

IMPERX



Cheetah Pregius Cameras User Manual 10 GigE Vision Interface with SFP+

The Imperx Cheetah CMOS cameras provide exceptional video image quality in a remarkably compact and ruggedized design with resolutions from 2 MP to 31 MP. The cameras use Sony Pregius™ Gen 3 and Pregius S™ Gen 4 CMOS sensors for their high sensitivity, image clarity, and high dynamic range. They achieve frame rates up to 434.2 frames per second with 10 GigE Vision interface. An SFP+ connector is provided to mate with various transceiver modules

Revision 1.3

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.

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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.

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.

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REVISION HISTORY

Revision	Date	Reviser	Comments
0.1	08/12/2020	I. Barabanova	Preliminary version
1.0	10/08/2020	I. Barabanova	Initial release
1.1	5/6/2021	I. Barabanova	Adjusted Frame Rates Added UKCA compliance Changed GevSCPSPacketSize maximum value to 8164 Changed Operating Temperature Range Added description for the IpxPlayer panels: Histogram, Camera Terminal, HexPixelDump Added <i>Saving Image in AVI Movie File Format</i> section Added new Power Supply (PS12V14A) Changed Strobe Min/Max Width and Delay Updated Canon Lens Control specifications Added Focus and Iris adjustment procedures for a Canon Lens
1.2	6/13/2025	I. Barabanova	Added SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341 cameras Added Ethernet Adapter Configuration procedures for Linux OS Added Filter Driver Added IpxPlayer installation in Linux Added Action Command feature Added IEEE 1588 PTP feature Changed Digital gain range to 0x – 4x with a step of 1/4096
1.3	6/29/2025	I. Barabanova	Updated screen shots

TERMINOLOGY

Defective pixels – these are pixels whose sensitivity deviates due to fluctuations in the CMOS manufacturing process and materials.

Fast trigger mode – a camera exposes a frame and then exposes the next frame while reading out the previous frame. In this way, the camera overlaps the exposure and readout times. Fast trigger mode requires a predictable and stable trigger period. The *TriggerOverlap* setting is On.

Free-running mode – a camera runs without synchronization to an external trigger pulse (untriggered mode).

Hot pixels – 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 far brighter than the average of the pixels surrounding it. In some cases, the pixel becomes so bright that it saturates.

Standard trigger mode – a camera waits for a trigger pulse, then exposes using an internal exposure timer and reads out a frame and waits for next trigger pulse. The exposure and readout do not overlap. The *TriggerOverlap* setting is Off.

Trigger mode – a camera waits for a trigger pulse to start the image capture, synchronizing it to either an internal or external event.

AEC – Automatic exposure control

AGC – Automatic gain control

AOI – Area of interest

AWB – Automatic white balance

DPC – Defective pixel correction

FFC – Flat field correction

HDR – High dynamic range

HPC – Hot pixel correction

LUT – Look-up table

PIV – Particle image velocimetry

SFP – Small Form-factor Pluggable

About the Camera

General

The 10 GigE Vision SFP+ Cheetah CMOS cameras are built around advanced Sony Pregius CMOS image sensors with global shutter for high quality images in a small ruggedized form factor. The cameras conform to the GigE Vision 2.0 and support IEEE1588 PTP synchronization and Scheduled Action Commands. Cheetah cameras are progressive scan digital cameras featuring a built-in image-processing engine, low power consumption, low noise, high dynamic range (71dB), and fast frame rates for high throughput applications.

The cameras provide several trigger modes and output strobes allowing you to synchronize the image capture of one or more cameras to an external event. You can vary exposure times using internal controls or an external pulse width.

The cameras also provide one Master and two Processing areas of interest (AOI), programmable look-up tables (LUT) and the ability to store up to four different camera configurations. Using the simple GenCam™ compliant user interface, you can quickly change the camera configuration. User-defined LUT capabilities optimize the cameras' dynamic range. Hot and defective pixel correction is available to correct over-responding or under-responding pixels.

The cameras feature low power consumption and operate over an extended temperature range from -30 °C to +75 °C.

The cameras are suitable for a wide range of environmental conditions and applications, such as machine vision, industrial inspection, surveillance, aerospace, and more.

The SFP-C5341, SFP-C4540, and SFP-C5340 cameras feature 16 MP, 20.4 MP, and 24.6 MP Sony Pregius S CMOS sensors respectively. The Pregius S technology uses a stacked back-illuminated pixel structure offering reduced pixel size of 2.74 μm, increased peak quantum efficiency, and improved sensitivity with fast lenses. A dual ADC mode enables HDR imaging by combining high gain and low gain lines within the image sensor. Short interframe time of 2 microseconds makes the camera suitable for PIV applications.

The SFP-C5440, SFP-C4440, and SFP-C6440 cameras feature 17 MP, 20 MP, and 31 MP Sony Pregius CMOS sensors respectively, provide support for active Canon EOS lens with iris and focus controls.

Camera Model	Resolution (MP)	Resolution (H x V)	Frame Rate (Max)	Type (Color/ Mono)	Optical format	Pixel Size (microns)	Sony Sensor Model
SFP-C1640	2	1632 x 1248	434.2	C, M	1/1.7"	4.5	IMX422
SFP-C1941	2.86	1920 x 1472	319.4	C, M	2/3"	4.5	IMX421
SFP-C3240	7	3200 x 2208	129	C, M	1.1"	4.5	IMX420
SFP-C5341	16	5312 x 3040	56.6	C, M	1.1"	2.74	IMX532
SFP-C5440	17	5472 x 3084	55.3	C, M	4/3"	3.45	IMX387
SFP-C4440	20	4416 x 4436	39.6	C, M	4/3"	3.45	IMX367

Camera Model	Resolution (MP)	Resolution (H x V)	Frame Rate (Max)	Type (Color/ Mono)	Optical format	Pixel Size (microns)	Sony Sensor Model
SFP-C4540	20.4	4512 x 4512	45.6	C, M	1.1"	2.74	IMX531
SFP-C5340	24.6	5312 x 4608	37.9	C, M	1.2"	2.74	IMX530
SFP-C6440	31	6464 x 4860	30	C, M	APS-C	3.45	IMX342

Note:

C – color sensor

M – monochrome sensor

Key Features

- Global shutter (GS)
- Color and monochrome versions
- Low power consumption
- Fast frame rates
- Back-illuminated pixel structure (SFP-C4540, SFP-C5340, and SFP-C5341 cameras only)
- Short interframe interval of 2 μ s (SFP-C4540, SFP-C5340, and SFP-C5341 cameras only)
- HDR Imaging (Dual ADC) feature (SFP-C4540, SFP-C5340, and SFP-C5341 cameras only)
- High data transfer rates up to 10 Gbit/s
- IEEE 1588 PTP
- Action Command (Trigger over Ethernet)
- Internal and external exposure controls
- Automatic exposure and gain control (AEC/AGC)
- Analog and digital gain control
- Offset control
- Built-in pulse generator
- One Master and two Processing areas of interest (AOI)
- Programmable external inputs and outputs
- Multiple Trigger/Synchronization options
- Automatic white balance
- Four 12-bit look-up tables (LUT)
- Hot and defective pixel correction, user-defined and factory
- Eight flat field correction tables, user-defined and factory
- Dynamic transfer function
- Canon EOS EF lens control
- Temperature monitor
- Field upgradeable firmware

Technical Specifications

SFP-C1640 Camera Specifications

Specifications	SFP-C1640 (2 MP)
Active image resolution	1632 (H) x 1248 (V)
Pixel size	4.5 μm
Optical format	1/1.7 inch
Shutter	Global
Frame rate (max)	434.2 fps (8-bit), 223.3 fps (10-bit/12-bit unpacked), 272.4 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	77 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	7 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
Trigger inputs	External, pulse generator, software, trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V to 33 V external power supply); 2 A inrush @ 12 V
Power consumption	Typ.: 5.04 W @ 12 V
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C1941 Camera Specifications

Specifications	SFP-C1941 (2.86 MP)
Active image resolution	1920 (H) x 1472 (V)
Pixel size	4.5 μm
Optical format	2/3 inch
Shutter	Global
Frame rate (max)	319.4 fps (8-bit), 161.9 fps (10-bit/12-bit unpacked), 215.7 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	77 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	7 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
Trigger inputs	External, pulse generator, software, Trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V to 33 V external power supply); 2 A inrush @ 12 V
Power consumption	Typ.: 5.04 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C3240 Camera Specifications

Specifications	SFP-C3240 (7 MP)
Active image resolution	3200 (H) x 2208 (V)
Pixel size	4.5 μm
Optical format	1.1 inch
Shutter	Global
Frame rate (max)	129 fps (8-bit), 65.2 fps (10-bit/12-bit unpacked), 87 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	77 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	7 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
Trigger inputs	External, pulse generator, software, Trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V to 33 V external power supply); 2 A inrush @ 12 V
Power consumption	Typ.: 5.52 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C5341 Camera Specifications

Specifications	SFP-C5341 (16 MP)
Active image resolution	5312 (H) x 3040 (V)
Pixel size	2.74 μm
Optical format	1.1 inch
Shutter	Global
Frame rate (max)	56.6 fps (8-bit), 28.4 fps (10-bit/12-bit unpacked), 37.9 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	71 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	8 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
HDR Imaging (Dual ADC)	Available with 12-bit sensor digitization only
Trigger inputs	External, pulse generator, software, Trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
PIV mode	Available in Free run and Fast trigger modes
PIV interframe time	2 microseconds (recommended by the image sensor's manufacturer)
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V to 33 V); 2 A inrush @ 12 V
Power consumption	Typ.: 5.16 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C5440 Camera Specifications

Specifications	SFP-C5440 (17 MP)
Active image resolution	5472 (H) x 3084 (V)
Pixel size	3.45 μm
Optical format	4/3 inch
Shutter	Global
Frame rate (max)	55.3 fps (8-bit), 27.8 fps (10-bit/12-bit unpacked), 37.0 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	71 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	36 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0–4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
Trigger inputs	External, pulse generator, software, Trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	F-mount (default), Canon EOS active or passive, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V
Power consumption	Typ.: 6.24 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 87.7 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	526.5 g
Vibration, shock	20G (20–200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C4440 Camera Specifications

Specifications	SFP-C4440 (20 MP)	
Active image resolution	4416 (H) x 4436 (V)	
Pixel size	3.45 μm	
Optical format	4/3 inch	
Shutter	Global	
Frame rate (max)	39.6 fps (8-bit), 24.1 fps (10-bit/12-bit unpacked), 28.3 fps (10-bit/12-bit packed)	
Sensor digitization	10 or 12-bit	
Dynamic range	71 dB	
Output bit depth	8, 10, or 12-bit	
Shutter speed	36 μs to 16.0 s	
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)	
Digital gain	0x to 4x (12 dB), 1/4096 step	
AEC/AGC	Off, once, auto	
Gamma correction	0.00 to 4.00 with a step of 0.01	
Black level offset	Manual (0–4095), auto	
Exposure control	Manual, auto, once, external, off	
White balance	Manual, auto, once, off	
Area of Interest (AOI)	One Master AOI, two Processing AOI	
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)	
Sub-sampling decimation	1x2, 2x1, 2x2	
Trigger inputs	External, pulse generator, software, Trigger over Ethernet	
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce	
Trigger modes	Free-run, standard, fast	
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)	
Strobe output	2 strobes, programmable position and duration	
Pulse generator	Yes, programmable	
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables	
IEEE 1588 PTP	Supported	
Lens mount	F-mount (default), Canon EOS active or passive, M42 (optional)	
Camera housing	6000 series aluminum	
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V	
Power consumption	Typ.: 6.24 W @ 12 V, 25 $^{\circ}\text{C}$;	
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 87.7 mm (L)	
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)	
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)	
Weight	526.5 g	
Vibration, shock	20G (20–200 Hz XYZ) / 100G	
Environmental	Operating	-30 $^{\circ}\text{C}$ to +75 $^{\circ}\text{C}$
	Storage	-40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$
Relative humidity	10% to 90% non-condensing	
MTBF (using Telcordia SR-332)	452,000 hours @ 50 $^{\circ}\text{C}$ (EST)	
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA	

SFP-C4540 Camera Specifications

Specifications	SFP-C4540 (20.4 MP)
Active image resolution	4512 (H) x 4512 (V)
Pixel size	2.74 μm
Optical format	1.1 inch
Shutter	Global
Frame rate (max)	45.6 fps (8-bit), 22.8 fps (10-bit/12-bit unpacked), 30.5 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	71 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	8 μs to 16.0 s
Analog / Digital gain	Manual, auto; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
HDR Imaging (Dual ADC)	Available with 12-bit sensor digitization only
Trigger inputs	External, pulse generator, software, Trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
PIV mode	Available in Free run and Fast trigger modes
PIV interframe time	2 microseconds (recommended by the image sensor's manufacturer)
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V
Power consumption	Typ.: 5.16 W @ 12 V, 25 $^{\circ}\text{C}$;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 $^{\circ}\text{C}$ to +75 $^{\circ}\text{C}$ Storage -40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 $^{\circ}\text{C}$ (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C5340 Camera Specifications

Specifications	SFP-C5340 (24.6 MP)
Active image resolution	5312 (H) x 4608 (V)
Pixel size	2.74 μm
Optical format	1.2 inch
Shutter	Global
Frame rate (max)	37.9 fps (8-bit), 19.0 fps (10-bit/12-bit unpacked), 25.4 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	71 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	8 μs to 16.0 s
Analog / Digital gain	Manual, auto; 0 to 48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step (0.000244x)
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0 to 4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
HDR Imaging (Dual ADC)	Available with 12-bit sensor digitization only
Trigger inputs	External, pulse generator, software, trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
PIV mode	Available in Free run and Fast trigger modes
PIV interframe time	2 microseconds (recommended by the image sensor's manufacturer)
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobos, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	C-mount (default), Canon EOS active or passive, F-Mount, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V
Power consumption	Typ.: 6.24 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 88.1 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	461 g
Vibration / Shock	20G (20 to 200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

SFP-C6440 Camera Specifications

Specifications	SFP-C6440 (31 MP)
Active image resolution	6464 (H) x 4860 (V)
Pixel size	3.45 μm
Optical format	APS-C
Shutter	Global
Frame rate (max)	30 fps (8-bit), 15 fps (10-bit/12-bit unpacked), 20 fps (10-bit/12-bit packed)
Sensor digitization	10 or 12-bit
Dynamic range	71 dB
Output bit depth	8, 10, or 12-bit
Shutter speed	36 μs to 16.0 s
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)
Digital gain	0x to 4x (12 dB), 1/4096 step
AEC/AGC	Off, once, auto
Gamma correction	0.00 to 4.00 with a step of 0.01
Black level offset	Manual (0–4095), auto
Exposure control	Manual, auto, once, external, off
White balance	Manual, auto, once, off
Area of Interest (AOI)	One Master AOI, two Processing AOI
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)
Sub-sampling decimation	1x2, 2x1, 2x2
Trigger Inputs	External, pulse generator, software, trigger over Ethernet
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce
Trigger modes	Free-run, standard, fast
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)
Strobe output	2 strobes, programmable position and duration
Pulse generator	Yes, programmable
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables
IEEE 1588 PTP	Supported
Lens mount	F-mount (default), Active or passive Canon EOS, M42 (optional)
Camera housing	6000 series aluminum
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V
Power consumption	Typ. : 6.48 W @ 12 V, 25 °C;
Camera size (W x H x L)	60 mm (W) x 60 mm (H) x 87.7 mm (L)
Camera size with SFP-MMF-MOD	60 mm (W) x 60 mm (H) x 101 mm (L)
Camera size with SFP-RJ45-MOD	60 mm (W) x 60 mm (H) x 114 mm (L)
Weight	526.5 g
Vibration, shock	20G (20–200 Hz XYZ) / 100G
Environmental	Operating -30 °C to +75 °C Storage -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing
MTBF (using Telcordia SR-332)	452,000 hours @ 50 °C (EST)
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA

Ordering Information

When ordering a camera, please specify the camera ordering code. To create your own customer Cheetah ordering code, simply choose one element from each column:

Interface	Camera model	Sensor Type	Ruggedized	Lens Mount	Filter/customization options
SFP = 10 GigE Vision with SFP+ connector	C1640 – 1632 x 1248	C = Color	R = Ruggedized	F = F-Mount	000 = none
	C1941 – 1920 x 1472	M = Monochrome		M = M42	
	C3240 – 3200 x 2208			L = Canon EF EOS Active Mount	
	C4540 – 4512 x 4512			E = Canon EF EOS Passive Mount	
	C5340 – 5312 x 4608			C = C-Mount*	
	C5341 – 5312 x 3040			S = CS-Mount*	
	C5440 – 5472 x 3084			(*C- and CS- Mounts are not available for: SFP-C4440, SFP-C5440, SFP-C6440)	
	C4440 – 4416 x 4436 C6440 – 6464 x 4860				

- **000 (none)** filter/customization option means that a color camera has an IR-cut filter, while a monochrome camera does not have any filters.
- Sample codes:
SFP-C6440M-RF000: Cheetah Monochrome 31 MP camera with F-Mount and 10 GigE Vision with SFP+ connector.
SFP-C5440C-RL000: Cheetah Color 17 MP camera with Canon EF EOS Active Mount and 10 GigE Vision with SFP+ connector
SFP-C4540C-RC000: Cheetah Color 20.4 MP camera with C-Mount and 10 GigE Vision with SFP+ connector
- An external power supply is required.
- The Imperx PS12V14A power supply is available for use with SFP cameras and can be purchased separately.

Accessories

Imperx offers a power supply for use with the cameras. The power supply is sold separately.

Part Number	Description	Compatible with:
PS12V14A	Standard Power Supply 12 V DC, 3 A, With one strobe and one trigger, 1.75 m length	SFP-C1640 SFP-C1941 SFP-C3240 SFP-C4440 SFP-C4540 SFP-C5340 SFP-C5341 SFP-C5440 SFP-C6440

Technical Support

Each camera is fully tested before shipping. If, for some reason, the camera is not operational after power up, check the following:

1. Check the power supply, Ethernet, and all I/O cables.
Make sure that all the connectors are firmly attached.
2. Enable the test mode and verify that the communication between a computer and the camera is established.
If the test pattern is not present, power off the camera, check all the cabling, frame grabber settings, and computer status.

If you still have problems with the camera operation, contact technical support at:

Email: support@imperx.com

Toll Free 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our website: www.imperx.com

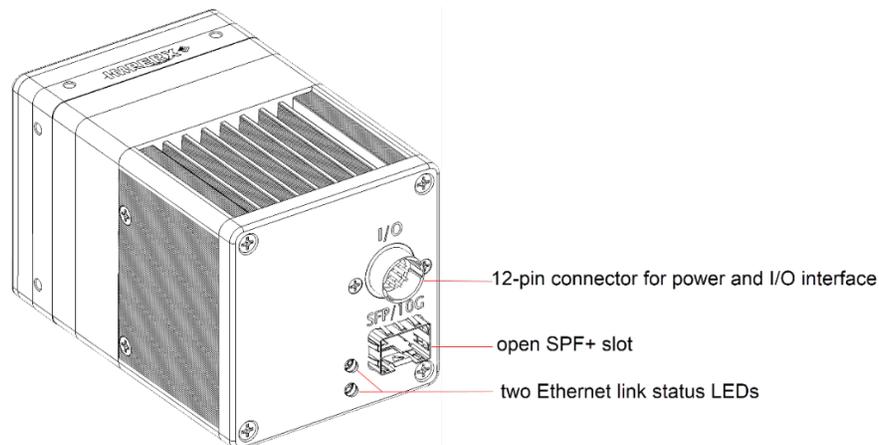
Hardware

This chapter contains the detailed information needed for the initial design-in process:

- connector types, pin numbering and assignments
- SFP transceiver module options
- electrical connectivity and voltage requirements
- mechanical drawings and cabling
- optical and environmental information

SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341 Cameras Connectivity

The back panel of the camera provides two Ethernet link status indicators and connectors needed to operate and control the camera.



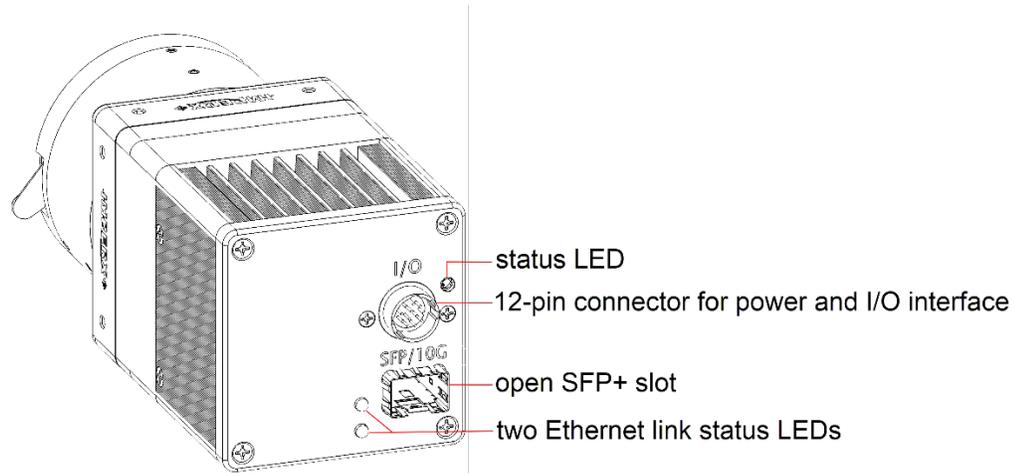
The camera provides the following connectors:

- an open SFP+ slot providing data, control, and serial interface. The SFP+ slot accepts a variety of transceiver modules, including Fiber 10GBase-R and copper 10GBase-T.
- male 12-pin Hirose miniature locking receptacle #HR10A-10R-12PB(71) providing power input and I/O interface. Use a female Hirose miniature locking plug #HR10A-10P-12S(73) on the mating end of your I/O cable
- two Ethernet link LED status indicators
- the camera's model and serial number

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.

SFP-C4440, SFP-C5440, SFP-C6440 Cameras Connectivity

The back panel of the camera provides two Ethernet link status indicators and connectors needed to operate and control the camera.



The camera provides the following connectors:

- an open SFP+ slot providing data, control, and serial interface. The SFP+ slot accepts a variety of transceiver modules, including Fiber 10GBase-R and copper 10GBase-T.
- male 12-pin Hirose miniature locking receptacle #HR10A-10R-12PB(71) providing power input and I/O interface. Use a female Hirose miniature locking plug #HR10A-10P-12S(73) on the mating end of your I/O cable
- two Ethernet link LED status indicators
- a camera status LED indicator
- USB type B programming/SPI connector for factory use only
- the camera's model and serial number

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.

SFP Transceiver Module Options

The camera’s open SFP+ slot accepts a variety of commercially available SFP transceiver modules, including Multi-mode and single mode fiber and 10GBase-T copper modules.

SFP transceiver module	SFP transceiver module part number	Cable length	Compatible SFP+ NIC (example)
10GBase-R fiber module	FS SFP-10GSR-85 (10G SFP+ 850 nm)	300 m	Intel 82599EN Single-Port 10G SFP+ PCIe 2.0 x8
10GBase-T copper module	Cisco SFP-10G-T-S Compatible	30 m	Intel X540-T1 10Gb, Intel X550-T1 10Gb, 10Gtek 10Gb PCI-E

10GBase-SR Multi-Mode Fiber Example

Below is an example of a 10GBase-SR SFP+ 850 nm Multi-mode Fiber Transceiver module (p/# FS SFP-10GSR-85) with 300 m range compatible with the Imperx SFP camera.



For optimal performance, Imperx recommends a 10G Network Interface Card with SFP+ slot. Imperx has tested and recommends the Intel 82599EN Single-Port 10G SFP+ PCIe 2.0 x8, Ethernet Network Interface card shown below.

Available for purchase; contact Imperx sales: sales@imperx.com or +1-561-989-0006.



For a multi-mode fiber optic connection, both the Imperx SFP camera and the NIC card must have a 10GBase-SR SFP+ Multi-mode Fiber Transceiver installed like the one shown above.

10GBase-T Copper Example

Below is an example of a Cisco SFP-10G-T-S Compatible, 10GBase-T SFP+ Copper Transceiver with RJ-45 connector.



Imperx recommends an Intel X540-T1 or X550-T1 10Gb NIC card or equivalent. For example, the 10Gb PCI-E NIC Card with single copper RJ45 Port from 10Gtek as shown below.

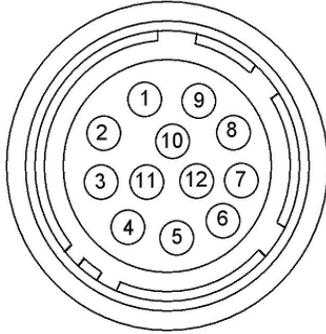


After installation of the 10GBase-T SFP+ Copper Transceiver, the SFP camera can be connected to any 10GigE compatible NIC or Server using standard LAN CAT-5 (CAT-5e) or CAT-6 cables. Shielded cables are recommended. The cable length can vary based on the SFP+ module transceiver. For example, the above transceiver is suitable for distances up to 30 m.

To help clients achieve first iteration success, Imperx offers a variety of transceiver modules and a 10G SFP+ NIC card for sale which have been tested together. Contact Imperx sales department for more information: sales@imperx.com or +1-561-989-0006.

Pin Assignments

The 12-pin Hirose connector on the camera's back panel is a male type miniature locking receptacle #HR10A-10R-12PB(71).



Pin	Signal Name	Use
1	12/24 VDC Return	12 or 24 VDC Main Power Return
2	+12/24 VDC	12 or 24 VDC Main Power
3	Reserved	Reserved
4	Reserved	Reserved
5	OUT2 RTN	General Purpose Output 2, Contact 1 (Opto-isolated)
6	OUT1 RTN	General Purpose Output 1 Return (TTL)
7	OUT1	General Purpose Output 1 (TTL)
8	INPUT1	General Purpose Input 1 (Opto-isolated)
9	INPUT2	General Purpose Input 2 (TTL/LVTTL)
10	INPUT1 RTN	General Purpose Input 1 Return (Opto-isolated)
11	INPUT2 RTN	General Purpose Input 2 Return (TTL/LVTTL)
12	OUT2	General Purpose Output 2, Contact 2 (Opto-isolated)

Camera LED Status Indicator

The SFP-C4440, SFP-C5440, and SFP-C6440 cameras have a red-green-yellow LED on the back panel of the camera. The following LED colors and light patterns indicate the camera status and mode of operation.

LED Condition	Status Indication
 Green steady ON	Normal operation. You should see a normal image coming out of the camera.
 Green blinks at ~0.5 Hz	Long integration enabled.
 Green blinks at ~2.0 Hz	Trigger enabled.
 Amber steady ON	Test mode. You should see one of the test patterns.
 Amber blinks at ~0.5 Hz	Camera is in AGC/AEC mode. In this mode, changing the shutter slider does not affect image luminance.
 Amber blinks at ~2.0 Hz	Camera receives an external synchronization pulse
 Red steady ON	Communications or firmware load error.*
 Red blinks at ~2.0 Hz	Power failure
 Green – Red blinks at ~1 Hz	GigE Vision firmware error.
 LED OFF	Power not present. Possible power supply failure or faulty external AC adapter. Re-power camera and load factory settings. If the LED is still OFF, contact the factory.

Ethernet LED Status Indicators

Two LEDs on the camera’s back panel indicate Ethernet status.

Ethernet Status	Amber LED	Green LED
10 Gbps Link – No Activity	Off	Solid On
10 Gbps Link – Activity	Off	Blinks
5 Gbps Link – No Activity	Solid On	Solid On
5 Gbps Link – Activity	Blinks	Blinks
2.5 Gbps Link – No Activity	Solid On	Off
2.5 Gbps Link – Activity	Blinks	Off
1 Gbps Link – No Activity	Blinks	Off
1 Gbps Link – Activity	Blinks	Off
100 Mbps Link – Activity	Off	Blinks at 1Hz
100 Mbps Link – No Activity	Off	Blinks at 1Hz
10 Mbps Link – Activity	Blinks at 1Hz	Off
10 Mbps Link – No Activity	Blinks at 1Hz	Off

Powering the Camera



The maximum supply voltage **must not** exceed 33 V DC.
Plug in the SFP module prior to powering the camera

Use an external power supply to power the camera.

The external power supply should provide 6.5 V – 33 V DC with the inrush current 2 A @ 12 V. The power supply should terminate in a female HIROSE plug #HR10A-10P-12S(73).

Imperx offers the PS12V14A Standard Power Supply adapter for use with the cameras. The PS12V14A power supply can be purchased separately. It ships with a power cable that terminates in a female HIROSE plug #HR10A-10P-12S(73). The PS12V14A includes connectors for trigger (black wire) and strobe (white wire). Refer to the section [PS12V14A Standard Power Supply](#) for more information.

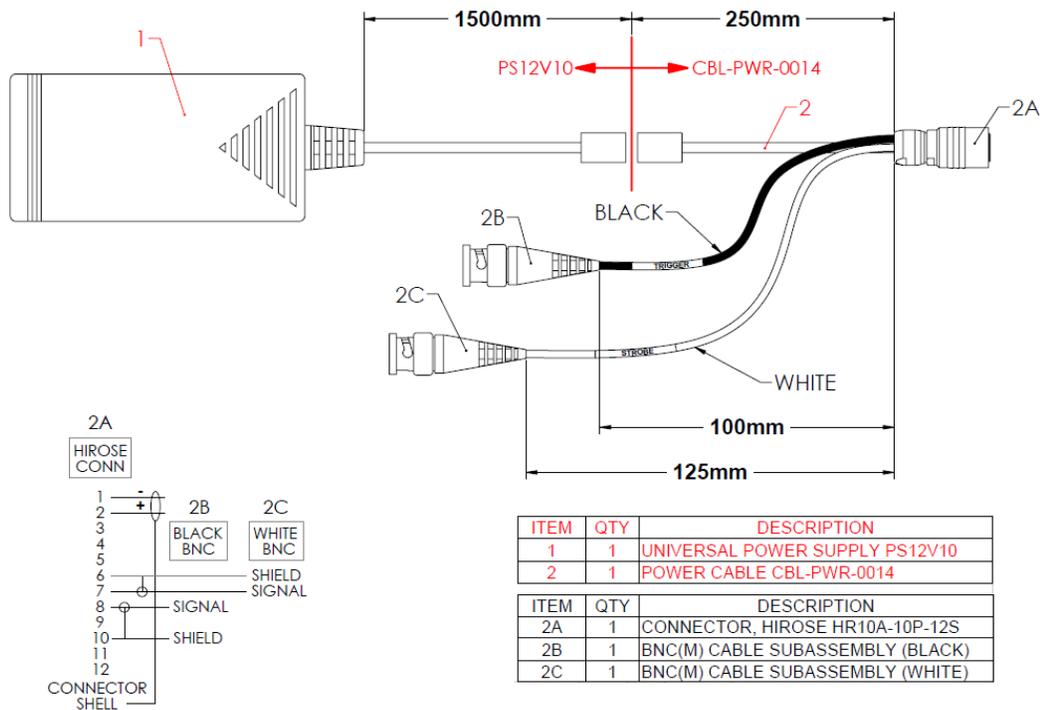
PS12V14A Standard Power Supply

A universal PS12V14A power adapter provides +12 V DC \pm 5% and up to 3 A DC current. The operating input voltage range is 100 to 240 V AC.

The PS12V14A power supply terminates in a female Hirose type miniature locking plug #HR10A-10P-12S(73). It has two BNC pig-tail cables providing external trigger input (black) and strobe output (white)

CAUTION

Imperx recommends using the PS12V14A power adapter for powering C1640, C1941, C3240, C4540, C5340, C5341, C4440, C5440, and C6440 cameras.



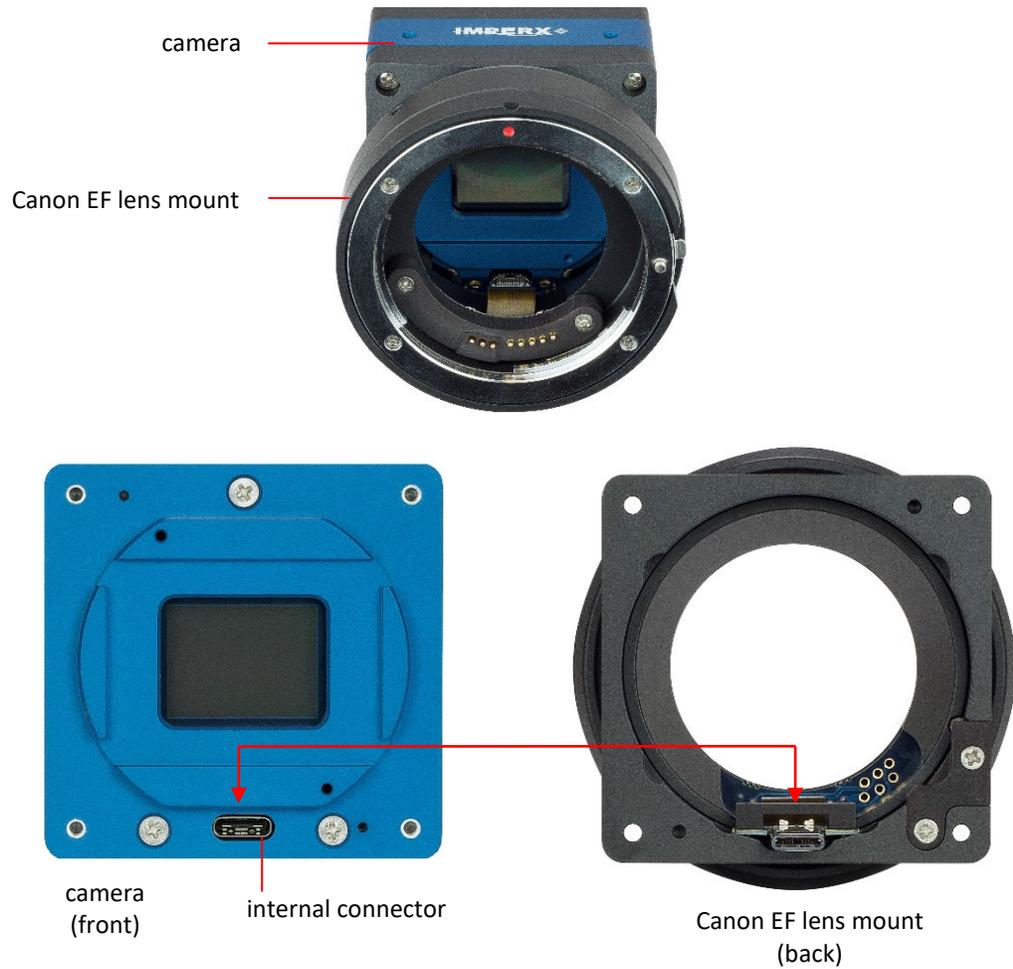
PS12V14A Power Supply Specifications

Specifications	Description
Input	
Voltage	100–240 V AC
Frequency	50–60 Hz
Current	1 A max
Inrush Current	70 A max / 230 V AC (cold start @ 25 °C, full load)
Efficiency	Eff (av) ≥ 87.4 % (at 115 V AC & 230 V AC) Eff ≥ 78.303 % (at 230V/50Hz input @10% load for CoC Tier2)
Output	
Voltage	11.4 V to 12.6 V DC, 12 V DC nominal
Current	3 A max
Load Regulation	± 5%
Ripple & Noise	1% Vpp max for Output Voltage @ full load
Total Power	36.0 W Max
Protection	
Over-Voltage Protective (OVP)	V out * 180% (max)
Short-Circuit Protective (SCP)	Automatic recovery after short circuit fault being removed
Over Current Protection (OCP)	I out * 200% (max)
Safety, EMI and EMC Requirement	
Safety	UL, CUL, GS, PSE, BSMI, CB, RCM, CCC, KC, LPS
Dielectric Strength	10 mA max. cut off current (1) Primary to Secondary: 3000 V AC for 1 minute (2) Primary to Frame Ground: 1500 V AC for 1 minute
Insulation Resistance	(1) Primary to Secondary: 10 MOhm for 500 V DC (2) Primary to Frame Ground: 10 MOhm for 500 V DC
EMI Requirement	CE, FCC Class B, Conduction and Radiation meet
Leakage Current	Less than 3.5 mA
Grounding Test	Resistance 0.1 Ohm max @ 32 A
Environmental	Operating: 0 °C to +40 °C Storage: -20 °C to +80 °C
Relative humidity	Operating: 20% to 80% non-condensing Storage: 10% to 90% non-condensing
Regulatory	DoE VI, ErP (Lot 7), GEMS, NRCAN, CEC, RoHS
Cable Length	
Supplied AC power input cable (IEC)	1.8 m (6')
Power supply output (+12 V)	1.75 m (5') ± 15 cm (6"), connector HIROSE #HR10A-10P-12S
Strobe	12.5 cm (5") ± 1 cm (0.4") connector BNC male
Trigger	10 cm (4") ± 1 cm (0.4") connector BNC male

Active Canon EF mount

The Canon EF lens mount provides active lens control for C4440, C5440, and C6440 cameras.

The cameras provide communication and power to the mount through an internal connector on the front of the camera. The connector eliminates the need for a special power supply and external cable between the camera and the Canon EF mount.

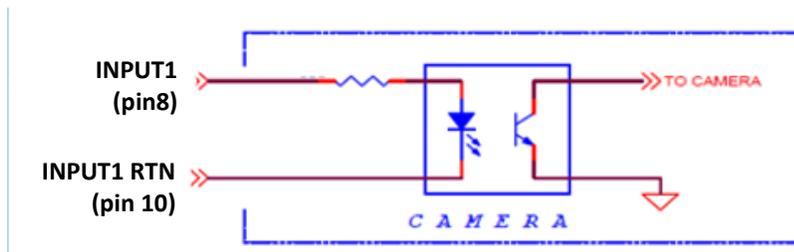


Electrical Connectivity

The Cheetah camera has two external inputs, INPUT1 and INPUT2. INPUT1 is optically isolated while INPUT2 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 output electrical connections.

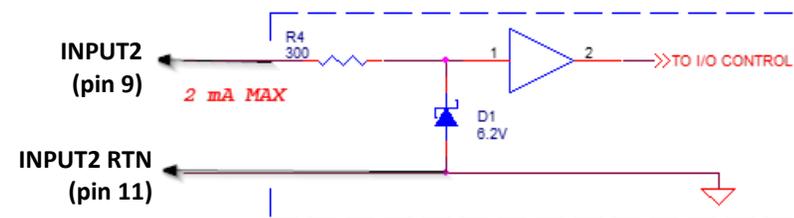
Opto-Isolated Input

Input signals INPUT1 and INPUT1 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.



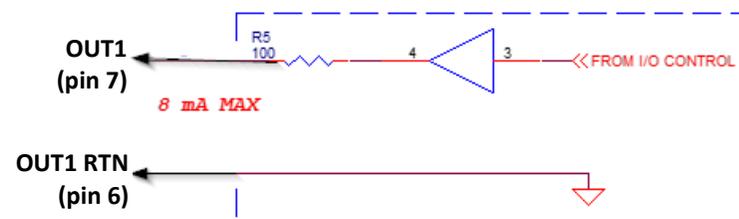
TTL/LVTTL Input

Input signals INPUT2 and INPUT2 RTN provide interfaces to a TTL or LVTTL input signal. The signal level (voltage difference between the inputs INPUT2 and INPUT2 RTN) **must be** LVTTL (3.3 V) or TTL (5.0 V). The total maximum input current **must not** exceed 2.0 mA.



TTL Output

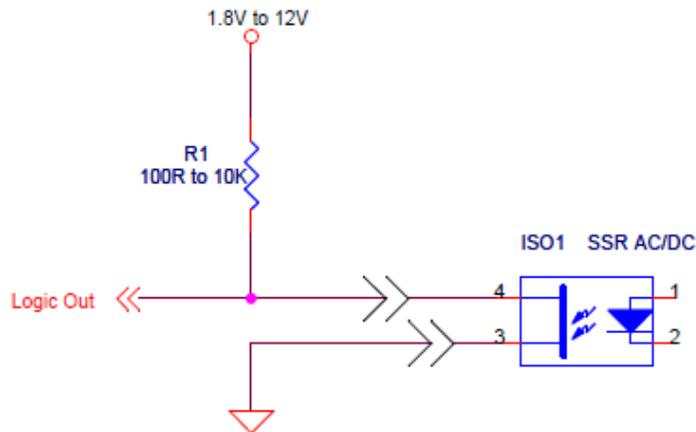
TTL output provides interface to a TTL compatible output signal. The signal level (voltage difference between the outputs OUT1 and OUT1 RTN) is TTL (5.0 V). The maximum output current **must not** exceed 8.0 mA.



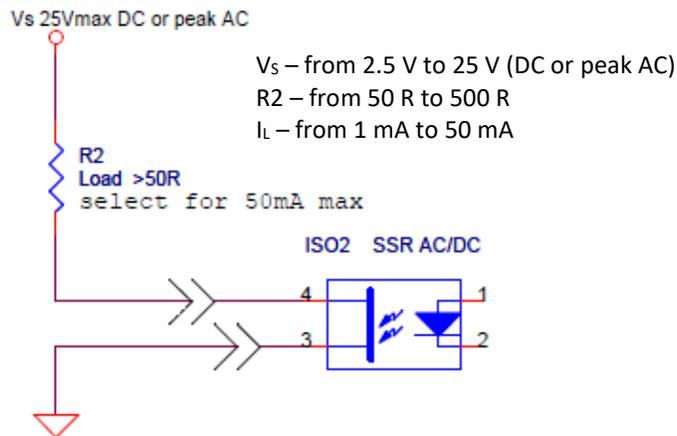
Opto-Isolated Output

Opto-isolated output is an optically isolated switch. There is no pull-up voltage on either contact. An 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 Contact 1 and 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.

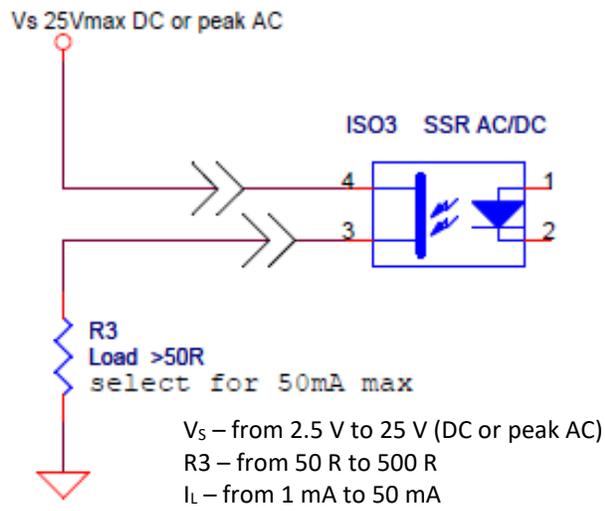
OUT2 Open drain logic driver circuit:



OUT2 Low side load driver circuit:



OUT2 High side load driver circuit:

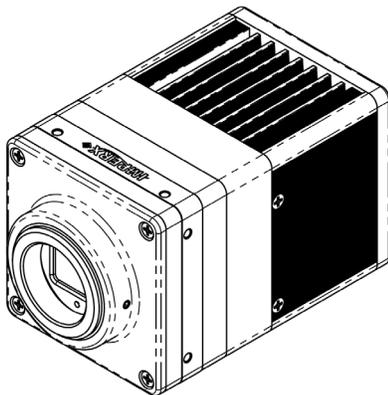


Mechanical Drawings

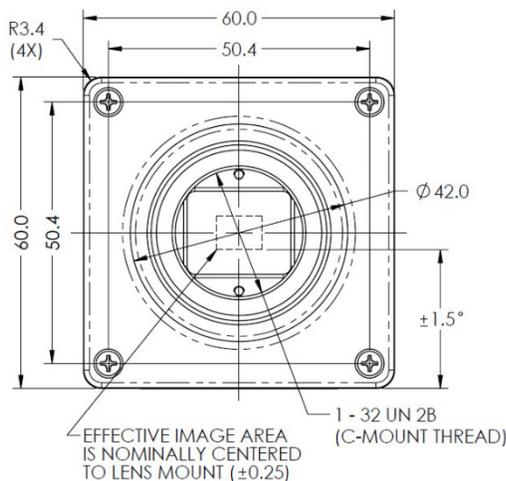
Camera model	Camera size (W x H x L)	Mounting holes		
		Size	Qty.	Location
SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341	60 x 60 x 88.1 mm 60 x 60 x 101 mm with SFP-MMF-MOD 60 x 60 x 114 mm with SFP-RJ45-MOD	M3 x 0.5mm 5.0 mm deep	8	2 holes on each side
SFP-C4440, SFP-C5440, SFP-C6440	60 x 60 x 87.7 mm 60 x 60 x 101 mm with SFP-MMF-MOD 60 x 60 x 114 mm with SFP-RJ45-MOD	M3 x 0.5mm 5.0 mm deep	8	2 holes on each side

The camera’s housing is made of precision-machined aluminum. For maximum flexibility, the camera has eight M3X0.5mm mounting holes located towards the front of the camera on all four sides. An additional plate with ¼-20 UNC (tripod mount) and hardware ship with each camera

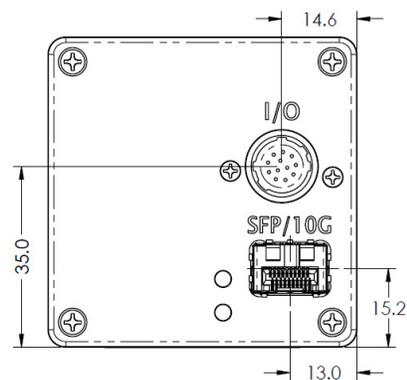
SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341 Cameras



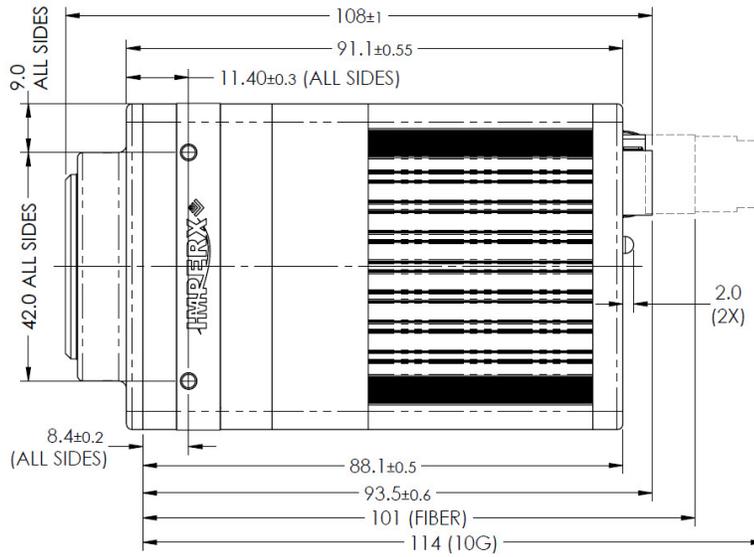
Front View:



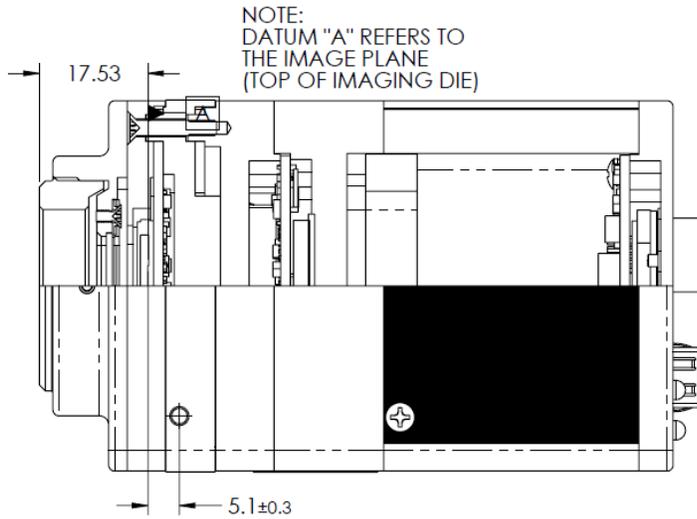
Back View:



Top View:

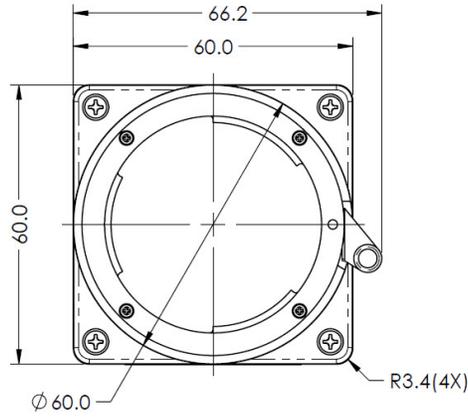


Side View with Image Plane:

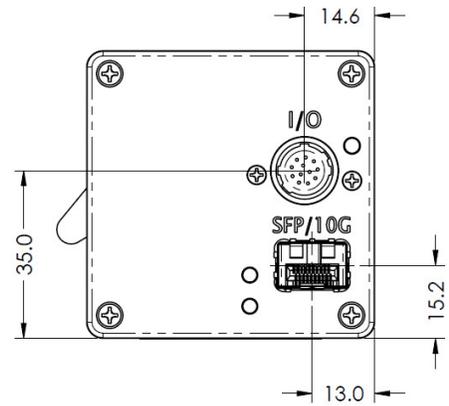


SFP-C4440, SFP-C5440, SFP-C6440 Cameras

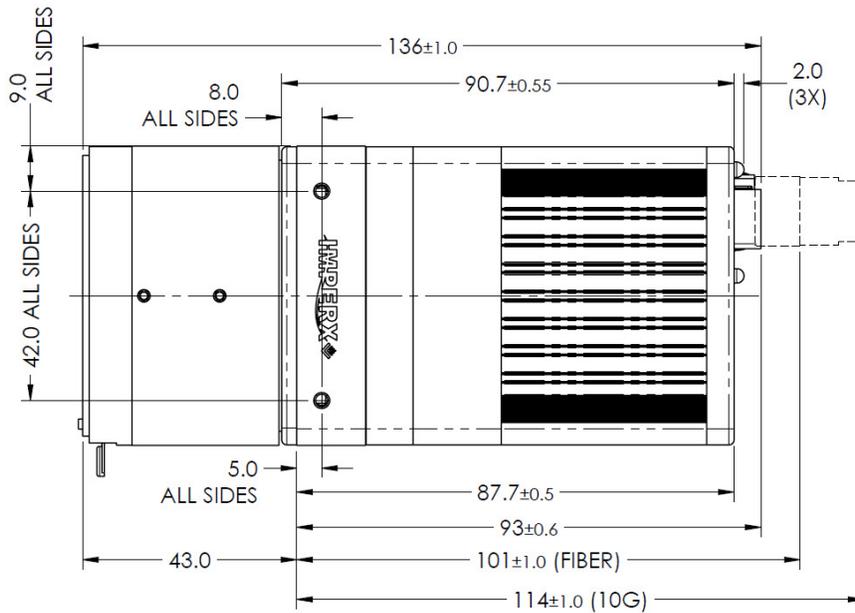
Front View:



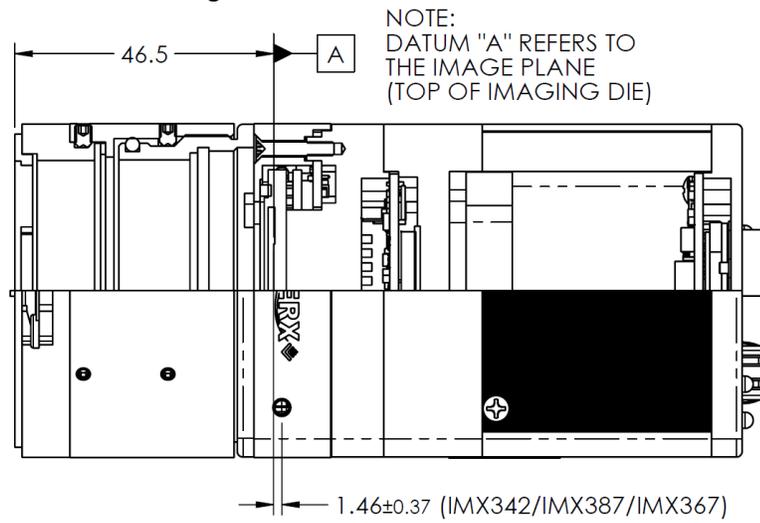
Back View:



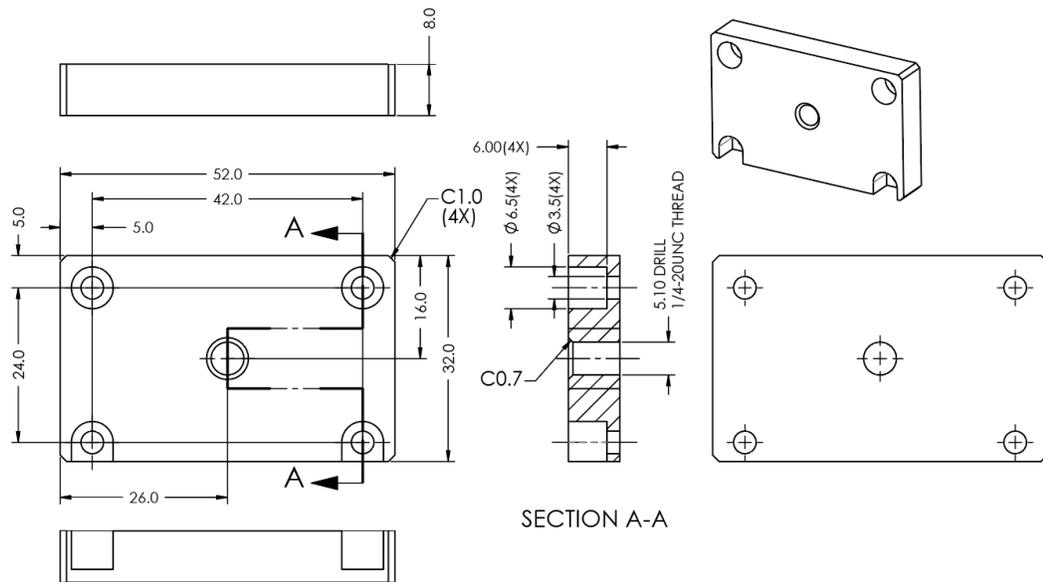
Top View:



Side View with Image Plane:



Mounting Plate



Optical

The Cheetah 10GigE SFP cameras come with varying adapters for C-mount or F-mount lenses different back focal distances. You can use an F-mount lens with a C-mount camera using an F-mount-to-C-mount adapter (with SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341 cameras). You can purchase the adapter separately.

