

## Product overview

The ULS24 Solution Kit is an "out of box" solution to allow the user to conveniently evaluate Anitoa ULS24 Ultra Low-light CMOS imager chip. The ULS 24 Solution Kit includes the ULS24 sensor IC, an interface board, and software. This solution kit can readily interface with a PC via USB.

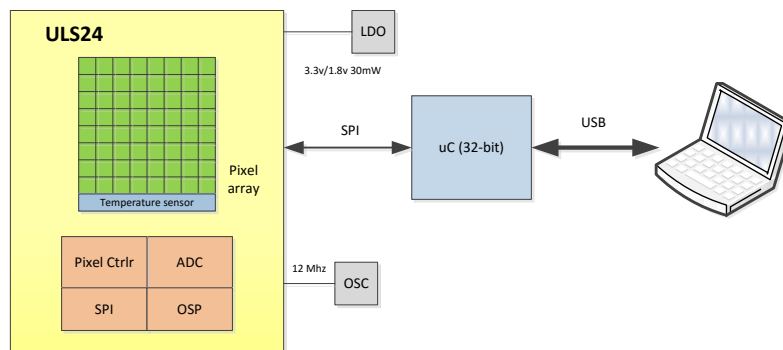


Figure 1 ULS24 Solution Kit Block Diagram

## Features of Anitoa ULS24 CMOS Imager

- Ultra low-light sensitivity. Detection threshold  $\sim 3.0 \times 10^{-6}$  lux.
- Low dark current, high SnR (>13dB at detection threshold).
- 12-bit ADC
- Wide dynamic range ( $\sim 85$ dB). Excellent linearity.
- Digital interface through Serial Peripheral Interface (SPI).
- Built-in junction temperature sensor.
- 3.3V and 1.8V power supply, 30mW max power.
- Operating temperature range  $-15\text{ }^{\circ}\text{C} - 85\text{ }^{\circ}\text{C}^1$ .

<sup>1</sup> The image sensor can meet noise spec at junction temperature up to  $55\text{ }^{\circ}\text{C}$

## Kit Content

**Sensor board** - This is a small (24mm x 26mm) PCB board that contains the ULS24 Ultra low-light CMOS imager chip. On the back of the Sensor board is a small connector that connects to the 16-pin ribbon cable.

**uC Interface board** - This is a 70mm x 90mm board that contains an STM32 ARM Cortex-M3 microcontroller. The system firmware is pre-programmed into the microcontroller. The Interface board connects with the sensor board through a 16-pin ribbon cable. Interface board also connects to a PC through USB interface.

**Ribbon cables** - This is a 16-pin ribbon cable that connects the sensor board with the uC Interface Board. 3 cables of different lengths, 150mm, 300mm, and 800mm, are provided.

**USB cable** - This connects the uC Interface Board with the PC.

**Dongle with software** - It is a USB Flash Drive that contains all the software and documentation.

## ULVision overview

ULVision is a PC software that displays captured image and allow user to enter control parameters. Detailed description of these control parameters is provided below.

