

Applications Note:

Dynamic Range Expansion Using The ISG LightWise Global Shutter Camera (LW-1.3-G-1394-M)

Introduction

It is often desirable to use a camera in applications that include dark and bright scene areas. This may include scenes, which combine indoor and outdoor elements, or machine vision applications with bright objects in a dim background. Traditionally, this has posed a difficult problem for CCD and CMOS-based camera systems, which must use an exposure time that either leaves the dim areas too dark, or the bright areas saturated or washed out.

The ISG Global Shutter Camera (LW-1.3-G-1394-M) supports a unique feature that combines images taken with different integration times into one image. This is accomplished in the sensor's pixels before frame readout. The result is an image with greatly extended dynamic range. This is achieved without applying non-linear digital gain or lookup table methods, which can add significant noise at lower grey level values.

The camera will support up to 4 exposures per frame. Each exposure has a programmable integration time and a fixed knee point. The pixel-reset voltage applied to each pixel between exposures determines the knee point, and this reset voltage increases with each exposure frame by about 25% of the pixel saturation voltage. The figures below illustrate the integration and readout sequence for two exposures per frame (dual slope).

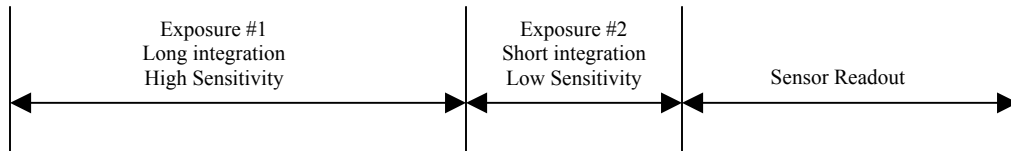


Figure 1: Integration - Read Sequence for Dual Slope Mode

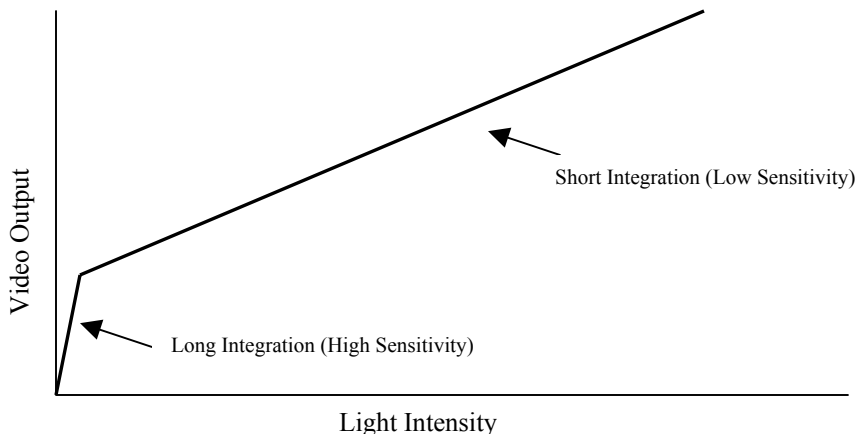


Figure 2: Dual Slope Response

The following series of images show an example of the same scene captured with a single short exposure time, with a single long exposure time, and finally in dual slope mode.



Figure 3: Single Exposure = 8ms

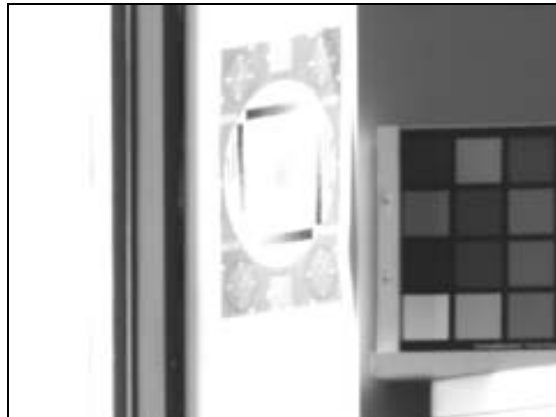


Figure 4: Single Exposure = 30ms



Figure 5: Dual Exposure of 30ms and 8 ms

Programming the ISG Global Shutter Camera for Multiple Slope Modes.

The multiple slope modes are easily programmed using the ISG GUI application. When not using the ISG GUI, the programming of the camera must be done using quadlet writes to the camera internal registers.

Using the ISG GUI for Multiple Slope Mode

After starting the GUI application, bring up the Camera Control Dialogue and select the tab labeled Multislope Control. On this page you can select from 1 – 4 exposures per frame with the mode pull down. A slider to control integration time for each exposure is also available. As a starting point, the integration time for the first exposure should be ~4x that of the second exposure. The integration time for the second exposure should be ~4x that of the third and so on. A minimum integration time of 18.7us (750 pixel clocks) is required for each exposure in multiple slope mode. When in single slope mode the exposure time can be as low as 1 pixel clock.

Programming for Multiple Slope mode without the ISG GUI

When not using the ISG GUI, the camera must be programmed directly using the quadlet interface. Bits[4:3] of the CNTL2 register at address 0x424 are used to control the multi slope mode. The integration count registers (0x428 – 0x434) are used to program the integration time for each exposure. Please see the programming guide section of the users spec for more information on these registers. A minimum integration time of 18.7us (750 pixel clocks) is required for each exposure in multiple slope mode.

Frame Time Calculations

A Spreadsheet is available for calculating frame times with different slope settings and integration times. Please contact ISG for more information.

Note: FPGA version 305 and UI Application version 5.00.010 or higher are required for multiple slope functionality.