Camera model	Lens Mount (default)	Back focal distance
SFP-C1640, SFP-C1941, SFP-C3240, SFP-C4540, SFP-C5340, SFP-C5341	C-Mount	17.53 mm
SFP-C4440, SFP-C5440, and SFP-C6440	F-Mount	46.50 mm

The SFP-C4440, SFP-C5440, and SFP-C6440 cameras can also be equipped with M42, Canon EF EOS Active or Passive mounts (refer to the section [Ordering Information](#)).

The camera is highly sensitive in the infrared (IR) spectral region. All color cameras have an IR cut-off filter installed. Monochrome cameras do not have any optical filter. If necessary, the monochrome camera can accommodate an IR filter (1 mm thickness or less) inserted under the front lens bezel.

CAUTION

Avoid direct exposure to a high intensity light source (such as a laser beam). This may damage the image sensor!

Avoid foreign particles on the surface of the image sensor.

Do not use methylated alcohol for cleaning the image sensor!

Please refer to the Sensor Cleaning Procedure document found in the camera's information ZIP file or contact Imperx support for cleaning procedures.

Avoid touching or cleaning the front surface of the image sensor. If the sensor needs cleaning, use soft lint free cloth and an optical cleaning fluid.

TIP

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 exposures increase the amount of dark noise and thus decrease the signal to noise ratio.

Environmental

Always operate the camera within temperature and humidity specifications listed below:

Specification	Definition
Operating temperature	-30 °C to +75 °C
Storage temperature	-40 °C to + 85 °C
Relative humidity	10% to 90%

CAUTION

Avoid direct exposure to moisture and liquids. The camera housing is not hermetically sealed and any exposure to liquids may damage the camera electronics!

Avoid operating the camera in the environment without any air circulation, near an intensive heat source, strong magnetic or electric fields.

Do not touch the camera for at least 20 minutes after shutting it down. Allow the camera to cool down. Hot surface may cause burns.

GenICam™ API Module – Configuring the Camera

Overview

Imperx Cheetah cameras are highly programmable and flexible. They allow control of all the camera's resources, camera settings, internal registers, video amplifiers, parameter flash, and so on. You communicate with the camera from a simple GenICam compliant graphical user interface (GUI). The GUI is bi-directional allowing you to issue commands to the camera and allowing the camera to issues responses (either status or information).

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

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 (Default), User Space (User set 0–User Set 3).
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.

GenApi Camera Configuration

The camera XML nodes are listed below with a description of the camera configuration parameters, the interface type, the 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 highlighted in *red italic* letters are changeable only if image acquisition is turned **off**. You cannot change these parameters if image acquisition is on. After making changes, you can turn the camera image acquisition back **on**.

Device Control

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

Parameter Name	Type	Value	Access	Description
DeviceVendorName	String		RO	Provides the name of the manufacturer of the camera.
DeviceModelName	String		RO	Provides the model of the device.
DeviceVersion	String		RO	Provides the version of the camera.
DeviceFirmwareVersion	String		RO	Provides firmware version of the camera.
DeviceManufacturerInfo	String		RO	Provides extended manufacturer information about the camera.
DeviceSerialNumber	String		RO	Provides serial number of the camera.
DeviceUserID	String		RW	Provides user defined name of the device.
DeviceSFNCVersionMajor	Integer		RO	Major version of SFNC used for XML.
DeviceSFNCVersionMinor	Integer		RO	Minor version of SFNC used for XML.
DeviceSFNCVersionSubMinor	Integer		RO	Sub-minor version of SFNC used for XML.
DeviceScanType	Enumeration	String Areascan	Num 0 RO	Specifies the scan type of the sensor.
DeviceReset	Command		WO	Resets camera to power-up state (resets both the 10G Engine and the camera head).
CPUReset	Command		WO	Resets the camera's circuitry. The 10G Engine doesn't reset. NOTE: After the camera has been reset, issue a <i>UserSetLoad</i> command.

Parameter Name	Type	Value	Access	Description	
DeviceTemperatureSelector	Enumeration	String	Num	RW	Selects the location within the device, where the temperature will be measured.
		Sensor	0		
		MainBoard	1		
		SensorBoard	2		
DeviceTemperature	Float		RO	Device temperature in degrees Celsius (C). It is measured at the location selected by <i>DeviceTemperatureSelector</i> .	

Temperature Control

The camera supports a safe mode that removes power to the image sensor when the camera's sensor board temperature reaches a user defined threshold. For example, Sony image sensors are rated for operation up to 75 °C ambient temperature so setting the safe mode temperature to 75 °C ensures the image sensor is always operated within its specification limits.

The camera supports two safe modes – *Sensor Shut Down Force* and *Sensor Shut Down Auto*. Setting the camera to the *Sensor Shut Down Force* mode immediately removes power to the image sensor. To restore the power, set the safe mode to *Off*.

In the *Sensor Shut Down Auto* mode, the power to the image sensor is removed when the camera's sensor board temperature reaches the *SafeTemperatureThreshold* value. The power is restored once the camera's sensor board temperature is 4 °C below the *SafeTemperatureThreshold* value.

Parameter Name	Type	Value	Access	Description	
<i>SafeMode</i>	Enumeration	String	Num.	RW	Sets the safe operation mode of the camera's sensor.
		Off	0		
		SensorShutDownForce	1		
		SensorShutDownAuto	2		
<i>SafeTemperatureThreshold</i>	Float		RW	Sets the temperature in Celsius degrees, when the camera's sensor will be shut down. (110 °C – maximum value)	
SensorStatus	Enumeration	String	Num.	RO	Returns the camera's sensor status.
		On	0		
		Standby	1		

Version Information

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

Parameter Name	Type	Value	Access	Description	
SensorType	Enumeration	String	Num.	RO	Returns the CMOS sensor type.
		Monochrome	0		
		Bayer	1		
SensorModel	Enumeration	String	Num.	RO	Returns the CMOS model name.
		Unknown	0		
		IMX342LQ	0x00000156		
		IMX342LL	0x00000556		
		IMX367LQ	0x0000016F		
		IMX367LL	0x0000056F		
		IMX387LQ	0x00000183		
		IMX387LL	0x00000583		
		IMX420LQ	0x000001A4		
		IMX420LL	0x000005A4		
		IMX421LQ	0x000001A5		
		IMX421LL	0x000005A5		
		IMX422LQ	0x000001A6		
		IMX422LL	0x000005A6		
		IMX530AAQ	0x00000212		
		IMX530AAM	0x00000612		
		IMX531AAQ	0x00000213		
		IMX531AAM	0x00000613		
		IMX532AAQ	0x00000214		
		IMX532AAM	0x00000614		
IMX535AAQ	0x00000217				
IMX535AAM	0x00000617				
IMX661AAQ	0x00000295				
IMX661AAM	0x00000695				
SensorGenerationFirmwareID	Integer		RO	Returns the Sensor Generation Firmware ID number.	
RgsID	Integer		RO	Returns RGS ID.	
CPUFirmwareImage	Integer		RO	Returns the firmware image ID (F=Factory or A= Application).	
CPUFirmwareVersion	Integer		RO	Returns the CPU firmware version number.	
CPUFirmwareBuild	Integer		RO	Returns the CPU firmware build number.	
FPGA FirmwareImage	Integer		RO	Returns the FPGA Firmware Image ID (F=Factory or A=Application).	

Parameter Name	Type	Value	Access	Description
FPGA FirmwareVersion	Integer		RO	Returns the FPGA firmware version number.
FPGA FirmwareBuild	Integer		RO	Returns the FPGA firmware build number.
PTP FirmwareImage	Integer		RO	Returns the PTP Firmware Image ID (F=Factory or A=Application).
PTP FirmwareVersion	Integer		RO	Returns the PTP firmware revision number.
CustomerID	Integer		RO	Returns Customer ID for custom cameras (0 = Imperx Standard camera).
FamilyID	Integer		RO	Returns the camera family ID.
XMLVersion	Integer		RO	Returns XML version.

Troubleshooting

Parameter Name	Type	Value	Access	Description
slvsecStatus	Enumeration	String NoSync Sync	Num. 0 1	RO Shows SLVS-EC status.
slvsecSyncState	Enumeration	String WaitSync WaitEmpty SyncCode WaitIdle StateSync Finished	Num. 0 1 2 3 4 5	RO Shows SLVS-EC sync state.
ElapsedTimer	Float		RO	Elapsed timer in minutes.

Image Format Control

Image Format Control lets you change screen resolution, select pixel format, set processing AOI size and more.

Parameter Name	Type	Value	Access	Description								
SensorWidth	Integer		RO	Returns effective width of sensor in pixels.								
SensorHeight	Integer		RO	Returns effective height of sensor in pixels.								
WidthMax	Integer		RO	Returns max. width of image in pixels for <i>OffsetX=0</i> calculated after horizontal binning, decimation, or other functions are applied.								
HeightMax	Integer		RO	Returns max. height of image in pixels <i>OffsetY=0</i> calculated after horizontal binning, decimation, or other functions are applied.								
<i>Width</i>	Integer	Min: Depends on <i>PixelFormat</i> Max: Depends on camera model	RW	Represents actual image output width of master AOI (in pixels). The width must be a multiple of 32.								
<i>Height</i>	Integer	Min: Depends on <i>PixelFormat</i> Max: Depends on camera model	RW	Represents actual image output height of master AOI (in pixels). The height must be a multiple of 4.								
OffsetX	Integer	Min: 0 Max: Depends on <i>Width</i>	RW	Horizontal offset from origin to area of interest (in pixels). The number must be a multiple of 32.								
OffsetY	Integer	Min: 0 Max: Depends on <i>Height</i>	RW	Vertical offset from origin to area of interest (in pixels). The number must be a multiple of 4.								
PixelFormat	Enumeration	<table border="0"> <tr> <td>String</td> <td>Num.</td> </tr> <tr> <td>Bpp8</td> <td>0</td> </tr> <tr> <td>Bpp10</td> <td>1</td> </tr> <tr> <td>Bpp12</td> <td>2</td> </tr> </table>	String	Num.	Bpp8	0	Bpp10	1	Bpp12	2	RO	Number of bits per pixel.
String	Num.											
Bpp8	0											
Bpp10	1											
Bpp12	2											

Parameter Name	Type	Value	Access	Description	
PixelColorFilter	Enumeration	String	Num.	RO	Returns type of color filter that is applied to the image.
		None	0		
		BayerRG	1		
		BayerGB	2		
		BayerGR	3		
		BayerBG	4		
<i>PixelFormat</i>	Enumeration	String	Num.	RW	Sets output data pixel format. Color cameras, without image flipping or reversal, use BayerRG8, BayerRG10 or BayerRG12, BayerRG10Packed or BayerRG12Packed format. The <i>PixelFormat</i> of color cameras changes automatically when <i>ReverseX</i> or <i>ReverseY</i> is applied.
		Mono8	0x01080001		
		Mono10	0x01100003		
		Mono10Packed	0x010C0004		
		Mono12	0x01100005		
		Mono12Packed	0x01100005		
		BayerGR8	0x01080008		
		BayerRG8	0x01080009		
		BayerGB8	0x0108000A		
		BayerBG8	0x0108000B		
		BayerGR10	0x0110000C		
		BayerRG10	0x0110000D		
		BayerGB10	0x0110000E		
		BayerBG10	0x0110000F		
		BayerGR12	0x01100010		
		BayerRG12	0x01100011		
		BayerGB12	0x01100012		
		BayerBG12	0x01100013		
		BayerGR10Packed	0x010C0026		
		BayerRG10Packed	0x010C0027		
BayerGB10Packed	0x010C0028				
BayerBG10Packed	0x010C0029				
BayerGR12Packed	0x010C002A				
BayerRG12Packed	0x010C002B				
BayerGB12Packed	0x010C002C				
BayerBG12Packed	0x010C002D				
<i>BinningVertical</i>	Integer	Min: 1 Max: 2		RW	Number of vertical photo-sensitive cells to combine. This reduces the vertical resolution (height) of the image
<i>BinningHorizontal</i>	Integer	Min: 1 Max: 2		RW	Number of horizontal photo-sensitive cells to combine. This reduces the horizontal resolution (width) of the image.

Parameter Name	Type	Value	Access	Description
<i>DecimationVertical</i>	Integer	Min: 1 Max: 2	RW	Vertical sub-sampling of the image. This reduces the vertical resolution (height) of the image by the specified vertical decimation factor.
<i>DecimationHorizontal</i>	Integer	Min: 1 Max: 2	RW	Horizontal sub-sampling of the image. This reduces the horizontal resolution (width) of the image by the specified horizontal decimation factor.
<i>ReverseX</i> ¹	Boolean		RW	Horizontally flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
<i>ReverseY</i> ¹	Boolean		RW	Vertically flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
TestPattern ²	Enumeration	String Off GreyHorizontalRamp GreyVerticalRamp GreyHorizontalRampMoving GreyVerticalRampMoving FlatField	Num 0 1 2 3 4 5	RW Selects type of test pattern generated by the camera replacing the image sensor as the source (refer to section Test Image Pattern for more information).
<i>SensorTestPattern</i> ³	Enumeration	String Off Mode0 Mode1	Num 0 1 2	RW Selects the type of test pattern that is generated by the camera image sensor. Mode0 and Mode1 are used to verify the sensor's connectivity to an FPGA
AdcBitDepth	Enumeration	String Bit10 Bit12	Num 10 12	RO Returns which ADC bit depth is used. A higher ADC bit depth results in better image quality but slower maximum frame rate.

Parameter Name	Type	Value	Access	Description
SensorShutterMode	Enumeration	String Global	Num 1	RO Returns the shutter mode of the device.
<i>HDRMode</i> ⁴	Enumeration	String Off Processing	Num 0 2	RW Controls multi-slope gain state.

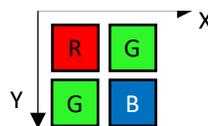
NOTE *

To enable binning feature, set *BinningHorizontal* or *BinningVertical* to 2.

The binning is disabled when *DecimationVertical* or *DecimationHorizontal* is enabled, and vice versa.

¹When *ReverseX* and/or *ReverseY* are enabled for a color camera, the *PixelFormat* changes automatically according to the current Bayer pattern start pixel:

Original *PixelFormat*: BayerRG8



ReverseX is enabled
New *PixelFormat*: BayerGR8



ReverseY is enabled
New *PixelFormat*: BayerGB8



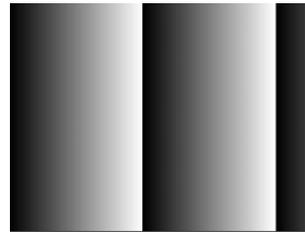
ReverseX and *ReverseY* are enabled together
New *PixelFormat*: BayerBG8



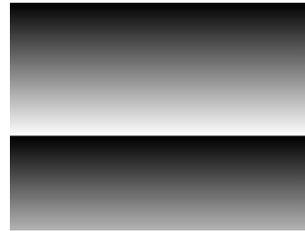
²**Test Pattern** values:

Off: Image is coming from the sensor

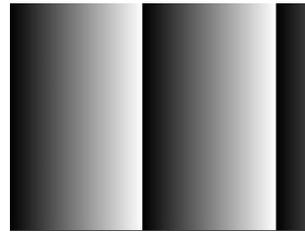
GreyHorizontalRamp: Image is filled horizontally with a digital pattern that goes from the darkest possible value to the brightest.



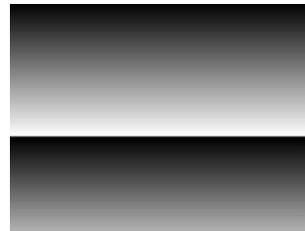
GreyVerticalRamp: Image is filled vertically with a digital pattern that goes from the darkest possible value to the brightest.



GreyHorizontalRampMoving: Image is filled horizontally with digital pattern that goes from the darkest possible value to the brightest and that moves horizontally from left to right at each frame.



GreyVerticalRampMoving: Image is filled vertically with digital pattern that goes from the darkest possible value to the brightest and that moves vertically from top to bottom at each frame.



FlatField: Displays a constant grey level for all display pixels.



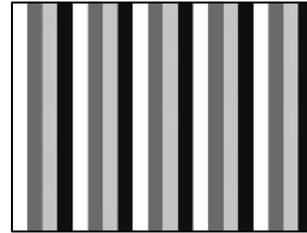
³**Sensor Test Pattern** values:

Mode0: The sensor test image is filled with a vertical stripe pattern of one pixel width. Values are:

12-bit: FFFh/555h/AAAh/000h

10-bit: 3FFh/155h/2AAh/000h

8-bit: FFh/55h/Aah/00h

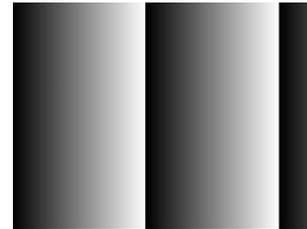


This ensures that the connection between the sensor and FPGA is synchronized.

*For color cameras, make sure that *BalanceRatio* is set to 1.0 and *BalanceWhiteAuto* is Off.

Mode1: The sensor test image is filled horizontally with digital pattern that goes from the darkest possible value to the brightest.

This ensures that the connection between the sensor and FPGA is synchronized.

⁴**HDRMode** values:

- Off – HDR mode is disabled
- Processing – Low gain lines and high gain lines are combined and output.

(See [HDR Processing Control](#) for more information on HDR Mode.)

NOTE (★) The *HDRMode* feature is available for images with a 12-bit pixel format only.

The HDR Processing Control feature is available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only.

To enable the HDR Mode:

1. Set the *PixelFormat* to **Mono12** for monochrome cameras or to **Bayer12** for color cameras.
2. Set *HDRMode* to **Processing**.
3. Set HDR mode parameters on the Analog Control menu (see the [HDR Processing Control](#) section on page 61).

Processing AOI

Parameter Name	Type	Value	Access	Description
PAOISelector	Enumeration	String AWB AEC_AGC	Num 0 1	RW Selects the Processing AOI to configure. AWB – Pixels within the PAOI are used by the Auto White Balance (AWB) feature to calculate white balance coefficients. AEC_AGC – Pixels within the PAOI are used by Auto Exposure Control (AEC) and/or Auto Gain Control (AGC) to calculate the luminance statistics.
PAOIMode	Enumeration	String Disable Enable	Num 0 1	RW Enables/Disables the Processing AOI.
PAOIWidth	Integer	Min: Max: Depends on camera model	RW	Represents the actual image width expelled by the camera of the Processing AOI (in pixels).
PAOIHeight	Integer	Min: Max: Depends on camera model	RW	Represents the actual image height expelled by the camera of the Processing AOI (in pixels).
PAIOffsetX	Integer	Min: 0 Max:	RW	Horizontal offset from the origin to the Processing AOI (in pixels).
PAIOffsetY	Integer	Min: 0 Max:	RW	Vertical offset from the origin to the Processing AOI (in pixels).

Acquisition Control

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

Parameter Name	Type	Value	Access	Description
AcquisitionMode	Enumeration	String SingleFrame MultiFrame Continuous	Num. RW 0 1 2	Defines the number of frames to capture during acquisition and the way the acquisition stops
AcquisitionStart	Command		WO	Starts device acquisition.
AcquisitionStop	Command		WO	Stops acquisition after current frame completes readout.
AcquisitionAbort	Command		WO	Stops acquisition immediately; a partially transferred image will be completed.
<i>AcquisitionFrameCount</i>	Integer	Min: 1 Max: 65535	RW	Sets the number of frames to be acquired in MultiFrame AcquisitionMode.
<i>ExposureMode</i> ¹	Enumeration	String Off Timed TriggerWidth	Num. RW 0 1 2	Sets exposure mode (refer to Exposure Control for more information).
ExposureTime ²	Float		RW	Sets the exposure time in microseconds when ExposureMode is Timed and ExposureAuto is Off.
ExposureAuto	Enumeration	String Off Once Continuous	Num. RW 0 1 2	Sets the automatic exposure mode when ExposureMode is Timed.
<i>AcquisitionFrameRateEnable</i>	Boolean		RW	Controls if the AcquisitionFrameRate and AcquisitionFrameTime features are writable and used to control the acquisition rate. If On, you can extend the actual frame time beyond the free-running frame time. Trigger is disabled and cannot be used in combination with this feature.
AcquisitionFrameTime	Integer		RW	Sets Frame Time in microseconds.

Parameter Name	Type	Value	Access	Description	
AcquisitionFrameRate	Float		RW	Controls the acquisition rate (in Hz) of frames captured.	
<i>AcquisitionLineTimeEnable</i>	Boolean		RW	Controls if the <i>AcquisitionLineTime</i> feature are writable and used to control the acquisition line time.	
AcquisitionLineTime	Integer		RW	This feature sets the actual line time in pixel clocks (74.25MHz).	
<i>AcquisitionBurstFrameCount</i>	Integer	Min: 1 Max: 65535	RW	Number of frames to acquire for each trigger.	
CurrentExposureTime	Integer		RO	Returns current exposure time in microseconds.	
CurrentFrameTime	Integer		RO	Returns current frame time in microseconds.	
<i>TriggerMode</i>	Enumeration	String Off On	Num. 0 1	RW	Enables Trigger mode of operation. Not available if <i>AcquisitionFrameRateEnable</i> parameter is On.
TriggerSoftware	Command		WO	Generates internal trigger. <i>TriggerSource</i> must be set to Software.	
<i>TriggerSource</i> ³	Enumeration	String Line1 Line2 Action0 PulseGenerator Software	Num. 0 1 2 4 5	RW	Specifies internal signal or external Line as trigger source. <i>TriggerMode</i> must be set to On (refer to Trigger Sources for more information).
<i>TriggerActivation</i>	Enumeration	String RisingEdge FallingEdge	Num. 0 1	RW	Specifies activation edge of trigger.
<i>TriggerOverlap</i>	Enumeration	String Off ReadOut	Num. 0 1	RW	Specifies the trigger overlap mode, if the camera receives a trigger pulse while processing the previous trigger. Off – Standard Trigger mode; ReadOut – Fast Trigger mode.
<i>TriggerDebounceTime</i>	Integer	Min: 0 Max: 65535	RW	Specifies time period (in microseconds) when a second trigger is not accepted.	

Parameter Name	Type	Value	Access	Description
<i>TriggerFilterTime</i>	Integer	Min: 0 Max: 65535	RW	Specifies the minimum Trigger signal pulse width. Any pulse shorter than the selected time is ignored.
<i>TriggerDelay</i>	Integer	Min: 0 Max: 16000000	RW	Specifies delay between trigger and start of exposure (in microseconds).

¹**Exposure Mode** values:

Off	Disables the Exposure. The exposure time is equal to frame time.
Timed	The exposure duration is set by the <i>ExposureTime</i> or <i>ExposureAuto</i> features.
TriggerWidth	The exposure duration is set by the width of the current trigger signal pulse. Note that if <i>TriggerActivation</i> is set to <i>RisingEdge</i> , the exposure duration will be the time the trigger stays high. If <i>TriggerActivation</i> is set to <i>FallingEdge</i> , the exposure time lasts as long as the trigger stays low.

²**ExposureTime:** The maximum exposure time is equal to the frame time. For longer exposure times, increase the frame period using the *AcquisitionFrameTime* or *AcquisitionFrameRate* features.

³**TriggerSource** values:

Line1	Hardware Input Line GP Input 1 (Trigger 1) is used as external source for the trigger signal.
Line2	Hardware Input Line GP Input 2 (Trigger 2) is used as external source for the trigger signal.
Action0	Trigger source is generated by software using the Action Command #0 (Trigger over Ethernet)
PulseGenerator	Specifies that the trigger source will be generated by camera's internal Pulse Generator.
Software	Specifies that the trigger source will be generated by software using the <i>TriggerSoftware</i> command.

Short Interval Shutter Control

NOTE (*) The Short Interval Shutter Control category is available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only.

It allows you to enable PIV mode, set exposure time for the first frame and gain value for the second frame. It also allows you to synchronize your system with the exposure duration of first, second, or both frames.

Parameter Name	Type	Value	Access	Description
<i>ShortIntervalShutterMode</i>	Enumeration	String Off On	Num. 0 1	RW Controls short interval shutter state (enables/disables PIV mode).
<i>Frame1ExposureTime</i>	Float			RW Sets the Exposure time in microseconds for the first frame.
<i>Frame1ExposureTimeLimit</i>	Float			RW Sets the Exposure time limit in microseconds for the first frame.
<i>Pulse1Source</i>	Enumeration	String ExposureFrame1 ExposureFrame2 ExposureFrame1 AndFrame2	Num. 0 1 2	RW Selects which Exposure source signal to output on the selected Line.
<i>Pulse2Source</i>	Enumeration	String ExposureFrame1 ExposureFrame2 ExposureFrame1 AndFrame2	Num. 0 1 2	RW Selects which Exposure source signal to output on the selected Line.
<i>Frame2Gain</i>	Float	Min: 0.0 Max: 48.0		RW Controls the gain as an absolute physical value for the second frame.

Analog Control

Analog Control provides parameters for configuring gain, black level, gamma correction, and auto white balance.

Parameter Name	Type	Value	Access	Description
Gain	Float	Min: 0.0 Max: 48.0	RW	Controls the selected gain as an absolute physical value. This is an amplification factor applied to the video signal.
GainAuto	Enumeration	String Off Once Continuous	Num. 0 1 2 RW	Sets the automatic gain control (AGC) mode. <i>ExposureMode</i> can be set to Timed, PulseWidth, or Off.
BlackLevel	Float	Min: 0.0 Max: 4095.0	RW	Controls the on-sensor analog black level as an absolute physical value. This represents a DC offset applied to the video signal.
SensorBlackLevelRecommended	Boolean		RW	Uses recommended value of <i>BlackLevel</i> from the sensor.
BlackLevelAuto	Enumeration	String Off Continuous	Num. 0 1 RW	Sets the on-sensor mode for automatic black level adjustment.
Gamma	Float	Min: 0.00 Max: 4.00	RW	Controls the gamma correction of pixel intensity with an increment of 0.01.
DigitalGain	Float	Min: 0.0 Max: 4.0	RW	Controls the Digital Gain.
DigitalBlackLevel	Float	Min: -4096.0 Max: 4095.0	RW	Controls the Digital Black Level.
BalanceRatioSelector	Enumeration	String Red Blue	Num. 0 1 RW	White Balance Control: Selects which color will be impacted by the <i>BalanceRatio</i> control.
BalanceRatio	Float	Min: 0.25 Max: 4.00	RW	White balance color ratio. Controls ratio of the selected color component to green, which is the reference color. If the Red and Blue Balance ratios are manually set to 1.0, no white balance correction is applied to the pixels.

Parameter Name	Type	Value	Access	Description	
BalanceWhiteAuto	Enumeration	String	Num.	RW	Controls the mode for automatic white balancing between the color channels. The white balancing color ratios are automatically adjusted by selecting either Once or Continuous. If Off, the White Balance color ratios are set manually using <i>BalanceRatioSelector</i> and <i>BalanceRatio</i> controls.
		Off	0		
		Once	1		
		Continuous	2		

HDR Processing Control

The HDR mode (Dual ADC) allows to extend the dynamic range of the image sensor. This is achieved by on-sensor combination of low gain and high gain images that are taken on the same frame. The resulting 12-bit HDR image provides improved recognition.

The **HDR Processing Control** category allows you to configure high gain extension, bit extension threshold, gradation compression points and gains, and maximum analog gain. See the [HDR Mode](#) section on page 187 for more information.

NOTE ⚠ The HDR Processing Control category is available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only.

Make sure to set the *PixelFormat* feature to **12-bit** and the *HDRMode* feature to **Processing** to activate parameters on the HDR Processing Control category.

Parameter Name	Type	Value	Access	Description	
HDRProcessingMode	Enumeration	String Manual	Num. 0	RO	Controls HDR processing mode.
HighGainExtension	Enumeration	String	Num.	RW	Gain setting added to high gain side.
		plus_0_dB	0		
		plus_6_dB	1		
		plus_12_dB	2		
		plus_18_dB	3		
plus_24_dB	4				
BitExtensionThreshold	Integer	Min: 0 Max: 8191		RW	Threshold for data selection of low gain side or high gain side.
GradationCompressionPoint1	Integer	Min: 0 Max: 9		RW	Sets the first start point of gradation compression: 0 – off; 1 – 0000h 2 – 0100h 3 – 0200h 4 – 0400h

Parameter Name	Type	Value	Access	Description
				5 – 0800h 6 – 1000h 7 – 2000h 8 – 4000h 9 – 8000h
GradationCompressionGain1	Integer	Min: 0 Max: 15	RW	Sets the gain of the first gradation compression: 0 – 1/1 1 – 1/2 2 – 1/4 3 – 1/8 4 – 1/16 5 – 1/32 6 – 1/64 7 – 1/128 8 – 1/256 9 – 1/512 10 – 1/1024 11 – 1/2048 12 – 1/4096; 13 – 1/8192 14 – 1/16384 15 – 1/32678
GradationCompressionPoint2	Integer	Min: 0 Max: 9	RW	Sets the second start point of gradation compression: 0 – off 1 – NA 2 – 0100h 3 – 0200h 4 – 0400h 5 – 0800h 6 – 1000h 7 – 2000h 8 – 4000h 9 – 8000h
GradationCompressionGain2	Integer	Min: 0 Max: 15	RW	Set the gain of the second gradation compression: 0 – 1/1 1 – 1/2 2 – 1/4 3 – 1/8 4 – 1/16 5 – 1/32 6 – 1/64 7 – 1/128 8 – 1/256 9 – 1/512 10 – 1/1024 11 – 1/2048 12 – 1/4096 13 – 1/8192 14 – 1/16384 15 – 1/32678

Parameter Name	Type	Value	Access	Description
AnalogGainMax	Float	Min: 0.0 Max: 24.0	RW	Controls the analog gain maximum for HDR mode as an absolute physical value.

Auto White Balance, Exposure and Gain Algorithm Control

Auto Algorithm Control lets you configure settings for AWB (Automatic White Balance), AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) algorithms.

You can set the camera to AEC/AGC to keep the same image brightness during changing lighting conditions. On the Auto Algorithm Control panel, you can configure the range of exposure times and gain values for AEC/AGC by placing minimum and maximum limits on these parameters.

Parameter Name	Type	Value	Access	Description
BalanceWhiteAutoLowerLimit	Float	Min: 0.25 Max: BalanceWhiteAutoLowerLimitMax	RW	Controls the minimum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoUpperLimit	Float	Min: 0.25 Max: BalanceWhiteAutoUpperLimitMax	RW	Controls the maximum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoSpeed	Integer	Min: 1 Max: 64	RW	Speed of AWB algorithm. 1 is slowest, 64 is fastest.
ExposureAutoLowerLimit	Float	Min: ExposureTimeMin Max: ExposureAutoUpperLimit	RW	The shortest exposure time that Auto Exposure can set
ExposureAutoUpperLimit	Float	Min: ExposureAutoLowerLimit Max: ExposureTimeMax	RW	The longest exposure time that Auto Exposure can set.
GainAutoLowerLimit	Float	Min: 0.0 Max: GainAutoUpperLimit	RW	The lowest gain that Auto Gain can set.
GainAutoUpperLimit	Float	Min: GainAutoLowerLimit Max: 48.0	RW	The highest gain that Auto Gain can set.
ExposureGainAutoPriority	Enumeration	String Gain ExposureTime	Num. RW 0 1	Selects whether to adjust gain or exposure first.

Parameter Name	Type	Value	Access	Description
ExposureGainAutoMode	Enumeration	String Average	Num. RO 0	Shows what luminance mode is used during AGC or AEC.
ExposureGainAutoTarget	Integer	Min: 1 Max: 4095	RW	Sets the desired luminance level to be maintained during AGC or AEC with 12-bits per pixel.
ExposureGainAutoTargetThres hold	Integer	Min: 0 Max: 4095	RW	Sets the acceptable steady-state error of the luminance level to be maintained during AGC or AEC. Normal initial setting for stability is 16.
AverageLuminosity	Integer		RO	Shows average luminosity of the image.
CurrentFrameCounterLow	Integer		RO	Shows number of frames captured since the camera power up (lower 32 bits).
CurrentFrameCounterHigh	Integer		RO	Shows number of frames captured since the camera power up (upper 32 bits).

Exposure Auto PID Coefficients



Imperx does not recommend changing min and max limits of the P coefficient. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AEC algorithm.

If you need to change the P coefficient, please contact Imperx support.

Parameter Name	Type	Value	Access	Description
ExposureAutoPMin	Float	Min: 0.0 Max: 256.0	RW	Controls the minimum of the P coefficient for Exposure Auto control loop.
ExposureAutoPMax	Float	Min: 0.0 Max: 256.0	RW	Controls the maximum of the P coefficient for Exposure Auto control loop.
ExposureAutoExposureForPMax	Float	Min: ExposureTimeMin Max:	RW	Maps the maximum of the P coefficient to the value of exposure in the Exposure Auto control loop.

Please refer to the section [P, I, and D Coefficients](#) for more information.

Gain Auto PID Coefficients

CAUTION

Imperx does not recommend changing the P, I, and D coefficients. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AGC algorithm.

If you need to change the P, I, and D coefficients, please contact Imperx support.

Parameter Name	Type	Value	Access	Description
GainAutoPcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the P coefficient for Gain Auto control loop.
GainAutoIcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the I coefficient for Gain Auto control loop.
GainAutoDcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the D coefficient for Gain Auto control loop.

Please refer to the section [P, I, and D Coefficients](#) for more information.

Data Correction

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

Parameter Name	Type	Value	Access	Description
LUTEnable	Enumeration	String Off	Num. RW 0	Selects and enables LUT to be used in processing image. (LUT1 and LUT3 are preprogrammed with Gamma 0.45, LUT 2 and LUT 4 – with negative function)
		LUT1	1	
		LUT2	2	
		LUT3	3	
		LUT4	4	
FFCEnable	Enumeration	String Off	Num. RW 0	Selects FFC to be used in processing image.
		FactoryFFC	1	
		FFC1	2	
		FFC2	3	
		FFC3	4	
		FFC4	5	
		FFC5	6	
		FFC6	7	
FFC7	8			
DefectPixelCorrection	Enumeration	String Off	Num. RW 0	Enables defect pixel correction. You can upload your own defect pixel map.
		Factory	1	
		User	2	
DefectPixelCorrectionMode ¹	Enumeration	String Average	Num. RW 0	Controls the method used for replacing defective pixels (Highlight and Zero are for testing purposes only)
		Highlight	1	
		Zero	2	
BadPixelCorrection	Enumeration	String Off	Num. RW 0	Enables Hot Pixel Correction. You can upload your own hot pixel map.
		Factory	1	
		User	2	
BadPixelCorrectionMode ¹	Enumeration	String Average	Num. RW 0	Controls the method used for replacing hot pixels (Highlight and Zero are for testing purposes only).
		Highlight	1	
		Zero	2	
DefectPixelCountMax	Integer		RO	Maximum number of pixels in the Defect Pixel Correction Table.
BadPixelCountMax	Integer		RO	Maximum number of pixels in the Hot Pixel Correction Table.

¹**DefectPixelCorrectionMode** and **BadPixelCorrectionMode** values:

Average	Defective or Hot Pixels are replaced with the average of their neighbors.
Highlight	Defective or Hot Pixels are replaced with the maximum pixel value.
Zero	Defective or Hot Pixels are replaced by the value zero.

Digital Input / Output Control

Digital Input / Output Control allows you to map camera's inputs and outputs and configure strobes.

Parameter Name	Type	Value	Access	Description	
LineSelector	Enumeration	String	Num.	RW	Selects the physical line (or pin) of the external camera connector or the virtual line of the Transport Layer to configure.
		Input1	0		
		Input2	1		
		Output1	2		
		Output2	3		
LineMode	Enumeration	String	Num.	RO	Returns the status of the physical line used to input or output a signal.
		Input	0		
		Output	1		
LineInverter	Boolean			RW	Controls the inversion of the signal of the selected input or output line.
LineStatus	Boolean	logic 1 – true logic 0 – false		RO	Returns the current signal level on the selected input or output line.
LineSource ¹	Enumeration	String	Num.	RW	Selects which internal signal to output on the selected line. <i>LineSelector</i> must be set to Output.
		Off	0		
		ExposureStart	1		
		ExposureEnd	2		
		MidExposure	3		
		ExposureActive	4		
		TriggerActual	5		
		TriggerDelayed	6		
		PulseGenerator	7		
		Strobe1	8		
		Strobe2	9		
		Pulse1Source	10		
Pulse2Source	11				
LineFormat ²	Enumeration	String	Num.	RO	Returns the current electrical format of the selected physical input or output line.
		NoConnect	0		
		TriState	1		
		TTL	2		
		OptoCoupled	3		
Strobe1Reference	Enumeration	String	Num.	RW	Sets the reference event for Strobe #1 signal.
		Exposure	0		
		Readout	1		
		Trigger	2		
		Pulse1Source	3		
		Pulse2Source	4		
Strobe1Enable	Enumeration	String	Num.	RW	Enables or disables the Strobe #1.
		Off	0		
		On	1		
Strobe1Width	Integer	Min: 10 Max: 16000000		RW	Sets Strobe #1 pulse duration in microseconds.

Parameter Name	Type	Value	Access	Description
Strobe1Delay	Integer	Min: 0 Max: 16000000	RW	Sets Strobe #1 delay from the reference, in microseconds.
Strobe2Reference	Enumeration	String Exposure Readout Trigger Pulse1Source Pulse2Source	Num. 0 1 2 3 4	RW Sets the reference event for Strobe #2 signal.
Strobe2Enable	Enumeration	String Off On	Num. 0 1	RW Enables or disables the Strobe #2.
Strobe2Width	Integer	Min: 10 Max: 16000000	RW	Sets Strobe #2 pulse duration in microseconds.
Strobe2Delay	Integer	Min: 0 Max: 16000000	RW	Sets Strobe #2 delay from the reference, in microseconds.

¹**LineSource** values (for outputs only):

ExposureStart	A short pulse indicating the beginning of the exposure
ExposureEnd	A short pulse indicating the end of the exposure
MidExposure	A short pulse indicating the middle of the exposure
ExposureActive	The output signal is active for the duration of exposure time
TriggerActual	Maps the input trigger pulse to the output with no delay
TriggerDelayed	Maps the input trigger pulse to the output with trigger delay
PulseGenerator	Maps the internal pulse generator waveform to the output
Strobe1	Maps the Strobe 1 signal to the corresponding external output
Strobe2	Maps the Strobe 2 signal to the corresponding external output
Pulse1Source / Pulse2Source	Maps the Pulse 1 Source / Pulse 2 Source to the corresponding external output. The Pulse 1 Source and Pulse 2 Source are set on the Short Interval Shutter Control panel. The options are: <ul style="list-style-type: none"> ExposureFrame1 – The output signal is active for the duration of Frame 1 exposure time in PIV mode. ExposureFrame2 – The output signal is active for the duration of Frame 2 exposure time in PIV mode. ExposureFrame1AndFrame2 – The output signal is active for the duration of Frame 1 and Frame 2 exposure time

²**LineFormat** values:

NoConnect	The line is not connected
TriState	The line is currently in Tri-State mode (Not driven)
TTL	The line is currently accepting or sending TTL level signals
OptoCoupled	The line is opto-coupled

You can monitor the current logic level (1 or 0) of the signal on the selected input or output by using the *LineStatus* parameter.

The *LineMode* parameter shows the status of the selected input or output line.

Depending on line selected under *LineSelector* (Input or Output), you can apply the following controls:

LineSelector	Available controls	Values
Input1 or Input2	<i>LineInverter</i>	True False
Output1 or Output2	<i>LineInverter</i>	True False
	<i>LineSource</i>	Off ExposureStart ExposureEnd MidExposure ExposureActive TriggerActual TriggerDelayed PulseGenerator Strobe1 Strobe2 Pulse1Source Pulse2Source

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.

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 = 1 μ S, x10=10 μ S, etc.
PulseGenWidth	Integer		RW	Sets pulse width of Pulse Generator where each unit is equal to <i>PulseGenGranularity</i> .
PulseGenPeriod	Integer		RW	Sets pulse period of Pulse Generator where each unit is equal to <i>PulseGenGranularity</i> .
PulseGenNumPulses	Integer	Min: 1 Max: 65536	RW	Sets number of pulses to be generated by Pulse Generator.
PulseGenMode	Enumeration	String Continuous NumPulses	Num. 0 1	RW Sets the mode of the Pulse Generator.
PulseGenEnable	Boolean		RW	Enables Pulse Generator. The pulse generator output can be mapped to the OUTPUT1 or OUTPUT2 output signals. It also can be used as a trigger source.

Canon Lens Control

Canon EF Lens supports motorized iris and focus (not zoom). Canon Lens Control parameters give you control over iris and focus position. Refer to the [Canon Lens Control](#) section for more information on lens adjusting procedures.

Controller Settings

Parameter Name	Type	Value	Access	Description
InitLens	Command		WO	Initializes the Canon Lens. Always initialize lens after power up.
StopLens	Command		WO	Removes power from the Iris drive. Run the <i>InitLens</i> command to resume the lens control.
LensControllerStatus	Enumeration	String InitLens_Failed InitLens_Done	Num. 0 1	RO Shows status of Canon Lens initialization.
LensAF_MF	Enumeration	String AutoFocus ManualFocus	Num. 0 1	RO Shows status of Auto/Manual focus switch located on the lens.
GetLensStatus	Command		WO	Requests the value of Lens Status register.
LensStatus	Integer		RO	Returns the status of the Lens after the <i>GetLensStatus</i> run
CanonFocusingDrivesIneffective	Boolean		RO	Shows the status of focusing drive mechanism. Appears True if mechanism reached FarFull or NearFull position.
CanonFocusingRingsActive	Boolean		RO	This feature indicates the state of focusing drive. Stays True while focusing drive is accelerating or decelerating.
CanonElectronicRingDriveOn	Boolean		RO	Shows the power status of focusing drive. Focusing drive may consume power even if not moving.
CanonIrisFullyOpened	Boolean		RO	Shows the status of Iris.
GetLensID	Command		WO	Requests value of Lens ID register.
LensID	Integer		RO	Returns Lens ID after the <i>GetLensID</i> command is issued.

Focus

Parameter Name	Type	Value	Access	Description
NearFull	Command		WO	Drives the focus to the fully Near position.
FarFull	Command		WO	Drives the focus to the fully Far position.
FocusSetupValue	Integer	Min: 1 Max: 255	RW	Sets the focus step used with NearStep and FarStep commands.
NearStep	Command		WO	Drives the focus to the Near direction by the amount defined in the <i>FocusStepValue</i> feature.
FarStep	Command		WO	Drives the focus in the Far direction by the amount defined in the <i>FocusStepValue</i> feature.
FocusReqPosition	Integer	Min: 0 Max: FocusMaxReg	RW	Sets the desired focus value to use with the <i>SetFocusPosition</i> command.
SetFocusPosition	Command		WO	Drives the focus to the absolute position defined in the <i>FocusReqPosition</i> feature.
FocusMax	Integer		RO	Returns Maximum Focus Limit
FocusSetMax	Command		WO	Sets the Maximum Focus Limit
GetFocusEncoderStatus	Command		WO	Requests the focus encoder position value.
FocusEncoderStatus	Integer		RO	Returns the current focus encoder value after the GetFocusEncoderStatus command issued.
ResetFocusEncoder	Command		WO	Resets the Focus encoder.

Iris

Parameter Name	Type	Value	Access	Description
IrisRequestedPositionRaw	Integer	Min: IrisMin2 Max: IrisMax	RW	Sets raw iris absolute position.
SetIrisPosition	Command		WO	Drives the iris to the absolute position value of <i>IrisRequestedPositionRaw</i> .
CurrentFNumber	Float		RO	Returns the current f-number value of the lens iris. A Value of 0.0 means the iris position is unknown
OpenIrisFull	Command		WO	Opens the iris to the fully opened position.
CloseIrisStep	Command		WO	Closes the iris by the amount defined in the <i>IrisStepValue</i> feature.
OpenIrisStep	Command		WO	Opens the iris by the amount defined in the <i>IrisStepValue</i> feature.
IrisStepValue	Integer	Min: 1 Max: 127	RW	Sets the iris step to be used with <i>OpenStep</i> and <i>CloseStep</i> commands.
GetIrisRange	Command		WO	Sends the <i>Get Iris Range</i> command to the camera.
IrisMin	Integer		RO	Returns the minimum iris limit.
IrisMax	Integer		RO	Returns the maximum iris limit.
IrisRange	Integer		RO	Displays the limit values of the iris, after the <i>GetIrisRange</i> command issued.

Transport Layer Control

The Transport Layer Control provides a variety of configuration settings and read-only information for configuring communications between the cameras and other devices with the 10 GigE Vision interface.

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.

GigE Vision

Parameter Name	Type	Value	Access	Description
GevMACAddress	Integer		RO	Stores the MAC address of the given network interface.
<i>GevGVSPExtendedIDMode</i>	Enumeration	String Off On	Num. 0 1 RW	Sets the extended ID mode for GVSP (64 bit block_id64, 32 bit packet_id32). This bit cannot be reset if the stream channels do not support the standard ID mode.
GevCurrentIPConfigurationLLA	Boolean		RW	Indicates if Link Local Address IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationDHCP	Boolean		RW	Indicates if DHCP IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationPersistentIP	Boolean		RW	Indicates if PersistentIP configuration scheme is activated on the given network interface
GevCurrentIPAddress	Integer		RO	Reports the IP address for the given network interface once it has been configured
GevCurrentSubnetMask	Integer		RO	Provides the subnet mask of the given interface

Parameter Name	Type	Value	Access	Description																						
GevCurrentDefaultGateway	Integer		RO	Indicates the default gateway IP address to be used on the given network interface																						
GevPersistentIPAddress	Integer		RW	Indicates the Persistent IP address for this network interface																						
GevPersistentSubnetMask	Integer		RW	This feature indicates the Persistent subnet mask associated with the Persistent IP address on this network interface.																						
GevPersistentDefaultGateway	Integer		RW	Indicates the persistent default gateway for this network interface.																						
GevIEEE1588Supported	Boolean		RO	Indicates whether the IEEE 1588 V2 Precision Time Protocol (PTP) is supported.																						
GevIEEE1588	Boolean		RW	Enables the IEEE 1588 Precision Time Protocol to control the timestamp register.																						
GevIEEE1588Status	Enumeration	<table border="0"> <tr> <td>String</td> <td>Num.</td> </tr> <tr> <td>Unknown</td> <td>0</td> </tr> <tr> <td>Initializing</td> <td>1</td> </tr> <tr> <td>Faulty</td> <td>2</td> </tr> <tr> <td>Disabled</td> <td>3</td> </tr> <tr> <td>Listening</td> <td>4</td> </tr> <tr> <td>PreMaster</td> <td>5</td> </tr> <tr> <td>Master</td> <td>6</td> </tr> <tr> <td>Passive</td> <td>7</td> </tr> <tr> <td>Uncalibrated</td> <td>8</td> </tr> <tr> <td>Slave</td> <td>9</td> </tr> </table>	String	Num.	Unknown	0	Initializing	1	Faulty	2	Disabled	3	Listening	4	PreMaster	5	Master	6	Passive	7	Uncalibrated	8	Slave	9	RO	Provides the status of the IEEE 1588 clock.
String	Num.																									
Unknown	0																									
Initializing	1																									
Faulty	2																									
Disabled	3																									
Listening	4																									
PreMaster	5																									
Master	6																									
Passive	7																									
Uncalibrated	8																									
Slave	9																									
GevIEEE1588Mode	Enumeration	<table border="0"> <tr> <td>String</td> <td>Num.</td> </tr> <tr> <td>Auto</td> <td>0</td> </tr> <tr> <td>SlaveOnly</td> <td>1</td> </tr> </table>	String	Num.	Auto	0	SlaveOnly	1	RW	Provides the mode of the IEEE 1588 clock.																
String	Num.																									
Auto	0																									
SlaveOnly	1																									
GevIEEE1588GrandmasterClockID	Integer		RO	This feature stores the clock ID of PTP grandmaster.																						
GevLinkSpeed	Integer		RO	Indicates the speed of transmission negotiated by the given network interface in Mbps.																						

Parameter Name	Type	Value	Access	Description
GevFirstURL	String		RO	This feature stores the first URL to the XML device description file.
GevSecondURL	String		RO	This feature stores the second URL to the XML device description file.
GevCCP	Enumeration	String OpenAccess 0 ExclusiveAccess 1 ControlAccess 2	RO	
GevPrimaryApplicationSocket	Integer		RO	Indicates the UDP source port of the primary application.
GevPrimaryApplicationIPAddress	Integer		RO	Indicates the address of the primary application.
GevMCPHostPort	Integer		RW	Controls the port to which the device must send messages. Setting this value to 0 closes the message channel.
GevMCDA	Integer		RW	Controls the destination IP address for the message channel.
GevMCTT	Integer		RW	Provides the message channel transmission timeout value in milliseconds.
GevMCRC	Integer		RW	Controls the number of retransmissions allowed when a message channel message times out.
GevMCSP	Integer		RO	Indicates the source port for the message channel
GevSCCFGUnconditionalStreaming	Boolean		RW	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	Integer		RW	Indicates the port to which the device must send data stream.

Parameter Name	Type	Value	Access	Description
<i>GevSCPSFireTestPacket</i>	Boolean		RW	When this bit is set, the device fires one test packet.
<i>GevSCPSDoNotFragment</i>	Boolean		RW	This bit is copied into the <i>do not fragment</i> bit of the 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.
<i>GevSCDA</i>	Integer		RW	Indicates the destination IP address for this stream channel.
<i>GevSCFTD</i>	Integer	Min: 0 Max: GevSCFTDMax	RW	Sets a frame transmission delay in microseconds to sequence multiple camera outputs on network. The value of delay between the frame acquisition and transmission.
<i>GevSCPSPacketSize</i>	Integer	Min: 80 Max: 16256	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 the current heartbeat timeout in milliseconds.
GevTimestampTickFrequency	Integer		RO	This 64-bit feature indicates the number of timestamp ticks during 1 second.
GevTimestampControlLatch	Command		WO	Latches current timestamp counter into Timestamp Value register.
GevTimestampControlReset	Command		WO	Resets timestamp 64-bit counter to 0.
GevTimestampValue	Integer		RO	Reports the latched 64-bit value of the timestamp counter.

