Linea SWIR GigE

Quick Start Guide

This Quick Start Guide helps you to set up your camera for basic operation. Refer to the Linea SWIR GigE Camera User's Manual for specifications, networking, external signal connections and application development. **Note:** screen images were made using the 1k model but instructions also apply to the 512 model.

Before you begin, ensure that you have:

- Camera power cable or Power over Ethernet (PoE) setup using a PoE Ethernet Switch or PoE Injector.

- Cat 5e or Cat 6 Ethernet cable. Note**:** cable should not be less than 1 meter (3 feet) long or more than 100 meters (328 feet) long.

- A computer with a second or unused Gigabit Network Interface (NIC) and any necessary imaging software (such as Sapera LT).

- Other necessary components of your system, including: light sources, camera mounts, lenses, encoders, etc. Please note that for best imaging performance it is recommended to use a lens designed for short wave infrared wavelengths between 900 and 1700 nm. Standard lenses designed for visible light may not transmit IR light fully nor perform to specification outside of their intended wavelength range. There are several manufacturers that make C-mount SWIR lenses specifically for machine vision systems. For assistance in selecting suitable optics for your application please contact one of our regional sales offices.

Connect the Linea SWIR GigE Camera

Before connecting power to the camera, test the power supplies. The camera requires a single voltage input (Min +12 V to Max +24 V) on Auxiliary connector or PoE Class 2 setup.
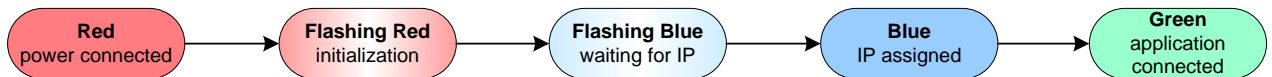
- Connect power via PoE or the 10-pin connector, but **not both**. Although the camera has protection, differences in ground levels may cause operational issues or electrical faults. The Auxiliary connector pinout is outlined below. See the Camera User's Manual (document number 03-032-20280) for detailed information and recommended cable solutions.

### Face View of the 10-pin Auxiliary Connector and Pinout Description

SAMTEC
TFM-105-02-L-D-WT
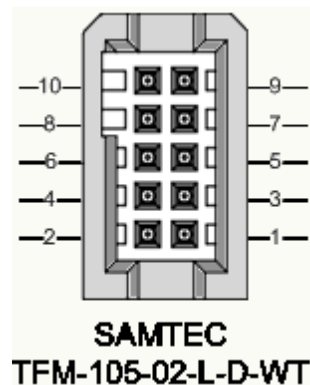
Pin Number	Linea SWIR	Direction	Definition
1	PWR-GND	-	Camera Power - Ground
2	PWR-VCC	-	Camera Power – DC +12 to +24Volts
3	GPI-Common	-	General Input Common Ground
4	GPO-Power	-	General Output Common Power
5	GPI 1	In	General External Input 1
6	GPO 1	Out	General External Output 1
7	GPI 2	In	General External Input 2
8	GPO 2	Out	General External Output 2
9	RESERVED	-	Reserved for Future Use
10	Chassis	-	Camera Chassis

- Apply power to the camera.
- Connect Linea SWIR GigE to the host computer GigE network adapter or to PoE Ethernet switch via a CAT5e or CAT6 Ethernet cable.
- Once communication with the host computer is started, the automatic IP configuration sequence will assign an IP address, as described in the user manual (see Linea SWIR GigE IP Configuration Sequence).
- Check the diagnostic LED on the back of the camera, which will initially be red and then switch colors as shown in the diagram below. A steady blue color indicates that the IP address has been assigned and the camera is ready to connect to an application.

| **Red** power connected | → | **Flashing Red** initialization | → | **Flashing Blue** waiting for IP | → | **Blue** IP assigned | → | **Green** application connected |

