

Application Note

Image Quality, Noise, CL600x2

Version: AN-Image Quality Noise CL600x2-A

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Image Quality, Noise

Please follow the instructions to improve image quality. There are at least 3 ways and several grades of improving quality:

1) Use FPN correction.

- a) Activate FPN (Command #F).
(This may reduce vertical stripes)

Please note, that FPN correction may deactivate automatically, when changing Frame Format or changing other characteristics of the sensor.

2) Use Black Level, FPN correction and LUT

Black level changes the dark voltage reference of the image sensor. Values of black level are between 0 and 255 (Please refer to Command #z in 1846-SU-06 CL600x2 user manual). Best black level values range between 120 and 170 depending on Gain (Sensitivity) settings. Low values (typically below ~120) tend to saturate some Pixel to 0 LSB, High values (typically above 170) tend to saturate some Pixel to 1023 LSB. In both situations, FPN correction may fail and may add vertical stripes to the image.

Black Level for Gain 1 is mostly uncritical and ranges at typically 128. Black level for higher Gain up to 4 becomes more critical and has to be analysed in detail. Here typically higher values (> 128) are suggested to avoid Pixel saturation below 0. But as higher values may lead to Fixed Pattern in the upper saturation range, it is suggested to use then the Look up table to fit the output range to usefull range of the sensor.

- a) Activate FPN correction (Command #F).
- b) Adjust (Increase) Black level (Command #z).
Increasing Black Level may eliminate vertical stripes
- c) Use LUT (Commands #I, #L)
Using LUT may reduce black level to clamp near 0 LSB.

Description of using 2):

The CamSetup black level value is an arbitrary value and is not directly related to the black level value of the image:

Increasing the CamSetup black level value increases black level value of the image. Reducing this value reduces black level to a certain minimum. Below this minimum level strong Fixed Pattern noise will appear.