User Set Control

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

Parameter Name	Type	Value		Access	Description
<i>UserSetSelector</i>	Enumeration	String	Num.	RW	Selects User Set to load, save, or configure. Default settings are configured by the factory and are write-protected
		Default	0		
		UserSet0	1		
		UserSet1	2		
		UserSet2	3		
UserSet3	4				
<i>UserSetLoad</i>	Command			WO	Loads User Set specified by <i>UserSetSelector</i> from non-volatile memory into camera RAM and makes it active.
<i>UserSetSave</i>	Command			WO	Saves User Set 0, 1, 2 or 3 specified by <i>UserSetSelector</i> to non-volatile memory.
<i>UserSetDefault</i>	Enumeration	String	Num.	RW	Selects User Set to load and activate when a camera is powered on or reset. Default Configuration is set by the factory.
		Default	0		
		UserSet0	1		
		UserSet1	2		
		UserSet2	3		
UserSet3	4				

Action Control

Parameter Name	Type	Value	Access	Description
NumberOfActionSignals	Integer	1	RO	<p>Returns number of separate action signals supported by the device. Determines how many action signals the device can handle in parallel, i.e. how many different action commands can be set up for the device.</p> <p>As the Cheetah cameras support only one action command, <i>NumberOfActionSignals</i> is always set to 1.</p>
ActionDeviceKey	Integer	Min: 0 Max: 0xFFFFFFFF	WO	<p>Provides the device key that allows the device to check the validity of action commands. The device internal assertion of an action signal is only authorized if the <i>ActionDeviceKey</i> and the action device key value in the protocol message are equal.</p>
ActionQueueSize	Integer	1	RO	<p>Indicates the size of the scheduled action commands queue. This number represents the maximum number of scheduled action commands that can be pending at a given point in time.</p>
ActionSelector	Integer	0	RO	<p>Returns an action signal (<i>Action0</i>) that is defined by the <i>ActionGroupMask</i> and <i>ActionGroupKey</i> values specified below.</p> <p>As the Cheetah cameras support only one action command, <i>ActionSelector</i> is always set to 0.</p>
ActionGroupMask	Integer	Min: 0 Max: 0xFFFFFFFF	RW	<p>Provides the mask that the device will use to validate the action on reception of the action protocol message.</p>
ActionGroupKey	Integer	Min: 0 Max: 0xFFFFFFFF	RW	<p>Provides the key that the device will use to validate the action on reception of the action protocol message.</p>

Event Control

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

Parameter Name	Type	Value	Access	Description	
EventSelector ¹	Enumeration	String	Num.	RW	Selects which Event to signal to the host application.
		AcquisitionStart	0x9105		
		AcquisitionEnd	0x9106		
		Stream0TransferIntDrop	0x9107		
		MessageTransferOverflow	0x9108		
		IN1	0x9101		
		IN2	0x9102		
		OUT1	0x9103		
OUT2	0x9104				
EventNotification	Enumeration	String	Num.	RW	Activate or deactivate the notification to the host application of the occurrence of the selected Event.
		Off	0		
		On	1		

¹EventSelector values:

- **AcquisitionStart** – Device just started the acquisition of one or many frames.
- **AcquisitionEnd** – Device just completed the acquisition of one or many frames.
- **Stream0TransferIntDrop** – Stream channel internal drop.
- **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).

Configuring an Ethernet Adapter and Host Computer



Make sure that the version of your NIC driver is the most recent one, update it if necessary. Using an outdated version of a NIC driver might negatively affect the data transmission.

Linux:

To find the driver name and version of your network interface card, run the following command:

```
ethtool -i <your_nic_id>
```

See the **driver** parameter for the driver name and the **version** parameter for the driver version.

```

:~$ ethtool -i enp10s0
driver: atlantic
version: 5.15.0-105-generic
firmware-version: 3.1.77
    
```

For the best system performance, Imperx recommends configuring the following parameters of your network interface card (NIC): Jumbo Frames (Jumbo Packets), Receive/Transmit Buffers, Interrupt Moderation Rate to the values shown below. You also might need to disable antivirus software and Firewalls, turn off power saving plan, and configure IP addresses for multiple NICs on the host computer.

Parameter	Value
Jumbo Frames (or Jumbo Packets)	9000 (9014, 16K, or 9 KB MTU)
Receive Buffers (or Receiver Descriptors)	Maximum
Transmit Buffers	Maximum
Interrupt Moderation	Enable
Interrupt Moderation Rate (or Interrupt Throttling)	Extreme

For adjusting procedures, see the [Adjusting Jumbo Frames, Receive/Transmit Buffers, and Interrupt Moderation Rate in Windows](#) section.

NOTE *

The parameter names and configuring procedures depend on the adapter model and manufacturer and may differ from the ones described in this chapter. When adjusting the adapter parameters, select the ones that relate to the parameters listed above. For more information, refer to the NIC documentation.

Jumbo Frames

Jumbo Frames (or **Jumbo Packets**) parameter allows for payloads larger than the standard maximum transmission unit (MTU) of 1,500 bytes and supports up to 9,000 bytes per packet. Jumbo Frames are used to reduce the overhead load per packet, decrease CPU load, and increase data transfer rate. As fewer packets are needed to transfer data, the number of interrupts decreases resulting in lower overall CPU usage.

Make sure that your network equipment (cameras, switches, routers, Network Interface Cards (NICs)) supports Jumbo frames and is configured to use the same frame size. If any network devices do not support Jumbo Frames, packet and frame drops may occur.

Most network adapters have Jumbo Packets disabled. To enable Jumbo Packet, please follow the steps in the [Adjusting Jumbo Frames, Receive/Transmit Buffers, and Interrupt Moderation Rate in Windows](#) section.

TIP ⓘ

Connect the Cheetah 10 GigE Vision camera to a dedicated Ethernet port and use an Ethernet adapter that supports Jumbo Packets.

Receive/Transmit Buffers

Receive Buffers (or **Receive Descriptors**) and **Transmit Buffer** parameters set the amount of system memory that can be used by the adapter driver when copying data to the memory. Typically, it is set to a low value by default (usually 256) which causes dropped packets (older packets will be overwritten). For maximum performance, Imperx recommends that you set these parameters as high as possible.

Increasing the Receive Buffers and Transmit Buffers size will improve stability and can be configured on the most systems without causing any system level interrupt. However, it can negatively affect systems which have limited system memory.

NOTE ⓘ

Receive/Transmit Buffers settings do not affect your system's CPU usage.

Interrupt Moderation Rate

Interrupt Moderation Rate (or **Interrupt Throttling**) sets the maximum number of interrupts per second to the CPU when processing the transmitted and received packets.

Minimizing the interval between interrupts reduces the latency on each packet but increases CPU usage and decreases throughput. To minimize CPU usage, larger interrupt intervals are required.

Some NICs support only Interrupt Moderation control, while the others support both Interrupt Moderation and Interrupt Moderation Rate control.

When the Interrupt Moderation setting is disabled, an interrupt is created for every packet, reducing the latency on each packet. However, this significantly increases CPU usage. Enabling the Interrupt Moderation setting allows multiple packets to be processed for each interrupt lowering CPU usage.

TIP ⓘ

The Interrupt Moderation Rate can be set at about 8,000 (or Extreme) interrupts per second to achieve lower latency.

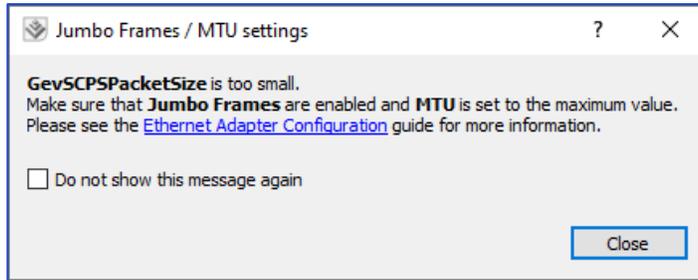
If some latency is acceptable, the Interrupt Moderation Rate can be set at about 1,000 (or Low) interrupts per second to achieve lower CPU usage.

Experiment with your system to determine the optimal setting. You can try the following options as well:

- Use the default value set by the manufacturer's drivers.
- Set a NIC to the adaptive interrupt moderation mode. In this mode, the interval is dynamically changed according to packet size and throughput.

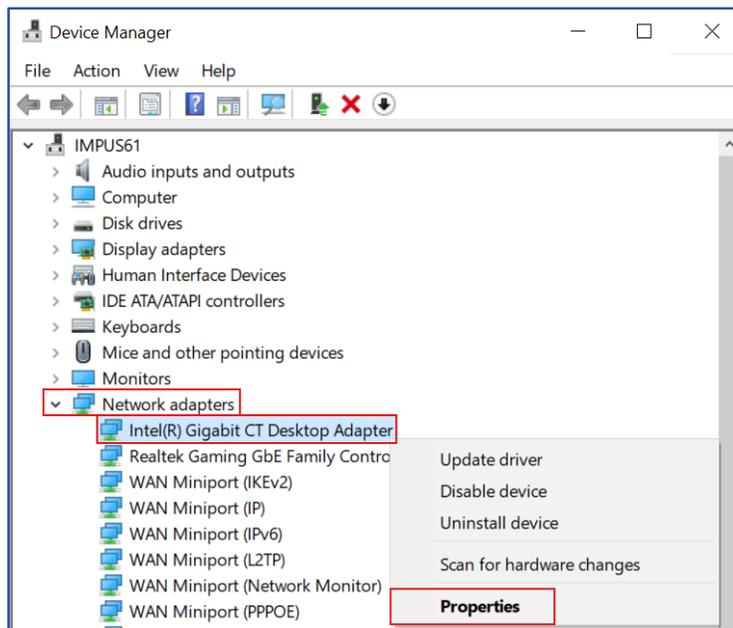
Adjusting Jumbo Frames, Receive/Transmit Buffers, and Interrupt Moderation Rate in Windows

If your network adapter has Jumbo Frames disabled, the following pop-up window opens while connecting the camera:



To adjust Jumbo Frames, MTU size, and other parameters, follow the steps below.

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Hardware and Sound** → **Devices and Printers** → **Device Manager**.
3. Expand **Network Adapters** list → Right-click the Ethernet adapter that works with your camera → **Properties**.



4. On the **Advanced** tab, set the following parameters:
 - **Jumbo Packet** (or **Jumbo Frame**) → Set **Value** to *9014 Bytes* (or *9 KB MTU, 9000, 16K* – depends on NIC).
 - **Receive Buffers** (or **Receive Descriptors**) → Set to the maximum value possible.
 - **Transmit Buffers** → Set to the maximum value possible.
 - **Interrupt Moderation** → *Enable*.
 - **Interrupt Moderation Rate** (or **Interrupt Throttling**) → Set to *Extreme*.
 At higher data rates, the Extreme setting may improve system performance. At lower data rates, a Low setting is preferred since delayed interrupts cause additional latency.

If **Jumbo Packet** or **Jumbo Frame** is absent from the list, your NIC does not support Jumbo Packets. Maximum camera performance cannot be achieved.

→

Intel(R) Gigabit CT Desktop Adapter Properties

Events Resources Power Management

General **Advanced** Driver Details

The following properties are available for this network adapter. Click the property you want to change on the left, and then select its value on the right.

Property:	Value:
Adaptive Inter-Frame Spacing	Disabled
Flow Control	4088 Bytes
Gigabit Master Slave Mode	9014 Bytes
Interrupt Moderation	Disabled
Interrupt Moderation Rate	
IPv4 Checksum Offload	
Jumbo Packet	
Large Send Offload V2 (IPv4)	
Large Send Offload V2 (IPv6)	
Locally Administered Address	
Log Link State Event	
Maximum Number of RSS Queue	
Packet Priority & VLAN	
Receive Buffers	

OK Cancel

5. Click **OK**. The network connectivity may be lost for a couple of seconds.
6. Reboot your PC to ensure that new settings have been activated.

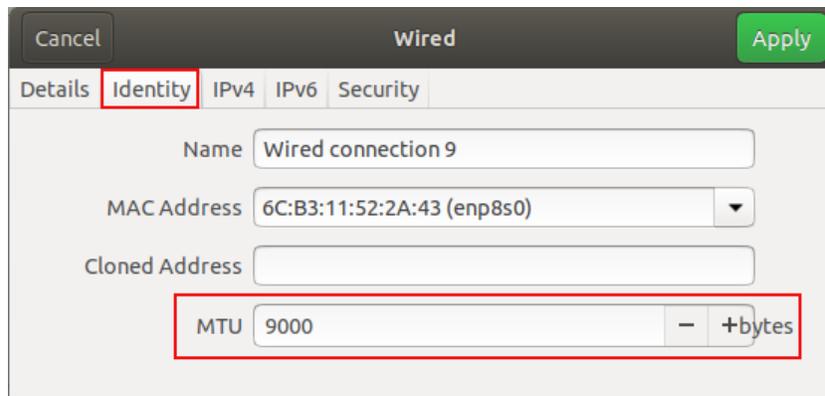
Enabling Jumbo Frames in Linux

To enable Jumbo Frames and set MTU size to 9000 using the console, run the following command:

```
sudo ip link set <eth_link_name> mtu 9000
sudo ip link set <eth_link_name> mtu 9000
sudo ip link set <eth_link_name> up
```

To enable Jumbo Frames and set MTU size to 9000 using the Network Settings in the Ubuntu GUI, follow the steps below:

1. In the top right-hand corner of the screen, click the Wired Network icon  → Settings  → Network → select the Ethernet adapter that works with your camera → click the  button.
2. On the Identity tab, set the MTU size to 9000 bytes and click Apply:



3. The Ethernet link reset may be required for this change to take effect.

Adjusting Receive/Transmit Buffers in Linux

To set RX/TX buffer size, use the **ethtool** utility.

1. If the **ethtool** utility is not installed, run the following command to install it:

```
sudo apt-get install ethtool
```

2. Find the maximum RX/TX values by running the following command:

```
ethtool -g <eth_link_name>
```

```
tester@kola-ubuntu18:~$ ethtool -g enp6s0
Ring parameters for enp6s0:
Pre-set maximums:
RX:                4096
RX Mini:           0
RX Jumbo:          0
TX:                4096
Current hardware settings:
RX:                512
RX Mini:           0
RX Jumbo:          0
TX:                512
```

3. Set the maximum RX/TX (as shown above, rx-max = 4096, tx-max=4096) by running the following command:

```
sudo ethtool -G <eth_link_name> rx 4096 tx 4096
```

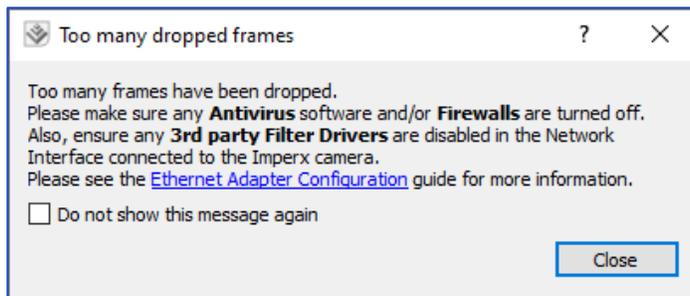
```
tester@kola-ubuntu18:~$ sudo ethtool -G enp6s0 rx 4096 tx 4096
tester@kola-ubuntu18:~$ ethtool -g enp6s0
Ring parameters for enp6s0:
Pre-set maximums:
RX:                4096
RX Mini:           0
RX Jumbo:          0
TX:                4096
Current hardware settings:
RX:                4096
RX Mini:           0
RX Jumbo:          0
TX:                4096
```

Configuring a Host Computer in Windows

This section describes how to disable the Windows Firewall, turn off the power saving plan, and configure IP addresses for multiple NICs on the host computer.

Antivirus software, Firewalls, or third-party filter drivers may impact the efficiency of the system resulting an excessive number of dropped frames and slow video streaming.

When too many frames have been dropped, the video acquisition rate slows down. The following pop-up window opens:



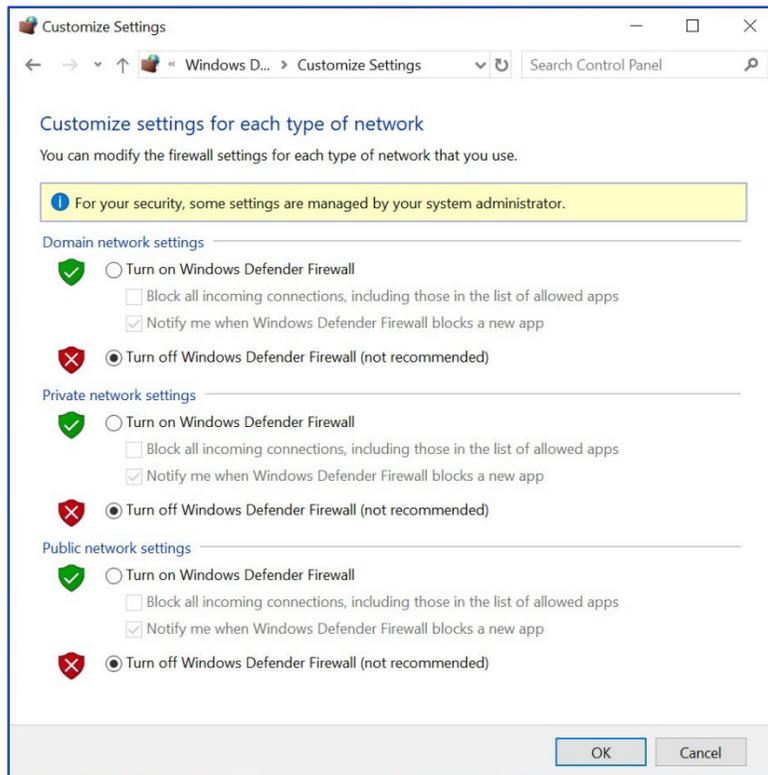
Imperx recommends **turning off** any Firewalls, antivirus software, and third-party filter drivers and to disable Windows Performance Monitor (perfmon.exe) or Wireshark (use it solely for debugging purposes), and not opening the Networking tab in Windows Task Manager.

To turn off the Firewall, please refer to the sections [Disabling Windows Firewall for All Connections](#) and [Disabling Windows Firewall for Selected Network Adapters](#).

Please contact your IT Department on turning off antivirus software and any third-party filter drivers.

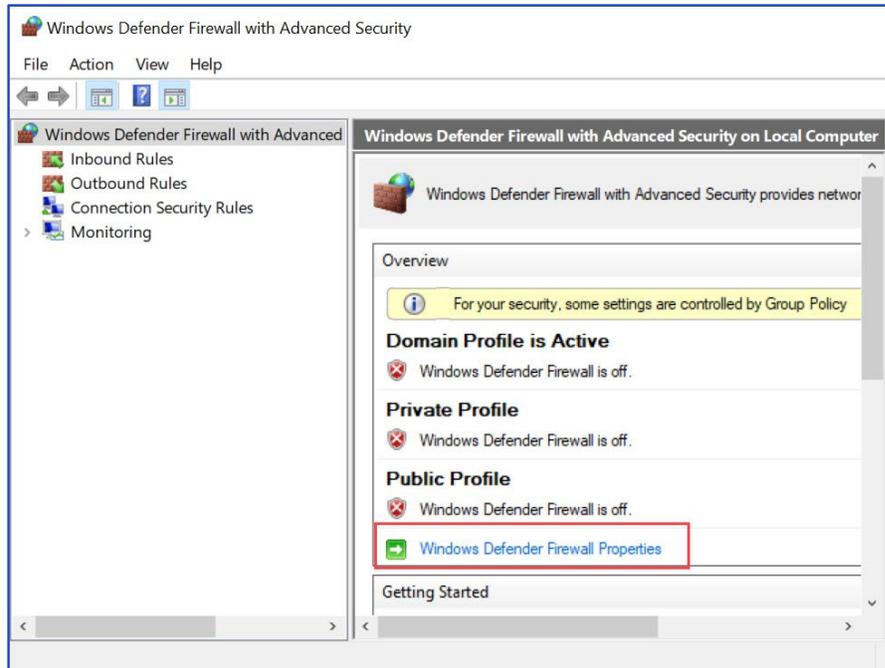
Disabling Windows Firewall for All Connections

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **System and Security** → **Windows Defender Firewall**.
3. On the left panel, click **Turn Windows Defender Firewall on or off**. The **Customize settings** windows opens.
4. Select a network type that your camera is connected to, and click **Turn off Windows Defender Firewall (not recommended)**. Click **OK**.

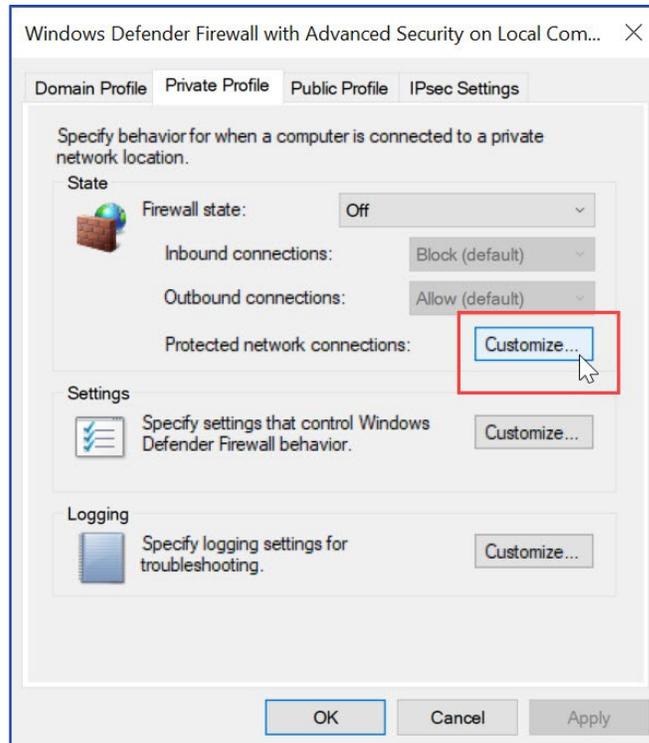


Disabling Windows Firewall for Selected Network Adapters

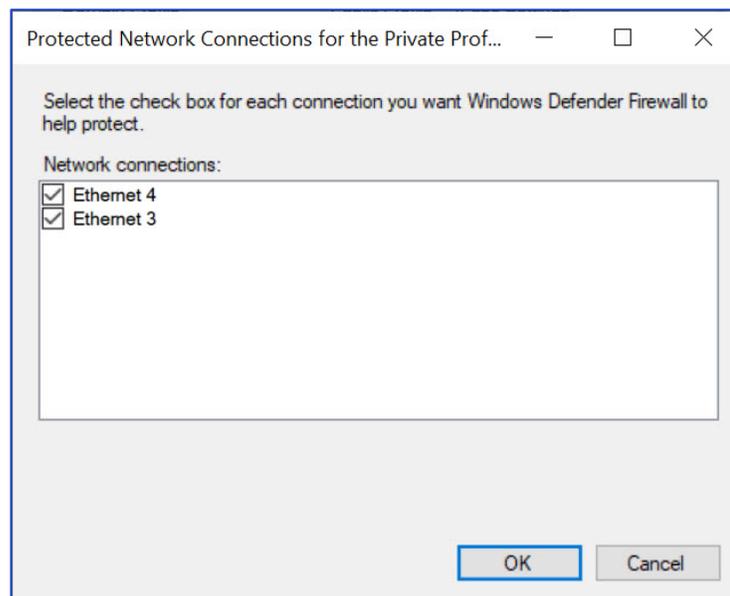
1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **System and Security** → **Windows Defender Firewall**.
3. On the left panel, click **Advanced settings**. The **Windows Defender with Advanced Security** windows opens.
4. Click **Windows Defender Firewall Properties**.



5. In the **Windows Defender Firewall with Advanced Security on Local Computer Properties...** window, select the tab of the profile to turn off the firewall and click **Customize...** in the State section.



- The **Protected Network Connections for the Private Profile** windows shows a list of the network connections with the firewall turned on. To disable the firewall, uncheck those connections that contain your cameras. Click **OK**.



Configuring IP Addresses

Camera and NIC addresses must be in the same subnet. To assign a unique IP address to a NIC, you can use one of the following methods:

Method	When to use
Configuring a static IP address	In networks without a DHCP server, if cameras have persistent IP address specified
Configuring a dynamic IP address via DHCP	In networks with a DHCP server installed
Link-Local IP Addressing	In the absence or failure of static or dynamic address configurations

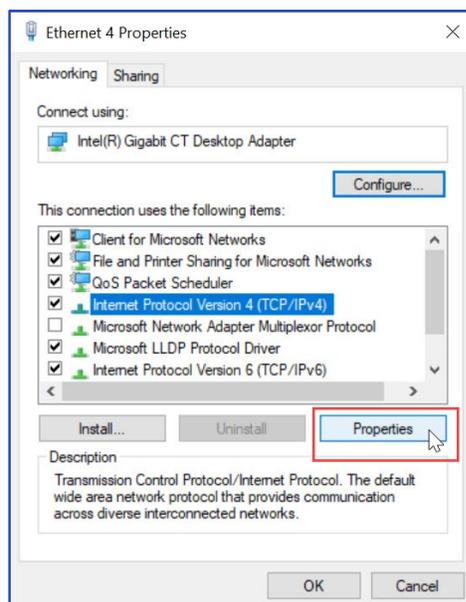
TIP ⓘ

Before assigning a dynamic IP address, please make sure that a DHCP server is running in your network. The DHCP server assigns the IP address to each NIC and camera with DHCP/Auto IP setting enabled.

If the DHCP server is not running in the network, you can use the LLA configuration or manually assign static IP addresses to each NIC and 10 GigE Vision camera.

Configuring a Static IP Address in Windows

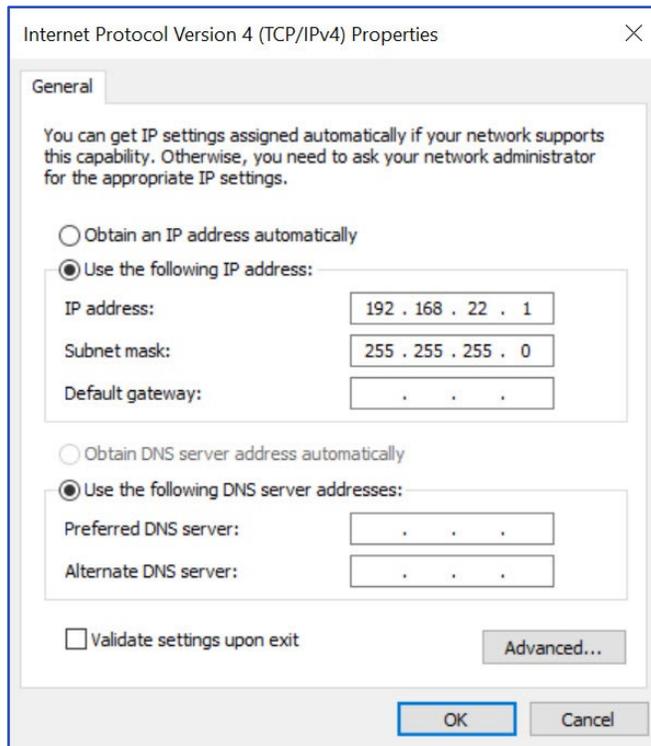
1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Select Internet **Protocol Version 4 (TCP/IPv4)**, click **Properties**.



6. Select **Use the following IP address** and assign an IP address to the network adapter. The **Default gateway** field should be blank.

Imperx recommends using a private network IP address. The following IPv4 address ranges are reserved for private networks:

RFC1918 name	IP address range	Largest CIDR block (subnet mask)
24-bit block	10.0.0.0–10.255.255.255	10.0.0.0/8 (255.0.0.0)
20-bit block	172.16.0.0–172.31.255.255	172.16.0.0/12 (255.240.0.0)
16-bit block	192.168.0.0–192.168.255.255	192.168.0.0/16 (255.255.0.0)

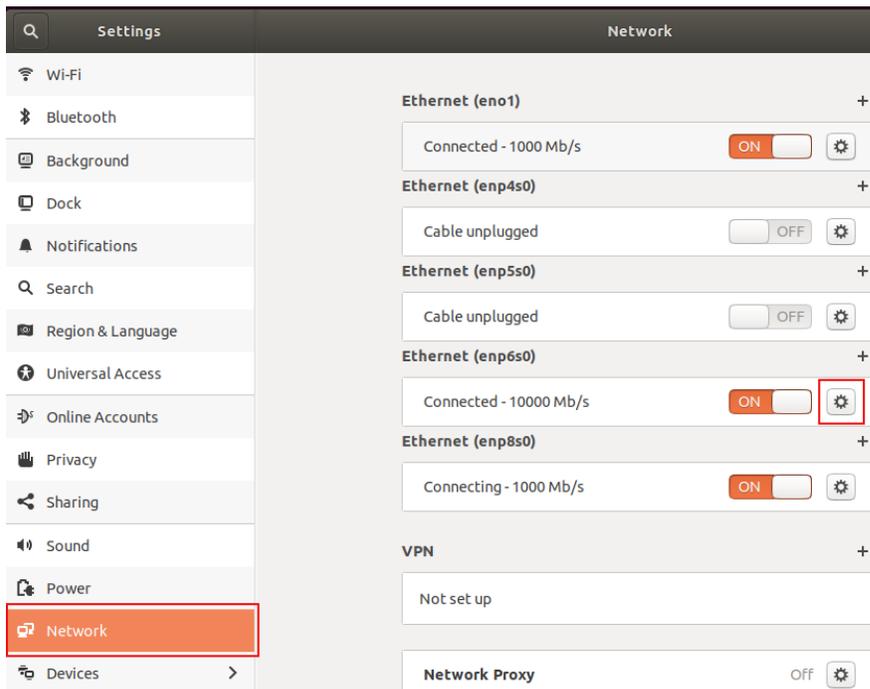


7. Click **OK**.
8. Repeat steps 4–7 for each NIC on your computer.

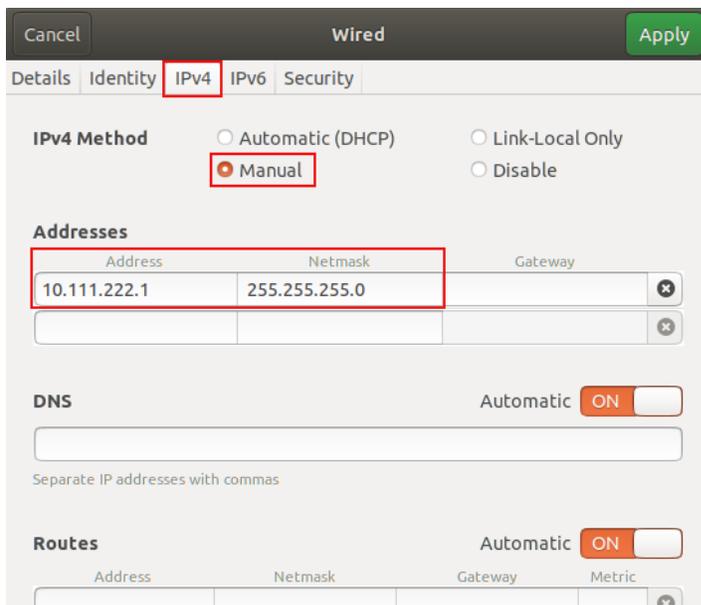
Configuring a Static IP Address in Linux

To assign a static IP address manually, follow the steps below.

1. In the top right-hand corner of the screen, click the **Wired Network** icon → **Settings** → **Network** → select the Ethernet adapter that works with your camera → click the button.



2. On the **IPv4** tab, set **IPv4 Method** to **Manual** and enter an IP address and Netmask in the Addresses area. The **Gateway**, **DNS**, and **Routes** fields should be left blank.



Imperx recommends using a private network IP address. The following IPv4 address ranges are reserved for private networks:

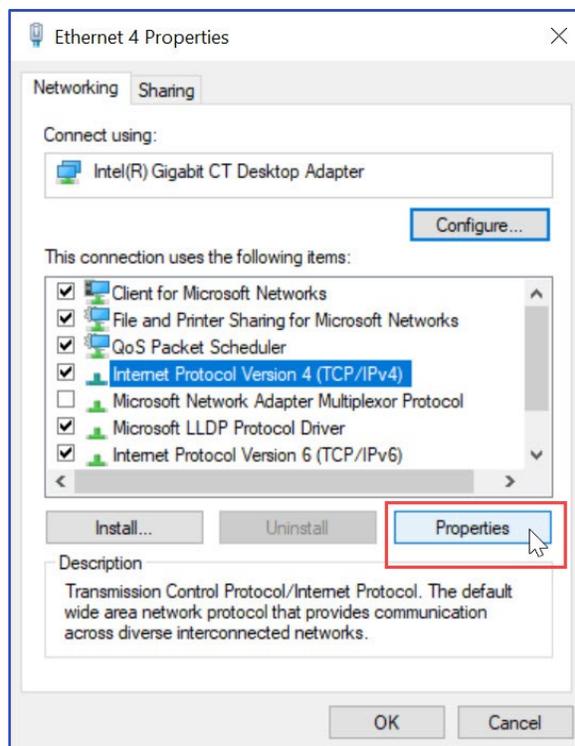
RFC1918 name	IP address range	Largest CIDR block (subnet mask)
24-bit block	10.0.0.0–10.255.255.255	10.0.0.0/8 (255.0.0.0)
20-bit block	172.16.0.0–172.31.255.255	172.16.0.0/12 (255.240.0.0)
16-bit block	192.168.0.0–192.168.255.255	192.168.0.0/16 (255.255.0.0)

3. Click **Apply**.
4. Repeat steps 1–3 for each NIC on your computer

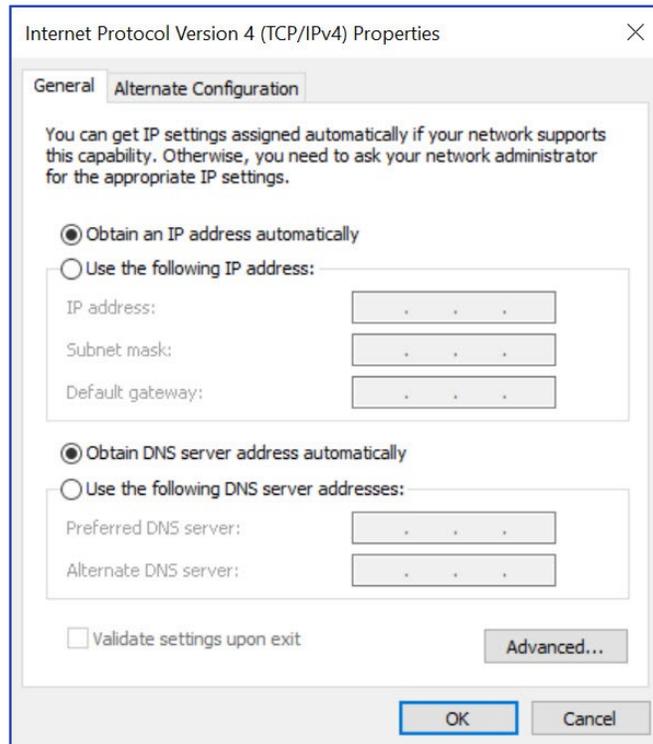
Configuring a Dynamic IP Address via DHCP in Windows

For a NIC to obtain an IP address automatically, follow the steps below.

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Select Internet **Protocol Version 4 (TCP/IPv4)**, click **Properties**.



6. Make sure that **Obtain an IP address automatically** is enabled.

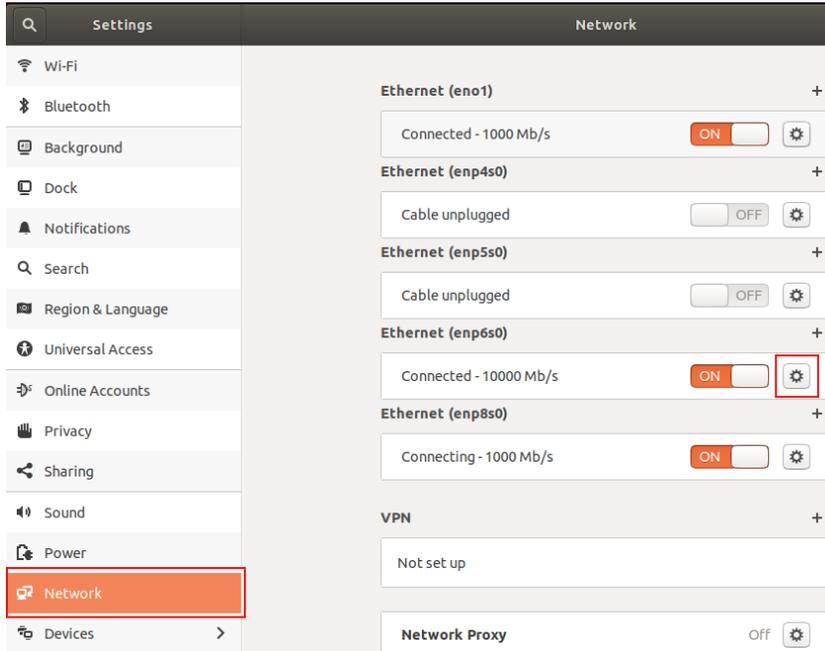


NOTE ⚠ The DHCP server assigns a dynamic IP address to the NIC and camera. If the DHCP server is not available/not running, a link-local address assignment takes place.

Configuring an IP Address Using DHCP in Linux

For a NIC to obtain an IP address automatically, follow the steps below.

1. In the top right-hand corner of the screen, click the **Wired Network** icon  → **Settings**  → **Network** → select the Ethernet adapter that works with your camera → click the  button.



2. On the **IPv4** tab, set **IPv4 Method** to **Automatic (DHCP)** and click **Apply**.



3. Repeat steps 1, 2 for each NIC that is connected to a camera and has a running DHCP server.

NOTE (*) The DHCP server assigns a dynamic IP address to the NIC and camera. If the DHCP server is not available/not running, a link-local address assignment takes place.

Link-Local IP Address

A NIC assigns a link-local IP address automatically when a static IP address has not been configured and a DHCP is not enabled. This address is valid only for a local network and is not routable.

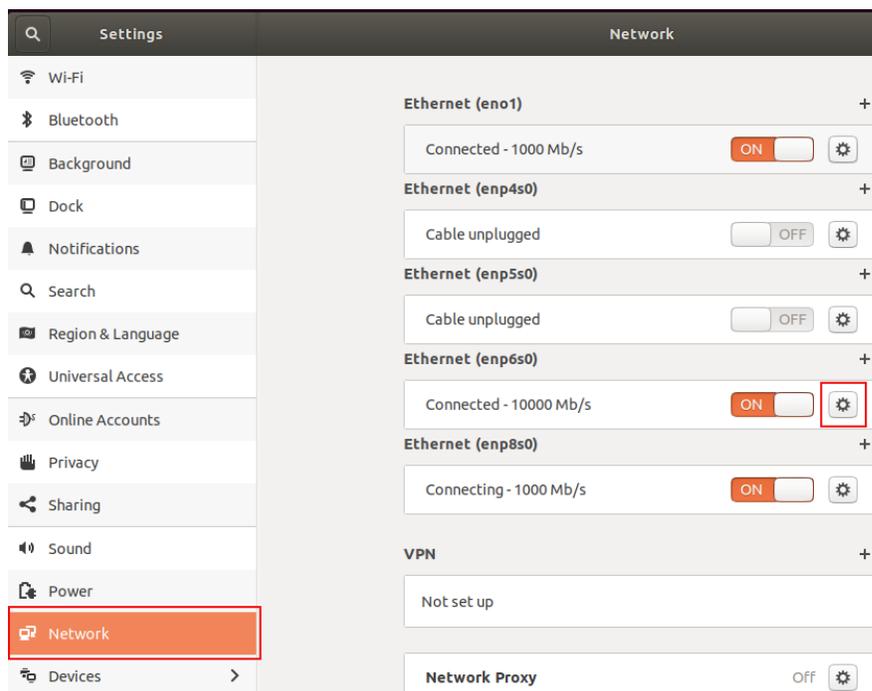
The IPv4 address range is 169.254.0.0–169.254.255.255.

When a static IP address or DHCP becomes available, a new IP address is assigned instead of the link-local address.

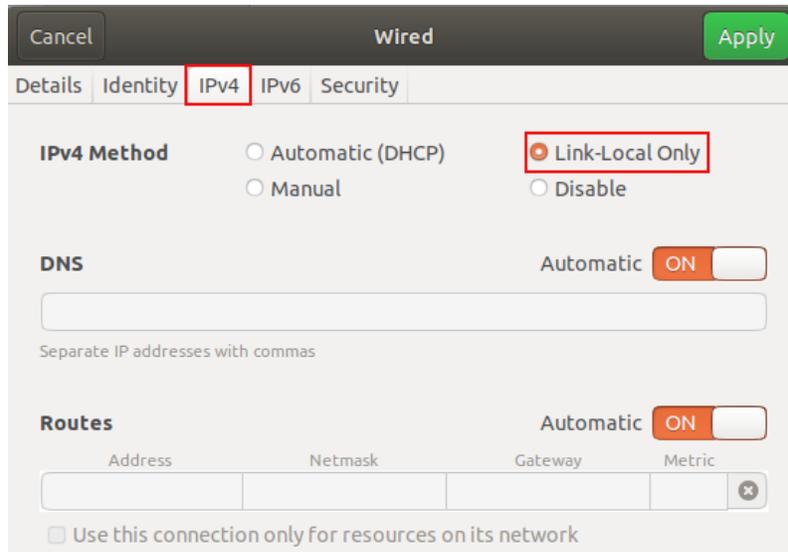
Configuring a Link-Local Address in Linux

For a NIC to obtain a link-local IP address, follow the steps below.

1. In the top right-hand corner of the screen, click the Wired Network icon  → **Settings**  → **Network** → select the Ethernet adapter that works with your camera → click the  button.



2. On the **IPv4** tab, set **IPv4 Method** to **Link-Local Only** and click **Apply**.



3. Repeat steps 1, 2 for each NIC on your computer.

Configuring a Persistent IP Address for a Camera

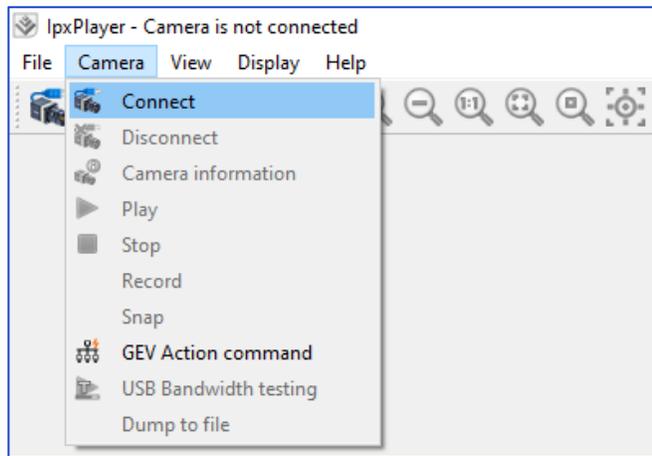
A camera has the following default parameters:

LLA	True (Enabled)
DHCP	True (Enabled)
Persistent IP	False (Disabled)
Subnet Mask	255.255.0.0
Default Gateway	0.0.0.0

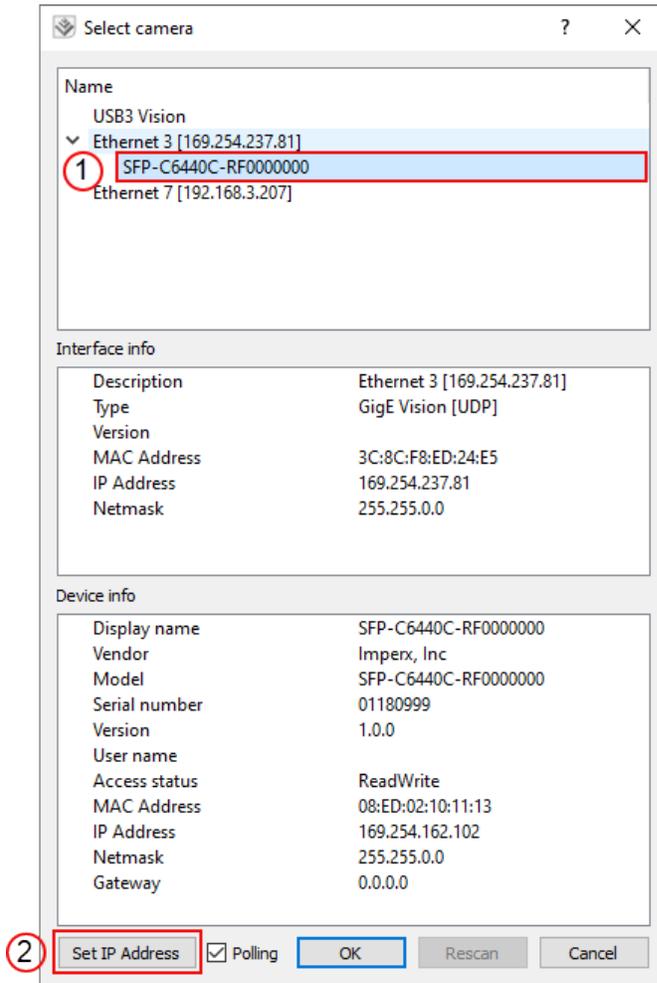
To set a persistent IP address, subnet mask, and default gateway, follow the steps below:

1. Open the IpxPlayer application and click Camera menu and select Connect (or click the

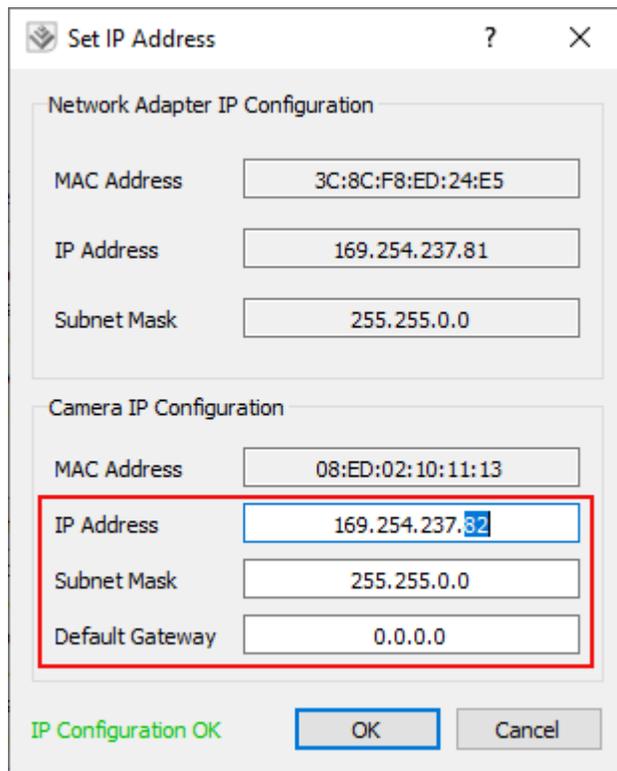
Connect icon  on the tool bar).



2. Select a camera and click **Set IP Address**.



3. Set IP Address, Subnet Mask, and Default Gateway to values that will meet your network constrains and then click **OK**.



The screenshot shows a dialog box titled "Set IP Address" with a question mark icon and a close button. It is divided into two sections: "Network Adapter IP Configuration" and "Camera IP Configuration".

Network Adapter IP Configuration:

- MAC Address: 3C:8C:F8:ED:24:E5
- IP Address: 169.254.237.81
- Subnet Mask: 255.255.0.0

Camera IP Configuration:

- MAC Address: 08:ED:02:10:11:13
- IP Address: 169.254.237.82 (highlighted with a red box)
- Subnet Mask: 255.255.0.0
- Default Gateway: 0.0.0.0

At the bottom, there is a green status indicator "IP Configuration OK", an "OK" button, and a "Cancel" button.

4. In the **TransportLayerControl** category, make sure that the following parameters are configured:

- *GevCurrentIPConfigurationPersistenIP*: True
- *GevPersistentIPAddress*: What you set it to previously
- *GevPersistentSubnetMask*: What you set it to previously
- *GevPersistentDefaultGateway*: What you set it to previously

TransportLayerControl	
PayloadSize	31415040
GigEVision	
GevMACAddress	08:ED:02:10:11:13
GevGVSPExtendedIDMode	On
GevCurrentIPConfigurationLLA	True
GevCurrentIPConfigurationDHCP	True
GevCurrentIPConfigurationPersistentIP	True
GevCurrentIPAddress	169.254.162.102
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
GevIEEE1588Supported	True
GevIEEE1588	False
GevIEEE1588Status	Unknown
GevIEEE1588Mode	Auto
GevIEEE1588GrandmasterClockID	0
GevLinkSpeed	10000
GevFirstURL	Local:lpX10G_CheetahPregiusPF.zip;31c00000;8ba4
GevSecondURL	

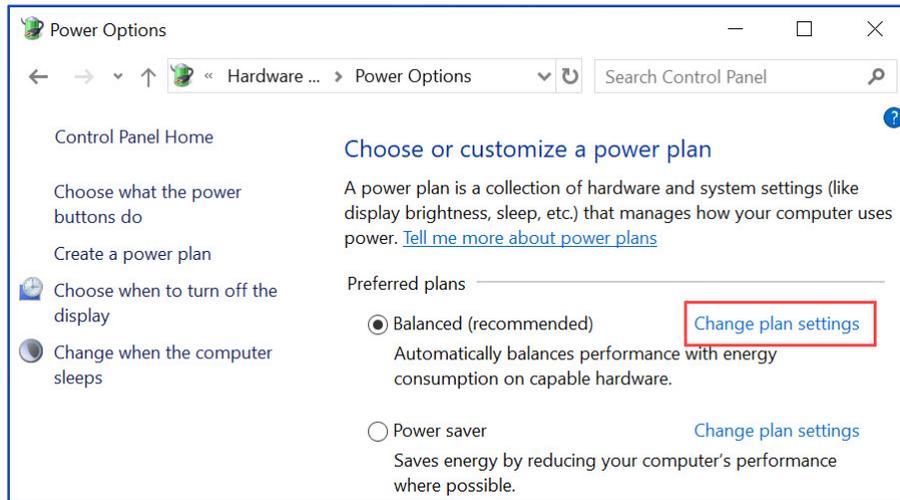
If parameter *GevCurrentIPConfigurationPersistentIP* is set to True, the persistent IP address takes priority, and the camera starts up with the persistent address configured. If the parameter is set to False, the device defaults to DHCP or LLA.

Configuring Power Management in Windows

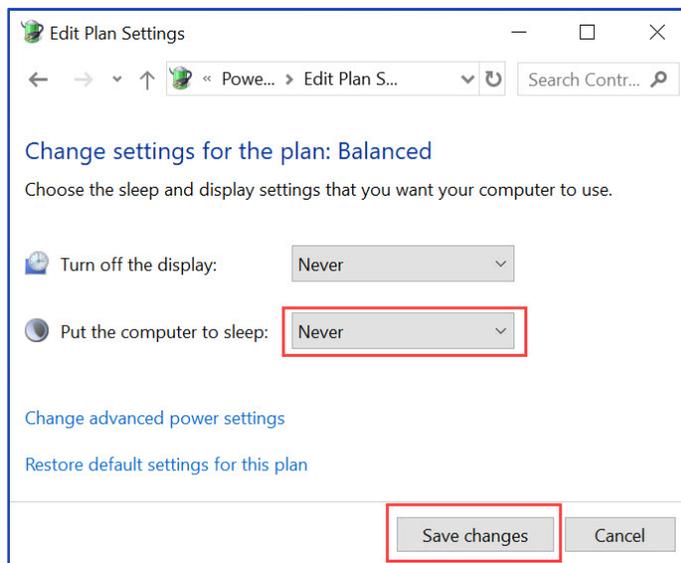
For applications with extended periods of image streaming, configuring power management is required. Typically, if there is no activity from the keyboard or mouse, the computer or NIC goes to sleep, and the image stream gets interrupted. To prevent Windows from powering down the NIC or computer, you need to change the power plan settings.

To change power plan settings for the computer:

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Hardware and Sound** → **Power Options**.
3. Next to the power plan, click **Change plan settings**.

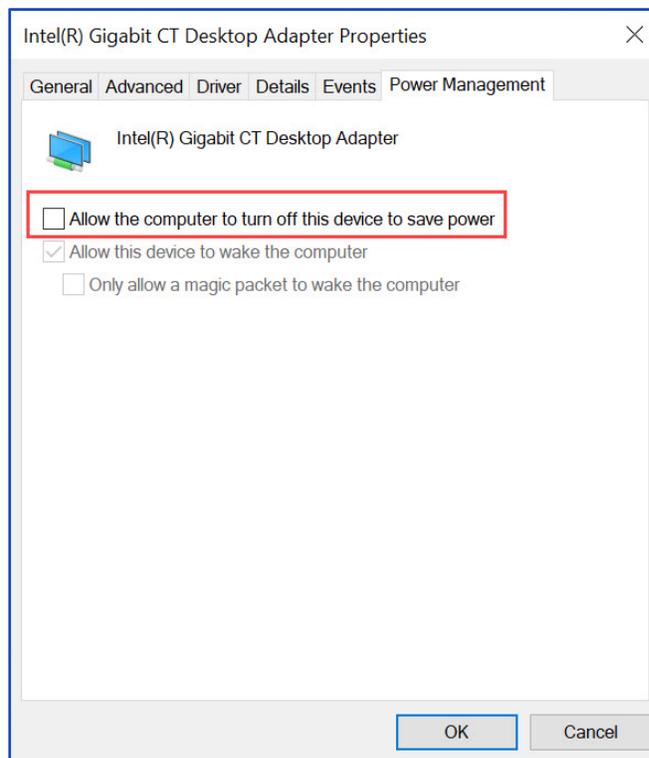


4. In the **Put the computer to sleep** dropdown list select **Never** and click **Save changes**. **Turn off display** can be set to any value.