- Start the Sapera CamExpert application by double-clicking the desktop icon created during the Sapera LT installation. If using a different software application, then follow the specific instructions for your application.
- CamExpert will search for installed Sapera devices. The connected Linea SWIR GigE camera should be listed in the Device window on the left side of the app once CamExpert completes the automatic device search (device discovery).
- Select the camera by clicking on the camera's user-defined name. By default, the camera is identified by its serial number.
- The camera's status LED will turn green, indicating that the CamExpert application is now connected. The camera is ready for imaging.
- Click on the Grab button for live acquisition (the camera's factory default mode is Internal Trigger with a vertical height parameter defining the virtual image frame).
- If the camera doesn't have a lens, select one of the internal test patterns available (Image Format Controls > Test Image Selector).
- The following screenshot shows the camera connected to CamExpert and outputting the Grey Horizontal Ramp test patter:
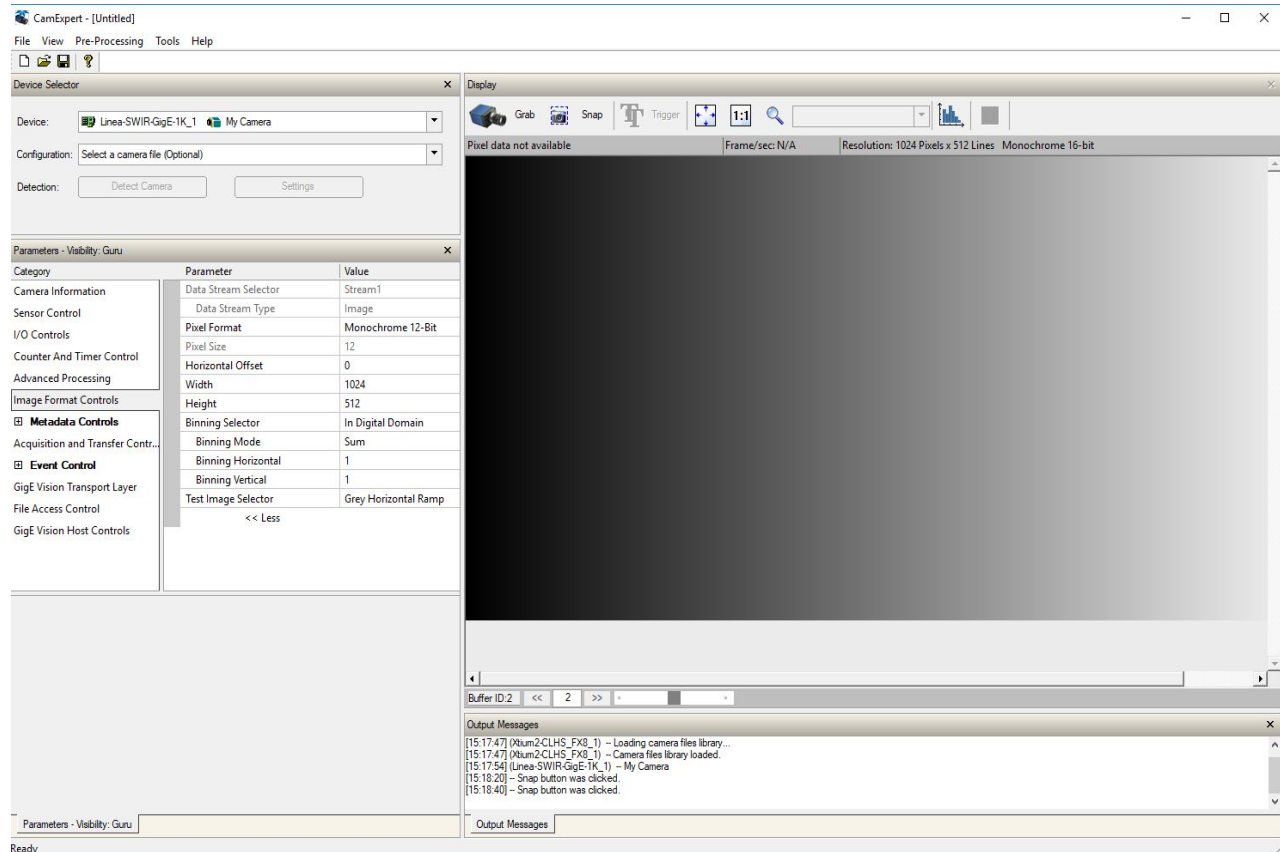
- You can now stop the grab, add a lens and adjust other camera parameters—such as Line Rate, Exposure time, etc. to develop your imaging application.
- Refer to the camera's user's manual for a description of all of the available camera commands.

Flat Field Correction Overview

The Flat Field Correction function (FFC) uses two coefficients per pixel to correct the gain and offset of the corresponding pixel. These corrections compensate for Photo-Response Non-uniformity (PRNU) and Fix Pattern Noise (FPN) unique to each camera sensor.

Note: it is important that you perform the FFC calibration under the same conditions the camera will be used in.

Before calibration, the camera should be powered on long enough to achieve its nominal temperature. The exposure time and camera internal temperature need to be similar to the expected operating conditions—otherwise, image sensor variations (over temperature and exposure) will render the FFC calibration invalid.

The current camera version supports an FFC calibration through Sapera CamExpert, while the FFC correction is done in the camera device.

The following is a brief overview of the main calibration steps for users already familiar with the Flat Field Correction.

Refer to the FFC section in the User Manual for a detailed description of the FFC process and for guidelines on how to optimize the image quality.

Since the FFC is done on the entire sensor (1k model: 1024 x 1 pixels or 512 model: 512 x 1 pixels), verify in the Image Format Controls section that the Horizontal and Vertical binning are set to "1" and that the image Width is set to "1024" (or "512" for the 512 model)—as shown here:

| Parameters - Visibility: Guru		✕
Category	**Parameter**	**Value**
Camera Information	Data Stream Selector	Stream1
Sensor Control	Data Stream Type	Image
I/O Controls	Pixel Format	Monochrome 12-Bit
	Pixel Size	12
Counter And Timer Control	Horizontal Offset	0
Advanced Processing	Width	1024
Image Format Controls	Height	512
⊞ **Metadata Controls**	Binning Selector	In Digital Domain
Acquisition and Transfer Contr...	Binning Mode	Sum
⊞ **Event Control**	Binning Horizontal	1
GigE Vision Transport Layer	Binning Vertical	1
File Access Control	Test Image Selector	Off
GigE Vision Host Controls	<< Less	

Before performing an FFC, we strongly recommend that you evaluate the "bare image" characteristics. The bare image quality determines the quality of FFC that will be applied to the image.

To obtain a bare image:
(1) Disable the FPN and PRNU coefficients and (2) choose *Off* from the Flat Field Correction Mode.

