APPLICATION NOTE

AN-P16

CHEETAH GMAX CAMERA SERIES

CXP-C9440

FLAT FIELD CORRECTION

Abstract: This application note describes how to create and use Flat Field
Correction files for the Cheetah CXP-C9440 camera.

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Introduction

A CMOS image sensor consists of a two-dimensional array of light sensitive pixels. Each pixel within the array has its own unique light sensitivity characteristics. Differences in the angle of incident create charge transport artifacts and deviations in sensitivity. The artifacts cause a shading effect on images during normal camera operation.

A process known as FFC (Flat Field Correction) calibrates the camera to reduce shading. Refer to Figures 1 and 2 for images acquired before and after FFC.

The Cheetah CXP-C9440 camera incorporates an FFC mechanism. The mechanism measures the response to illumination of each pixel in the CMOS array and corrects any variations over the field of the array. The optical system likely introduces some variation in the illumination pattern over the field of the array. The flat field correction process compensates for uneven illumination if the illumination is a stable characteristic of each object exposure.

During factory final testing, our manufacturing engineers run a program specially designed to identify the shading characteristics of the camera. The program creates a Flat Field Correction file that contains coefficients describing the shading characteristics. This file is then uploaded into the camera's non-volatile memory. When Flat Field Correction is enabled, the camera will use the Flat Field Correction coefficients to compensate for the shading effect.

You can create your own FFC file to handle issues unique to your operating environment (e.g., lens, F-stop, lighting, and so on).

This application note describes how to generate an FFC file using the Imperx IpxToolkit. You can then use the Imperx Upload Utility to download the FFC into the camera.
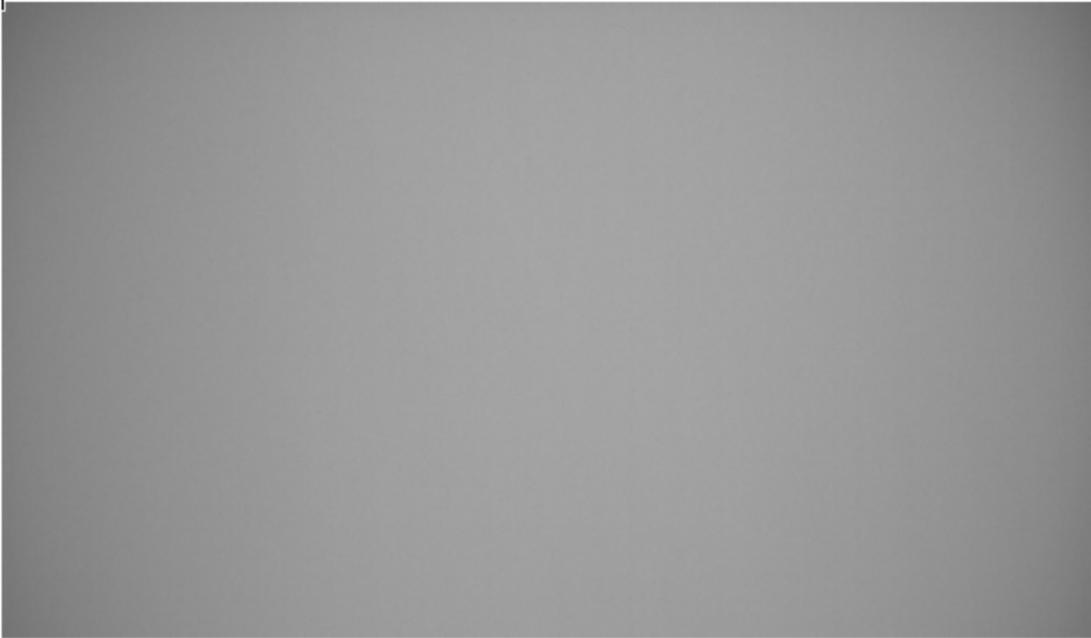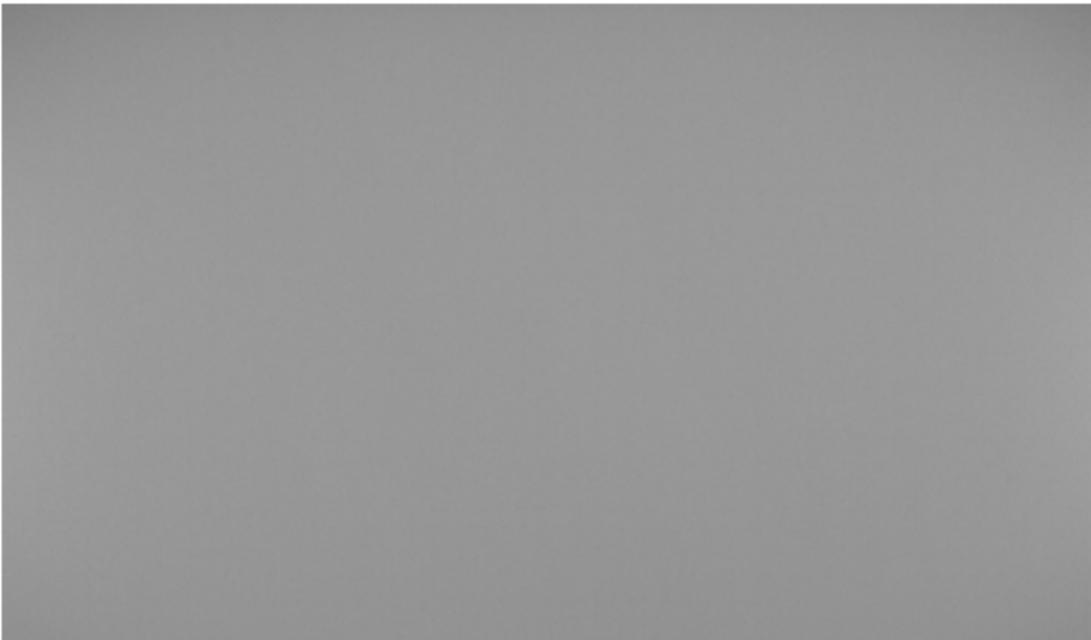
Figure 1: Original image showing shading effect

