ON Semiconductor®

Product Bulletin

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Title of Change:	Operating recommendations for longer exposure times for all PYTHON CMOS Image Sensors
Effective date:	November 21, 2017
Contact information:	Contact your local ON Semiconductor Sales Office
Type of notification:	This Product Bulletin is for notification purposes only. ON Semiconductor will proceed with implementation of this change upon publication of this Product Bulletin.
Change category:	☐ Wafer Fab Change ☐ Assembly Change ☐ Test Change ☒ Other Datasheet update

Change Sub-Category(s):

☐ Manufacturing Site Change/Addition
☐ Manufacturing Process Change
☐ Material Change
☐ Product specific change
☒ Datasheet/Product Doc change
☐ Shipping/Packaging/Marking
☐ Other: _____

Sites Affected:	ON Semiconductor Sites: ON Mechelen, Belgium	External Foundry/Subcon Sites: None

Description and Purpose:

This document summarizes the renewed operating condition for DAC_trans_low and the anomalies of the pixel saturation behaviour of the PYTHON Image Sensor family observed at longer exposure times in combination with low light levels and provides recommendations on improving image quality.

The datasheet of the PYTHON300/500/1300 has been updated to reflect these new recommended settings (new version is Revision 4). The version of the datasheet of the PYTHON2000/5000/10K/12K/16K/25K has not been updated as these reflected the correct settings for DAC_trans_low already.

SUMMARY

Under low light levels and long exposure times (such as exposures well above 100ms) the pixel saturation level of some PYTHON image sensors has been found to be lower than expected. In the worst case, this can result in non-uniformities and a non ADC-clipped image which is not entirely 'white' as expected. This behavior causes the maximum output swing of the pixels to fall entirely within the range of the on-chip ADCs, preventing a proper digital saturation at the maximum ADC code (1023, 10 bit scale). All PYTHON product lines (from the PYTHON 300 to the PYTHON 25K, in both color and monochrome configurations) exhibit this behavior to varying degrees.

The root cause for reduced saturation level of the pixel as function of exposure time, and thus a non ADC clipped image, is a voltage level dependent leakage current through the transfer gate. Although being relatively small, this leakage current does prohibit some of the generated photocurrent to contribute to the voltage signal built up during the exposure of the pixel to the incoming light. The parasitic leakage current increases as function of the output level of the pixel, eventually reducing maximum saturation level preventing the ADC to clip to the maximum digital output code 1023. Note that this effect is not or hardly noticeable during regular exposure times (i.e. when the generated photocurrent is high).

ON Semiconductor has performed various tests and revised screening methods to avoid this saturation issue from happening, however no adequate solution has been found which entirely avoid this phenomenon from happening.

To improve the saturation behaviour, ON Semiconductor recommends the following:

1. Increasing the analog gain of the sensor when operating the sensor at longer exposure times in combination with low light levels. An increased analogue gain amplifies the analog signal of the pixel such that on average, the saturated regions will be pushed outside the input range of the ADC. For optimal noise performance, the analog gain should be applied to the first stage of the readout chain. While the increase in analog gain allows the ADC to clip, it lowers the full-well charge negligibly and changes the overall behavior of the sensor's response curve (please anticipate a ~10% deviation). Higher gain settings in the range of 1.1 to 1.3 will significantly improve the exposure behavior for all devices up to an exposure time of 1 sec or beyond.

2. For PYTHON300/500/1300 specifically: change DAC_trans_low to 0 (Register 42, set at 0x4103 instead of 0x4113). This change has a positive effect on the saturation behaviour by reducing parasitic leakage currents in the pixel. This change will align the register setting for DAC_trans_low of all PYTHON devices; while this setting is the default operating condition for PYTHON2000/5000/10K/12K/16K/25K, the PYTHON300/500/1300 originally operated using a different setting. Starting September 1st 2017, ON Semiconductor uses this revised DAC_trans_low setting during production testing for PYTHON300/500/1300 (as well as for all other PYTHON devices)

