IMPERX

Cheetah Python CMOS Cameras
User Manual
with GigE Vision® and 10GigE Vision interfaces

The Imperx Cheetah GigE Vision® and 10GigE Vision CMOS cameras offer 25, 16, and 12-megapixel sensors with Ethernet network compatibility. These cameras produce high-resolution images, a range of frame rates, low noise, and excellent near-infrared sensitivity. The cameras deliver exceptional durability and performance in the most demanding applications and includes a GenICam™ compliant graphical user interface for custom programming.

Document Version 1.4

IMPERX
Industrial Cameras & Imaging Systems

About Imperx, Inc.

IMPERX, Inc. is a leading designer and manufacturer of high performance, high quality digital cameras, frame grabbers, and accessories for industrial, commercial, military, and aerospace imaging applications including flat panel inspection, biometrics, aerial mapping, surveillance, traffic management, semiconductors and electronics, scientific & medical Imaging, printing, homeland security, space exploration, and other imaging and machine vision applications.

Fortune 100 companies, federal and state government agencies, domestic and foreign defense agencies, academic institutions, and other customers worldwide use IMPERX products.

Imperx, Inc. | 6421 Congress Ave. | Boca Raton, FL, 33487
US Phone: +1 (561) 989-0006

Warranty

IMPERX warrants performance of its products and related software to the specifications applicable at the time of sale in accordance with IMPERX's standard warranty, which is 2 (two) years parts and labor. FOR GLASSLESS CAMERAS THE CCD OR CMOS IS NOT COVERED BY THE WARRANTY.

Do not open the housing of the camera. Warranty voids if the housing has been open or tampered.

IMPORTANT NOTICE

This camera has been tested and complies with the limits of Class A digital device, pursuant to part 15 of the FCC rules.

Copyright © 2019 IMPERX Inc. All rights reserved. All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by IMPERX for its use. IMPERX reserves the right to make changes to this information without notice. Redistribution of this manual in whole or in part, by any means, is prohibited without obtaining prior permission from IMPERX. IMPERX reserves the right to make changes to its products or to discontinue any product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

IMPERX PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS, WHERE MALFUNCTION OF THESE PRODUCTS CAN REASONABLY BE EXPECTED TO RESULT IN PERSONAL INJURY. IMPERX CUSTOMERS USING OR SELLING THESE PRODUCTS FOR USE IN SUCH APPLICATIONS DO SO AT THEIR OWN RISK AND AGREE TO FULLY INDEMNIFY IMPERX FOR ANY DAMAGES RESULTING FROM SUCH IMPROPER USE OR SALE.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REVISION HISTORY

Revision	Date	Reviser	Comments
1.0	12/7/2017	R.Johnston	Initial release.
1.1	1/4/2018	R.Johnston	Revised active area specs.
1.2	5/15/18	R.Johnston	Added image plane mechanical drawings; removed Zero ROT Modified LED Status RJ45 Added AEC/AGC LED red blinking Status Updated camera power supply order number, cable length, and electrical output.
1.3	11/27/2019	I. Barabanova	Added 10 GigE Vision (10G) cameras Added PS12V07B Power Supply specifications. Added "Creating Look-up Tables" and "Creating DPC/HPC Tables" chapters. Updated xml node tree and IpxPlayer screen shots.
1.4	1/03/2020	I. Barabanova	Removed logos

1 About the Cheetah Camera

1.1 General

The Cheetah Python series of cameras provide a robust imaging platform with the latest digital technology and industrial grade components. They use CMOS imaging sensors and offer a broad range of resolutions and frame rates. Cheetah cameras are available in both monochrome and color.

The cameras in this manual are compatible with the GigE Vision® (GEV) and 10 GigE Vision (10G) output interfaces, support GigE Vision Standard v1.2 and use a GenICam™ compliant graphical user interface for programming.

The following table provides information about the C5180, C4181, and C4180 cameras.

Table 1: Cheetah cameras with GigE Vision® and 10 GigE Vision interfaces

Model	Resolution (H x V)	Resolution (MP)	Type	Frame Rate (max)	Optics	ON Semiconductor Sensor Model
GigE Vision® cameras						
GEV-C5180M	5120 x 5120	25	Mono	4.3	APS-H	NOIP1SN025KA
GEV-C5180N	5120 x 5120	25	ENIR	4.3	APS-H	NOIP1FN025KA
GEV-C5180C	5120 x 5120	25	Color	4.3	APS-H	NOIP1SE025KA
GEV-C4181M	4096 x 4096	16	Mono	6.2	APS-H	NOIP1SN016KA
GEV-C4181N	4096 x 4096	16	ENIR	6.2	APS-H	NOIP1FN016KA
GEV-C4181C	4096 x 4096	16	Color	6.2	APS-H	NOIP1SE016KA
GEV-C4180M	4096 x 3072	12	Mono	8.3	4/3"	NOIP1SN012KA
GEV-C4180N	4096 x 3072	12	ENIR	8.3	4/3"	NOIP1FN012KA
GEV-C4180C	4096 x 3072	12	Color	8.3	4/3"	NOIP1SE012KA
10 GigE Vision cameras						
10G-C5180M	5120 x 5120	25	Mono	40.6	APS-H	NOIP1SN025KA
10G-C5180N	5120 x 5120	25	ENIR	40.6	APS-H	NOIP1FN025KA
10G-C5180C	5120 x 5120	25	Color	40.6	APS-H	NOIP1SE025KA
10G-C4181M	4096 x 4096	16	Mono	60.5	APS-H	NOIP1SN016KA
10G-C4181N	4096 x 4096	16	ENIR	60.5	APS-H	NOIP1FN016KA
10G-C4181C	4096 x 4096	16	Color	60.5	APS-H	NOIP1SE016KA
10G-C4180M	4096 x 3072	12	Mono	80.4	4/3"	NOIP1SN012KA
10G-C4180N	4096 x 3072	12	ENIR	80.4	4/3"	NOIP1FN012KA
10G-C4180C	4096 x 3072	12	Color	80.4	4/3"	NOIP1SE012KA

Note: ENIR = Enhanced Near-Infrared

Cheetah CMOS line of cameras are ruggedized, for greater durability and performance. They offer high-resolution, progressive scan technology and are fully programmable and field upgradeable. Programmable functions include automatic and manual exposure control, frame rate control, area of interest, subsampling, pixel averaging, automatic and manual gain control, offset, triggering options, strobes, output control, defective pixel correction, and user-programmable look-up tables (LUT). The cameras provide support for active Canon EOS lens with Iris and focus controls. The cameras use ON Semiconductor area scan Python CMOS image sensors and feature a built-in image processing engine, low noise characteristics, and optimized thermal distribution.

The cameras use global shutter operation for superior motion capture with exceptionally high frame rates for high throughput applications. You can synchronize the cameras to an external trigger source and vary exposure times using internal controls or an external pulse width. The cameras support exposure times up to 1 second with 1 µs increments. An Area of Interest (AOI) can be programmed for each acquisition frame, and subsampling or pixel averaging capabilities are also available. They also support analog gains up to 10 dB (3.17x) and allow further expansion of the low-end signal with 24 dB (16x) of additional digital gain available.

Built-in gamma correction and user-defined look-up table (LUT) capabilities optimize the camera's dynamic range features. Defective pixel correction (DPC) and hot pixel correction (HPC) correct for pixels that are over-responding or under-responding. Auto White Balance (AWB) is available in color cameras to correct for color temperature. The cameras have a compatible interface that includes 8- and 10-bit data transmission, as well as camera control functionality in one cable.

The camera's ruggedized design and flexibility enable its use in a diverse range of applications including machine vision, metrology high-definition imaging and surveillance, medical and scientific imaging, intelligent transportation systems, aerial imaging, character recognition, document processing and many more.

1.1.1 GigE Vision Interface

The GigE Vision and 10 GigE Vision interfaces operate on standards designed to enable high-speed video transmission and control over Ethernet networks. The standard enables compatibility with Ethernet CAT 5 and 6 cables and components installed on many PCs. In many cases, GigE and 10 GigE Vision provides a drop-in solution for existing networked cameras with its GenICam compliant user interface (GUI) for programming the camera.

1.1.2 Key Features

- Global shutter (GS)
- Monochrome or color
- Large 4.5-micron pixels
- Enhanced near infrared (NIR) sensitivity version available upon request
- Frame rates up to 40.6 fps (10G-C5180), 60.5 (10G-C4181), 80.4 (10G-C4180)
- High data transfer rates up to 1000 megabits per second (or 1Gbit/s) – for GEV cameras or up to 10,000 megabits per second (or 10 Gbit/s) – for 10G cameras
- Uses CAT5e or CAT6 cables and standard connectors
- Data transfer up to 100 meters in length
- Configurable pixel clock
- Pixel averaging
- Subsampling
- Area of Interest
- Analog and digital gain controls
- Exposure and gain control: manual and automatic
- Offset control
- Three selectable trigger sources: external, pulse generator, or software
- Built-in pulse generator
- Two programmable output strobes
- Auto-white balance: once, manual, or automatic
- Two 12-bit look-up tables (LUT)
- Defective and hot pixel correction (DPC/HPC), Fixed pattern noise (FPN) correction
- Two programmable external inputs (one opto-isolated) and two external outputs (one opto-isolated)
- Flat Field Correction (FFC), user-defined and factory
- Support for the Active Canon EOS lens
- Temperature monitor
- Field upgradeable firmware, LUT, DPC, HPC, FFC
- Two user-defined camera configuration memories

1.1.3 Camera Link, CoaXPress, and USB3 interfaces

The C5180, C4181, and C4180 cameras are also available with the following output interfaces:

– Camera Link®,

– CoaXPress (2- and 4-channel CXP-6),

– USB3.

If you are adding a new C5180, C4181, and C4180 with an interface other than GigE Vision® or 10 GigE Vision to your system, you can start configuring the camera right away as the key features (refer to 1.1.2 Key Features and 1.2 Technical Specifications sections) remain the same for all camera interfaces. Depending on the output interface, the following parameters may be different:

Table 2: Cheetah Python output interfaces

Feature		GigE Vision®	10 GigE Vision®	CoaXPress®	Camera Link®	USB3
Frame Rate (max)	C5180	4.3	40.6	44 / 80 (C5190)	32	13
	C4181	6.2	60.5	68 / 120 (C4191)	50	20
	C4180	8.3	80.4	90 / 160 (C4190)	67	27
Active Canon EOS Lens mount		Supported	Supported	Supported	Not Supported	Supported
Trigger Sources		External, Pulse generator, Software	External, Pulse generator, Software	External, Pulse generator, Software, Trigger over CoaXPress (CXP)	External, Pulse generator, Software, Computer	External, Pulse generator, Software
Dimensions (W x H x L, mm)		72.0 x 72.0 x 33.8	72.0 x 72.0 x 72.3	72.0 x 72.0 x 34.3 / 72.0 x 72.0 x 44.3 (C5190, C4191, C4190)	72.0 x 72.0 x 33.8	72.0 x 72.0 x 34.7
Operating temperatures		-40 °C to +85 °C	-40 °C to +75 °C	-40 °C to +70 °C	-40 °C to +85 °C	-40 °C to +85 °C
Weight		389 g	579.5 g	379 g	385 g	370 g
Power		12 V (5 V to 33 V)	12 V (5 V to 33 V)	Power over CXP	12 V (10 V to 33 V) or PoCL	12 V (5 V to 33 V)

[1] NOTE: Cheetah Python cameras with the CoaXPress® interface are available in two variations:
1) 2-channel CXP-6 CoaXPress® cameras (CXP-C5180, CXP-C4181, CXP-C4180)
2) 4-channel CXP-6 CoaXPress® cameras (CXP-C5190, CXP-C4191, CXP-C4190)

This User Manual provides information on cameras with GigE Vision® or 10 GigE Vision interfaces only.

For more information and technical documentation on cameras with other interfaces please visit our web site www.imperx.com.

1.2 Technical Specifications

The following table describes general features and specifications common to all Cheetah cameras with ON Semi Python sensors.

Table 3: Cheetah cameras general specifications

Specifications	Cheetah Cameras
Shutter operation	Global only
Exposure time	1 second max in 1 micro-second steps
Area of Interest*	One
Analog gain	Up to 10 dB (1x, 1.26x, 1.87x, 3.17x)
Digital gain	Up to 24 dB
Subsampling	Keep one, skip one
Pixel averaging (mono)	1x2, 2x1, and 2x2
Auto-white balance	Yes
Test image	Static, dynamic
Defective pixel correction	Static, dynamic, user DPM
Hot pixel correction	Static, dynamic, user HPM
Inputs	1-LVTTL / 1-Opto-coupled
Outputs	1-TTL / 1-Opto-coupled
Triggers	Programmable rising/falling and de-bounce
Pulse generator	Yes
In-camera image processing	2 LUTs
Camera housing	Aluminum
Supply voltage range*	5 V to 33 V DC; 6.5 V to 33 V DC with Canon Lens Control
Upgradeable firmware	Yes
Upgradeable LUT, DPM, FFC	Yes
Environmental – operating*	-40 °C to +85 °C
Environmental – storage*	-50 °C to +90 °C
Relative humidity	10% to 90% non-condensing

*The specifications may vary between different Cheetah cameras.

1.2.1 GEV-C5180 and 10G-C5180 Cameras

The following table provides specifications on the GEV-C5180 and 10G-C5180 cameras. Frame rates may vary based on computer or network speed.

Table 4: Cheetah GEV-C5180 and 10G-C5180 specifications

Specifications	GEV-C5180 and 10G-C5180 (25 MP)
Active image resolution	5120 x 5120
Active image area (H x V)	23.0 mm x 23.0 mm 32.5 mm diagonal; APS-H optical format
Pixel size	4.5 μm
Video output	Digital, 8/10-bit
Interface	**GEV-C5180:** GigE Vision® **10G-C5180:** 10 GigE Vision
Host connector	RJ45 connector for Ethernet cable
Maximum frame rate	**GEV-C5180:** 4.3 (8-bit), 2.9 (10-bit packed), 2.2 (10-bit unpacked) **10G-C5180:** 40.6 fps (8-bit), 22.9 (10-bit packed), 21.5 fps (10-bit unpacked)
Dynamic range	59 dB
Shutter speed	~50 μs to 1 s
Area of Interest	One
Analog gain	0 to 10 dB
Digital gain	0 to 24 dB
Black level offset	-511 to +511, 1/step
User LUT	2 LUTs: gamma and user LUT
Flat Field Correction (FFC)	Factory and User
Hardware trigger	Asynchronous; Fast trigger – exposure & readout overlap
Strobe modes	Programmable width, delay
Trigger sources	External, pulse generator, software
Trigger features	Rising/falling edge, de-glitch, delay, strobe
Size (W x H x L)	**GEV-C5180:** (72 x 72 x 33.8) mm **10G-C5180:** (72 x 72 x 72.3) mm
Weight	**GEV-C5180:** 370 g **10G-C5180:**579.5 g
Lens mount	F-Mount, M42, active or passive Canon EOS
Supply voltage range	12 V DC (5 V – 33 V) 1.5 A inrush without enabled Canon controller 12 V DC (6.5 V – 33 V) 1.5 A inrush with enabled Canon controller
Camera current @12 V	**GEV-C5180:** Typical: 0.52 A, Maximum: 0.66 A **10G-C5180:** Typical: 1.1 A, Maximum: 1.2 A
Environmental – operating	**GEV-C5180:** -40 °C to +85 °C **10G-C5180:** -40 °C to +75 °C
Environmental – storage	-50 °C to +90 °C

1.2.2 GEV-C4181 and 10G-C4181 Cameras

The following table provides specifications on the GEV-C4181 and 10G-C4181 cameras. Frame rates may vary based on computer or network speed.

Table 5: Cheetah C4181 and 10G-C4181 specifications

Specifications	GEV-C4181 and 10G-C4181 (16 MP)
Active image resolution	4096 x 4096
Active image area (H x V)	18.4 mm x 18.4 mm 26.0 mm diagonal; APS-H optical format
Pixel size	4.5 µm
Video output	Digital, 8/10-bit
Interface	**GEV-C4181:** GigE Vision® **10G-C4181:** 10 GigE Vision
Host connector	RJ45 connector for Ethernet cable
Maximum frame rate	**GEV-C4181:** 6.2 (8-bit), 4.4 (10-bit packed), 3.3 (10-bit unpacked) **10G-C4181:** 60.5 fps (8-bit), 36 fps (10-bit packed), 28.3 fps (10-bit unpacked)
Dynamic range	59 dB
Shutter speed	~50 µs to 1 s
Area of Interest	One
Analog gain	0 to 10 dB
Digital gain	0 to 24 dB
Black level offset	-511 to +511, 1/step
User LUT	2 LUTs: gamma and user LUT
Flat Field Correction (FFC)	Factory and User
Hardware trigger	Asynchronous; Fast trigger – exposure & readout overlap
Strobe modes	Programmable width, delay
Trigger sources	External, pulse generator, software
Trigger features	Rising/falling edge, de-glitch, delay, strobe
Size (W x H x L)	**GEV-C4181:** (72 x 72 x 33.8) mm **10G-C4181:** (72 x 72 x 72.3) mm
Weight	**GEV-C4181:** 370 g **10G-C4181:** 579.5 g
Lens mount	F-Mount, M42, active or passive Canon EOS
Supply voltage range	12 V DC (5 V – 33 V) 1.5 A inrush without enabled Canon controller 12 V DC (6.5 V – 33 V) 1.5 A inrush with enabled Canon controller
Camera current @12 V	**GEV-C4181:** Typical: 0.52 A, Maximum: 0.66 A **10G-C4181:** Typical: 1.1 A, Maximum: 1.2 A
Environmental – operating	**GEV-C4181:** -40 °C to +85 °C **10G-C4181:** -40 °C to +75 °C
Environmental – storage	-50 °C to +90 °C

1.2.3 GEV-C4180 and 10G-C4180 Cameras

The following table provides specifications on the GEV-C4180 and 10G-C4180 cameras. Frame rates may vary based on computer or network speed.

Table 6: Cheetah GEV-C4180 and 10G-4180 specifications

Specifications	GEV-C4180 and 10G-C4180 (12 MP)
Active image resolution	4096 x 3072
Active image area (H x V)	18.4 mm x 13.8 mm 23.0 mm diagonal; 4/3" optical format
Pixel size	4.5 µm
Video output	Digital, 8/10-bit
Interface	**GEV-C4180:** GigE Vision® **10G-C4180:** 10 GigE Vision
Host connector	RJ45 connector for Ethernet cable
Frame rate	**GEV-C4180:** 8.3 (8-bit), 6.0 (10-bit packed), 4.5 (10-bit unpacked) **10G-C4180:** 80.4 fps (8-bit), 48 fps (10-bit packed), 44.8 fps (10-bit unpacked)
Dynamic range	59 dB
Shutter speed	~50 µs to 1 s
Area of Interest	One
Analog gain	0 to 10 dB
Digital gain	0 to 24 dB
Black level offset	-511 to +511, 1/step
User LUT	2 LUTs: gamma and user LUT
Flat Field Correction (FFC)	Factory and User
Hardware trigger	Asynchronous; Fast trigger – exposure & readout overlap
Strobe modes	Programmable width, delay
Trigger sources	External, pulse generator, software
Trigger features	Rising/falling edge, de-glitch, delay, strobe
Size (W x H x L)	**GEV-C4180:** (72 x 72 x 33.8) mm **10G-C4180:** (72 x 72 x 72.3) mm
Weight	**GEV-C4180:** 370 g **10G-C4180:** 579.5 g
Lens mount	F-Mount, M42, active or passive Canon EOS
Supply voltage range	12 V DC (5 V – 33 V) 1.5 A inrush without enabled Canon controller 12 V DC (6.5 V – 33 V) 1.5 A inrush with enabled Canon controller
Camera current @12 V	**GEV-C4180:** Typical: 0.52 A, Maximum: 0.66 A **10G-C4180:** Typical: 1.1 A, Maximum: 1.2 A
Environmental – operating	**GEV-C4180:** -40 °C to +85 °C **10G-C4180:** -40 °C to +75 °C
Environmental – storage	-50 °C to +90 °C

1.3 Ordering Information

Table 7: Cheetah GigE Vision® and 10 GigE Vision Cameras Ordering Codes

Sample Codes:					
GEV-C5180M-RF000: Cheetah Monochrome 25MP camera with F-Mount and GigE Vision® interface without a filter/customization					
10G-C4180C-RL400: Cheetah Color 12MP camera with Canon EF EOS Active Mount and 10 GigE Vision interface featuring front cover glass filter					
Interface	Camera model	Sensor Type	Ruggedized	Lens Mount	Filter/ Customization options
GEV = GigE Vision ® 10G = 10 GigE Vision	C5180 – 5120 x 5120 C4180 – 4096 x 3072 C4181 – 4096 x 4096	C = Color M = monochrome N = Enhanced NIR	R = Ruggedized	F = F-Mount (default) M = M42 L = Canon EF EOS Active Mount E = Canon EF EOS Passive Mount	000 = none
					200 = Color w/out IR filters
					400 = Color w/out IR filter, w/clear cover glass
					700 = Mono w/clear cover glass
Notes:					
000 (none) filter/customization option means that a color camera has IR filter, a monochrome camera does not have any filters.					

For any other custom camera configurations, contact Imperx, Inc. at:

      Email: sales@imperx.com
      Tel.(+1) 561-989-0006
      Fax: (+1) 561-989-0045
      Visit our website: www.imperx.com

1.4 Technical Support

Imperx fully tests each camera before shipping. If the camera is not operational after power up, check the following:

1. Check the power supply and all I/O cables. Make sure all connectors are firmly attached.
2. Check the status LED and verify it is steady ON. If it is not, refer to the section 2.6 LED Status Indicators.
3. Enable the test mode and verify that the communication between the computer and the camera is established. If the test pattern is not present, power off the camera and check cabling, IpxPlayer settings, and computer status.
4. If you still have problems with camera operation, contact technical support at:

      Email: techsupport@imperx.com
      Toll Free 1 (866) 849-1662 or (+1) 561-989-0006
      Fax: (+1) 561-989-0045
      Visit our website: www.imperx.com

2 Hardware

2.1 GEV Camera Back Panel

The back panel of the camera provides connectors needed to operate and control the camera. The panel also provides a status LED indicator. The panel includes:

1. A standard RJ-45 connector provides data, sync, control, and serial interface.
2. Two mounting holes to use with an Ethernet cable with horizontal locking screws for a secure connection.
3. A male Hirose type miniature locking receptacle #HR10A-10R-12PB (71) provides power and I/O interface.
4. A USB type B programming/SPI connector for factory use only.
5. A camera status LED indicator.
6. The camera's model / serial number.

USB type B connector for factory use

Camera LED status indicator

Ethernet cable mounting holes

RJ-45 Ethernet connector with 2 communications status LEDs

12-pin Hirose type connector for power and I/O interface
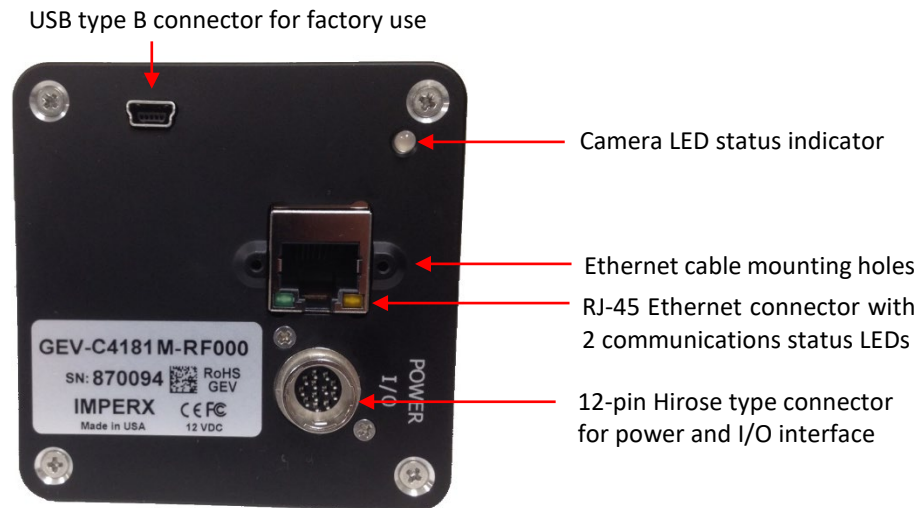
Figure 1: GEV-C5180, GEV-C4181, and GEV-C4180 camera back panel

The camera transmits serialized video data output and communications over the Gigabit Ethernet interface with consistently low, predictable latencies. The network interface is compatible with IP/Ethernet networks operating at 1000 megabits per second using LAN CAT-5 (CAT-5e) or CAT-6 cables. Shielded cables are recommended. The cable length can reach up to 100 m. For longer distances or harsh environments with high electromagnetic interference (EMI), CAT7 (or higher) cable is required.