Parameters - Visibility: Guru		✕
Category	**Parameter**	**Value**
Camera Information	Flat Field Correction Mode	Off
Sensor Control	Flat Field Correction Current Active Set	Not Enabled
I/O Controls	Flat Field Correction Type	Line-Based
Counter And Timer Control	Flat Field Correction Algorithm	Method 1
Advanced Processing	<< Less	
Image Format Controls		
⊞ **Metadata Controls**		
Acquisition and Transfer Control		
⊞ **Event Control**		
GigE Vision Transport Layer		
File Access Control		
GigE Vision Host Controls		

The camera is now ready to produce bare images. The line profile tool is best used to evaluate a bare image. The following line profile is an example of the bare image of a white uniform object:
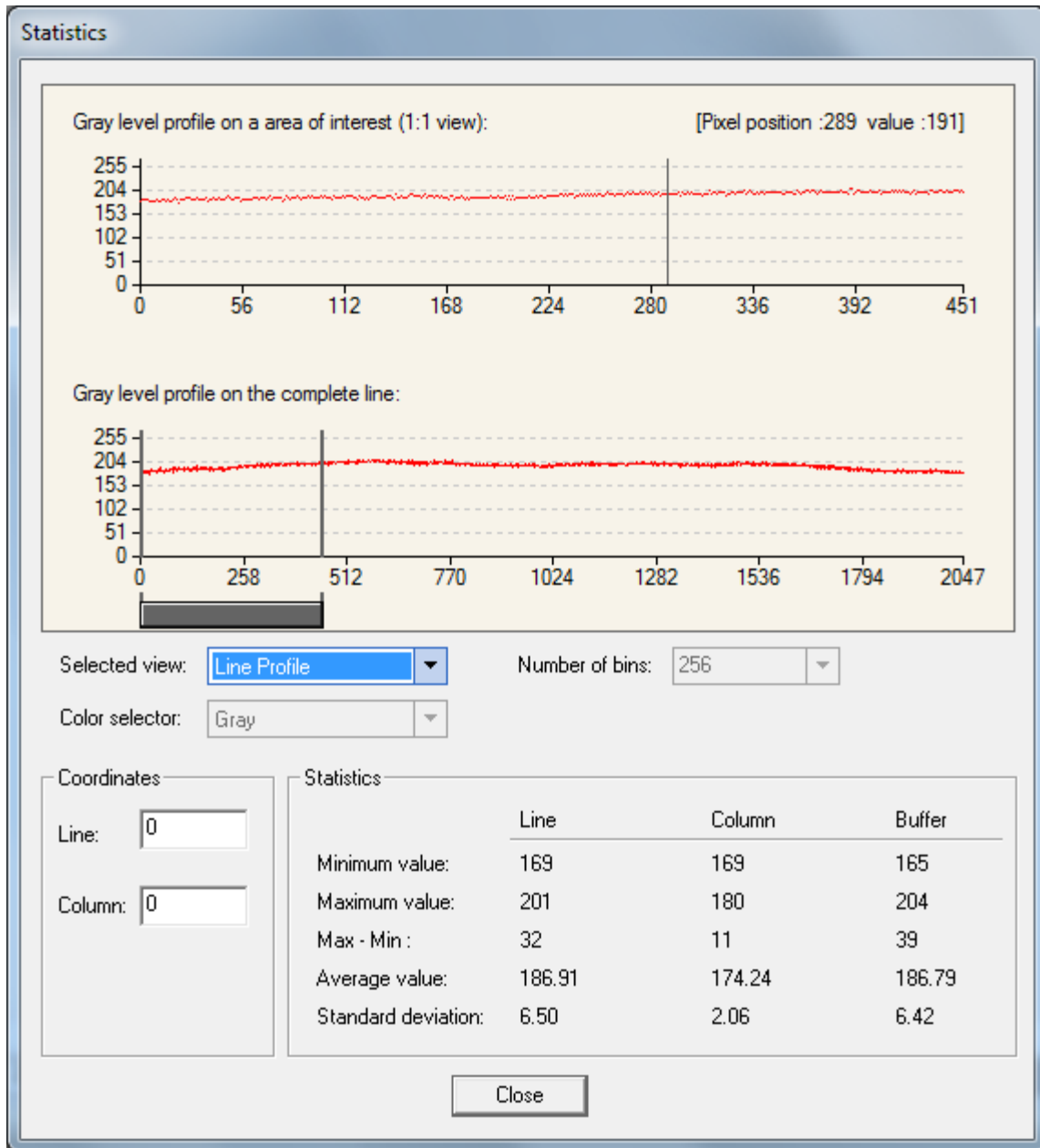
Make sure that the average output level is set close to your calibration target. An extremely low output will increase the noise level significantly high after the PRNU is corrected, such that the SNR and/or DNR may not meet your application's requirements.

How to do a FFC Setup

The process requires images be snapped in black and bright conditions, followed by the FFC process.

- If using a sheet as a white target, it must be completely free of blemishes and texture.

- Dirt or texture will generate variating in the image and incorporate it into the calibration coefficients of the camera. Vertical stripes are visible while imaging after the target is removed.

- A moving target during calibration will average out any dirt or texture present.

Set up Black and Bright Acquisitions with the Histogram Tool

Verify the camera's acquisition with a live grab and prepare to grab a flat light gray image required for calibration. Ideally, a controlled diffused light source aimed directly at the lens should be used or a non-glossy paper with the lens slightly out of focus (or evenly lite wall). Note the lens iris position for a bright but not saturated image.