To change power plan settings for the NIC:

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Click **Configure**. Adapter Properties window opens.
6. On the **Power Management** tab, uncheck the **Allow the computer to turn off this device to save power** option, click **OK**.
7. Repeat steps 4–6 for each NIC.

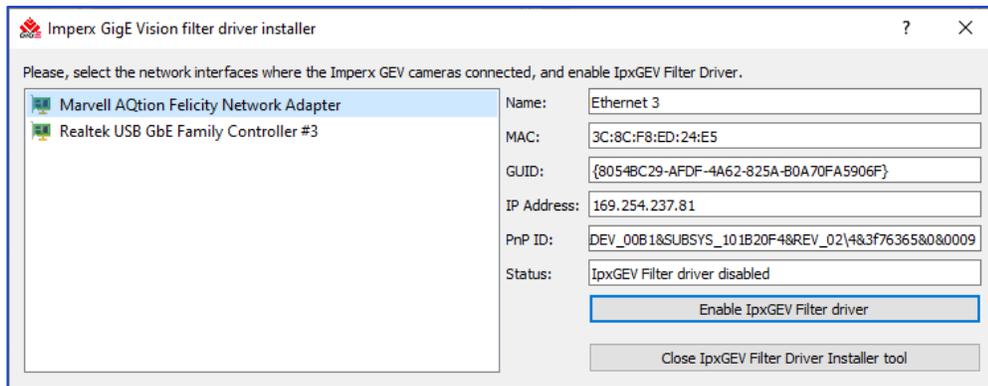


Enabling Imperx Filter Driver in Windows

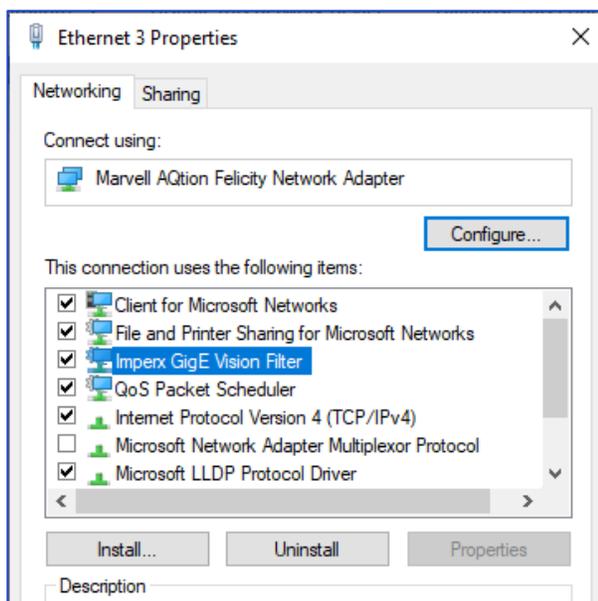
Imperx recommends enabling Filter Driver when multiple 10 GigE Vision cameras are connected to a host computer. It allows to prevent or significantly reduce frame drops.

The Imperx Filter Driver is available in Imperx Camera SDK ver.1.5.x.xxxx or later. Make sure that the version of your Camera SDK is the most recent one, update it if necessary. The Filter driver installs during the Camera SDK installation. To download the most recent Camera SDK version, visit the Imperx website <https://www.imperx.com/subscribers/downloads/>.

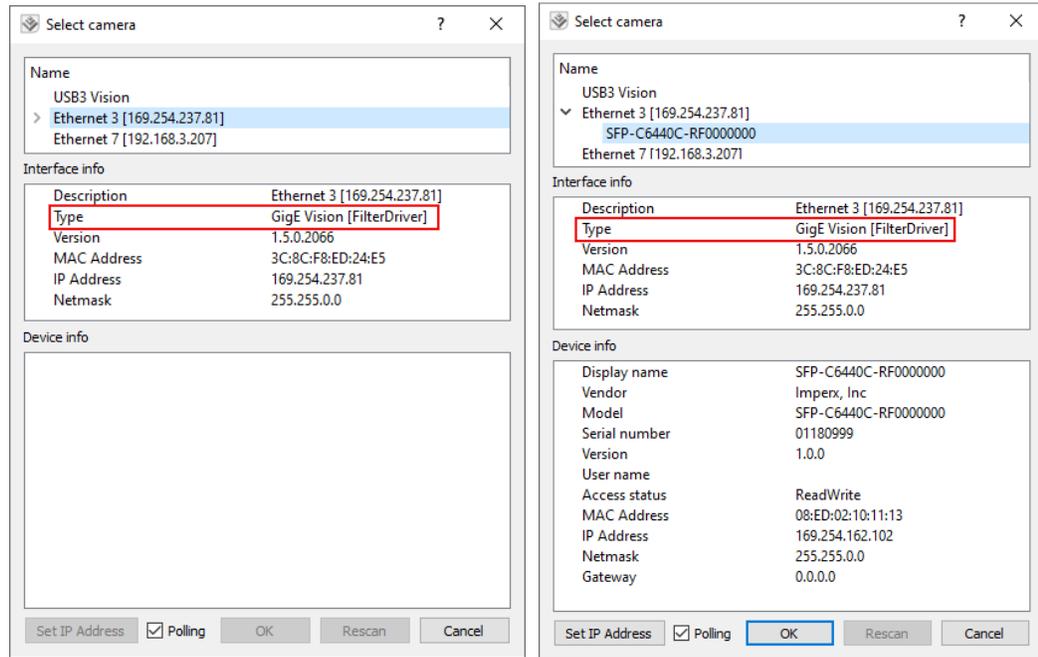
You can install Filter Driver yourself by running the executable file that is located in SDK binaries folder C:\Program Files\Imperx\Imperx Camera SDK\bin\win64_x64\IpxGEVFilterInstaller.exe. On the **Imperx GigE Vision filter driver installer** screen, select network adapters that are connected to Imperx GigE Vision cameras, click **Enable IpxGEV Filter driver**, and close the filter driver installer.



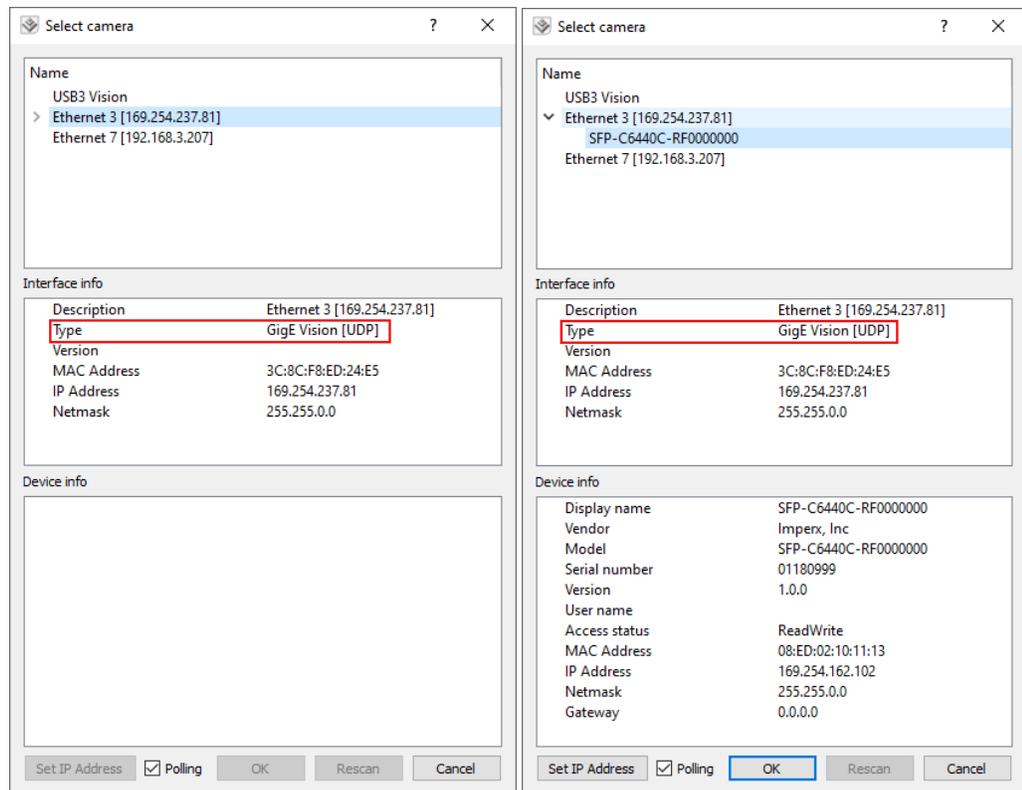
When installed, the Filter Driver appears in Ethernet connection properties. Make sure that the **Imperx GigE Vision Filter** check box is checked. (If it is unchecked, the Filter Driver is disabled.)



The Filter Driver also appears, if installed and enabled, in the Select camera dialog (in SDK or IpxPlayer), when you select NIC or camera.



If the Filter Driver is disabled or not installed, GigE Vision [UDP] will be displayed:



Camera's UDP Ports

A standard GigE Vision Control Protocol (GVCP) port is a UDP port used to receive camera commands. The Internet Engineering Task Force (IETF) has designated port number 3956 as the standard GVCP port. For multi-service device, this is the port attached to the first service.

The camera Outgoing UDP port for Control Channel GVCP packets is 3956 (0x0F74), while the incoming port on the software side can be any dynamic port within the range 49152–65535.

The camera Outgoing Stream Channel UDP port for GigE Vision Stream Packets (GVSP) is 3011 (0x0BC3) for firmware v1.*, and 49153 (0xC001) for firmware v2.*. The incoming port on software side is any dynamic port within the range 49152–65535.

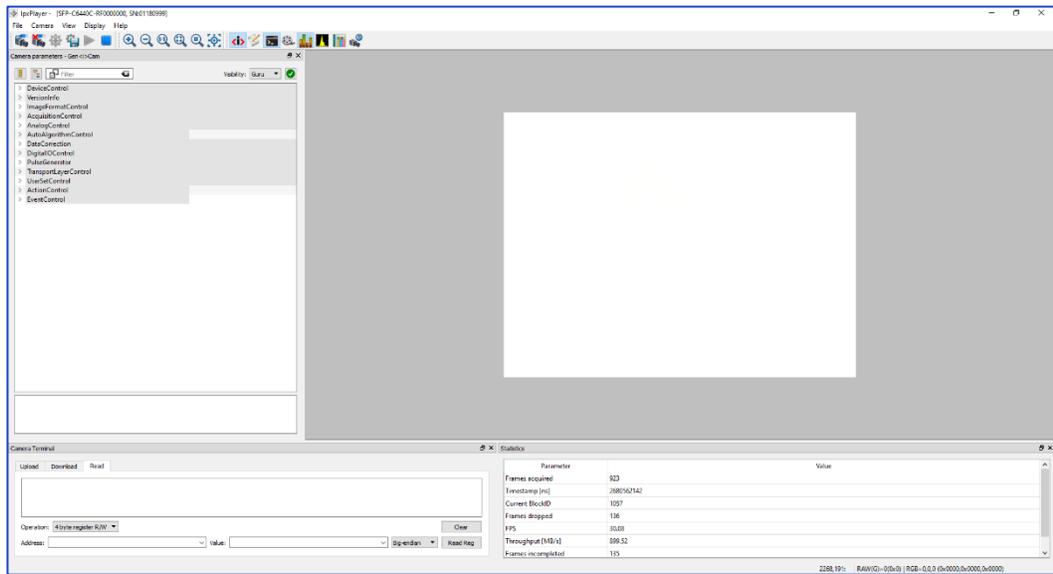
The camera Outgoing UDP port for Message Channel GVCP packets is 49152 (0xC000), while incoming port on software side is any dynamic port within the range 49152–65535.

Software GUI

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.



Supported Operating Systems

The IpxPlayer is compatible with the following operating systems:

- Windows 10, 32-bit and 64-bit
- Ubuntu Linux 18.04 64-bit
- Ubuntu Linux 18.04 64-bit, ARM CPU
- Ubuntu Linux 20.04 64-bit
- Ubuntu Linux 20.04 64-bit, ARM CPU

Compatibility

The imperx Camera SDK and IpxPlayer are compatible with the Imperx GigE Vision, 10 GigE Vision, and USB3 cameras.

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 a series of images to a file.
- Saves and loads camera configuration files.

Installing the Software in Windows

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



If a previous version of the Camera SDK 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:

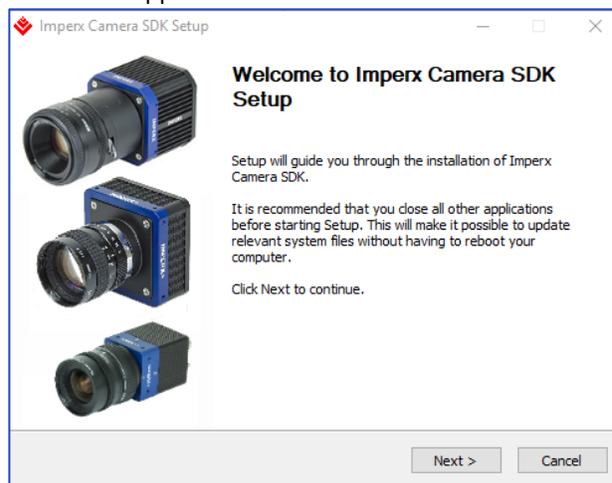
1. Open **Control Panel** on your computer.
2. Select **Programs and Features**.
3. Select the Imperx Camera SDK software and click **Uninstall**.

Installation

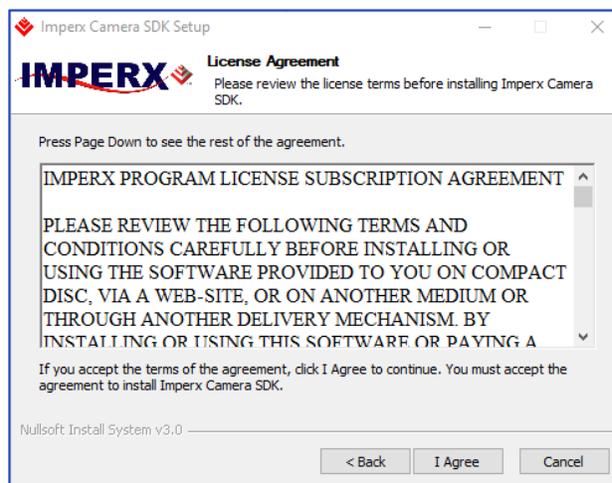
1. Drag the `IpxCameraSdk***.exe` file to your computer desktop. If a Security screen appears, click **OK**.



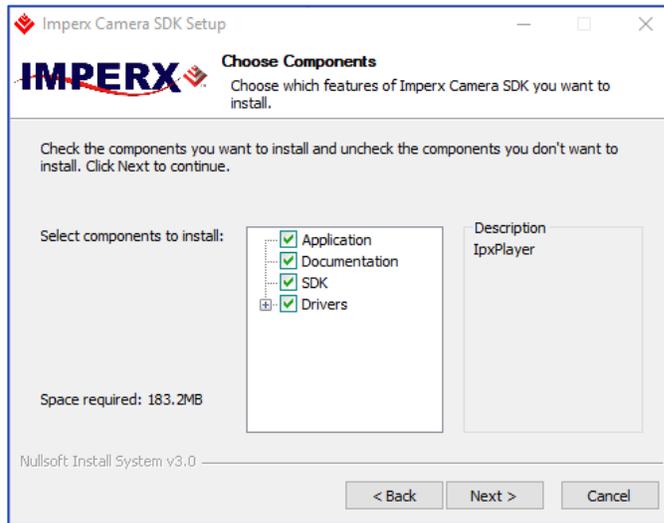
2. Double click the executable file `IpxCameraSdk***.exe`. Note the recommendation to close other applications and click **Next**.



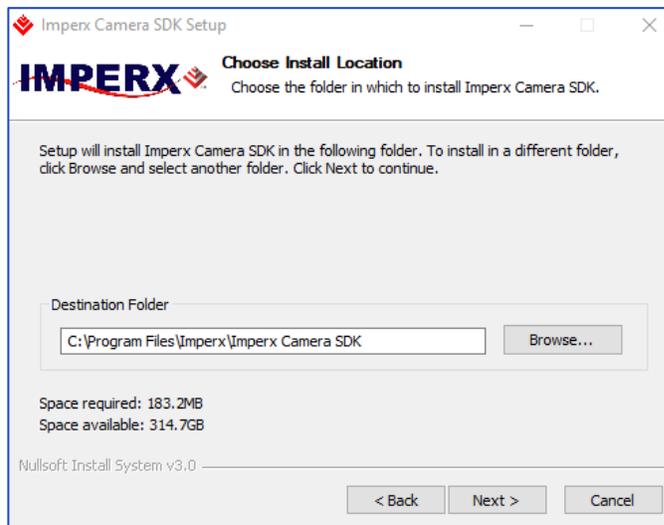
3. Read the License Agreement and click **I Agree**.



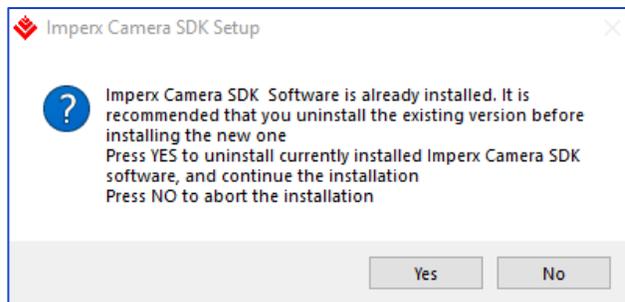
- Select all the Cheetah Camera SDK components and click **Next**.



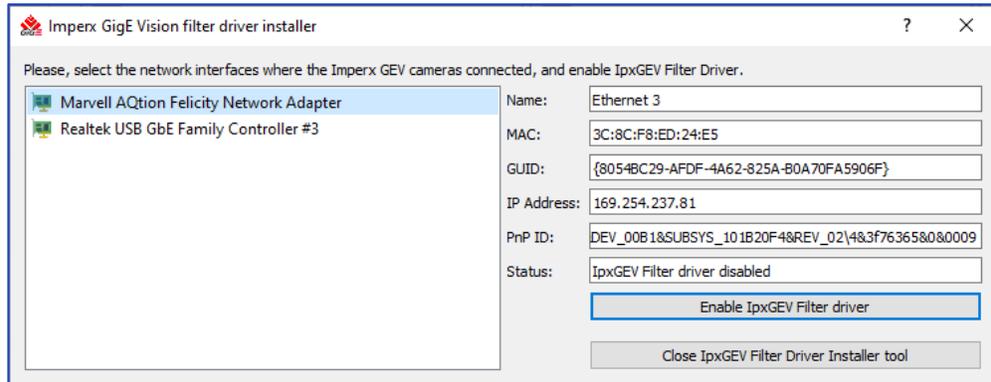
- Accept the default destination folder or click **Browse** and select a different location, click **Next** and then **Install**.



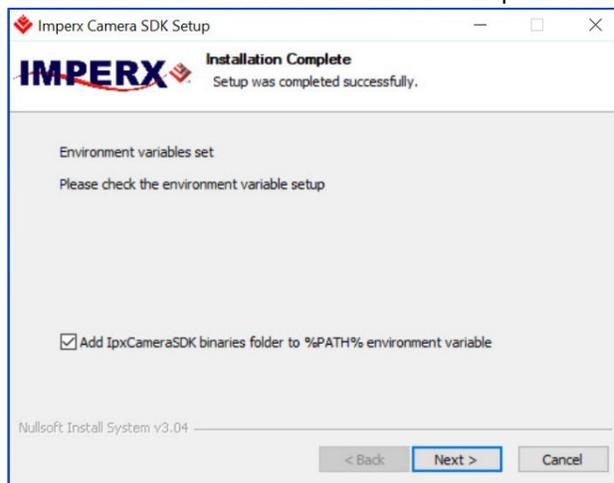
The installer prompts you to uninstall any existing versions of the software from your computer before continuing the installation.



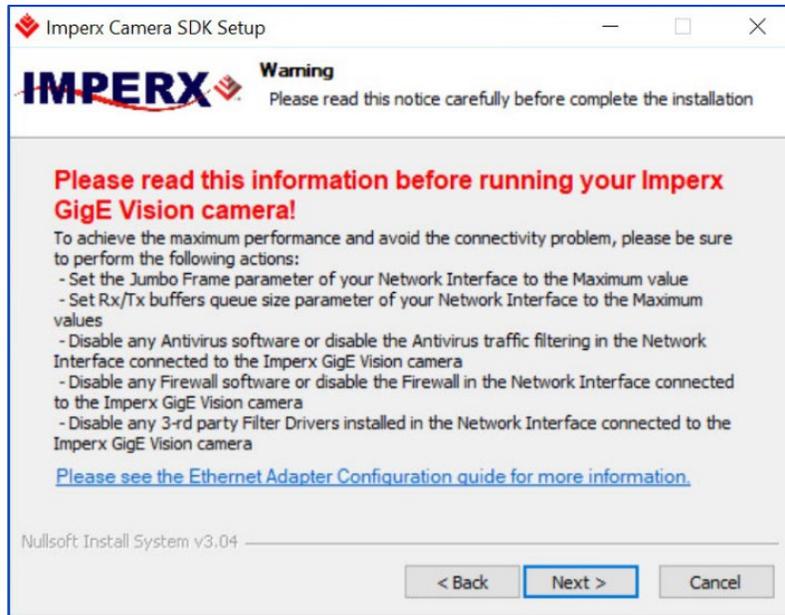
- Select network adapters that are connected to Imperx GigE Vision cameras, click **Enable IpxGEV Filter driver**, and close the filter driver installer.



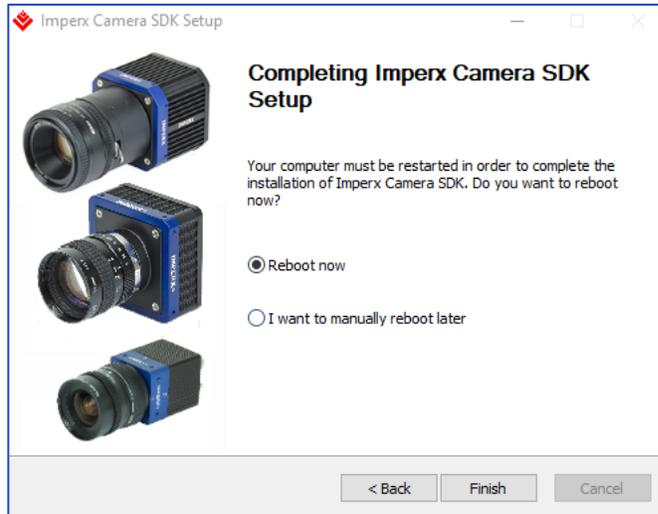
- Make sure that the environment variable setup is checked and click **Next**.



- Read the warning message and click **Next**.
After finishing the installation, be sure to configure your Ethernet adapter and host computer before running the Cheetah camera. Refer to [the Configuring an Ethernet Adapter and Host Computer](#) chapter on page 82 for more information.



9. Select Reboot now and click **Finish**. The Imperx IpxPlayer icon appears on your desktop.



Installing the Software in Linux

1. Run the IpxCameraSDK installer using the console:

```
tester@kola-ubuntu18:~$ ./IpxCameraSDK_1.5.0.54-Ubuntu_18.04-x86_64.sh
```

2. Read the Warning message and press Enter

```
tester@kola-ubuntu18:~$ ./IpxCameraSDK_1.5.0.54-Ubuntu_18.04-x86_64.sh
IpxCameraSDK Installer Version: 1.5.0.54, Copyright (c) Imperx, Inc.

This is a self-extracting archive.

*****
WARNING:
*****
If you are planning to display an image that is greater than 7MB. You must
login as root to modify the usbfs_memory_mb. You can modify the size of the
usbfs memory if needed by editing:

'/sys/module/usbcore/parameters/usbfs_memory_mb' file.

For example:

sudo sh -c "echo 1000 > /sys/module/usbcore/parameters/usbfs_memory_mb"

or

just run the "manage_usbfs_memory_size.sh" script as sudo which is
located in the "bin/Linux64_x64" installed directory

Press enter to continue.
█
```

3. Read the Note message and press Enter:

```
*****
NOTE:
*****
This 'usbfs_memory_mb' command must be reset each time you reboot your system.
Please consult with your system administrator for further instructions on
how to set this usbfs_memory_mb value permanently.
If your init system is systemd, you can use "usbfs-memsize-systemd.service"
file to set desired size of usbfs_memory_mb(default 1000) permanently.
Just copy "usbfs-memsize-systemd.service" to /etc/systemd/system directory
and run following commands: cd /etc/systemd/system
sudo systemctl enable usbfs-memsize-systemd.service

Press enter to continue.
█
```

4. Read the Warning message and type Y or N

```
*****
WARNING:
*****
You are running this script as a regular user!

To be able to use the USB3 Vision Device you must add
an udev rule to the system to allow the regular user to access the device.

If you proceed as a regular user, you will not be able to install the udev
rule. However, you can do this action later by running the
"manage_udevrules.sh" script as sudo. This script is located in the
"bin/Linux64_x64" installed directory.

Would you like to proceed? [Yn]:

```

5. Accept the default destination directory or change it

```
The archive will be extracted to:
/home/tester

You can change the default directory to your specified location by running
the archive with the flag --prefix=dir

For example:
"./IpxCameraSDK-1.5.0.54-Ubuntu_18.04-x86_64.sh --prefix=/opt/imperx"

If you want to stop extracting, please press <ctrl-C>.

By default the IpxCameraSDK will be installed in:
"/home/tester/IpxCameraSDK-1.5.0.54"

Do you want to include the subdirectory IpxCameraSDK-1.5.0.54?

Typing 'n' will install it at the following location:
"/home/tester" [Yn]:

```

```
Using target directory: /home/tester/IpxCameraSDK-1.5.0.54
Extracting, please wait...

Unpacking finished successfully!

Installed successfully!
Thank you for using IpxCameraSDK!
```

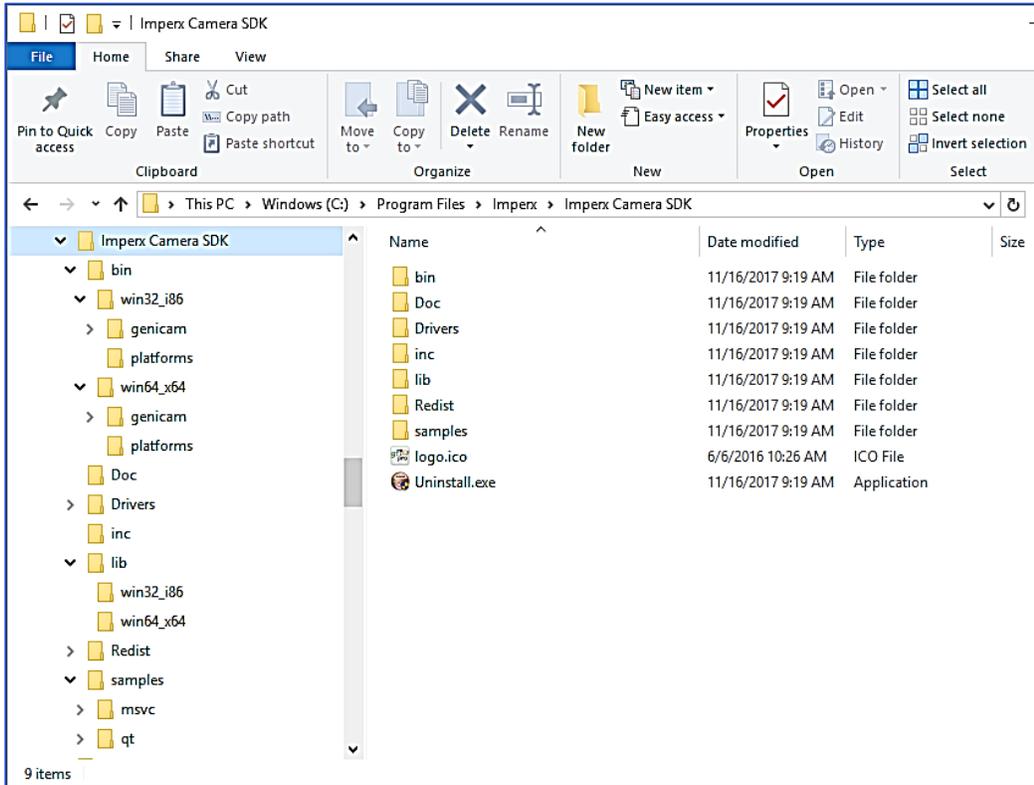
6. To open the IpxPlayer application, run the following command:

```
tester@kola-ubuntu18:~$ cd ~/IpxCameraSDK-1.5.0.54/bin/Linux64_x64/
tester@kola-ubuntu18:~/IpxCameraSDK-1.5.0.54/bin/Linux64_x64$ sudo ./manage_rp_filter.sh
[sudo] password for tester:
Setting rp_filter mode to 'Strict Reverse Path'...
For all the system's interfaces
Setting rp_filter mode to 'Strict Reverse Path' DONE
tester@kola-ubuntu18:~/IpxCameraSDK-1.5.0.54/bin/Linux64_x64$ sudo ./manage_socket_buffer_size.sh
Setting socket write maximum buffer size to 10485760 bytes
Setting socket read maximum buffer size to 10485760 bytes
tester@kola-ubuntu18:~/IpxCameraSDK-1.5.0.54/bin/Linux64_x64$ sudo ./manage_usbfs_memory_size.sh
Setting usbfs memory size to 1000 ...
usbfs memory size has been set to 1000
tester@kola-ubuntu18:~/IpxCameraSDK-1.5.0.54/bin/Linux64_x64$ ./IpxPlayer
```

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\).



<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

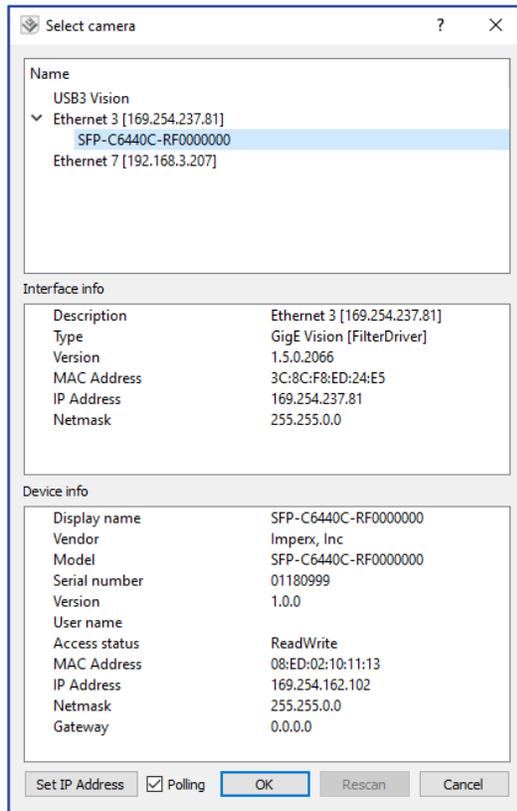
<InstallationFolder> \lib\ – contains SDK C++ library files

<InstallationFolder> \samples\ – contains SDK C++, C#, Python samples

<InstallationFolder> \Drivers\ – contains kernel drivers for Imperx GEV and USB3 cameras

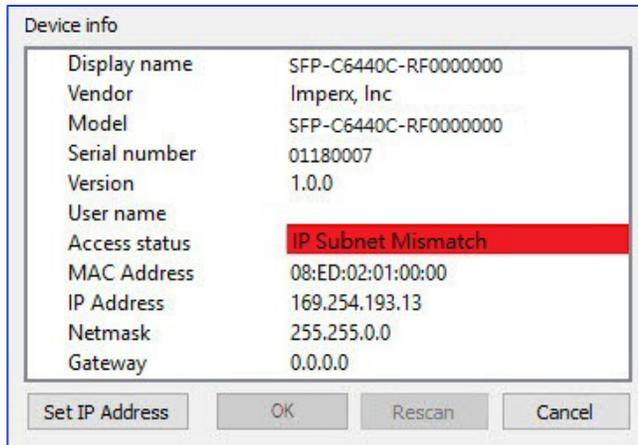
Connecting to Cameras

- Locate and open the IpxPlayer from your desktop.
- 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.
- Select a camera listed on the dialog.
Camera information appears in the Device info section of the dialog.
- Click **OK**. If needed, click **Rescan** to update the list of cameras.



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 not available.

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

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.

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.

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.

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 USB3 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.
GEV Action command		Shows/hides the Action Command panel.

View Menu

GenICam Tree		Shows/hides the camera control GenICam tree panel.
Log		Shows/hides the camera control Log panel (Control, Stream, Events).
Camera Terminal		Shows/hides the Camera Terminal panel. Use this panel for uploading Firmware Updates, LUT, FFC, DPC/HPC files or downloading LUT, FFC, DPC/HPC files.
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.
Histogram		Shows/hides the Histogram panel.
Hex Pixel Dump		Shows/hides the Hex Pixel Dump panel. Use this panel for pixel analysis.

Display Menu

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.

Saving and 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:

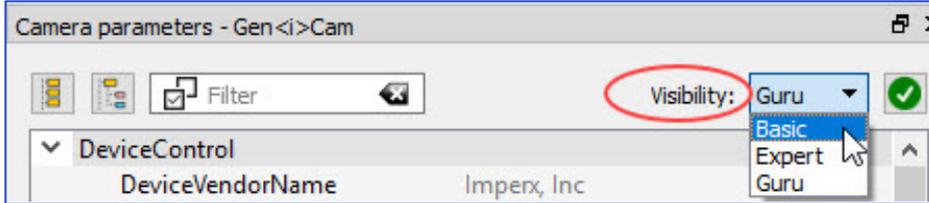
1. Select the **File** menu.
2. Select **Save Configuration as**.
3. Navigate to location on your host computer.
4. Create a file name.
5. Click **Save**.

To load a configuration:

1. Select the **File** menu.
2. Select **Load Configuration**.
3. Navigate to the folder containing the file.
4. Click **Open**.

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.



- Basic** Provides visibility of all the basic features of the camera.
- Expert** Provides visibility of advanced features of the camera that require a more in-depth knowledge of the camera functionality. This is the preferred visibility level for all advanced features in the cameras.
- Guru** Provides visibility of more advanced features that, if set incorrectly, might cause the camera to work improperly.

Device Control Category

The Device Control parameters provide information about the camera.

DeviceControl	
DeviceVendorName	Imperx, Inc
DeviceModelName	SFP-C5340C-RF0000000
DeviceVersion	1.0.0
DeviceFirmwareVersion	v101b007
DeviceManufacturerInfo	Support: 1-561-989-0006
DeviceSerialNumber	01300999
DeviceUserID	
DeviceSFNCVersionMajor	2
DeviceSFNCVersionMinor	3
DeviceSFNCVersionSubMinor	0
DeviceScanType	Areascan
DeviceReset	Execute
CPUReset	Execute
DeviceTemperatureSelector	Sensor
DeviceTemperature	35.75C

- DeviceVendorName** Imperx, Inc.
- DeviceModelName** Full camera part number.
- DeviceVersion** Camera Hardware version.
- DeviceManufactureInfo** Technical support: 1-561-989-0006
- DeviceSerialNumber** Camera serial number.
- DeviceUserID** User-defined camera name.

DeviceSFNCVersionMajor	The major version number of the GenICam Standard Features Naming Convention.
DeviceSFNCVersionMinor	The minor version number of the GenICam Standard Features Naming Convention.
DeviceSFNCVersionSubMinor	The sub major version number of the GenICam Standard Features Naming Convention.
DeviceScanType	Scan type of the sensor.
DeviceReset	Resets the entire camera, including communications.
CPUReset	Resets the camera's circuitry. The 10G Engine doesn't reset. NOTE: After the camera has been reset, issue a <i>UserSetLoad</i> command.
DeviceTemperatureSelector	Selects the location within the device, where the temperature will be measured.
DeviceTemperature	Device temperature in degrees Celsius (C). It is measured at the location selected by <i>DeviceTemperatureSelecto</i> .

Temperature Control Category

The Temperature Control parameters allow you to set the TEC operation mode.

▼ TemperatureControl	
SafeMode	Off
SafeTemperatureThreshold	110C
SensorStatus	On

SafeMode	Sets the safe operation mode of the camera's sensor.
SafeTemperatureThreshold	Sets the temperature in Celsius degrees, when the camera's sensor will be shut down. (110 °C – maximum value)
SensorStatus	Returns the camera's sensor status.

Version Info Category

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

VersionInfo	
SensorType	Bayer
SensorModel	IMX530AAQ
SensorGenerationFirmwareID	4
RgsID	A002
CPUFirmwareImage	A
CPUFirmwareVersion	10001
CPUFirmwareBuild	7
FPGA FirmwareImage	A
FPGA FirmwareVersion	10001
FPGA FirmwareBuild	7
PTP FirmwareImage	A
PTP FirmwareVersion	2EB7
CustomerID	0
FamilyID	30
XmlVersion	10400

SensorType	The CMOS sensor type: Bayer Color or Monochrome
SensorModel	The CMOS sensor model.
SensorGenerationFirmwareID	Returns the Sensor Generation Firmware ID number.
RgsID	The camera’s register ID number.
CPUFirmwareImage	The Firmware Image ID (F=Factory or A=Application).
CPUFirmwareVersion	The CPU firmware version number.
CPUFirmwareBuild	The CPU firmware build number.
FPGA FirmwareImage	FPGA Firmware Image ID (F=Factory or A=Application).
FPGA FirmwareVersion	The FPGA firmware version number.
FPGA FirmwareBuild	The FPGA firmware build number.
PTP FirmwareImage	The PTP Firmware Image ID (F=Factory or A=Application).
PTP FirmwareVersion	The PTP firmware revision number.
CustomerID	The Customer ID for custom firmware (0=Imperx standard firmware).
FamilyID	The Family ID.
XmlVersion	The version of the XML file.

Troubleshooting Category

▼ Troubleshooting	
slvsecStatus	Sync
slvsecSyncState	Finished
ElapsedTimer	7590

slvsecStatus Shows SLVS-EC status.

slvsecSyncState Shows SLVS-EC sync state.

ElapsedTimer Elapsed timer in minutes.

Image Format Control Category

The Image Format Control category lets you change screen resolution, select pixel format, set processing AOI size and more. It also provides information on the camera base resolution and output resolution.

ImageFormatControl	
SensorWidth	5328
SensorHeight	4608
WidthMax	5312
HeightMax	4608
Width	5312
Height	4608
OffsetX	0
OffsetY	0
PixelFormat	Mono12
PixelSize	Bpp12
PixelColorFilter	BayerRG
BinningVertical	1
BinningHorizontal	1
DecimationVertical	1
DecimationHorizontal	1
ReverseY	False
ReverseX	False
TestPattern	Off
SensorTestPattern	Off
AdcBitDepth	Bit12
SensorShutterMode	Global
HDRMode	Off
ProcessingAOI	
PAOISelector	AEC_AGC
PAOIMode	Disable
PAOIWidth	5312
PAOIHeight	4608
PAIOffsetX	0
PAIOffsetY	0

available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only

SensorWidth Effective width of the sensor in pixels.

SensorHeight Effective height of the 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. The width must be a multiple of 32.

Height Allows you to create an AOI: sets the output image height in number of lines. The height must be a multiple of 4.

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 32.
OffsetY	AOI Offset in the vertical dimension: Enter the number of pixels to offset the image output from the top of the image. The number must be a multiple of 4.
PixelFormat	The number of bits of memory associated with each pixel. Options are: Mono8, Mono10, Mono10Packed, Mono12, Mono12Packed, BayerGR8, BayerRG8, BayerGB8, BayerBG8, BayerGR10, BayerRG10, BayerGB10, BayerBG10, BayerGR12, BayerRG12, BayerGB12, BayerBG12, BayerGR10Packed, BayerRG10Packed, BayerGB10Packed, BayerBG10Packed, BayerGR12Packed, BayerRG12Packed, BayerGB12Packed, BayerBG12Packed.
PixelSize	Number of bits per pixel in memory (8-, 10-, or 12-bits).
PixelColorFilter	Shows the color filter pattern.
BinningVertical	Sets number of rows to combine.
BinningHorizontal	Sets number of columns to combine.
DecimationVertical	Sets number of rows to skip.
DecimationHorizontal	Sets number of columns to skip.
ReverseX	Horizontally flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
ReverseY	Vertically flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
TestPattern	Enables test patterns based on the following selections: GreyHorizontalRamp, GreyVerticalRamp, GreyHorizontalRampMoving, GreyVerticalRampMoving, FlatField.
SensorTestPattern	Selects the type of test pattern that is generated by the camera image sensor.
ADCBitDepth	Returns which ADC bit depth is used. A higher ADC bit depth results in better image quality but slower maximum frame rate.
SensorShutterMode	Returns the shutter mode of the device.
HDRMode	Controls multi-slope gain state.

Processing AOI Category

ProcessingAOI	
PAOISelector	AEC_AGC
PAOIMode	Disable
PAOIWidth	5312
PAOIHeight	4608
PAIOffsetX	0
PAIOffsetY	0

PAOISelector	Selects the Processing AOI to configure.
PAOIMode	Enables/Disables the Processing AOI.
PAOIWidth	Represents the actual image width expelled by the camera of the Processing AOI (in pixels). The number must be a multiple of 32.
PAOIHeight	Represents the actual image height expelled by the camera of the Processing AOI (in pixels). The number must be a multiple of 4.
PAIOffsetX	Horizontal offset from the origin to the Processing AOI (in pixels). The number must be a multiple of 32.
PAIOffsetY	Vertical offset from the origin to the Processing AOI (in pixels). The number must be a multiple of 4.

Acquisition Control Category

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

AcquisitionControl	
AcquisitionMode	Continuous
AcquisitionStart	Execute
AcquisitionStop	Execute
AcquisitionAbort	Execute
AcquisitionFrameCount	1
ExposureMode	Off
ExposureTime	52345us
ExposureAuto	Off
AcquisitionFrameRateEnable	False
AcquisitionFrameTime	52564
AcquisitionFrameRate	19.02Hz
AcquisitionLineTimeEnable	False
AcquisitionLineTime	822
AcquisitionBurstFrameCount	1
CurrentExposureTime	52345
CurrentFrameTime	52564
TriggerMode	Off
TriggerSoftware	Execute
TriggerSource	Line1
TriggerActivation	RisingEdge
TriggerOverlap	ReadOut
TriggerDebounceTime	0
TriggerFilterTime	0
TriggerDelay	0
ShortIntervalShutterControl	
ShortIntervalShutterMode	On
Frame1ExposureTime	89us
Frame1ExposureTimeLimit	133us
Pulse1Source	ExposureFrame1
Pulse2Source	ExposureFrame2
Frame2Gain	3.000000dB

available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only

AcquisitionMode	Supports three modes of acquiring images: SingleFrame, MultiFrame, and Continuous.
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 Acquisition mode.

ExposureMode	Sets the operation mode of the exposure. Options are: Off, Triggerwidth, Timed (refer to the section Exposure Control for more information).
ExposureTime	Sets the exposure time in microseconds when <i>ExposureMode</i> is Timed and <i>ExposureAuto</i> is Off.
ExposureAuto	Sets the automatic exposure mode when <i>ExposureMode</i> is Timed.
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 <i>AcquisitionFrameTime</i> affect the <i>AcquisitionFrameRate</i> 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 <i>AcquisitionFrameRate</i> affect the <i>AcquisitionFrameTime</i> setting.
AcquisitionLineTimeEnable	Controls the acquisition line time. If this mode is On, you can extend line time beyond the free-running line time.
AcquisitionLineTime	This feature sets the actual line time in pixel clocks (74.25MHz).
AcquisitionBurstFrameCount	Sets the number of frames to acquire for each trigger.
CurrentExposureTime	This is a read-only feature providing a real-time monitor of the camera exposure time in microseconds.
CurrentFrameTime	This is a read-only feature providing a real-time monitor of the camera output period in microseconds.
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	Instructs the camera to generate one short trigger pulse to capture and read out one frame when <i>TriggerSource</i> is set to Software.
TriggerSource	Specifies the internal signal or physical input line to use as trigger source. Options are Line1, Line2, Action 0, PulseGenerator, and Software (Software is a single frame capture using internal exposure setting).
TriggerActivation	Sets the triggering edge to Rising or Falling.
TriggerOverlap	Sets trigger overlap mode to Off (default). If the camera receives a trigger pulse while the previous trigger is still being processed, the camera ignores this pulse.
TriggerDebounceTime	Sets the trigger signal de-bounce time. Subsequent trigger signals coming to the camera within the de-bounce time interval are ignored.
TriggerFilterTime	Specifies the minimum Trigger signal pulse width. Any pulse shorter than the selected time is ignored.
TriggerDelay	Sets the delay time in microseconds between the trigger pulse and the start of exposure.

Short Interval Shutter Control

NOTE (*) The Short Interval Shutter Control category is available for SFPC4540, SFP-C5340, and SFP-C5341 cameras only.

It allows you to enable PIV mode, set exposure time for the first frame and gain value for the second frame. It also allows you to synchronize your system with the exposure duration of first, second, or both frames.

▼ ShortIntervalShutterControl	
ShortIntervalShutterMode	On
Frame1ExposureTime	89us
Frame1ExposureTimeLimit	133us
Pulse1Source	ExposureFrame1
Pulse2Source	ExposureFrame2
Frame2Gain	3.000000dB

ShortIntervalShutterMode	Controls short interval shutter state (enables/disables PIV mode).
Frame1ExposureTime	Exposure time in microseconds for the first frame.
Frame1ExposureTimeLimit	Exposure time limit in microseconds for the first frame.
Pulse1Source	Selects which Exposure source signal to output on the selected Line.
Pulse2Source	Selects which Exposure source signal to output on the selected Line.
Frame2Gain	Controls the gain as an absolute physical value for the second frame.

Analog Control Category

These parameters define analog and digital gain controls, black level, gamma correction, and auto white balance.

▼ AnalogControl		
Gain	20.000000dB	
GainAuto	Off	
BlackLevel	240.000000	
SensorBlackLevelRecommended	True	
BlackLevelAuto	Continuous	
DigitalGain	1.000000x	
DigitalBlackLevel	0.000000	
BalanceRatioSelector	Red	
BalanceRatio	1.000000x	
BalanceWhiteAuto	Continuous	
▼ HDRProcessingControl		
HDRProcessingMode	Manual	available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only
HighGainExtension	plus_18_dB	
BitExtensionThreshold	4095	
GradationCompressionPoint1	4	
GradationCompressionGain1	1	
GradationCompressionPoint2	8	
GradationCompressionGain2	3	
AnalogGainMax	24.000000dB	

- Gain** Sets analog/digital gain from 0 to 48 dB with 0.1 dB step.
- GainAuto** Sets the automatic gain control (AGC) mode. [ExposureMode](#) can be set to Timed, PulseWidth, or Off.
- BlackLevel** This represents a DC offset applied to the video signal. Values can range from 0 to 4095.
- SensorBlackLevelRecommended** Uses recommended value of *BlackLevel* from the sensor.
- BlackLevelAuto** Automatically adjusts the black level based on measurements of the dark reference lines at the start of each frame.
- Gamma** Controls the gamma correction of pixel intensity with an increment of 0.01.
- DigitalGain** Sets digital gain from 0x to 4x.
- DigitalBlackLevel** Controls the Digital Black Level for all taps.
- BalanceRatioSelector** Selects which color will be impacted by the BalanceRatio control.
- BalanceRatio** Controls ratio of the selected color component to green, which is the reference color.
- BalanceWhiteAuto** Controls the mode for automatic white balancing between the color channels. The white balancing color ratios are automatically adjusted by selecting either Once or Continuous. If Off, the White Balance color ratios are set manually using *BalanceRatioSelector* and *BalanceRatio* controls.

HDR Processing Control Category

The **HDR Processing Control** category allows you to configure high gain extension, bit extension threshold, gradation compression points and gains, and maximum analog gain.

NOTE (*) The HDR Processing Control category is available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only.

Make sure to set the *PixelFormat* feature to **12-bit** and the *HDRMode* feature to **Processing** to activate parameters on the HDR Processing Control category.

▼ HDRProcessingControl	
HDRProcessingMode	Manual
HighGainExtension	plus_18_dB
BitExtensionThreshold	4095
GradationCompressionPoint1	4
GradationCompressionGain1	1
GradationCompressionPoint2	8
GradationCompressionGain2	3
AnalogGainMax	24.000000dB

HDRProcessingMode	Controls HDR processing mode.
HighGainExtension	Gain setting added to high gain side.
BitExtensionThreshold	Threshold for data selection of low gain side or high gain side.
GradationCompressionPoint1	Sets the first start point of gradation compression.
GradationCompressionGain1	Sets the gain of the first gradation compression.
GradationCompressionPoint2	Sets the second start point of gradation compression.
GradationCompressionGain2	Sets the gain of the second gradation compression.
AnalogGainMax	Controls the analog gain maximum for HDR mode as an absolute physical value.

Auto Algorithm Control Category

Auto Algorithm Control lets you configure settings for AWB (Automatic White Balance), AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) algorithms.

You can set the camera to AEC/AGC to keep the same image brightness during changing lighting conditions. On the Auto Algorithm Control panel, you can configure the range of exposure times and gain values for AEC/AGC by placing minimum and maximum limits on these parameters.

▼ AutoAlgorithmControl	
BalanceWhiteAutoLowerLimit	0.250000x
BalanceWhiteAutoUpperLimit	4.000000x
BalanceWhiteAutoSpeed	64
ExposureAutoLowerLimit	50us
ExposureAutoUpperLimit	21353us
GainAutoLowerLimit	0.000000dB
GainAutoUpperLimit	48.000000dB
ExposureGainAutoPriority	ExposureTime
ExposureGainAutoMode	Average
ExposureGainAutoTarget	1500
ExposureGainAutoTargetThreshold	16
AverageLuminosity	0
CurrentFrameCounterLow	24840
CurrentFrameCounterHigh	0
▼ ExposureAutoPIDCoefficients	
ExposureAutoPMin	0.040000x
ExposureAutoPMax	8.000000x
ExposureAutoExposureForPMax	25000us
▼ GainAutoPIDCoefficients	
GainAutoPcoef	0.060000x
GainAutoIcoef	0.000000x
GainAutoDcoef	0.030000x

available for SFP-C4540, SFP-C5340, and SFP-C5341 cameras only

BalanceWhiteAutoLowerLimit	Controls the minimum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoUpperLimit	Controls the maximum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoSpeed	Sets the speed of AWB algorithm. 1 is slowest, 64 is fastest.
ExposureAutoLowerLimit	Sets the minimum exposure time value in microseconds.
ExposureAutoUpperLimit	Sets the maximum exposure time value in microseconds.
GainAutoLowerLimit	Sets the minimum gain when <i>GainAuto</i> is Continuous (step is 0.1 dB).
GainAutoUpperLimit	Sets the maximum gain (up to 48 dB in 0.1 dB steps).
ExposureGainAutoPriority	Selects whether to adjust gain or exposure first.
ExposureGainAutoMode	Shows what luminance mode is used during AGC or AEC.

ExposureGainAutoTarget	Sets the desired luminance level to be maintained during AGC or AEC or both assuming 12-bits per pixel.
ExposureGainAutoTargetThreshold	Sets the acceptable steady-state error of the luminance level to be maintained during AGC or AEC. Normal initial setting for stability is 16.
AverageLuminosity	Shows current average luminosity of the image.
CurrentFrameCounterLow	Shows number of frames captured since the camera power up (lower 32 bits).
CurrentFrameCounterHigh	Shows number of frames captured since the camera power up (upper 32 bits).

Exposure Auto PID Coefficients Category

▼ ExposureAutoPIDCoefficients	
ExposureAutoPMin	0.040000x
ExposureAutoPMax	8.000000x
ExposureAutoExposureForPMax	25000us

- ExposureAutoPMin** Controls the minimum of the P coefficient for Exposure Auto control loop.
- ExposureAutoPMax** Controls the maximum of the P coefficient for Exposure Auto control loop.
- ExposureAutoExposureForPMax** Maps the maximum of the P coefficient to the value of exposure in the Exposure Auto control loop.

CAUTION

Imperx does not recommend changing min and max limits of the P coefficient. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AEC algorithm.

If you need to change the P coefficient, please contact Imperx support.

Gain Auto PID Coefficients Category

▼ GainAutoPIDCoefficients	
GainAutoPcoef	0.060000x
GainAutoIcoef	0.000000x
GainAutoDcoef	0.030000x

- GainAutoPcoef** Controls the P coefficient for Gain Auto control loop.
- GainAutoIcoef** Controls the I coefficient for Gain Auto control loop.
- GainAutoDcoef** Controls the D coefficient for Gain Auto control loop.

CAUTION

Imperx does not recommend changing the P, I, and D coefficients. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AGC algorithm.

If you need to change the P, I, and D coefficients, please contact Imperx support.

