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THIS SPEC IS OBSOLETE

Spec No: 001-14741

Spec Title: FREQUENTLY ASKED QUESTIONS ABOUT THE STAR-250 DEVICE - AN5012

Sunset Owner: Evelyn Beard (EYB)

Replaced by: None

Frequently Asked Questions about STAR-250 Device - AN5012

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1. Does the STAR-250 suffer from an incomplete reset (image lag)?

With the default settings in the data sheets the STAR-250 suffers from image lag mainly visible at higher gains. Image lag is defined as an incomplete reset of the previous frame and therefore saturated parts in the previous frame are not complete reset to the dark level at the beginning of the current frame.

This image lag is the image lag associated with “soft reset” operation. I.e., in the 3T pixel, both the supply (=VPIX) and VRESET (=VDD) are equal (5V). During reset, the reset MOSFET is in weak inversion, and will only asymptotically reach equilibrium— in the absence of current. Response to small excursions of this equilibrium happens with large time constants.

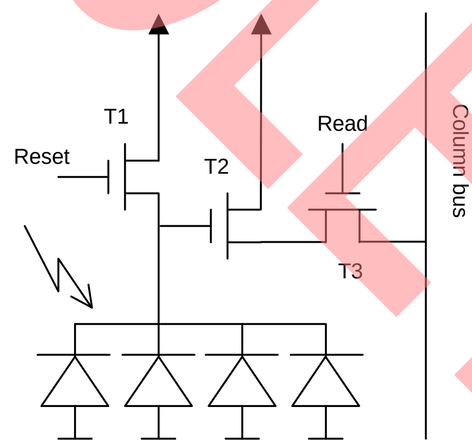

Figure 1. Pixel schematic with T1 as Reset MOSFET

This can be solved by a bias current operating the pixels in “hard reset”. This is accomplished by avoiding that the reset MOSFET goes in weak inversion; this is done by, e.g., turning the VPIX down to about 3...3.5 V. If VRESET-VPIX < Vth, the reset MOSFET is NOT in linear regime during reset, but in weak inversion, causing thus the image lag as it behaves as a current source with long time constant. If VRESET-VPIX > Vth, the reset MOSFET is in linear regime during reset, and acts as an (+/–) ideal switch. The value VPIX is the highest (starting) voltage on the photodiode. By light or by dark current the voltage on the photodiode will gradually drop.

The pixel's (highest) output voltage is (VRESET – Vth – Vth) or (VPIX – Vth) whichever is lower. This explains the fact that the voltage range can change al little bit in hard reset mode (of course, the voltage that you see at the sensors output goes through some additional stages...).

2. How does it come that the first image after initialization has a banding effect?

Figure 2 below shows a scene of a wall where banding is present. This banding is only seen in the very first image acquired after initialization.

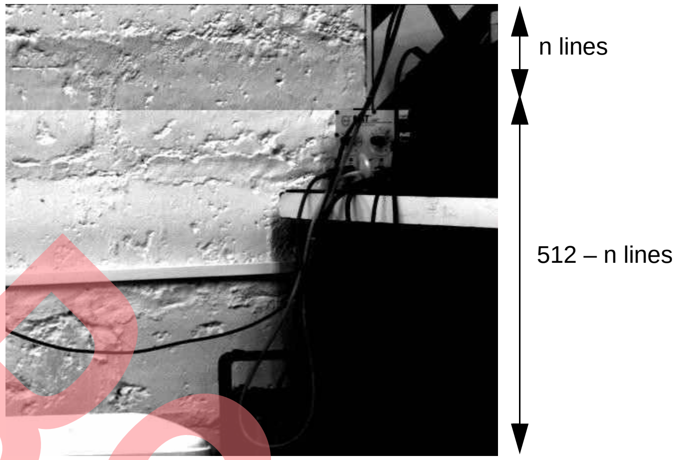

Figure 2. STAR-250 Image with Banding

The reason for the darker offset in the top lines is an influence of the number of resets (one or two in a row) to the level where pixels are reset too. The exposure of the sensor is set between the synchronization of the reset pointer and the synchronization of the read out pointer as explained in the data sheets. Suppose that the exposure is set to n-lines than will the first n-lines of the first image have a darker offset compared to the other lines. During the initial reset of these lines no other lines are read out yet. Because of that the RESET pulse is only pulsed once a row that causes a different load to the internal reset supply compared to residual lines of the image.