2.2 10G Camera Back Panel

The back panel of the camera provides connectors needed to operate and control the camera. The panel also provides a status LED indicator. The panel includes:

1. A standard RJ-45 connector provides data, sync, control, and serial interface.
2. Two mounting holes to use with an Ethernet cable with horizontal locking screws for a secure connection.
3. A male 12-pin Hirose type miniature locking receptacle #HR10A-10R-12PB(71) provides power and I/O interface.
4. A USB type B programming/SPI connector for factory use only.
5. A camera status LED indicator.
6. The camera's model / serial number.
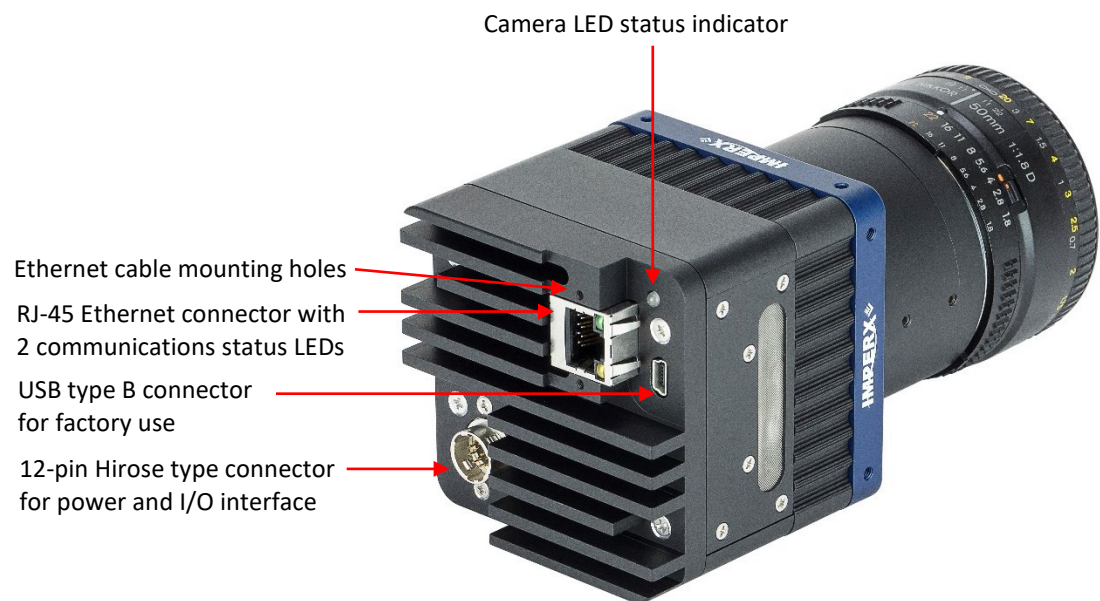
Figure 2: 10G-C5180, 10G-C4181, and 10G-C4180 camera back panel

The camera transmits serialized video data output and communications over the 10 Gigabit Ethernet interface with consistently low, predictable latencies. The network interface is compatible with IP/Ethernet networks operating at 10 gigabits per second using LAN CAT-5 (CAT-5e) or CAT-6 cables. Shielded cables are recommended. The cable length can reach up to 100 m. For longer distances or harsh environments with high electromagnetic interference (EMI), CAT7 (or higher) cable is required.

2.3 Ethernet Port

The RJ-45 connector's pin assignment conforms to the Ethernet standard IEEE 802.3 1000BASE-T for GEV cameras and IEEE 802.3 10GBASE-T for 10G cameras.

2.4 Camera Connector

The 12-pin Hirose connector provides power and all external input/output signals supplied to the camera (Figure 3). The connector is a male HIROSE type miniature locking receptacle #HR10A-10R-12PB (71). The optionally purchased power supply ships with a power cable that terminates in a female HIROSE plug #HR10A-10P-12S (73). Refer to the following power connector pins table.
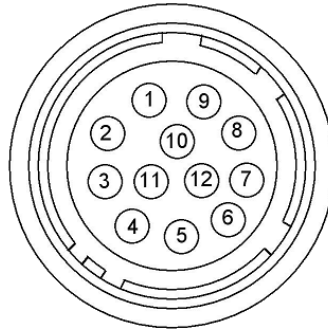
Figure 3: Power and I/O Connector Pin-outs

2.4.1 Power and I/O Connector Pin Assignment

The following table provides the Hirose connector pin mappings.

Table 8: Power connector pin mappings

Pin	Signal	Description
1	12 VDC Return	12 VDC Main Power Return
2	+ 12 VDC	+ 12 VDC Main Power
3	Reserved	Reserved
4	Reserved	Reserved
5	OUT 2 RTN	General Purpose Output 2, Contact 1 (Opto-isolated)
6	OUT 1 RTN	General Purpose Output 1 Return (TTL)
7	OUT 1	General Purpose Output 1 (TTL)
8	IN 1	General Purpose Input 1 (Opto-isolated)
9	IN 2	General Purpose Input 2 (TTL/LVTTL)
10	IN 1 Return	General Purpose Input 1 Return (Opto-isolated)
11	IN 2 Return	General Purpose Input 2 Return (TTL/LVTTL)
12	OUT 2	General Purpose Output 2, Contact 2 (Opto-isolated)

2.4.2 Electrical Connectivity

The camera has two external inputs: IN 1 and IN 2. Input IN1 is optically isolated while input IN2 accepts low voltage TTL (LVTTL). The camera provides two general-purpose outputs. Output OUT1 is a 5 V TTL compatible signal and output OUT2 is opto-isolated. The following figures show the external input and the external output electrical connections.

A. Input IN 1 – Opto-Isolated

Input signals IN1 and IN1 RTN are optically isolated. The voltage difference between the two must be positive between 3.3 V and 24 V. The minimum input current is 3.3 mA.
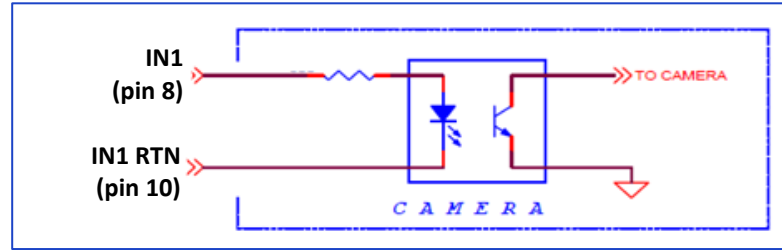
Figure 4: IN1 electrical connection

B. Input IN 2 – LVTTL

Input signals IN2 and IN2 RTN provide interfaces to a TTL or LVTTL input signal. The signal level (voltage difference between the inputs IN2 and IN2 RTN) must be LVTTL (3.3 V) or TTL (5.0 V). The total maximum input current must not exceed 2.0 mA.
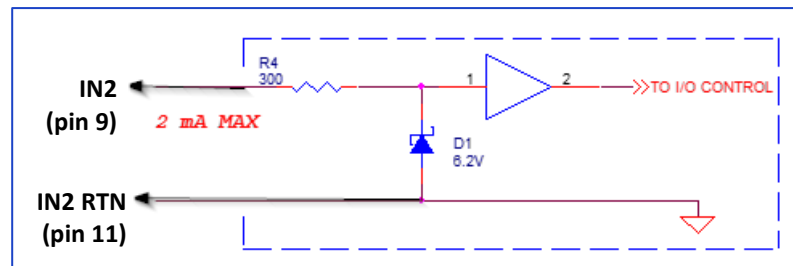
Figure 5: IN2 electrical connection

C. Output OUT 1 – TTL

Output OUT1 is a 5 V TTL compatible signal and the maximum output current must not exceed 8 mA.
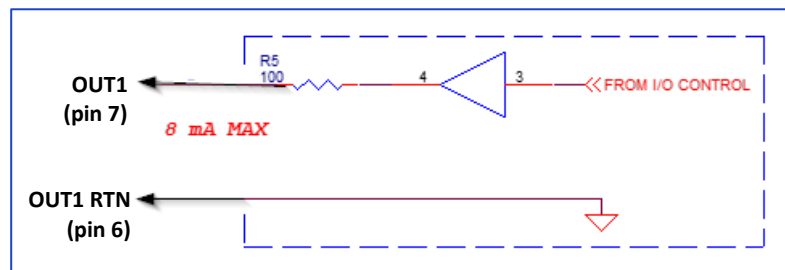
Figure 6: OUT1 LVTTL electrical connection

D. Output OUT 2 – Solid state relay, optically isolated

Output OUT2 is an optically isolated switch. There is no pull-up voltage on either contact. External pull-up voltage of up to 25 V is required for operation. Output is not polarity sensitive. AC or DC loads are possible. The voltage across OUT2 Contact 1 and OUT2 Contact 2 must not exceed 25 V and the current through the switch must not exceed 50 mA. On resistance is less than 5 Ohms.
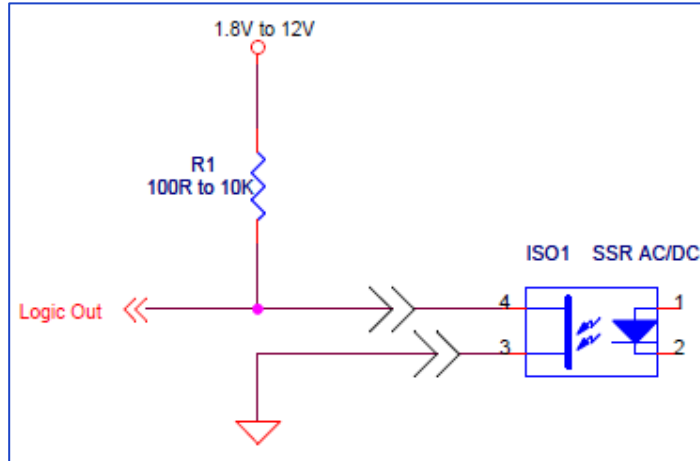
Figure 7: Open drain logic driver
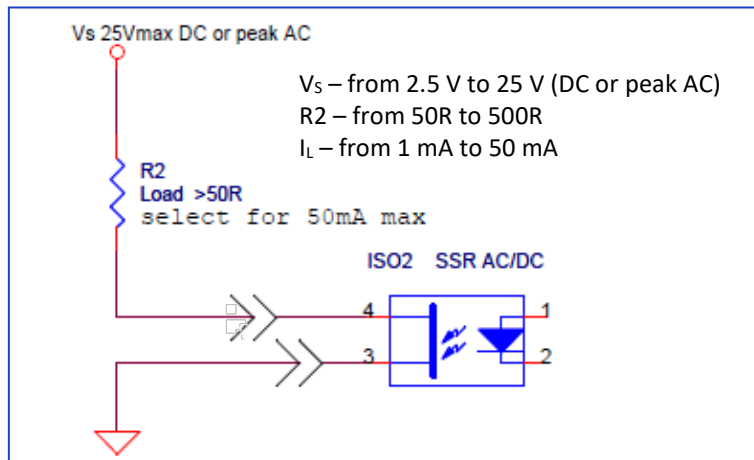
Figure 8: Low side load driver
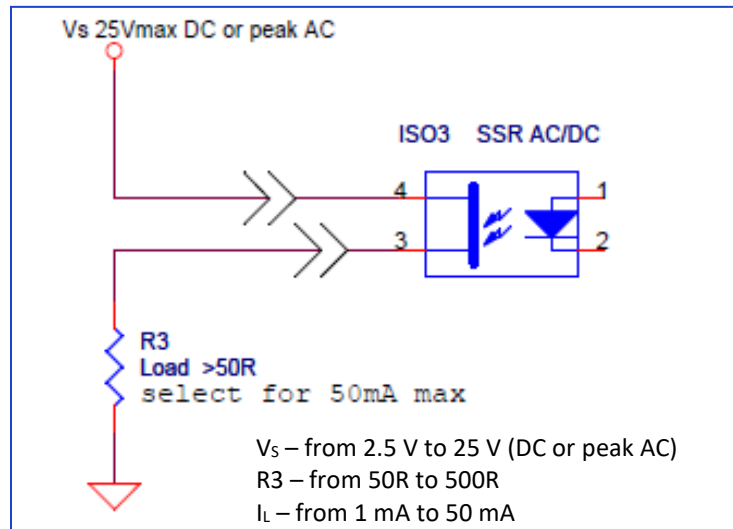
Figure 9: High side load driver

2.5 Power Supply

Cheetah Python cameras use the PS12V04A Standard Power Supply shown in the following figure, which includes power for the camera and a cable with Trigger input and Strobe 1 output brought out to BNC-terminated pigtails.

If using Canon EOS active lens control with the camera, use the PS12V07B power supply (Figure 10).

2.5.1 PS12V04A Standard Power Supply

Figure 10: PS12V04A power supply (ordered separately)

PS12V04A Standard Power Supply:

Cable Lengths:
Supplied AC power input cable (IEC): 1.8 m (6') 100 - 240 VAC, 50 – 60 Hz 1 A
Power supply output cable: 1.5 m (5') ± 15 cm (6") connector HIROSE #HR10A-10P-12S
Strobe (white) & Trigger (black): 15 cm (6") ± 1 cm (0.5") connector BNC male

Electrical Specifications:
Over-Voltage Protective Installation
Short-circuit Protective Installation
Protection Type: Auto-Recovery
12 V to 13 VDC, 12.6 VDC nominal, 2 A.
Load regulation ± 5%
Ripple & Noise 1% Max.

Regulatory:
Class 1
Safety standards UL60950-1, EN60950-1, IEC60950-1
Safety (1) EMC UL/CUL, CE, TUV, DoIR+C-Tick, Semko, CCC, FCC
Safety (2) BSMI, FCC

ITEM	QTY	DESCRIPTION
1	1	12V DESKTOP AC/DC ADAPTER WITH SHIELDED CABLE, LEVELVI
2	1	CONNECTOR, HIROSE HR10A-10P-12S
3	1	BNC(M) CABLE SUBASSEMBLY (BLACK)
4	1	BNC(M) CABLE SUBASSEMBLY (WHITE)
5	1	POWER SUPPLY ASSEMBLY NOTES, DWG 5100-0000
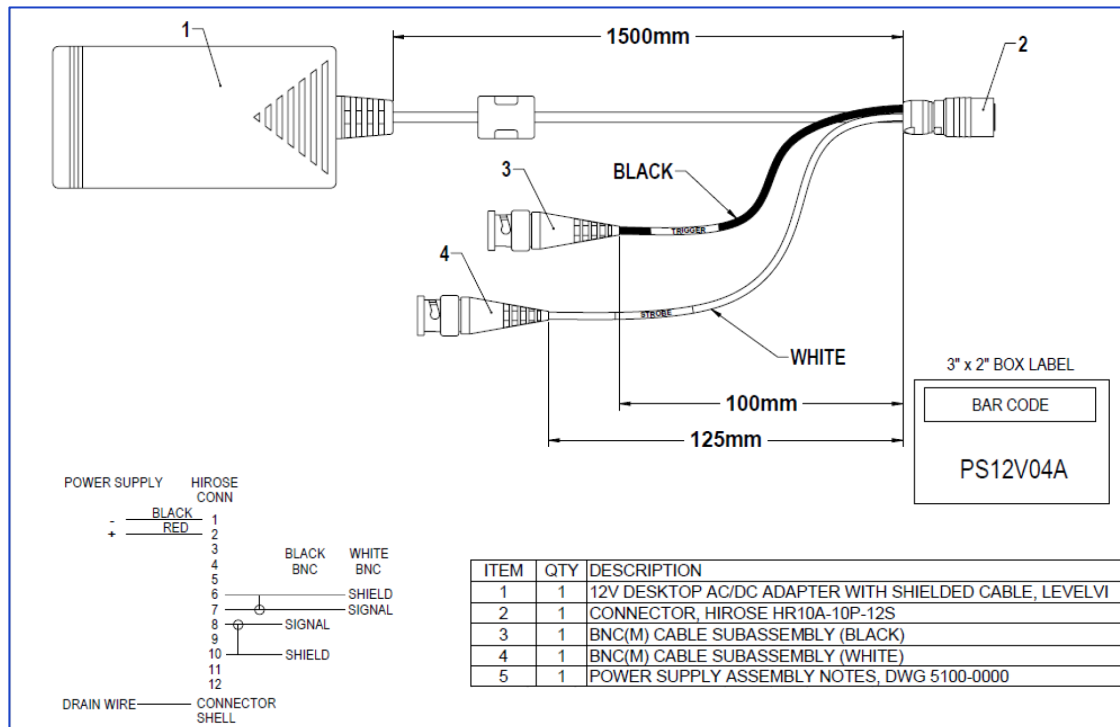
Figure 11: PS12V04A Power Supply assembly

2.5.2 PS12V07B Power Supply with support for Canon Lens Control

Use the PS12V07B power supply if using Canon Lens Control with the camera. The power supply provides power to the camera and connectors for Canon EOS lens control, trigger input, and strobe output. Trigger and strobe cables are terminated with male BNC connectors, and the lens control cable is terminated with female Sam Woo connector (Figure 12).

Figure 12: The PS12V07B Power Supply with Canon lens control (ordered separately)

Cable Lengths:
Supplied AC power input cable (IEC): 1.8 m (6') 100 - 240 VAC, 50 – 60 Hz 1 A
Power supply output cable: 1.5 m (5') ± 15 cm (6") connector HIROSE #HR10A-10P-12S
Strobe (white) & Trigger (black): 15 cm (6") ± 1 cm (0.5") connector BNC male
Canon EF lens control: 15 cm (6") ± 1 cm (0.5") connector Sam Woo female 6-pin #SNH-8-6(P)

Electrical Specifications:
Over-Voltage Protective Installation
Short-circuit Protective Installation
Protection Type: Auto-Recovery
12 V to 13 VDC, 12.6 VDC nominal, 3.17 A.
Load regulation ± 5%
Ripple & Noise 1% Max.

Regulatory:
Class 1
Safety standards UL60950-1, CSA C22.2, EN60950-1, IEC60950-1
Safety (1) EMC UL/CUL, CE, TUV, DoIR+C-Tick, Semko, CCC, FCC
Safety (2) BSMI, FCC
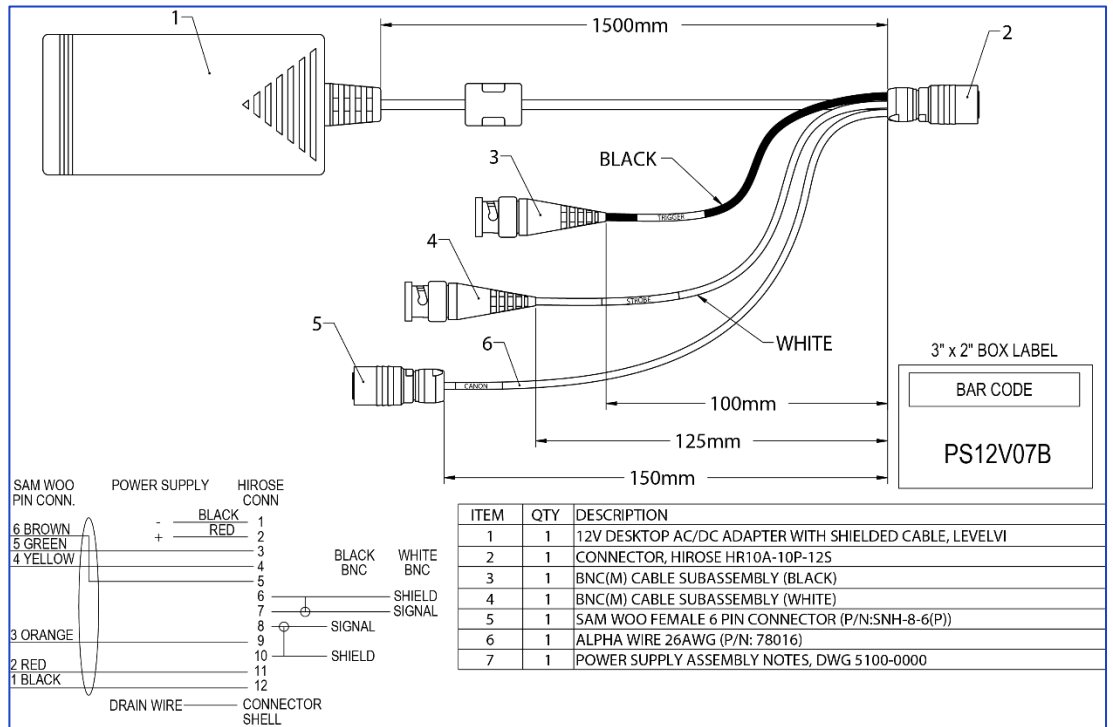
Figure 13: PS12V07B Power Supply assembly

2.6 LED Status Indicators

2.6.1 Camera LED Status Indicator

The camera provides a dual red/green LED status indicator on the back panel. The LED indicates the following:

Table 9: Camera LED status indicators

	Camera LED Color	Status Description
	Green steady ON	Normal operation, camera should produce a normal image.
	Green blinking	Trigger enabled.
	Amber steady ON	Test mode enabled. You should see one of the test patterns.
	Red blinking	Camera in AEC/AGC mode.
	Red steady ON	Communications or firmware load error.*
	Green - Red blinking (~1Hz)	GigE Vision firmware error.
	LED OFF	No power. Indicates power supply failure.**

*Re-power the camera and load the factory settings. If the condition is still present, contact the factory
**A faulty external AC adapter could also cause this error. To restore the camera operation, re-power the camera and load the factory settings. If the LED is still OFF, contact the factory.

2.6.2 Ethernet LED Status Indicators

The female RJ-45 connector on the back panel of the camera provides LEDs for indicating Ethernet status. The LEDs indicate the following:

Table 10: GigE Vision Cameras Ethernet LED status indicators

Ethernet Status	LED (1) — Amber	LED (0) — Green
1000 Mbps Link – No Activity	Off	Solid On
1000 Mbps Link – Activity	Off	Blink
100 Mbps Link – No Activity	Solid On	Solid On
100 Mbps Link – Activity	Blink	Blink
10 Mbps Link – No Activity	Solid On	Off
10 Mbps Link – Activity	Blink	Off
No link	Off	Off

Table 11: 10 GigE Vision cameras Ethernet LED status indicators

Ethernet Status	LED (1) - Amber	LED (0) - Green
10 Gbps Link – No Activity	Off	Solid On
10 Gbps Link – Activity	Off	Blink
5 Gbps Link – No Activity	Solid On	Solid On
5 Gbps Link – Activity	Blink	Blink
2.5 Gbps Link – No Activity	Solid On	Off
2.5 Gbps Link – Activity	Blink	Off
1 Gbps Link – No Activity	Blink	Off
1 Gbps Link – Activity	Blink	Off
100 Mbps Link – Activity	Off	Blink 1Hz
100 Mbps Link – No Activity	Off	Blink 1Hz
10 Mbps Link – Activity	Blink 1Hz	Off
10 Mbps Link – No Activity	Blink 1Hz	Off

2.7 Mechanical, Optical, Environmental

2.7.1 Mechanical Drawings

The camera housing is made of high quality series 6000 aluminum. For maximum usability, the camera has eight (8) M3X0.5mm mounting screws located towards the front and the back. The camera ships with an additional plate with ¼-20 UNC tripod mount and hardware. All dimensions are in millimeters.

2.7.1.1 Mechanical Drawings of GEV-C5180/C4181/C4180 Cameras
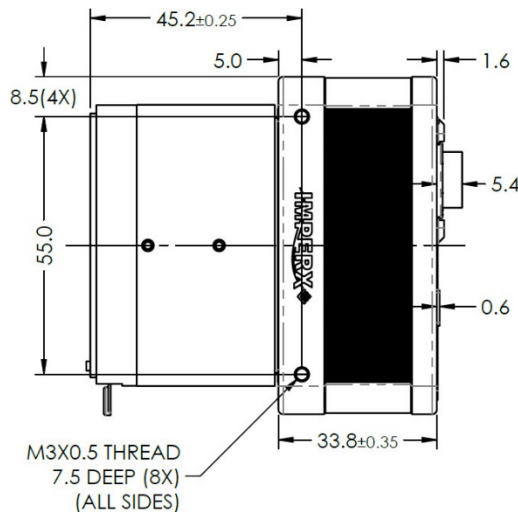
Top View: **Side View with Image Plane:**
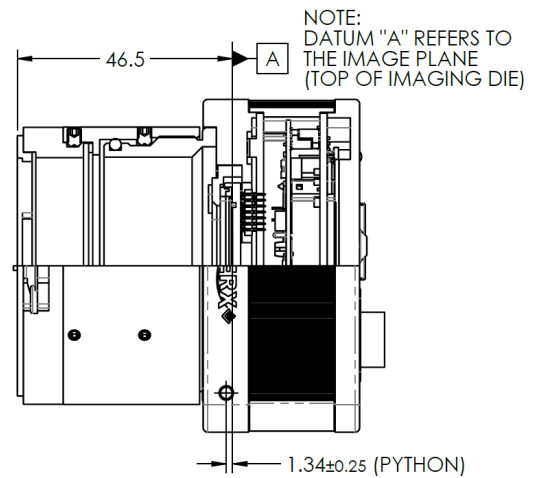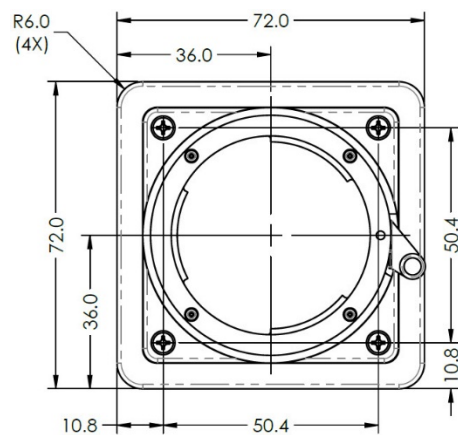
Front View: **Back View:**
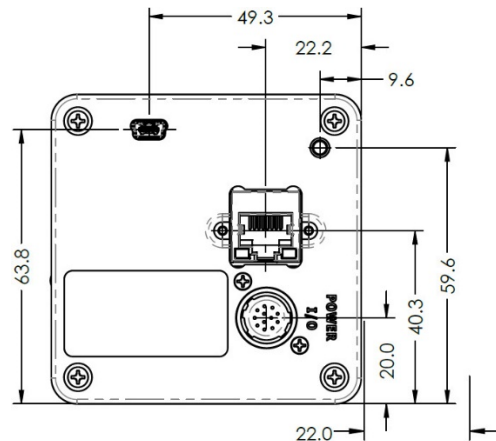
Figure 14: Mechanical drawings of GEV-C5180, GEV-C4181, and GEV-C4180 cameras

2.7.1.2 Mechanical Drawings of 10G-C5180/C4181/C4180 Cameras
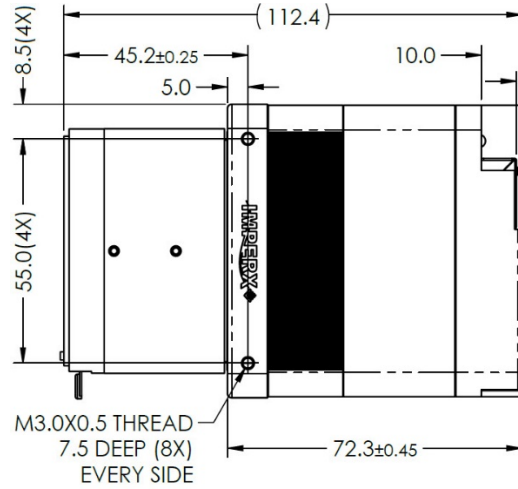
Top View: **Side View with Image Plane:**
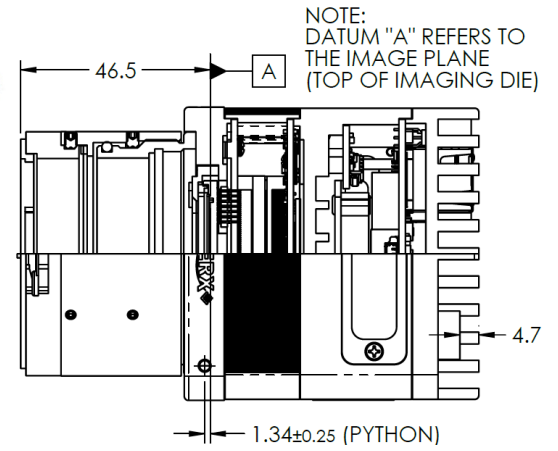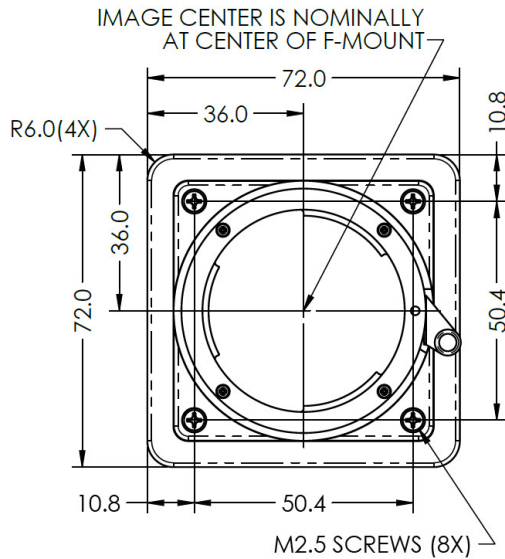
Front View: **Back View:**
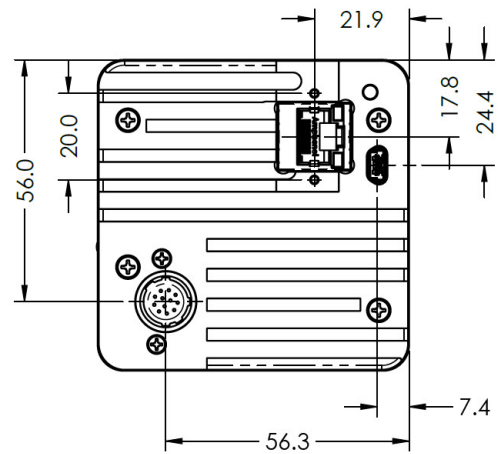
Figure 15: Mechanical drawings of 10G-C5180, 10G-C4181, and 10-C4180 cameras

2.7.2 Optical

The camera's 72 mm x 72 mm cross-section comes with an adapter for F-mount lenses, which have a 46.50 mm back focal distance.