Verify a Black Acquisition

Close the camera lens iris and cover the lens with the lens cap. Using CamExpert, click on the grab button and then select Histogram. The following figure shows a typical histogram for a camera grabbing a dark image.
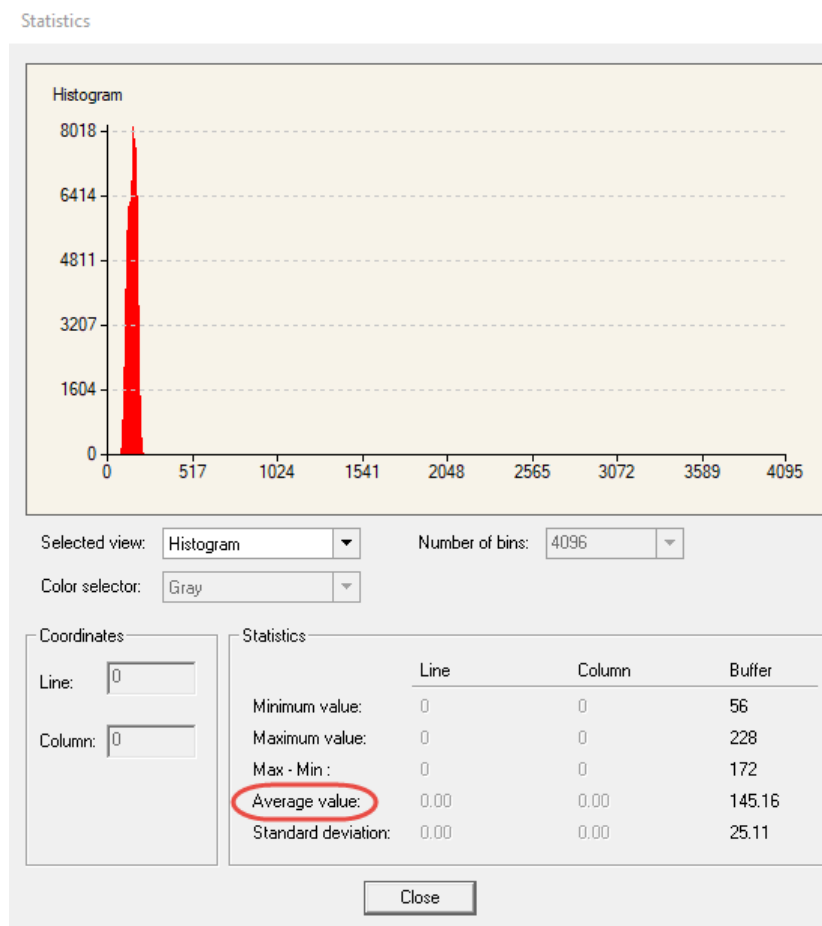
	Important: the average pixel value for the frame is close to black. Note: Sensors might show a much higher maximum pixel value due to one or more "hot pixels".

Verify a Bright Acquisition

Point the camera at a diffused light source or evenly lit white wall with no shadows falling on it. Click the grab button, followed by 'histogram' in the drop down menu. Use the lens iris to adjust for a bright gray approximately pixel value 200 (for 8-bit pixels). The following figure displays a histogram while grabbing a bright gray image.
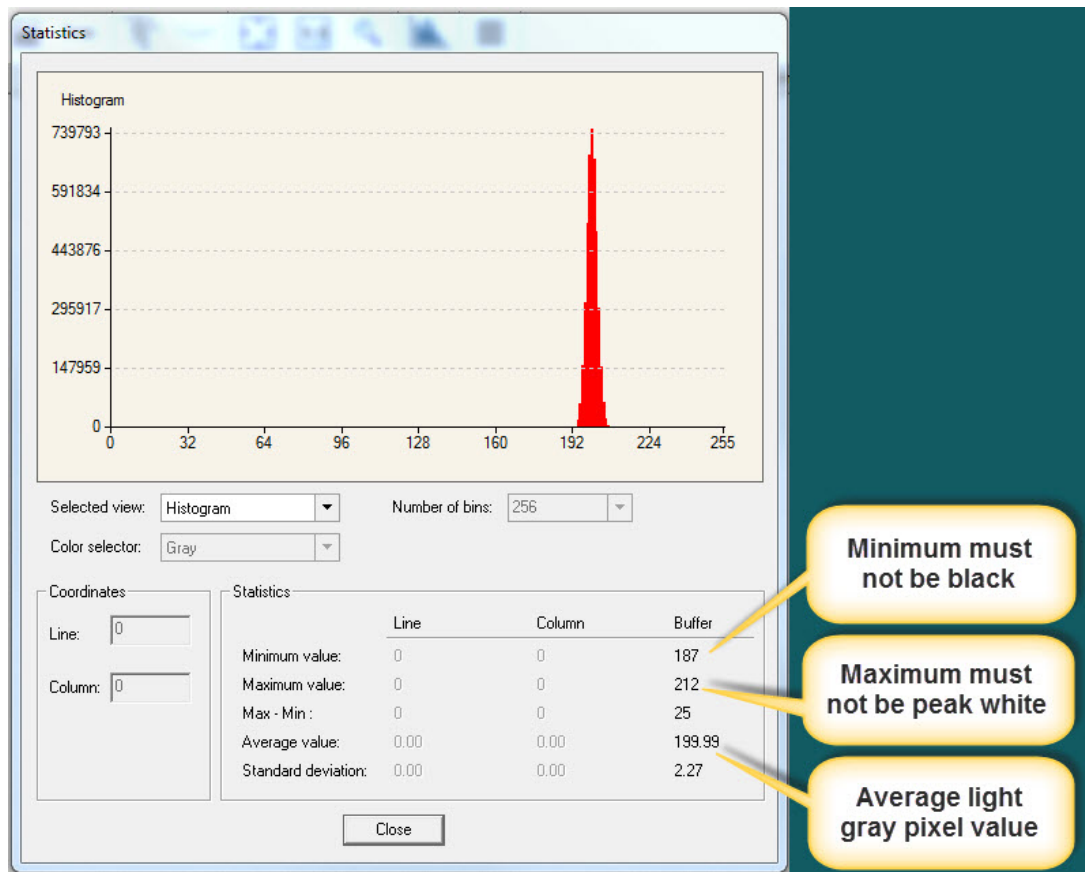
	Important: In this example, the average pixel value for the frame is bright gray. Note: Sensors may show a much higher maximum or a much lower minimum pixel value due to one or more "hot or dead pixels". The sensor specification accounts for a small number of hot, stuck or dead pixels (pixels that do not react to light over the full dynamic range specified for that sensor).