There's only one reset pulse in the row timing during the reset of the first n lines (only red pulses are applied; see *Figure 3*). Starting from line n+1 two reset pulses are applied each row (both black and red pulses; see *Figure 3*). This is affecting the reset level to which the line is reset (due to the different load on the reset supply) and can hence be seen in the image as an illumination difference.

This effect is only visible in the first frame that is read out after initialization. In the second frame the reset timing is the same for each row and no banding effect is seen. It is advised to ignore the first frame that is read out after initialization since no work-around can be found to avoid the banding effect.

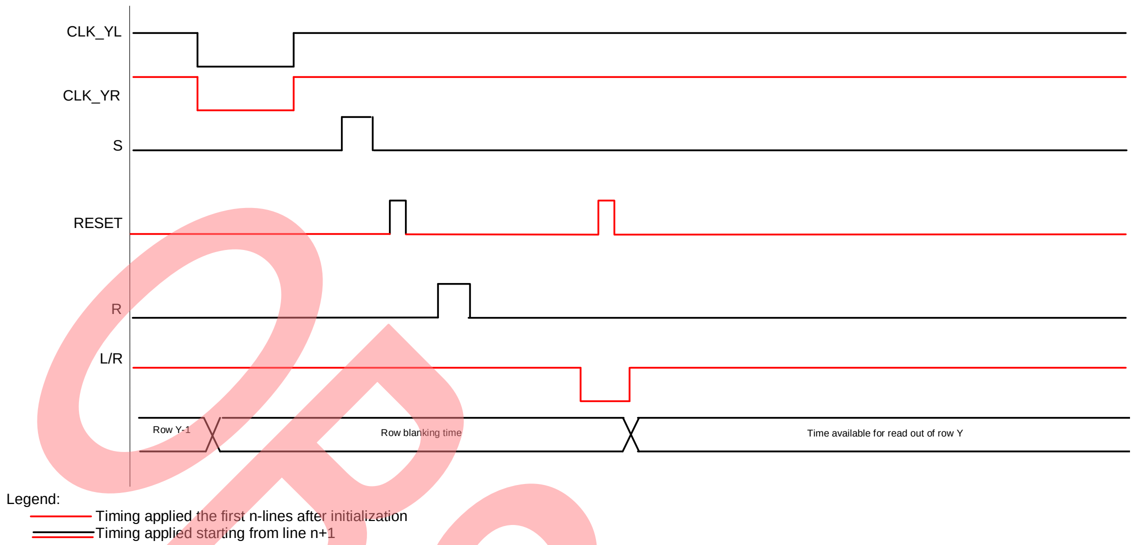

Figure 3. Row Timing of the STAR-250 Sensor

3. Is it possible to reduce the power consumption of the STAR-250?

Despite the fact that there is no standby pin on the STAR-250 sensor there are still possibilities to reduce the power consumption. In general there are two ways to reduce the power consumption. Firstly one can implement a kind of standby mode since not all applications are acquiring images all the time. Secondly one can reduce the pixel rate (< 8 MHz) but continuously acquire images or thirdly one can combine the first two solutions (lower pixel rate in combination with a standby mode).

The first way to reduce the overall power consumption is to implement a kind of stand by mode without power-down of the complete sensor. Since the output amplifier and the internal ADC have the highest part in the total power consumption (together they consume 70-80% of the total power consumption) and both parts have a separate supply one can reduce the power consumption in a stand by mode to < 30% of the normal power consumption by switching off (0V) these supplies during standby. All other supplies should still be supplied with their nominal power level (5V) and all timing signals should be pulsed continuously during the 'standby' period.