Camera performance and signal-to-noise ratio (SNR) depend on the illumination (amount of light) reaching the sensor and the exposure time. Always try to balance these two factors. Unnecessarily long exposure will increase the amount of noise, thus decreasing the signal-to-noise ratio.

The cameras are highly sensitive in the infrared (IR) spectral region. All color cameras have an IR cut-off filter installed. The monochrome cameras come without an IR cut-off filter. The camera provides space under the front lens bezel for inserting an IR filter (1 mm thickness or less) if necessary.

CAUTION ⚠️

1. Avoid direct exposure to a high intensity light source (such as a laser beam). This may damage the camera optical sensor!
2. Avoid foreign particles on the surface of the imager.

2.7.3 Environmental

The camera operating temperature ranges from -40 °C to +85 °C for GEV cameras and from -40 °C to +75 °C for 10G cameras in a dry environment. The relative humidity should not exceed 90% non-condensing. Always keep the camera as cool as possible. Always allow sufficient time for temperature equalization if the camera is stored below 0 °C.

The camera should be stored in a dry environment with the temperature ranging from -50 °C to + 90 °C.

CAUTION ⚠️

1. Avoid direct exposure to moisture and liquids. The camera housing is not hermetically sealed and any exposure to liquids might damage the camera electronics!
2. Avoid operating in an environment without any air circulation or in close proximity to an intensive heat source, strong magnetic or electric fields.
3. Avoid touching or cleaning the front surface of the optical sensor. To clean the sensor, use only a soft lint-free cloth and an optical cleaning fluid.

    Do not use methylated alcohol!
    Please refer to the Sensor Cleaning Procedure document found on the camera's information USB stick or contact Imperx support for cleaning procedures.

3 GenICam™ API Module – Configuring the Camera

3.1 Overview

Imperx Cheetah cameras are highly programmable and flexible. They allow control all of the camera's resources. You can communicate with the camera from a simple GenICam™ compliant GigE graphical user interface (GUI). The GUI is bi-directional allowing you to issue commands to the camera and enabling the camera to issues responses (either status or information). You can configure and monitor all of the camera's features and resources.

The Cheetah camera ships with the Imperx Camera SDK software which includes the SDK and IpxPlayer application to control the camera and view/save images.

3.2 Camera Configuration

3.2.1 Configuration Memory – Parameter Flash

The camera has built-in configuration memory divided into four segments: Work Space, Factory Space, User Space #1, and User Space #2. The Work Space segment contains the current camera settings while the camera is powered up and operational. All camera registers are located in this space. You can program these registers and change the camera configuration through these registers.

The Work Space is RAM based. All camera registers clear upon camera power-down. The Factory Space segment is ROM based, write protected, and contains the default camera settings. This space is available for read operations only. User Space #1 and User Space #2 are non-volatile, flash-based, and used to store two user defined configurations or User Sets. Upon power up or software reset, the camera firmware loads the Work Space registers from the Factory Space, User Space #1, or User Space #2 as determined by a User Set Default Selector setting.

At any time, you can instruct the camera to load its Work Space with the contents of the Factory Space, User Space #1, or User Space #2 using the User Set Load command. Similarly, the user can instruct the camera to save the current Work Space settings into either User Space #1 or User Space #2 using the User Set Save command.

The non-volatile parameter Flash memory also contains the Defective Pixel Map, Hot Pixel Map, LUT 1, and LUT 2, which you can load to the camera's internal memory upon enabling the corresponding camera feature. You can also create DPM, HPM, and LUT tables and upload them to the parameter Flash using the Imperx Upload Utility, which is a separate utility available from the Imperx website https://www.imperx.com.

3.3 Camera Startup

Upon powering up or receiving a 'DeviceReset' command, the camera performs the following steps:

1. Boot loader checks program flash memory for a valid firmware image and loads it into the field-programmable gate array (FPGA).
2. The camera reads the "Boot From" register from the parameter Flash and loads a workspace from one of the configuration spaces determined by the User Set Default Selector. The configuration spaces are: Factory Space, User Space #1, and User Space #2.
3. The camera runs the IP configuration according the GigE Vision standard, obtains the IP address, and is ready for device enumeration by host application.

3.4 GenApi Camera Configuration

The camera XML nodes are listed below with a description of the camera configuration parameters, interface type, range of control values, and the access mode for the parameter (RW: Read/Write, RO: Read Only, WO: Write Only).

NOTE ✱

In the following tables, parameter names underlined in *red bold italic* letters indicate that you must turn image acquisition **off** in order to change the parameters. You cannot change these parameters if image acquisition is **on**. After making changes, you can turn the camera image acquisition back **on**.

3.4.1 Device Control

Device Control provides read-only information about the camera's XML file and enables camera reset functionality.

Table 12: Device Control parameters

Parameter Name	Type	Value	Access	Description
DeviceVendorName	StringReg		RO	Name of the manufacturer of the camera
DeviceModelName	StringReg		RO	Full camera part number
DeviceManufacturerInfo	StringReg		RO	Extended manufacturer information
DeviceFirmwareVersion	StringReg		RO	Camera Firmware version
DeviceVersion	StringReg		RO	Camera Hardware version
DeviceSerialNumber	StringReg		RO	Camera serial number
DeviceUserID	StringReg		RO	User-programmable identifier
DeviceSFNCVersionMajor	Integer		RO	Major version of SFNC used for XML.
DeviceSFNCVersionMinor	Integer		RO	Minor version of SFNC used for XML
DeviceSFNCVersionSubMinor	Integer		RO	Subminor version of SFNC used for XML

Table 12: Device Control parameters (continued)

Parameter Name	Type	Value		Access	Description
DeviceReset	Command			WO	Resets device to power-up state (reset both the GEV Engine and the camera head).
CameraHeadReset	Command			WO	Resets camera circuitry. GigE does not reset. Note: After camera reset, issue a UserSetLoad command.
CurrentTemperature[1]	Integer			RO	Returns current camera temperature
CurrentTemperatureFpga[1, 2]	Integer				Returns current FPGA temperature
CurrentTemperaturePhy[1, 2]	Integer				Returns current PHY temperature
FanControl[2]	Enumeration	**String** "Auto" "Off" "On"	**Num.** 0 1 2	RW	Controls the camera fan

[1]Current Temperature returns a two's complement number. The range is +127 °C to -127 °C. A value greater than 127 indicates negative temperature. To calculate negative temperature, subtract 255 from the value. For example, a value of 254 indicates a temperature of 254-255 = -1 °C.

[2]CurrentTemperatureFpga, CurrentTemperaturePhy and FanControl parameters are available for the 10G cameras only.

3.4.2 Version Information

Version Information provides read-only information identifying the camera's firmware, hardware, software, image sensor, and so on. This information is programmed during the manufacturing process and stored in non-volatile memory.

Table 13: Version Information parameters

Parameter Name	Type	Value		Access	Description
SensorType	Enumeration	**String** "Monochrome" "Bayer"	**Num.** 0 1	RO	Returns the CMOS sensor type.
RgsID	Integer			RO	Returns RGS ID register.
FpgaID	Integer			RO	Returns FPGA ID (0=EP4C25, 1=EP4C40, 3=5CEFA4).
EpcsID	Integer			RO	Returns EPCS ID (0=EPCS16, 1=EPCS64, 2=EPCS128).
FirmwareImage	Integer			RO	Returns the Firmware Image ID (F=Factory or A=Application).

Table13: Version Information parameters (continued)

Parameter Name	Type	Value	Access	Description
CameraHeadFirmwareVersion	Integer		RO	Returns the CameraHead Firmware version number.
CameraHeadFirmwareBuild	Integer		RO	Returns the CameraHead Firmware build number.
CustomerID	Integer		RO	Returns Customer ID for custom firmware (0 = Imperx standard firmware).
FamilyID	Integer		RO	Returns Family ID.
XmlVersion	Integer		RO	Returns version of the XML file.
GevFirmwareSwVersion	Integer		RO	Shows software version of GigE Vision engine firmware.
GevFirmwareHwVersion	Integer		RO	Shows hardware version of GigE Vision engine firmware.

3.4.3 Image Format Control

Image Format Control lets you change screen resolution, select camera bit depth, apply averaging and subsampling modes, and more.

Table 14: Image Format parameters

Parameter Name	Type	Value	Access	Description
SensorWidth	Integer		RO	Effective width of sensor in pixels.
SensorHeight	Integer		RO	Effective height of sensor in pixels.
WidthMax	Integer		RO	Max. width of image in pixels for OffsetX=0 calculated after horizontal binning, decimation, or other function.
HeightMax	Integer		RO	Max. height of image in pixels for OffsetY=0 calculated after vertical binning, decimation, or other function.
Width	Integer	Min: 256 Max: Depends on camera model	RW	AOI width represents actual image output width (in pixels).

Table 14: Image Format parameters (continued)

Parameter Name	Type	Value		Access	Description
Height	Integer	Min: 2 Max: Depends on camera model		RW	AOI height represents actual image output height (in lines).
OffsetX	Integer	Min: 0 Max: Depends on Width		RW	AOI horizontal offset from left side of image (in pixels).
OffsetY	Integer	Min: 0 Max: Depends on Height		RW	AOI vertical offset from top of image (in pixels).
PixelSize	Enumeration	**String** "Bpp8" "Bpp10" "Bpp12" "Bpp14" "Bpp16" "Bpp24"	**Num.** 0 1 2 3 4 5	RO	Indicates pixel bit depth in computer memory.
PixelFormat	Enumeration	**String** "Mono8" "Mono10" "Mono10Packed" "BayerRG8" "BayerRG10" "BayerRG10Packed"	**Num.** 0x01080001 0x01100003 0x010C0004 0x01080009 0x0110000D 0x010C0027	RW	Indicates pixel format of the output data.
PixelColorFilter	Enumeration	**String** "None" "BayerRG"	**Num.** 0 1	RO	Returns type of color filter applied to the image.
AveragingMode	Enumeration	**String** "Off" "Horizontal" "Vertical" "BothDirections"	**Num.** 0 1 2 3	RW	Sets averaging mode.
SubsamplingMode	Enumeration	**String** "Off" "Horizontal" "Vertical" "BothDirections"	**Num.** 0 1 2 3	RW	Sets subsampling mode.
PixelClockInfo	Integer			RO	Indicates current pixel clock frequency in MHz.
TestPattern	Enumeration	**String** "Off" "GreyHorizontalRamp" "GreyVerticalRamp" "GreyHorizontalRampMoving" "GreyVerticalRampMoving" "Crosshair" "IpxGevPattern"	**Num.** 0 1 2 3 4 5 16	RW	Selects type of test pattern generated by device as image source (refer to the section 5.11 Test Image Patterns).

3.4.4 Acquisition Control

Acquisition Control lets you configure settings for image capture, exposure, frame rates, triggers, and so on. It also provides a variety of read-only information.

Table 15: Acquisition Control parameters

Parameter Name	Type	Value		Access	Description
AcquisitionMode	Enumeration	**String** "SingleFrame" "MultiFrame" "Continuous"	**Num.** 0 1 2	RW	Defines number of frames to capture during acquisition and the way the acquisition stops.
AcquisitionStart	Command			WO	Starts device acquisition.
AcquisitionStop	Command			WO	Stops acquisition at the end of the current frame.
AcquisitionAbort	Command			WO	Aborts acquisition immediately , but a partially transferred image will be completed.
AcquisitionFrameCount	Integer	Min: 1 Max: 65535		RW	Number of frames to acquire in MultiFrame Acquisition mode.
ExposureMode	Enumeration	**String** "Off" "TriggerWidth" "Timed"	**Num.** 0 1 2	RO	Sets operation mode of exposure (refer to 5.1 Exposure Control for more information)
ExposureTime	Float			RW	Sets exposure time in microseconds when ExposureMode is Timed and ExposureAuto is Off.
AcquisitionFrameRateEnable	Boolean			RW	Controls whether AcquisitionFrameRate and AcquisitionFramePeriod features are writable and used to control acquisition rate. If this mode is On, you can extend frame time beyond the free-running frame time.

Table 15: Acquisition Control parameters (continued)

Parameter Name	Type	Value		Access	Description
AcquisitionFrameTime	Integer			RW	Sets frame time in microseconds.
AcquisitionFrameRate	Float			RW	Controls acquisition rate (in Hz) of frames captured.
ZeroROTEnable	Boolean			RW	Enables Zero Row Overhead Time (ROT) mode allowing you extend frame time beyond the free-running frame time.
PixelClock	Integer			RW	Sets pixel clock in MHz. 32 MHz is minimum
CurrentExposureTime	Integer			RO	Returns current exposure time in microseconds.
CurrentFrameTime	Integer			RO	Returns current frame time in microseconds.
MinMaxExposureTime	Integer			RO	Returns the exposure min and max time in microseconds.
TriggerMode	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Enables the trigger mode of operation. A trigger initiates an exposure then readout sequence – exposure and readout can overlap
TriggerSoftware	Command			WO	Generates internal trigger. TriggerSource must be set to Software.
TriggerSource	Enumeration	**String** "Line1" "Line2" "PulseGenerator" "Software"	**Num.** 0 1 4 5	RW	Specifies internal signal or external input as trigger source. Selected trigger must have TriggerMode set to On (refer to 5.5.1 Triggering Inputs for more information)
TriggerActivation	Enumeration	**String** "RisingEdge" "FallingEdge"	**Num.** 0 1	RW	Specifies activation edge of trigger.

Table 15: Acquisition Control parameters (continued)

Parameter Name	Type	Value		Access	Description
TriggerDebounce	Enumeration	**String** "Disabled" "TenMicroSeconds" "FiftyMicroSeconds" "OneHundredMicroSeconds" "FiveHundredMicroSeconds" "OneMilliSecond" "FiveMilliSeconds" "TenMilliSeconds"	**Num.** 0 1 2 3 4 5 6 7	RW	Specifies debounce period of the trigger signal.
TriggerDelay	Integer	Min: 0 Max: 1000000		RW	Specifies delay time in microseconds between the trigger pulse and start of exposure.
TriggerNumFrames	Integer	Min: 1 Max: 65535		RW	Selects the number of frames delivered after every trigger signal

3.4.5 Gain Control

Gain Control provides parameters for setting analog gain, black level raw, and digital gain.

Table 16: Gain control parameters

Parameter Name	Type	Value		Access	Description
AnalogGain	Enumeration	**String** "Gain_1x0" "Gain_1x26" "Gain_1x87" "Gain_3x17"	**Num.** 0 1 2 3	RW	Controls analog gain for all taps.
BlackLevelAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Enables automatic black level adjustment.
BlackLevel	Float	Min: -511 Max: 511		RW	Controls analog black level as an absolute physical value. It represents a DC offset applied to the video signal.
DigitalGain	Float	Min: 1.0 Max: 15.999		RW	Controls digital gain in steps of 0.01x for all taps.
DigitalGainRaw	Integer	Min: 1024 Max: 16383		RW	Sets Digital Gain from 1024 (1x) to 16383 (15.9x) in steps of 0.00097x (see section 5.7.2 Digital Gain).
DigitalOffset	Integer	Min: -512 Max: 511		RW	Adds a digital offset to the image data.

3.4.6 Auto Gain and Auto Exposure

You can set the camera to automatic exposure control (AEC) to keep the same image brightness during changing light conditions. You can enable both AEC and automatic gain control (AGC) independently or together. Auto gain and auto exposure controls let you control the range of exposure times and gain values used by placing minimum and maximum limits on these parameters. When both AEC and AGC are enabled together, exposure times are varied until the maximum exposure time limit is reached, then gain is applied.

3.4.6.1 Control

Table 17: Auto Exposure and Auto Gain Control parameters

Parameter Name	Type	Value		Access	Description
GainAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Enables automatic gain control (AGC) mode.
AgcGainMin	Float	Min: 1.0 Max: AgcGainMax		RW	Sets min. digital gain multiplier value for AGC in increments of 0.01x; e.g. 2.05x gain.
AgcGainMinRaw	Integer	Min: 1024 Max: AgcGainMax		RW	Sets min. digital gain value for AGC in RAW units (see section 5.7.2 Digital Gain).
AgcGainMax	Float	Min: AgcGainMin Max: 15.999		RW	Sets max. digital gain multiplier value for AGC in increments of 0.01x.
AgcGainMaxRaw	Integer	Min: AgcGainMin Max: 16383		RW	Sets max. digital gain value for AGC mode in RAW units (see section 5.7.2 Digital Gain).
ExposureAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Enables automatic exposure control (AEC) mode.
AecExposureMin	Integer	Min: IntExposureMin Max: AecExposureMax		RW	Sets min. exposure time value for AEC in microseconds.
AecExposureMax	Integer	Min: AecExposureMin Max: IntExposureMax		RW	Sets max. exposure time value for AEC in microseconds.
AgcAecLuminanceLevel	Integer	Min: 1 Max: 4095		RW	Sets target luminance level for AGC/AEC up to 4095 counts.
AgcAecLuminanceType	Enumeration	**String** "Average" "Peak"	**Num.** 0 1	RW	Sets the luminance mode to be used during AGC or AEC.
AgcAecSpeed	Enumberation	**String** "x1" "x2" "x3" "x4"	**Num.** 0 1 2 3	RW	Controls the speed during AGC or AEC where x1=slowest and x4=fastest.

3.4.6.2 Status

Table 18: Status parameters

Parameter Name	Type	Value	Access	Description
AgcGainCurrentValue	Float	Min: 1.0 Max: 15.999	RO	Reports the current value of digital gain in AGC mode
AgcGainCurrentValueRaw	Integer		RO	Reports current value of gain in AGC mode in RAW units.
AgcMinLimitReached	Integer		RO	Returns 1 if min. digital gain limit was reached or 0 if not reached during AGC operation.
AgcMaxLimitReached	Integer		RO	Returns 1 if max. digital gain limit was reached or 0 if not reached during AGC operation.
AecExposureCurrentValue	Integer		RO	Reports current value of exposure in microseconds in AEC mode.
AecMinLimitReached	Integer		RO	Returns 1 if min. exposure limit was reached or 0 if not reached during AEC operation
AecMaxLimitReached	Integer		RO	Returns 1 if max. exposure limit was reached or 0 if not reached during AEC operation
CurrentAvgOrPeakLuminance	Integer		RO	Returns current average or peak luminance in counts.
AgcAecStatus	Integer		RO	Displays the value of AgcAecStatus register

3.4.7 Data Correction

Data Correction parameters enable you to implement tables and other techniques to improve image sensor performance.

Table 19: Data Correction parameters

Parameter Name	Type	Value		Access	Description
LUTSelector	Enumeration	**String** "LUT1" "LUT2"	**Num.** 0 1	RW	Selects LUT to be used in processing image.
LUTEnable	Boolean			RW	Activates selected LUT.
FFCSelector	Enumeration	**String** "FFC1" "FFC2"	**Num.** 0 1	RW	Selects FFC to be used in processing image.
FFCEnable	Boolean			RW	Activates selected FFC.
FixedPatternNoiseCorrection	Enumeration	**String** "On" "Off"	**Num.** 0 1	RW	Enables column Fixed Pattern Noise Correction.
DefectPixelCorrection	Enumeration	**String** "Off" "Static" "Dynamic" "Both"	**Num.** 0 1 2 3	RW	Enables Defective Pixel Correction.
DefectPixelThreshold	Integer	Min: 0 Max: 4095		RW	Sets threshold for dynamic Defect Pixel Correction algorithm.
HotPixelCorrection	Enumeration	**String** "Off" "Static" "Dynamic" "Both"	**Num.** 0 1 2 3	RW	Enables Hot Pixel Correction.
HotPixelThreshold	Integer	Min: 0 Max: 4095		RW	Sets threshold for dynamic Hot Pixel Correction algorithm.

3.4.8 White Balance

White Balance parameters give you control over the individual red, green, and blue colors produced by the sensor in color cameras.

Table 20: White Balance parameters

Parameter Name	Type	Value		Access	Description
BalanceWhiteAuto	Enumeration	**String** "Off" "Once" "Continuous" "Manual"	**Num.** 0 1 2 3	RW	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted (see 5.12 White Balance and Color Conversion)
RedCoefficient	Integer	Min: 0 Max: 4095		RW	Manually sets white balance coefficient for red channel.
GreenCoefficient	Integer	Min: 0 Max: 4095		RW	Manually sets white balance coefficient for green channel.
BlueCoefficient	Integer	Min: 0 Max: 4095		RW	Manually sets adjusted white balance coefficient for blue channel.
AutoTrackingSpeed	Enumeration	**String** "x1" "x2" "x3" "x4" "x5"	**Num.** 0 1 2 3 4	RW	Controls speed of auto white balance update rate: x1=slowest x5=fastest.

3.4.9 Strobe

Strobe parameters enable you to configure strobe settings, performance, and outputs.

3.4.9.1   OUT1

Table 21: OUT1 parameters

Parameter Name	Type	Value		Access	Description
OUT1Polarity	Enumeration	**String** "ActiveLow" "ActiveHigh"	**Num.** 0 1	RW	Sets active logic level of OUT1 output.
OUT1Selector	Enumeration	**String** "None" "Trigger" "PulseGenerator" "Strobe1" "Strobe2"	**Num.** 0 1 2 3 4	RW	Maps various internal signals to OUT1 output.

3.4.9.2   OUT2

Table 22: OUT2 parameters

Parameter Name	Type	Value		Access	Description
OUT1Polarity	Enumeration	**String** "ActiveLow" "ActiveHigh"	**Num.** 0 1	RW	Sets active logic level of OUT2 output.
OUT1Selector	Enumeration	**String** "None" "Trigger" "PulseGenerator" "Strobe1" "Strobe2"	**Num.** 0 1 2 3 4	RW	Maps various internal signals to OUT2 output.

3.4.9.3   Strobe

Table 23: Strobe parameters

Parameter Name	Type	Value		Access	Description
Strobe1Mode	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Enables/disables Strobe 1.
Strobe1Reference	Enumeration	**String** "ExposureStart" "ReadoutStart"	**Num.** 0 1	RW	Sets reference point for Strobe 1.
Strobe1Width	Integer	Min: 1 Max: 1000000		RW	Sets Strobe 1 pulse duration in microseconds.
Strobe1Delay	Integer	Min: 1 Max: 1000000		RW	Sets Strobe 1 delay from reference in microseconds.
Strobe2Mode	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Enables/disables Strobe 2.