Figure 2: Flat Field corrected image

Performing Flat Field Correction

Performing the FFC is necessary if the camera's operating environment (i.e. lens, lighting, exposure, gain) differs from the factory testing environment.

What You Need

- lens suitable for your application
- uniform light source
- uniform white target
- Imperx ToolKit_2_0_1_1765
- Imperx Upload Utility_2_2_0_1735

⚠**CAUTION**   If the operating environment has been changed, it might be necessary to create another RAW file and repeat the steps below.

STEP 1: Create a RAW File

Imperx recommends acquiring a 12 bit per pixel RAW image with average pixel luminosity about 2000–3000.

1. Connect and power up the camera.

2. Place a uniform white target against the camera and illuminate the target with a uniform light source.

3. Open the frame grabber's programming software GUI.

4. In the **Image Format Control** menu, set the following parameters:

- *Width*: 9344
- *Height*: 7000
- *Pixel Format*: Mono12
- *AdcBitDepth*: 12 Bit

ImageFormatControl	
Width	9344
Height	7000
PixelFormat	Mono12
AdcBitDepth	12 Bit

5. In the **Acquisition Control** menu, set the *Exposure Mode* (Off by default) and *Exposure Time* parameters as required by your application, make sure that *Exposure Auto* is Off.

AcquisitionControl	
ExposureMode	Off
ExposureTime	41,453
ExposureAuto	Off

6. In the **Analog Control** menu, set the *Gain* value as required by your application (1.25x by default), make sure that the *Gain Auto* parameter is set to Off:

AnalogControl	
Gain	1.25
GainAuto	Off

For a color camera, make sure that *Balance White Auto* parameter is set to Off.