Supply Name	Normal Level	'Standby' Level
VDD_ANA	5V	5V
VDD_DIG	5V	5V
VDD_AMP	5V	0V
VDD_RES	5V	5V
VDD_PIX	5V	5V
VDD_ADC_DIG	5V	5V
VDD_ADC_ANA	5V	0V
Power consumption	**100%**	**25%**

Note that this power reduction method needs a controllable power supply level for VDD_AMP (pin 31) and VDD_ADC_ANA (pin 53, 56). The level of these power supplies has to be switched between 5V (nominal) and 0V (stand by). After 'standby' when the level of VDD_AMP and VDD_ADC_ANA are switched back from 0V to 5V it takes at least 1 ms before the STAR-250 sensor is back in normal operation conditions.

The second way to reduce the power consumption is to reduce the pixel rate of the STAR-250 sensor. This lower pixel rate allows to have higher bias resistor values on some bias nodes which reduces the bias current and thus also the power consumption. The table below compares a nominal setting of the bias resistors (8 MHz pixel rate) and bias setting optimized for 3 MHz.

Bias Resistor	Nominal Value (8 MHz)	Optimized Value (3 MHz)
NBIASARR	500k	500k
PBIAS	40k	100k
NBIAS_AMP	82k	200k
NBIASANA	100k	250k
NBAISANA2	100k	100k
PBIASDIG2	100k	100k
PBIASENCL	100k	250k
PBIASDIG1	47k	47k

The bias settings for other pixel rate frequencies can be recalculated accordingly.

To reduce the power consumption further one can combine the two methods explained above (reduced pixel rate and 'stand-by' period).

4. Is there a gradient from left to right in a dark image?

When looking to a highly amplified dark frame taken with the STAR-250 one can see a dark gradient from left to right (left of the image is darker as the right of the image).

Figure 4. Dark Frame Gradient

Cypress is still investigating the possible cause and possible countermeasures to be taken to avoid this gradient. At the moment no solution is provided yet.

5. Why is the first row of every image darker than the others?

The first row of every image has a small offset compared to other rows of the STAR-250. The average response of the first row is maximum 1% darker compared to the normal response of the other rows. At the moment no solution is provided yet.

6. Do the internal bias resistor values depend on temperature?

Yes, the internal bias resistors value depends on the temperature of the sensor die due to the temperature dependency of the poly sheet resistance. This is most important for the ADC input range since this range is set with a resistor ladder of two external resistors (VLOW_ADC and VHIGH_ADC) and the internal ADC. The internal ADC resistor value increases approximately 4.4 Ω/°C with increasing temperature.

Temp. [°C]	R_{ADC} [Ω]
–40	850
+23	1150
+85	1400

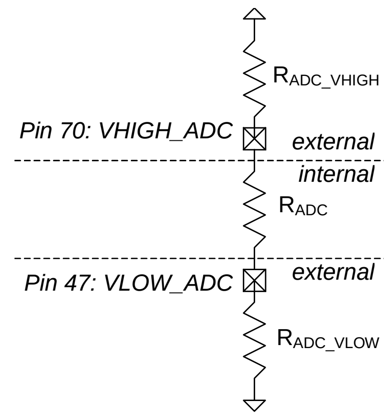

Figure 5. ADC Ladder Resistor Setting

7. Where is pixel 0,0 located in the package?

The STAR-250 sensor is bonded in a 84-pin JLCC package (see data sheets p31 paragraph 6.1 for a detailed package drawing). The centre of the pixel array is placed in the centre of the ceramic package. Pixel 0,0 is located on the top right corner in *Figure 7*.