Table 23: Strobe parameters (continued)

Parameter Name	Type	Value		Access	Description
Strobe2Reference	Enumeration	**String** "ExposureStart" "ReadoutStart"	**Num.** 0 1	RW	Sets reference point for Strobe 2.
Strobe2Width	Integer	Min: 1 Max: 1000000		RW	Sets Strobe 2 pulse duration in microseconds.
Strobe2Delay	Integer	Min: 1 Max: 1000000		RW	Sets Strobe 2 delay in microseconds.

3.4.10   Pulse Generator

The camera provides an internal pulse generator for generating a trigger signal. You can program it to generate a discrete sequence or a continuous trail of pulse signals.

Table 24: Pulse Generator parameters

Parameter Name	Type	Value		Access	Description
PulseGenGranularity	Enumeration	**String** "x1uS" "x10uS" "x100uS" "x1000uS"	**Num.** 0 1 2 3	RW	Sets the multiplication factors of the Pulse Generator where x1 = 1µS, x10=10 µS, etc.
PulseGenWidth	Integer			RW	Sets pulse width of Pulse Generator in microseconds.
PulseGenPeriod	Integer			RW	Sets pulse period of the Pulse Generator in microseconds.
PulseGenNumPulses	Integer	Min: 1 Max: 65535		RW	Sets number of pulses to be generated by Pulse Generator.
PulseGenMode	Enumeration	**String** "Continuous" "NumPulses"	**Num.** 0 1	RW	Sets mode of Pulse Generator.
PulseGenEnable	Boolean			RW	Enables Pulse Generator.

3.4.11 Canon Lens Control

If using Canon lens control, the following parameters provide options for controlling the lens or checking its status.

Table 25: Lens Status parameters

Parameter Name	Type	Value	Access	Description
GetLensStatus	Command		WO	Requests value of Lens Status register.
LensStatus	Integer		RO	Returns status of Lens after GetLensStatus runs.

3.4.11.1 Controller Settings

Table 26: Controller Settings

Parameter Name	Type	Value		Access	Description
InitLens	Command			WO	Initializes Canon Lens if one is mounted to the camera.
StopLens	Command			WO	Removes the power from the Iris drive. Run InitLens command to resume the lens control.
LensControllerStatus	Enumeration	**String** "InitLens_Failed" "InitLens_Done"	**Num.** 0 1	RO	Shows status of Canon Lens initialization.
IrisRangeCheck	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Enables internal checkout of Iris Position and Step.
LensPresenceCheck	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Enables or disables check of lens presence
LensClockPolarity	Enumeration	**String** "Negative" "Positive"	**Num.** 0 1	RW	Sets polarity of Lens Clock

3.4.11.2 Focus

Table 27: Focus parameters

Parameter Name	Type	Value	Access	Description
NearFull	Command		WO	Drives focus to fully Near position.
FarFull	Command		WO	Drives focus to fully Far position.
NearStep	Command		WO	Drives focus toward Near focus based on amount defined in FocusStepValue feature.
FocusStepValue	Integer	Min: 1 Max: 255	RW	Sets focus step to be moved with NearStep and FarStep commands.
FarStep	Command		WO	Drives focus toward Far focus based on amount defined in FocusStepValue feature.
FocusStop	Command		WO	Stops focus movement immediately.
FocusEncoderStatus	Integer		RO	Returns current focus encoder value after GetFocusEncoderStatus command issued.
ResetFocusEncoder	Command		WO	Resets Focus encoder.

3.4.11.3 Iris

Table 28: Iris parameters

Parameter Name	Type	Value	Access	Description
CurrentFNumber	Float		RO	Returns the current f-number value of the lens iris. Value of 0.0 signals unknown iris position.
CloseIrisFull	Command		WO	Closes iris to fully closed position
OpenIrisFull	Command		WO	Opens iris to fully opened position
CloseIrisStep	Command		WO	Closes iris by amount defined in the IrisStepValue feature
OpenIrisStep	Command		WO	Opens iris by amount defined in the IrisStepValue feature
IrisStepValue	Integer	Min: 1 Max: 127	RW	Sets iris step to move with OpenStep and CloseStep commands
GetIrisRange	Command		WO	Sends Get Iris Range command to the camera.
IrisMin	Integer		RO	Returns the minimum iris limit.
IrisMax	Integer		RO	Returns the maximum iris limit.
IrisRange	Integer		RO	Displays limit values of iris after GetIrisRange command is issued.

3.4.12 Transport Layer Control

The Transport Layer control provides a variety of configuration settings and read-only information for configuring communications between the camera with the GigE Vision interface.

Table 29: Transport Layer Control parameters

Parameter Name	Type	Value	Access	Description
PayloadSize	Integer		RO	Provides the number of bytes transferred for each image on the stream channel, including any end-of-line, end-of-frame statistics or other stamp data
ShortReachModeControl	Boolean		RW	Enables the Short Reach power saving mode. Camera power cycle is required to make the change take effect
ShortReachModeStatus	Boolean		RO	Displays the Short Reach mode status
EeeModeControl	Boolean		RW	Enables the Energy Efficient Ethernet (EEE) power saving mode. Camera power cycle is required to make the change take effect
EeeModeStatus	Boolean		RO	Displays Energy Efficient Ethernet (EEE) power saving mode status

3.4.12.1 GigE Vision

Table 30: GigE Vision parameters

Parameter Name	Type	Value	Access	Description
GevMACAddress	Integer		RO	Stores MAC address of network interface.
GevCurrentIPConfigurationLLA	Boolean		RW	Indicates if Link Local Address IP configuration scheme is activated on network interface.
GevCurrentIPConfigurationDHCP	Boolean		RW	Indicates if DHCP IP configuration scheme is activated on network interface.
GevCurrentIPConfigurationPersistentIP	Boolean		RW	Indicates if PersistentIP configuration scheme is activated on network interface.
GevCurrentIPAddress	Integer		RO	Reports IP address of network interface after configuring it.
GevCurrentSubnetMask	Integer		RO	Provides subnet mask of network interface.

Table 30: GigE Vision parameters (continued)

Parameter Name	Type	Value			Access	Description
GevCurrentDefaultGateway	Integer				RO	Indicates default gateway IP address to use on network interface.
GevPersistentIPAddress	Integer				RW	Indicates Persistent IP address of network interface.
GevPersistentSubnetMask	Integer				RW	Indicates Persistent subnet mask associated with Persistent IP address on network interface.
GevPersistentDefaultGateway	Integer				RW	Indicates persistent default gateway for network interface.
GevLinkSpeed	Integer				RO	Returns the speed of transmission in Mbps as negotiated by the network interface.
GevFirstURL	StringReg				RO	Stores the first URL to the XML device description file
GevSecondURL	StringReg				RO	Stores the second URL to the XML device description file
GevCCP	Enumeration	**String** "OpenAccess" "ExclusiveAccess" "ControlAccess"		**Num.** 0 1 2	RW	Use to grant privilege to an application.
GevPrimaryApplicationSocket	Integer				RO	Indicates UDP source port of primary application.
GevPrimaryApplicationIPAddress	Integer				RO	Indicates address of primary application.
GevMCPHostPort	Integer				RW	Controls port to which the device must send messages. Setting this value to 0 closes the message channel.
GevMCDA	Integer				RW	Controls destination IP address for the message channel.
GevMCTT	Integer				RW	Provides message channel transmission timeout value in milliseconds.

Table 30: GigE Vision parameters (continued)

Parameter Name	Type	Value	Access	Description
GevMCRC	Integer		RW	Controls number of retransmissions allowed when a message channel message times out.
GevMCSP	Integer		RO	Indicates source port for the message channel.
GevSCCFGUnconditionalStreaming	Boolean		RW	Enables camera to continue streaming for this stream channel if its control channel is closed or regardless of the reception of any ICMP messages (such as destination unreachable messages).
GevSCPHostPort	Integer		RW	Indicates the port to which the device must send data stream.
GevSCPSFireTestPacket	Boolean		RW	When this bit is set, the device will fire one test packet.
GevSCPSDoNotFragment	Integer		RW	This bit is copied into the "do not fragment" bit of IP header of each stream packet.
GevSCPD	Integer		RW	Indicates the delay (in timestamp counter unit) to insert between each packet for this stream channel.
GevSCDA	Integer		RW	Indicates destination IP address for this stream channel.
GevSCPSPacketSize	Integer	Min: 72 Max: 9 KB	RW	The stream packet size to send on this channel, except for data leader and data trailer; and the last data packet which might be of smaller size (since packet size is not necessarily a multiple of block size for stream channel).
GevHeartbeatTimeout	Integer	Min: 500 Max: 4294967295	RW	Indicates current heartbeat timeout in milliseconds.

Table 30: GigE Vision parameters (continued)

Parameter Name	Type	Value	Access	Description
GevTimestampTickFrequency	Integer		RO	64-bit feature indicates the number of timestamp ticks during 1 second.
GevTimestampControlLatch	Command		WO	Latch current timestamp counter into "Timestamp value" register.
GevTimestampControlReset	Command		WO	Resets timestamp 64-bit counter to 0.
GevTimestampValue	Integer		RO	Reports latched 64-bit value of the timestamp counter.

3.4.13 User Set Control

User Set Control allows you to save custom settings and reload them into the camera as needed.

Table 31: User Set Control parameters

Parameter Name	Type	Value		Access	Description
UserSetSelector	Enumeration	**String** "Default" "UserSet0" "UserSet1"	**Num.** 0 1 2	RW	Selects User Set to load or save. Default is defined by the Factory.
UserSetLoad	Command			WO	Loads User Set specified by 'UserSetSelector' from non-volatile memory into camera and makes it active.
UserSetSave	Command			WO	Saves User Set specified by 'UserSetSelector' to non-volatile memory.
UserSetDefault	Enumeration	**String** "Default" "UserSet0" "UserSet1"	**Num.** 0 1 2	RW	Selects User Set to load and activate when device reset.
UserSetLastLoaded	Enumeration	**String** "Default" "UserSet0" "UserSet1" "UserSet2" "UserSet3"	**Num.** 0 1 2 3 4	RO	Returns the User Set currently loaded (from the power-up or device reset).

3.4.14 Event Control

Event Control allows you to notify a host application (IpxPlayer or a third-party application) about the events occurred (start or end of the acquisition, dropped frames, rising edge of a signal on the camera's input or output).

Table 32: Event Control parameters

Parameter Name	Type	Value		Access	Description
EventSelector[1]	Enumeration	**String** "AcquisitionStart" "AcquisitionEnd" "Stream0TransferOverflow" "MessageTransferOverflow" "IN1" "IN2" "OUT1" "OUT2"	**Num.** 0x9105 0x9106 0x9107 0x9108 0x9101 0x9102 0x9103 0x9104	RW	Selects which Event to signal to the host application
EventNotification	Enumeration	**String** "Off" "On"	**Num.** 0 1	RW	Activate or deactivate the notification to the host application of the occurrence of the selected Event.

[1]**EventSelrctor** values:

- **AcquisitionStart** – Device just started the acquisition of one or many frames.

- **AcquisitionEnd** – Device just completed the acquisition of one or many frames.

- **Stream0TransferOverflow** – Stream channel FIFO overflow.

- **MessageTransferOverflow** – Message channel FIFO overflow.

- **IN1** – The event will be generated when a Rising Edge is detected on the Hardware Input Line GP IN 1 (TRIGGER 1)

- **IN2** – The event will be generated when a Rising Edge is detected on the Hardware Input Line GP IN 2 (TRIGGER 2).

- **OUT1** – The event will be generated when a Rising Edge is detected on the Hardware Output Line GP OUT 1 (STROBE 1).

- **OUT2** – The event will be generated when a Rising Edge is detected on the Hardware Output Line GP OUT 2 (STROBE 2).

4 Software GUI

4.1 Overview

The IpxPlayer software application provides a graphical user interface (GUI) with functionality for controlling Imperx camera parameters, acquiring video, showing acquired video, and saving acquired images or video on the host computer.

The application also collects and displays statistical information on acquired images and generates a log of data transfers between the camera and the host computer.
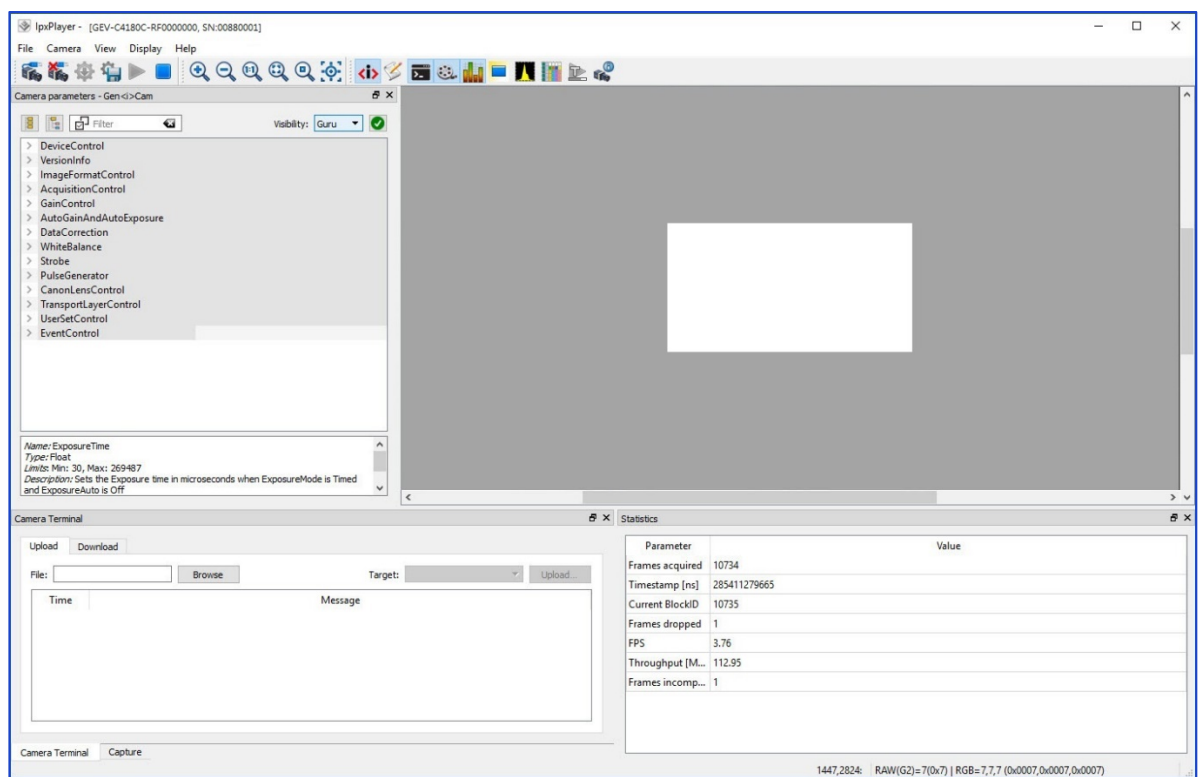
Figure 16: IpxPlayer graphical user interface.

4.1.1 Supported Operating Systems

The IpxPlayer is compatible with the following operating systems:
- Windows 7, 32-bit and 64-bit
- Windows 8, 32-bit and 64-bit
- Windows 10, 32-bit and 64-bit
- Ubuntu Linux 16.04 64bit
- Ubuntu Linux 16.04 64-bit, ARM CPU

4.1.2 Compatibility

The IpxPlayer is compatible with the Imperx GigE Vision cameras.

4.1.3 User Interface and Functionality

The IpxPlayer provides the following functionalities:
- Detects camera.
- Connects to the camera and will run multiple instances of applications.
- Controls camera parameters (gain, exposure, trigger, white balance, and so on) using the GenICam node tree GUI.
- Logs all protocol-related data (commands, images, events, and so on) transferred between the camera and host computer.
- Shows live video from the selected camera.
- Saves acquired video images or series of images to files.
- Saves and loads camera configuration files.

4.2 Installing the Software

Use the installation wizard to install the Imperx Camera SDK software supplied with your camera.

CAUTION ⚠️

If a previous version of the GUI software is installed on your computer, you must remove it before completing the installation. The installation wizard will do this for you during the installation process. Or, you can uninstall a previous version yourself.

To remove previous versions yourself:
1. Open **Control Panel** on your computer.
2. Select **Programs and Features**.
3. Select the software from the list.
4. Click **Uninstall.**

4.2.1 Installation

1. Locate the executable file (`IpxCameraSdk***.exe`) on the media that shipped with your camera.
2. Drag the file to your computer desktop. If a Security screen appears, click **OK.**
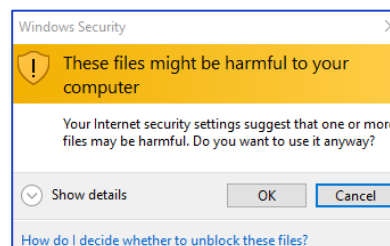
Figure 17: Security screen

3. Double click the executable file (`IpxCameraSdk***.exe`) on your desktop. The Welcome Setup screen opens. Note the recommendation to close other applications and then click **Next**.

Figure 18: Welcome Setup screen

4. When the License Agreement screen appears, read the agreement and click **I Agree**.
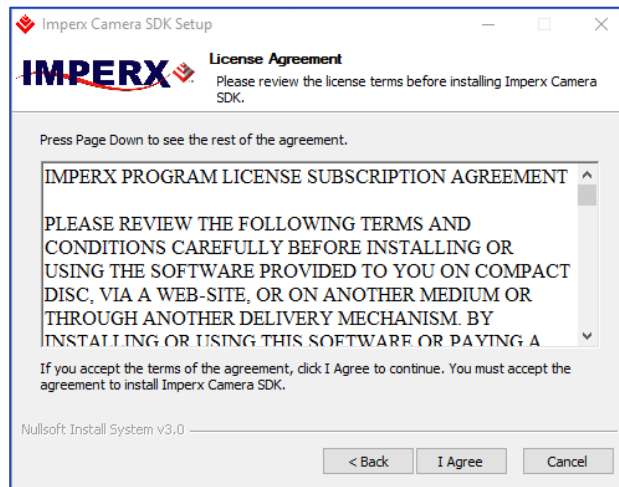
Figure 19: License Agreement screen

5. On the Choose Components screen, select all the Cheetah Camera SDK components and then click **Next**.
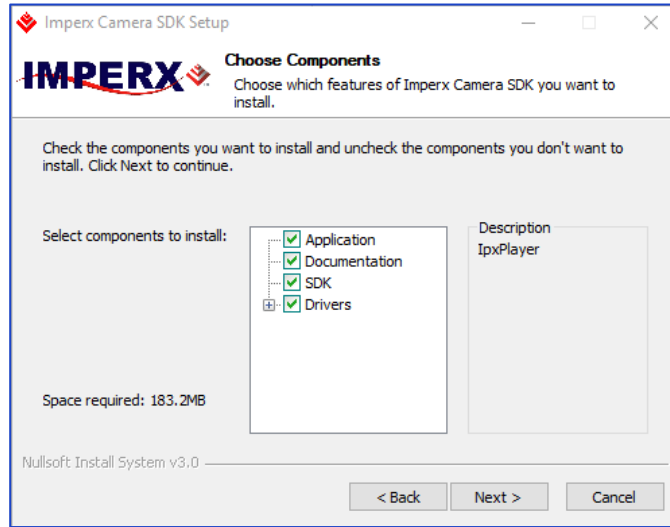
Figure 20: Choose Components screen

6. On the Choose Install Location screen, accept the default destination folder or click **Browse** and select a different location and then click **Next** and then **Install.** The installer prompts you to uninstall any existing versions of the software from your computer before continuing the installation.
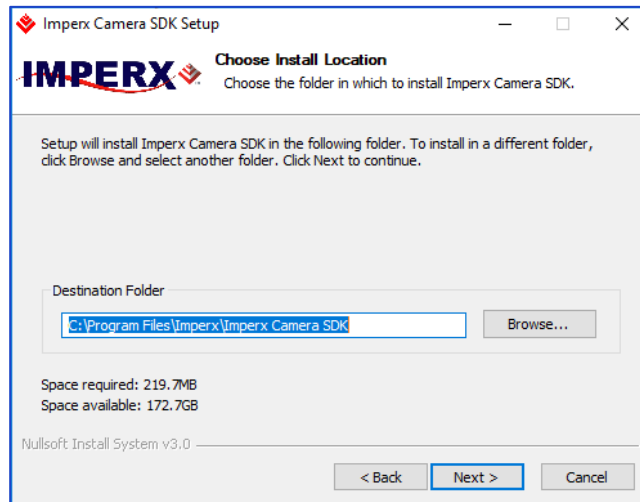
Figure 21: Choose Install Location screen
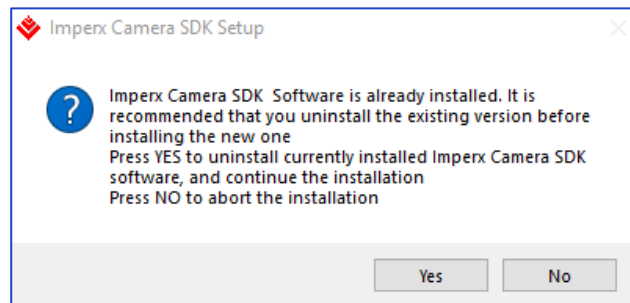
Figure 22: Uninstall any existing versions dialog

7. On the Installation Complete screen, select the check box to register your software and then click **Next**. When the Imperx website appears, complete the Subscriber Registration and click **Submit**.
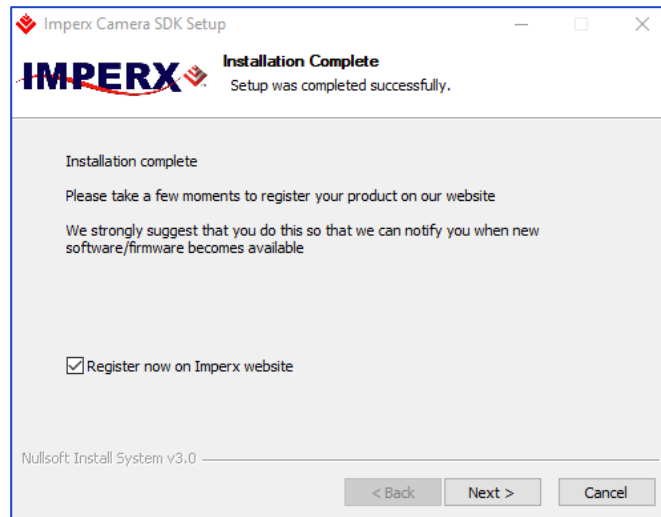
Figure 23: Installation Complete screen

8. On the Completing Imperx Camera SDK Setup screen, select Reboot now and click **Finish**. The Imperx IpxPlayer icon appears on your desktop.

Figure 24: Completing Imperx Camera SDK Setup screen
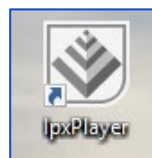
Figure 25: IpxPlayer Icon

4.3 Camera SDK

The installation process places the Imperx camera SDK files on your computer's hard drive using following structure:

<InstallationFolder> – root SDK folder (usually, on the Windows OS, it is C:\Program Files\Imperx\Imperx Camera SDK\).
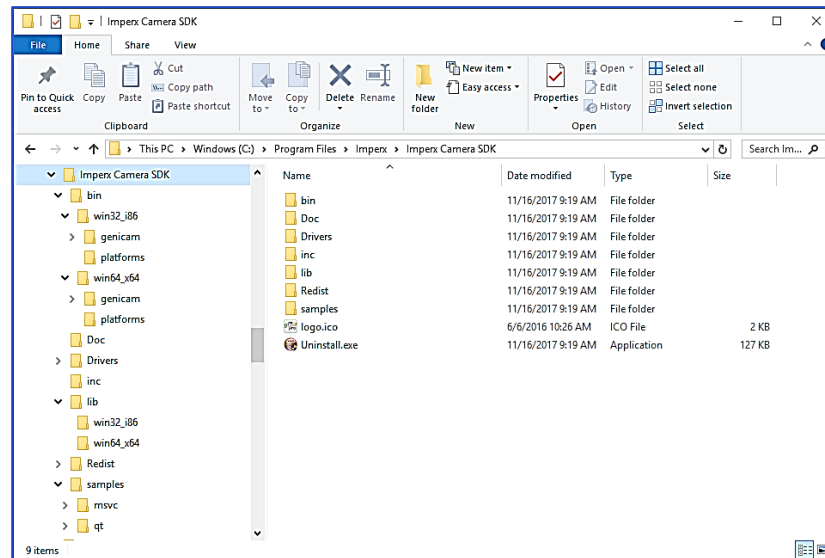
Figure 26: Imperx Camera SDK file locations on your computer

<InstallationFolder> **\bin** – contains SDK binary executable files, including SDK dynamic libraries and IpxPlayer application executable
<InstallationFolder> **\Doc** – contains SDK user manual files
<InstallationFolder> **\inc** – contains SDK C++ header files
<InstallationFolder> **\lib** – contains SDK C++ library files
<InstallationFolder> **\samples** – contains SDK samples
<InstallationFolder> **\Drivers** – contains kernel drivers for Imperx USB3 cameras

4.4 Connecting to Cameras

The installation process places the IpxPlayer application shortcut on the computer desktop. Launch the application by double clicking the shortcut. The first task is to connect to a camera.
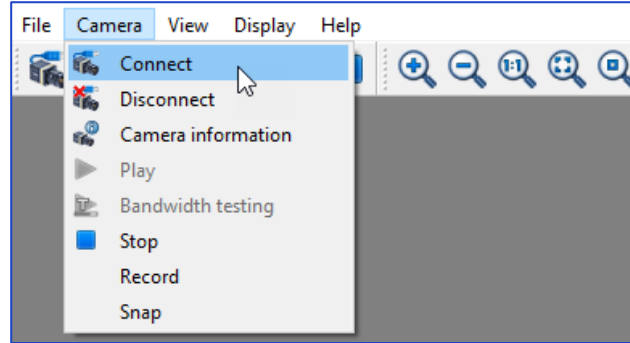
Figure 27: Connecting to a camera

To connect to a camera:

1. Locate and open the IpxPlayer from your desktop.
2. Click **Camera** menu and select **Connect** (or click the camera **icon**   ).
    The Select Camera dialog appears. The dialog lists all connected cameras. The version number refers to the installed Imperx GUI driver.
3. Select a camera listed on the dialog. Camera information appears in the Device info section of the dialog.
4. Click **OK**. If needed, click **Rescan** to update the list of cameras.
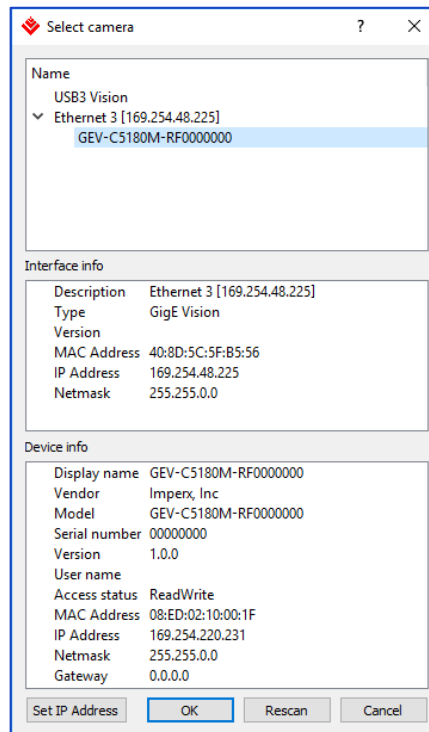
Figure 28: Select Camera dialogue

TIP ⓘ

The first time you attempt to connect to the camera, you might need to set the IP address if IP Subnet Mismatch appears highlighted in red and the OK button is <u>not</u> available (as shown in the following figure).
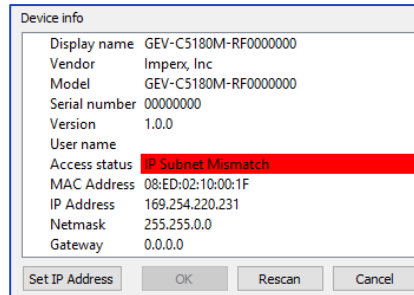
Figure 29: Access status showing IP Subnet Mismatch

To Set the IP Address:
1. Click **Set IP Address**.
2. When the Set IP Address screen appears, click **OK**.
3. On the Select Camera screen, click **OK**.