7. In the **Data Correction** menu, make sure that the *FFCEnable* parameter is set to Off:

DataCorrection	
FFCEnable	Off

8. Turn on the image acquisition.

9. Focus the lens on the target.

10. Adjust the light intensity so that the image sensor pixel signals are at about 50% ADU capacity (~2000–3000 for 12-bit image).

If lighting conditions differ from the recommended level, adjust the light intensity as required by your application.

You can monitor the average pixel luminosity on the **Auto Algorithm Control** menu:

AutoAlgorithmControl	
AverageLuminosity	2339

11. Capture an image.

12. Save the image in RAW format.

STEP 2: Create a Flat Field Correction File

1. Start the IMPERX IpxToolKit_2_0_1_1765 application.

2. Navigate to the RAW file stored in the folder tree on the left side of the IpxToolKit.

3. Select the RAW file and set the following image properties:
   - *Device Type:* GigEVision
   - *Width:* 9344
   - *Height:* 7000
   - *Pixel Type:* Mono12 (for both mono and color cameras)
   - *Bit Shift:* 0
   - *Bayer pattern:* GB (for color cameras only)
   - *Algorithm:* Simple (for color cameras only)
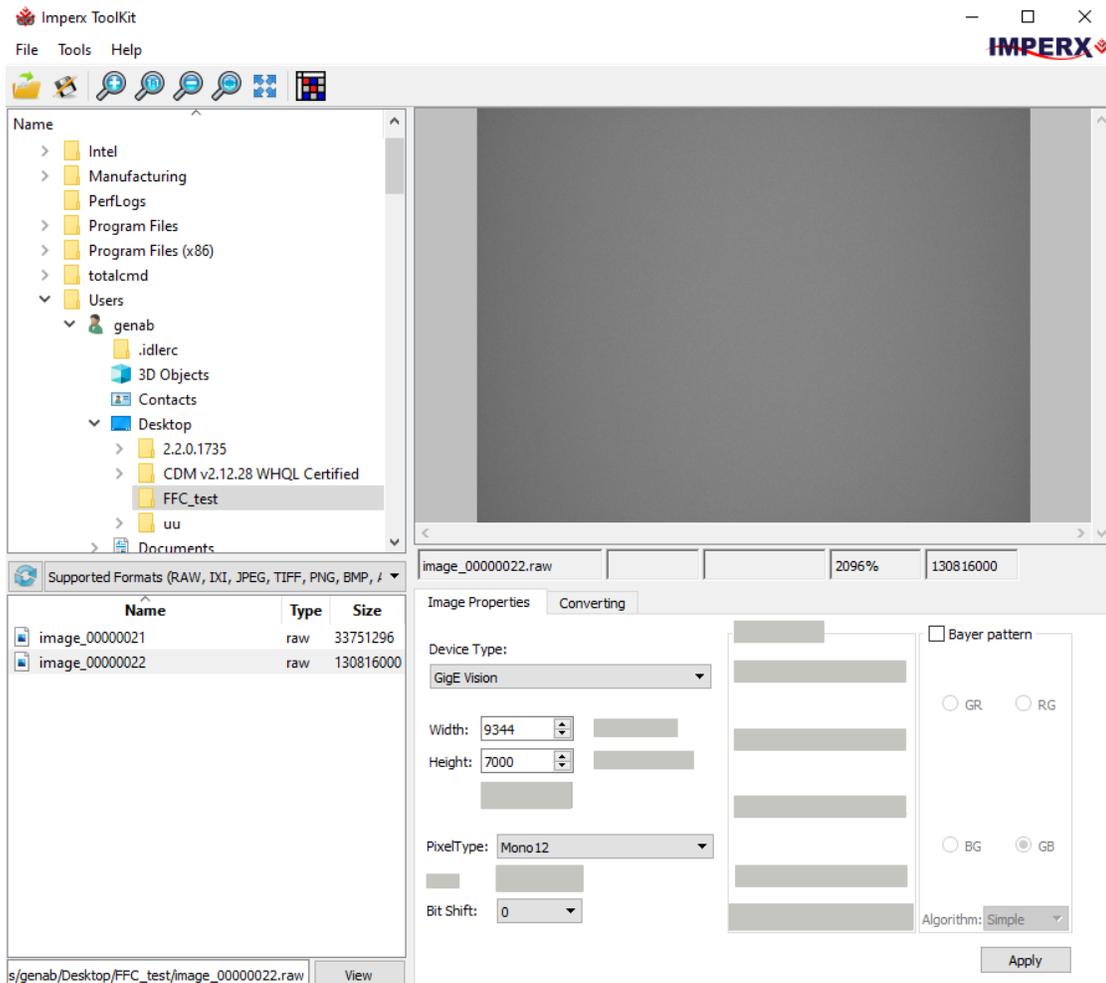
4. Click **Apply**.

