Electronic Shuttering

- What is Electronic Shuttering
- Why is it Important to High Speed Video

Shutter

- Shuttering is the process of exposing an imaging sensor to light at a rate equal to or faster than the frame rate. The purpose of the shuttering is to reduce the motion blur within an image frame.

Shutter Techniques

- electronic strobes that put out a dominant light for a short duration
- mechanical wheel with a slit that exposes light to a sensor for a short duration
- a laser that is pulsed for a short duration as a dominant light source
- a light value or LCD that is polarize on and off that will pass light for a short duration
- electronic shutter built into the imaging sensor

Image Sensor Shuttering

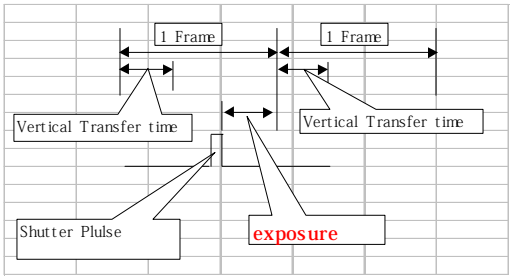
- Frame Transfer
- Rolling or Block
- Global

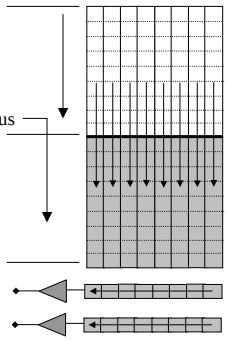
Frame Transfer Shutter

- The frame transfer type of imaging sensor can be shuttered by exposing the photodiode and then transferring the entire image at one time into the shaded storage area. The transfer time varies depending on the sensors performance. To achieve clear images, this transfer time must be very fast. In some sensors, it can be as slow as 200 microseconds.

Frame Transfer Example

- Motion Corder SR





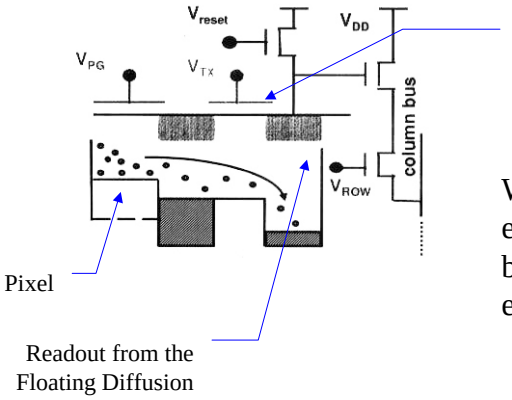
1000FPS	
Shutter Speed	exposure time(μsec)
1／2000	494
1／3000	324
1／5000	194
1／10000	89
1／20000	40

Rolling or Block Shutter

- The rolling shutter is where a line or a group of lines is read out while all other lines on the sensor continue to be exposed. When a group of lines are read out at one time, this is called a block readout. Typical line times, depending on the frame rate and sensor architecture, can be several hundred microseconds.

Rolling Shutter (RS)

- Typical CMOS Architecture

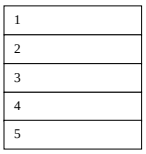


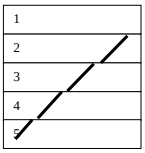
With no storage cell, the entire line must be read before the line can be exposed.

RS Image Artifacts

- Imaging sensor with only 5 lines of resolution using rolling shutter readout. In this example we read line 1 completely before line 2 is read and so forth. A line consists of many pixels. Typical line times, depending on the frame rate and sensor architecture, can be several hundred microseconds.

- When reading line 1 out, lines 2,3, 4 & 5 are being exposed. Line 1 will start being exposed again after it is completely readout. Therefore, a fast moving object within one frame time could have discontinuities due to the "rolling exposure".



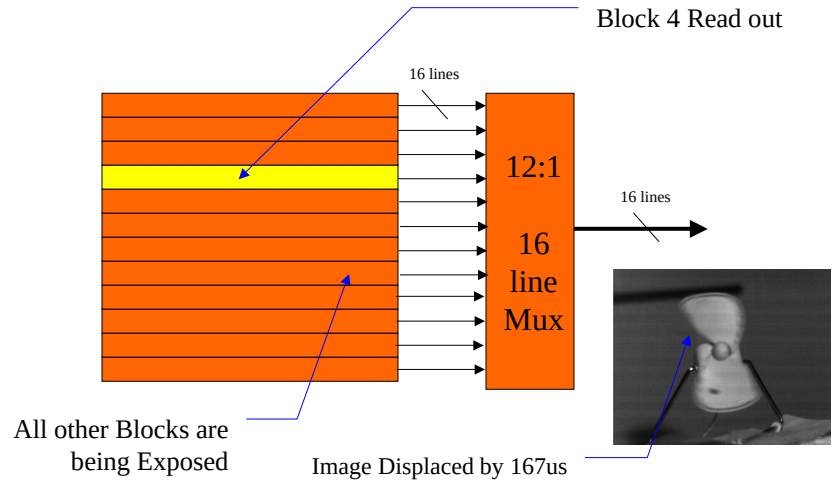


Rolling Shutter Technology

- It is very difficult to design a CMOS sensor to have a true electronic shutter. This requires a storage element within the pixel that can hold the charge before it is time to read out the charge.

- Most CMOS designs today are targeted for the highest image quality in point and shoot cameras. Adding a storage element into a CMOS design will introduce image lag, increase the cost and size of the sensor. All of these factors are undesirable for most CMOS designs.

Block Readout Example

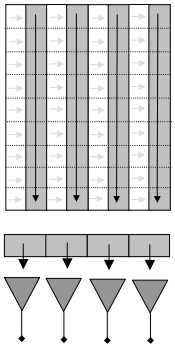


Global Shutter

- A global shutter, unlike the rolling shutter, exposes all pixels at the same time.
- There is no time discontinuity in the image.
- The global shutter has a storage element that allows the pixel to dump the storage charge into a shielded area. This shielded area than can be read out while the next image frame is being exposed. Therefore, there are no discontinuities or image artifacts associated with the electronic exposure.

Global shutter Architecture

- This is a high speed architecture for an interline CCD. The gray area is the shielded area that is protected from light. Charge is transferred into this protected area very fast. The charge can now be readout and the next frame can be exposed, all at the same time.



Why is Global Shuttering Better

- Image is integrated without discontinuities in time
- Image Quality is superior with less motion blur
- Measurements are more accurate
- No mechanical moving parts
- Strobes are not required to stop the motion blur
- Special Recording modes such as Slip Sync or Burst ROC are only possible with Electronic Shuttering (Global).