After the camera connects, click the play ▶ icon on the IpxPlayer to begin capturing and displaying images.

4.5 Using the IpxPlayer

The IpxPlayer displays and controls camera features and attributes based on an XML file stored in Flash memory inside the camera. The main window provides access to menus, shortcut icons, camera parameters, live images, capture options, a log, and camera statistics. You can customize the screen by closing, resizing, or hiding certain sections. Click **Log** at the bottom of the screen to see recent data transfers to or from the connected camera.

4.5.1 Menu Bar

The menu bar provides File, Camera, View, and Display options. Icons below the menu bar provide quick access to many of the menu bar functions. You can display an icon's function by rolling the computer cursor over it.

4.5.1.1 File Menu

Load Configuration		Opens the Open File dialog for loading a Camera Configuration file.
Save Configuration		Saves changes to an opened configuration file.
Save Configuration As		Opens the Save File dialog for saving the Camera Configuration file with a user-specified file name.
Exit		Closes the application.

4.5.1.2 Camera Menu

Connect		Opens the Connection dialog for connecting to a camera.
Disconnect		Disconnects the camera.
Camera Information		Displays Camera Information including model, version, sensor type, firmware version, XML version, and so on.
Play		Starts live video.
Bandwidth testing		Allows you to find the optimal Pixel Clock value for given interface bandwidth
Stop		Stops live video.
Record		Toggles video recording start/stop on the computer's hard drive.
Snap		Captures one image and saves it to the computer's hard drive.

4.5.1.3   View Menu Functions

GenICam Tree		Shows/hides the camera control GenICam tree panel.
Log		Shows/hides the camera control Log panel (Control, Stream, Events).
Capture		Shows/hides the Capture panel.
Statistics		Shows/hides the Statistics panel.
Inspection View		Opens a window showing a portion of the image. Use Inspection View sliders to reposition the view of your image. Drag to reposition the window.

4.5.1.4   Display Menu Functions

Zoom IN		Increases the zoom by 25 percent around the center of the image when clicked.
Zoom OUT		Decreases the zoom by 25 percent around the center of the image when clicked.
Actual Size (100%)		Sets zoom to 1:1 in the center of the image.
Fit to Window		Scales the image to fit within the window height while maintaining aspect ratio.
Spread to Window		Scales the image width to fit across the display window while maintaining the image aspect ratio.
Center Image		Moves the center of the image to the center of display window.

4.6 Saving / Loading Configurations

The File menu provides a **Save As** function for configuration changes made in the camera parameters section of the screen. Saved configurations on the host computer have a file extension of `.iccf.`

You can share these files with other users by email and other file transfer methods. You can load saved configurations into the IpxPlayer at any time.

To save a configuration:
1. Select the **File** menu.
2. Select **Save Configuration as**.
3. Navigate to location on your host computer.
4. Create a file name.
5. Click **Save**.

To load a configuration:
1. Select the **File** menu.
2. Select **Load Configuration**.
3. Navigate to the folder containing the file.
4. Click **Open**.

4.7 Camera Parameters Panel

The GenICam node tree displays the camera's available configuration parameters. Use the Visibility drop-down to select an access level of Basic, Expert, or Guru.
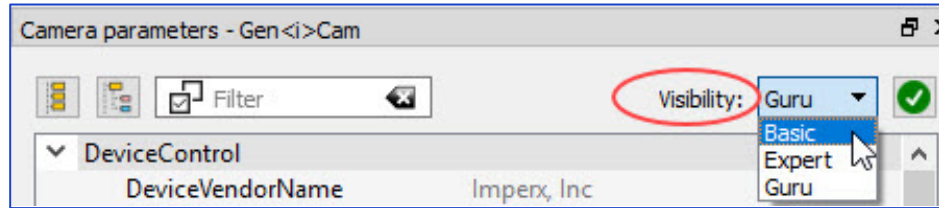
Figure 30: Select an access level

4.7.1 Device Controls

The Device Controls parameters provide information about the camera:

Figure 31: Device control parameters

DeviceVendorName	Imperx, Inc.
DeviceModelName	Full camera part number.
DeviceManufactureInfo	Imperx technical support: 561-989-0006; email: support@imperx.com.
DeviceVersion	Camera Hardware version.
Device Serial Number	Camera serial number.
DeviceUserID	User-defined camera name.
Device SFNC Version Major	The major version number of the GenICam Standard Features Naming Convention.
Device SFNC Version Minor	The minor version number of the GenICam Standard Features Naming Convention.

Device SFNC Version Sub Minor	The sub major version number of the GenICam Standard Features Naming Convention.
DeviceReset	Resets the entire camera, including communications.
CameraHeadReset	Resets only the image sensor to default.
Current Termperature	Returns the current camera temperature.
CurrentTemperatureFpga	Returns current FPGA temperature (10 G cameras only)
CurrentTemperaturePhy	Returns current PHY temperature (10G cameras only)
FanControl	Controls the camera fan (10G cameras only)

4.7.2 Version Info Controls

The camera contains non-volatile memory that stores manufacturing related information. The factory programs this information during the manufacturing process.

Figure 32: Version info parameters

SensorType	Returns the CMOS sensor type: Bayer Color, Monochrome, or Monochrome Enhanced NIR.
RgsID	The camera's register ID number.
FpgaID	Shows the field-programmable gate array (FPGA) ID (0=EP4C25, 1=EP4C40, 3=5CEFA4).
EpcsID	Shows the EPCS ID (0=EPCS16, 1=EPCS64, 2=EPCS128).
FirmwareImage	The Firmware Image ID (F=Factory or A=Application).
CameraHeadFirmwareVersion	The Firmware version number.
CameraHeadFirmwareBuild	The Firmware build number.
CustomerID	The Customer ID for custom firmware (0=Imperx standard firmware).
FamilyID	The Family ID.
XmlVersion	The version of the XML file.
GevFirmwareSwVersion	Displays the camera's firmware software version.

GevFirmwareHwVersion   Displays the camera's firmware hardware version.

4.7.3 Image Format Controls

Provides information on the camera base resolution and output resolution.

Image Format Control	
SensorWidth	5120
SensorHeight	5120
WidthMax	5120
HeightMax	5120
Width	5120
Height	5120
OffsetX	0
OffsetY	0
PixelFormat	Mono8
PixelSize	Bpp8
Pixel Color Filter	None
AveragingMode	Off
SubsamplingMode	Off
PixelClockInfo	138
Test Pattern	Off

Figure 33: Image format control parameters

SensorWidth	Horizontal resolution of the image sensor in pixels.
SensorHeight	Vertical resolution of the image sensor in pixels.
WidthMax	Maximum width of the image in pixels calculated after horizontal binning, decimation, or any other functions change horizontal dimension of image.
HeightMax	Maximum height of image in pixels calculated after vertical binning, decimation, or any other functions change vertical dimension of image.
Width	Allows you to create an AOI: sets the output image width in number of pixels (multiples of 8).
Height	Allows you to create an AOI: sets the output image height in number of lines (multiples of 2).
OffsetX	AOI Offset in horizontal dimension: Enter the number of pixels to offset the image output from the left edge of the image. The number must be a multiple of 8.
OffsetY	AOI Offset in the vertical dimension: Enter the number of pixels to offset the image output from the top of the image.
PixelFormat	Options are Mono8 and Mono10, representing the number of bits of memory associated with each pixel.
PixelSize	Number of bits per pixel in memory.
Pixel Color Filter	Defines the color filter pattern, if any.

AveragingMode	Uses the average of several adjacent pixels in either horizontal, vertical, or both directions to reduce image resolution. You cannot apply averaging and subsampling simultaneously.
SubsamplingMode	Sets the Subsampling decimation with a "skip one, keep one" algorithm in either horizontal, vertical, or both directions.
PixelClockInfo	Indicates the current pixel clock frequency in MHz.
TestPattern	Enables test patterns based on the following selections: GreyHorizontalRamp, GreyVerticalRamp, GreyHorizontalRampMoving, GreyVerticalRampMoving, CrossHair, and IpxGevPattern (refer to the section 5.11 Test Image Patterns).

4.7.4 Acquisition Control

Acquisition Control determines the data flow between the camera and the computer.

Figure 34: Acquisition control parameters.

AcquisitionMode	Supports three modes of acquiring images: • Continuous: acquires images continuously. • SingleFrame: acquires one image during the acquisition period. • MultiFrame: acquires a specified number of images during the acquisition period.
AcquisitionStart	Starts the acquisition of the device.
AcquisitionStop	Stops the acquisition of the device at the end of the current frame.
AcquisitionAbort	Aborts acquisition immediately, but a partially transferred image will be completed. If acquisition is not in progress, command is ignored.

AcquisitionFrameCount	Lets you enter the number of frames to acquire when using the MultiFrame Acquision mode.
ExposureMode	Sets the operation mode of the exposure. Options are: Off, Triggerwidth, Timed (refer to 5.1 Exposure Control for more information).
ExposureTime	Sets the exposure time in microseconds when Exposure Mode is set to Timed. The maximum exposure time is equal to the frame period. For longer exposure times, increase the frame period using the Acquisition Frame Time feature or the Frame Rate feature.
AcquisitionFrameRateEnable	Controls the acquisition frame rate/frame time. If this mode is On, you can extend frame time beyond the free-running frame time.
AcquisitionFrameTime	Allows you to set the actual frame time in microseconds. Changes to Acquisition Frame Time affect the Acquisition Frame Rate setting.
AcquisitionFrameRate	Allows you to set the acquisition rate (in Hz with a precision of 0.01 Hz) at which the frames are captured. Changes to Acquisition Frame Rate affect the Acquisition Frame Time setting and vice versa.
ZeroROTEnable	Enables Zero Row Overhead Time (ROT) mode allowing you extend frame time beyond the free-running frame time.
PixelClock	Defines how fast the camera outputs pixel data. Decreasing the pixel clock rate allows you to match the camera output rate to the computer capture rate. Increasing the pixel clock rate increases the camera output rate.
	You should never use Pixelclock to control camera frame rate; for best image quality, you should always set Pixelclock to the maximum rate possible without dropping frames.
CurrentExposureTime	This is a read-only feature providing a real-time monitor of the camera exposure time in micoseconds.
CurrentFrameTime	This is a read-only feature providing a real-time monitor of the camera output period in micoseconds.
MinMaxExposureTime	For internal camera use.
TriggerMode	Enables or disables the triggering operation. A trigger initiates an exposure then readout sequence. Triggers received prior to completion of this sequence are ignored.
TriggerSoftware	The Start SW Trigger command instructs the camera to generate one short trigger pulse to capture and read out one frame when software trigger mode is selected under TriggerSource.
TriggerSource	Specifies the internal signal or physical input line to use as trigger source. Options are External Input Line1, External Input Line2, PulseGenerator, and Software (Software is a single frame capture using internal exposure setting). Refer to 5.5.1 Triggering Inputs for more information.
TriggerActivation	Selects the triggering edge to Rising or Falling.

TriggerDebounce	Selects the trigger signal de-bounce time. Subsequent trigger signals coming to the camera within the de-bounce time interval are ignored.
TriggerDelay	Enables specifying the delay time in microseconds between the trigger pulse and the start of exposure. The exposure and readout are not overlapped.

4.7.5 Gain Controls

These parameters define analog and digital gain controls.

Figure 35: Gain Control.

AnalogGain	Sets the Analog Gain. You can select from 1.0x (0 dB), 1.26x (2 dB), 1.87x (5.4dB) and 3.17x (10dB) gain. Always apply analog gain before digital gain.
BlackLevelAuto	When set to Continuous, this automatically adjusts the black level based on measurements of the dark reference lines at the start of each frame.
BlackLevel	Controls the analog black level as an absolute physical value when BlackLevelAuto is disabled. This represents a DC offset applied to the video signal. Values can range from -511 to +511.
DigitalGain	This feature sets the Digital Gain from 1x to 15.999.
DigitalGainRaw	Allows finer control of the Digital Gain. You can control the digital gain by 0.00097x per step from 1024 to 16383. Refer to the section 5.7.2 Digital Gain for more information.
DigitalOffset	The offset is a digital count added or subtracted from each pixel's digital value. The range is -512 to +511 counts.

4.7.6 Auto Gain and Auto Exposure

You can set the camera to automatic exposure control (AEC) to keep the same image brightness during changing light conditions. You can enable both AEC and automatic gain control (AGC) independently or together. Auto gain and auto exposure controls let you control the range of exposure times and gain values used by placing minimum and maximum limits on these parameters. When both AEC and AGC are enabled together, exposure times are varied until the maximum exposure time limit is reached, then gain is applied.

Figure 36: Auto Gain and Auto Exposure.

4.7.6.1 Control Settings

GainAuto	Enables continuous automatic gain control. After selecting Continuous, the camera constantly adjusts gain to achieve the luminance target level (AgcAecLuminanceLevel). When AGC is disabled, the gain defaults to the Digital gain set in the Gain Controls panel.
AgcGainMin	Sets the minimum digital gain (1x to 7.95x).
AgcGainMinRaw	Sets the minimum digital gain in RAW units (1024 to 8189).
AgcGainMax	Sets the maximum digital gain (7.95x to 15.9x).
AgcGainMaxRaw	Sets the maximum digital gain in RAW units (8189 to 15456).
ExposureAuto	Enables automatic exposure control. When enabled, the camera constantly adjusts the exposure to achieve the luminance target level (AgcAecLuminanceLevel). When AEC is disabled, the exposure

defaults to the Exposure settings specified in the Acquisition Control panel.

AecExposureMin	Sets the minimum exposure time value in microseconds.
AecExposureMax	Sets the maximum exposure time value in microseconds.
AgcAecLuminanceLevel	Sets the desired luminance level to be maintained during AGC or AEC or both.
AgcAecLuminanceType	Sets how the luminance target is calculated in AGC or AEC. Options are Average or Peak.
AgcAecSpeed	Sets speed AEC/AGC tracking speed. 4x is fastest, 1x is slowest.

4.7.6.2   Status Settings

AgcGainCurrentValue	Shows current status of digital gain value calculated in AGC mode.
AgcGainCurrentValueRaw	Shows current status of digital gain value calculated in AGC mode in RAW units.
AgcMinLimitReached	Shows status of whether minimum digital gain limit was reached while in AGC mode.
AgcMaxLimitReached	Shows status of whether maximum digital gain limit was reached while in AGC mode.
AecExposureCurrentValue	Shows status of exposure value in microseconds, calculated by the camera in AEC mode.
AecMinLimitReached	Shows status of whether the minimum exposure limit was reached during AEC mode.
AecMaxLimitReached	Shows status of whether the maximum exposure limit was reached during AEC mode.
CurrentAvgOrPeakLuminance	Shows the current status of average or peak luminance.
AgcAecStatus	Internal camera use.

4.7.7 Data Correction Controls

These parameters enable data correction and image improvements with Look-up tables and file corrections.

Figure 37: Data correction parameters.

LUTSelector	Lets you select a lookup table to use (either LUT1 or LUT2).
LUTEnable	Enables the selected LUT.
FFCSelector	Selects a Flat Field Correction, either FFC1 or FFC2.
FFCEnable	Enables Flat Field Correction. FFC1 has a factory preset correction and should be enabled to minimize Fixed Pattern Noise.
FixedPatternNoiseCorrection	Enables Determines Fixed Pattern Noise Correction.

DefectPixelCorrection   Provides the following three modes of correction:
- **Static**: corrects defective pixels using a factory or user-supplied table of defective pixel locations.
- **Dynamic**: corrects defective pixels on the fly (dynamically) based on a user-defined threshold.
- **Both**: applies both Static and Dynamic defective pixel correction (DPC).

DefectPixelThreshold   Sets the threshold for dynamic defective pixel correction. The sensitivity increases as the value decreases. Defective Pixel Threshold should be set with the image data output level at about 75% of maximum.

HotPixelCorrection   Provides the following modes of correction:
- **Static**: corrects hot pixels using a factory or user-supplied table of hot pixel locations.
- **Dynamic**: corrects hot pixels on the fly (dynamically) based on a user-defined threshold.
- **Both**: applies both Static and dynamic hot pixel correction.

HotPixelThreshold   Sets the threshold for dynamic hot pixel correction. The sensitivity of the correction increases as the value decreases. You should set the hot pixel threshold using the longest expected exposure time with the longest expected frame time at the maximum expected ambient temperature. The camera should be warmed up for 10 minutes prior to determining the desired threshold.

4.7.8 White Balance Controls

White balance compensates for differences in the color temperature of light sources. The IpxPlayer enables color adjustments that preserve the original color so white objects appear white (also, see 5.12 White Balance and Color Conversion).

Figure 38: White balance parameter.

BalanceWhiteAuto Selects the white balance mode with the following options: Off, Once, Auto or Manual. In Once mode, the camera determines the red, green, and blue coefficients one time and applies them to subsequent frames. In Auto mode, the camera continuously computes the red, green, and blue coefficients to achieve good color reproduction. In manual mode, you define the coefficients.

RedCoefficient This applies the white balance correction coefficients for Red used in manual mode. In manual mode, you enter the value. In Once or Auto modes, the camera returns the actual (calculated) coefficient. Coefficient values range from 0.000 (0 Hex) to +15.996 (FFF Hex) in steps of 0.004 (4096 steps).

GreenCoefficient This applies the white balance correction coefficients for Green in manual mode. In manual mode, you enter the value. In Once or Auto modes, the camera returns the actual (calculated) coefficient. Coefficient values range from 0.000 (0 Hex) to +15.996 (FFF Hex) in steps of 0.004 (4096 steps).

BlueCoefficient This applies the white balance correction coefficients for Blue in manual mode. In manual mode, you enter the value. In Once or Auto modes, the camera returns the actual (calculated) coefficient. Coefficient values range from 0.000 (0 Hex) to +15.996 (FFF Hex) in steps of 0.004 (4096 steps).

AutoTrackingSpeed The camera will automatically track the scene and adjust white balance according to five different tracking rates, x1 – x5 (x1 is slowest; x5 is fastest update rate).

4.7.9 Strobe Controls

These registers enable and control the two available strobes. Strobe signals map to one or both of the available strobe outputs.

∨	**Strobe**	
	∨ OUT1	
	OUT1Polarity	ActiveHigh
	OUT1Selector	Strobe1
	Strobe1Mode	On
	Strobe1Reference	ExposureStart
	Strobe1Width	1000
	Strobe1Delay	0
	∨ OUT2	
	OUT2Polarity	ActiveHigh
	OUT2Selector	Strobe2
	Strobe2Mode	On
	Strobe2Reference	ExposureStart
	Strobe2Width	1000
	Strobe2Delay	0

Figure 39: Strobe parameters.

The following descriptions apply the same to either Output 1 (OUT1) or Output 2 (OUT2) and to either Strobe1 or Strobe2.

OUT1Polarity / OUT2Polarity	Sets the OUT1 or OUT2 active logic level to either Active Low or Active High.
OUT1Selector / OUT2Selector	Maps the camera's internal signals — Trigger, Pulse Generator, Strobe 1 or Strobe 2 — to the respective Output.
Strobe1Mode / Strobe2Mode	Enables or disables the strobe.
Strobe1Reference / Strobe2Reference	Sets the reference for the strobe to either the start of exposure or start of image readout.
Strobe1Width / Strobe2Width	Sets the strobe pulse duration in microseconds.
Strobe1Delay / Strobe2Delay	Sets the strobe delay from the selected Reference in microseconds.

4.7.10 Pulse Generator Controls

The Pulse Generator provides a signal generator for camera sourced trigger or control signals.

PulseGenerator	
PulseGenGranularity	x1uS
PulseGenWidth	1
PulseGenPeriod	1
PulseGenNumPulses	1
PulseGenMode	Continuous
PulseGenEnable	false

Figure 40: Pulse generator parameters.

PulseGenGranularity	Sets the pulse generator main timing resolution. The x1 resolution is in microseconds. The following four granularity steps are possible: x1, x10, x100, x1000 (x1000 is equal to 1 ms timing resolution).
PulseGenWidth	Sets the value of the pulse width in microseconds.
PulseGenPeriod	Sets the value of the pulse period in microseconds.
PulseGenNumPulses	Sets the number of pulses generated by the Pulse Generator.
PulseGenMode	Sets the Pulse Generator to generate either a continuous sequence (Continuous) or a discrete number of pulses (NumPulses).
PulseGenEnable	Enables the pulse generator.

4.7.11 Canon Lens Control

If using Canon lens control, the following parameters provide options for controlling the lens or checking its status.

CanonLensControl	
ControllerSettings	
Focus	
Iris	
GetLensStatus	Execute
LensStatus	0

Figure 41: Canon lens control general parameters

GetLensStatus	Request the value of the LensStatus register.
LensStatus	Returns the status of the lens after the GetLensStatus runs.

4.7.11.1 Controller Settings

Figure 42: Canon lens control – Controller settings

InitLens Initializes the Canon Lens, if one is mounted to the camera, and should be applied after power up.

StopLens Removes the power from the Iris drive. Run InitLens command to resume the lens control.

LensControllerStatus Shows the status of Canon Lens initialization.

IrisRangeCheck Enables internal checkout of Iris.

LensPresenceCheck Enables/disables the check of lens presence.

LensClockPolarity Sets the polarity of the Lens Clock.

4.7.11.2 Focus Settings

Figure 43: Canon lens control – Focus settings

NearFull Drives the focus to the fully Near position.

FarFull Drives the focus to the fully Far position.

FocusStepValue Sets the focus step size for NearStep and FarStep focus. A typical step size has a value of 4.

NearStep Drives the focus toward the Near direction based on the amount defined in the FocusStepValue feature.

FarStep Drives the focus toward the Far direction based on amount defined in the FocusStepValue feature.

FocusStop Stops focus movement.

FocusEncoderStatus Shows the current focus encoder value after issuing the GetFocusEncoderStatus command.

Reset Focus Encoder Resets the Focus encoder.

4.7.11.3 Iris Settings

Figure 44: Canon lens control – Iris settings

CurrentFNumber f-number value of the lens iris. Value of 0.0 signals an unknown iris position

CloseIrisFull   Fully closes the iris.

OpenIrisFull   Fully opens the iris.

CloseIrisStep   Closes the iris based on amount entered in the IrisStepValue function.

OpenIrisStep   Opens the iris by the amount defined in the IrisStepValue feature.

IrisStepValue   Sets the iris step size (between 1 and 127) when using the OpenStep and Close Step commands. A typical step is 3 (one iris step = 1/3 of a main f-stop).

GetIrisRange   Determines the Iris Range. The values are read using the IrisRange Command.

IrisMin   Returns the minimum iris limit

IrisMax   Returns the maximum iris limit

IrisRange   Shows the limit values of the iris after issuing the GetIrisRange command.

4.7.12   Transport Layer Control

The Transport Layer controls the exchange of data between the camera and the host computer.