When the bright gray acquisition setup is complete, note the camera and lens iris position for repeatability in the future.
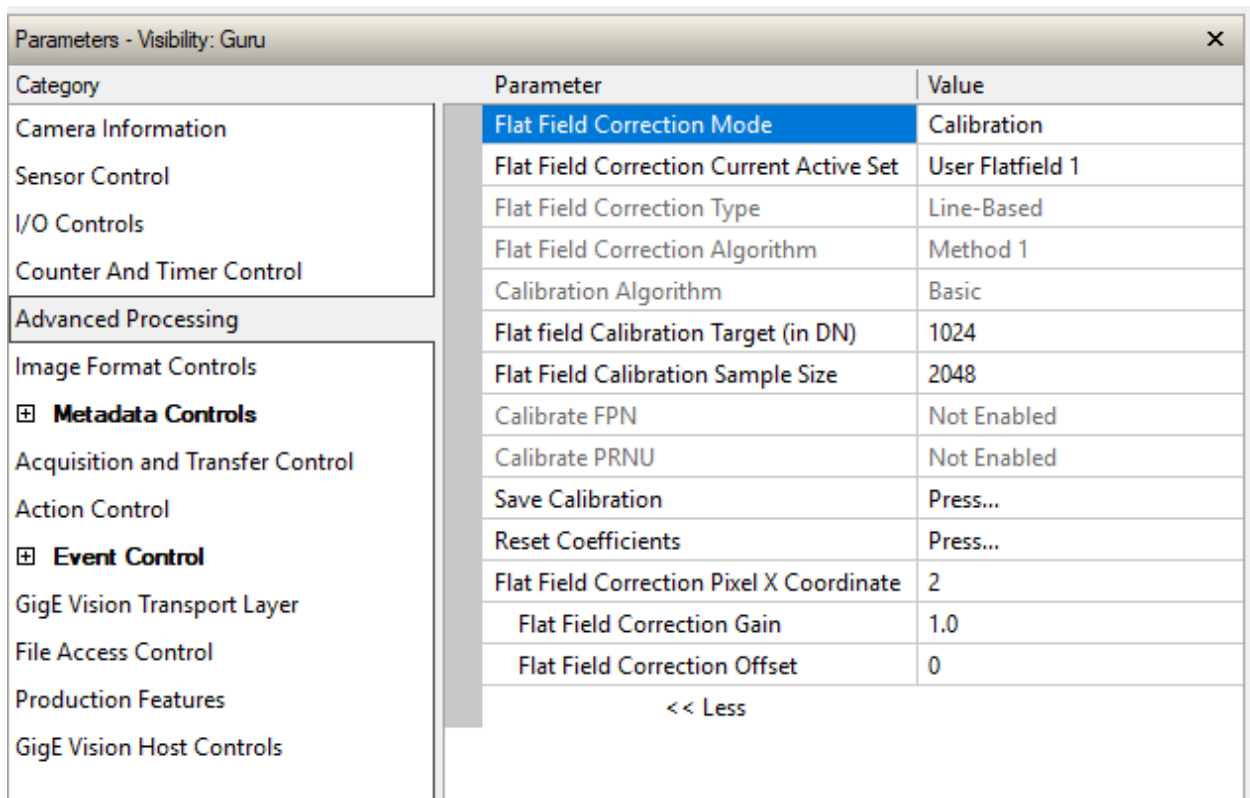
Flat Field Correction Calibration

Flat Field Correction Calibration (FFC) contains FPN (Fixed Pattern Noise) and PRNU (Photon Response non-uniformity) corrections.

NOTE: Before performing a FFC, we recommend you evaluate the "bare image" characteristics, which determine the quality of FFC, applied to the image.
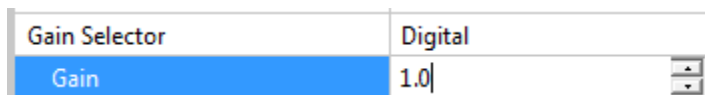
To obtain a bare image, disable FPN and PRNU coefficients:
- Choose Off from Flat Field Correction Mode.