5. Click **Tools** and select **FFC utility**.
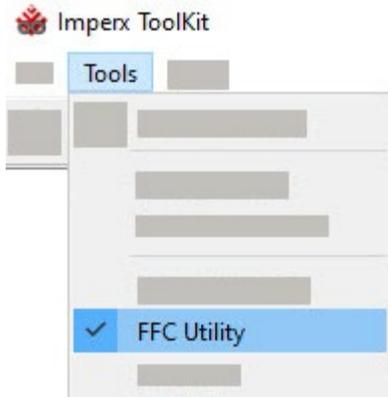
The utility processes the image and creates a set of FFC coefficients. It will then display the original image and its histogram in the top panel and the post-FFC processed image and its histogram in the bottom panel. The histogram includes two plots:

- yellow curve: the average pixel value (Y-axis) versus column position (X-axis)
- purple curve: the average pixel value (Y-axis) versus row position (X-axis)
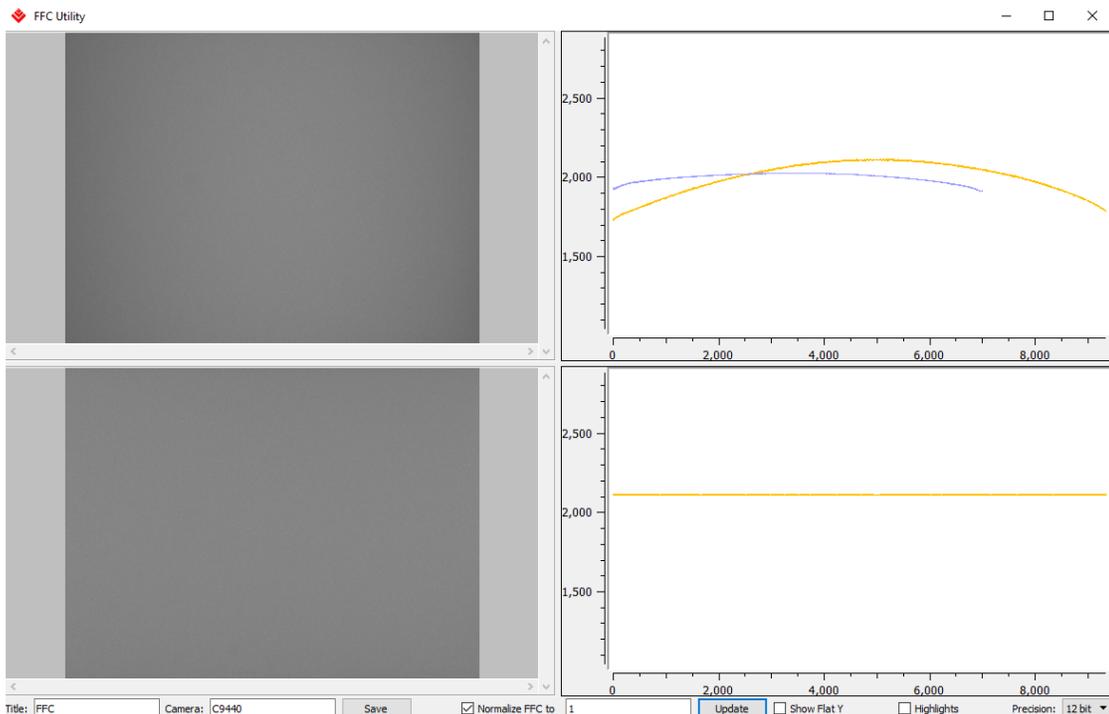
Note that the algorithm the utility uses to correct the original image, using the FFC coefficients generated, is the same algorithm implemented inside the camera.

