KAYA INSTRUMENTS

# Flat Field Correction

# In JetCam Cameras

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International Distributor

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## Revision History

| Version | Date | Notes |
|---|---|---|
| 0.1 | 13/01/19 | Initial Release |
| | | |

## 2.1 Overview

The dark-field correction and the bright-field correction are both part of the flat field correction that corrects for DSNU and PRNU, which both require two different calibration processes.

The flat field correction is used to improve the quality of the image by removing the artifacts that are caused by fixed pattern noise and variations in the pixel-to-pixel sensitivity of the detector. A flat field correction corrects for dark signal non-uniformities (DSNU), photo response non-uniformities (PRNU) and/or artifacts caused by the illumination and illumination optics. These application notes describe how to calibrate the flat field functions and how to use them to improve the quality of the image. These functions are available in all JetCam series cameras.


Figure 1 : JetCam Camera front view with lens

## 2.2 Requirements

- A computer with the following:
  - ✓ Processor with an Intel 64-bit architecture, or equivalent
  - ✓ An availably x4 (or x8 or x16) PCIe Gen 3 slot
- Vision Point Application installation
- JetCam Camera
- Komodo Fiber Frame Grabber
- Fiber cables (Multi or Single mode)
- Fiber QSFP+ or/and SFP+ modules (depending on camera design)

- Uniform light source
- Solid cap

## 2.3 System connection

Please take a minute to read carefully the system connection instructions listed below.

1. Firmly insert the Komodo board to PCIe connector of the motherboard.
2. Align the QSFP+/SFP+ transceiver in front of the module's transceiver socket opening and carefully slide the QSFP+/ SFP+ transceiver into the socket until the transceiver makes contact with the socket electrical connector.
3. Insert the fiber cable into the module, by firmly pushing each cable into the module, until you will hear a click.
4. Connect the Power Adaptor to the JetCam power supply connector.
5. Turn the camera and the computer on and start your Vision Point software application.

An example of JetCam system connection is described in the image below:

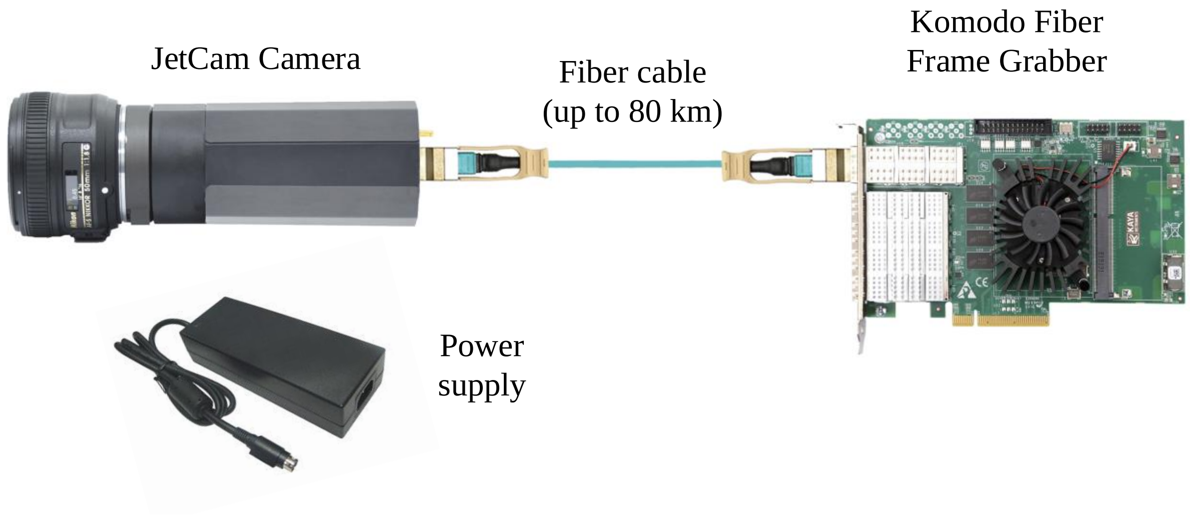


Figure 2 : JetCam Camera system connection diagram

For more detailed information please refer to JetCam User Guide documentation.

# 3 Using the DSNU and PRNU corrections

To make DSNU / PRNU correction, two pictures should be taken. For DSNU a reference image has to be recorded in dark, with lens closed (offset should be boosted) or fully removed from the camera and covered with a solid cap. To calibrate for PRNU a reference image has to be recorded with a uniform illumination of around 40%. These two separate steps in the flat field correction are therefore referred to as dark field calibration and bright field calibration, respectively.