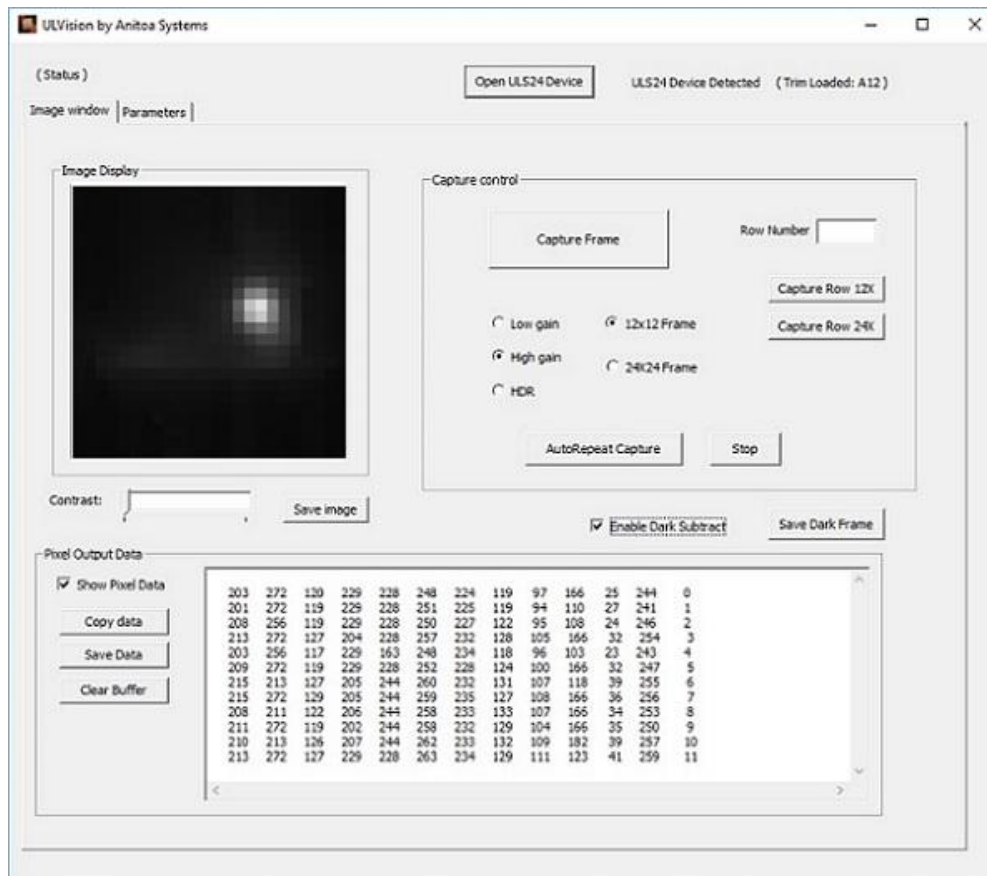


Figure 2 ULVision PC Software screen shot

## Getting started guide

Below is a step-by-step instruction to set up the whole system and test the basic functions.

1. Visually inspect the components of the kit to make sure nothing is damaged. If damages are found, please contact Anitoa Systems, LLC (info@anitoa.com) to request a replacement.
2. Connect the Sensor Board with the uC Interface Board - follow instructions in Appendix B, insert and lock the ribbon cable with connectors on the Sensor Board and uC Interface Board. **The metal contact portion of the ribbon cable end should face down.**
3. Install Software on a PC. Insert the included USB Flash Disk into a PC. Copy ULVision.exe from the folder ULVision to any directory in the PC.
4. Connect and power on uC Interface Board - Connect the uC Interface Board with the PC using the included USB Cable. The USB provides power to the whole system. When connected, the LED on the uC Interface board will start flashing.
5. Start ULVision on the PC. You should see the program starts in in figure 2. If the uC Interface board is already plugged in, it will automatically connect to ULVision. The status should display "ULS24 Device Detected".
6. With all parameters taking their default value, place the sensor in a dark area, click on "Capture" button, you should see a gray scale image displayed. Adjust the integration time to achieve best exposure.

Note: Because of the high sensitivity of this sensor, under normal illumination level, the sensor would likely saturate. When the sensor saturates, the output will not be updated.

## Control Parameters

### Integration time

Integration time is the amount of time each pixel uses to collect light. It is not the same, but related to frame time, which is the amount of time the image sensor uses to collect light for the frame.

Integration time is chosen according to the light illumination level. For very low level of light, longer integration time is needed for the pixels to generate sufficient level of response to show the feature of interest. The sensor's response to a fixed level of light is proportional to integration time.

In general, choose the shortest integration time first and observe the image, if it is too dark, then increase integration time until the feature of interest is in the middle of the sensor dynamic range.

Frame time is longer than the integration time because of command overhead (time to transmit commands) and data transfer time.

### Resolution

Choose either 24 x 24 or 12 x 12 resolution.

In 12 x 12 resolution mode, 4 Every 4 adjacent pixels are binned together to form a big pixel. By setting the binning pattern, we can choose any combination of these 4 small pixels to collect light. When more than one of the small pixels is chosen, the light sensitivity is multiplied.

### Gain control

Each pixel in the imager has operation modes which will affect its sensitivity and dynamic range. In the high gain mode, the pixels have higher light sensitivity than in the low gain mode. The responsivity ratio between high gain mode and low gain mode is 8 : 1.

There is also a high dynamic range mode (HDR mode) where high gain operation mode and low gain operation mode are combined to achieve higher dynamic range. The HDR mode is achieved in firmware, and is not a native operation mode of the pixels.