Parameters - Visibility: Guru		✕
Category	**Parameter**	**Value**
Camera Information	Flat Field Correction Mode	Calibration
Sensor Control	Flat Field Correction Current Active Set	User Flatfield 1
I/O Controls	Flat Field Correction Type	Line-Based
Counter And Timer Control	Flat Field Correction Algorithm	Method 1
Advanced Processing	Calibration Algorithm	Basic
Image Format Controls	Flat field Calibration Target (in DN)	1024
⊞ Metadata Controls	Flat Field Calibration Sample Size	2048
Acquisition and Transfer Control	Calibrate FPN	Not Enabled
Action Control	Calibrate PRNU	Not Enabled
⊞ Event Control	Save Calibration	Press...
GigE Vision Transport Layer	Reset Coefficients	Press...
File Access Control	Flat Field Correction Pixel X Coordinate	2
Production Features	Flat Field Correction Gain	1.0
GigE Vision Host Controls	Flat Field Correction Offset	0
	<< Less	

1. Setting gain to 1x.

Type or use the numeric up-down control to set the value to 1.0 as seen below.

Gain Selector	Digital
Gain	1.0

2. Choose *Off* from Flat Field Correction Mode.

To evaluate a bare image use the line profile tool shown below.

Line Profile Example
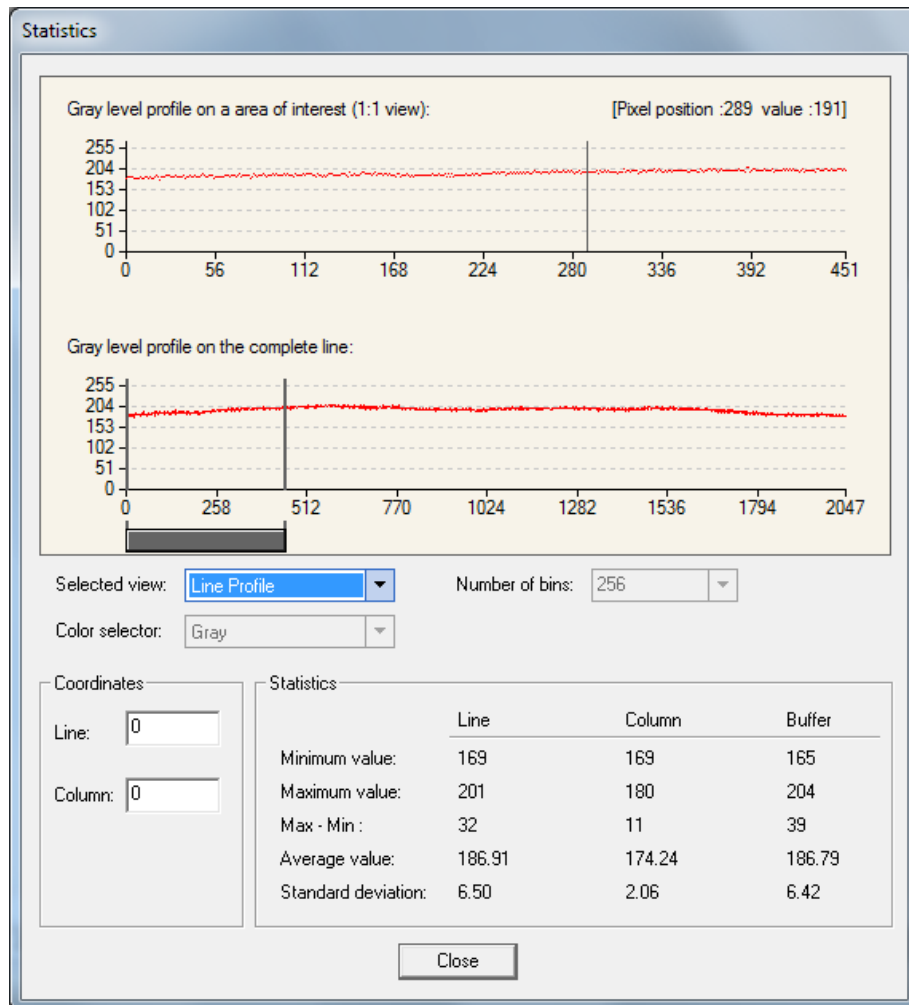
A line profile is mainly determined by two factors: Flatness and Height

1) Flatness: The Line profile represents a Flat Field measurement. Due to lens-shading effect, light falls-off near the edges and results in lower output. This produces higher noise levels near the edge. A smaller aperture opening and longer focal length can reduce lens - shading effect. In some demanding applications, optimized low - shading lenses should be considered.

2) Height: An average value near your calibration target is ideal.
An extremely low output compared to the target will increase noise level significantly after the PRNU is corrected. To avoid SNR and / or DNR not meeting your application requirements, the profile should reach a level near the calibration target.

NOTE: Changes to gain do not improve image quality from a SNR perspective. Gains are analog and digital multipliers that scale up signal and noise proportionally.