Data Correction Category

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

▼ DataCorrection	
LUTEnable	Off
FFCEnable	FactoryFFC
DefectPixelCorrection	Factory
DefectPixelCorrectionMode	Average
BadPixelCorrection	Factory
BadPixelCorrectionMode	Average
DefectPixelCountMax	1024
BadPixelCountMax	4096

LUTEnable	Selects LUT to be used in processing image (LUT1 – LUT4). LUT1 and LUT3 are pre-programmed with Gamma 0.45, LUT2 and LUT 4 are preprogrammed with negative LUT.
FFCEnable	Selects FFC to be used in processing image. FactoryFFC has a factory preset correction. You can create and load your FFC to FFC1–FFC7.
DefectPixelCorrection	Enables defect pixel correction. You can upload your own defect pixel map.
DefectPixelCorrectionMode	Controls the method used for replacing defective pixels.
BadPixelCorrection	Enables Hot Pixel Correction. You can upload your own hot pixel map.
BadPixelCorrectionMode	Controls the method used for replacing hot pixels.
DefectPixelCountMax	Maximum number of pixels in the Defect Pixel Correction Table.
BadPixelCountMax	Maximum number of pixels in the Hot Pixel Correction Table.

Digital IO Control Category

These controls enable you to map camera's inputs and outputs and configure strobes.

DigitalIOControl	
LineSelector	Input1
LineMode	Input
LineInverter	False
LineStatus	False
LineSource	Off
LineFormat	OptoCoupled
Strobe1Reference	Exposure
Strobe1Enable	On
Strobe1Width	1000
Strobe1Delay	0
Strobe2Reference	Exposure
Strobe2Enable	On
Strobe2Width	1000
Strobe2Delay	0

LineSelector	Selects the physical line (or pin) of the external camera connector or the virtual line of the Transport Layer to configure.
LineMode	Returns the status of the physical line used to input or output a signal.
LineInverter	Controls the inversion of the signal of the selected input or output line.
LineStatus	Returns the current signal level on the selected input or output line.
LineSource	Maps the camera's internal signals to the respective Output. The signals are: ExposureStart, ExposureEnd, MidExposure, ExposureActive, TriggerActual, TriggerDelayed, PulseGenerator, Strobe1, Strobe2, Pulse1Source, Pulse2Source.
LineFormat	Returns the current electrical format of the selected physical input or output line.
Strobe1Reference / Strobe2Reference	Sets the reference event for the strobe signal.
Strobe1Enable / Strobe2Enable	Enables or disables the strobe.
Strobe1Width / Strobe2Width	Sets the strobe pulse duration in microseconds.
Strobe1Delay / Strobe2Delay	Sets the strobe delay from the reference in microseconds.

Pulse Generator Category

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

▼ PulseGenerator	
PulseGenGranularity	x1uS
PulseGenWidth	1000
PulseGenPeriod	50000
PulseGenNumPulses	1
PulseGenMode	Continuous
PulseGenEnable	False

- 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. To set Pulse Generator in continuous mode, set the parameter in 65536.
- PulseGenMode** Sets the mode of the Pulse Generator.
- PulseGenEnable** Enables the Pulse Generator.

Canon Lens Control Category

If using Canon EF Active lens mount, the following parameters are available for controlling the lens or checking its status. Please refer to the [Canon Lens Control](#) section for more information on lens adjusting procedures.

Controller Settings Category

▼ CanonLensControl	
▼ ControllerSettings	
InitLens	Execute
StopLens	Execute
LensControllerStatus	InitLens_Done
LensAF_MF	AutoFocus
GetLensStatus	Execute
LensStatus	0
CanonFocusingDrivelsIneffective	False
CanonFocusingRinglsActive	False
CanonElectronicRingDriveOn	False
CanonIrislsFullyOpened	True
GetLensID	Execute
LensID	9126

InitLens	Initializes the Canon Lens, if one is mounted to the camera. Always execute the <i>InitLens</i> command upon powering up.
StopLens	Removes the power from the Iris drive. Run <i>InitLens</i> command to resume the lens control.
LensControllerStatus	Shows status of Canon Lens initialization.
LensAF_MF	Shows status of Auto / manual focus switch located on the lens.
GetLensStatus	Requests the value of Lens Status register.
LensStatus	Returns the status of the Lens after the <i>GetLensStatus</i> run.
CanonFocusingDrivelsIneffective	Shows the status of focusing drive mechanism. Appears True if mechanism reached FarFull or NearFull position.
CanonFocusingRinglsActive	This feature indicates the state of focusing drive. Stays True while focusing drive is accelerating or decelerating.
CanonElectronicRingDriveOn	Shows the power status of focusing drive. Focusing drive may consume power even not moving.
CanonIrislsFullyOpened	Shows the status of Iris.
GetLensID	Request the value of the Lens ID register.
LensID	Returns the Lens ID after the <i>GetLensID</i> command is issued

Focus Category

Focus	
NearFull	Execute
FarFull	Execute
FocusStepValue	50
NearStep	Execute
FarStep	Execute
FocusReqPosition	0
SetFocusPosition	Execute
FocusMax	0
FocusSetMax	Execute
FocusEncoderStatus	65234
GetFocusEncoderStatus	Execute
ResetFocusEncoder	Execute

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 <i>NearStep</i> and <i>FarStep</i> 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 <i>FocusStepValue</i> feature.
FarStep	Drives the focus toward the Far direction based on amount defined in the <i>FocusStepValue</i> feature.
FocusReqPosition	Sets the desired focus value to use with <i>SetFocusPosition</i> command.
SetFocusPosition	Drives the focus to the absolute position defined in the <i>FocusReqPosition</i> feature.
FocusMax	Returns maximum focus encoder limit.
FocusSetMax	Sets the maximum focus encoder limit by copying current encoder value
FocusEncoderStatus	Shows the current focus encoder value after issuing the <i>GetFocusEncoderStatus</i> command.
GetFocusEncoderStatus	Requests the focus encoder position value.
Reset Focus Encoder	Resets the Focus encoder.

Iris Category

▼ Iris	
IrisRequestedPositionRaw	0
SetIrisPosition	Execute
CurrentFNumber	4.55515
OpenIrisFull	Execute
CloseIrisStep	Execute
OpenIrisStep	Execute
IrisStepValue	1
GetIrisRange	Execute
IrisMin	43
IrisMax	80
IrisRange	502B2B2B

IrisRequestedPositionRaw	Sets raw iris absolute position.
SetIrisPosition	Drives the iris to the absolute position value of <i>IrisRequestedPositionRaw</i> .
CurrentFNumber	F-number value of the lens iris. Value of 0.0 signals an unknown iris position.
OpenIrisFull	Fully opens the iris.
CloseIrisStep	Closes the iris based on amount entered in the <i>IrisStepValue</i> feature.
OpenIrisStep	Opens the iris by the amount defined in the <i>IrisStepValue</i> feature.
IrisStepValue	Sets the iris step size (between 1 and 127) when using the <i>OpenIrisStep</i> and <i>CloseIrisStep</i> commands.
GetIrisRange	Determines the Iris Range. The values are read using the <i>GetIrisRange</i> command.
IrisMin	Returns the minimum iris limit.
IrisMax	Returns the maximum iris limit.
IrisRange	Shows the limit values of the iris after issuing the <i>GetIrisRange</i> command.

Transport Layer Control Category

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

▼ TransportLayerControl	
PayloadSize	48955392
▼ GigEVision	
GevMACAddress	08:ED:02:10:12:09
GevGVSPExtendedIDMode	On
GevCurrentIPConfigurationLLA	True
GevCurrentIPConfigurationDHCP	True
GevCurrentIPConfigurationPersis...	False
GevCurrentIPAddress	169.254.170.77
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
GevIEEE1588Supported	True
GevIEEE1588	False
GevIEEE1588Status	Unknown
GevIEEE1588Mode	Auto
GevIEEE1588GrandmasterClockID	0
GevLinkSpeed	10000
GevFirstURL	Local:lpX10G_CheetahPregiusPF.zip;31c0000...
GevSecondURL	
GevCCP	ExclusiveAccess
GevPrimaryApplicationSocket	55751
GevPrimaryApplicationIPAddress	169.254.237.81
GevMCPHostPort	55752
GevMCDA	169.254.237.81
GevMCTT	0
GevMCRC	0
GevMCSP	49152
GevSCCFGUnconditionalStreami...	False
GevSCPHostPort	60899
GevSCPSFireTestPacket	False
GevSCPSDoNotFragment	True
GevSCPD	0
GevSCDA	169.254.237.81
GevSCFTD	0
GevSCSPPacketSize	9216
GevHeartbeatTimeout	3000
GevTimestampTickFrequency	74250000
GevTimestampControlLatch	Execute
GevTimestampControlReset	Execute
GevTimestampValue	21419

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.
GevMACAddress	Displays the MAC address of the Ethernet network interface.
GevGVSPExtendedIDMode	Sets the extended ID mode for GVSP (64 bit block_id64, 32 bit packet_id32). This bit cannot be reset if the stream channels do not support the standard ID mode.
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.
GevIEEE1588	Enables the IEEE 1588 Precision Time Protocol to control the timestamp register.
GevIEEE1588Status	Provides the status of the IEEE 1588 clock.
GevIEEE1588Supported	Indicates whether the IEEE 1588 V2 Precision Time Protocol (PTP) is supported.
GevIEEE1588Mode	Provides the mode of the IEEE 1588 clock.
GevIEEE1588GrandmasterClockID	This feature stores the clock ID of PTP grandmaster.
GevLinkSpeed	Indicates the speed of transmission negotiated by network interface in Mbps.
GevFirstURL	This feature stores the first URL to the XML device description file.
GevSecondURL	This feature stores the second URL to the XML device description file.
GevCCP	Enables granting privilege to an application. Options are open access, exclusive access, or control access.
GevPrimary Application Socket	Indicates the UDP source port of the primary application.

GevPrimary 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.
GevSCCFG UnconditionalStreaming	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.
GevSCPD	Indicates the delay (in timestamp counter unit) to insert between each packet for this stream channel.
GevSCDA	Indicates the destination IP address for this stream channel.
GevSCFTD	Sets a frame transmission delay in microseconds to sequence multiple camera outputs on network. The value of delay between the frame acquisition and transmission.
GevSCSPPacketSize	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

User Set Control Category

UserSetControl	
UserSetSelector	Default
UserSetLoad	Execute
UserSetSave	<Value not available>
UserSetDefault	Default

- UserSetSelector** Points to User Configuration Set (Default, User Set 0...User Set 3) 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).
- UserSetSave** Saves the User Configuration Set 0, 1, 2, or 3 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.

Event Control Category

▼ EventControl	
EventSelector	AcquisitionStart
EventNotification	Off

EventSelector Selects which Event to signal to the host application.

EventNotification Activate or deactivate the notification to the host application of the occurrence of the selected Event.

Action Control Category

▼ ActionControl	
NumberOfActionSignals	1
ActionDeviceKey	<Value not readable>
ActionQueueSize	1
ActionSelector	0
ActionGroupMask	0
ActionGroupKey	0

NumberOfActionSignals Returns number of separate action signals supported by the device. Determines how many action signals the device can handle in parallel, i.e. how many different action commands can be set up for the device. In Cheetah cameras, this value is 1.

ActionDeviceKey Provides the device key which the device uses to check the validity of action commands. The device execution of an action signal is only authorized if the *ActionDeviceKey* and the device key value in the protocol message are equal.

ActionQueueSize Indicates the size of the scheduled action commands queue. This number represents the maximum number of scheduled action commands that can be pending at a given point in time. In Cheetah cameras, this value is 1.

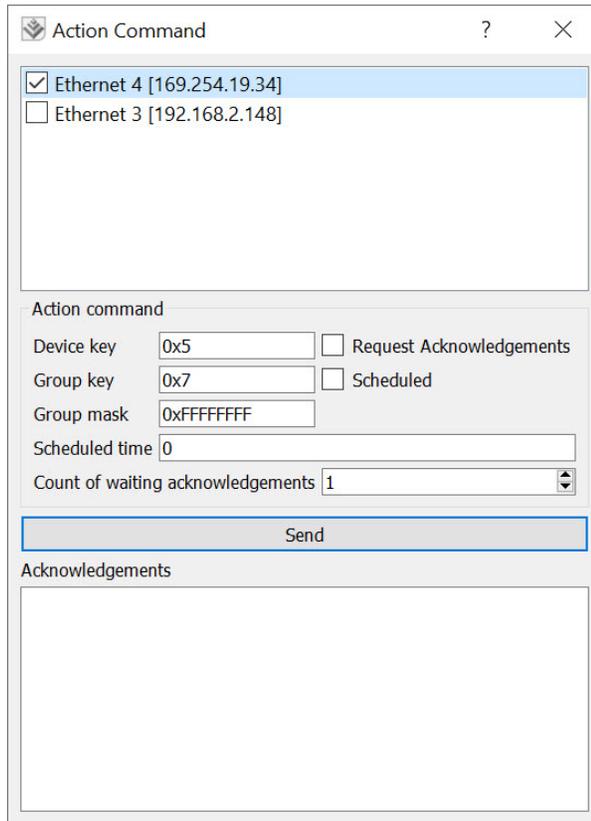
ActionSelector Selects to which Action Signal further Action settings apply.

ActionGroupMask Provides the mask that the device will use to validate the action on reception of the action protocol message.

ActionGroupKey Provides the key that the device will use to validate the action on reception of the action protocol message. If the *ActionGroupKey* equals the group key in the action protocol message, then the action is validated.

Action Command Panel

The Action Command panel in the IPXPlayer application allows you to broadcast an action command (also known as Trigger over Ethernet) from a computer to multiple GigE Vision cameras using a single protocol message.



Function	Description														
Device key	<p>A 32-bit unique key used to validate and authorize action commands in the camera. Min: 0 Max: 0xFFFFFFFF</p> <p>The <i>Device key</i> value sent in the action protocol message must equal the <i>ActionDeviceKey</i> value configured in the camera using the Action Control panel. If the <i>Device key</i> does not equal the <i>ActionDeviceKey</i> stored in the camera, the camera will not execute the action command.</p> <table border="1"> <thead> <tr> <th colspan="2">ActionControl</th> </tr> </thead> <tbody> <tr> <td>NumberOfActionSignals</td> <td>1</td> </tr> <tr> <td>ActionDeviceKey</td> <td>5 write-only feature</td> </tr> <tr> <td>ActionQueueSize</td> <td>1</td> </tr> <tr> <td>ActionSelector</td> <td>0</td> </tr> <tr> <td>ActionGroupMask</td> <td>FFFFFFFF</td> </tr> <tr> <td>ActionGroupKey</td> <td>7</td> </tr> </tbody> </table>	ActionControl		NumberOfActionSignals	1	ActionDeviceKey	5 write-only feature	ActionQueueSize	1	ActionSelector	0	ActionGroupMask	FFFFFFFF	ActionGroupKey	7
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ActionDeviceKey	5 write-only feature														
ActionQueueSize	1														
ActionSelector	0														
ActionGroupMask	FFFFFFFF														
ActionGroupKey	7														

Function	Description														
Group key	<p>A 32-bit key that is used to organize cameras into groups. Min: 0 Max: 0xFFFFFFFF</p> <p>The <i>Group key</i> value sent in the action protocol message should equal the <i>ActionGroupKey</i> value stored in the camera using the Action Control panel. Otherwise, the camera will not execute the action command.</p> <table border="1"> <thead> <tr> <th colspan="2">▼ ActionControl</th> </tr> </thead> <tbody> <tr> <td>NumberOfActionSignals</td> <td>1</td> </tr> <tr> <td>ActionDeviceKey</td> <td><Value not readable></td> </tr> <tr> <td>ActionQueueSize</td> <td>1</td> </tr> <tr> <td>ActionSelector</td> <td>0</td> </tr> <tr> <td>ActionGroupMask</td> <td>FFFFFFFF</td> </tr> <tr> <td>ActionGroupKey</td> <td>7</td> </tr> </tbody> </table> <p>All cameras in the group perform the same action (Action 0) at the same time (unless subgroups are specified).</p>	▼ ActionControl		NumberOfActionSignals	1	ActionDeviceKey	<Value not readable>	ActionQueueSize	1	ActionSelector	0	ActionGroupMask	FFFFFFFF	ActionGroupKey	7
▼ ActionControl															
NumberOfActionSignals	1														
ActionDeviceKey	<Value not readable>														
ActionQueueSize	1														
ActionSelector	0														
ActionGroupMask	FFFFFFFF														
ActionGroupKey	7														
Group mask	<p>A 32-bit number that is used to organize cameras into subgroups within a group. All cameras in the subgroup perform the same action (Action 0) at the same moment.</p> <p>The logical AND operation of the <i>Group mask</i> in the protocol message and the <i>ActionGroupMask</i> stored in the camera must result in a non-zero value to enable a camera to respond to an action protocol message. The group mask and <i>ActionGroupMask</i> must have at least one common bit set to 1 before the camera will accept an action command. If the AND operation of the Group mask in the protocol message and the <i>ActionGroupMask</i> results in zero, the camera does not perform the action.</p> <table border="1"> <thead> <tr> <th colspan="2">▼ ActionControl</th> </tr> </thead> <tbody> <tr> <td>NumberOfActionSignals</td> <td>1</td> </tr> <tr> <td>ActionDeviceKey</td> <td><Value not readable></td> </tr> <tr> <td>ActionQueueSize</td> <td>1</td> </tr> <tr> <td>ActionSelector</td> <td>0</td> </tr> <tr> <td>ActionGroupMask</td> <td>FFFFFFFF</td> </tr> <tr> <td>ActionGroupKey</td> <td>7</td> </tr> </tbody> </table> <p>Min: 1 Max: 0xFFFFFFFF</p>	▼ ActionControl		NumberOfActionSignals	1	ActionDeviceKey	<Value not readable>	ActionQueueSize	1	ActionSelector	0	ActionGroupMask	FFFFFFFF	ActionGroupKey	7
▼ ActionControl															
NumberOfActionSignals	1														
ActionDeviceKey	<Value not readable>														
ActionQueueSize	1														
ActionSelector	0														
ActionGroupMask	FFFFFFFF														
ActionGroupKey	7														

Function	Description
Scheduled time	<p>Defines the time when cameras will execute a scheduled action command. Cameras execute commands synchronously once their internal timestamps reach the scheduled value.</p> <p>The time is entered in ticks where one tick equals 1 ns.</p> <p>Scheduled action commands require enabling the IEEE1588 PTP on each camera that you want to control with the scheduled action command.</p>
Count of waiting acknowledgements	Number of waiting acknowledgement messages when the <i>Request Acknowledgements</i> check-box is checked.
Request Acknowledgements	Enables/disables acknowledgement messages
Scheduled	Enables/disables the scheduled action command.

Action commands can be immediate or scheduled. Immediate action commands are used to control multiple devices at roughly the same time without precise synchronization. Setting the Scheduled time parameter to 0 ticks enables immediate action command execution so that Ethernet devices execute an immediate action command directly upon receiving and validating it. The transmission and latency delays between cameras introduces some errors in the exact capture time.

Scheduled action commands provide precise time-based control of multiple devices by executing a command synchronously at a predetermined time in the future. Scheduled action commands are suitable for applications that demand precise timing.

NOTE ⚠ Immediate action commands do not require IEEE1588 PTP (Precision Time Protocol). Transmission and processing latencies affect the time of the command execution so devices execute immediate action commands at slightly different moments.

Scheduled action commands, however, require IEEE1588 PTP. With IEEE1588 PTP enabled, internal clocks of Ethernet devices are synchronized. As a result, devices execute the action command synchronously at precisely the same time because the action is scheduled to occur at some future time compensating for transmission and processing latencies.

Action commands can be sent to one or more devices within an Ethernet network segment.

The Imperx Cheetah 10 GigE Vision v.2.0 cameras support one action command—Action 0. The Action 0 command triggers synchronous image acquisition on one or multiple cameras. The camera waits for the action command and starts image acquisition upon accepting the action command.

NOTE ⚠ Before sending action commands, make sure that the Windows Firewall is disabled (see the [Disabling Windows Firewall for All Connections](#) section on p. 90 and [Disabling Windows Firewall for Selected Network Adapters](#) section on p. 91 sections) and configure camera's parameters such as Trigger Source and Action Control parameters (see the [Configuring the Camera to Work with Action Control](#) section on p. 216).

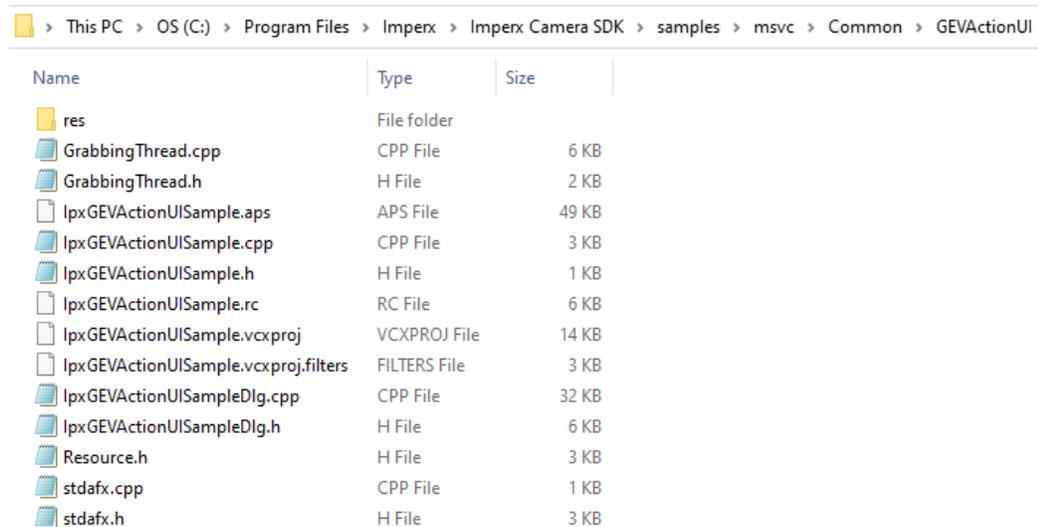
Sending the Immediate Action Command

You can broadcast an action command from a computer to multiple GigE Vision cameras using a single protocol message.

To send out an action command, use either the Imperx IpxPlayer application, Imperx Camera SDK C/C++/.NET API, or third-party software that supports action commands.

A C++ code sample can be found in the following folder on your computer:

c:\Program Files\Imperx\Imperx Camera SDK\samples\msvc\Common\GEVActionUI

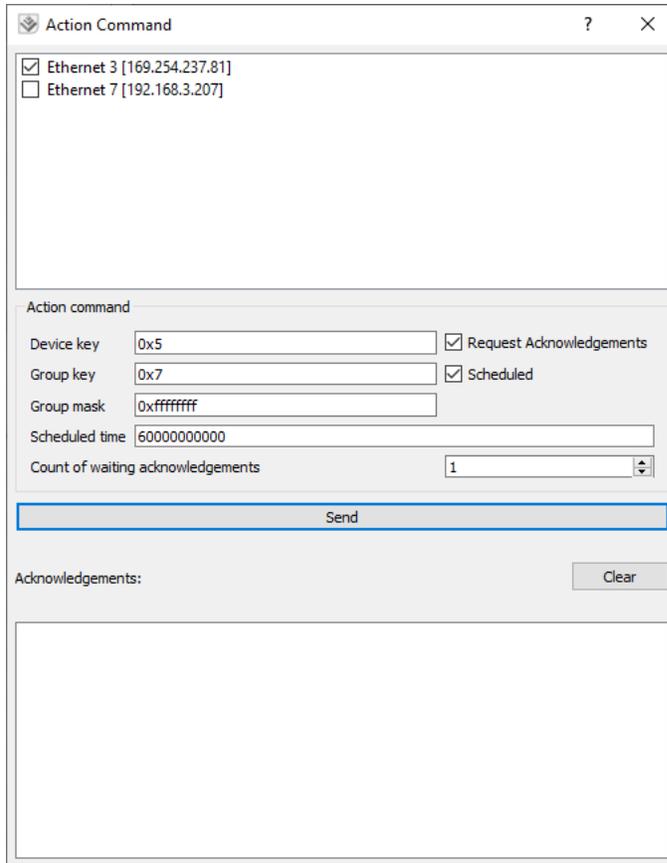


File Explorer path: > This PC > OS (C:) > Program Files > Imperx > Imperx Camera SDK > samples > msvc > Common > GEVActionUI

Name	Type	Size
res	File folder	
GrabbingThread.cpp	CPP File	6 KB
GrabbingThread.h	H File	2 KB
IpxGEVActionUISample.aps	APS File	49 KB
IpxGEVActionUISample.cpp	CPP File	3 KB
IpxGEVActionUISample.h	H File	1 KB
IpxGEVActionUISample.rc	RC File	6 KB
IpxGEVActionUISample.vcxproj	VCXPROJ File	14 KB
IpxGEVActionUISample.vcxproj.filters	FILTERS File	3 KB
IpxGEVActionUISampleDlg.cpp	CPP File	32 KB
IpxGEVActionUISampleDlg.h	H File	6 KB
Resource.h	H File	3 KB
stdafx.cpp	CPP File	1 KB
stdafx.h	H File	3 KB

To send out the immediate action command using the Imperx IpxPlayer application, follow the steps below:

1. Run the Imperx IpxPlayer application and connect to the camera.
2. Click **Camera** → **GEV Action command** on the Imperx IpxPlayer menu bar. The Action Command dialog opens.
3. Select those NICs (Network Interface Cards) to which action controlled cameras are connected.



4. Enter values for *Device key*, *Group key*, and *Group mask*.

NOTE ⚠ The host PC's and camera's *Device key* values must be equal.
The host PC's and camera's *Group key* values must be equal.
The logical AND operation of the host PC's and camera's *Group mask* must result in non-zero value.

5. Optionally, check the **Request Acknowledgements** check box and enter a value for **Count of waiting acknowledgements**.
6. Make sure that all cameras are running.
7. Click **Send**.

Sending the Scheduled Action Command

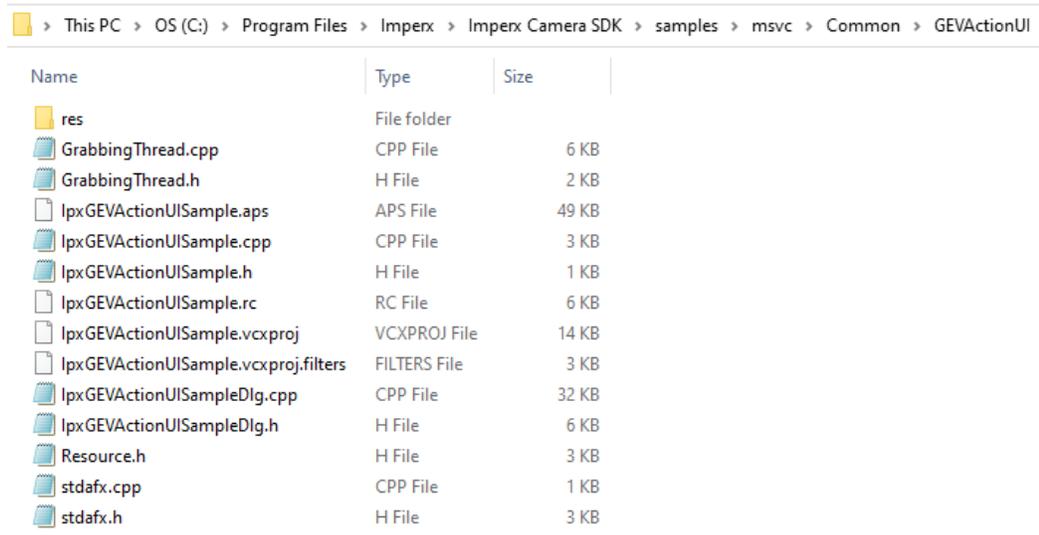
Scheduled action commands use the same basic parameters as immediate action command: *Device key*, *Group key*, and *Group mask*. Additionally, they require setting the **Scheduled time** parameter that defines when cameras are to execute a command. Cameras execute a command synchronously once their internal timestamps reach the scheduled value.

NOTE  Scheduled action commands require enabling the IEEE1588 PTP on each camera that you want to control with the scheduled action command. The IEEE1588 PTP synchronizes clocks between the devices on the network. Make sure that the *GevIEEE1588* parameter is enabled on each camera.

Cheetah cameras can store one scheduled action command. The *ActionQueueSize* parameter indicates the maximum number of scheduled action commands that can be pending at a given point of time. A camera ignores an action command if the queue is full.

To send out a scheduled action command, use either the Imperx IpxPlayer application, Imperx Camera SDK C/C++/.NET API, or third-party software that supports action commands.

A C++ code sample can be found in the following folder on your computer:
 "c:\Program Files\Imperx\Imperx Camera SDK\samples\msvc\Common\GEVActionUI"



To send out the scheduled action command using the Imperx IpxPlayer application, follow the steps below:

1. Run the Imperx IpxPlayer application and connect to the camera.
2. Select either **Expert** or **Guru** in the *Visibility* drop-down list.
3. Unfold the **TransportLayerControl** → **GigEVision** sub-category and set the *GevIEEE1588* parameter to **True**.

▼ TransportLayerControl	
PayloadSize	31415040
▼ GigEVision	
GevMACAddress	08:ED:02:10:11:13
GevGVSPExtendedIDMode	On
GevCurrentIPConfigurationLLA	True
GevCurrentIPConfigurationDHCP	True
GevCurrentIPConfigurationPersistentIP	True
GevCurrentIPAddress	169.254.162.102
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
GevIEEE1588Supported	True
GevIEEE1588	False
GevIEEE1588Status	True
GevIEEE1588Mode	False
GevIEEE1588GrandmasterClockID	0
GevLinkSpeed	10000

Synchronization of Ethernet devices may take several minutes. The cameras negotiate amongst themselves and/or other network devices with IEEE1588 capability (network switch, router, PLC, etc) to determine which device will provide the master clock. Once this negotiation is complete, each camera indicates its status—Master or Slave—in the *GevIEEE1588Status* field.

NOTE * Enabling IEEE1588 PTP changes the camera’s internal tick frequency to 1 GHz (one timestamp tick equals 1 ns). When IEEE1588 PTP is disabled, the camera’s internal tick frequency equals 100 MHz.

4. Repeat steps 2–4 from the [Sending the Immediate Action Command](#) section.

5. Check the **Scheduled** check box to activate the scheduled action command.

The screenshot shows a dialog box titled "Action Command". At the top, there are two checkboxes: "Ethernet 3 [169.254.237.81]" (checked) and "Ethernet 7 [192.168.3.207]" (unchecked). Below this is the "Action command" section with several input fields: "Device key" (0x5), "Group key" (0x7), "Group mask" (0xffffffff), "Scheduled time" (60000000000), and "Count of waiting acknowledgements" (1). There are two checkboxes: "Request Acknowledgements" (checked) and "Scheduled" (checked and highlighted with a red box). A "Send" button is located below the input fields. At the bottom, there is an "Acknowledgements:" label and a "Clear" button.

6. Determine the action time by following the steps below.

- 6.1. Issue the *GevTimestampControlLatch* command on the **GigEVision** sub-category. A current 64-bit timestamp value appears in *GevTimestampValue*. The value is in ticks where one tick is equal to 1 ns and represents the exact camera timestamp when the *GevTimestampControlLatch* command was received and executed.

GevSCSPPacketSize	7168
GevHeartbeatTimeout	3000
GevTimestampTickFrequency	99000000
GevTimestampControlLatch	Execute
GevTimestampControlReset	Execute
GevTimestampValue	561664608497

- 6.2. Add a delay to the *GevTimestampValue* so the execution of the action command is at an appropriate time in the future. The delay must account for the time to read and process the *GevTimestampValue* and the transmission and processing delays between the various cameras.
For example, add $GevTimestampValue + 10\,000\,000\,000$ (10 seconds) so the command is executed 10 seconds in the future.

7. Enter the action time (the resulting value from the step 6.2) in the **Scheduled time** field. The camera executes the scheduled action command at the time specified in the **Scheduled time** field. The time is entered in ticks where one tick is equal to 1 ns.

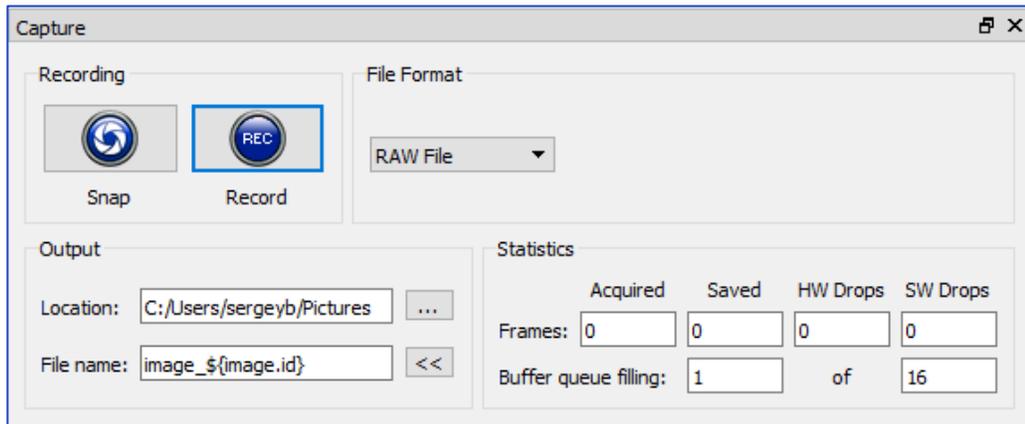
NOTE * There is a delay between issuing an action command from the host computer and the start of image acquisition. Knowing the maximum delay, you can set the **Scheduled time** to compensate for the maximum delay.

Setting **Scheduled time** to 0 (zero) triggers immediate execution of an action command without precision synchronization of cameras. (See [Sending the Immediate Action Command.](#))

8. Make sure that all cameras are running.
9. Click **Send**.

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.



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.
- Statistics** 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.

Saving Image Output

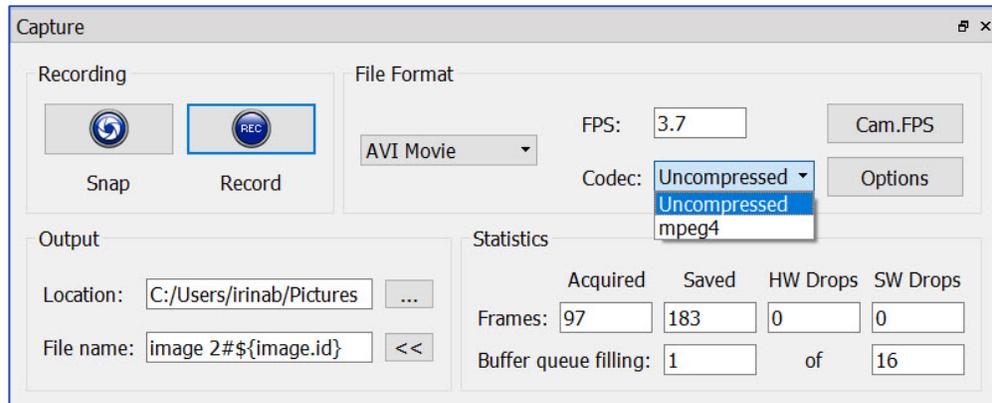
The Output section of the Capture screen lets you configure the location and format of saved images in the computer.

- Output Location** 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 (see the [Saving Image in AVI Movie File Format](#) section).

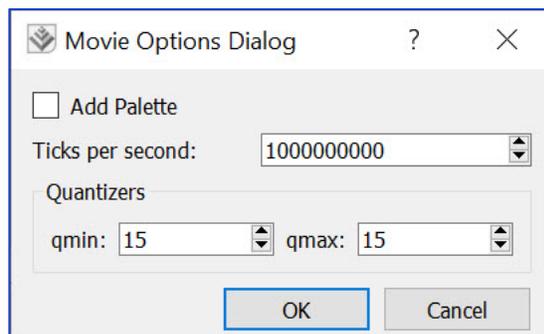
Saving Image in AVI Movie File Format

When saving images in AVI Movie format, follow the steps below:

1. In the **File Format** drop-down list, select AVI Movie.
2. In the **Codec** drop-down list, select a compression method—MPEG 4 or Uncompressed.
3. In the **FPS** field, enter a desired value of the frame rate or click **Cam.FPS** to get the current frames per second from the camera.



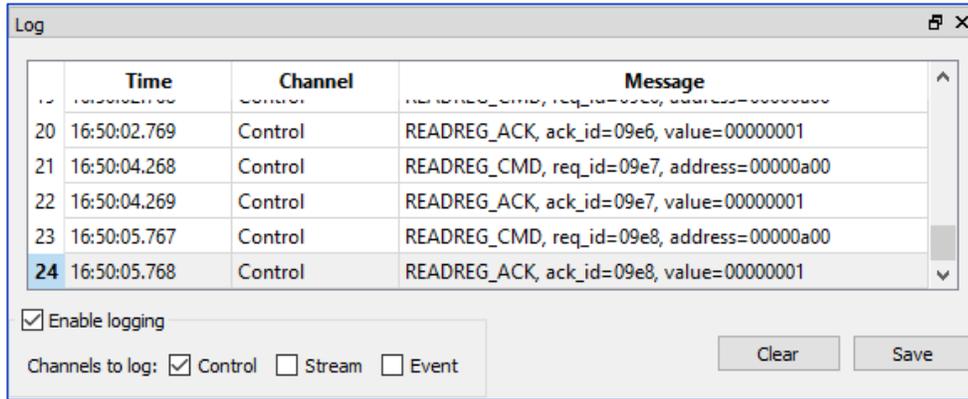
4. Click **Options**.
The Movie Options Dialog screen appears.
5. If pixel format of the images is 8-bit per pixel and the AVI file is to be viewed in Windows OS, check the **Add Palette** checkbox to add a palette to 8-bit bitmap image.



6. Make sure that a value of the **Ticks per second** parameter matches the value of the *GevTimestampTickFrequency* parameter.
7. Set minimum and maximum quantizers and click **OK**.

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.



Channels to Log

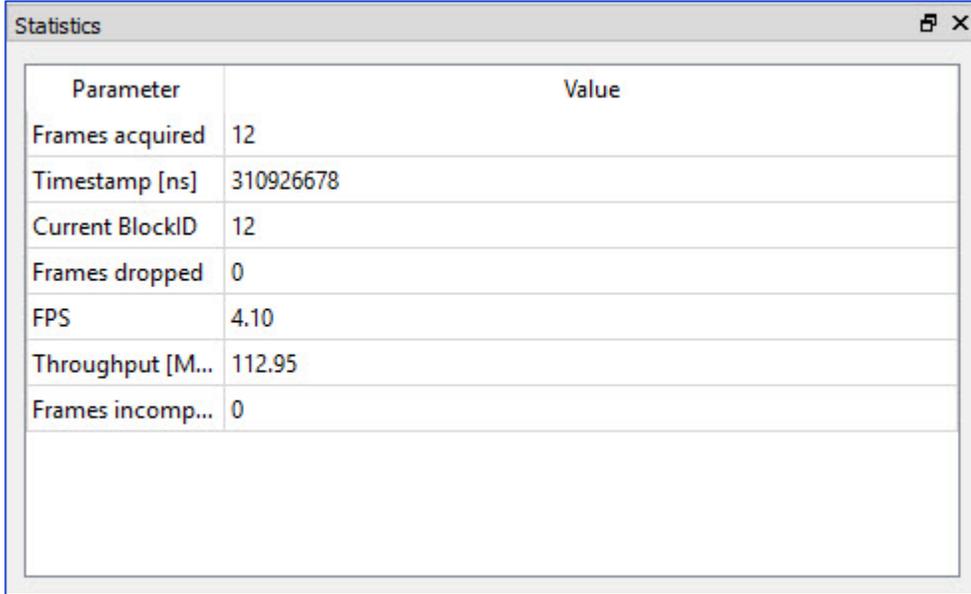
The Enable Logging check box initiates logging. You can save current log data to a TXT file (.txt) with space-separated fields.

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.

Statistics Panel

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

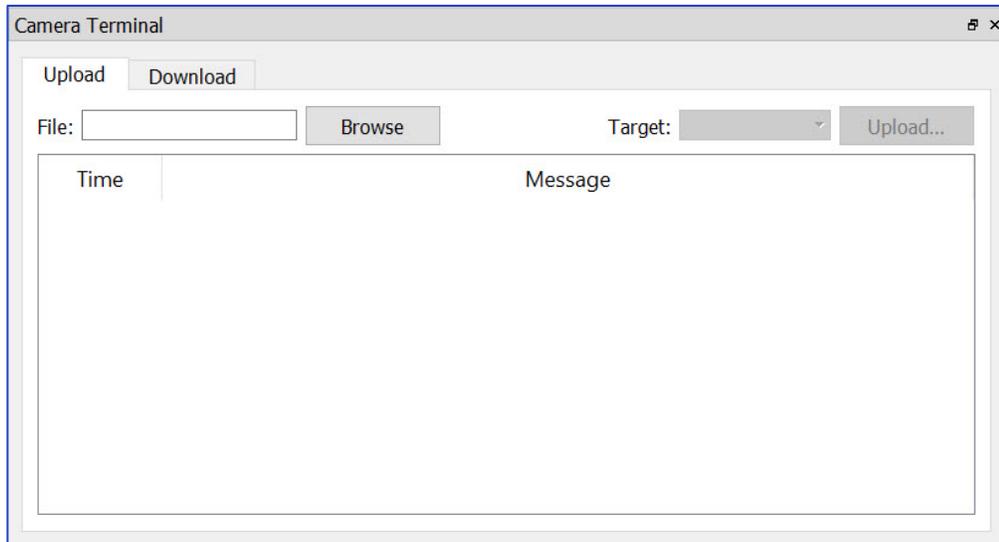


Parameter	Value
Frames acquired	12
Timestamp [ns]	310926678
Current BlockID	12
Frames dropped	0
FPS	4.10
Throughput [M...	112.95
Frames incomp...	0

- 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.

Camera Terminal Panel

The Camera Terminal panel lets you upload and download any custom files—DPM, HPM, Flat Field Correction (FFC), or Lookup Tables (LUT). It also allows you to upload Firmware updates.



Uploading Files

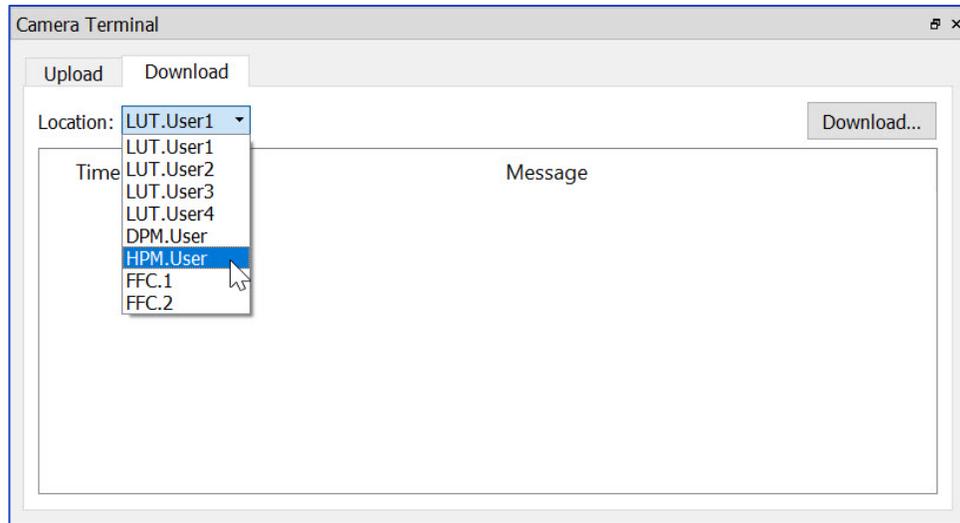
To upload DPM, HPM, FFC, or LUT files from the camera, follow the steps below.

1. On the Upload tab, click **Browse** and navigate to a file (ZIP, RGS, DPM, HPM, FFC, or LUT).
2. Select the file you want to upload.
3. Select a **Target** location for the file.
4. Click **Upload...**
Reboot the camera and restart the IpxPlayer for the changes to take into effect.

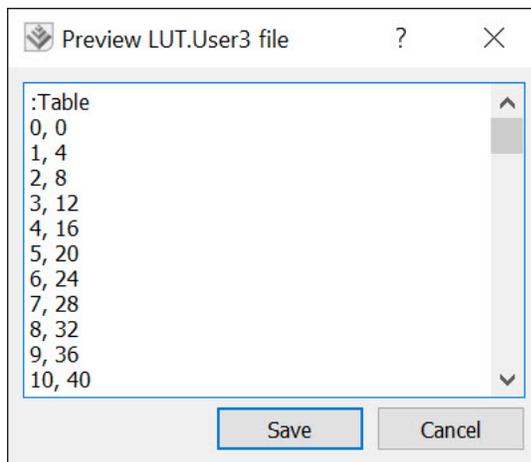
Downloading Files

To download DPM, HPM, FFC, or LUT files into the camera, follow the steps below.

1. On the Download tab, select a **Location** from which to download a file.

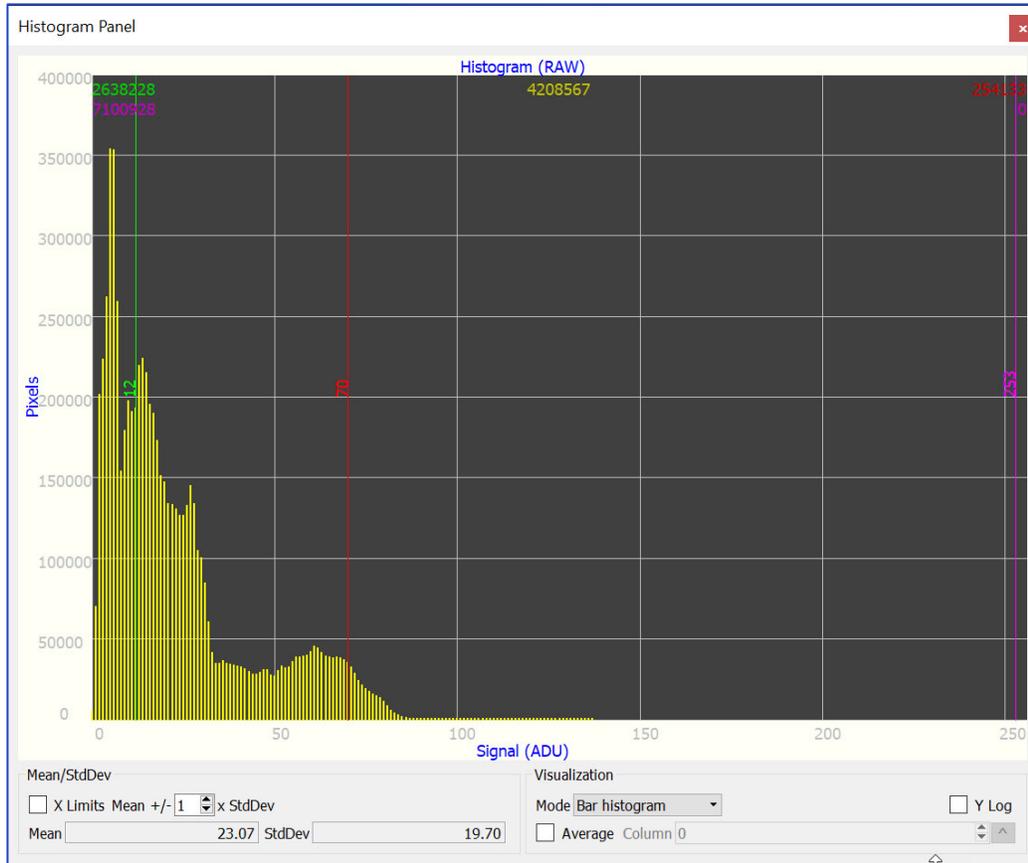


2. Click **Download...**
A readout begins.
3. Upon completing the readout, click **Save**.



Histogram Panel

The Histogram panel shows pixel values in ADU.



Mean/StdDev Pane

- X Limits**

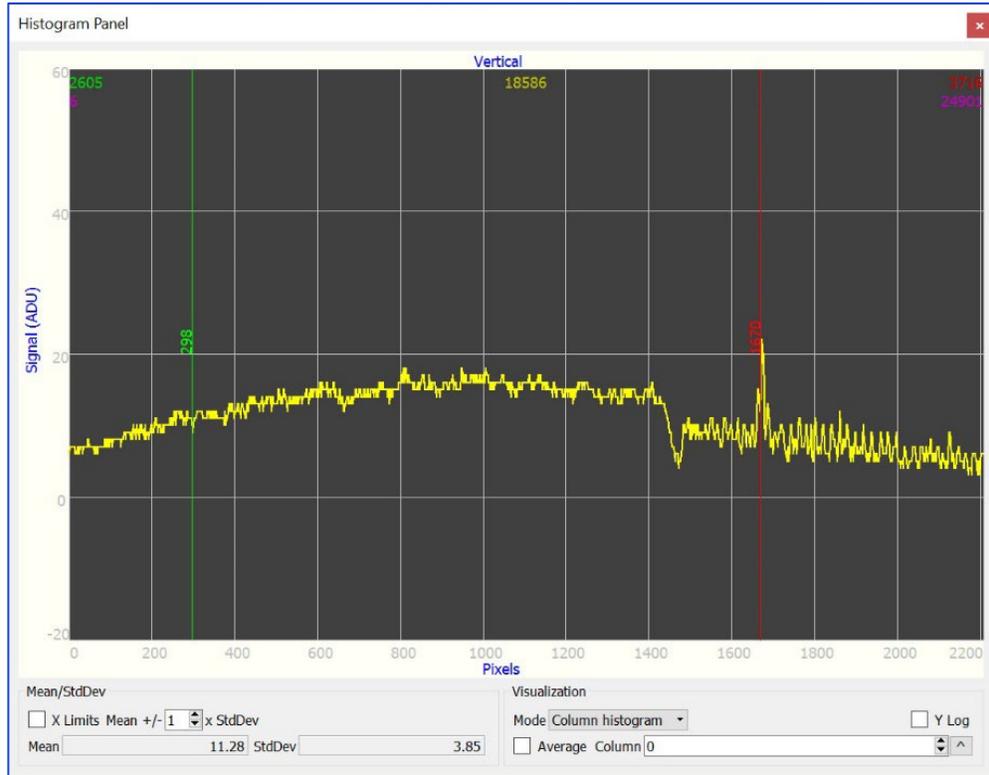
Enables/disables X axis scale adjustments.
By default, the pixel values are shown within 0–255 ADU. To change the limits, check the X Limits check box and select a coefficient (1–10). The new X axis limits are:

Max. limit = Mean + StdDev x coefficient.
Min. limit = Mean – StdDev x coefficient.
- Mean**

Shows the mean pixel value (in ADU)
- StdDev**

Shows the standard deviation of pixel values (in ADU)

- **Column histogram** Shows pixels' values in ADU in the selected column.



Row/Column selects a row/column coordinate to use in calculation.

Set the visualization **Mode** to **Row histogram** or **Column histogram** and select a row/column coordinate.

Average when checked, shows average pixels' values in the selected row/column.

Y Log when checked, a logarithmic Y axis is enabled.