RECOMMENDATIONS SUMMARY

- To align the sensor operating setting for all PYTHON family members, ON Semiconductor strongly encourages using setting DAC_trans_low = 0 (Register 42, set at 0x4103 instead of 0x4113) for the PYTHON300/500/1300 devices.
- The decreasing saturation level can be addressed by increasing the analogue gain up to approximately 1.1-1.3, depending on the chosen integration time. It will be up to the end-user to decide when additional gain is required in their specific application
- For optimal noise performance, the analog gain should be applied to the first stage in the readout chain

HOW TO CHANGE THE GAIN USING REGISTER 204[15:0]

Theoretical Gain	PYTHON 300/500/1300 Zero ROT	PYTHON 2000/5000 Zero ROT	PYTHON 10K/12K/16K/25K Zero ROT
Unity	0x01E1	0x01E1	0x01E4
1.14	0x00E1	0x00E1	0x001A
1.26	0x0061	0x0061	0x0018

List of Affected Standard Parts:

Web Part Number	Part Number	Description
PYTHON300	NOIP1SN0300A-QDI	PYTHON 300 LVDS Monochrome no protective foil
PYTHON300	NOIP1SN0300A-QTI	PYTHON 300 LVDS Monochrome with protective foil
PYTHON300	NOIP1SE0300A-QDI	PYTHON 300 LVDS Color no protective foil
PYTHON300	NOIP1SE0300A-QTI	PYTHON 300 LVDS Color with protective foil
PYTHON300	NOIP1FN0300A-QDI	PYTHON 300 LVDS NIR no protective foil
PYTHON300	NOIP1FN0300A-QTI	PYTHON 300 LVDS NIR with protective foil
PYTHON500	NOIP1SN0500A-QDI	PYTHON 500 LVDS Monochrome no protective foil
PYTHON500	NOIP1SN0500A-QTI	PYTHON 500 LVDS Monochrome with protective foil
PYTHON500	NOIP1SE0500A-QDI	PYTHON 500 LVDS Color no protective foil
PYTHON500	NOIP1SE0500A-QTI	PYTHON 500 LVDS Color with protective foil
PYTHON500	NOIP1FN0500A-QDI	PYTHON 500 LVDS NIR no protective foil
PYTHON500	NOIP1FN0500A-QTI	PYTHON 500 LVDS NIR with protective foil
PYTHON1300	NOIP1SN1300A-QDI	PYTHON 1300 LVDS Monochrome no protective foil
PYTHON1300	NOIP1SN1300A-QTI	PYTHON 1300 LVDS Monochrome with protective foil
PYTHON1300	NOIP1SE1300A-QDI	PYTHON 1300 LVDS Color no protective foil
PYTHON1300	NOIP1SE1300A-QTI	PYTHON 1300 LVDS Color with protective foil
PYTHON1300	NOIP1FN1300A-QDI	PYTHON 1300 LVDS NIR no protective foil
PYTHON1300	NOIP1FN1300A-QTI	PYTHON 1300 LVDS NIR with protective foil
PYTHON1300	NOIP2SE1300A-QDI	PYTHON 1300 CMOS Color no protective foil
PYTHON1300	NOIP2SN1300A-QDI	PYTHON 1300 CMOS Monochrome no protective foil
PYTHON1300	NOIP3SN1300A-QDI	PYTHON 1300 2 port LVDS NIR no protective foil
PYTHON1300	NOIP3SN1300A-QTI	PYTHON 1300 2 port LVDS NIR with protective foil
PYTHON1300	NOIP3SE1300A-QDI	PYTHON 1300 2 port LVDS color no protective foil
PYTHON1300	NOIP3SE1300A-QTI	PYTHON 1300 2 port LVDS color with protective foil
PYTHON1300	NOIP3FN1300A-QDI	PYTHON 1300 2 port LVDS Monochrome no protective foil
PYTHON1300	NOIP3FN1300A-QTI	PYTHON 1300 2 port LVDS Monochrome with protective foil
PYTHON2000	NOIP1SN2000A-QDI	PYTHON 2000 LVDS Monochrome no protective foil
PYTHON2000	NOIP1SN2000A-LTI	PYTHON 2000 LVDS Monochrome with protective foil LGA
PYTHON2000	NOIP1SN2000A-QTI	PYTHON 2000 LVDS Monochrome with protective foil
PYTHON2000	NOIP1SE2000A-LTI	PYTHON 2000 LVDS Color with protective foil LGA
PYTHON2000	NOIP1SE2000A-QDI	PYTHON 2000 LVDS Color no protective foil
PYTHON2000	NOIP1SE2000A-QTI	PYTHON 2000 CMOS Color no protective foil
PYTHON2000	NOIP1FN2000A-LTI	PYTHON 2000 LVDS NIR with protective foil LGA
PYTHON2000	NOIP1FN2000A-QDI	PYTHON 2000 LVDS NIR no protective foil
PYTHON2000	NOIP1FN2000A-QTI	PYTHON 2000 LVDS NIR with protective foil