TransportLayerControl	
PayloadSize	26214400
ShortReachModeControl	True
ShortReachModeStatus	True
EeeModeControl	True
EeeModeStatus	True
GigEVision	
GevMACAddress	08:ED:02:10:02:50
GevCurrentIPConfigurationLLA	True
GevCurrentIPConfigurationDHCP	True
GevCurrentIPConfigurationPersistentIP	False
GevCurrentIPAddress	169.254.228.66
GevCurrentSubnetMask	255.255.0.0
GevCurrentDefaultGateway	0.0.0.0
GevPersistentIPAddress	0.0.0.0
GevPersistentSubnetMask	0.0.0.0
GevPersistentDefaultGateway	0.0.0.0
GevLinkSpeed	1000
GevFirstURL	LOCAL:IpxGev_CheetahPYTHON_1.8.0.zip;30210000;5bf8
GevSecondURL	
GevCCP	ExclusiveAccess
GevPrimaryApplicationSocket	49145
GevPrimaryApplicationIPAddress	169.254.76.188
GevMCPHostPort	63937
GevMCDA	169.254.76.188
GevMCTT	0
GevMCRC	0
GevMCSP	49152
GevSCCFGUnconditionalStreaming	False
GevSCPHostPort	0
GevSCPSFireTestPacket	False
GevSCPSDoNotFragment	True
GevSCPD	0
GevSCDA	0.0.0.0
GevSCPSPacketSize	8164
GevHeartbeatTimeout	3000
GevTimestampTickFrequency	100000000
GevTimestampControlLatch	Execute
GevTimestampControlReset	Execute
GevTimestampValue	0

Figure 45: Transport layer control

PayloadSize	Provides the number of bytes transferred for each image on the stream channel, including any end-of-line, end-of-frame statistics, or other stamp data.
ShortReachModeControl	Enables the Short Reach power saving mode. Camera power cycle is required to make the change take effect.
ShortReachModeStatus	Displays the Short Reach mode status.
EeeModeControl	Enables the Energy Efficient Ethernet (EEE) power saving mode. Camera power cycle is required to make the change take effect.

EeeModeStatus	Displays Energy Efficient Ethernet (EEE) power saving mode status.
GevMACAddress	Displays the MAC address of the Ethernet network interface.
GevCurrentIPConfigurationLLA	Indicates whether a Link Local Address IP configuration scheme is activated on the network interface.
GevCurrentIPConfigurationDHCP	Indicates whether a DHCP IP configuration scheme is activated on the network interface.
GevCurrentIPConfigurationPersistentIP	Indicates whether a Persistent IP configuration scheme is activated on the network interface. A persistent IP address is hard-coded in non-volatile memory.
GevCurrentIPAddress	Displays the host computer's network IP Address.
GevCurrentSubnetMask	Displays the subnet mask of the interface.
GevCurrentDefaultGateway	Displays the default gateway IP address to be used on the network interface.
GevPersistentIPAddress	Indicates the Persistent IP address for the network interface. The persistent IP address is re-used by the camera on power-up when Persistent IP is enabled.
GevPersistentSubnetMask	Indicates the Persistent subnet mask associated with the Persistent IP address on the network interface.
GevPersistentDefaultGateway	Indicates the Persistent default gateway for the network interface.
GevLinkSpeed	Returns the speed of transmission in Mbps as negotiated by the network interface.
GevFirstURL	Displays the first stored URL to the XLM device description file.
GevSecondURL	Displays the second stored URL to the XLM device description file.
GevCCP	Enables granting privilege to an application. Options are open access, exclusive access, or control access.
Gev Primary Application Socket	Indicates the UDP source port of the primary application.
Gev Primary Application IP Address	Indicates the address of the primary application.
GevMCPHostPort	Controls the port to which the device must send messages. Setting this value to 0 closes the message channel.
GevMCDA	Controls the destination IP address for the message channel.
GevMCTT	Provides the message channel transmission timeout value in milliseconds.
GevMCRC	Controls the number of retransmissions allowed when a message channel message times out.

GevMCSP	Indicates the source port for the message channel.
Gev SCCFG Unconditional Streaming	Enables the camera to continue to stream for this stream channel if its control channel is closed or regardless of the reception of any ICMP messages (such as destination unreachable messages).
GevSCPHostPort	Indicates the port to which the device must send data stream.
GevSCPSFireTestPacket	When this bit is set, the device will fire one test packet.
GevSCPSDoNotFragment	This bit is copied into the "do not fragment" bit of IP header of each stream packet.
Gev SCPD	Indicates the delay (in timestamp counter unit) to insert between each packet for this stream channel.
Gev SCDA	Indicates the destination IP address for this stream channel.
GevSCPSPacketSize	The stream packet size to send on this channel, except for data leader and data trailer, and the last data packet that might be of smaller size (since packet size is not necessarily a multiple of block size for stream channel).
GevHeartbeatTimeout	Indicates the current heartbeat timeout in milliseconds.
GevTimestampTickFrequency	This 64-bit feature indicates the number of timestamp ticks during 1 second.
GevTimestampControlLatch	Latches current timestamp counter into "Timestamp value" register.
GevTimestampControlReset	Resets timestamp 64-bit counter to 0.
GevTimestampValue	Reports the latched 64-bit value of the timestamp counter.

4.7.13 User Set Controls
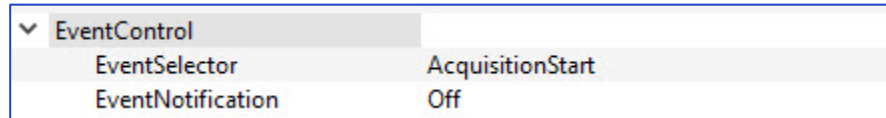
Figure 46: User set parameters

UserSetSelector	Points to User Configuration Set (Default, User Set 0, or User Set 1) to load into the camera or save into the camera's non-volatile memory. Default is the Factory Default Settings.
UserSetLoad	Loads the User Set specified by UserSetSelector into the camera workspace (volatile) and makes it active.
UserSetSave	Saves the User Configuration Set specified by UserSetSelector to the camera's non-volatile memory. The Default User Set is read only and cannot be modified by the user.

UserSetDefault	Points to User Configuration Set, which will be loaded and made active when the device is reset or after power is applied.
UserSetLastLoaded	Reports the User Set loaded from the last UserSetLoad command or device reset.

4.7.14 Event Control

Figure 47: Event Control parameters

EventSelector	Selects which Event to signal to the host application (see Table 32).
EventNotification	Activate or deactivate the notification to the host application of the occurrence of the selected Event.

4.8 Capture Panel

The Capture panel provides options for recording images and video and saving them to the computer hard drive. Click the Capture tab at the bottom of the IpxPlayer screen to access the panel.

4.8.1 Recording Acquired Images

Use the Recording section of the Capture screen to record snapped images or video images. The screen displays real-time capture information during recording.

- **Snap**. Saves the current image to the hard drive.
- **Record**. Starts or stops saving video to the hard drive.
- **Ststistics**. Shows the number of frames acquired, saved, and dropped during the current capture session. Dropped frames are frames received from the camera but not transferred due to a lack of host buffers.
- **Buffer Queue Filling**. Shows the current filling status of the capture frames queue.
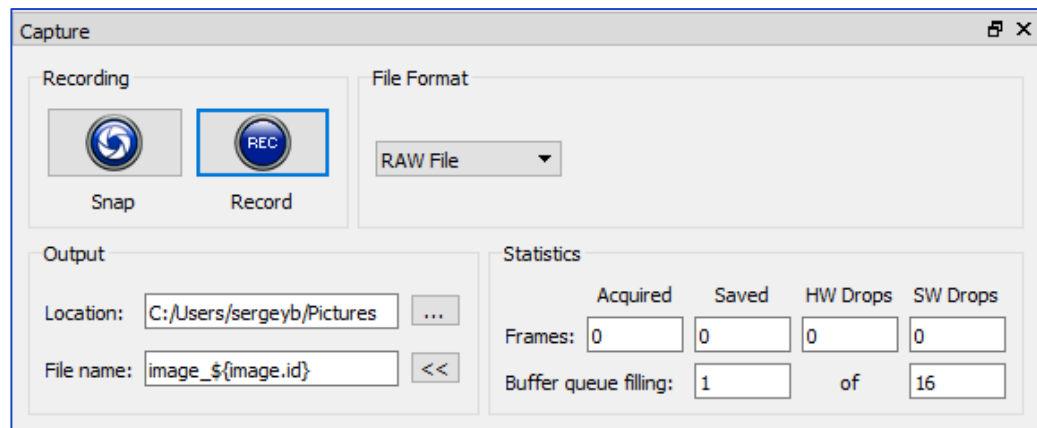
Figure 48: The Capture panel saves images and video

4.8.2 Saving Image Output

The Output section of the Capture screen lets you configure the location and format of saved images in the computer.

- **Output Folder**. You determine where to save files on the computer.
- **File Name**. Defines the file name template.
- **File Format**. Allows you to specify the output file format from a drop-down list.
  - RAW File. This is an unprocessed file format.
  - BMP Image. (8 bpp BMP for grayscale, 24 bpp for Color images)
  - JPG Image. You can adjust the image quality. Default is 85%.
  - TIFF Image. Normalized option affects pixel intensity values.
  - AVI Movie. Options are – you can set the frames per second or get the current frames per second from the camera.

4.9 Log Panel

The Log panel shows data transfers to or from the connected camera. Log information provides a numeric identifier assigned by the application, the transfer time, the control channel, and the message. Click the Log tab at the bottom of the IpxPlayer screen to access the panel.
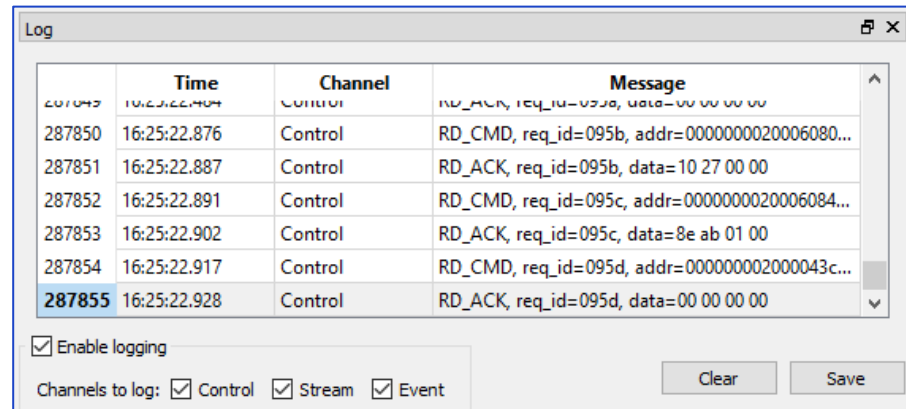
Figure 49: The Log panel records data transfers

4.9.1 Channels to Log
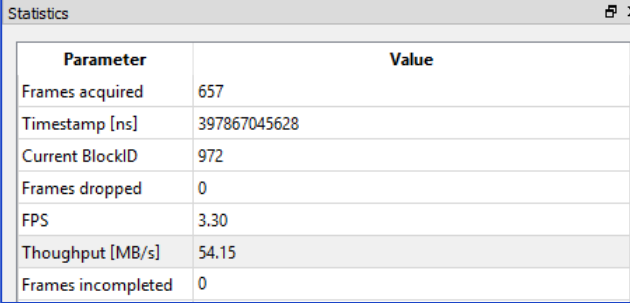
The Enable Logging check box initiates logging. You can save current log data to a TXT file (.txt) with space-separated fields.

You must select a channel to log. Channels are device channels linked to an appropriate camera interface. The following options are available:

- **Control Channel**. This is a data interface linked to the camera's Device Control Channel. The Control Channel is dedicated to camera parameters control. It sends and receives the data displayed on the Camera Parameters panel. The Control Channel is bi-directional, enabling data transfers from the host computer to the camera or from the camera to the host computer.
- **Stream Channel**. This links to the camera's Device Stream Channel. The Stream Channel is dedicated to transferring video data from the camera to the host computer.
- **Event Channel**. This links to the camera's Device Event Channel. The Event Channel notifies the host computer software about any events on the camera side. For example, the camera can notify the software that it received the trigger signal.

4.10 Statistics Panel

The Statistics panel displays camera performance and other information based on settings and parameters.

Figure 50: Statistics panel

Frames acquired   The number of frames acquired after you click the Play button.

Timestamp [ns]   The current value of the timestamp in the acquired image in nanoseconds.

Current Block ID   The current value of the block ID in the acquired image.

Frames dropped   The number of frames dropped by the camera (calculated from consequence block IDs).

FPS   The number of frames per second.

Throughput [MB/s]   The average throughput value of the camera interface in megabytes per second.

5 Camera Features

5.1 Exposure Control

You can select one of the exposure control modes: Off, Timed, or Trigger Width. When exposure control is **Off**, the frame readout time determines the exposure time.

However, the camera's electronic exposure control can precisely control the image exposure time by selecting the cameras internal timer. The electronic exposure control does not affect the frame rate in free-running mode and Fast Trigger mode, because the exposure and readout operations are overlapped in time.

In **Timed** mode, the camera controls the start of exposure. Use Exposure Time feature to set the exposure. The maximum exposure is equal to the frame time. For longer exposure times, increase the frame period using the Acquisition Frame Time or Acquisition Frame Rate features.

In **Trigger Width** mode, the pulse width of an external trigger signal controls the exposure. Ensure that Trigger Mode feature is enabled. Note that if TriggerActivation is RisingEdge, the exposure duration is the time the trigger stays High. If TriggerActivation is FallingEdge, the exposure duration is the time the trigger stays Low.

5.1.1 Internal Exposure Control - Electronic Shutter

In global shutter mode, all pixels in the array reset at the same time, then collect signal during the exposure time, and finally transfer the image to a non-photosensitive region within each pixel. After transferring the image to the non-photosensitive region, the readout of the array begins. In this way, all pixels capture the image during the same period, which reduces any image artifacts due to motion within the scene. The maximum exposure is frame-time dependent, and the minimum exposure is approximately 50 microseconds. The camera normally overlaps the exposure and read-out times as shown in the following figure.
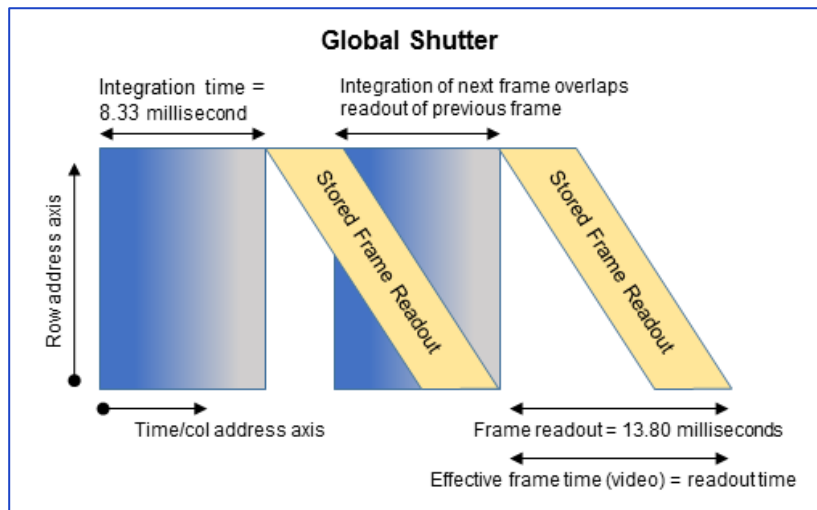
Figure 51: Global Shutter with 8.33 ms exposure time

5.1.2 External Exposure Control

The camera can use an external pulse to control exposure. The pulse duration determines the exposure. In global shutter mode, the minimum exposure time is about 50 microseconds. Refer to 5.5 Camera Triggering and 5.10 Input / Output Control.

5.2 Frame Time Control

5.2.1 Internal Line and Frame Time Control

The camera speed (frame rate) depends on the CMOS read-out time (frame time). Frame time is the time it takes to read out all of the pixels on the CMOS imager. The following formula (1.1) calculates the frame rate:

$$\text{Frame rate [fps]} = 1 / \text{read-out time [sec]} \qquad (1.1)$$

5.2.1.1   Pixel Clock Line Rate Control

You can use the Pixel Clock Rate function to program the camera's speed to match the GigE image capture rate. Decreasing the pixel clock rate decreases a camera output rate.

You should never use the Pixel Clock to set the camera frame rate; for best image quality, you should always set the Pixel Clock to the maximum rate possible without the GigE interface missing or skipping data. This minimizes the dark current generated within the pixel and the dark current noise.

5.2.1.2   Programmable Frame Time Control

After adjusting the Pixel Clock to match the GigE interface maximum bandwidth, you can increase the frame time using the Programmable Frame Time or Frame Rate Control feature. When increasing frame time, the sensor reads out the frame at the maximum possible rate, then idles, and inserts a vertical blanking period at the end of the frame readout to provide the desired frame rate.

In this way, you can match the camera's frame rate to application requirements. You can reduce the frame time to about one second with a precision of one microsecond with corresponding exposure times up to one second. Using the Frame Time control in the programming GUI, you can achieve exposure times exceeding the time needed to read out the image sensor.

TIP (i)

If the frame time is greater than 50 ms, keep camera vibration to a minimum, otherwise a motion induced smear will appear on the image.

5.2.2 Zero Row-Overhead Time (ROT) Control

A Row-Overhead time (ROT) control is provided and the control is called: "Zero-Row Overhead Time" (Zero-ROT). Disabling Zero-ROT adds one microsecond of blanking time at the end of each row to further reduce the line rate. Zero-ROT should only be used as a last resort and only when decreasing Pixel Clock line rate control to the minimum value still results in frame grabber overruns. Zero-ROT must always be disabled and is not supported when pixel averaging is used.

5.2.3 Camera Output Control

Cheetah camera supports the GigE Vision (GEV) and 10 GigE Vision (10G) interfaces. The interface transfers data at 1.0 Gbps (or 10 Gbps). Use the Pixel Clock control to slow down the interface transfer rate to prevent dropped frames. The following table describes tested GEV and 10G full frame rates.

Table 33: Maximum frame rates (may vary based on computer and/or network speed)

Camera	Bit Depth	Data Rate (Mbps)	Frame Rates at Full Resolution (fps max)
GigE Vision interface			
GEV-C5180	8	1000	4.3
	10	1000	2.2
	10 packed	1000	2.9
GEV-C4181	8	1000	6.2
	10	1000	3.3
	10 packed	1000	4.4
GEV-C4180	8	1000	8.3
	10	1000	4.5
	10 packed	1000	6.0
10 GigE Vision interface			
10G-C5180	8	10000	40.6
	10	10000	21.5
	10 packed	10000	22.9
10G-C4181	8	10000	60.5
	10	10000	28.3
	10 packed	10000	36
10G-C4180	8	10000	80.4
	10	10000	44.8
	10 packed	10000	48

NOTE ✳

Frame rates depend on camera configurations and several factors external to the camera, such as the host computer performance (host controller card speed, PCIe interface bandwidth, motherboard, etc.), cable length, and cable type (see 5.3.3 Factors Impacting Frame Rate).

5.3 Area of Interest

5.3.1 Overview

For some applications, you might not need the entire image, but only a portion of it. To accommodate this requirement, Cheetah cameras provide one Area of Interest (AOI), also known as a Region of Interest (ROI). An AOI is a unique field of view created within the camera's maximum field of view. This limitation is based on the structure of the camera's sensor. When creating an AOI, you will specify its horizontal and vertical dimensions and location (using horizontal and vertical offsets).

5.3.2 Creating an AOI Window

Set the starting and ending point for each AOI independently in the horizontal direction (Horizontal Window) and the vertical direction (Vertical Window) by setting the window (H & V) offset and (H & V) size, as shown in the following figure. The minimum window size is 320 (H) x 2 (V) pixel/line, and the horizontal dimension is limited to multiples of 8 pixels. In normal operation, the AOI defines the number of columns and rows output. However, you can apply subsampling and averaging modes to the AOI to reduce the number of rows and columns output even further. Using the AOI function and subsampling/averaging modes effectively increases the camera maximum frame rate. The maximum horizontal window size (H) and the vertical window size (V) are determined by the camera's image full resolution, for example, 5120 x 5120 for the C5180 camera.
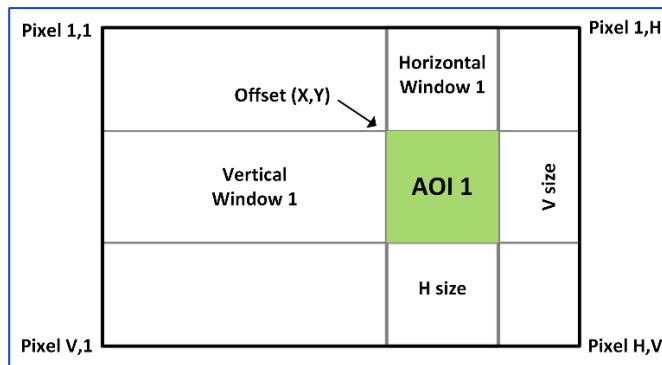
Figure 52: Horizontal and vertical window positioning

NOTE ✳

For color version with AOI enabled, use an even number for Offset X and Offset Y to achieve proper color reconstruction and white balance.

5.3.3 Factors Impacting Frame Rate

The camera frame rate depends upon a number of variables including the number of rows and columns in the AOI, the amount of decimation within the image, and the bandwidth of the output interface.

AOI size – Camera frame rate increases by decreasing either the number of columns or number of rows read out. Changing the number of rows read out causes the largest change in frame rate.

Decimation – The camera supports both subsampling and pixel averaging to reduce the output resolution. Sub-sampling and pixel averaging increase the sensor frame rate. However, subsampling decimation offers the largest frame rate improvement by reducing the number of rows and columns read out from the image sensor. Subsampling and pixel averaging decimation provide about a 2x to 3x increase in frame rate.

Output Interface Bandwidth – The bandwidth of the output interface can impact the maximum achievable frame rate.

5.4 Subsampling

Subsampling reduces resolution while maintaining the constant field of view. Pixel averaging reduces the output resolution by averaging several pixels together.

5.4.1 Pixel Averaging

The principal objective of pixel averaging is to reduce the image resolution with better final image quality than using a subsampling function. Pixel averaging reduces the output resolution by averaging several pixels together and has the advantage of reducing aliasing and reducing noise, which increases the signal-to-noise ratio (SNR). Subsampling — as opposed to averaging — has the advantage of increasing the output frame rate by reducing the number of rows read out, but also introduces aliasing in the final image. Subsampling, however, increases the output frame rate more than pixel averaging.

You cannot apply both averaging and subsampling decimation simultaneously. The camera does not support Zero ROT when averaging is enabled. Color cameras do not support pixel averaging.

The following graphic illustrates the concept of 4:1 averaging for a monochrome image sensor. The values of pixels P1, P2, P3 and P4 are summed together and the result is divided by 4 to achieve an average of the 4 adjacent pixels.
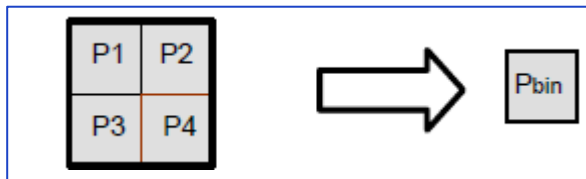
Figure 53: Monochrome pixel averaging

The averaging feature is usable on the full resolution image or within any area of interest. For example, if the area of interest is defined as quad full HD (3840 x 2160) and 4:1 averaging is selected, the output is 1080P (1920 x 1080)

5.4.2 Subsampling Decimation

Subsampling reduces the number of pixels output by reducing the output frame size while maintaining the full field of view. Selecting an area of interest (AOI) maintains the AOI field of view as shown in the following figures.

The cameras employ a "keep one pixel, skip one pixel" sequence. When enabled in both x and y, every other pixel within a line is retained and every other line within the image is retained.
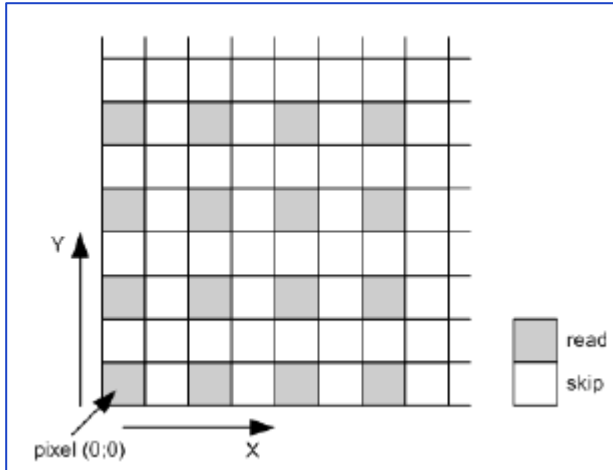
Figure 54: Monochrome subsampling
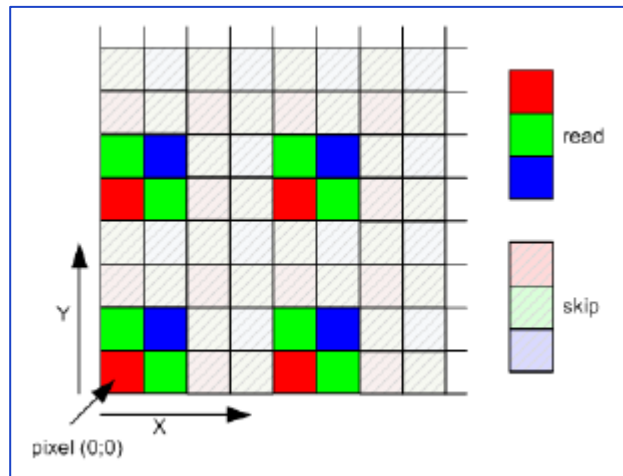
Figure 55: Color subsampling

5.5 Camera Triggering

5.5.1 Triggering Inputs

In the normal mode of operation, the camera is free running, which means the camera continually reads out the sensor. If using a trigger to initiate readout, trigger mode enables synchronizing the camera to a timing pulse.

The camera offers three input modes for triggering: external Line1 or Line2, internal (pulse generator), and software. You can select the trigger input to a corresponding camera input.

- **External** – the camera receives the trigger signal coming from the connector located on the back of the camera. Options are:

  Line 1 – hardware Input Line GP IN 1 (TRIGGER 1) is used as external source for the trigger signal.

  Line 2 – hardware Input Line GP IN 2 (TRIGGER 2) is used as external source for the trigger signal.

- **Internal** – the camera has a built-in programmable pulse generator (refer to the section 5.9 Pulse Generator). In Internal triggering mode, the camera receives the trigger signal from the internal pulse generator.