Figure 3 : JetCam Camera side view w/o lens

## 3.1 Dark field calibration process

The dark field correction is the easiest one to calibrate. It only requires a reference image to be recorded without illumination on the image sensor.

Follow this steps to perform dark field calibration process:

1. For dark field calibration, the light should be blocked from the sensor. This can be achieved by removing the lens and covering the sensor with a solid cap or closing the lens with a cap
2. Set the “Field Calibration Mode” to “Dark” (1)
3. Start camera’s stream either in free run or by applying an external trigger
4. Initiate the selected calibration with “Field Calibration Start” command Execute (2)
5. Stop camera’s stream
6. Enable the Dark filed correction (3)
7. Start camera’s stream either in free run or by applying an external trigger

NOTE that Dark field calibration should be performed before Flat field.

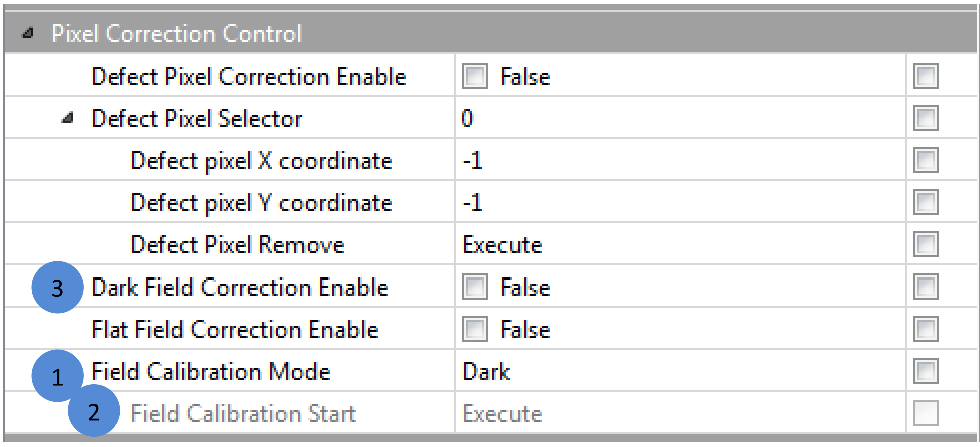


Figure 4 : Dark field calibration steps

## 3.2 Flat field calibration process

The choice of which light intensity to use for the bright field calibration requires a little bit more thought. If you perform the calibration with a light intensity too close to camera saturation you might compensate the camera too much and actually introduce more PRNU for low light intensities. If you use a weak light intensity, the differences in photo response might be too small and you under-compensate the sensor. In general a light intensity that gives a signal somewhere around 40% of the sensor full scale should give the optimal result.

Follow this steps to perform flat field calibration process:

1. Prepare light source. Uniform light should be applied across the sensor. This can be achieved by removing the lens and setting a uniform light source, such as diffused light or integrating sphere, in front of the camera
2. Set the “Field Calibration Mode” to “Flat” (1)
3. Start camera’s stream either in free run or by applying an external trigger
4. Initiate the selected calibration with “Field Calibration Start” command Execute (2)
5. Stop camera’s stream
6. Enable the Flat filed correction (3)
7. Start camera’s stream either in free run or by applying an external trigger

NOTE that Flat field calibration should be performed after Dark field calibration has already be performed for the selected camera settings.

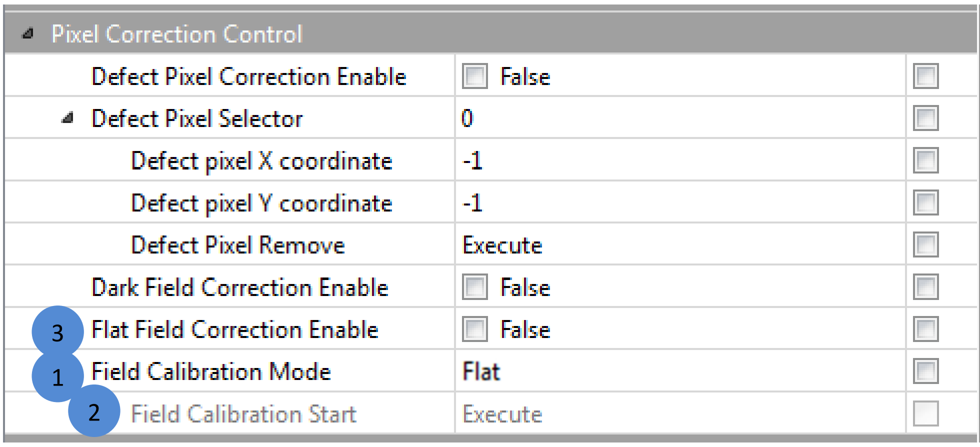


Figure 5 : Flat field calibration steps

Notes:

1. Errors might show up when a sudden peak in intensity is present in the reference scene as the correction is a low frequency correction.
2. There might be limits to the total difference that you will be able to correct for. The correction is often achieved by applying a gain per pixel or pixel segment. If the available gain is not sufficient to correct for the difference between the weakest and brightest illuminated pixel segment, a flat field cannot be achieved.

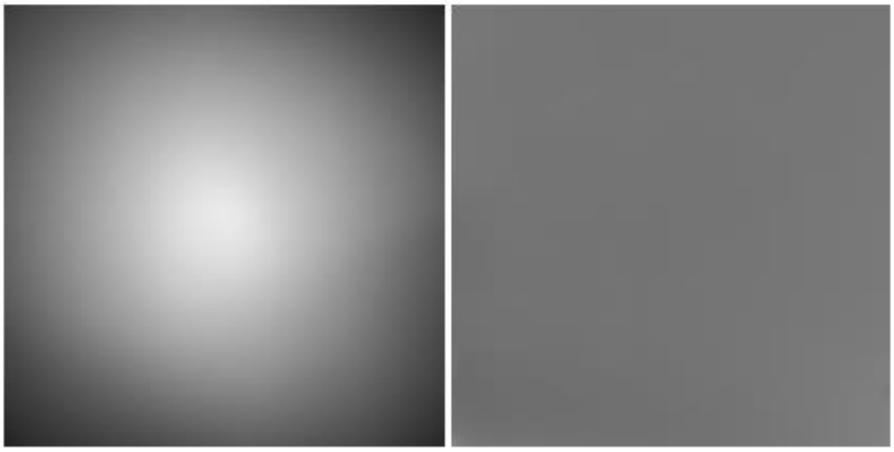

Figure 6 : Uniform light source before vs. after flat field calibration

To summarize, depending on the flat field correction variant, reference images have to be recorded in dark and in a bright field. Make sure the sensor is really dark when performing a dark field calibration and performing a bright field calibration in a light intensity range around 40% of the sensor full scale.

Note:

The PRNU and DSNU depends on exposure, gain, temperature and number of active fiber links. In case the above conditions might change during camera operation, it is advised to pre calibrate the system on several conditions and save them as different user sets. Load the user set if the conditions have been changed. User set control is described in the next section.

## 3.3 User Set Control category

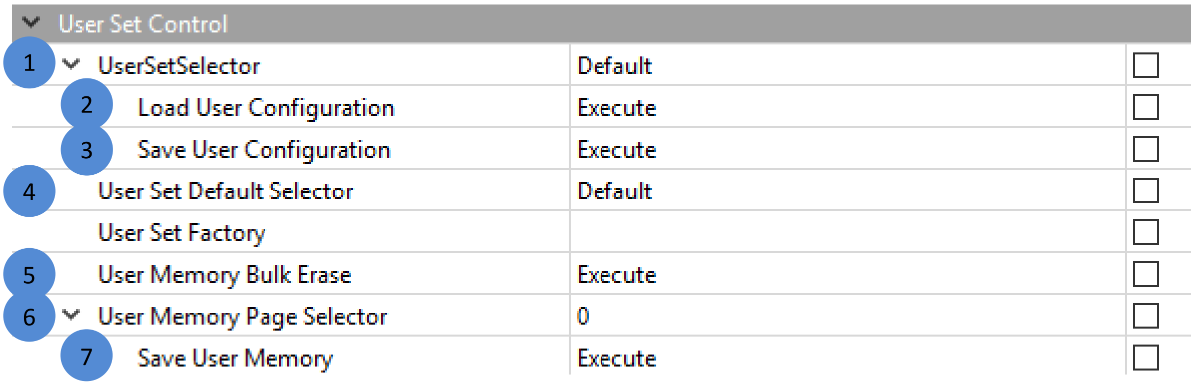


Figure 7 : Saving camera parameter configuration

Eight user sets are available for saving different camera parameter configurations. In addition, a “Default” UserSet is available so it will be possible to revert back to default factory settings.