## Pixel binning pattern: 4-bin mode

In low resolution, i.e. 12x12, mode, each big pixel consists of 4 small pixels. Any combination of the 4 small pixels can be turned on or off by software. This is accomplished by configuring the 4-bin mode input parameter. 4-bin mode parameter is a 4 bit binary entity. Appendix A explains how to bin normal pixels to a big pixel.

In 24x24 resolution, adjusting 4-bin mode has no effect.

## Capture mode

Row(s), for each capture request, one or more rows will be scanned. User can specify the starting row and ending row. All rows between the starting row and ending row (inclusive) will be scanned.

Frame, the whole frame is scanned

Multi-frame (Auto repeat mode): multiple frames will be scanned. The user specifies the time delay between frames. The time delay has to be greater than frame time, or else the frames will be captured back to back with no delay.

External trigger mode: When selected, capture request is generated from external trigger.

## (Re) initialize parameters

This will reset all system parameters to their default values. When the system powers up for the first time, or when the ULVision software starts for the first time, all system parameters will be initialized.

## Read junction temperature

This will cause the output of the junction temperature sensor to be returned. The junction temperature indicates the temperature of the image sensor pixels while in operation. This may or may not be exactly the same as the ambient temperature.

## Output format

The text output window contains pixel reading values printed out in a matrix. These values can be show either as decimal value or hex value.

## Sync output timing

A logic signal is provide to indicate the timing of frame capture. This signal can be used for a variety of purposes, including generating an excitation light in fluorescent imaging.

Setup time: the time (in ms) between the onset of sync signal and start of frame capture. Hold time: the time between finishing of frame capture and end of sync signal.

## Dark output level

Under normal operation, when the image sensor is in a completely dark environment, the pixel output value stays around 100 or so. Having a positive dark output is helpful for low light sensing as it keeps the sensor operating point away from the negative saturation point. However, having a positive dark output level will reduce the dynamic range of the sensor. The dark output level can be adjusted by changing this parameter to suite application's needs. Note this control parameter does not merely change the numeric output value of the pixels; it actually will affect how the pixel hardware works internally.

## Display control

The display setting will affect the image display on screen. It will not affect the actual data output. Contrast: the higher the contrast, the bigger the visual difference between dark and bright spots in the scene.

## Trouble shooting guide

### 1. ULVision cannot detect uC Interface Board

Make sure that the uC Interface Board is connected to the PC via provided USB cable. Also make sure the uC Interface Board receives power from the USB interface. When the uC Interface Board is powered and the firmware started running, the LEDs on the uC Interface Board will flash

### 2. uC Interface board is functioning property but the system cannot capture image.

Make sure that the Sensor Board and uC Interface Board are properly connected with the 16-pin ribbon cable.

### 3. Image remains completely dark even when there is enough illumination and the integration time is long.

This is most likely caused by signal saturation. When the sensor saturates, it will not update the output. In this case, we should lower the light input level, reduce the integration time, and choose low gain mode or HDR mode until we observe frame refreshes.

### 4. Portion or the entire image will not refresh and the image becomes distorted.

Again this is likely due to sensor saturation.

In normal operation, even when the input stays unchanged, the pixel output will fluctuate up and down by several digits. If the pixel output stay unchanged throughout successive capture, it is likely that portion of the image is too bright, causing the pixels to saturate. In this case, we should lower the sensitivity of the sensor by reducing the integration time. We could also choose low gain mode or HDR mode; adjust dark voltage level (lower) to avoid image saturation.



## Appendix A: ULS24 Pixel format and binning pattern explained

The orientation of the chip relative to the package is shown below.

