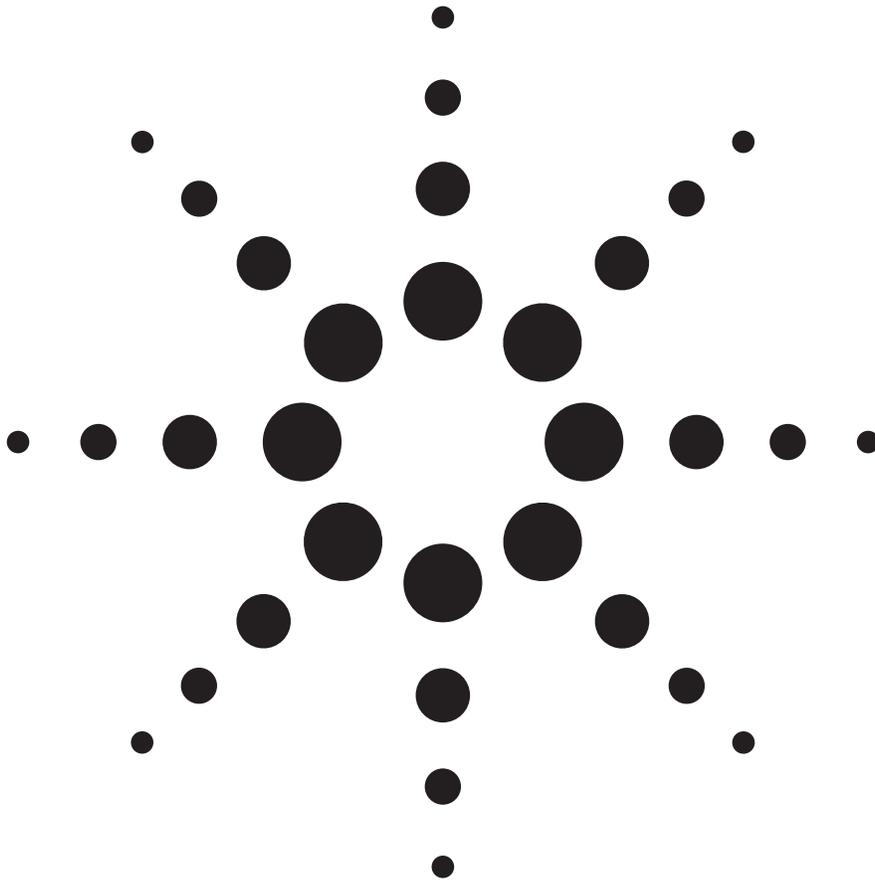


# **Optical Mice and how they Work:**

The Optical Mouse is a complete imaging system in a tiny package.

White Paper



Agilent Technologies  
Semiconductor Products Group

## Abstract

The mechanical computer mouse, Douglas Engelbart's invention of the 1960's, is starting to look like an endangered species. While users praise its ingenuity, many resent its unreliability and its need for frequent cleaning.

Change is on the way. Thanks to advances in optical navigation, solid-state optical mice have become the new standard. These new mice never need cleaning, track precisely and work on nearly all surfaces. They may even reduce repetitive stress injury, and to most people they just plain feel better.

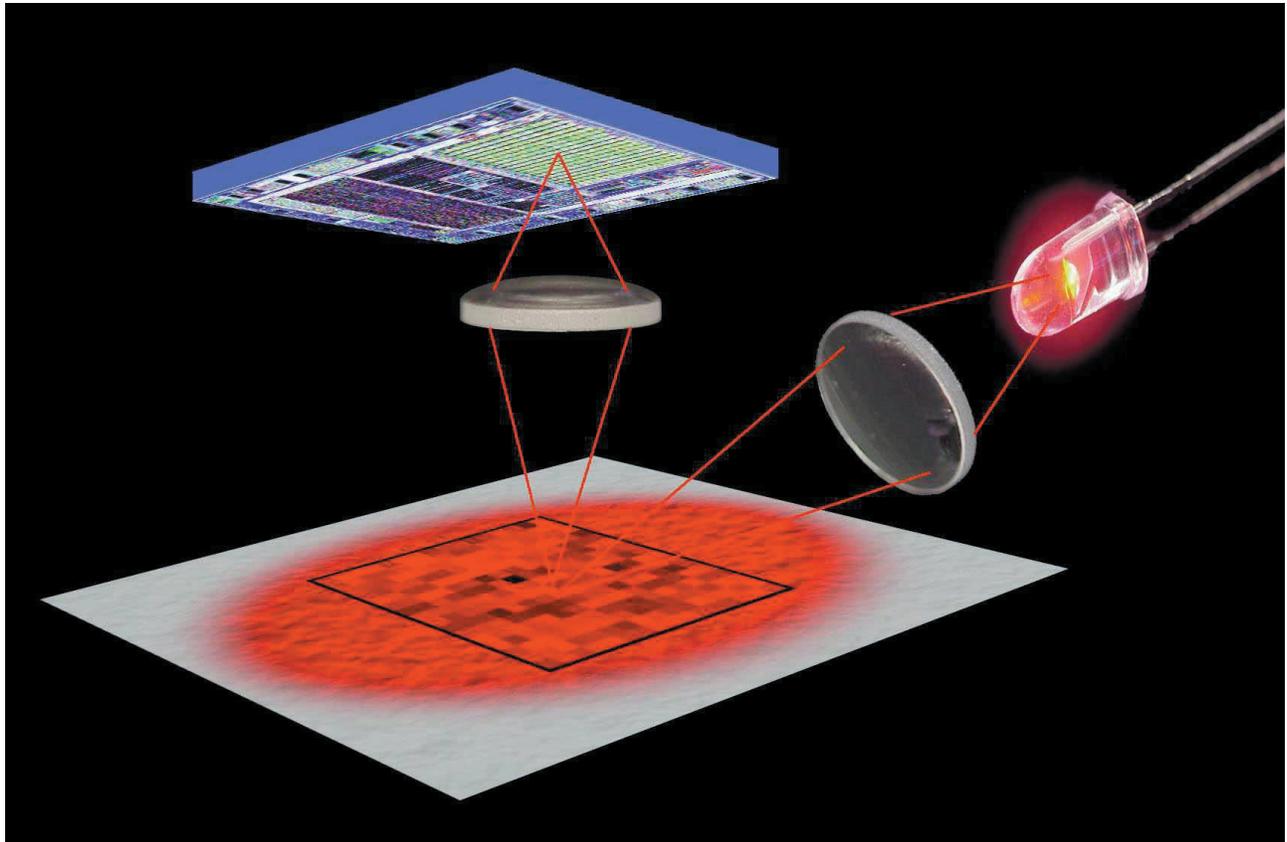
Their ease of use belies their complexity. Hidden inside the sleek plastic case is a sophisticated design, combining the best of today's electronic and optical technology.