**Before performing a FFC keep the following in mind:**
- Ensure the camera's temperature is at nominal operating condition. Power-on for minimum 30 min.
- All parameters should meet your application's specifications. If parameters change after FFC completion, the results may no longer be accurate. Perform another FFC.
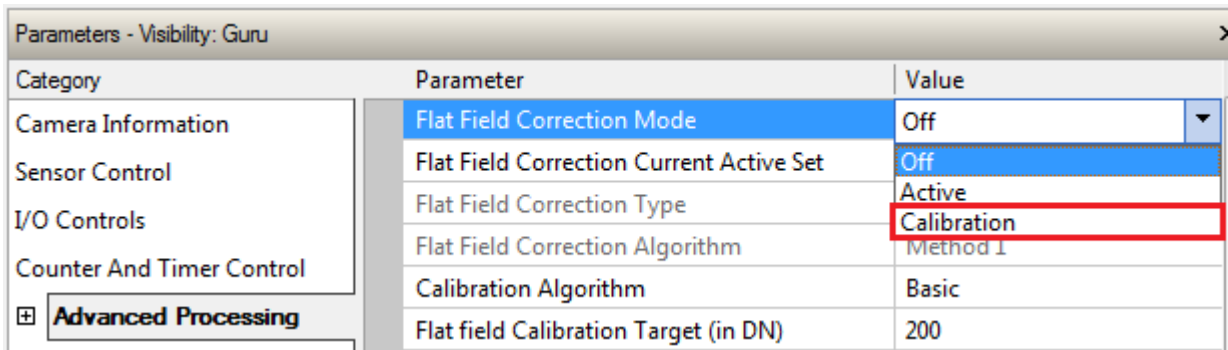
FPN Correction

Step 1: Cover the lens (place the sensor in black).
Step 2: Select *Off* from Flat Field Correction Mode drop-down menu and check the line profile / histogram. If pixel outputs are zero, adjust the "Black level (in DN)" to increase Minimum value above zero. The Black Level adjustment is located in the Sensor Control category.

Parameters - Visibility: Guru	✕

Category	Parameter	Value
Camera Information	Device Scan Type	Linescan
Sensor Control	Sensor Color Type	Monochrome Sensor
I/O Controls	Input Pixel Size	12 Bits/Pixel
Counter And Timer Control	Sensor Width	1024
Advanced Processing	Sensor Height	1
Image Format Controls	Acquisition Line ...	20000
⊞ **Metadata Controls**	Exposure Mode	Timed
Acquisition and Transfer Contr...	Exposure Alignm...	Reset
Action Control	Exposure Delay (i...	Not Enabled
⊞ **Event Control**	Exposure Time (i...	40.0
GigE Vision Transport Layer	Actual Exposure ...	40.0
File Access Control	Gain Selector	Sensor
Production Features	Gain	4.0
GigE Vision Host Controls	Black Level Select...	Analog
	Black Level (in ...	0.0
	<< Less	
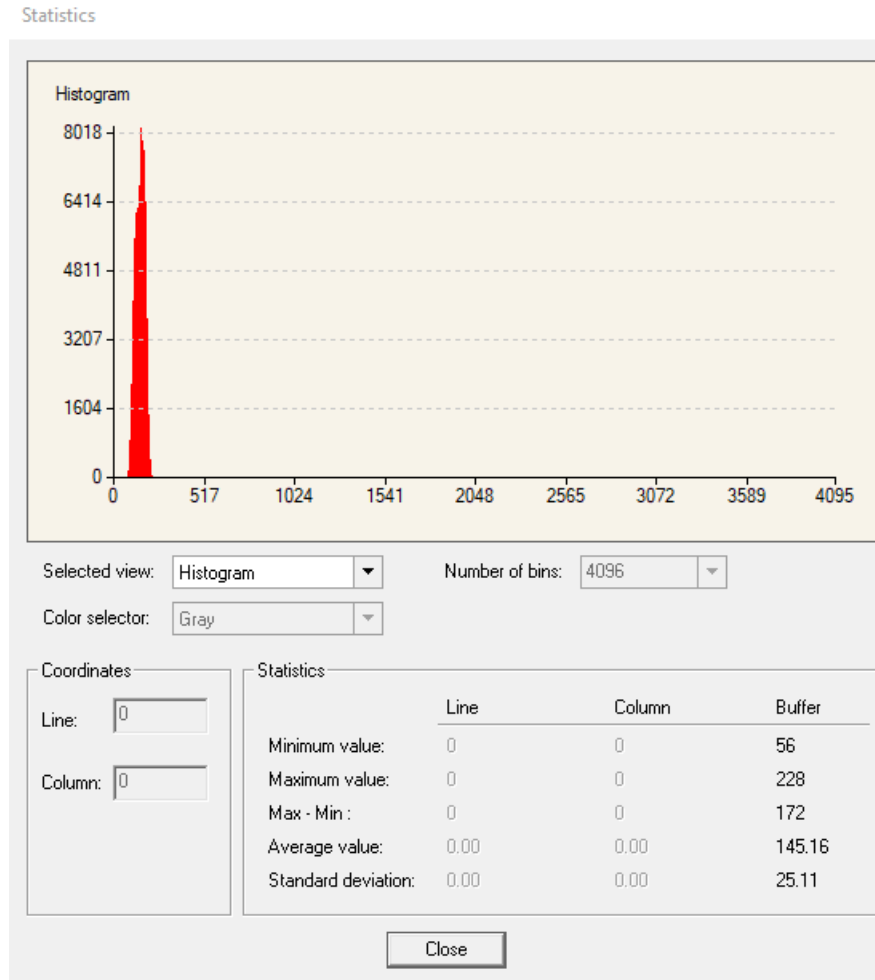
Step 3: Select *Calibration* from Flat Field Correction Mode drop-down menu.