Therefore, the results that you get with the FFC Utility will be identical to the results that you will receive with the camera.

To change the scale of the image:
a) Right-click the image.
b) Click **View**.
c) Click **Zoom by**.

6. Change *Precision* to 12 bit:

Note that if *Precision* is not changed to 12 bit, the FFC that is generated will be truncated and the resulting image will be dark.

7. Enter text into the **Title** and **Camera** fields.
This text will be included in the FFC file.
Note that the system enters the date into the FFC file.

8. Click **Save** to save the FFC file to your disk drive.

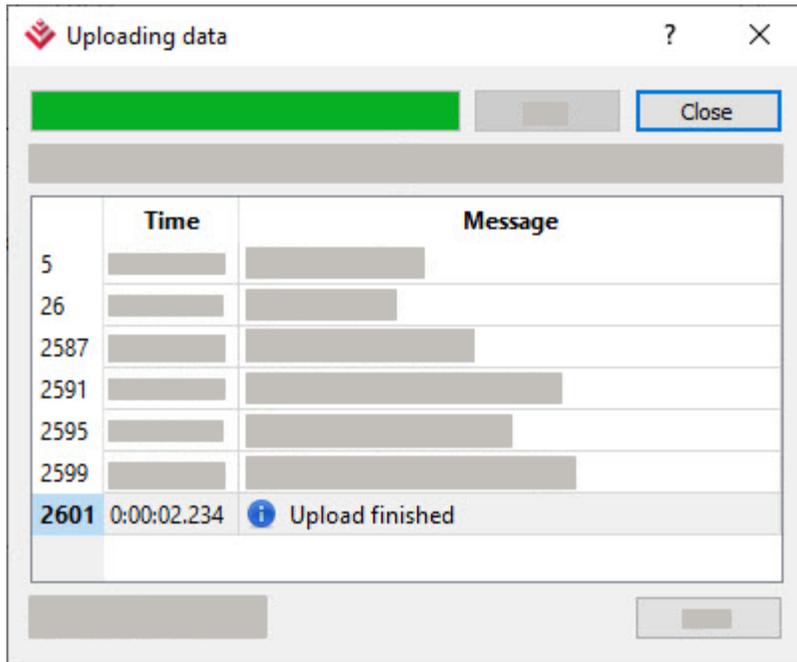## STEP 3: Upload the Flat Field Correction File into the Camera

1. Start the Imperx Upload Utility_2_2_0_1735 and wait until the utility finds the camera.
   If the utility does not detect the camera, click **Refresh** to restart the device collection.

