Product Document

Published by
ams OSRAM Group

Application Note

AN001032

Maximum Pixel Value

Mira220

v3-00 • 2022-Jul-07

Content Guide

1 Introduction

This application note explains the saturation level. With the default settings, the pixel will clip before the ADC and as a result, the maximum pixel value seen in images is around 3800 DN. It might be desired to have an image that saturates to 4095 DN in the 12-bit scenario (1023 DN in 10-bit and 255 DN in 8-bit). Some settings would need to change in order to achieve this.

2 Proposal

There are three ways that we can correct this.

- One involves increasing the RNC_DARK_TARGET (register 0x205B/C) from the current setting of 100 to a new setting of 400 or 450. As a result, the dark and bright images will increase by the same amount, shifting all the pixel values upwards but clipping at 4095 DN.
- A second approach would be to change the gain ramp trimming (register 0x4009) with DCDS disabled to get the pixel signal to clip at the ADC, then re-enable DCDS and increase flat field by ~150 codes to a new value of 250 - 300.
- A third reconfigures the row noise correction algorithm.

Of these first two options, the first (increasing flat field target only) will have the least amount of repercussions (considering it is a digital post-processing tweak).

Unfortunately, doing either of these first two will introduce 0 DN pixels. In a fully illuminated image, these sporadic dark pixels will not be present. However, in a 95 - 98% illuminated image they can crop up. They seem to appear when the ADC value approaches 4095 DN, but if the signal from the pixel is higher than that then there are no dark pixels in the image. Therefore, 100% illumination (saturated pixels) should not cause an issue. Just pixel “near” saturation.

This can be easily seen if you take the current settings, set the flat field register to ~300 - 310, and fully illuminate the sensor. At this setting, the pixel and the ADC will both be clipping near the 4095 DN threshold. Dark pixels will pop up randomly from frame to frame. In addition, these dark pixels start to appear more frequently across a row, changing each frame. At this critical threshold, the pixel and row noise which will either give 4095 DN or slightly above or below that.

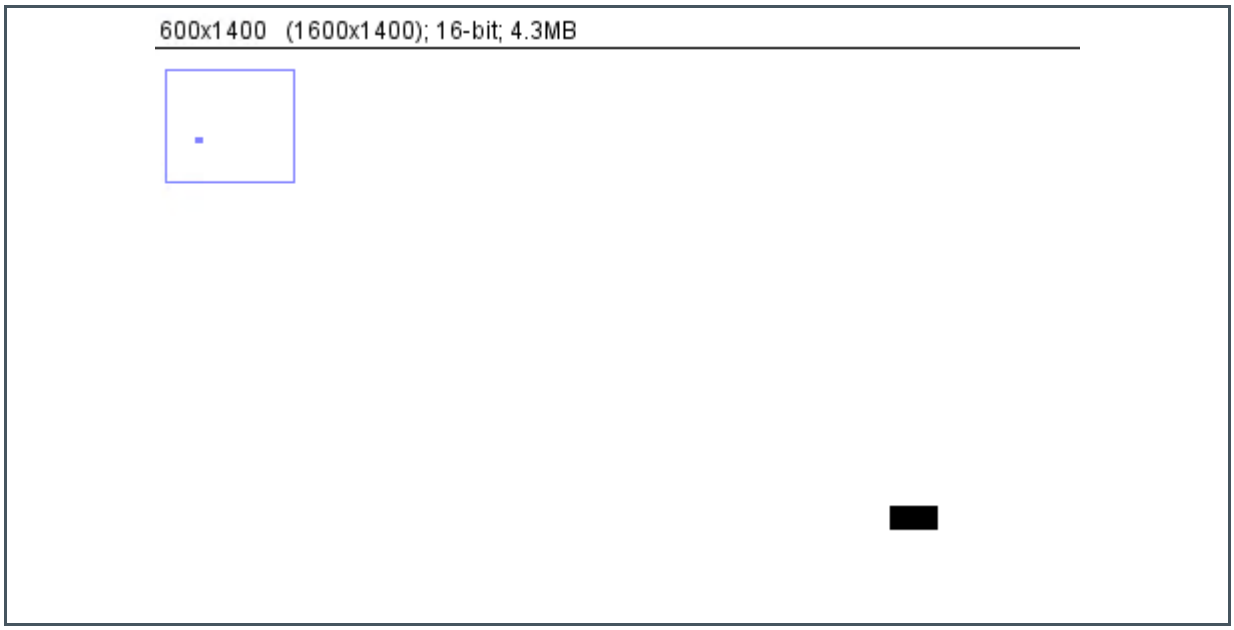
To get around this, the defect correction should be enabled with the following register settings:

- 0x24DC = 0x11
- 0x24DD = 0x03
- 0x24DE = 0x03
- 0x24DF = 0x00
- 0x24E3 = 0x01

These settings were tried on 5 samples with the flat field set to 310 decimal on a fully illuminated sensor. For comparison, it was observed that without the defect correction all 5 samples showed these dark pixels within the first few images captured. With the defect correction enabled, 900 continuous images were captured on each to check for this time varying error. The conclusions are as follows:

- 2 sensors showed no dark pixels anymore
- 2 sensors showed the cluster behavior in about 1 in 30 frames:

Figure 1:
Defect Correction Cannot Correct for a Cluster (2 or More Dark Pixels Next to Each Other)



- 1 sensor showed a dark pixel near the edge of the array that was not corrected (but again shows up sporadically).

Figure 2:
Defect Correction Cannot Correct for a Dark Pixel on the Edge of the Sensor

The defect correction does not do anything for pixels in the first or last row or column. A dark pixel is also not labeled as a defect if a nearby pixel is also dark. For these reasons, the results of the experiment were as expected. Ultimately, the defect correction helped in most situations but is not 100% successful.

The last proposal is setting register 0x204B to 0x01 (instead of 0x03). It resolves the issue, but comes at the cost of higher row noise. The issue appears to be a bug in the row noise correction part of the post-processing on the chip. Setting this register to 0x01 removes part of the row correction algorithm from the data path and the issue is no longer present (but at the cost of increased row noise). See example data in the Figure 3 captured from a single sample.

Figure 3:
Noise Comparison with 0x204B Set to 0x01 and 0x03

	Row Noise Correction 0x204b = 1 CSP: 00230016					Row Noise Correction 0x204b = 3 CSP: 00230016				
	trial #1	trial #2	trial #3	avg	std	trial #1	trial #2	trial #3	avg	std
Noise	2.44	2.44	2.43			2.45	2.46	2.45		
Row stripe Noise	0.58	0.59	0.57	0.58	0.008165	0.5	0.51	0.5	0.503333	0.004714
Total/Row Noise	4.206897	4.135593	4.263158	4.201883	0.052199	4.9	4.823529	4.9	4.87451	0.036049

3 Conclusion

This application note gives you three options to find the optimal trade-off between saturation level, dark pixels and row noise:

1. Continue to use the current settings, in which case the maximum pixel value will remain ~3800 DN. One can do post-processing (such as apply a gain of 1.1x and clip to 4095) if this is an issue.
2. Increase the flat field target to 400 - 450 and enable defect correction by default. The resulting images would saturate at 4095 DN and dark level will be ~500 DN. Dark pixels could show up intermittently as described above under specific illumination conditions.
3. Increase flat field to 400-450 and change register 0x204B to 0x01 (instead of 0x03). This increases the row noise by 15%.

4 Revision Information

Changes from previous version to current revision v3-00	Page
Document security is updated to “Confidential” in the footer	

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

5 Legal Information

Headquarters
ams-OSRAM AG
Tobelbader Strasse 30
8141 Premstaetten
Austria, Europe
Tel: +43 (0) 3136 500 0

Please visit our website at www.ams.com
Buy our products or get free samples online at www.ams.com/Products
Technical Support is available at www.ams.com/Technical-Support
Provide feedback about this document at www.ams.com/Document-Feedback
For sales offices, distributors and representatives go to www.ams.com/Contact
For further information and requests, e-mail us at ams_sales@ams.com