Step 4: Select *2048* or *4096* option from Flat Field Calibration Sample Size. The 2048 option reduces calculating time; 4096 option returns result that is more accurate.
Step 5: Press the *Press…* command in the Calibrate FPN menu

PRNU Correction

Step 1: Apply illumination and place a white flat target in the location where the real object will be. Ideally, you would use a professional target. For convenience, you can use white paper as the target. The result of using paper may produce grain effect — where visible vertical lines show up in grabbed images.

Two common ways to correct the grain effect are:

1) Target in motion while PRNU Correction is performed.

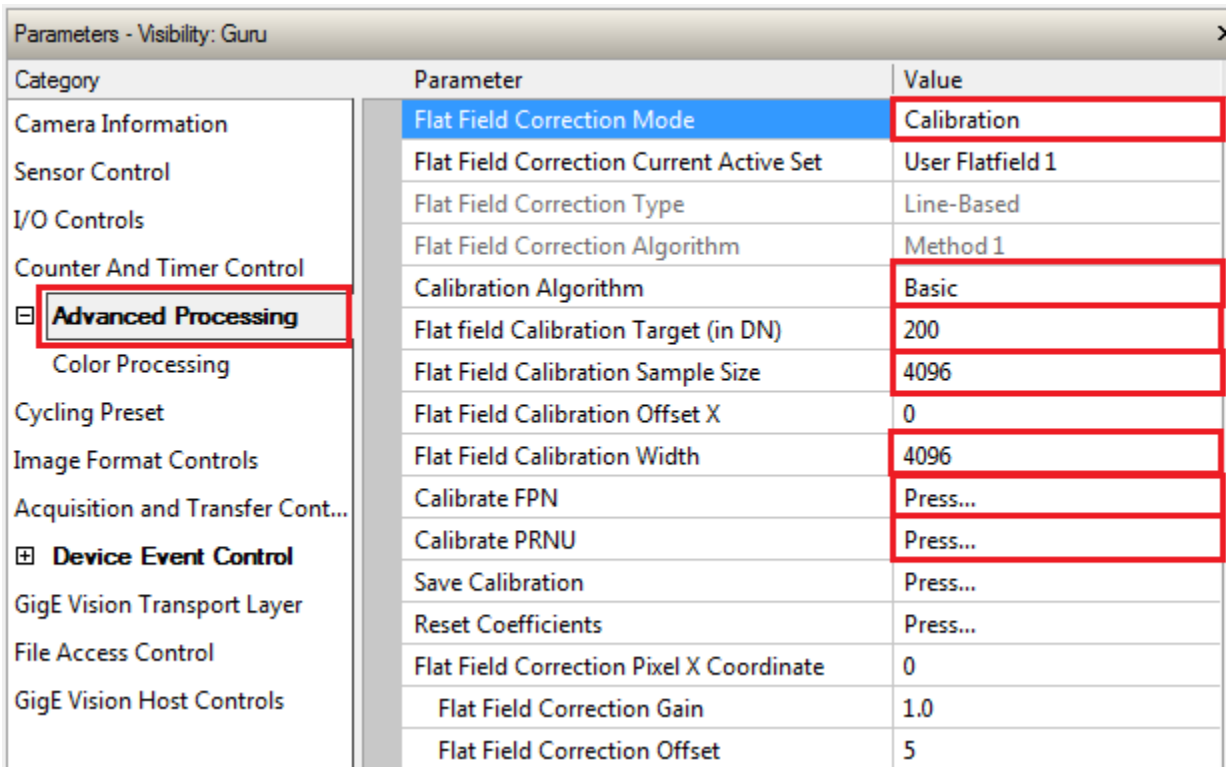2) Defocus lens while PRNU Correction is performed.

Select *Off* from Flat Field Correction Mode drop-down menu and check the bare image line profile.

Step 2: Select *Calibration* from Flat Field Correction Mode drop-down menu.

Step 3: Adjust the calibration target in the Flat Field Calibration Target (in DN) if necessary. **NOTE:** 200 DN is commonly used target in 8-bit output format.

Step 4: Select *2048* or *4096* from Flat Field Calibration Sample Size drop-down menu.

Step 5: Press the *Press…* command in Calibrate PRNU menu.

Category	Parameter	Value
Camera Information	Flat Field Correction Mode	Calibration
Sensor Control	Flat Field Correction Current Active Set	User Flatfield 1
I/O Controls	Flat Field Correction Type	Line-Based
Counter And Timer Control	Flat Field Correction Algorithm	Method 1
⊟ **Advanced Processing**	Calibration Algorithm	Basic
Color Processing	Flat field Calibration Target (in DN)	200
Cycling Preset	Flat Field Calibration Sample Size	4096
Image Format Controls	Flat Field Calibration Offset X	0
Acquisition and Transfer Cont…	Flat Field Calibration Width	4096
⊞ **Device Event Control**	Calibrate FPN	Press…
GigE Vision Transport Layer	Calibrate PRNU	Press…
File Access Control	Save Calibration	Press…
GigE Vision Host Controls	Reset Coefficients	Press…
	Flat Field Correction Pixel X Coordinate	0
	Flat Field Correction Gain	1.0
	Flat Field Correction Offset	5

Parameters - Visibility: Guru

Step 6: Select a User Flat field set from the Flat Field Correction Current Active Set. Press the Press…
command in Save Calibration menu to Active the Set. If not saved, the FFC result will be lost when the Active
Set or Calibration mode is changed.

Step 7: Select *Active* from *Flat Field Correction Mode* drop-down menu to apply the calibrated FPN and
PRNU parameters. Refer to the figure below to verify the line profile.