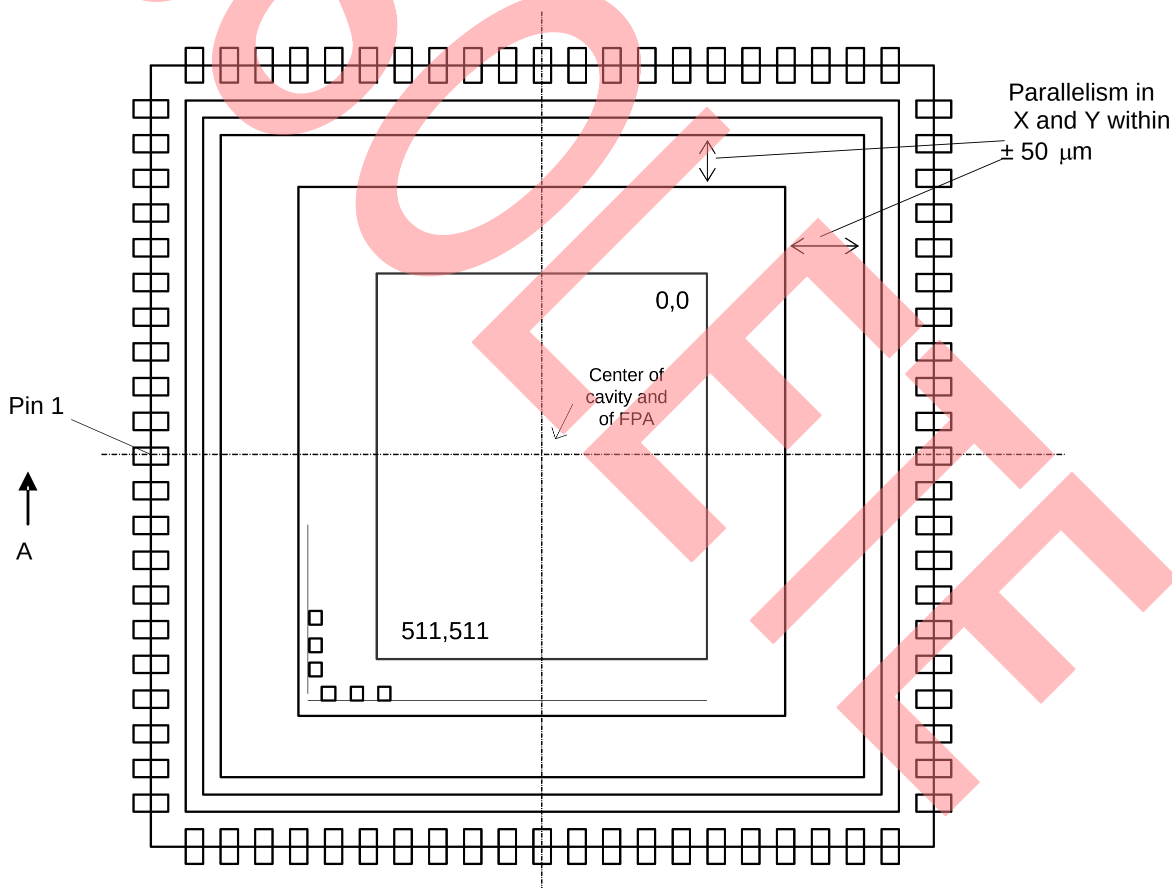

Figure 7. Die Placement of the STAR-250 Sensor

8. How is the frame rate of the STAR-250 calculated?

Due to the windowing functionality of the STAR-250 is the frame rate depending on the resolution of the ROI (region Of Interest) that is read out.

Frame period = (Nr. Lines * (RBT + pixel period * Nr. Pixels))

with: Nr. Lines: Number of Lines read out each frame (Y).

Nr. Pixels: Number of pixels read out each line (X).

RBT: Row Blanking Time = 3.2 μs (typical).

Pixel period: 1/8 MHz = 125 ns (typical).

Example: read out time of the full resolution at nominal speed (8 MHz pixel rate):

=> Frame period = (512 * (3.2 μs + 125 ns * 512)) = 34.4 ms => 29 fps.

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