



Brass Simple Monocular Microscope (circa 1830)

MOLECULAR EXPRESSIONS™

Optical Microscopy Primer

Digital Imaging in Optical Microscopy

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Electronic Shutters

Electronic shutters are employed in charge-coupled devices (CCDs) to control integration time (exposure) of the photodiode array and reduce smear when capturing moving objects in the microscope. Instructions for operation of the tutorial appear beneath the applet window.



Interactive Java Tutorial

ATTENTION

Our servers have detected that your web browser does not have the Java Virtual Machine installed or it is not functioning properly. Please install this software in order to view our interactive Java tutorials. Visitors using the Netscape and Microsoft Internet Explorer browsers can download the appropriate software from the websites where the browsers are distributed. Please do not contact us for information about specific URLs where this software can be obtained.

The tutorial initializes with the bias turned off to both the shutter and transfer gates so that the photodiode can proceed with charge integration. Use the mouse cursor to activate the **Exposure** button and trigger a sequence of shutter drain followed by charge transfer to the adjacent potential well. The **Wavelength** allows adjustment of incoming photon wavelength.

Integration of electrons in the photodiode potential well is controlled by the exposure control gate, which will shunt electrons to the scavenger diode when biased on by the CCD clock circuitry. In some CCD configurations, the electronic shutter can be used to balance the color response of the red, green, and blue channels.

Shutters allow all light sensitive photodiodes to be simultaneously erased without affecting darkened shift registers, thus controlling the time period between flushing the photodiodes and the start of the readout process. The exposure rate of an electronic shutter can vary between 1/60th and 1/16,000 second, depending upon CCD architecture.

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Last modification: Tuesday, Oct 22, 2002 at 02:40 PM

Access Count Since June 26, 2000: 2902

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