Web Part Number	Part Number	Description
PYTHON5000	NOIP1SN5000A-LTI	PYTHON 5000 LVDS Monochrome with protective foil LGA
PYTHON5000	NOIP1SN5000A-QDI	PYTHON 5000 LVDS Monochrome no protective foil
PYTHON5000	NOIP1SN5000A-QTI	PYTHON 5000 LVDS Monochrome with protective foil
PYTHON5000	NOIP1SE5000A-LTI	PYTHON 5000 CMOS Color no protective foil LGA
PYTHON5000	NOIP1SE5000A-QDI	PYTHON 5000 LVDS Color no protective foil
PYTHON5000	NOIP1SE5000A-QTI	PYTHON 5000 LVDS Color with protective foil
PYTHON5000	NOIP1FN5000A-LTI	PYTHON 5000 LVDS NIR with protective foil LGA
PYTHON5000	NOIP1FN5000A-QDI	PYTHON 5000 LVDS NIR no protective foil
PYTHON5000	NOIP1FN5000A-QTI	PYTHON 5000 LVDS NIR with protective foil
PYTHON5000	NOIP3SN5000A-LTI	PYTHON 5000 2 port LVDS Monochrome with protective foil LGA
PYTHON5000	NOIP3SN5000A-QDI	PYTHON 5000 2 port LVDS Monochrome no protective foil
PYTHON5000	NOIP3SN5000A-QTI	PYTHON 5000 2 port LVDS Monochrome with protective foil
PYTHON5000	NOIP3SE5000A-LTI	PYTHON 5000 2 port LVDS color with protective foil LGA
PYTHON5000	NOIP3SE5000A-QDI	PYTHON 5000 2 port LVDS color no protective foil
PYTHON5000	NOIP3SE5000A-QTI	PYTHON 5000 2 port LVDS color with protective foil
PYTHON10K	NOIP1SN010KA-GDI	PYTHON 10K LVDS Mono no protective foil
PYTHON10K	NOIP1SE010KA-GDI	PYTHON 10K LVDS Color no protective foil
PYTHON10K	NOIP1FN010KA-GDI	PYTHON 10K LVDS NIR no protective foil
PYTHON12K	NOIP1SN012KA-GDI	PYTHON 12K LVDS Mono no protective foil
PYTHON12K	NOIP1SE012KA-GDI	PYTHON 12K LVDS Color no protective foil
PYTHON12K	NOIP1FN012KA-GDI	PYTHON 12K LVDS NIR no protective foil
PYTHON16K	NOIP1SN016KA-GDI	PYTHON 16K LVDS Mono no protective foil
PYTHON16K	NOIP1SE016KA-GDI	PYTHON 16K LVDS Color no protective foil
PYTHON16K	NOIP1FN016KA-GDI	PYTHON 16K LVDS NIR no protective foil
PYTHON25K	NOIP1SN025KA-GDI	PYTHON 25K LVDS Mono no protective foil
PYTHON25K	NOIP1SE025KA-GDI	PYTHON 25K LVDS Color no protective foil
PYTHON25K	NOIP1FN025KA-GDI	PYTHON 25K LVDS NIR no protective foil