1. Selection between the different available user configuration
   Default – Factory settings
   UserSetX - Available user sets in non-volatile memory
2. Load the configuration of the selected user set
3. Save the configuration to the selected user set
4. Selection of the power up configuration

Non-volatile memory is available for user usage. Data save to this memory space will not be erase upon camera power-down.

5. Execute an erase of the entire user memory on the camera
6. Selection of the memory page for saving
7. Execute a save to the selected memory page

Characteristics and restrictions:

1. Up to 65536 bytes can be saved into camera's non-volatile memory.
2. All data will be erased in 1 burst.
3. Data can be saved in bursts of 256 bytes each time. All 256 should be filled either with valid or padding data.
4. If data is loaded before erase operation is performed (1 time for all data), this data may be corrupted.
5. Data can be read at any time. (It is best not to read non-volatile memory while camera is streaming).
6. The access to non-volatile memory will be performed via GeniCam interface:
   Operation sequence.

### 3.3.1 UserSet - save and load camera configuration

The following steps describe the sequence of saving and loading user set parameter configurations for a specific camera, using Vision Point application:

Save User Set:

1. Calibrate the desired camera parameters in “Camera” tab.
2. Open “User Set Control” category
3. Select the desired “UserSetSelector” numeration as UserSetX (X in range of 1-8). NOTE: “Default” user set contains factory settings and is not rewritable.
4. Execute “Save User Configuration” command.

Load User Set:

1. Select “UserSetSelector” to the desired UserSetX (X in range of 1-8).
2. Execute “Load User Configuration” command.
3. Press “Refresh” (located in the bottom of the project window).
4. In order to determine the user set configuration with which setting the camera will power up, set the desired user set in “User Set Default Selector” to UserSetX (X in range of 1-8). NOTE: “Default” user set will load camera’s factory settings.

The following function call sequence should be performed to achieve successful User Non-Volatile new memory save:

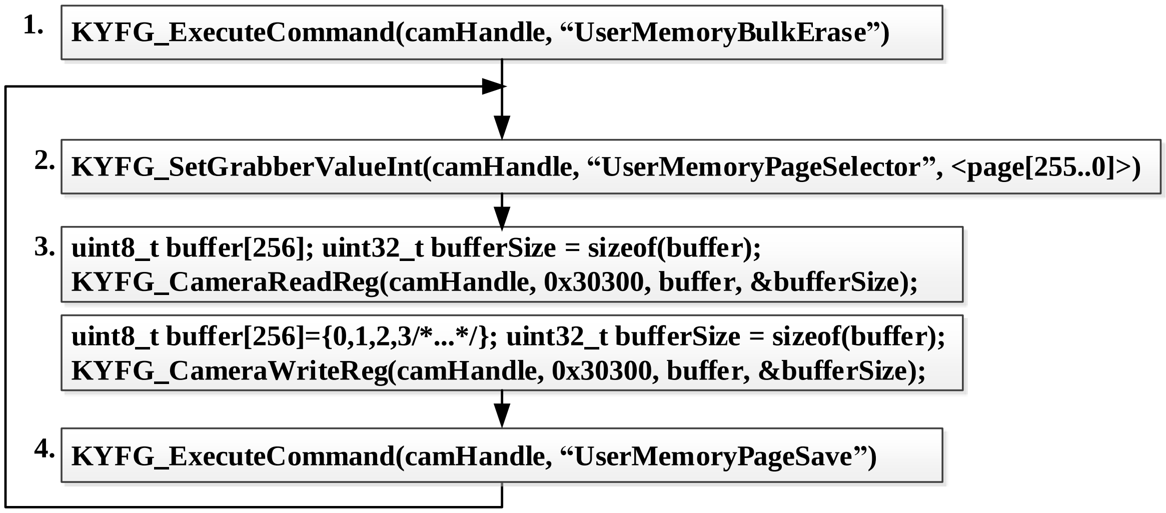


Figure 8 : Non-Volatile memory save function call sequence

1. “UserMemoryBulkErase” – erase all user non-volatile memory
2. “UserMemoryPageSelector” – select page[255..0] in memory (256 bytes for each page)
3. “UserMemoryPageAll” – array of 256 bytes to load data of specified page
4. “UserMemoryPageSave” – save selected page to non-volatile memory

NOTE: Firmware update may erase the saved user sets, and may change camera’s “Default” settings.