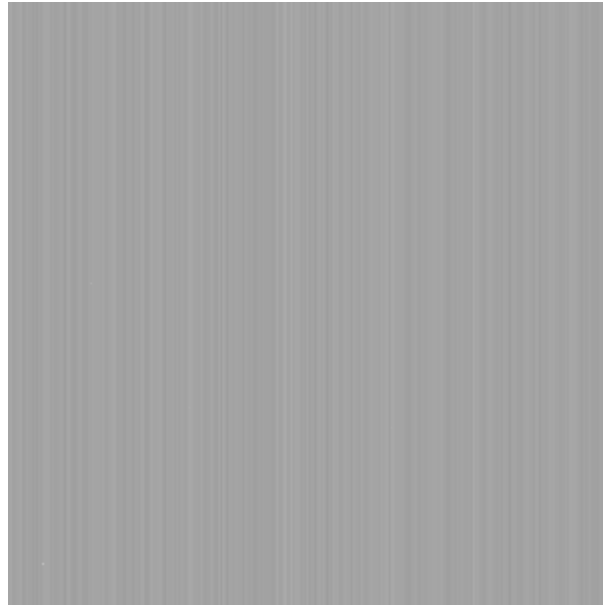


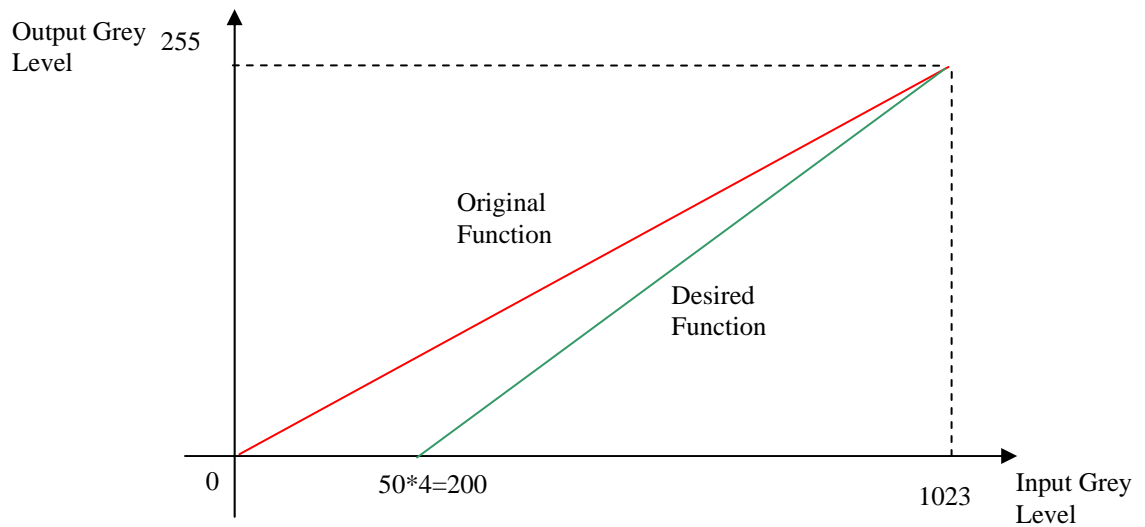
Figure: Strong Fixed Pattern Noise at Minimum of Black Level value

To avoid Fixed Pattern Noise as shown above, a higher black level value has to be selected.

When black level value has to be selected to lower values as limited by the level where additional Fixed Pattern appear (e.g. around 0 LSB instead of maybe > 200 LSB at 10bit), the 10 to 8 bit LUT has to be used:

Typical LUT function is the Original function (see red line on the figure below). Input grey levels from 0 to 1023 LSB are converted to 0 to 255 LSB at the output.

When e.g. input black level is around 200 LSB at 10 bits input level (equals 50 LSB at 8 bits output level), and the desired black level has to be 0, the desired function (green line on the figure below) has to be programmed into the camera: An input value of 200 LSB at 10 bits leads to an output value of 0 LSB. From 200 LSB to 1023 LSB the function is linear.



The LUT Excel file is generated corresponding to the mathematical function:
 $y=m*x-c$ whereas

m : corresponds to the slope of the desired function.

x : corresponds to the input grey level

y : corresponds to the output grey level

c : corresponds to the output grey level offset at $x = 0$

The mathematical formula for the Excel sheet is as follows:

$y = 0$ for input values from 0 to 200 and

$y = (255/(1024-200))*ZEILE()-61,893$ for the linear function from 201 to 1023

	A	B
1	0	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	
15	0	
16	0	
17	0	
18	0	
19	0	

	A	B
193	0	
194	0	
195	0	
196	0	
197	0	
198	0	
199	0	
200	0	
201	0	
202	1	
203	1	
204	1	
205	2	
206	2	
207	2	
208	2	
209	3	
210	3	
211	3	
212	4	
213	4	
214	4	
215	5	
216	5	
217	5	
218	6	
219	6	
220	6	
221	6	

3) Use Flatfield correction

Fixed pattern noise correction is made inside the sensor. Typically, a dark row is read and then subtracted to all other row directly in the sensor. This isn't the best correction while the fixed pattern can change a little from row to row. At Gain equal 1, this correction works well, but the higher gain, the worse correction. (Maybe same situation for low rep rates or long exposure times)

To eliminate the FPN, please first disable the FPN correction made by the camera, then select the gain (if needed), then adjust the black level and use maybe the LUT and then use the frame grabber "flat field correction". it makes a correction pixel to pixel instead of row to row and it will work properly.

Image Quality summary

Please note that 3) is the highest grade of correction but uses frame grabber functions. It is suggested at least to perform 2).

Salt and Pepper

Please note, that other known "noise" source is called salt and pepper. This are white and black pixels appearing statistically on the image. The origin is not coming from image sensor but comes from bad CameraLink transfer. The Salt and Pepper may appear in mainly full CameraLink mode where both CameraLink cables are attached. To solve Salt and Pepper problem please use CL600x2 Calibration Mode (Command #K).