Hex Pixel Dump Panel

The Hex Pixel Dump panel shows pixel values in the table in hex format. The active area is highlighted with a yellow frame on the display.

image column numbers

	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285
1788	R 3c G 44 B 11	R 3e G 47 B 12	R 40 G 4b B 12	R 42 G 4e B 13	R 43 G 50 B 14	R 44 G 54 B 16	R 46 G 55 B 18	R 47 G 57 B 19	R 48 G 58 B 19	R 48 G 5a B 1a	R 4a G 5f B 1a	R 4c G 62 B 1b	R 4c G 61 B 1c	R 4d G 61 B 1c
1789	R 3c G 42 B 11	R 3d G 46 B 11	R 40 G 4b B 12	R 42 G 4d B 13	R 44 G 4f B 15	R 45 G 53 B 16	R 46 G 56 B 17	R 47 G 55 B 18	R 48 G 56 B 19	R 48 G 5a B 1a	R 4a G 5f B 1b	R 4b G 61 B 1b	R 4c G 62 B 1b	R 4d G 63 B 1b
1790	R 3c G 43 B 10	R 3e G 45 B 11	R 40 G 4a B 12	R 42 G 4c B 14	R 44 G 4f B 15	R 44 G 53 B 16	R 45 G 55 B 16	R 46 G 56 B 17	R 47 G 57 B 18	R 48 G 58 B 1a	R 4a G 5e B 1b	R 4c G 61 B 1b	R 4c G 63 B 1a	R 4c G 66 B 1b
1791	R 3d G 44 B 10	R 3e G 46 B 11	R 41 G 4a B 12	R 44 G 4d B 14	R 44 G 4e B 15	R 43 G 52 B 16	R 44 G 54 B 17	R 45 G 57 B 17	R 47 G 59 B 18	R 48 G 5b B 19	R 4a G 5f B 1a	R 4c G 61 B 1b	R 4c G 62 B 1b	R 4b G 63 B 1b
1792	R 3d G 44 B 10	R 3e G 46 B 11	R 40 G 4a B 12	R 43 G 4e B 14	R 43 G 4f B 15	R 44 G 51 B 16	R 45 G 54 B 17	R 46 G 57 B 17	R 47 G 57 B 17	R 49 G 5d B 18	R 4a G 5e B 19	R 4c G 60 B 1b	R 4c G 62 B 1c	R 4c G 61 B 1c
1793	R 3c G 44 B 10	R 3e G 47 B 11	R 40 G 4a B 12	R 41 G 4e B 13	R 43 G 50 B 15	R 45 G 52 B 16	R 46 G 53 B 17	R 47 G 56 B 17	R 48 G 59 B 18	R 49 G 5c B 19	R 4a G 5d B 1a	R 4b G 60 B 1b	R 4c G 63 B 1c	R 4c G 62 B 1b
1794	R 3b G 45 B 0f	R 3d G 47 B 10	R 3f G 4b B 11	R 41 G 4e B 13	R 43 G 51 B 14	R 45 G 54 B 16	R 46 G 54 B 17	R 47 G 55 B 18	R 48 G 59 B 18	R 49 G 5b B 1a	R 4a G 5d B 1b	R 4c G 60 B 1b	R 4c G 62 B 1b	R 4c G 62 B 1b
1795	R 3b G 45 B 10	R 3c G 48 B 11	R 3e G 4c B 12	R 40 G 4e B 13	R 42 G 50 B 14	R 44 G 53 B 15	R 46 G 55 B 16	R 47 G 56 B 17	R 48 G 5a B 18	R 49 G 5b B 19	R 4b G 5c B 1b	R 4c G 60 B 1b	R 4c G 61 B 1b	R 4c G 62 B 1b
	R 3c	R 3e	R 3f	R 40	R 41	R 43	R 45	R 46	R 48	R 4a	R 4a	R 4b	R 4b	R 4b

image row numbers

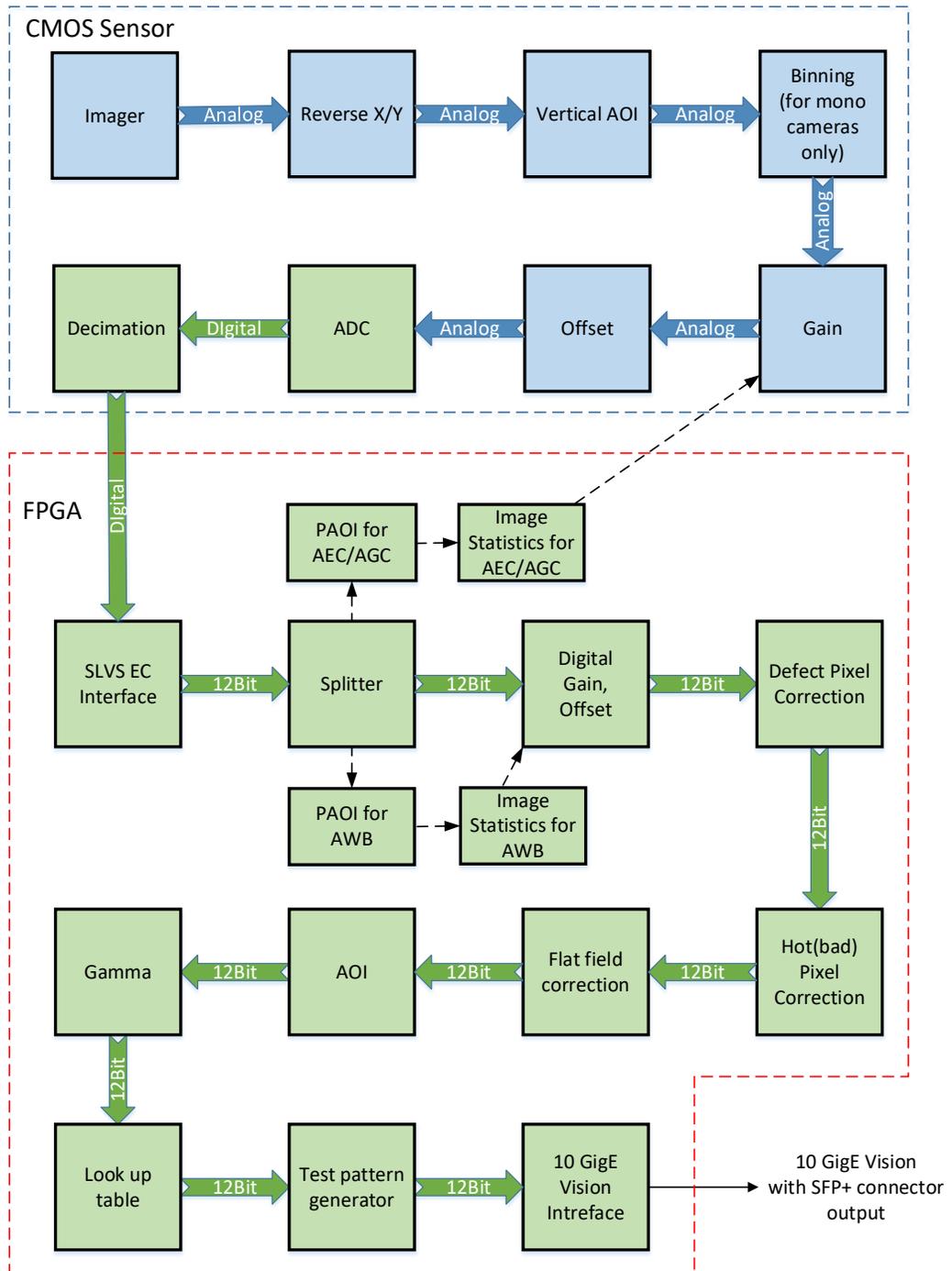
The pixel value is shown in RGB values for color images, and in Y (luminosity) values for monochrome image.

For the Hex pixel Dump to display the pixel values correctly, set the **Hex Pixel Dump data** parameter in the menu *File > Settings* with respect to the pixel format as shown below.

	Pixel Format	
	Packed	Unpacked
Hex Pixel Dump data	Processed	Either RAW or Processed

Camera Features

Image Data Flow



Exposure Control

The camera provides three exposure control modes—**Off**, **Timed**, and **Trigger Width**.

In the **Timed** mode, you can control exposure time manually or automatically. To enable manual control, set *ExposureAuto* to **Off** and specify the exposure time using the *ExposureTime* setting.

To enable AEC (Automatic Exposure Control), set *ExposureAuto* to **Once** or **Continuous**. Please refer to the section [Automatic Exposure and Gain Control](#) for more information on AEC.

The camera works either in trigger (Standard or Fast Trigger) or free-running (untriggered) mode, you might need to also adjust trigger parameters when setting exposure (refer to the section [Camera Triggering](#) for more information on trigger parameters).

NOTE (★) The AEC is not available when exposure mode is set to **Trigger Width**.

Exposure Control in Free-Running Mode

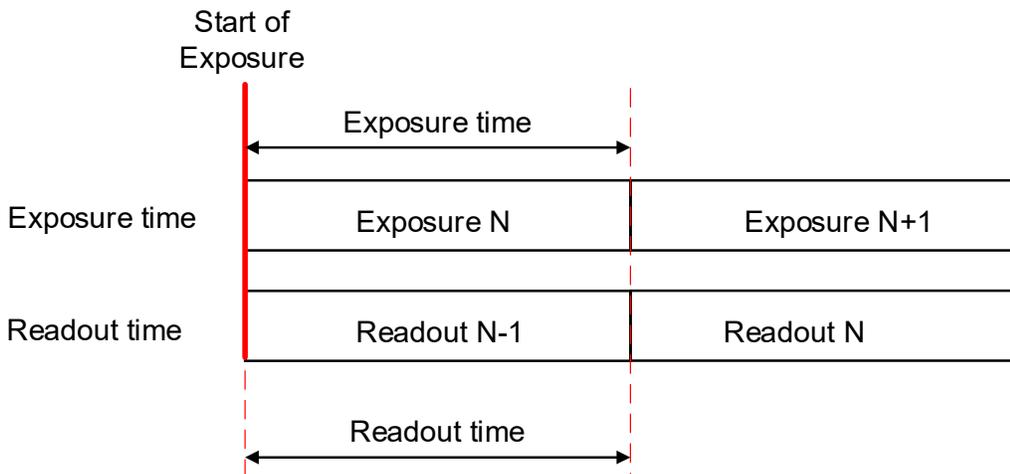
In **free-running mode**, the camera constantly reads out the sensor, and the exposure time is determined by the frame readout time. The exposure time equals the frame read out time when the exposure mode is set to **Off**.

Free-running mode, Exposure control is Off

Settings:

Exposure Mode: **Off**

Trigger Mode: **Off**



To reduce the image exposure time under bright lighting conditions, set the exposure control mode to **Timed**. The electronic exposure control does not affect the frame rate; it only changes the exposure time. When the Timed mode is active, the camera controls the start of exposure, so the new exposure ends just as the readout of the current frame ends and the readout of the next frame begins.

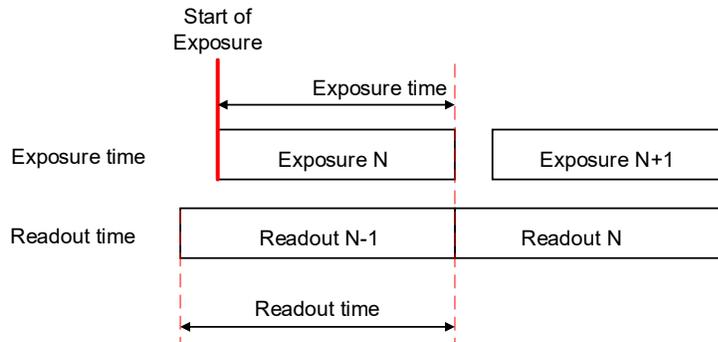
Free-running mode, Exposure control is Timed

Settings:

Exposure Mode: **Timed**

Trigger Mode: **Off**

Exposure Time: **User-specified** (Min. = 36 μ s; Max = Readout time)



To configure the camera to work in free-running mode with Timed expose control:

1. Turn off the camera image acquisition.
2. Set *ExposureAuto* to **Off** for manual exposure control, or to either **Once** or **Continuous** for automatic exposure control.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **Off**.
 - Set *ExposureMode* to **Timed**.
 - If *ExposureAuto* is **Off**, then set *ExposureTime* (in microseconds) to a user-specified value.

NOTE *

In free-running mode, the maximum exposure time equals frame time. You can extend the exposure time by increasing the frame time:

1. Check *AcquisitionFrameRateEnable* box.
2. Increase the frame time by using *AcquisitionFrameTime* (in μ s) or *AcquisitionFrameRate* (in Hz) settings.
3. Set *ExposureTime* within the extended frame time range.

In free-running mode, the minimum exposure is 7 μ s for SFP-C1940, SFP-C1941, SFP-C3240, 8 μ s for SFP-C4540, SFP-C5340, SFP-C5341, and 36 μ s for SFP-C4440, SFP-C5440, SFP-C6440 cameras.

While the *ExposureTime* allows for 1- μ s increments, the *CurrentExposureTime* increment equals 1-line time in μ s.

Exposure Control in Trigger Mode

In **trigger mode**, you can synchronize the camera's acquisition cycle to an external signal by setting the exposure control to either Timed or Trigger Width. Trigger mode can be set to either Standard or Fast (see [Camera Triggering](#)).

NOTE ⚠ The electronic exposure control does not affect the camera's frame rate in Fast trigger mode, because the exposure and readout operations are overlapped in time. In Standard Trigger mode, the maximum frame rate depends upon the exposure time, because the exposure and readout occur sequentially (not overlapped).

In **Timed** exposure control mode, you can set the external trigger pulse to control the start of exposure.

1. Turn off the camera image acquisition.
2. Set *ExposureAuto* to **Off** for manual exposure control, or to either **Once** or **Continuous** for automatic exposure control.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **On**.
 - Set *ExposureMode* to **Timed**.
 - If *ExposureAuto* is **Off**, then set *ExposureTime* (in μs) to a user-specified value.

NOTE ⚠ While the *ExposureTime* allows for 1- μs increments, the *CurrentExposureTime* increment equals 1-line time in μs .

4. Configure the trigger parameters.
Please refer to the section [Configuring the Trigger](#), steps 3–6.

In **Trigger Width** mode, you can set the external trigger signal to control the start and duration of exposure. This mode is available in both Standard and Fast trigger modes (refer to the section).

To configure the camera to work in **Trigger Width** Exposure mode:

1. Turn off the camera image acquisition.
2. Make sure that *ExposureAuto* is **Off** and *AcquisitionFrameRateEnable* is False.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **On**.
 - Set *ExposureMode* to **TriggerWidth**.
4. Configure the trigger pulse parameters.
Please refer to the section [Configuring the Trigger](#), steps 3–6.

NOTE (*) In Standard Trigger mode, the maximum exposure time is defined by the formula:

$$\text{Exposure Time (max)} = \text{Trigger Period} - \text{Readout Time},$$

where the Readout Time is equal to the *CurrentFrameTime* (in free-running mode, with *AcquisitionFrameRateEnable* off).

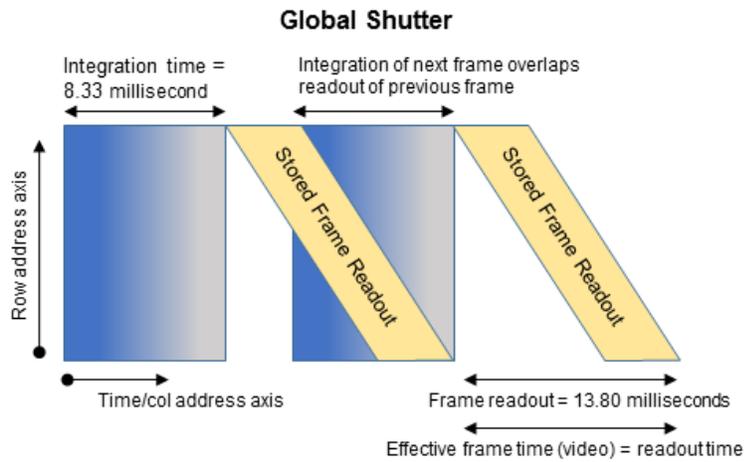
In Standard trigger mode, the minimum exposure is equal to 1 line time. This value depends on a sensor model and some other parameters such as *PixelFormat*.

In Fast Trigger mode, the maximum exposure time is 16 s.

Global 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 pixel memory region within each pixel. After transferring the image to the pixel memory 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 varies based on the image sensor.

The camera overlaps the exposure and read-out times in free-running and Fast Trigger modes as shown in the following figure.



Automatic Exposure and Gain Control

Automatic exposure control (AEC) and automatic gain control (AGC) enable the camera to maintain the same image brightness during the changing lighting conditions. You can enable both AEC and AGC independently or together by setting *ExposureAuto* and *GainAuto* to either **Once** or **Continuous**.

AEC/AGC Mode	Description
Off	AEC/AGC is disabled and a manual control is on. The camera applies the exposure time and gain you enter using the <i>ExposureTime</i> and <i>Gain</i> controls.
Once	Exposure duration/gain is adapted once by the camera. Once it has converged, it returns to the Off state; and the exposure and gains determined during the Once process are maintained until changed manually.
Continuous	Exposure duration/gain is constantly adapted by the camera to maximize the dynamic range.

When AEC / AGC are in **Continuous** or **Once** mode, you can set the image luminance (brightness) target (*ExposureGainAutoTarget*), and the camera adjusts the exposure and/or gain accordingly. The luminance target is a 12-bit value (4095 is a max. value). To determine the luminance target when using 8-bits per pixel, take the desired output in ADUs and multiply this value by 16. The target luminance is the average luminance within the image.

Also, for the **Once** mode, you can set an acceptable difference between the target and current image luminance (*ExposureGainAutoTargetThreshold*) in the range from 0 to 4095. When the threshold is reached, the camera turns off AEC/AGC algorithms and enables manual control over exposure duration and/or gain.

CAUTION

In some rapidly changing and bright light conditions, an image brightness oscillation (image intensity flipping from bright to dark) could occur. To prevent this, increase the AEC minimum exposure setting, increase the target luminance level and/or decrease the lens iris.

Initial conditions for AEC and AGC algorithms:

Exposure and gain are set to the user-specified values of the *ExposureTime* and *Gain* controls.

When AEC and AGC are enabled together, you might need to select whether to adjust gain or exposure first using *ExposureGainAutoPriority* control.

- If the **exposure priority** is selected (**ExposureTime**), the camera adjusts the exposure first within the user-specified minimum/maximum limits. If one of the limits is reached before the target image luminance (or threshold) is achieved, then gain is applied. The camera varies the gain until either the target image luminance (or threshold) is reached or one of gain limits is reached.
- If the **gain priority** is selected (**Gain**), the camera adjusts the gain first within the user-specified minimum/maximum limits. If one of the limits is reached before the target image

luminance (or threshold) is achieved, the exposure is applied. The camera varies the exposure until either the target image luminance (or threshold) is reached or one of exposure limits is reached.

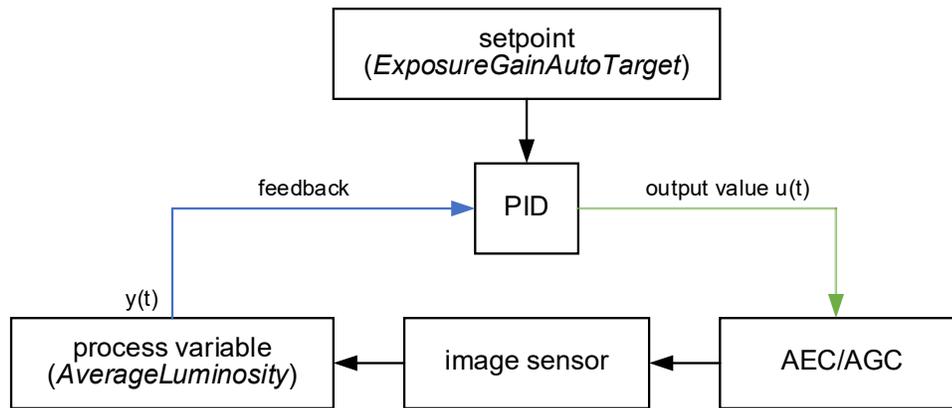
By default, the *ExposureGainAutoPriority* control are set to **ExposureTime**.

The AEC and AGC algorithms sample all pixels for the entire frame. The camera displays the current luminance within the frame.

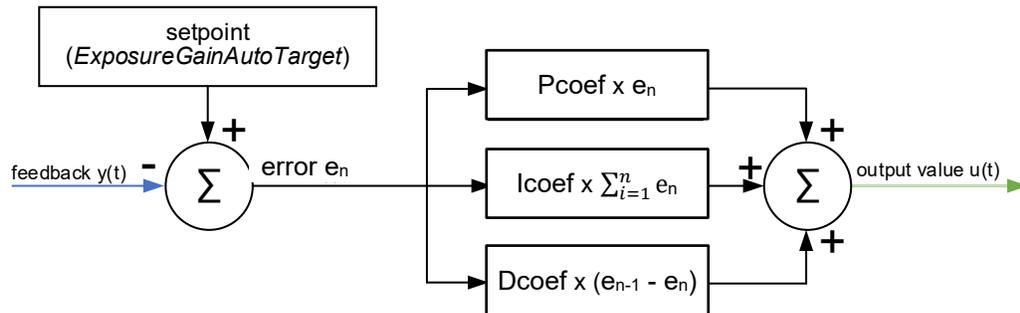
P, I, and D Coefficients

The P (Proportional), I (Integral), and D (Derivative) coefficients of PID feed-back control loops determine speed and stability of AEC and AGC algorithms.

A PID controller continuously calculates a difference (an error) between a setpoint (SP)—*ExposureGainAutoTarget*— and a process variable (PV)—*AverageLuminosity*. Based on the sum of proportional, integral, and derivative responses, the controller determines an output value and adjusts exposure or gain to minimize the error. The PID controller continuously varies the output value until the luminance reaches the setpoint.



The AGC algorithm uses all three responses with a manual control available over the P, I, and D coefficients.



The AEC algorithm uses only two responses – proportional and derivative with a manual control available over the P coefficient only.

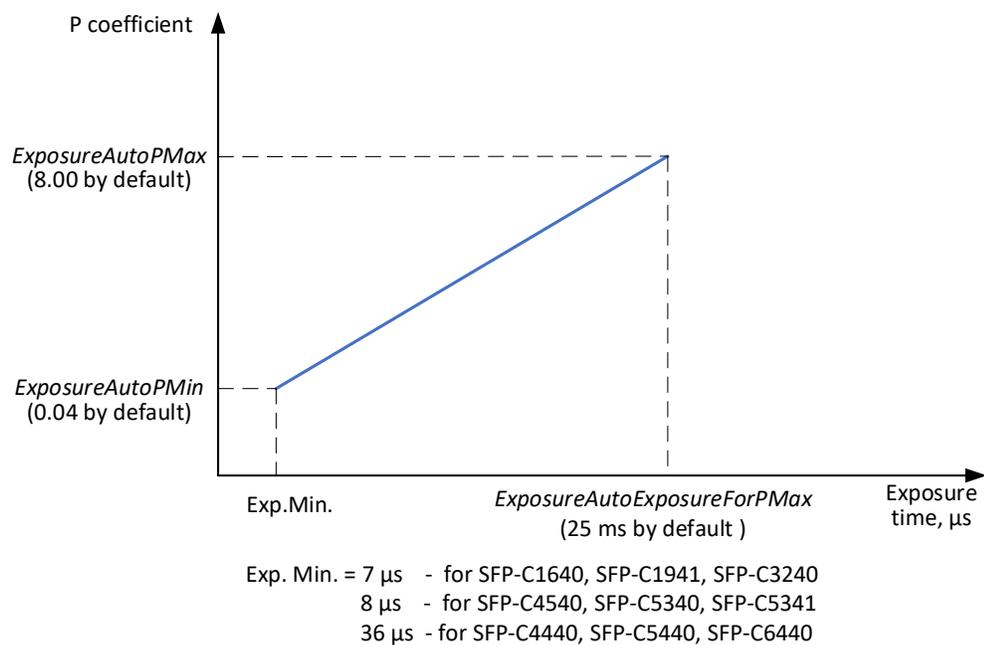
AEC/AGC	PID coefficients controls
AEC	P varies depending on exposure I = 0 D = P/2
AGC	P, I, and D are fixed values

Proportional Response

The proportional response is a difference (error) between the setpoint and the process variable. This error is then multiplied by the proportional coefficient P.

NOTE ⚠ Increasing the P coefficient increases the speed of the control algorithm and degrades its stability. If the P coefficient is too high, the image luminance begins to oscillate. With further increase of the P coefficient, the oscillations become larger, and the system becomes unstable and may even oscillate out of control.

The AEC algorithm uses an adaptive P coefficient.



The PID controller applies the P coefficient calculated on the previous iteration, computes the error, and adjusts exposure. The controller then re-calculates the P coefficient and applies the new value in the next iteration.

Integral Response

The integral response is the sum of the calculated errors over time multiplied by the integral coefficient I.

NOTE ⚠ Increasing the I coefficient decreases the speed of the control algorithm and degrades its stability.

Derivative Response

The derivative response is the difference between the error found on the previous sample and the current error multiplied by the derivative coefficient D. The derivative response is sensitive to noise in the process variable signal. Use very small derivative time.

NOTE  Increasing the D coefficient increases the speed of the control algorithm and improves its stability.

CAUTION

We do not recommend changing P, I, and D coefficients. Changing the coefficients may cause oscillations and destabilize the system.

If you need to change the coefficients, please contact Imperx support.

Imperx sets up optimal P, I, and D coefficients to balance the speed and stability of AEC and AGC algorithms.

XML Parameter	Default value
For AEC algorithm:	
ExposureAutoPMin	0.04
ExposureAutoPMax	8.00
ExposureAutoExposureForPMax	25,000 microseconds
For AGC algorithm:	
GainAutoPcoef	0.06
GainAutoIcoef	0.00
GainAutoDcoef	0.03

Camera Triggering

Use the **Trigger mode** control to synchronize the camera to an external event and acquire an image at a specific time. A trigger pulse is issued when the external event occurs. The camera then receives the trigger and acquires the images.

You can set the number of frames to acquire for each trigger using *AcquisitionBurstFrameCount* control. By default, *AcquisitionBurstFrameCount* is equal to 1 frame. The maximum number of frames is 65535.

The camera supports Standard and Fast Trigger modes. For the camera to work in the Standard Trigger mode, set *TriggerOverlap* parameter to Off. For the camera to work in the Fast Trigger mode, set *TriggerOverlap* parameter to ReadOut.

Standard Trigger Mode

In **Standard Trigger mode**, the camera first performs the exposure and then reads out the image. An external timing pulse controls the start of the exposure if exposure control mode is set to **Timed**.

Standard trigger mode, Exposure control is Timed

GenICam controls

TriggerMode: **On**

TriggerOverlap: **Off**

TriggerSource: **Line 1** (or Line2, Software, Pulse Generator, Action0)

TriggerActivation: **Rising Edge** (or Falling Edge)

TriggerFilterTime, TriggerDelay, TriggerDebounceTime: – **set if applicable**.

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μ s for SFP-C1640, SFP-C1941, SFP-C3240;
 8 μ s for SFP-C4540, SFP-C5340, SFP-C5341;
 36 μ s for SFP-C4440, SFP-C5440, SFP-C6440;
 Max = Readout time)

ExposureAuto: **Off**

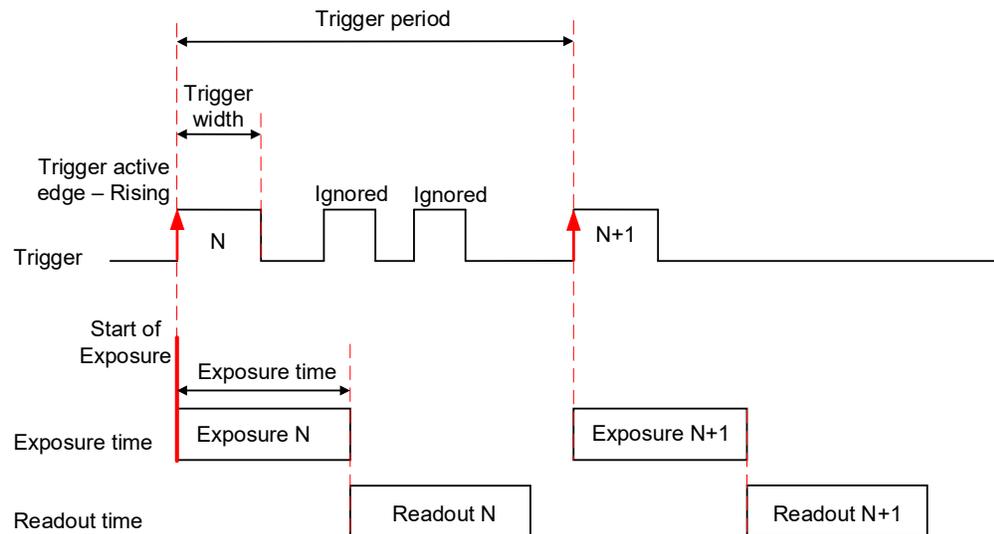
For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu$ s

Trigger period (min) = Exposure time (max) + Readout time



Setting exposure control mode to **Trigger Width** allows the external timing pulse to control the exposure duration.

Standard trigger mode, Exposure control is Trigger Width

GenICam controls

TriggerMode: **On**

TriggerOverlap: **Off**

TriggerSource: **Line 1** (or Line2, Pulse Generator)

TriggerActivation: **Rising Edge** (or Falling Edge)

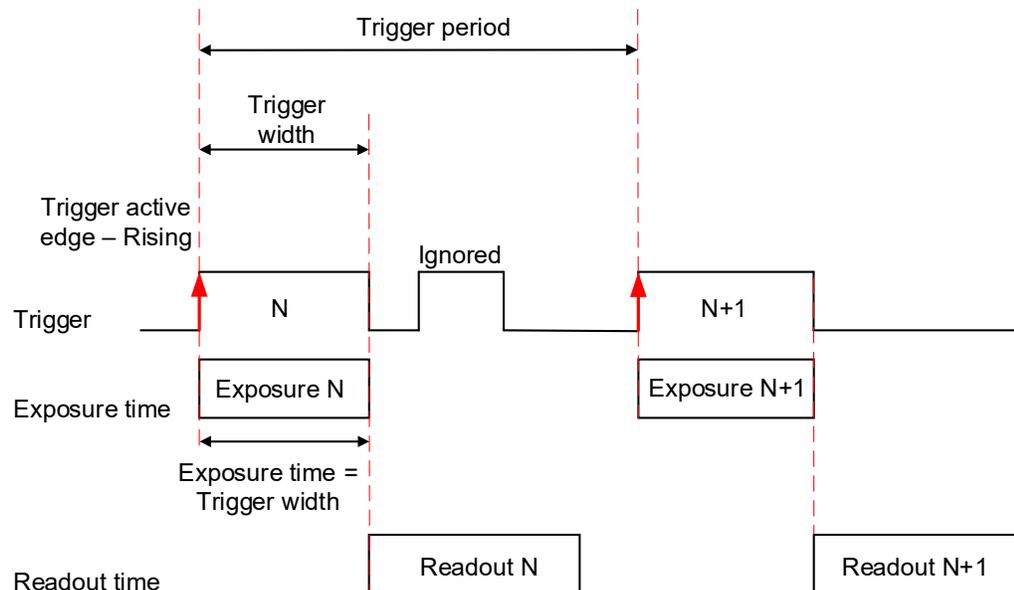
TriggerFilterTime, TriggerDelay, TriggerDebounceTime: **set if applicable**

ExposureMode: **Trigger Width**

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu\text{s}$

Trigger period (min) = Exposure time (max) + Readout time



The minimum trigger period is equal to the maximum exposure time plus the camera readout time:

$$\text{Trigger Period (min)} = \text{Exposure Time (max)} + \text{Readout Time,}$$

where the Readout Time is equal to the *CurrentFrameTime* (in free-running mode, with *AcquisitionFrameRateEnable* disabled).

If the next trigger pulse appears during the previous trigger period, the camera ignores it.

Fast Trigger Mode

In **Fast Trigger mode**, the exposure and readout are overlapped in a way that is similar to free-running (untriggered mode). Fast trigger mode depends upon a constant and stable trigger source so the camera can position the exposure period to conclude just as the previous frame readout ends. If the trigger period varies, the exposure varies with the trigger period, and uneven image illumination or wavering image brightness results.

An external timing pulse controls the start of the exposure when exposure control mode is **Timed**. The new exposure ends just as the readout of the current frame ends. The readout of the next frame begins with the next trigger. If the next trigger pulse appears during the previous trigger period, the camera ignores it.

Fast trigger mode, Exposure control is Timed

GenICam controls

Trigger Mode: **On**

Trigger Overlap: **On**

Trigger Source: **Line 1** (or Line2, Pulse Generator)

Trigger Activation: **Rising Edge** (or Falling Edge)

TriggerFilterTime, TriggerDelay, TriggerDebounceTime: – **set if applicable**

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μ s for SFP-C1640, SFP-C1941, SFP-C3240;
8 μ s for SFP-C4540, SFP-C5340, SFP-C5341;
36 μ s for SFP-C4440, SFP-C5440, SFP-C6440;
Max = Readout time)

ExposureAuto: **Off**

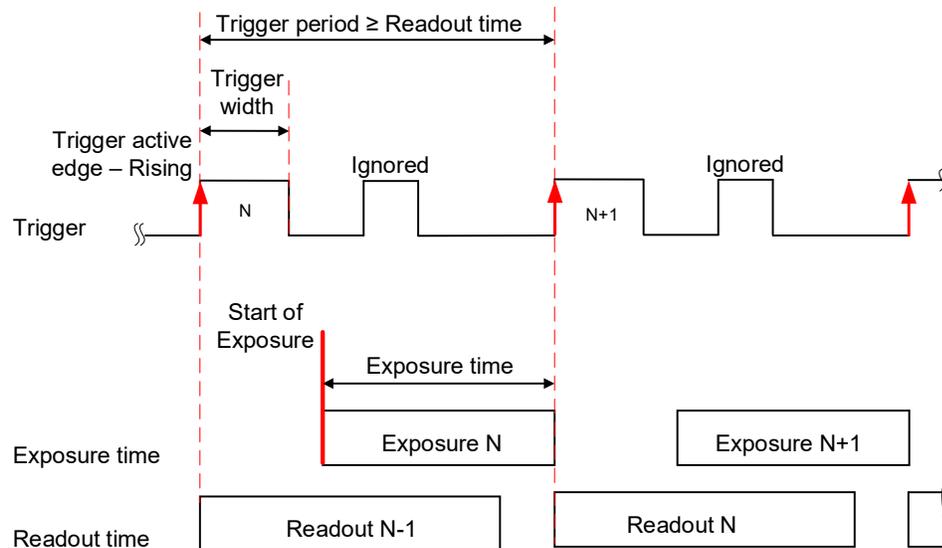
For Automatic exposure control:

ExposureAuto: **Continuous** (or Once)

Parameters of the external trigger pulse:

Trigger width: $\geq 10 \mu$ s

Trigger period (min) = Readout time



You can adjust the exposure duration to be equal to the external pulse width by setting the exposure control mode to **Trigger Width**. The new exposure begins with the next trigger pulse during the readout of the current frame.

Fast trigger mode, Exposure control is Trigger Width

GenICam controls

TriggerMode: **On**

TriggerOverlap: **On**

TriggerSource: **Line 1** (or Line2, Pulse Generator)

TriggerActivation: **Rising Edge** (or Falling Edge)

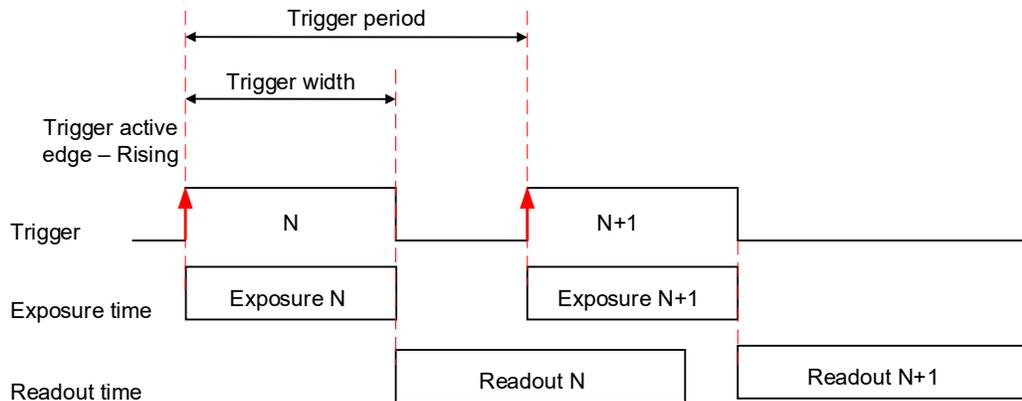
TriggerFilterTime, TriggerDelay, TriggerDebounceTime: **set if applicable**

ExposureMode: **Trigger Width**

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu\text{s}$

Trigger period: \geq Readout time



Trigger Sources

The camera allows for four sources for triggering: external Line1 or Line2, internal (pulse generator), and software. The minimum trigger pulse is 10 microseconds.

- **Line 1** – hardware Input Line GP Input1 (Trigger 1) is used as external source for the trigger signal.
- **Line 2** – hardware Input Line GP Input2 (Trigger 2) is used as external source for the trigger signal.
- **Action0** – trigger source is generated by software using the Action command #0 (Trigger over Ethernet).
- **Pulse Generator** – trigger source is generated by camera's 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.

Configuring the Trigger

To configure the camera to work in **trigger mode**, follow the steps below:

1. Turn off the camera image acquisition.
2. In the Acquisition Control menu, set *TriggerMode* to **On**.
3. Set *TriggerOverlap* to either **Readout** for the camera to work in Fast Trigger mode or to **Off** for the camera to work in Standard Trigger mode.
4. Select *TriggerSource*:
 - If *TriggerSource* is either Line1 (Input1) or Line2 (Input2), configure the external trigger signal source using *LineInverter* feature.
 - If *TriggerSource* is PulseGenerator, configure the camera's internal pulse generator (see section Pulse Generator) and make sure that the *PulseGenEnable* setting is checked.
 - If *TriggerSource* is Software, you do not need to configure a signal source. The camera generates one short trigger pulse when you click the GUI Software Trigger button or send the GenICam™ Trigger Software command.
 - If *TriggerSource* is Action0, trigger source is generated by software using the Action command #0 (Trigger over Ethernet).
5. For *TriggerActivation* setting, select what edge (**Rising** or **Falling**) will be used for triggering.

NOTE *

If the *TriggerActivation* is RisingEdge and *ExposureMode* is set to TriggerWidth, the exposure duration will be the time the trigger stays high.

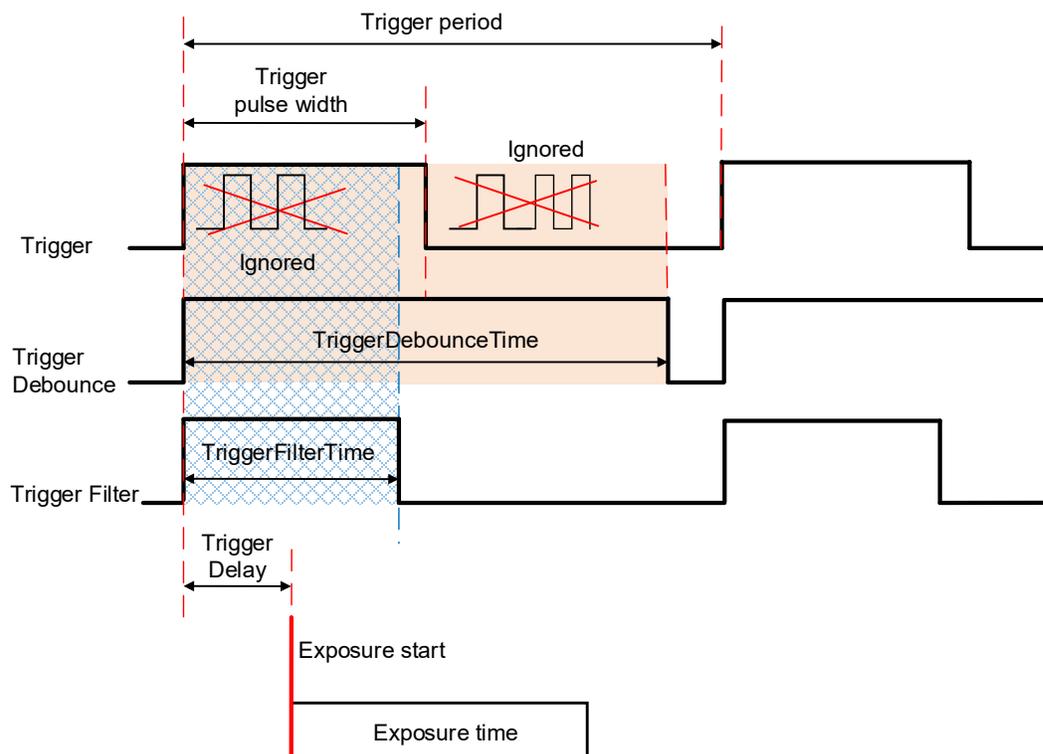
If *TriggerActivation* is FallingEdge and the *ExposureMode* is set to TriggerWidth, the exposure time will last as long as the trigger stays low.

Set *TriggerActivation* to FallingEdge if the camera works in Fast trigger mode (*TriggerOverlap* is set to Readout) with a trigger pulse width changing over time (*ExposureMode* is set to TriggerWidth).

6. If applicable, set *TriggerFilterTime*, *TriggerDebounceTime*, *TriggerDelay* to desired values. The *TriggerFilterTime* and *TriggerDebounce* features are used to prevent false triggering when a trigger signal is being generated by an external source mapped to the camera's Input 1 or Input 2.

<i>TriggerFilterTime</i>	Defines the input trigger signals minimum pulse width. By setting the <i>TriggerFilterTime</i> to a value slightly less than the input signal's pulse width, the camera will reject any noise with pulse widths less than the <i>TriggerFilterTime</i> setting.
<i>TriggerDebounceTime</i>	Defines the time period following a triggering event in which no additional triggers will be accepted by the camera. Always set the <i>TriggerDebounceTime</i> to a value higher than the trigger signal's pulse width. The camera filters out interfering signals once the trigger pulse ends. The camera ignores any pulses during the <i>TriggerDebounceTime</i> after receiving the trigger signal.
<i>TriggerDelay</i>	Defines the time between the beginning of the trigger pulse and the beginning of the exposure. The camera captures an image with some delay after the trigger event.

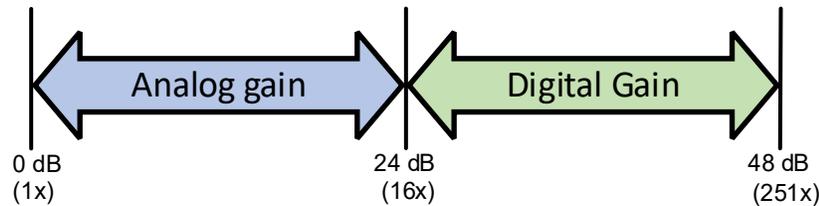
Trigger pulse width: $\geq 10 \mu\text{s}$
TriggerFilterTime: Recommended value $\leq 75\%$ of the Trigger pulse width
 Max. *TriggerFilterTime* = 65535 μs
 Max. *TriggerDebounceTime* = 65535 μs
 Max. *TriggerDelay* = 16000000 μs



Video Amplifier Gain and Offset

Image Sensor’s Analog and Digital Gain

The image sensor allows you to apply up to 48 dB of gain to the image prior to A/D conversion. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally.



Digital Gain

Digital gain can be varied from 0x to 4x (12 dB) with a precision of 0.000244x or 1/4096. There are 16384 gain steps from 0x gain to 4x gain. Digital Gain does not provide any improved contrast and should be used cautiously.

To determine the gain step when the gain value is known, use the following steps:

Gain Step = 4096 * Desired gain.

For example, if desired gain is 2.5x; then the gain step = 10240 (4096*2.5 = 10240)

If the desired gain is in dB, use the following formula:

Gain Step = [anti-log₁₀(Desired gain (dB)/20)]*4096.

For example, if desired gain is 6 dB; then the gain step is 8172 ([anti-log₁₀(6/20)]*4096 = 8172)

Below are other examples:

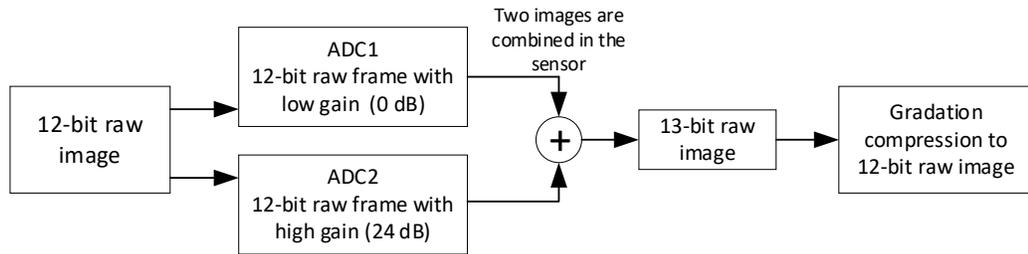
Gain (dB)	Multiplier	Gain Step
-72 dB	0.000244x	1
0 dB	1x	4096
3 dB	1.41254x	5785
5 dB	1.99526x	7283
6.02 dB	2x	8192
8 dB	2.51189x	10288
9.54 dB	3x	12288
12 dB	3.98107x	16306.

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 *BlackLevelAuto* engaged (Continuous). If *SensorBlackLevelRecommended* disabled (set to false), you can set the *BlackLevel* manually and adjust it from 0 to 4095 counts. Black level will vary with temperature and gain.

HDR Mode

The SFP-C4540, SFP-C5340, and SFP-C5341 cameras are built around Sony Pregius S sensors that support Dual ADC mode and built-in HDR image processing feature.

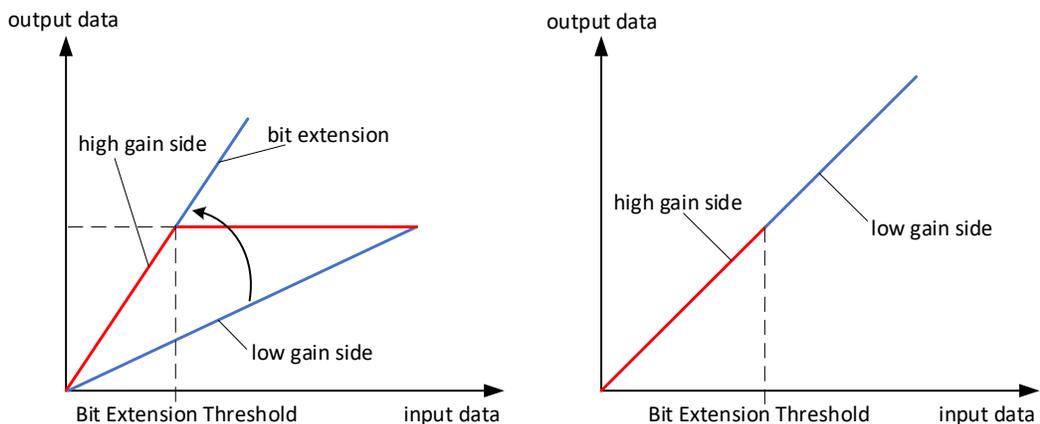


In Dual ADC mode of Sony Pregius S sensors, a 12-bit raw image is digitized using two ADCs (Analog Digital Convertors) with different analog gains.. Each pixel is read out with high gain (ADC2) and low gain (ADC1). Both frames are acquired at the same time and are not temporally shifted. A sensor’s built-in combination function merges the frame obtained at a low gain side and the frame obtained at a high gain side into one 13-bit raw frame by implementing bit extension. After that, the on-sensor gradation compression is applied to get a 12-bit output image.

Bit Extension Threshold and Data Selection

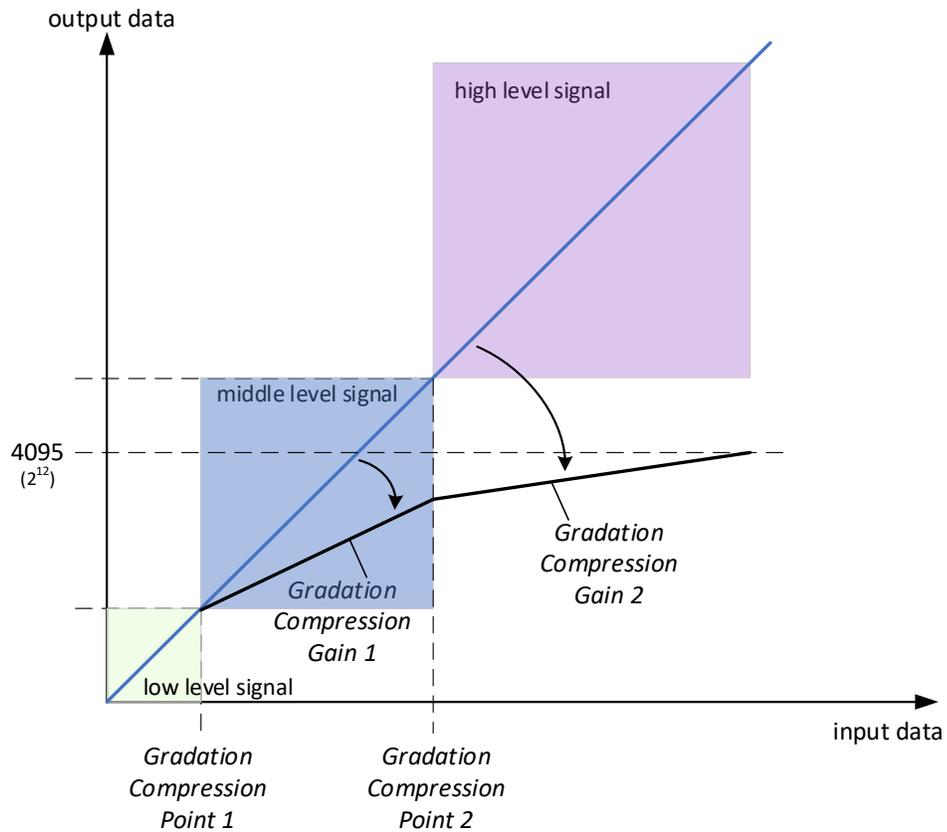
The *BitExtensionThreshold* parameter is an intensity level where the low gain data is used instead of high gain for oversaturated areas of image. It virtually extends the dynamic range of the image sensor.

If the data obtained by high gain side has a value greater or equal to the *BitExtensionThreshold*, bit-extended low gain data is selected. If the data is less than the *BitExtensionThreshold*, the ADC2 data is selected.



Gradation Compression

After data selection, gradation compression processing is performed to adjust the output bit length to 12 bits. Two pairs of knee points can be set for the gradation piecewise linear function: the compression position and the compression ratio (gain) starting from that position.



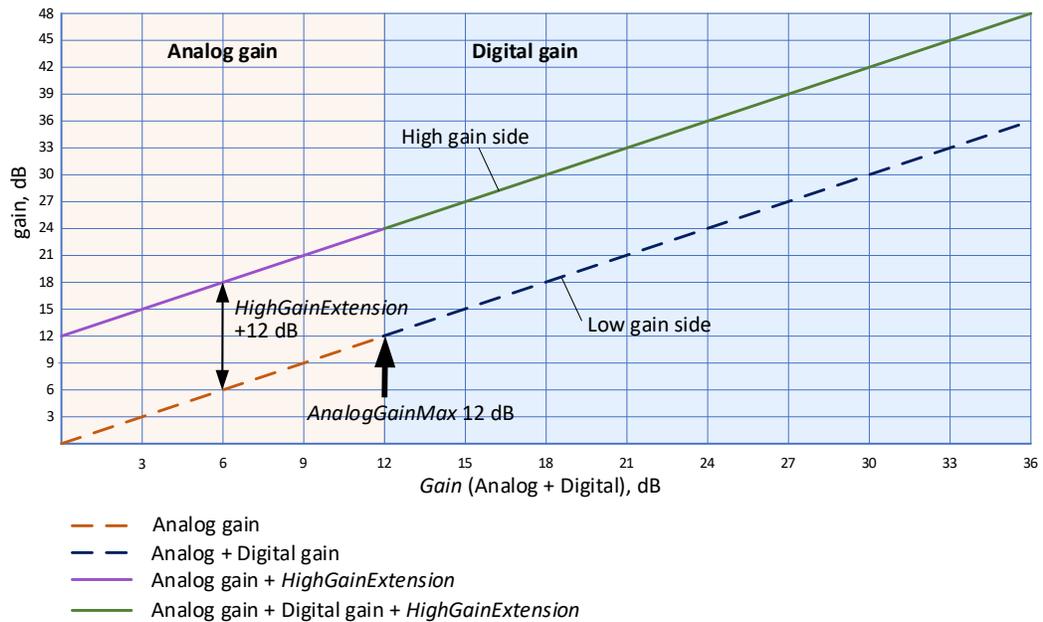
Gain Adjustment Function

In HDR mode, you can adjust the sensor’s maximum analog gain up to 24 dB with a step of 0.1 dB. For the high gain side, you can also add the *HighGainExtension* setting to the analog gain. The *HighGainExtension* can be set to either 0 dB, 6 dB, 12 dB, 18 dB, or 24 dB.

A table below shows the relationship between the total gain, analog gain, and digital gain in HDR mode.

Condition	Analog gain		Digital gain
	Low gain side	High gain side	Low gain and High gain sides
Gain < AnalogGainMax	Gain	Gain + HighGainExtension Gain + HighGainExtension should be ≤ 24 dB	0 dB
Gain ≥ AnalogGainMax	AnalogGainMax	AnalogGainMax + HighGainExtension AnalogGainMax + HighGainExtension should be ≤ 24 dB	Gain - AnalogGainMax

The diagram below shows the high gain side and low gain side under the following conditions:
AnalogGainMax is set to 12 dB
HighGainExtension is set to 12 dB



If the *Gain* value is lower than *AnalogGainMax*, the gain is analog within a range from 0 dB to 24.0 dB. The *Gain + HighGainExtension* value should be ≤ 24 dB.

If the *Gain* value is higher or equal to *AnalogGainMax*, the gain is Analog + Digital. The maximum value of Analog gain + Digital gain + *HighGainExtension* is 48 dB. The *AnalogGainMax + HighGainExtension* value should be ≤ 24 dB.

Data Output Format

The image sensor digitization is set automatically based on the *Pixel Format* setting. A *Pixel Format* of 8- or 10-bits enables 10-bits sensor digitization while *Pixel Format* of 12-bits sets sensor digitization to 12-bits.