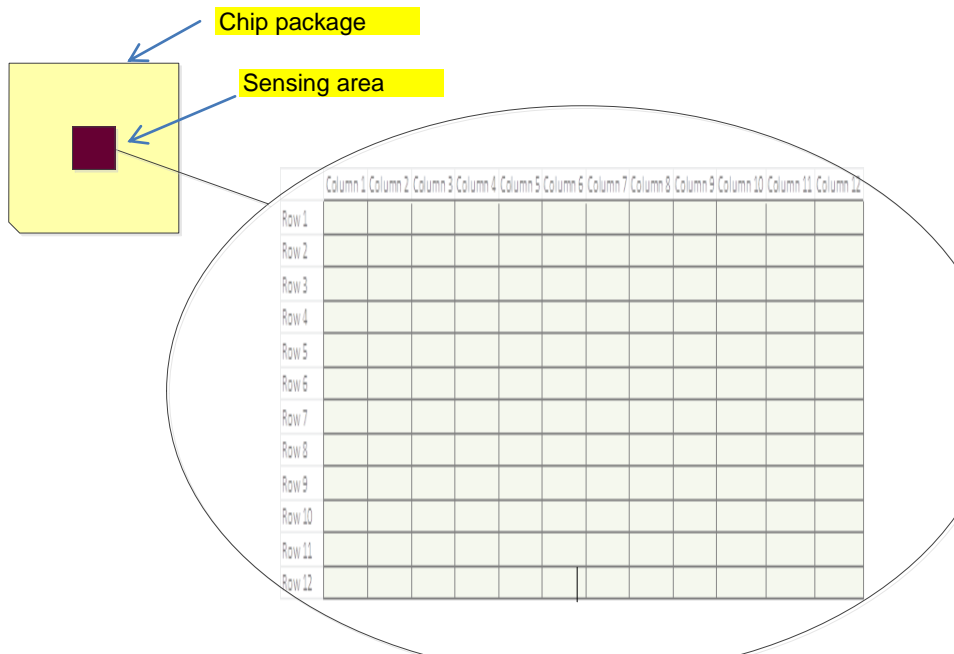


Figure 3 Chip orientation and pixel format

The pixels of the imager are arranged as a matrix shown below. Each big pixel is comprised of 4 subpixels.

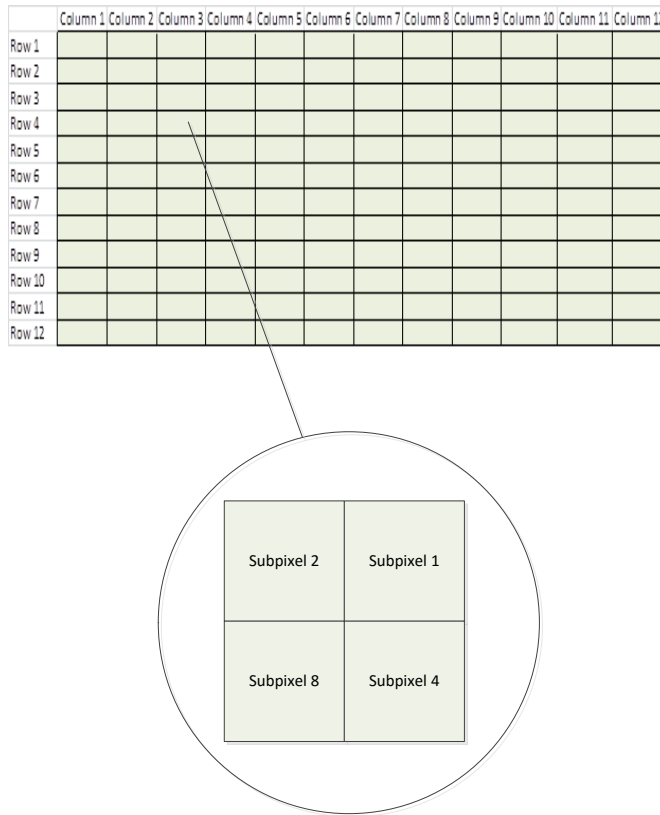


Figure 4a, Pixel binning pattern

In 12X12 low resolution mode, each effective pixel is comprised of 4 subpixels. Any combination of the 4 subpixels can be chosen to sense light. When more than one subpixel is chosen, the sensitivity is multiplied. For example, if all 4 pixels are chosen, the sensitivity of the device is quadrupled.

Below is the software interface for setting the binning pattern.