## Inside An Optical Mouse

If you took apart an optical mouse and looked inside, you'd find a complete imaging system. The mouse is essentially a tiny, high-speed video camera and image processor.

As shown in Figure 1, a light-emitting diode (LED) illuminates the surface underneath the mouse. The light from the LED reflects off microscopic textural features in the area.

A plastic lens collects the reflected light and forms an image on a sensor. If you were to look at the image, it would be a black-and-white picture of a tiny section of the surface. The sensor continuously takes pictures as the mouse moves. The sensor takes pictures quickly—1500 pictures (frames) per second or more—fast enough so that sequential pictures overlap. The images are then sent to the optical navigation engine for processing.



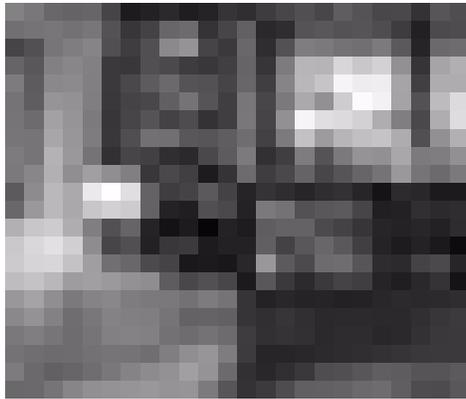
**Figure 1.** Optical mice illuminate an area of the work surface with an LED, to reveal a microscopic pattern of highlights and shadows. These patterns are reflected onto the navigation sensor, which takes pictures at a rate of 1500 images per second or more.

## The Basics of Optical Navigation

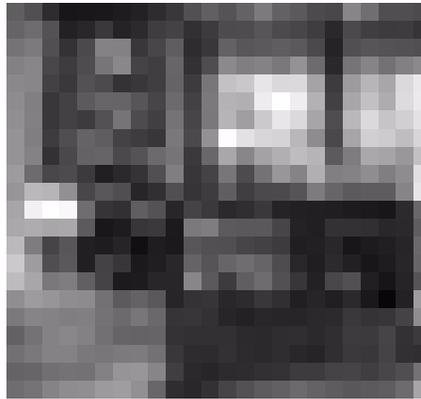
The optical navigation engine is the brain of the mouse. It identifies texture or other features in the pictures and tracks their motion. Figure 2 illustrates how this is done. Two images were captured sequentially as the mouse was panned to the right and upwards. Much of the same visual material can be recognized in both frames. Through a patented image-processing algorithm, the optical navigation engine identifies common features between these two frames and determines the distance between them. This information is then translated into X and Y coordinates to indicate mouse movement.

## Advantages of Optical Technology

Unlike traditional mechanical mice, optical mice have no moving ball that can clog up with dust or dirt. Users no longer need to perform regular cleaning for accurate tracking. In addition, optical technology can work on many surfaces where ball mice have difficulty, including curved surfaces or soft fabric. Because of their distinct advantages, optical mice are fast becoming the standard in computer stores around the world.



A. Image at  $t = 0$  ms



B. Image at  $t = 0.67$  ms

**Figure 2.** The Navigation Engine identifies common features in sequential images to determine the direction and amount of mouse movement. Image B was taken while the mouse was moving, a short time after image A. It shows the same features as image A, only shifted down and to the left.

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