- **Software** – the camera expects a computer to send a command to the camera for generating one short trigger pulse. You can trigger the camera by clicking the GUI Software Trigger button or by sending the GenICam™ Trigger Software command. The trigger exposure is internal register controlled. Pulse duration exposure is not supported.

5.5.2 Acquisition and Exposure Control

For each trigger input, the user can set the trigger edge and de-bounce (de-glitch) time.

- **Triggering Edge** – the user can select the active triggering edge:
  - **Rising** – the rising edge will be used for triggering
  - **Falling** – the falling edge will be used for triggering
- **De-bounce** – the trigger inputs de-bounced to prevent multiple triggering from ringing triggering pulses. The user has eight choices of de-bounce interval:
  - **Off** – no de-bounce (default)
  - **10** μs, **50** μs, **100** μs, or **500** μs de-bounce interval
  - **1.0** ms, **5.0** ms, **10.0** ms de-bounce interval
- **Exposure Time** – the exposure for all frames can be set in two ways:
  - **Pulse Width** – the trigger pulse width (duration) determines the exposure subject to limitations.
  - **Internal** – the camera internal exposure register determines the exposure.

CAUTION ⚠

1. The de-bounce interval MUST be smaller than the trigger pulse duration. Adjust the interval accordingly.
2. When Triggering Pulse Width is enabled, Internal Exposure timing is not active.

5.5.3 Triggering Modes

Exposure Control

With trigger mode enabled, you can set the exposure time using either the internal exposure timer or the trigger pulse width.

In "Fast" trigger mode, the camera idles and waits for a trigger signal. Upon receiving the trigger signal, the camera starts integration for the frame, then completes the integration, and reads out the image. If the next trigger occurs prior to completion of the readout, the camera will overlap the exposure and readout (see Figure 56 and Figure 57). You can set the exposure time manually using the internal exposure register setting or the duration of the trigger pulse (Trigger Width). Upon completing the readout, the camera idles while awaiting the next trigger pulse.

When using the internal exposure timer, the camera starts the exposure after the trigger delay time. In this way, the exposures from several cameras can be synchronized to an external light source or event. The trigger delay can be set from 0 to 1 second in 1 micro-second increments.
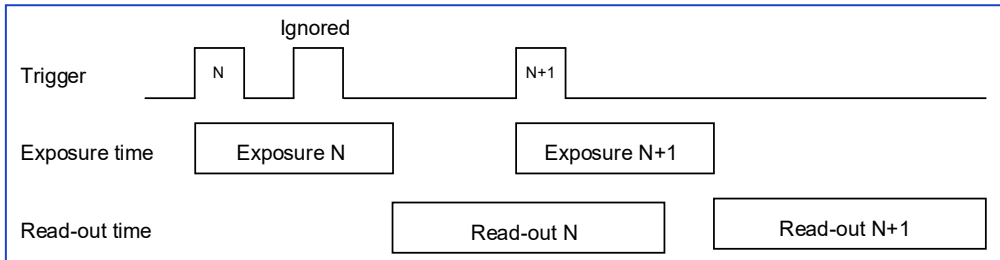
Figure 56: "Fast" Trigger Mode (Internal Exposure Control)
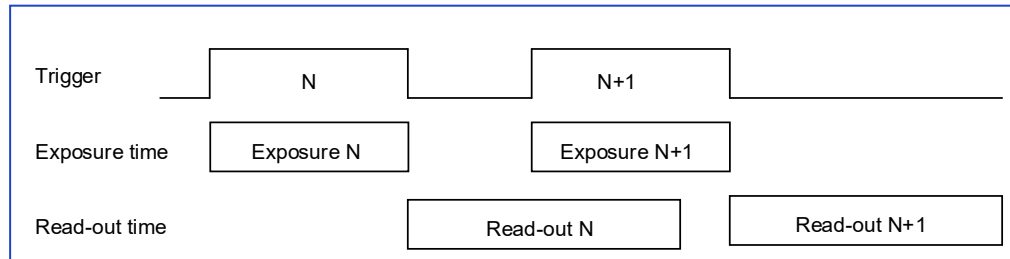
Figure 57: "Fast" Trigger Mode (Pulse Width Exposure Control)

CAUTION ⚠️

When using the internal exposure timer, if the next trigger activates prior to the completion of the previous exposure and readout time, the camera ignores it.

5.6 Strobes

The camera can provide up to two strobe pulses for synchronization with an external light source, additional cameras, or other peripheral devices. You can set each strobes pulse duration and the delay with respect to the start of the exposure time or the start of the readout time. You can set the maximum pulse duration and the maximum delay up to 1 second with 1.0 μs precision and assign the strobe pulse to either of the external outputs. The following graphic shows strobe signals positioned with respect to the start of exposure.
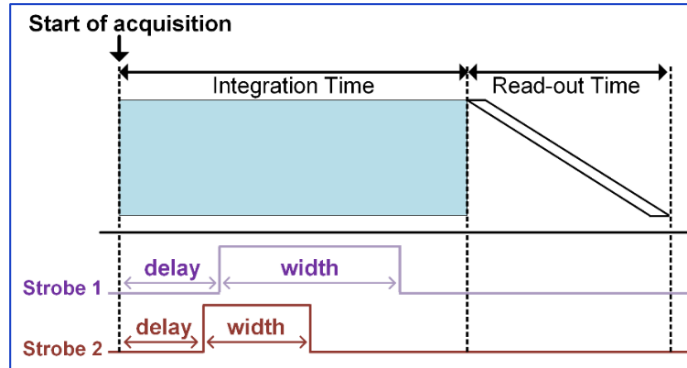
Figure 58: Strobe positioning with respect to exposure start

5.7 Video Amplifier Gain and Offset

5.7.1 Analog Gain

The cameras provide 1x (0 dB), 1.26x (2.0 dB), 1.87x (5.43 dB) and 3.17 (10.0 dB) analog gain. Always apply analog gain before applying digital gain.

5.7.2 Digital Gain

Digital gain can be varied from 1x (0dB) to 15.9 (24 dB) with a precision of ~0.00097x using the raw (fine) gain control. There are 15,360 gain steps from 1x gain to 15.9x gain. Each step increases the gain by 0.000969932x or 1/1031 (1.0x gain) from 1024 to 16384 (15.9x gain).

To determine the gain step when the gain value is known, use the following steps:
1. Subtract 1.0 from the desired gain multiplier (e.g. 2.54x gain).
2. Multiply the result by 1031.
3. Add 1024.

Or use this formula:

Gain coefficient = [(Desired gain − 1)*1031]+1024.

If the desired gain is in dB, use the following formula:
Gain coefficient = [[[anti-log$_{10}$(Desired gain(dB)/20)]-1]*1031]+1024.

EXAMPLES:

1) Desired gain is 7.9x (17.95 dB). [(7.9 – 1.0)/*1031] +1024 = 8137
Set coefficient to 8137.

2) Desired gain is 6 dB, then the code is 2050.
3) Minimum setting is 1024 corresponding to 1x gain.

Below are other examples:

Gain (dB)	Multiplier	Coefficient
0 dB	1x	1024
3 dB	1.41254x	1449
6 dB	1.99526x	2050
12 dB	3.98107x	4097

Digital Gain does not provide any improved contrast and should be used cautiously.

5.7.3 Digital Offset

Digital offset is a digital count added to or subtracted from each pixel. The range is +/- 512 counts.

5.7.4 Black Level Auto-calibration and Offset

The camera automatically adjusts black level based on measurements of the dark reference lines at the start of each frame. Imperx recommends leaving the black level auto-calibration engaged. If auto-calibration is disabled, you can set the Black Level Offset and adjust it by +/- 512 increments. Black level will vary with temperature and gain settings.

5.8 Data Output Format

5.8.1 Bit Depth

The image sensor digitization level is fixed at 10-bits, which enables 8-bit or 10-bit data format output. With 8-bit output, the camera uses the standard bit reduction process and truncates the least significant bits.

10-bit digitization
-   If the camera is set to output 10-bit data, sensor data bits map directly to D0 (LSB) to D9 (MSB).
-   If the camera is set to output 8-bit data, sensor data most significant data bits (D2 to D9) map to D0 (LSB) to D7 (MSB).

MSB			Camera Output – 10 bits						LSB
D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

MSB			Camera Output – 8 bits			LSB			
D7	D6	D5	D4	D3	D2	D1	D0	-	-
P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

Figure 59: 10-bit internal Digitization with 8 and 10-bit outputs

5.9 Pulse Generator

The camera has a built-in pulse generator allowing you to program the camera to generate a discrete sequence of pulses or a continuous sequence. You can use the pulse generator as a trigger signal or map it to one of the outputs (refer to the section 5.10 Input / Output Control for more information). You can set the discrete number of pulses from 1 to 65535 with a step of 1. You can also set the following options:

- **Granularity** – Indicates the number of clock cycles that are used for each increment of the width and the period. Four possible options are available: x1, x10, x100 and x1000.
- **Period –** Indicates the amount of time (also determined by the granularity) between consecutive pulses. Minimum value is 1; maximum is 1,048,575.
- **Width –** Specifies the amount of time (determined by the granularity) that the pulse remains at a high level before falling to a low level. Minimum value is 1, maximum is 524,287.
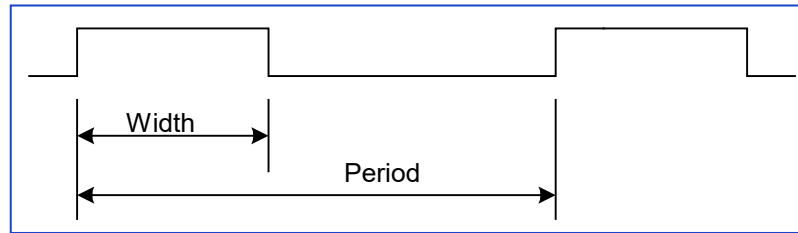
Figure 60: Internal pulse generator

5.10 Input / Output Control

5.10.1 Input / Output Mapping

The camera has two external inputs (1 TTL input and 1 opto-coupled input) and two external outputs (1 TTL output and 1 opto-coupled switch) wired to the 12-pin HIROSE connector on the back of the camera. You can map either one of the two external inputs to the Trigger input to the camera using the TriggerSource function. You can map camera outputs (OUT1 and OUT2) to Trigger, Pulse Generator, Strobe One, or Strobe Two (Table 35). For each mapped signal, select either active High or active Low. The following tables show all possible mapping options for the camera inputs and outputs:

Table 34: Cheetah camera input mapping

Input Signal	IN1	IN2
Trigger	✓	✓

Table 35: Cheetah camera output mapping

Output Signal	OUT1	OUT2
Trigger	✓	✓
Pulse Generator	✓	✓
Strobe One	✓	✓
Strobe Two	✓	✓

5.11 Test Image Patterns

5.11.1 Test Image patterns

The camera can output several test images to verify the camera's general performance and connectivity to the computer. This ensures that all the major modules in the hardware are working properly and the connection between your computer and camera is synchronized, that is, the image framing, output mode, communication rate, and so on are properly configured. Note that test image patterns do not exercise and verify the image sensor functionality.

Table 36: Test patterns

Patterns	Description
H Ramp Still	Displays a stationary horizontal ramp image.
V Ramp Still	Displays a stationary vertical ramp image.
H Ramp Move	Displays a moving horizontal ramp image.
V Ramp Move	Displays a moving vertical ramp image.
Cross-hairs	Displays cross-hair pattern in center of image over a superimposed live image (cross-hair thickness is 2 pixels).
Ipx GEV Pattern	Grey horizontal ramp moving (generated by the Ipx GEV interface).

5.12 White Balance and Color Conversion

5.12.1 White Balance Correction

The color representation in the image depends on the spectral content of the light source. Cheetah cameras have a built-in algorithm to compensate for this effect. With auto white balance correction enabled, the camera collects the data for all of the image sensor's red (R), green (G), and blue (B) pixels, analyzes it, and adjusts the color gain coefficients for each color pixel to properly proportion the colors so white objects appear white. The algorithm collects data from the entire image. You can enter your own coefficients using the manual mode.

When Auto-White Balance (AWB) Tracking mode is selected, you can select five tracking speeds from slow to fastest.

Table 37: Automatic white balance (AWB) modes

| AWB Mode	Description
Off	No white balance correction performed.
Once	Camera analyzes one image frame, calculates only one set of coefficients, and corrects all subsequent frames with this set of coefficients.
Continuous	Camera analyzes every frame, derives a set of correction coefficients for each frame, and applies them to the next frame.
Manual	Camera uses the correction coefficients you enter.

TIP ⓘ

To get the best white balance for the R, G, and B coefficients when the spectral source is constant:

1. Image a grey or white target over the camera's entire field of view using the intended lighting source.
2. Select **Once** mode for the **White Balance**. The R, G, and B coefficients appear in the RedCoefficient, GreenCoefficient, and BlueCoefficient areas respectively. The camera will now apply these coefficients to every frame captured.

5.13 Transfer Function Correction

The user defined LUT (Lookup Table) feature allows you to modify and transform the original video data into any arbitrary value. The LUT enables transforming any 12-bit value into any other 12-bit value. For the 10-bit Python sensor, the camera multiplies the 10-bit pixel data by 4 to get 12-bit pixel data for input to the 12-bit LUT. After the 12-bit LUT transforms the data, the 12-bit data is divided by 4 to get 10-bit pixel values for output to the camera interface (Figure 61). The camera supports two separate lookup tables, each consisting of 4096 entries, with each entry being 12 bits wide. Both LUTs are factory programmed with a standard Gamma 0.45 available for modifications. You can generate and upload a custom LUT using the Imperx Upload Utility application.
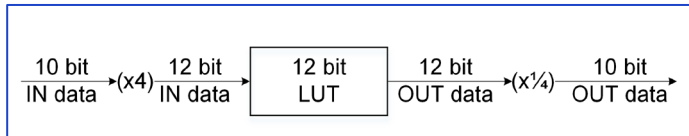
Figure 61: Look up table

5.13.1   Standard Gamma Correction

The image generated by the camera is normally viewed on a monitor and does not have a linear transfer function, that is, the display brightness is not linearly proportional to the scene brightness (as captured by the camera). As the object brightness is lowered, the brightness of the display correspondingly lowers. At a certain brightness level, the scene brightness decrease does not lead to a corresponding display brightness decrease. The same is valid if the brightness is increased. This is because the display has a nonlinear transfer function and a brightness dynamic range much lower than the camera.

The camera has a built-in transfer function to compensate for this non-linearity called gamma correction. Gamma correction can also help to map the camera's wider dynamic range to the limited dynamic range of the display. If enabled, the video signal is transformed by a non-linear function close to the square root function (0.45 power) (see the following formula). In the digital domain, this is a nonlinear conversion from 12-bit to 12-bit

$$\text{Output signal [V]} = (\text{input signal [V]})^{0.45} \qquad (2.4)$$
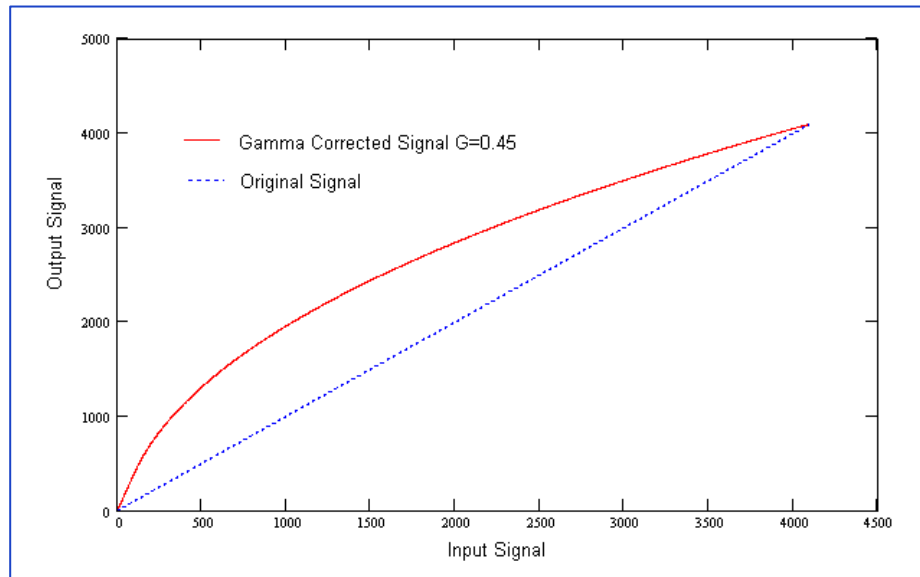
Figure 62: Gamma corrected video signal

5.13.2   User Defined LUT

You can define any 12-bit to 12-bit transformation as a user Look-up Table (LUT) and upload it to the camera using the configuration utility software called the Imperx Upload Utility. You can specify a transfer function to match the camera's dynamic range to the scene's dynamic range. There are no limitations to the profile of the function. The LUT must include all possible input values (0 to 4095).
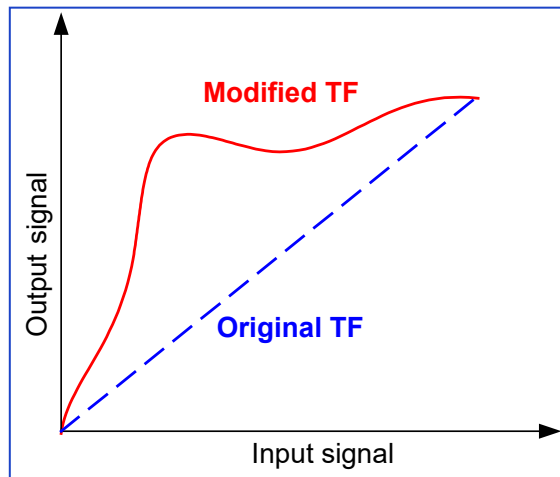
Figure 63: Custom LUT

5.14 Defective Pixel Correction

A CMOS imager is composed of a two-dimensional array of light sensitive pixels. In general, the majority of the pixels have similar sensitivity. However, some pixels deviate from the average pixel sensitivity and are called "defective pixels." In most cases, defective pixels are responsive to light, and rarely is a pixel totally dark or totally bright. There are two major types of pixel defects: defective and hot.

Defective – These are pixels whose sensitivity deviates due to fluctuations in the CMOS manufacturing process, materials, and contamination (dust) deposited on the array during the chip assembly process. At the factory, final testing identifies and corrects up to 1024 defective pixels using defective pixel correction. Two types of defective pixels are possible:

- **Dark** - a pixel whose sensitivity is lower than the sensitivity of the adjacent pixels. In some cases, this pixel will have no response (completely dark).
- **Bright** - a pixel whose sensitivity is higher than the sensitivity of the adjacent pixels. In some cases, this pixel will have full response (completely bright).

Hot – These are pixels that in normal camera operation behave as normal pixels (sensitivity equal to one of the adjacent pixels), but during long exposures or at elevated temperatures, the pixel becomes much, much brighter than the average of the pixels surrounding it. In some cases, the pixel becomes so bright that the pixel saturates. Final camera testing at the factory identifies and automatically corrects up to 8192 hot pixels.

5.14.1 Static Pixel Correction

Static pixel correction works with predetermined and preloaded defective and hot pixel maps. During factory final testing, engineers identify the coordinates of defective and hot pixels. They create a map file listing the coordinates (row and column) of every defective and hot pixel. The camera corrects the defective and hot pixels found at these coordinates. These files, called the Defect Pixel Map (DPM) and Hot Pixel Map (HPM), are loaded by the factory into the camera's non-volatile memory.

Since your operating environment or imaging requirements might be different from the Imperx test conditions, you can create and upload your own DPM and HPM files (see chapter 8 Creating DPC / HPC Tables). When using Static Pixel Correction, the camera corrects the defective pixel according to the pixel's coordinates provided in the DPM; when using Hot Pixel Correction, the camera corrects the Hot pixels according to the coordinates provided in the HPM.

5.14.2 Dynamic Pixel Correction

Dynamic pixel correction provides another method of correcting defective and hot pixels. Dynamic pixel correction works without preloaded pixel maps. Instead, you set a dynamic threshold value between zero and 4096 (12-bit) counts. The threshold determines how much a pixel's luminance can deviate from neighboring pixels (either brighter or darker) before the camera recognizes the pixel as defective (or hot) and applies correction. If the deviation between bright or dark is too great, the camera corrects the pixel.

Dynamic and Static corrections can be enabled independently or simultaneously.

5.15 Flat Field and Noise Correction

The camera provides a factory installed flat field correction (FFC) algorithm to correct some of the image sensor's non-uniformity and employs an algorithm to correct the fixed pattern noise (FPN) within the image sensor. You can upload your own FFC table. While not recommended, you can disable both the FFC and FPN corrections.

5.16 Camera Interface

5.16.1 Temperature Monitor

The camera has a built-in temperature sensor that monitors the internal camera temperature at the hottest spot in the camera. The internal camera temperature is displayed on the IpxPlayer screen, and you can query it at any time with the 'Current Temperature' command (refer to the Table 12: Device Control parameters).

5.16.2 Exposure Time Monitor

The camera has a built-in exposure time monitor. In any mode of operation (normal, AOI, and so on) you can query the camera for the current exposure time by issuing a 'CurrentExposuretime' command. The camera will return the current camera integration time in units of microseconds (refer to the Table 15: Acquisition Control parameters).

5.16.3 Frame Time Monitor

The camera has a built-in frame rate monitor. In any mode of operation (normal, AOI, and so on), you can query the camera for the current frame time by issuing a 'CurrentFrameTime' command (refer to Acquisition Control). The camera will return the current camera frame time in units of microseconds (refer to the Table 15: Acquisition Control parameters).

5.16.4 Current image size

The camera image size can change based on a camera feature selected. In any mode of operation (normal, AOI, and so on), you can query the camera for the current image size by issuing a command (refer to commands 'Widthmax' and Heightmax' in the Table 14: Image Format parameters). The camera will return current camera image size in (pixels x lines).

5.16.5   Auto Gain and Auto Exposure Control (AGC/AEC)

Automatic Gain Control (AGC) and Automatic Exposure Control (AEC) keep the same image brightness despite changing light conditions. You can enable both AEC and AGC simultaneously. In these modes, you set the image brightness (luminance) target level in counts, and the camera adjusts the exposure and/or gain accordingly. The target luminance can be the average luminance or peak brightness within the entire image.

If AEC and AGC are both enabled, the camera first adjusts the exposure within the preset minimum/maximum limits you set. If the maximum exposure limit is reached, the camera indicates the limit has been reached and begins increasing the gain.

The camera displays the current values for AGC/AEC luminance, current exposure, and current gain.

CAUTION ⚠️

In some rapidly changing bright light conditions, an image brightness oscillation (image intensity flipping from bright to dark) could occur. To prevent this situation, increase the minimum exposure limit or decrease the AEC speed.

6 Image Sensor Technology

6.1 General Information

A CMOS camera is an electronic device for converting light into an electrical signal. The camera contains an ON Semiconductor CMOS (Complementary Metal-Oxide Semiconductor) image sensor.

The sensor consists of a two-dimensional array of silicon photodiodes. The photons falling on the CMOS surface create photoelectrons within the pixels, and the number of photoelectrons is linearly proportional to the light level. Although the number of electrons collected in each pixel is linearly proportional to the light intensity and exposure time, the number of electrons varies with the wavelength of the incident light.

In general operation, when the desired exposure time is reached, the photo-electrons collected within each photodiode are moved onto a storage register within the pixel. The pixels are then read out one row at a time, processed in the analog domain, and digitized to 10 bits. Frame time, or read-out time, is the time interval required for all the pixels from the entire imager to read out of the image sensor. While reading out the image from the storage registers within each pixel, the camera captures the next image overlapping the exposure of the next image with the readout of the current image. The exposure is timed to end just as the readout of the previous frame ends and the readout of the next frame begins.

Unlike traditional CCD image sensors, the CMOS image sensor digitizes each pixel within a row simultaneously. This allows for more settling time, which lowers the overall noise floor and provides improved sensitivity. The low noise floor, combined with a reasonably large pixel charge capacity, translates into a dynamic range of 59dB.

A set of color filters (red, green, and blue) arranged in a Bayer pattern over the pixels generates color images.

6.1.1 A/D Architecture and Frame Rate Controls

The image sensors multiplex 80 (C5180) and 64 columns (C4181, C4180) respectively into an array of 64 A/D converters. The camera takes care of all the details of re-ordering the lines so they are sequentially deposited in computer memory. Unlike a CCD sensor where digitization occurs within one pixel-time, these cameras perform digitization at $1/64^{th}$ the pixel rate (64 A/D converters), and the digitization has a depth of 10-bits.

The camera uses 8 of the image sensor's Low-Voltage Differential Signaling (LVDS) outputs, and the time to read out one line from the image sensor is far less than the time needed to capture the data using the GigE interface. The camera compensates for this mismatch in data output rate versus data capture rate using two methods: a variable pixel clock for line readout and the ability to add 1 microsecond of delay (row overhead) time at the end of each line output by the camera. Slowing down the pixel line clock and adding delay (dead time) at the end of each line allow the camera to match the computer's GigE interface capture rate.