With 8-bit output, the camera uses the standard bit reduction process and truncates the least significant bits as described below.

12-bits sensor digitization

If the camera is set to output 12-bit data, sensor data bits map directly to D0 (LSB) to D11 (MSB).

MSB		Camera Output – 12 bits								LSB	
D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

10-bits sensor digitization

If the camera is set to output 10-bit data, sensor data bits map directly to D0 (LSB) to D9 (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	

If the camera is set to output 8-bit data, sensor most significant data bits (P2 to P9) map to D0 (LSB) to D7 (MSB).

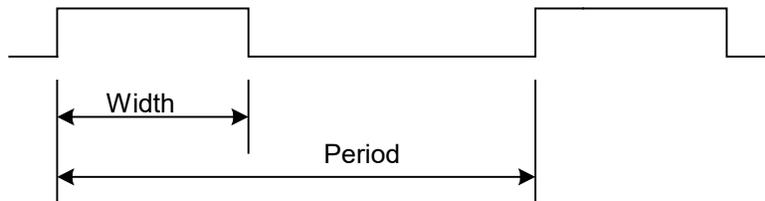
MSB		Camera Output – 8 bits						LSB		
D7	D6	D5	D4	D3	D2	D1	D0	-	-	
P9	P8	P7	P6	P5	P4	P3	P2	P1	P0	

Pulse Generator Settings

The camera has a built-in pulse generator that you can program 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. You can set the discrete number of pulses from 1 to 65535 with a step of 1 or configure the pulse generator to work in continuous mode.

You can also set the following options:

- **Granularity** – Indicates the number of clock cycles used for each increment of the width and the period. Four possible options are available: x1, x10, x100, and x 1000.
- **Width** – Specifies the amount of time (determined by the granularity) the pulse remains at a high level before falling to a low level.
- **Period** – Indicates the amount of time (also determined by the granularity) between consecutive pulses.



Input / Output Control

The camera supports two inputs and two outputs (TTL and opto-isolated):

Input / Output #	Pin #	Description	Voltage/Current
Input 1	Pin 8 and Pin10 (Return)	Opto-isolated	Voltage 3.3–24 V, Current (min) 3.3 mA
Input 2	Pin 9 and Pin 11 (Return)	TTL/LVTTL	Voltage 5 V (TTL) or 3.3 V (LVTTL) Current (max) 2.0 mA
Output 1	Pin 7 and Pin 6 (Return)	TTL	Voltage 5.0 V (TTL) Current (max) 8.0 mA
Output 2	Pin 12 and Pin 5 (Return)	Opto-isolated	Voltage (max) 25 V Current (max) 50 mA

You can map Input 1 or Input 2 to the camera trigger source by following the steps 1 – 6 in the section [Configuring the Trigger](#). In Step 4, set *TriggerSource* to **Line 1** (Input1) or **Line 2** (Input2) respectively.

You can invert the input signal by using *LineInverter* setting in the Digital IO Control menu:

1. Select Input1 or Input2 in *LineSelector*.
2. Check the *LineInverter* box.

You can map one of nine signals to either Output 1 or Output 2 in the Digital IO Control menu:

1. Set *LineSelector* to **Output1** or **Output2**.
2. Select output signal in *LineSource* menu (refer to the section [Strobe and Synchronization Controls](#)).
3. You can invert the output signal by checking the *LineInverter* box.
4. If applicable, enable a strobe and specify its width, delay, and reference (for more information, refer to the section [Configuring the Strobe in Free-Running Mode](#) or [Configuring a Strobe in Trigger Mode](#)).

Strobe and Synchronization Controls

The camera allows you to synchronize your system from several references. You can synchronize with the trigger input, the start, middle or end of exposure, or the internal pulse generator signals. You can also synchronize your system with exposure duration of the first or second frame in PIV mode.

Output Signal	Description
ExposureStart	A 10-microsecond pulse indicating the beginning of the exposure
ExposureEnd	A 10-microsecond pulse indicating the end of the exposure
MidExposure	A 10-microsecond indicating the middle of the exposure
ExposureActive	The output signal is active for the duration of exposure time
TriggerActual	Maps the input trigger pulse to the output with no delay
TriggerDelayed	Maps the input trigger pulse to the output with trigger delay
PulseGenerator	Maps the internal pulse generator waveform to the output
Strobe1	Maps the Strobe 1 signal to the corresponding external output
Strobe2	Maps the Strobe 2 signal to the corresponding external output
Pulse1Source	Maps the Pulse 1 Source to the corresponding external output (in PIV mode)
Pulse2Source	Maps the Pulse 1 Source to the corresponding external output (in PIV mode)

The camera provides signals indicating the start of exposure, mid-exposure, and end of exposure. These signals have a fixed duration of 10 microseconds. If a longer pulse period is required, the strobe feature can be used.

The camera provides two strobes for synchronization with an external light source, other cameras, or peripheral devices. You can position each strobe pulse within the entire frame-timing period with a precision of 1.0 microsecond.

You can position a strobe pulse with the following references, depending on the camera mode:

Camera Mode	Strobe Reference
Free-running mode	Start of Exposure, Start of Readout, Pulse1 Source, Pulse2 Source
Standard Trigger mode	Start of Exposure, Start of Readout, Trigger
Fast Trigger mode	Start of Exposure, Start of Readout, Trigger, Pulse1 Source, Pulse2 Source

Configuring the Strobe in Free-Running Mode

In **free-running mode**, you can set the strobe pulse duration (*StrobeWidth*) and the delay (*StrobeDelay*) with respect to the start of the exposure or the start of the readout period. The strobe period is equal to the frame time. You can map a strobe to either Output 1 (TTL) or Output 2 (opto-isolated).

Positioning the Strobe1 with a Reference to the Exposure Start

1. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
2. Set *LineSource* to Strobe1.
The strobe is mapped to the output selected under *LineSelector*.
3. If necessary, check the *LineInverter* box.
It inverts the output signal.
4. Set *Strobe1Reference* to Start of Exposure.
5. Set *Strobe1Enable* to On.
6. If necessary, set *Strobe1Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
7. Set *Strobe1Width* to a desired value.

Positioning the Strobe2 with a Reference to the Readout Start

1. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
2. Set *LineSource* to Strobe2.
The strobe is mapped to the output selected under *LineSelector*.
3. If necessary, check the *LineInverter* box.
It inverts the output signal.
4. Set *Strobe2Reference* to Start of Readout.
5. Set *Strobe2Enable* to On.
6. If necessary, set *Strobe2Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
7. Set *Strobe2Width* to a desired value.

**Strobes Positioned with Respect to the Start of Exposure and Readout,
Free-running Mode**

GenICam controls

TriggerMode: **Off**

LineSelector: **Output1** (or Output2)

LineSource: **Strobe1** (or Strobe2)

Strobe1Reference: **Exposure**

Strobe1Enable: **On**

Strobe1Width: **User-specified** (in μs)

Strobe1Delay: **User-specified** (Min.= 10 μs)

Strobe2Reference: **Readout**

Strobe2Enable: **On**

Strobe2Width: **User-specified** (in μs)

Strobe2Delay: **User-specified** (Min.= 10 μs)

Exposure Mode: **Timed** (or Off)

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μs for SFP-C1640, SFP-C1941, SFP-C3240;
8 μs for SFP-C4540, SFP-C5340, SFP-C5341;
36 μs for SFP-C4440, SFP-C5440, SFP-C6440;
Max = Readout time)

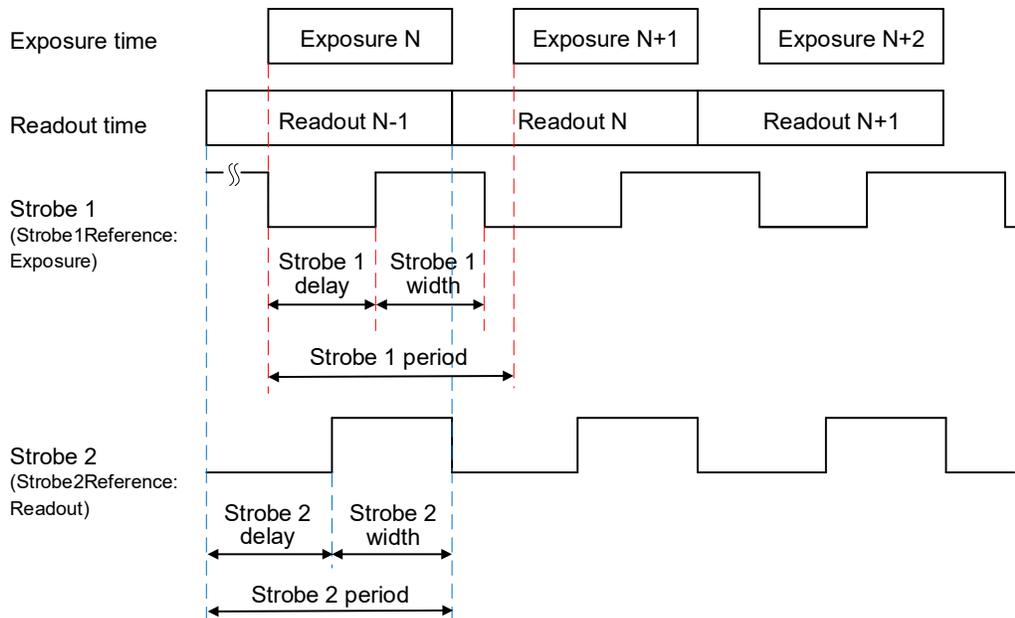
ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = frame time



Configuring a Strobe in Trigger Mode

If the camera is in the **Trigger mode** (Standard or Fast Trigger), you can set the strobe pulse duration and the delay with respect to the trigger pulse active edge, start of the exposure, or start of the readout period. The strobe period equals the trigger period.

Positioning the Strobe1 with a Reference to Trigger or Exposure Start

1. Make sure that *TriggerMode* is On in the Acquisition Control menu.
2. Select a *TriggerSource* and *TriggerActivation*.
3. Set *TriggerDelay* to 0. If applicable, set *TriggerFilterTime* and *TriggerDebounce* to desired values.
4. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
5. Set *LineSource* to Strobe1.
The strobe is mapped to the output selected under *LineSelector*.
6. If necessary, check the *LineInverter* box.
It inverts the output signal.
7. Set *Strobe1Reference* to Trigger (or Start of Exposure).
8. Set *Strobe1Enable* to On.
9. If necessary, set *Strobe1Delay*.
Without a delay, the strobe occurs simultaneously with the trigger active edge (start of exposure).
10. Set *Strobe1Width* to a desired value.

Positioning the Strobe2 with a Reference to the Readout Start

1. Make sure that *TriggerMode* is On in the Acquisition Control menu.
2. Select a *TriggerSource* and *TriggerActivation*.
3. If applicable, set *TriggerDelay*, *TriggerFilterTime* and *TriggerDebounce* to desired values.
4. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
5. Set *LineSource* to Strobe2.
The strobe is mapped to the output selected under *LineSelector*.
6. If necessary, check the *LineInverter* box.
It inverts the output signal.
7. Set *Strobe2Reference* to Start of Readout.
8. Set *Strobe2Enable* to On.

9. If necessary, set *Strobe2Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
10. Set *Strobe2Width* to a desired value.

**Strobes Positioned with Respect to a Trigger, Exposure Start, or Readout Start
Standard Trigger Mode**

GenICam controls

TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator, Action0)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **0** (no delay)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Trigger** (or Exposure)
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μs)
 Strobe1Delay: **User-specified** (Min.= 10 μs)
 Strobe2Reference: **Readout**
 Strobe2Enable: **On**
 Strobe2Width: **User-specified** (in μs)
 Strobe2Delay: **User-specified** (Min.= 10 μs)

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μs for SFP-C1640, SFP-C1941, SFP-C3240;
 8 μs for SFP-C4540, SFP-C5340, SFP-C5341;
 36 μs for SFP-C4440, SFP-C5440, SFP-C6440;
 Max = Readout time)

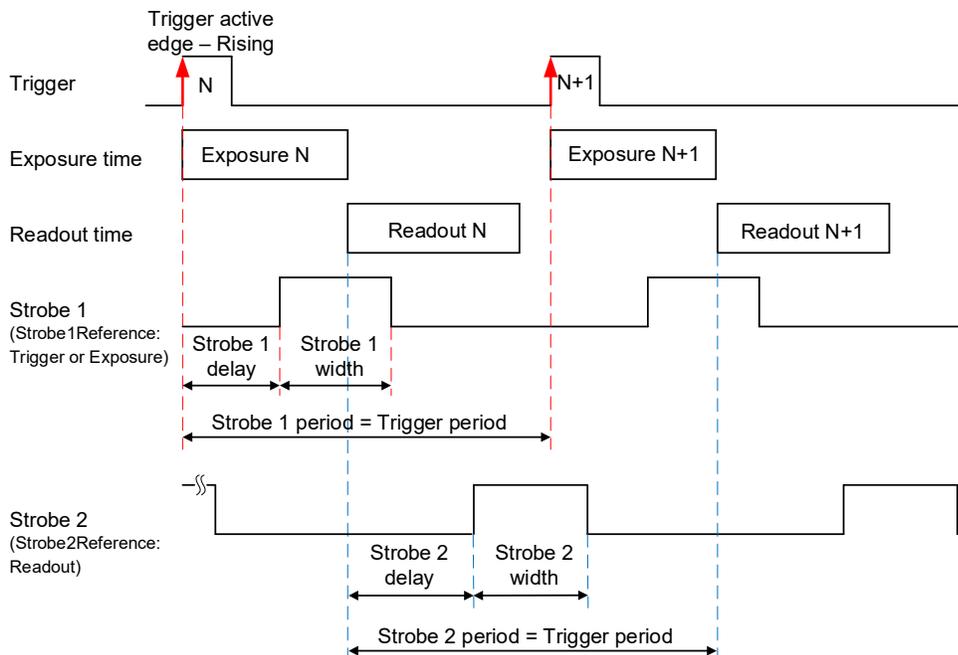
ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = Trigger period



Strobe 1 is positioned with respect to the exposure start with a trigger delay. The camera is in Standard Trigger mode with Timed Exposure Control.

**Strobes Positioned with Respect to the Exposure Start
Standard Trigger Mode**

GenICam controls

TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator, Action0)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **User-specified** (Min.= 10 μ s)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Exposure**
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μ s)
 Strobe1Delay: **User-specified** (in μ s)

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μ s for SFP-C1640, SFP-C1941, SFP-C3240;
 8 μ s for SFP-C4540, SFP-C5340, SFP-C5341;
 36 μ s for SFP-C4440, SFP-C5440, SFP-C6440;
 Max = Readout time)

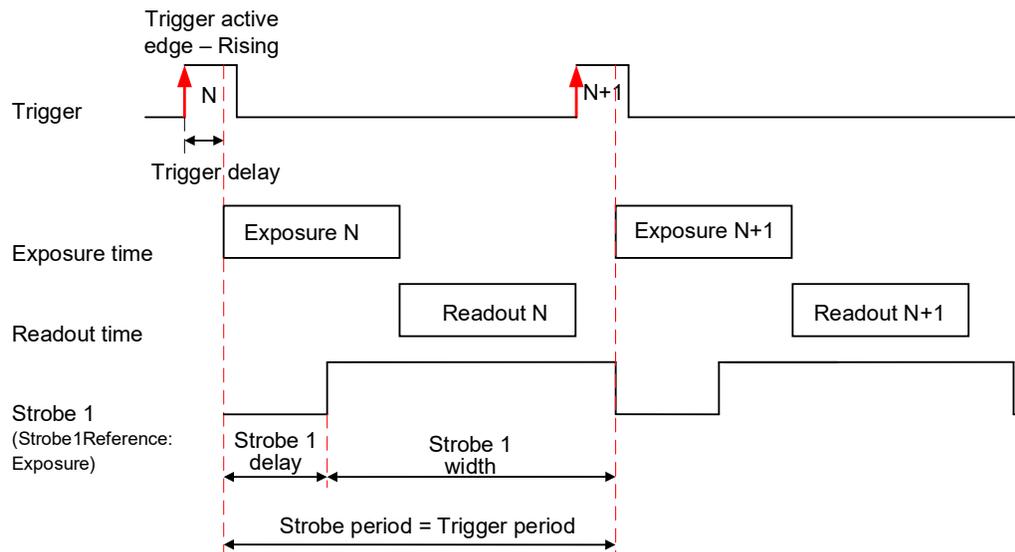
ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = Trigger period



If your application requires activating a light source before the start of the exposure period, you can use *StrobeReference* and *StrobeDelay* settings to position the strobe to occur earlier than the exposure. To configure the strobe, follow the steps below:

1. Make sure that *TriggerMode* is **On** and *TriggerDelay* is set to a desired value in the Acquisition Control menu.
The Exposure starts with the delay after the trigger event.
2. Set *StrobeReference* to **Trigger**. The strobe occurs simultaneously with the trigger active edge.
3. Set *StrobeDelay* to a value lower than the *TriggerDelay* duration.
4. Set *StrobeWidth* to a desired value.

Strobes Positioned with Respect to the Trigger
Standard Trigger Mode

GenICam controls

TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator, Action0)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **User-specified** (Min.= 10 μ s)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Trigger**
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μ s)
 Strobe1Delay: **0** (no delay)
 Strobe2Reference: **Trigger**
 Strobe2Enable: **On**
 Strobe2Width: **User-specified** (in μ s)
 Strobe2Delay: **User-specified** (in μ s)

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 7 μ s for SFP-C1640, SFP-C1941, SFP-C3240;
 8 μ s for SFP-C4540, SFP-C5340, SFP-C5341;
 36 μ s for SFP-C4440, SFP-C5440, SFP-C6440;
 Max = Readout time)

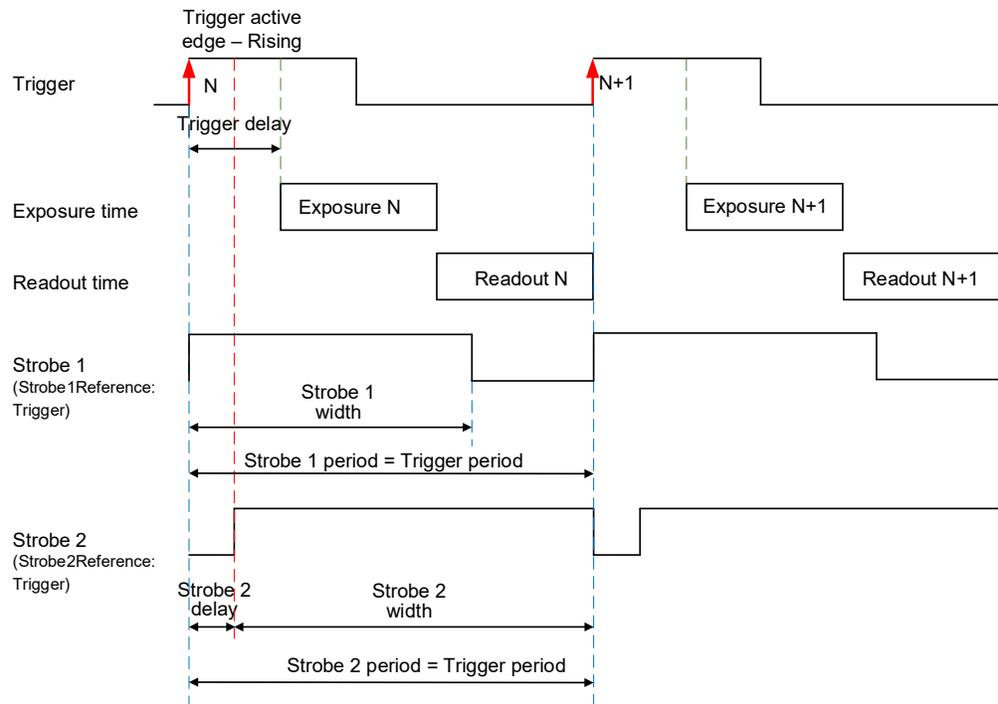
ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

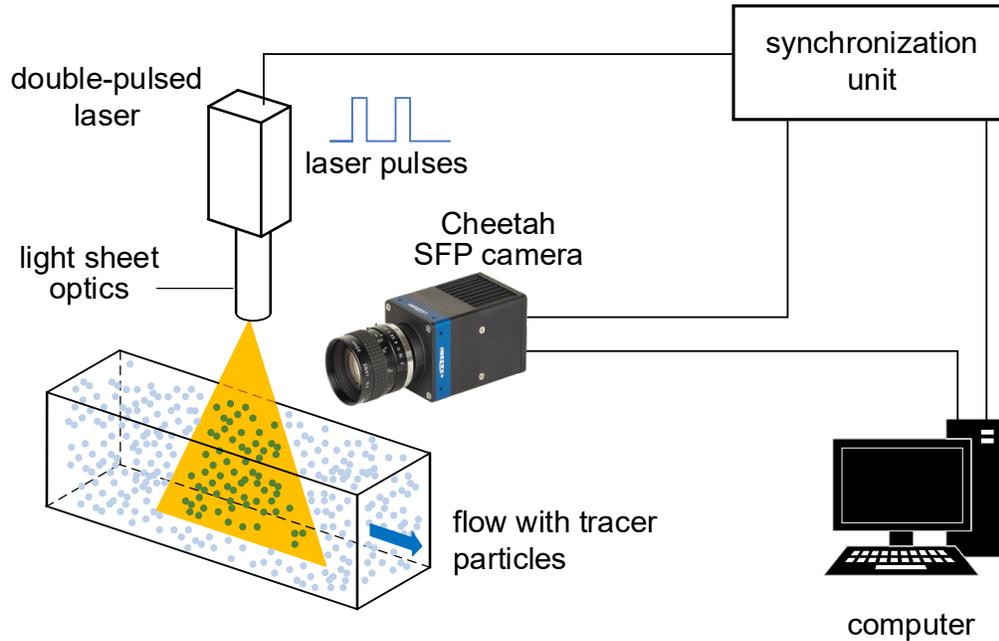
Parameters of the strobe signal

Strobe period = Trigger period

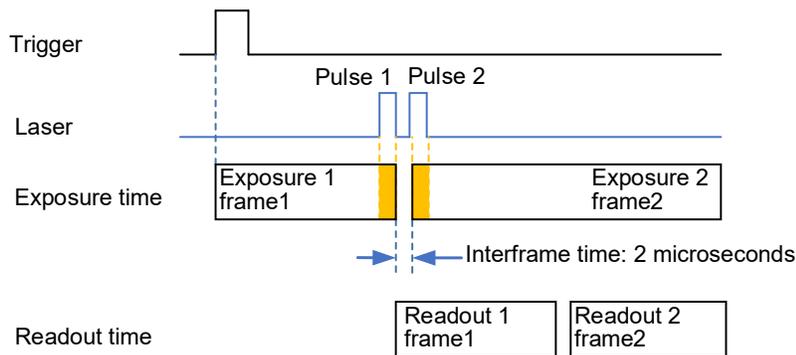


PIV Mode

Particle image velocimetry (PIV) is an optical method of flow visualization used to determine velocity and direction of the flow. A standard PIV system uses a camera, triggerable pulse laser with a cylindrical lens, synchronization unit, and a computer with software performing cross-correlation analysis.



The synchronization unit provides two pulses to the laser causing it to illuminate tracer particles injected into the flow of gas or liquid. The first pulse is fired at the end of the first exposure, and the second pulse – at the beginning of the second exposure. The time between the laser pulses should overlap the interval between the two image frames captured by the camera. The two images are then analyzed by software to measure displacement of the particles.



The Cheetah SFP cameras capture a sequence of two images with interframe time of 2 μ s (recommended by the image sensors' manufacturer). The camera also provides two output signals for synchronizing your PIV system with start and duration of the exposure of the first or second frame.

Setting the *ShortIntervalShutterMode* feature to **On** enables the PIV mode on Cheetah SFP cameras.

NOTE ⚠ The PIV mode is available for the Cheetah SFP-C4540, SFP-C5340, and SFP-C5341 cameras in **free-running** or **Fast Trigger** modes.

Always set the *TriggerOverlap* feature to **Readout** before enabling the PIV mode, even when the camera is in free-running mode. This allows the exposure of the next frame and readout of the current frame to overlap. Otherwise, the *ShortIntervalShutterMode* feature remains inactive.

To configure the camera to work in **PIV mode** with output signals synchronized to the start and duration of the exposure of the first frame follow the steps below:

1. Make sure that the camera image acquisition is turned off.
2. In the Acquisition Control menu, set *TriggerOverlap* to **Readout**.
3. Set *TriggerMode* to **On**.
4. Select *TriggerSource*:
 - If *TriggerSource* is either Line1 (Input1) or Line2 (Input2), configure the external trigger signal source using *LineInverter* feature.
 - If *TriggerSource* is Action0, trigger source is generated by software using the Action command #0 (Trigger over Ethernet)
 - If *TriggerSource* is PulseGenerator, configure the camera's internal pulse generator (see section Pulse Generator) and make sure that the *PulseGenEnable* setting is checked.
 - If *TriggerSource* is Software, you do not need to configure a signal source. The camera generates one short trigger pulse when you click the GUI Software Trigger button or send the GenICam™ Trigger Software command.
5. For *TriggerActivation* setting, select what edge (**Rising** or **Falling**) will be used for triggering.
6. If applicable, set *TriggerFilterTime*, *TriggerDebounceTime*, *TriggerDelay* to desired values. The *TriggerFilterTime* and *TriggerDebounce* features are used to prevent false triggering when a trigger signal is being generated by an external source mapped to the camera's Input 1 or Input 2.
7. Set *ShortIntervalShutterMode* to **On**.
8. Set *Frame1ExposureTime* and *Frame1ExposureTimeLimit*.
By default, they are pre-set to minimum possible values.
9. Set *Pulse1Source* to **ExposureFrame1**.
10. Set *LineSelector* to **Output1**.
11. Set *LineSource* to **Strobe1**.
12. Set *Strobe1Reference* to **Pulse1Source**.
13. Set *Strobe1Enable* to **On**.
14. Set *Strobe1Width* and *Strobe1Delay* to a desired value.

On the diagram below, the signal on the Output1 line starts as the exposure of the first frame begins. The width of the signal equals the exposure duration. The Output2 line is configured to output a strobe signal that is positioned with respect to the start of the exposure and has user-specified width and delay.

**Short Interval Sutter Mode (PIV) Example
Fast Trigger Mode**

GenICam controls

TriggerMode: **On**
 TriggerOverlap: **ReadOut**
 TriggerSource: **Line 1** (or Line2, Pulse Generator, Action0)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **0** (no delay)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

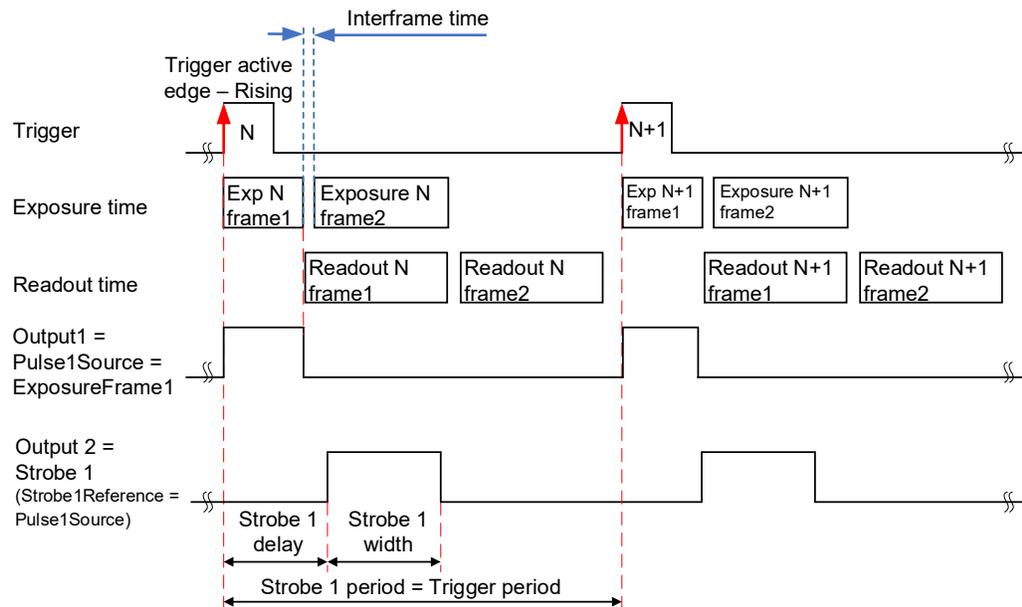
ShortIntervalShutterMode: **On**
 Frame1ExposureTime: **User-specified** (in μs , limited)
 Frame1ExposureTimeLimit: **User-specified** (in μs , limited)
 Pulse1Source: **ExposureFrame1**
 Pulse2Source: -

LineSelector: **Output1**
 LineSource: **Pulse1Source**

LineSelector: **Output2**
 LineSource: **Strobe1**
 Strobe1Reference: **Pulse1Source**
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (Min.= 10 μs)
 Strobe1Delay: **User-specified** (in μs)

Parameters of the strobe signal

Strobe period = Trigger period

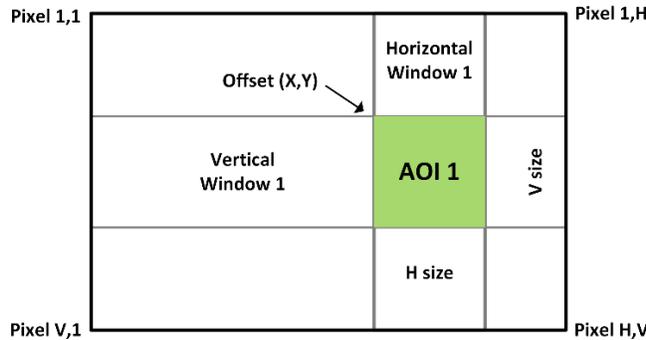


Area of Interest

For some applications, you might not need the entire image, but only a portion of it. To accommodate this requirement, the Cheetah camera allows you to create one Region of Interest (ROI), also known as an Area of Interest (AOI).

Horizontal and Vertical 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. The horizontal dimension is limited to multiples of 32 pixels. The vertical dimension is limited to multiples of 4 pixels. In normal operation, the AOI defines the number of columns and rows output. The maximum horizontal window size (H) and the vertical window size (V) are determined by the camera’s image full resolution.



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

Factors Impacting Frame Rate

The camera frame rate depends upon a number of variables including the exposure time, number of rows and columns in the AOI, 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.

Exposure Time: In free-running or Fast trigger mode, the camera overlaps the exposure time and image readout so frame rate has no dependence on exposure time. In Standard trigger mode, however, the exposure and readout time do not overlap, and long exposure times will decrease frame rate.

Line time: This is the time required to read out one line from CMOS sensor. Increasing the line time decreases the camera frame rate and extends exposure time. Please note that the extended line time decreases bandwidth usage.

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

Processing Area of Interest (PAOI)

A Processing Area of Interest (PAOI) can be enabled as White Balance or AEC/AGC image processing area of interest. When enabled as AWB processing AOI, the AWB function will apply only to the selected AOI, all data outside of the area will not be processed with the selected function. When enabled as AEC/AGC processing AOI, the AEC/AGC will use luminance calculated only for the selected AOI and then be applied to the full image.

Binning and Subsampling Decimation

Binning

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

The following graphic illustrates the concept of 4:1 binning for a monochrome image sensor. The values of pixels P1, P2, P3 and P4 are summed together resulting in a single larger pixel output value.

The binning feature can be used on the full resolution image or within any area of interest.



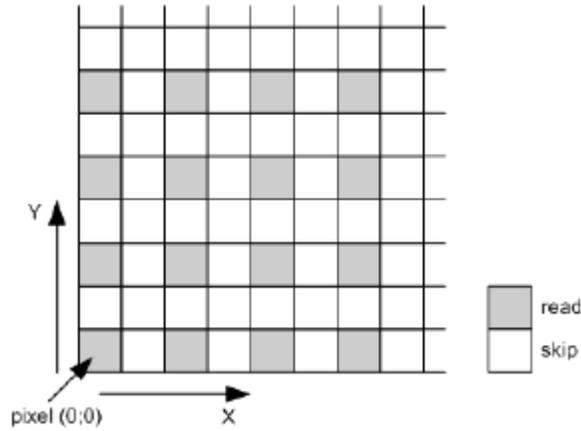
NOTE (★) You cannot apply both binning and subsampling decimation simultaneously.
Color cameras do not support binning.

Subsampling Decimation

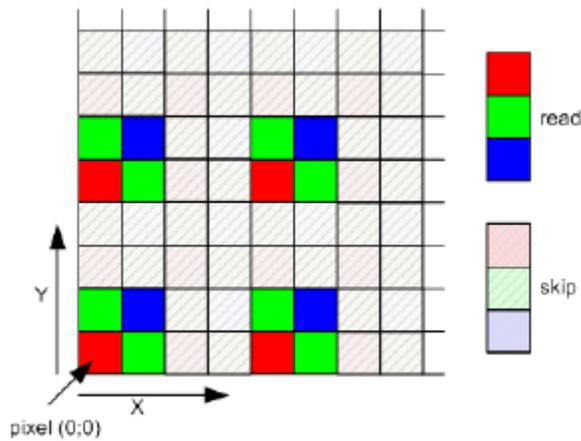
Subsampling reduces the number of pixels output by reducing the output frame size but maintains the full field of view. If an area of interest (AOI) is selected, then the field of view of the AOI is maintained.

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.

Monochrome subsampling:

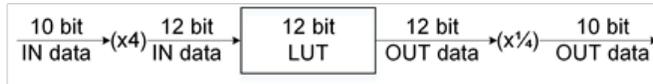


Color subsampling:



Transfer Function Correction

The user-defined LUT (Lookup Table) feature transforms any 12-bit video data into any other 12-bit value. For the 10-bit sensor digitization, the camera multiplies the 10-bit pixel data by 4 to get 12-bit pixel data for input into the 12-bit LUT. After the 12-bit LUT transforms the data, the camera divides the 12-bit data by 4 to get 10-bit pixel values for output to the camera interface.



The camera supports a Gamma control feature and four separate LUTs. All LUTs are available for modifications. You can generate and upload a custom LUT using the Imperx Upload Utility (see [Uploading the LUT File](#)).

You can control the image luminance by setting the Gamma control or/and by enabling one of the LUT. When both Gamma and LUT enabled, the camera implements the Gamma control first and then applies the LUT.

Gamma Control

The camera's built-in processing engine enables adjustments to the luminance (brightness) of an image on the monitor. Using Gamma control, you can stretch or compress the image luminance by adjusting a pixel value (pixel intensity).

By default, Gamma is equal to 1 and does not affect the image luminance. The output signal equals the input signal. To enable the Gamma control, set it to any other value.

If Gamma control is enabled, the video signal is transformed by a non-linear function as shown in the following formula.

$$\text{Output signal (ADU with 12 bpp)} = 4095 * [(\text{LUT input}/4095)^{\text{Gamma}}]$$

where Gamma is a power applied to the pixel value, from 0.00 to 4.00, with a step of 0.01. It is not a gamma of a display.

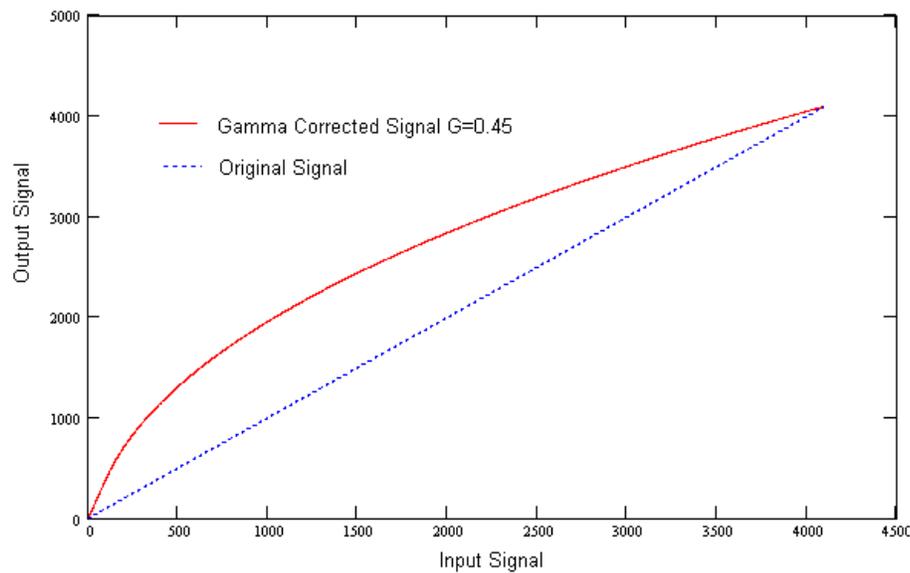
Factory LUTs

Each LUT consists of 4096 entries, with each entry being 12 bits wide. LUT1 and LUT3 are factory programmed with a standard Gamma 0.45, LUT2 and LUT4 are pre-programmed with negative LUT ($LUT_{OUTPUT} = 4095 - LUT_{INPUT}$).

The Gamma 0.45 LUT uses the following formula:

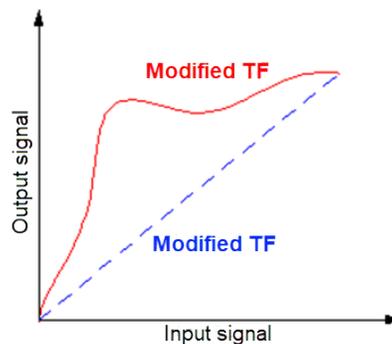
$$LUT_{OUTPUT} \text{ (ADU with 12 bpp)} = 4095 * [(LUT_{INPUT}/4095)^{0.45}]$$

For example, if the LUT_{INPUT} is 1024 ADU (12 bpp), then LUT_{OUTPUT} is $4095 * (1024/4095)^{0.45} = 2195$.



User Defined LUT

You can define any 12-bit to 12-bit transformation as a user LUT and upload it to the camera using Imperx Upload Utility (see [Uploading the LUT File](#)). 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) (refer to the [Appendix C: Look Up Tables](#)).



Hot and Defective Pixel Correction

A CMOS imager is composed of a two-dimensional array of light sensitive pixels. In general, most of the pixels have similar sensitivity. However, some pixels deviate from the average pixel sensitivity and are called *defective pixels* and *hot pixels*.

Defective pixels (also known as *dead pixels*)—these are pixels whose sensitivity deviates due to fluctuations in the CMOS manufacturing process and materials. 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 pixels – 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 far brighter than the average of the pixels surrounding it. In some cases, the pixel becomes so bright that it saturates.

At the factory, final testing identifies and stores maps of both hot and defective pixels. Enabling *DefectPixelCorrection* and *BadPixelCorrection* using the Factory option, corrects hot and defective pixels using the Factory map.

The camera employs *static* pixel maps to correct up hot and defective pixels. During factory testing, engineers identify the coordinates of hot and defective pixels. They create a map file listing the pixel coordinates of these pixels by row and column, and the camera corrects the hot and defective pixels found at these coordinates. The map file downloads into the camera's non-volatile memory.

When Factory or User correction is enabled, the camera compares each pixel's coordinates with entries in the pixel map. If a match is found, the camera corrects the defective pixel.

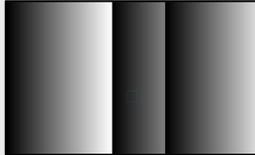
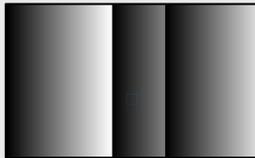
You can create your own Hot Pixel Map (HPM) or Defective Pixel Map (DPM) file and upload it using the Imperx Upload Utility application (refer to the [Appendix B](#) for more information).

Flat Field Correction

The camera uses a factory installed flat field correction (located in FFC0) algorithm to correct some of the image sensor's non-uniformity. You can upload your own FFC table to one of the FFC1 – FFC8 tables using Imperx Upload Utility. While not recommended, you can disable the FFC.

Test Image Pattern

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. The following table show a list of test images available.

Test pattern	Description	Pattern
Off	Image is coming from the sensor	-
GreyHorizontalRamp	Image is filled horizontally with an image that goes from the darkest possible value to the brightest	
GreyVerticalRamp	Image is filled vertically with an image that goes from the darkest possible value to the brightest	
GreyHorizontalRampMoving	Image is filled horizontally with an image that goes from the darkest possible value to the brightest and that moves horizontally from left to right at each frame.	
GreyVerticalRampMoving	Image is filled vertically with an image that goes from the darkest possible value to the brightest and that moves vertically from top to bottom at each frame.	
FlatField	Displays a constant grey value.	

Automatic White Balance

The camera provides white balance options for controlling image color under different lighting conditions. You can load the camera with your preferred white balance coefficients or let the camera determine the color coefficients one time or continuously (auto).

AWB Mode	Description
Off	AWB is disabled and a manual control is on. The camera applies the correction coefficients you enter using the <i>BalanceRatioSelector</i> and <i>BalanceRatio</i> controls.
Once	The camera analyzes one image frame, calculates only one set of coefficients, and corrects all subsequent frames with this set of coefficients.
Continuous	The camera analyzes every frame, derives a set of correction coefficients for each frame, and applies them to the next frame. You can set a tracking speed to be from 1 to 64 with 1 being the slowest and 64 the fastest.

To compensate for color shift, the Green channel is used as a reference and the Red and Blue channel gains are changed to match the Green channel. For example, to increase the Red channel gain by 75%, set the Red *BalanceRatio* to 1.75x. The camera applies 75% more gain to the Red channel than to the Green.

Manual Control over the Correction Coefficients (AWB mode: Off)

To adjust the Red and Blue channel gain coefficients with respect to Green (the reference), use the control *BalanceRatioSelector* to point to the color (Red or Blue) whose gain should be adjusted. Then *BalanceRatio* control is used to set a gain value between 0.25x to 4.00x for the selected color. The Green channel gain is always set to 1.

BalanceRatio value	Red/Blue channel gain
from 0.25x to 0.99x	the channel gain decreases
from 1.01x to 4.00x	the channel gain increases
1.00x	the gain does not change

To disable Auto-White Balance, set *BalanceRatio* to 1.00x for both Red and Blue channel gains.

EXAMPLE

To set Blue channel gain with respect to Green to 2x and set Red channel gain to 0.8x:

1. On **AnalogControl** panel, set *BalanceWhiteAuto* to **Off**.
2. Set *BalanceRatioSelector* to **Blue**.
3. Set *BalanceRatio* to 2.00.

AnalogControl	
Gain	7.00
GainAuto	Off
BlackLevel	60.00
SensorBlackLevelRecomended	<input checked="" type="checkbox"/> True
BlackLevelAuto	Continuous
Gamma	1.00
DigitalGain	1.00
DigitalBlackLevel	0.00
2 BalanceRatioSelector	Blue
3 BalanceRatio	2.00
1 BalanceWhiteAuto	Off

4. Set **BalanceRatioSelector** to Red.

5. Set **BalanceRatio** to 0.80.

4 BalanceRatioSelector	Red
5 BalanceRatio	0.80
BalanceWhiteAuto	Off

6. In the **User Set Control** menu, point to one of the User Sets to store your configuration using the *UserSetSelector*.
The options are UserSet0, UserSet1, UserSet2, or UserSet3. The Default is a factory configuration that cannot be changed.

UserSetControl	
6 UserSetSelector	Default
UserSetLoad	Default
UserSetSave	UserSet0
UserSetDefault	UserSet1
SpecialFeatures	UserSet2
	UserSet3

7. Execute **UserSetSave** command to save your configuration to the camera’s non-volatile memory.

8. Select your User Set (must be the same as in step 6) in **UserSetDefault** menu.
The camera loads and activates this User Set upon the next reset or upon power-up.

UserSetControl	
UserSetSelector	UserSet0
UserSetLoad	Execute
7 UserSetSave	Execute
8 UserSetDefault	UserSet0
SpecialFeatures	Default
	UserSet0
	UserSet1
	UserSet2
	UserSet3

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

AWB mode: Once

For the best color reproduction when the source has a stable spectral output, Imperx suggests illuminating a uniformly grey card with the intended source then using the **Once** option to determine the coefficients and then saving these coefficients into the camera and saving this configuration to one of the User Sets.

To get the best white balance coefficients when the spectral source is constant:

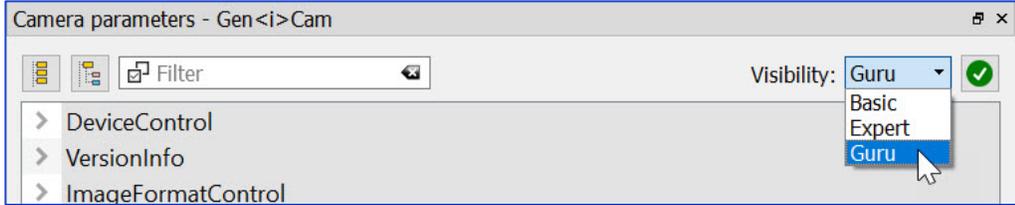
1. Image a grey or white target over the camera's entire field of view using the intended lighting source.
2. Select **Once** mode for the *BalanceWhiteAuto*. The Red and Blue coefficients appear in the *BalanceRatio* area.
3. Save this configuration to one of the User Sets.

AWB mode: Continuous

The camera automatically adjusts the Red and Blue channel gains when *BalanceWhiteAuto* is set to **Continuous**.

Canon Lens Control

Make sure that a switch on your Canon EOS EF lens is set to Auto (AF), and Visibility is set to Guru on the IpxPlayer GUI screen:



The camera initializes the lens upon power cycling. Check **Lens Controller Status** parameter. If the status is `InitLens_Done`, the initialization was successfully completed, and you can start adjusting the lens. If the initialization failed, issue **InitLens** command on Controller Setting screen.

Focus Control

1. For the camera to learn the range of the Canon lens’s Focus Encoder, issue the following sequence of commands:
 - a. Issue the *Canon Focus Near-Full* command.
 - b. Issue the *Reset Focus Encoder* command.
 - c. Issue the *Canon Focus Far-Full* command.
 - d. Issue the *Get Focus Encoder Status* command.
 - e. Issue the *Focus Set Max* command. The *Focus Max* parameter will be adjusted automatically to this value.

<ul style="list-style-type: none"> ▼ CanonLensControl <ul style="list-style-type: none"> > ControllerSettings <ul style="list-style-type: none"> ▼ Focus <table border="1"> <tr> <td>NearFull</td> <td>Execute</td> <td>a.</td> </tr> <tr> <td>FarFull</td> <td>Execute</td> <td>c.</td> </tr> <tr> <td>FocusStepValue</td> <td>1</td> <td></td> </tr> <tr> <td>NearStep</td> <td>Execute</td> <td></td> </tr> <tr> <td>FarStep</td> <td>Execute</td> <td></td> </tr> <tr> <td>FocusReqPosition</td> <td>0</td> <td></td> </tr> <tr> <td>SetFocusPosition</td> <td>Execute</td> <td></td> </tr> <tr> <td>FocusMax</td> <td>0</td> <td></td> </tr> <tr> <td>FocusSetMax</td> <td>Execute</td> <td>e.</td> </tr> <tr> <td>FocusEncoderStatus</td> <td>0</td> <td></td> </tr> <tr> <td>GetFocusEncoderStatus</td> <td>Execute</td> <td>d.</td> </tr> <tr> <td>ResetFocusEncoder</td> <td>Execute</td> <td>b.</td> </tr> </table> 	NearFull	Execute	a.	FarFull	Execute	c.	FocusStepValue	1		NearStep	Execute		FarStep	Execute		FocusReqPosition	0		SetFocusPosition	Execute		FocusMax	0		FocusSetMax	Execute	e.	FocusEncoderStatus	0		GetFocusEncoderStatus	Execute	d.	ResetFocusEncoder	Execute	b.
NearFull	Execute	a.																																		
FarFull	Execute	c.																																		
FocusStepValue	1																																			
NearStep	Execute																																			
FarStep	Execute																																			
FocusReqPosition	0																																			
SetFocusPosition	Execute																																			
FocusMax	0																																			
FocusSetMax	Execute	e.																																		
FocusEncoderStatus	0																																			
GetFocusEncoderStatus	Execute	d.																																		
ResetFocusEncoder	Execute	b.																																		

2. Set *FocusReqPosition* to a desired value.
3. Issue the *SetFocusPosition* command and the lens will move to the *FocusReqPosition* value. *FocusEncoderStatus* will be updated to reflect the new position

The Focus Encoder uses a Hall effect sensor and is not perfectly precise, so *FocusEncoderStatus* values can vary. It does not provide sufficiently accurate location information to change lens focus after power cycling and the error tends to increase with the number of focus movements. However, once the lens is focused, it will retain focus after repeated power cycling.

The *FocusEncoderStatus* is a signed binary value (2's complement). Negative values can result if the Focus Encoder position is close to the Near Full position. For example, a value of 65352 means negative 184 or 184 steps past the Near Full Position.

Iris Control

A Canon EF EOS lens provides an iris range in raw units and the camera reads out an iris range from a Canon lens in raw units upon issuing the *GetIrisRange* command. Each time the iris is changed, the camera calculates and returns the *CurrentFNumber* using the following formula:
 $CurrentFNumber = \sqrt{2}^{[(Raw\ unit/8) - 1]}$

For example, if Raw unit = 32, then *CurrentFNumber* = 2.83.

Using XML features *IrisRequestedPositionRaw* and *SetIrisPosition*, you can set an aperture to a required value. The aperture will be changed with *IrisStepValue* until it is greater than or equal to the target position in raw units.

▼ CanonLensControl	
> ControllerSettings	
> Focus	
▼ Iris	
IrisRequestedPositionRaw	0
SetIrisPosition	Execute
CurrentFNumber	4.55515
OpenIrisFull	Execute
CloseIrisStep	Execute
OpenIrisStep	Execute
IrisStepValue	1
GetIrisRange	Execute
IrisMin	43
IrisMax	80
IrisRange	502B2B2B

Configuring the Camera to Work with Action Control Commands

NOTE (*) Before configuring the camera:
Make sure that all cameras belong to the same Ethernet network segment, and reachable for broadcast packets from your host computer.

If using scheduled action commands, make sure that your cameras and software support IEEE1588 PTP and Scheduled action command features. Be sure to enable the `GeVIEEE1588` parameter on each camera that you want to control with the scheduled action command.

Make sure that the Windows Firewall is disabled (see the [Disabling Windows Firewall for All Connections](#) and [Disabling Windows Firewall for Selected Network Adapters](#) sections).

Configure action control parameters for cameras and host PC in the following order:

1. Configure trigger parameters on each camera that you want to control with the action command (see below).
2. Configure action control parameters on each camera that you want to control with the action command (see p. 218).
3. Configure action control parameters on the host PC (see [Sending the Immediate Action Command](#) on p. 152 and [Sending the Scheduled Action Command](#) on p. 154)

Configuring Trigger Parameters

To configure trigger parameters on the Imperx Cheetah GigE Vision camera using the Imperx IpxPlayer application, follow the steps below:

1. Run the Imperx IpxPlayer application and connect to the camera.
2. Make sure that the camera image acquisition is turned off and `AcquisitionFrameRateEnable` is **False** in the Acquisition Control category.
If `AcquisitionFrameRateEnable` is **True**, you will not be able to set `TriggerMode` parameter to On.
3. Set `TriggerMode` to **On**.
4. Select **Action0** under `TriggerSource`.
Trigger source is generated by the software using the action command #0 (Trigger over Ethernet).
5. Select **Off** under `TriggerOverlap`.
6. Enter a value for `TriggerDelay` (optional).

▼ AcquisitionControl	
AcquisitionMode	Continuous
AcquisitionStart	Execute
AcquisitionStop	Execute
AcquisitionAbort	Execute
AcquisitionFrameCount	1
ExposureMode	Off
ExposureTime	52345us
ExposureAuto	Off
AcquisitionFrameRateEnable	False
AcquisitionFrameTime	52564
AcquisitionFrameRate	19.02Hz
AcquisitionLineTimeEnable	False
AcquisitionLineTime	822
AcquisitionBurstFrameCount	1
CurrentExposureTime	52345
CurrentFrameTime	52564
TriggerMode	On
TriggerSoftware	Execute
TriggerSource	Action0
TriggerActivation	RisingEdge
TriggerOverlap	Off
TriggerDebounceTime	0
TriggerFilterTime	0
TriggerDelay	0

optional

- Repeat steps 1–6 for each camera.