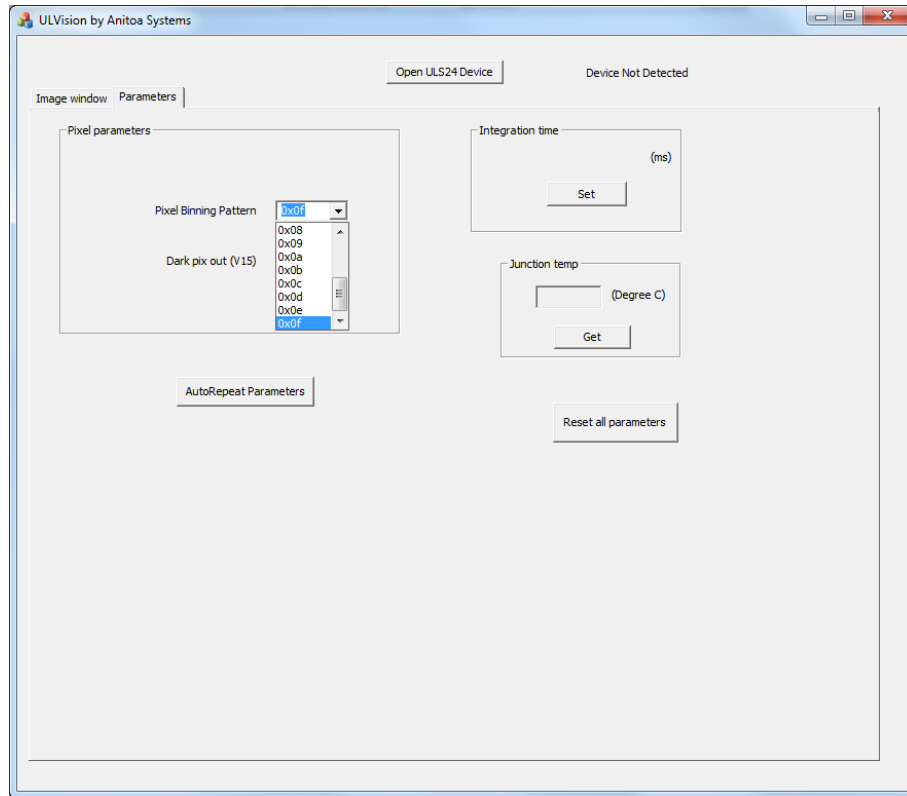


Figure 4b Software interface to set binning pattern

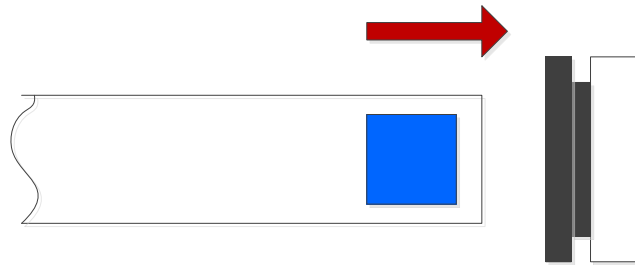
<b>Binning pattern</b>	<b>Subpixel8</b>	<b>Subpixel4</b>	<b>Subpixel2</b>	<b>Subpixel1</b>	<b>Gain</b>
0	0	0	0	0	x0
1	0	0	0	1	x1
2	0	0	1	0	x1
3	0	0	1	1	x2
4	0	1	0	0	x1
5	0	1	0	1	x2
6	0	1	1	0	x2
7	0	1	1	1	x3
8	1	0	0	0	x1
9	1	0	0	1	x2
A	1	0	1	0	x2
B	1	0	1	1	x3
C	1	1	0	0	x2
D	1	1	0	1	x3
E	1	1	1	0	x3
F	1	1	1	1	x4

Figure 4c Binning pattern code explained

## Appendix B: 16-pin Ribbon Cable and Connector Guide

### Method to connect 16-pin ribbon cable

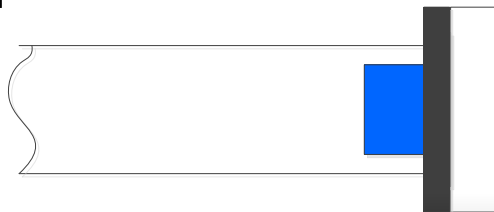
1. Insert cable with blue portion facing up, and with locking tab pulled out



2. Pull in the locking tab



3. Make sure cable is fully inserted and locked



## Contact

Anitoa Systems, LLC  
1717 Embarcadero Rd.  
Palo Alto, CA 94303  
[www.anitoa.com](http://www.anitoa.com)  
[info@anitoa.com](mailto:info@anitoa.com)