The following figure shows a typical CMOS image sensor architecture.
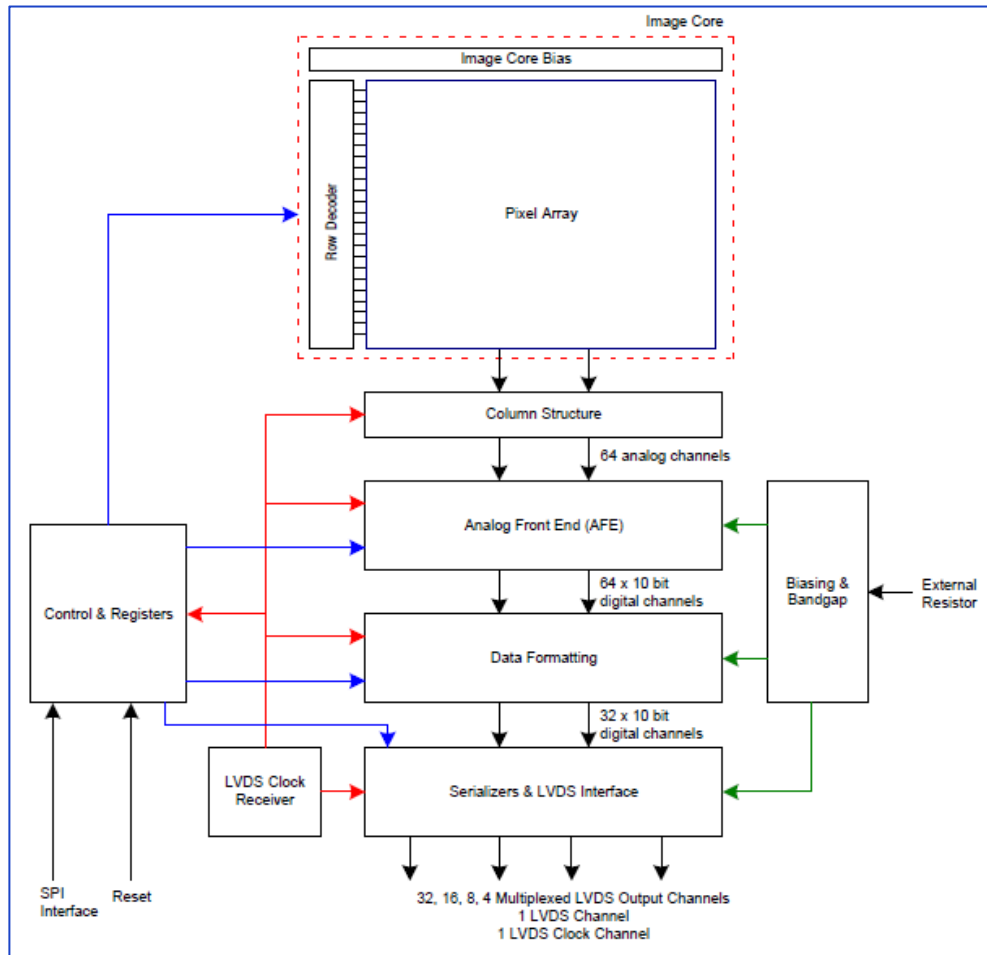
Figure 64: Typical CMOS image sensor architecture

6.1.2 Spectral Sensitivity

The following figures show the camera's spectral response.
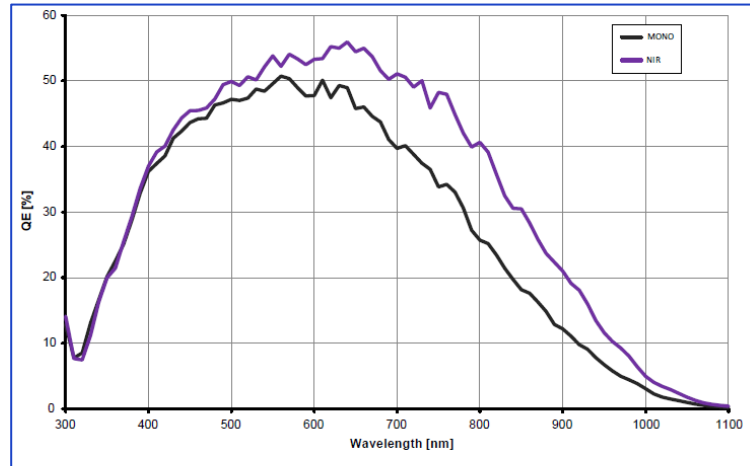
Figure 65: Python CMOS mono spectral response (monochrome with the cover glass) for monochrome and enhanced NIR versions
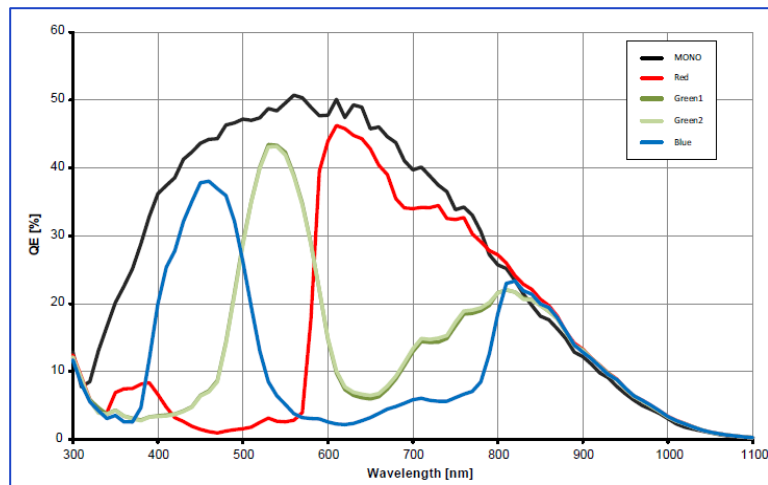
Figure 66: Python CMOS typical color spectral response (with micro lens and cover glass)

6.1.3 Bayer Pattern Information

Cheetah Python cameras are available with a Monochrome or Color CMOS imager. Color cameras use filters (red, green, and blue) arranged in a Bayer pattern and placed over the pixels to generate color images. Red is the starting color for camera readout.

7 Creating Look-up Tables

7.1 Overview

A Look-up Table (LUT) is provided with each camera. You can create your own LUT file using any standard ASCII text editor, Microsoft Notepad, or Microsoft Excel. Additionally, you can use any spreadsheet or mathematical program capable of generating a comma delimited (.csv) file.

7.2 Using an ASCII Text Editor

A custom LUT can be prepared using any ASCII text editor, such as "Notepad" or similar. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, the file must be renamed to include the .lut file extension.

The .lut file has two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated in a comma. The table section of the file contains an array of 4096 lines with each line containing an input value followed by a comma and an output value. The input values represent incoming pixels and the output values represent what each incoming pixel should be converted into as an output pixel.
The format of the .lut file is as follows:

```
-- Look Up Table input file example,
-- lines beginning with two dashes are comments,
-- and are ignored by parser,
:Header,
-- this is the text that will get displayed with a 'glh' command,
Function is 'Negative Image',
Created by John Doe,
Date 1/14/09,
:Table,
-- input output,
     0,4095
     1,4094
     2,4093
     3,4092
     4,4091
     :
     4095,0
```

7.3 Using Microsoft Excel

The LUT file can be created in Excel as follows:

1. Create the spreadsheet as shown below (note that 4096 rows are required in the table).
2. Add the necessary equations into the output cells to generate the transfer function required.
3. Save the file as a .csv (comma delimited format).
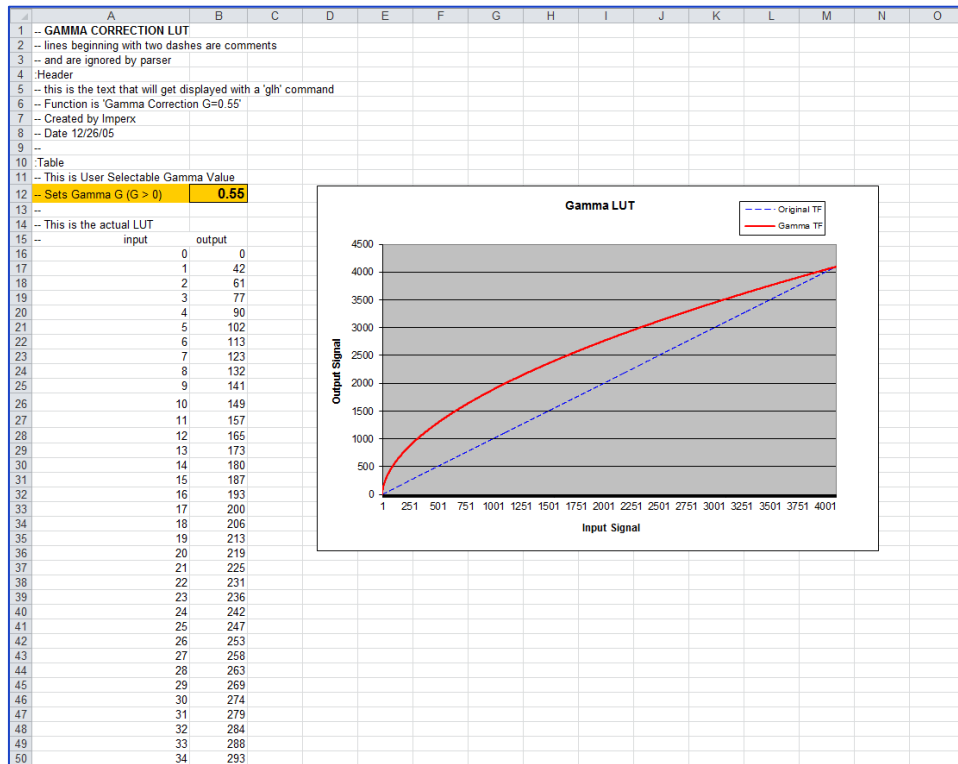4. Rename the .csv file to an extension of .lut.

Figure 67: Sample spreadsheet

8 Creating DPC / HPC Tables

8.1 Overview

Defective Pixel Correction and Hot Pixel Correction work with predetermined and preloaded Defective and Hot pixel maps. The Defective Pixel Map (DPM) and Hot Pixel Map (HPM) are downloaded into the camera's non-volatile memory.

You can edit the original DPM / HPM file, create your own file and upload it to fit the unique requirements of your operating environment or camera use.

NOTE ✳

To get the original DPM and HPM files please contact technical support at:

Email: techsupport@imperx.com
Toll Free 1 (866) 849-1662 or (+1) 561-989-0006
Fax: (+1) 561-989-0045
Visit our website: www.imperx.com

8.2 Editing DPM / HPM Files

You can edit DPM and HPM files in Microsoft Notepad or any other editing software. The files look like this:

```
-- Defective Pixel Map,
-- Date: 2.23.2018,
-- Model#: GEV-C5180M,
-- Serial#: LAC001,
:Table,
-- Column(X),Row(Y)
5683,155
3091,332
3532,893
650,1017
701,1017
1712,1053
914,1067
```

Pixel maps have two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the DPM or HPM in order of increasing Y (row) location. If the Y location is identical, the listing is in order of increasing X (column) location.

The maximum number of pixels in the DMP list is 512 and in HPM list is 4096.
To edit original DPM or HPM file, you need to identify defective or hot pixels, locate and adjust their coordinates, and accurately place pixels' coordinates into the pixel map.

8.2.1 Finding Defective Pixels

To find all of the defective pixels you need to add to the map, it is recommended that you take an image with a uniform light source illuminating the sensor at about 50% ADU capacity (~2000 for 12-bit, ~500 for 10-bit, ~130 for 8-bit modes). Ensure that the **DefectPixelCorrection** and **HotPixelCorrection** are set to "Static" on the "Data Correction" screen of the Software GUI, so the camera will correct the known pixel defects. You can then identify any visible pixel defects and add them to the defective pixel maps.

8.2.2 Finding Hot Pixels

To identify all hot pixels that need to be added to the map, put the lens cap on the camera and capture an image after the camera has reached the normal operating temperature. Use the longest expected exposure time at the normal frame rate. If the camera will operate with variable frame rates, set the camera to the slowest frame rate expected. Ensure that the **HotPixelCorrection** is set to "Static" on the "Data Correction" screen of the software GUI, so the camera will correct the known hot pixels automatically. From this image, you can then identify all of the hot pixels not in the factory map and add them to the hot pixel map.

8.2.3 Locating and Adding Pixel Coordinates

Follow the steps below to find first pixel coordinates, locate and adjust defective pixel coordinates, and accurately place defective pixel coordinates into the pixel map.

STEP 1: Find the First Pixel Coordinates

Your frame grabber's first pixel coordinates can affect the location accuracy of defective pixel coordinates. So, you must find the image sensor's first pixel coordinates and potentially adjust the defective pixel coordinates based on your findings.

Click the first pixel at the upper most left corner of the screen to find your frame grabber's first pixel X, Y coordinates (Figure 68). The coordinates will be either 0, 0 or 1, 1:

- If your frame grabber's first pixel coordinates are 0,0, you must add 1 to both the X and Y coordinates of the bad pixel.
- If the first pixel coordinates are 1, 1, do not add 1 to either coordinate.

STEP 2: Find Defective Pixel Coordinates

Click the defective pixel to find its X, Y coordinates (Figure 69).
The Figure 69 shows a pixel defect at location 593, 4816 — where X (Column) = 593 and Y (Row) = 4816.

IMPORTANT: Frame grabbers from different manufacturers may display pixel location coordinates in different order, for example:

<div align="center">

X (Column), Y (Row) or,

X (Row), Y (Column).

</div>

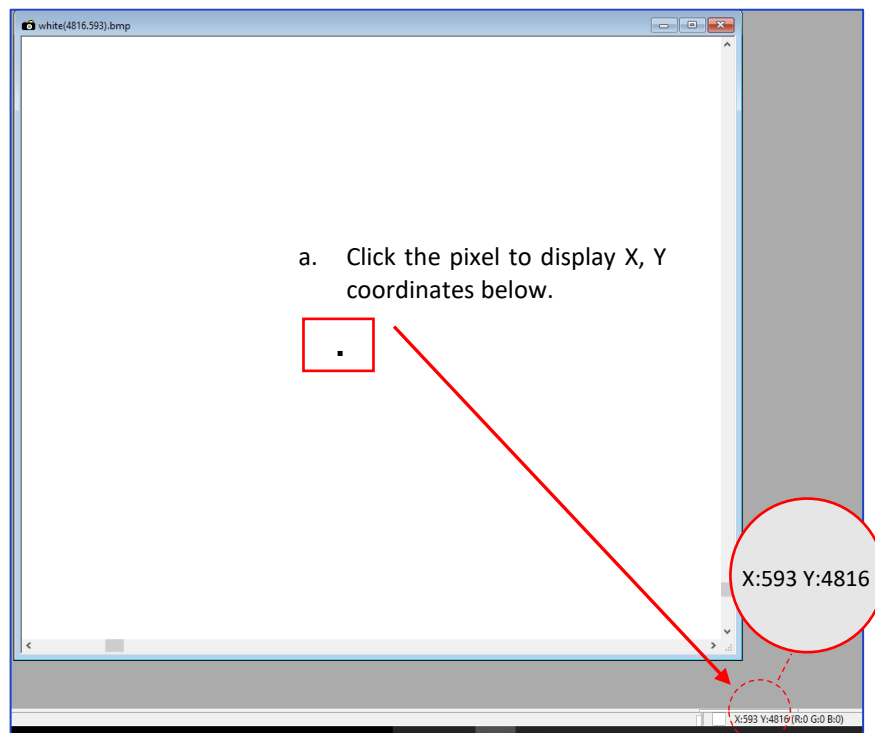You must put defective pixel coordinates into the pixel correction map file in this order:
X (Column), Y (Row).

If your frame grabber identifies pixel coordinates by X **(Row)**, Y **(Column)**, you <u>must</u> transpose the coordinates to X (**Column**), Y (**Row**) before entering them into the pixel map files. For example, if the 593, 4816 coordinates in the screen below (Figure 69) had been displayed in

this order, where X:593 is row and Y:4816 is column, you would have had to transpose the coordinates to 4816, 593.
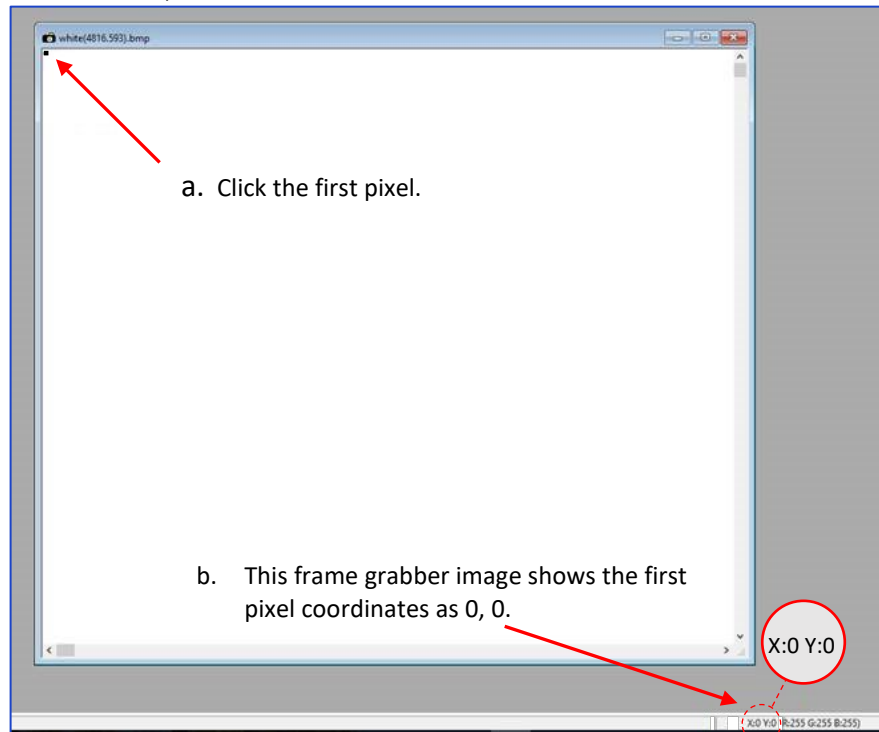
Figure 68: Frame grabber's firs pixel

Figure 69: Locating defective pixel

STEP 3: Adjust Defective Pixel Coordinates

As described in **STEP 1**, if the first pixel coordinates are 0, 0, you must adjust the defective pixel coordinates by adding 1 to both coordinates as shown in the following:

593 (+1), 4816 (+1) = 594, 4817

- If the frame grabber pixel coordinates are Column (X), Row (Y), then go to **STEP 4**.
- If the frame grabber pixel coordinates are Row (X), Column (Y), then transpose the coordinates to the form Column, Row and then go to **STEP 4**.

STEP 4: Add Defective Pixel Coordinates to Defective Pixel Map

Place the defective pixel coordinates in the Defective Pixel Map file in ascending (increasing) numerical order of the Y (row) coordinate. The value of all Y coordinates should progressively increase as you look down the list of X, Y coordinates.

Example 1: Different Y coordinates		Example 2: Identical Y coordinates

`-- Defective Pixel Map,`
`-- Date: 4.12.2018,`
`-- Model#: GEV-C5180M,`
`-- Serial#: LAC001,`
`:Table,`
`-- Column(X),Row(Y)`
`701,1017` Row coordinates are
`100,1018` in ascending order
`4325,1019` (increasing Y values).
`2241,1020`
`458,1021`
`1712,1053`
`914,1067`
`3954,1546`
`2516,1670`
`3451,3331`
`1111,4149`
`95,`**`4364`**
`594,`**`4817`**
`433,`**`4828`**
`205,4899`
		`-- Defective Pixel Map,`
		`-- Date: 4.12.2018,`
		`-- Model#: GEV-C5180M,`
		`-- Serial#: LAC001,`
		`:Table,`
		`-- Column(X),Row(Y)`
		`650,`**`1017`** Column coordinates are in
		`698,`**`1017`** ascending order (increasing X
		`701,`**`1017`** values).
		`100,1018`
		`4325,1019`
		`2241,1020`
		`458,1021`
		`1712,1053`
		`914,1067`
		`3954,1546`
		`2516,1670`
		`3451,3331`
		`1111,4149`
		`95,4364`
		`433,4828`
		`205,4899`

As shown in the **Example 1** above, the Y coordinate of 594, 4817 is higher than **4364** and lower than **4828**. Do not add defective pixel coordinates at the end of the list unless the Y coordinate is the highest of all Y values.

NOTE ✳

If adding a defective pixel with a Y location identical to one or more other defective pixels, insert its coordinates based on the order of increasing X location.

As shown in the **Example 2** above, the Y coordinate of 698, 1017 is identical to two other defective pixels. Place its coordinates between **650,** 1017 and **701,** 1017 because its X location (698) is higher than 650 but lower than 701.

STEP 5: Save your DPM/HPM

- Save your Defective Pixel Map with the file extension .dpm.
- Save your Hot Pixel Map with file extension .hpm.

8.3 Creating new DPM / HPM Files

You can create your own DPM and HPM files using any ASCII text editor, such as "Notepad" or similar. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, the file must be renamed to include the .dpm or .hpm file extension. The files look like this:

```
-- Defective Pixel Map,
-- Date: 2.23.2018,
-- Model#: CLF-C5180M-CF,
-- Serial#: LAC001,
:Table,
-- Column(X),Row(Y)
5683,155
3091,332
3532,893
650,1017
701,1017
1712,1053
914,1067
```

Pixel maps have two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the DPM or HPM in order of increasing Y (row) location. If the Y location is identical, the listing is in order of increasing X (column) location.

The maximum number of pixels in the DMP list is 512 and in HPM list is 4096.

To create a DPM or HPM file:

1.   Identify defective or hot pixels (refer to the sections 8.2.1 Finding Defective Pixels and 8.2.2 Finding Hot Pixels).

IMPORTANT: When creating a new pixel map, you need to get all defective pixel visible. Ensure that the **DefectivePixelCorrection** and **HotPixelCorrection** are set to "Off" on the "Data Correction" screen of the software GUI, so the camera will not correct the known pixel defects.

2.   Locate and adjust defective pixels' coordinates (refer to the section 8.2.3 Locating and Adding Pixel Coordinates, **STEP1 – STEP3**).
3.   Place pixels' coordinates into the pixel map and save the file (refer to the section 8.2.3 Locating and Adding Pixel Coordinates **STEP4, STEP5**).

EXAMPLE

In this example, the first table entry is pixel 4 from row 1, the next entry is pixel 588 from row 1, and the next entry is pixel 78 from row 5, and so on. The file looks like this:

```
:Table,
-- Column(X),Row(Y)
        4,1
      588,1
       78,5
       82,27
      405,300
```

8.4 Uploading DPM / HPM Files

After saving the maps, you can upload them to the camera using the Imperx **Upload Utility**. The Upload Utility ships with your camera and enables uploads of DPM, HPM, and other files to your camera.

To upload DPM and HPM files:
1. Connect and power up your camera.
2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera (Figure 70). If the utility does not detect the camera, click **Refresh** to restart the device collection.
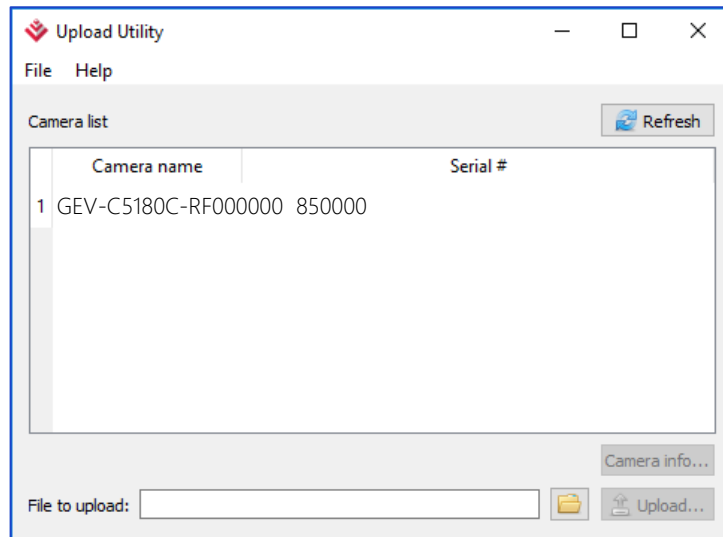

Figure 70: Detect a camera

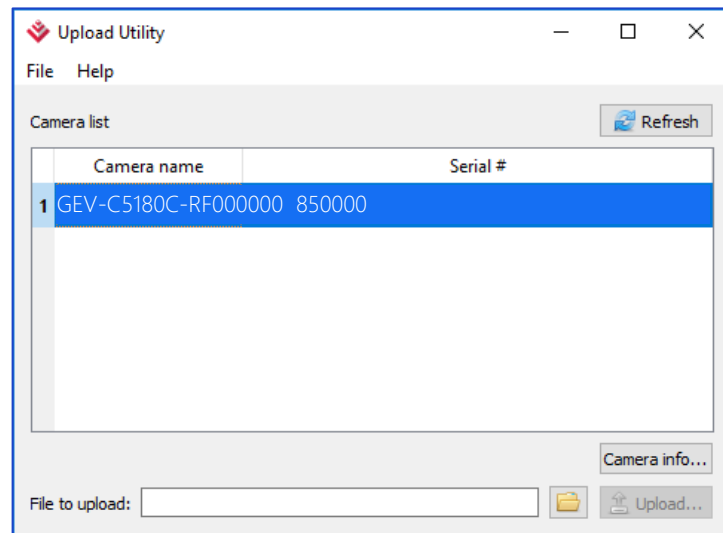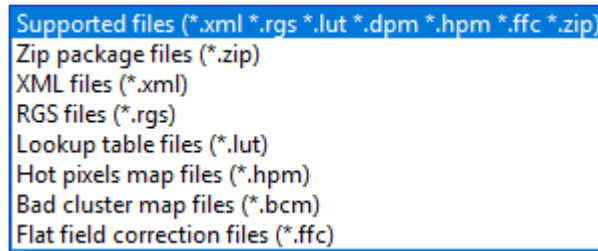3. Select the camera to update if more than one appears.

Figure 71: Select detected camera.

4. Browse for either the edited .dpm file or .hpm file, select it, and click the **Upload** button. Wait for the upload to finish.

Figure 72: Supported upload files

5. After the upload is completed, do a power cycle on the camera.
6. After the camera re-starts, start your software GUI and select **Data Correction**.
7. Ensure that DPC and HPC are set to **Static** so that the camera uses the maps you loaded.
8. Retake images as described in sections 8.2.1 Finding Defective Pixels and 8.2.2 Finding Hot Pixels to ensure all defective and hot pixels are now corrected.