2. Select the CXP-C9440 camera to update.

3. Click 📁 and browse for the new FFC file.

4. Select the FFC file you created for this camera and click **Upload**.
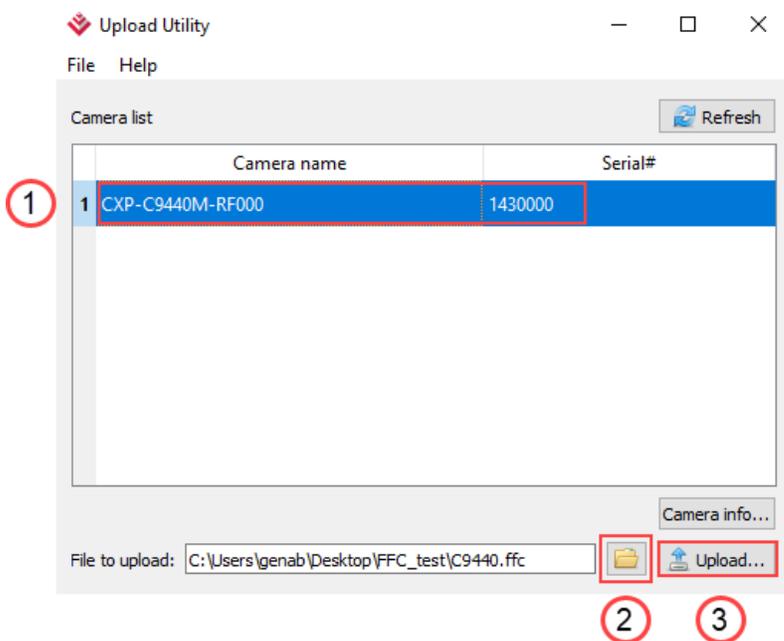
5. Select to which camera's FFC (User1–User7) to upload the FFC file and click **OK**.
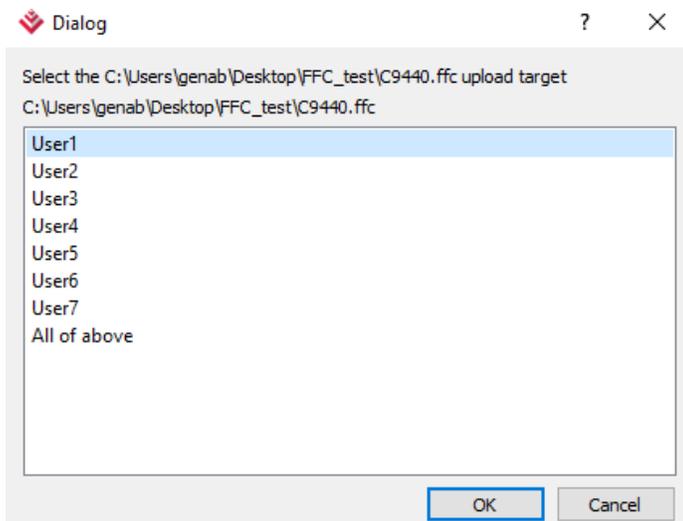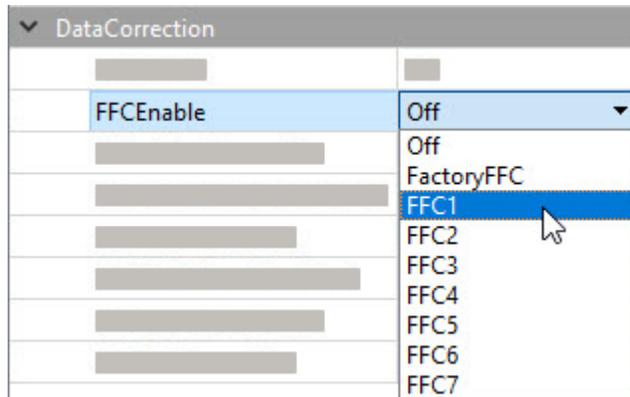
6. Wait for the upload to finish and click **Close**.

STEP 4: Enable the Flat Field Correction in the Camera

After uploading the FFC file to the camera, you can use it in place of the factory FFC file.

1. Open the frame grabber's programming software GUI.

2. In the **Data Correction** menu, select your FFC in the *FFCEnable* drop-down list (the FFC# must be the same as in STEP 3, i.5).

The camera loads and activates this FFC upon the next reset or upon power-up.

The FactoryFFC is a factory configuration that cannot be changed.

3. Power-cycle the camera for the changes to take effect.