

# Product Document



## Application Note

AN001032

# Maximum Pixel Value

**Mira220**

v3-00 • 2022-Jul-07

---

# Content Guide

1	Introduction .....	3	5	Legal Information.....	9
2	Proposal .....	4			
3	Conclusion.....	7			
4	Revision Information.....	8			

---

# 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.

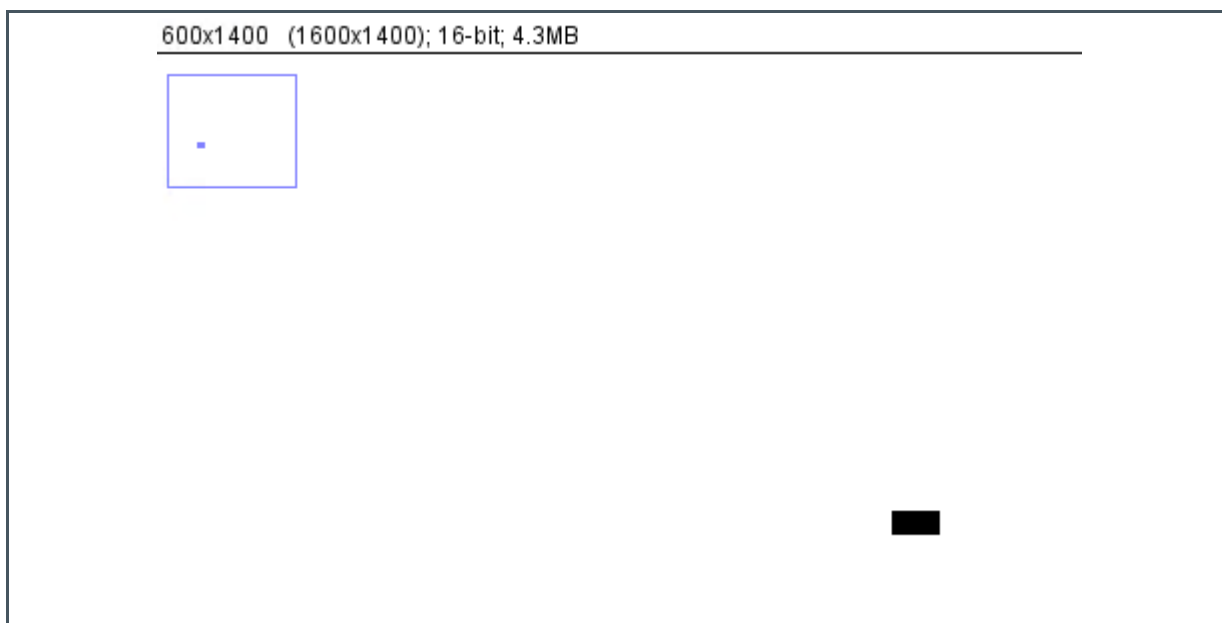
To get around this, the defect correction should be enabled with the following register settings:

- 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:

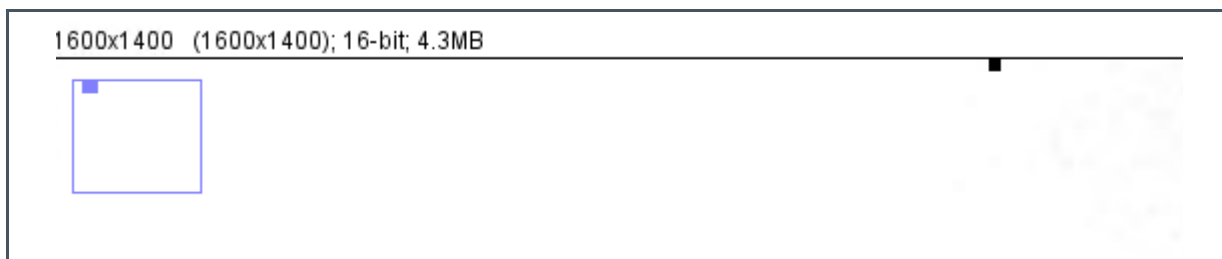
- 2 sensors showed no dark pixels anymore
- 2 sensors showed the cluster behavior in about 1 in 30 frames:

**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

Noise	Row Noise Correction 0x204b = 1					Row Noise Correction 0x204b = 3				
	CSP: 00230016					CSP: 00230016				
	trial #1	trial #2	trial #3	avg	std	trial #1	trial #2	trial #3	avg	std
	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

### Copyrights & Disclaimer

Copyright ams-OSRAM AG, Tobelbader Strasse 30, 8141 Premstaetten, Austria-Europe. Trademarks Registered. All rights reserved. The material herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner.

Information in this document is believed to be accurate and reliable. However, ams-OSRAM AG does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

Applications that are described herein are for illustrative purposes only. ams-OSRAM AG makes no representation or warranty that such applications will be appropriate for the specified use without further testing or modification. ams-OSRAM AG takes no responsibility for the design, operation and testing of the applications and end-products as well as assistance with the applications or end-product designs when using ams-OSRAM AG products. ams-OSRAM AG is not liable for the suitability and fit of ams-OSRAM AG products in applications and end-products planned.

ams-OSRAM AG shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interruption of business or indirect, special, incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data or applications described herein. No obligation or liability to recipient or any third party shall arise or flow out of ams-OSRAM AG rendering of technical or other services.

ams-OSRAM AG reserves the right to change information in this document at any time and without notice.

### RoHS Compliant & ams Green Statement

**RoHS Compliant:** The term RoHS compliant means that ams-OSRAM AG products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories plus additional 4 substance categories (per amendment EU 2015/863), including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

**ams Green (RoHS compliant and no Sb/Br/Cl):** ams Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material) and do not contain Chlorine (Cl not exceed 0.1% by weight in homogeneous material).

**Important Information:** The information provided in this statement represents ams-OSRAM AG knowledge and belief as of the date that it is provided. ams-OSRAM AG bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. ams-OSRAM AG has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. ams-OSRAM AG and ams-OSRAM AG suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

### 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](http://www.ams.com)

Buy our products or get free samples online at [www.ams.com/Products](http://www.ams.com/Products)

Technical Support is available at [www.ams.com/Technical-Support](http://www.ams.com/Technical-Support)

Provide feedback about this document at [www.ams.com/Document-Feedback](http://www.ams.com/Document-Feedback)

For sales offices, distributors and representatives go to [www.ams.com/Contact](http://www.ams.com/Contact)

For further information and requests, e-mail us at [ams\\_sales@ams.com](mailto:ams_sales@ams.com)