Configuring Camera’s Action Control Parameters

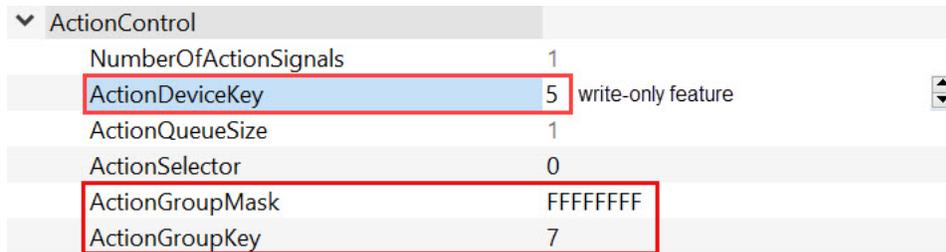
A camera receives an action command protocol message from a host computer. The protocol message contains values with the following parameters:

- *Device Key*
- *Group Key*
- *Group Mask*
- *Scheduled Time* (for scheduled action commands only)

If values of the *Device Key*, *Group Key*, and *Group Mask* parameters in the received message match the values configured in the camera, the camera accepts and executes the action command.

To configure the action control parameters on the Imperx Cheetah GigE Vision camera, follow the steps below:

1. Run the Imperx IpxPlayer application and connect to the camera.
2. Select **Guru** in the *Visibility* drop-down list.
3. On the Action Control panel, enter *ActionDeviceKey*, *ActionGroupKey*, and *ActionGroupMask* values.



Parameter	Value	Description
<i>ActionDevice Key</i>	The camera’s <i>ActionDeviceKey</i> value and the device key in the protocol message must be equal to initiate an action command. Min: 0 Max: 0xFFFFFFFF	<i>ActionDeviceKey</i> is a 32-bit unique key that authorizes the action command on the camera. The camera executes the action command only if its configured <i>ActionDeviceKey</i> is identical to the value in received protocol message. Note: 1. <i>ActionDeviceKey</i> must be set each time the camera is opened.

Parameter	Value	Description
		2. The <i>ActionDeviceKey</i> is write-only and cannot be read out from the camera.
<i>ActionGroupKey</i>	<p>The camera's <i>ActionGroupKey</i> and <i>group key</i> values in the protocol message must be equal.</p> <p>Min: 0 Max: 0xFFFFFFFF</p>	<p><i>ActionGroupKey</i> is a 32-bit key that is used to organize cameras into a group.</p> <p>All cameras in the group perform the same action (Action 0) at the same time (unless subgroups are specified using <i>ActionGroupMask</i> feature).</p> <p>The camera reacts to the action command only if its configured <i>ActionGroupKey</i> is identical to the value in received protocol message.</p> <p>Assign a common <i>ActionGroupKey</i> to each camera in the group.</p> <p>Note: You cannot include a camera into multiple groups assigned to the same action command.</p>
<i>ActionGroupMask</i>	<p>The logical AND operation of the camera's <i>ActionGroupMask</i> and the group mask within the protocol message must result in non-zero value. Both group masks must have at least one common bit set to 1.</p> <p>If the AND operation results in zero, the camera does not perform the action.</p> <p>Min: 0* Max: 0xFFFFFFFF</p> <p>*Note: minimum value for the <i>ActionGroupMask</i> on the host PC is 1. Cameras will not react to the value 0.</p>	<p><i>ActionGroupMask</i> is a 32-bit number that is used to organize cameras into subgroups within a group. All cameras in the subgroup perform the same action (Action 0) at the same moment.</p> <p>Note:</p> <ol style="list-style-type: none"> 1. You can include one camera into one or multiple subgroups. 2. You can exclude a camera from all subgroups by setting its <i>ActionGroupMask</i> to 0.

4. Repeat steps 1–3 for each camera that you want to control with the action command

IEEE1588 PTP

Overview

The IEEE1588 PTP standard allows synchronization of cameras and/or network switches supporting IEEE1588 to a single master clock. The Cheetah cameras have an embedded Best Master Clock algorithm which allows the cameras to negotiate amongst themselves and/or a network switch to determine which camera/switch will provide the ‘master’ clock. Once this negotiation is complete, each camera will indicate its status: Master or Slave. A calibration phase then ensues between the Master and the Slaves. During this phase, each camera determines the error (delay) between its internal Time Stamp register and the Master. Once this delay is determined, it synchronizes its internal Time Stamp register with the Masters. Each camera image is Time Stamped and once the calibration phase is complete, it is possible to precisely determine when images from different cameras were captured in relation to one another.

IEEE1588 Commands

The following three commands are used to control IEEE1588 functionality in the Cheetah cameras. The commands are listed in the XML under the Transport Layer/GigE Vision tabs.

GevIEEE1588supported is a read only register indicating if the camera supports 1588 functionality

GevIEEE1588 is a read/write Boolean register to enable and disable IEEE1588 functionality

GevIEEE1588Status conforms to the IEEE1588 standard and is a read only register providing IEEE1588 status information as shown below:

PTP Port State	Description
Unknown	Undefined status
Initializing	While a port is in the Initializing state, the port initializes its data sets, hardware and communication facilities. No port of the clock shall place any PTP messages on its communication path. If one port of a boundary clock is in the Initializing state, then all ports shall be in the Initializing state.
Faulty	The fault state of the protocol. A port in this state shall not place any PTP messages except for management messages that are a required response to another management message on its communication path. In a boundary clock, no activity on a faulty port shall affect the other ports of the device. If fault activity on a port in this state cannot be confined to the faulty port, then all ports shall be in the Faulty state.
Disabled	The port shall not place any messages on its communication path. In a boundary clock, no activity at the port shall be allowed to affect the activity at any other port of the boundary clock. A port in this state shall discard all PTP received messages except for management messages.
Listening	The port is waiting for the announceReceiptTimeout to expire or to receive an Announce message from a master. The purpose of this state is to allow an orderly addition of clocks to a domain. A port in this state shall not place any PTP messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, or signaling messages, or management messages that are a required response to another management message.

PTP Port State	Description
Pre_Master	The port shall behave in all respects as though it were in the Master state except that it shall not place any messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, signaling, or management messages.
Master	The port is behaving as a Master port.
Passive	The port shall not place any messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, or signaling messages, or management messages that are a required response to another management message.
Uncalibrated	One or more master ports have been detected in the domain. The appropriate master port has been selected, and the local port is preparing to synchronize to the selected master port. This is a transient state to allow initialization of synchronization servos, updating of data sets when a new master port has been selected, and other implementation-specific activity.
Slave	The port is synchronizing to the selected master port.

Configuration Memory

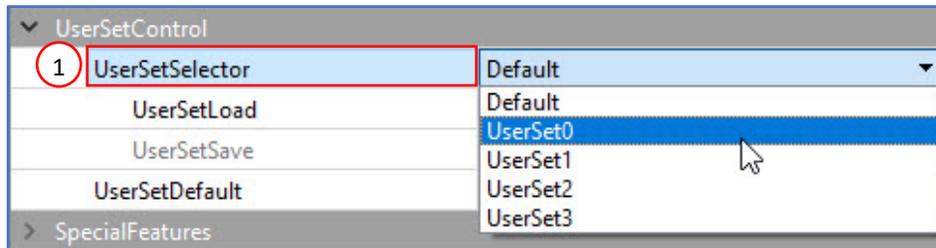
The camera has built-in configuration memory divided into six segments: Work Space, Factory Space (Default), User Space #0, #1, #2 or #3. The Work Space segment contains the current camera settings while the camera is powered up and operational. All camera registers are in this space. You can program 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 (Default) segment is ROM based, write protected, and contains the default camera settings. This space is available for read operations only. User Space #0, #1, #2 and #3 are non-volatile, flash-based, and used to store up to four user defined configurations or User Sets. Upon power up or software reset, the camera firmware loads the Work Space registers from the Factory Space (Default), User Space #0, #1, #2 or #3 as determined by a User Set Default Selector setting.

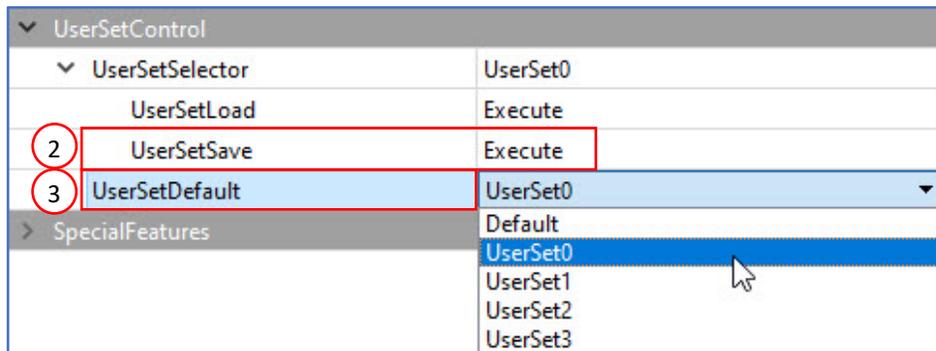
At any time, you can instruct the camera to load its Work Space with the contents of the Factory Space, User Space #0, #1, #2 or #3 by first using the *UserSetSelector* to point to the desired User Set then using the *UserSetLoad* command.

Similarly, you can instruct the camera to save the current Work Space settings into either User Space #0, #1, #2 or #3 by using the User Set Selector to point to the desired User Set and then using the User Set Save command:

1. In the **User Set Control** menu, point to one of the User Sets to store your configuration using the *UserSetSelector*.



2. Execute **UserSetSave** command to save your configuration to the camera’s non-volatile memory.
3. Select your User Set (must be the same as in step 2) in **UserSetDefault** menu. The camera loads and activates this User Set upon the next reset or upon power-up.



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

The non-volatile parameter Flash memory also contains the Bad Pixel Map (BPM), Defective Pixel Map (DPM), 8 Flat Field Correction (FFC) tables, and 4 LUTs which you can load to the camera's internal memory upon enabling the corresponding camera feature. You can create custom LUT tables using the Imperx IPX Toolkit utility and upload these tables to the parameter Flash using the Imperx Upload Utility. Both the IPX Toolkit and IPX Upload Utility are available from the Imperx website <https://www.imperx.com/>.

Image Sensor Technology

General Information

A CMOS camera is an electronic device for converting light into an electrical signal. The C1640, C1941, C3240 cameras contain 3rd Generation Sony Pregius CMOS (Complementary Metal-Oxide Semiconductor) image sensors with 4.5-micron square pixels. The C4440, C5440, and C6440 cameras contain 3rd Generation Sony Pregius CMOS image sensors with 3.45-micron square pixels, while the C4540, C5340, and C5341 cameras contain 4th Generation Sony Pregius S CMOS image sensors with 2.74-micron square pixels. The sensors have extremely low dark current and no visible fixed pattern noise, which has been the bane of traditional CMOS image sensors.

The Sony CMOS sensor consists of a two-dimensional array of sensitive elements called silicon photodiodes, also known as pixels. The photons falling on the CMOS surface create photoelectrons within the pixels. 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 level and exposure time, the number of electrons created in the pixel during any fixed time period varies with the wavelength of the incident light.

When the camera reaches the desired exposure time, it shifts the charges from each pixel photodiode onto a storage register within the pixel, reads out one row at a time digitizing each pixel at 10 or 12 bits. The user can selectively output the most significant 8, 10 or 12 bits from each pixel with an impact to camera's frame rate. Frame time, or read-out time, is the time interval required for all the pixels to be read out of the image sensor. In non-triggered or fast trigger mode, while reading out the image from the storage registers within each pixel, the camera captures the next image. The exposure ends just as the readout of the previous frame ends and the next frame begins.

The Sony 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 and extremely low dark current, translates into a large dynamic range of 71 dB (12-bits) or 12 F-stops.

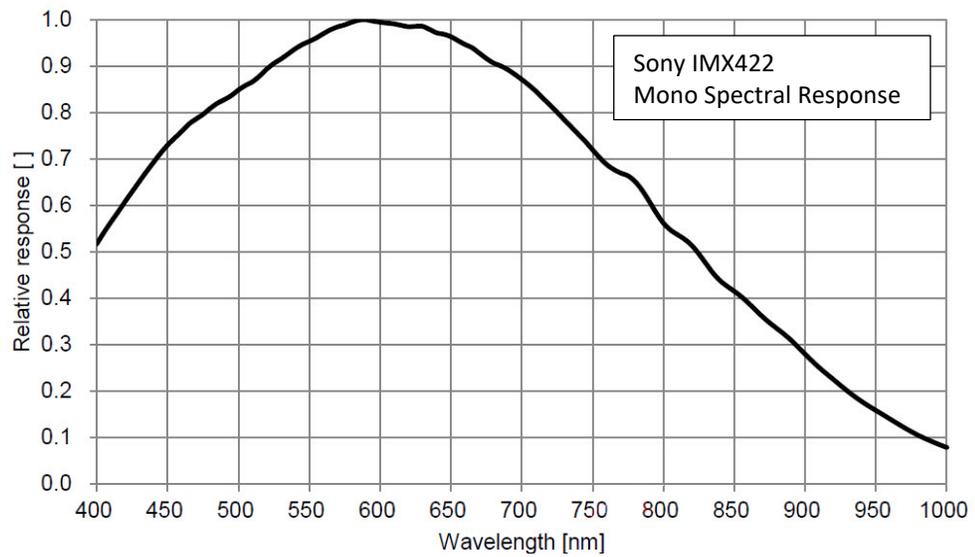
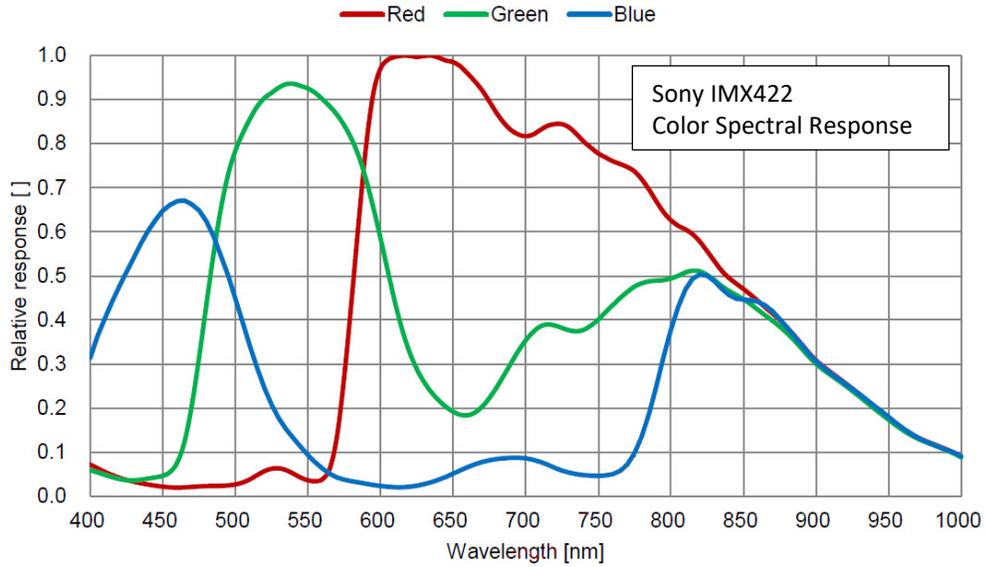
The sensor allows you to apply up to 48 dB of gain to the image. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally. Additional digital gain (up to 12 dB) can also be applied using the Digital Gain control.

Spectral Sensitivity

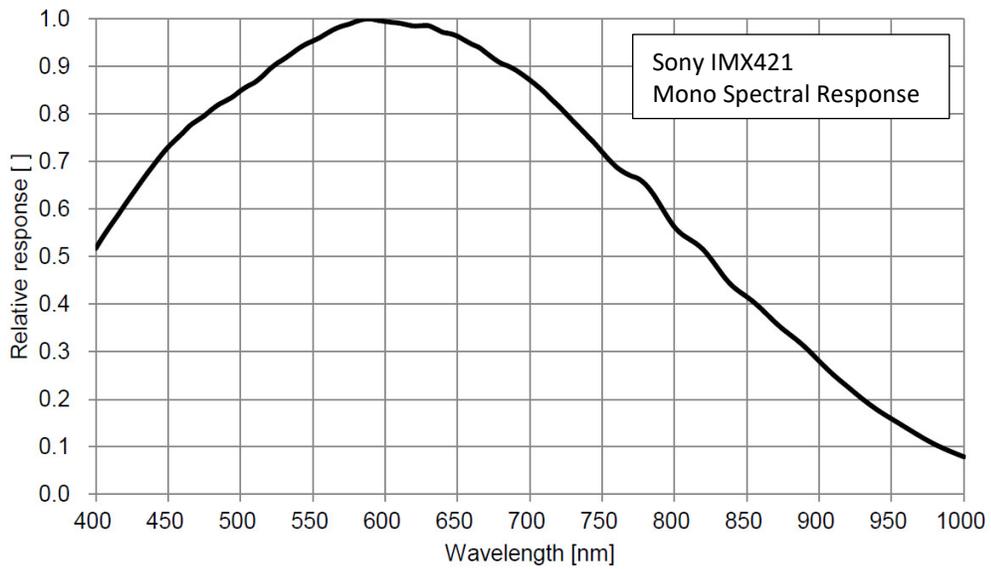
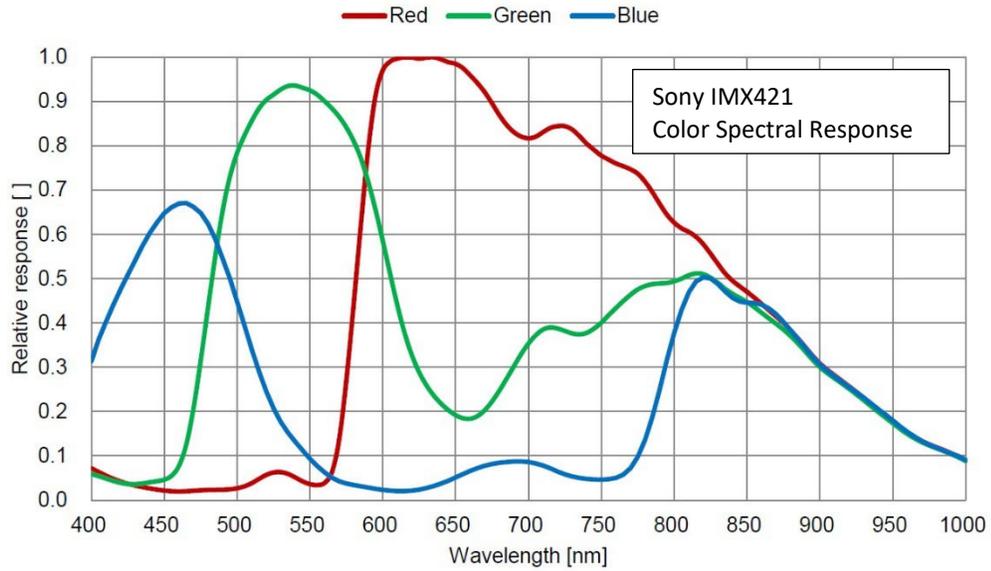
A set of color filters (red, green, and blue) arranged in a Bayer pattern over the pixels generates color images. The starting color is Red for SONY Pregius image sensors and follows the pattern: red, green, red, green, red, ... on row 1 and green, blue, green, blue, green, ... on row 2 and so on. The color and monochrome spectral responses of the sensors used in Cheetah cameras can be found in [Appendix A](#).

Appendix A: Spectral Response

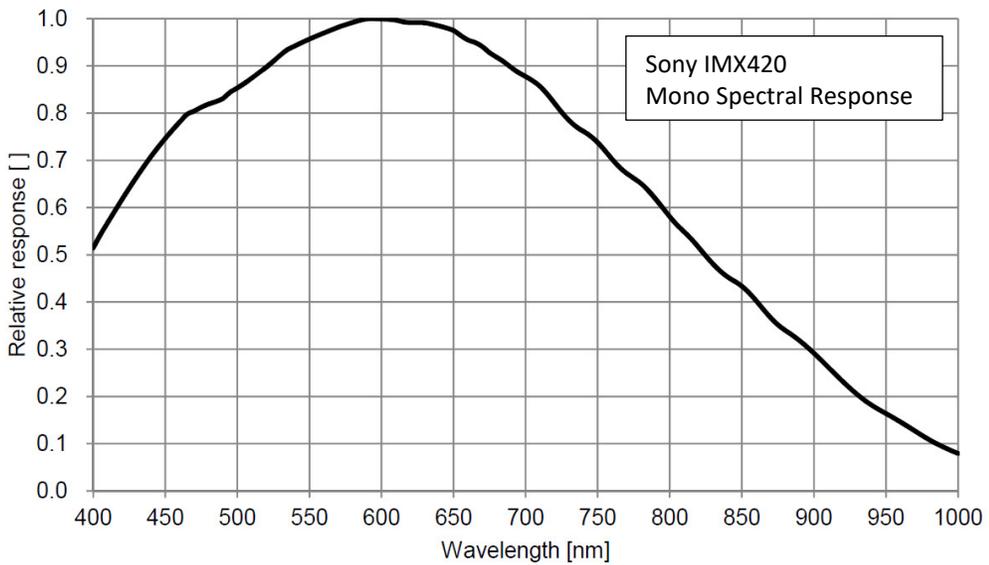
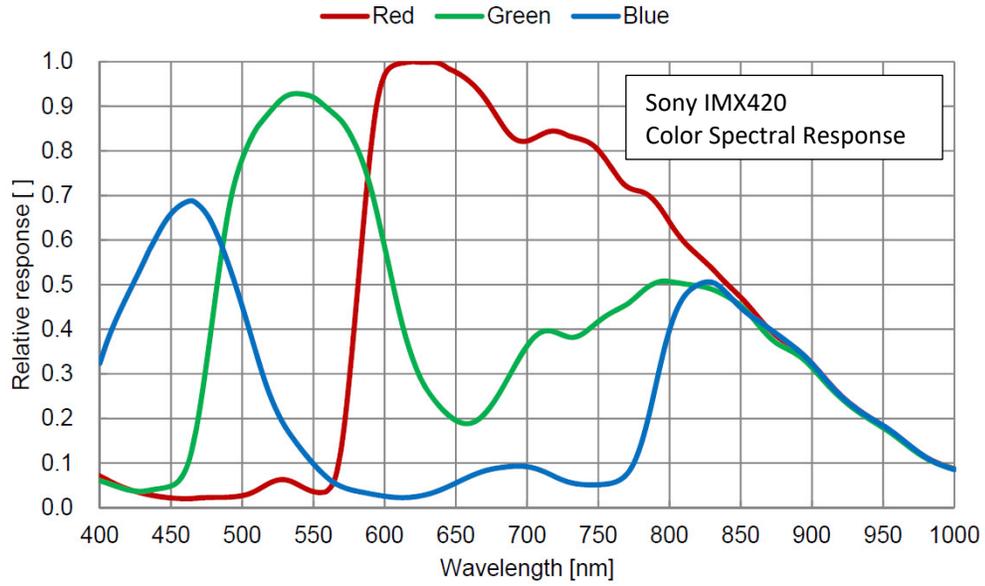
Cheetah C1640 Spectral Response



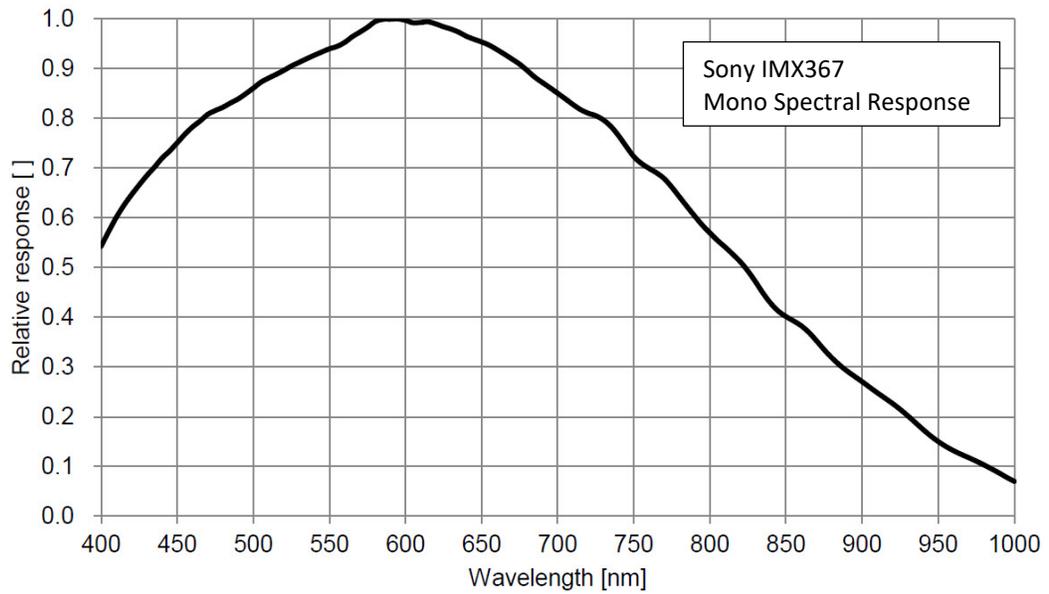
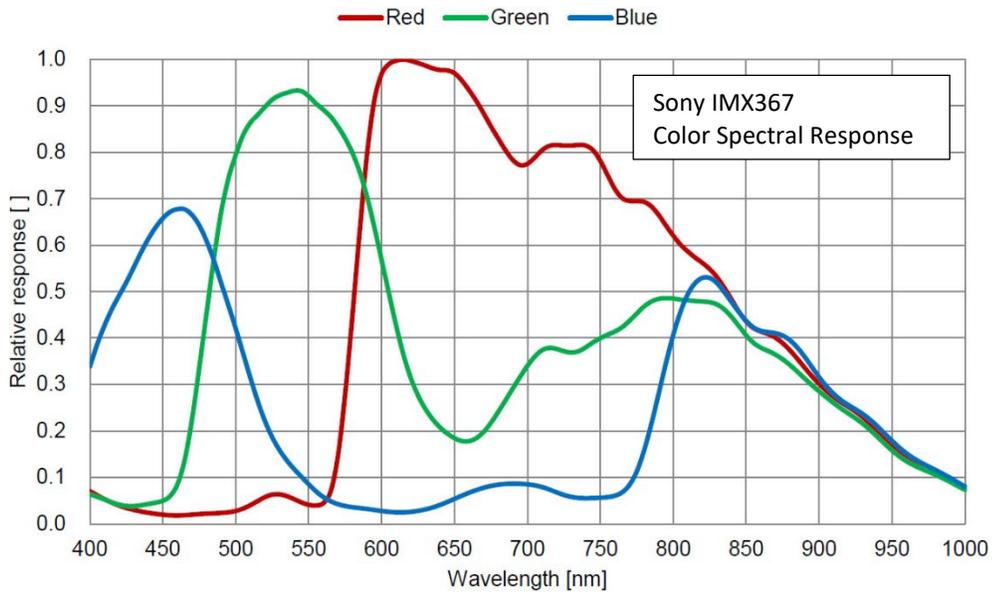
Cheetah C1941 Spectral Response



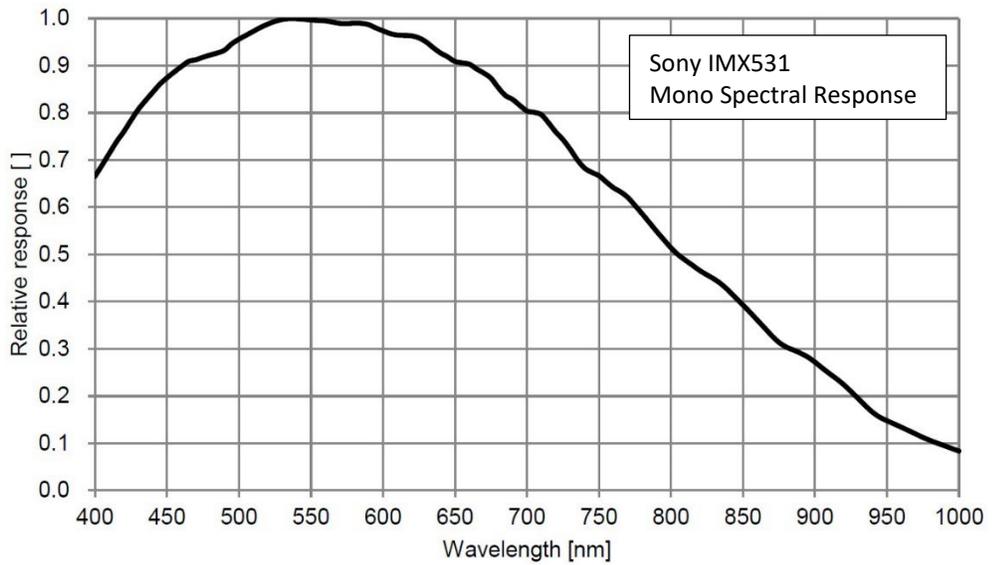
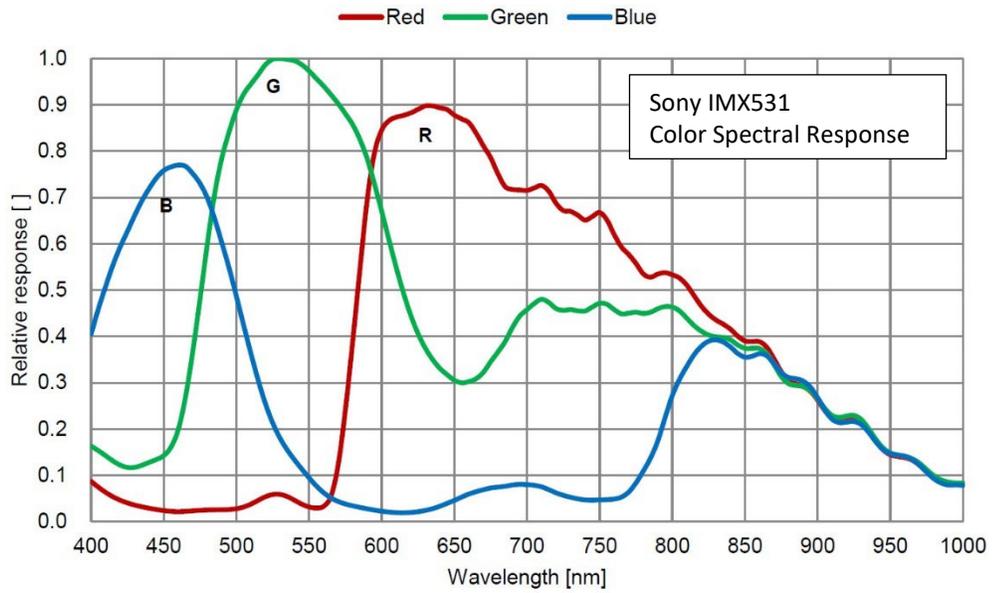
Cheetah C3240 Spectral Response



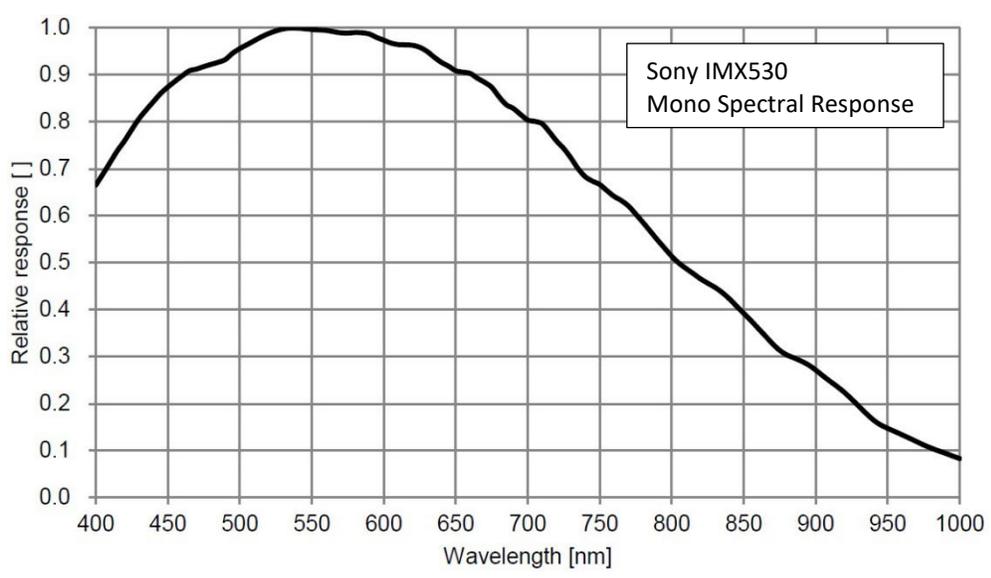
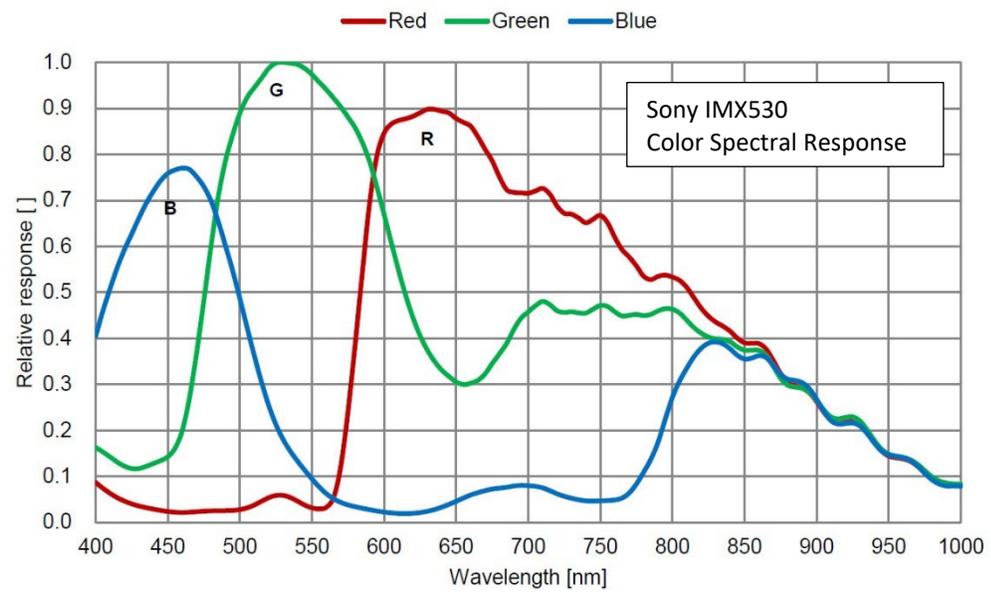
Cheetah C4440 Spectral Response



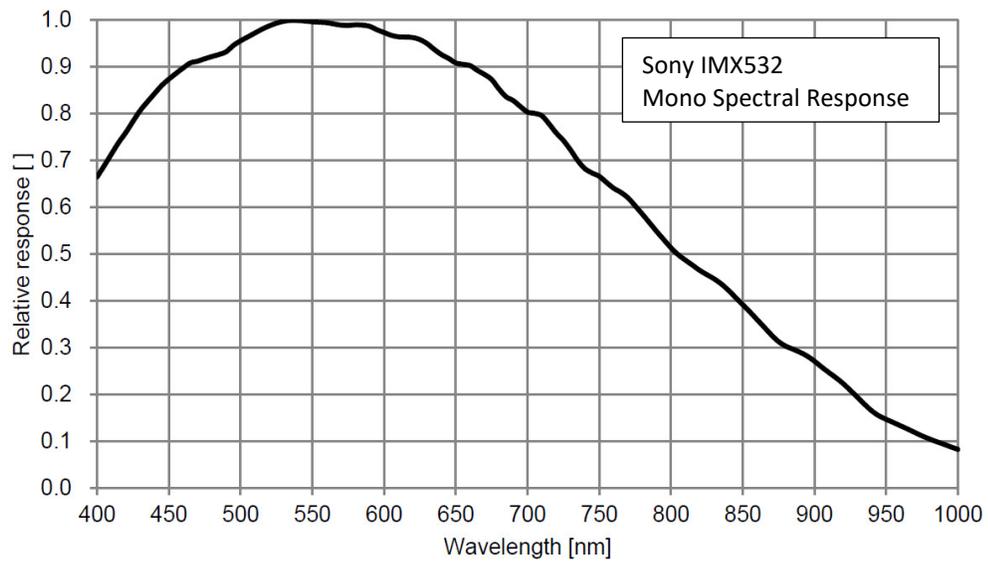
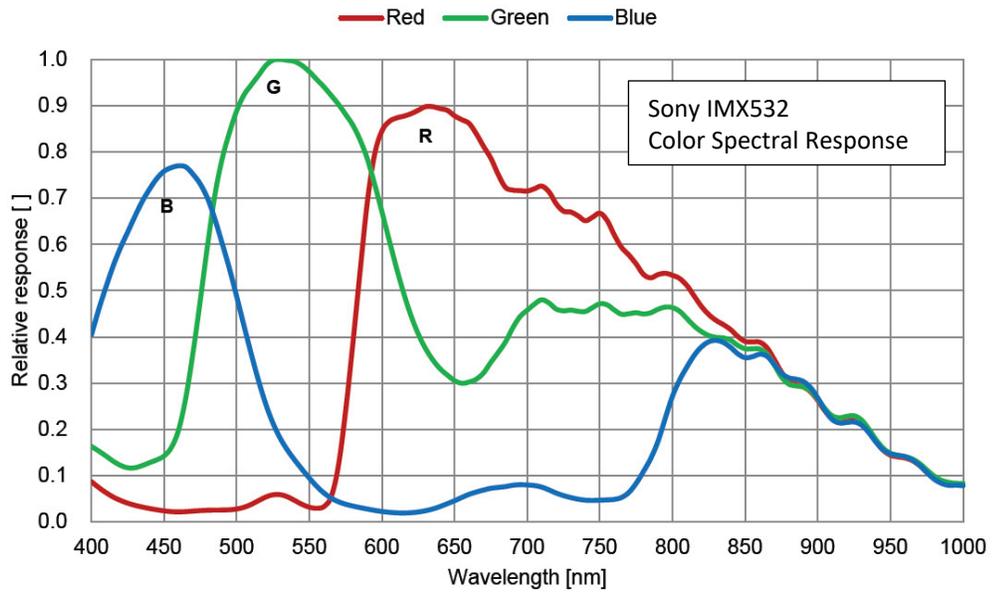
Cheetah C4540 Spectral Response



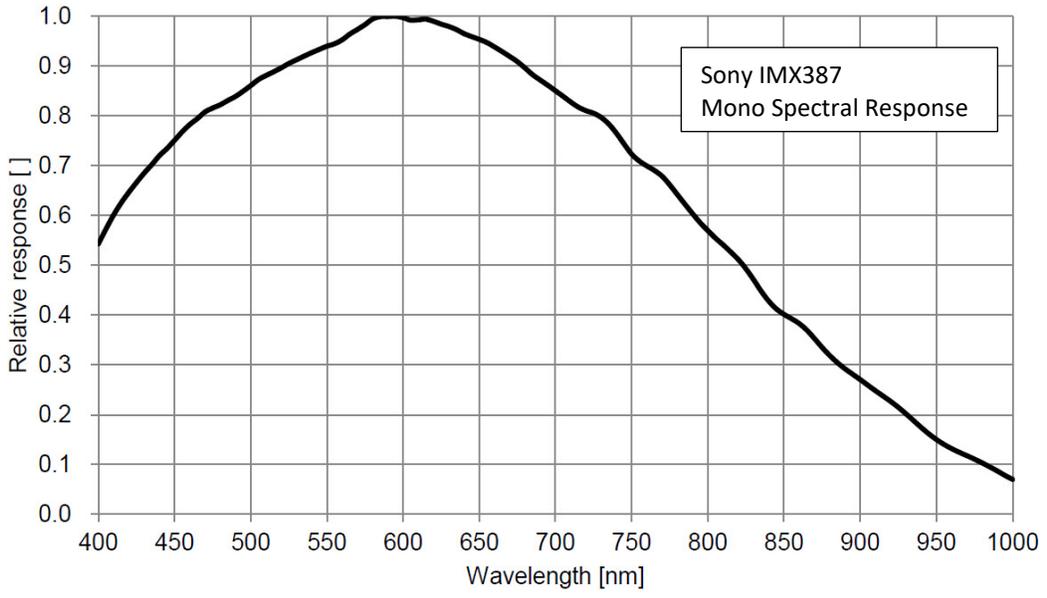
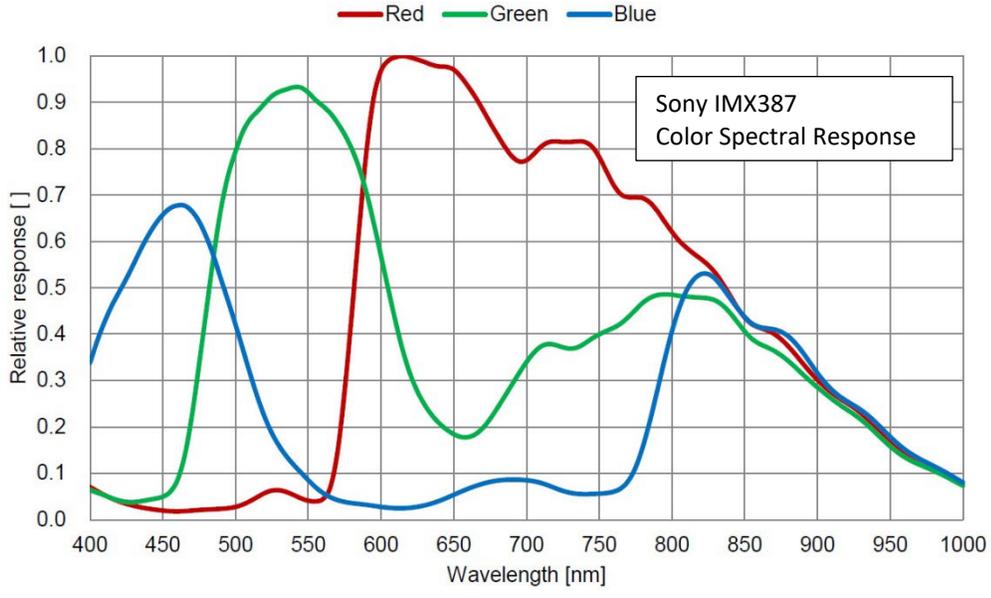
Cheetah C5340 Spectral Response



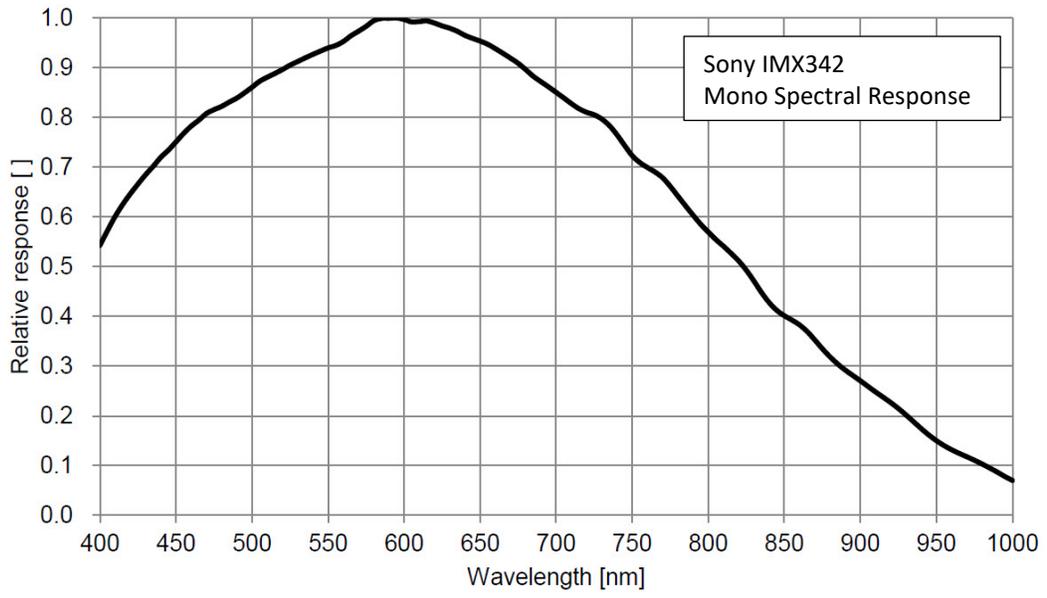
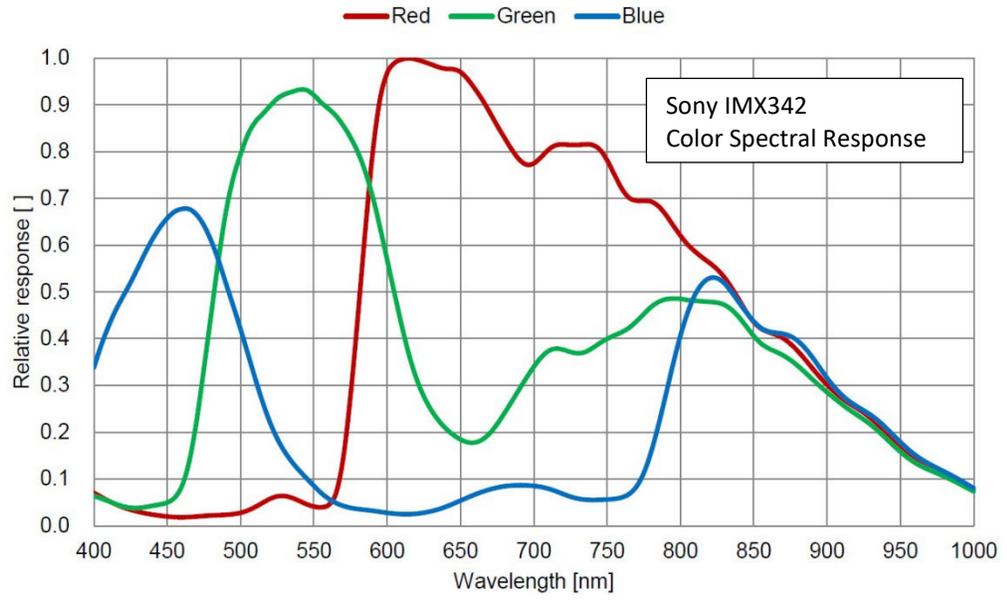
Cheetah C5341 Spectral Response



Cheetah C5440 Spectral Response



Cheetah C6440 Spectral Response



Appendix B: Creating Hot and Defective Pixel Correction Maps

Overview

Hot Pixel Correction and Defective Pixel Correction work with predetermined and preloaded Hot and Defective pixel maps.

Hot Pixel Map (HPM) and Defective Pixel Map (DPM) are uploaded into the camera's non-volatile memory.

You can edit the original (factory installed) HPM / DPM file and upload it into the camera to fit the unique requirements of your operating environment or camera use.

Editing HPM / DPM Files

You can edit HPM and DPM files in Microsoft Notepad or any other editing software. The file is a simple text file that looks like this:

```
-- Defective Pixel Map,  
-- Date: 05.18.2020,  
-- Model#: SFP-C6440M,  
-- 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 HPM or DPM in order of increasing Y (row) location. If there are multiple hot or defective pixels in the same row (Y location is identical for both defective pixels), the listing is in order of increasing X (column) location.

The maximum number of pixels in the DPM list is 1024 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.

Finding Defective Pixels

To see the defective pixels that are not in the factory DPM:

1. Make sure that the *DefectPixelCorrection* is set to Factory in the Data Correction menu of the software GUI.
The camera corrects the known pixel defects automatically.
2. Make sure that *TriggerMode* and *ExposureMode* are set to Off, and the camera resolution is set to maximum.
3. Capture 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).
4. Identify any visible defective pixel and add them to the DPM as described in [Locating and adding pixel coordinates](#).

To see all the defective pixels, including those in the factory DPM:

1. Set *DefectPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *BadPixelCorrection* is set to Factory.
3. Repeat steps 2–4 of the previous procedure.

TIP

To obtain the factory DPM file, contact Imperx technical support at:

Email: support@imperx.com

Toll Free: 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our website: www.imperx.com.

To create an HPM that contains all the hot pixels, see [Creating a DPM Using Imperx Toolkit](#).

To upload a new DPM into the camera, see [Uploading DPM / HPM Files](#).

Finding Hot Pixels

To see the hot pixels that are not in the factory HPM:

1. Make sure that *BadPixelCorrection* is set to Factory in the Data Correction menu.
The camera corrects the known hot pixels automatically.
2. Set the longest exposure time and slowest frame rate expected.
3. Put the lens cap on the camera.
4. Run the camera for at least 45 minutes at ambient temperature around 18–22 °C or higher.
5. Capture an image (or series of images).

6. Identify all visible hot pixels and add them to the HPM as described in [Locating and adding pixel coordinates](#).

To see all the hot pixels, including those in the factory HPM:

1. Set *BadPixelCorrection* to Off in Data Correction menu.
2. Make sure that *DefectPixelCorrection* is set to Factory.
3. Repeat steps 2–6 of the previous procedure.

TIP ⓘ

To obtain the factory HPM file, contact Imperx 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.

To create an HPM that contains all the hot pixels, see [Creating an HPM Using Imperx Toolkit](#).

To upload a new DPM to the camera, see [Uploading DPM / HPM Files](#).

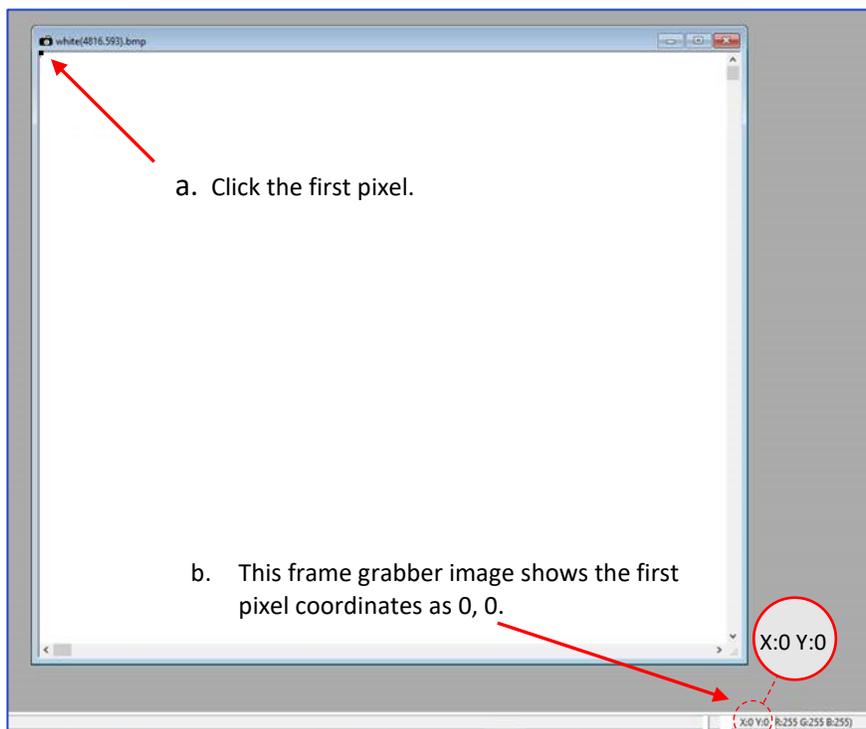
Locating and adding pixel coordinates

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.

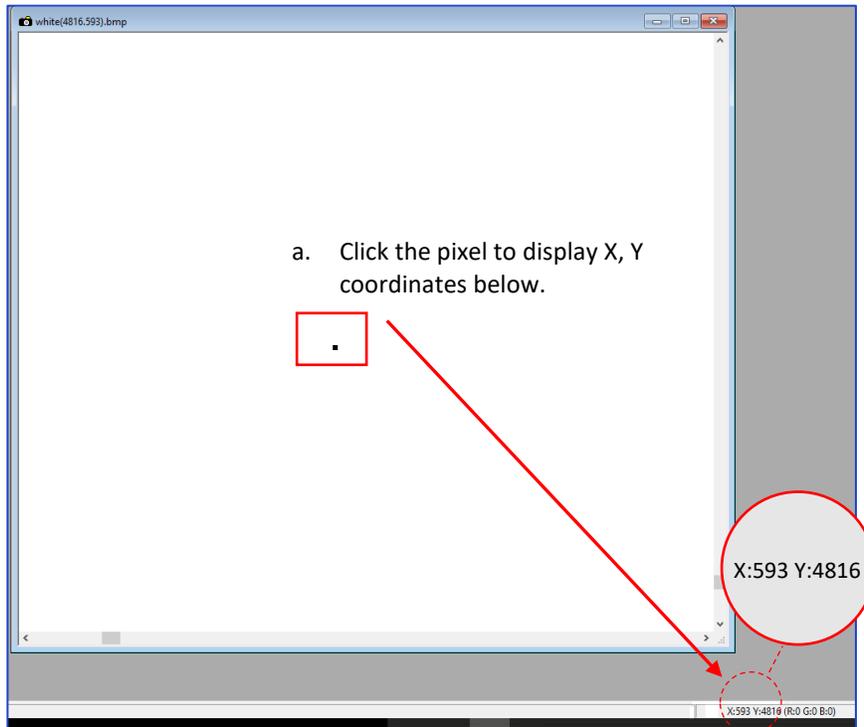


The coordinates will be either 0, 0 or 1, 1:

- If your frame grabber's first pixel coordinates are 0, 0, you should add 1 to both the X and Y coordinates of the defective 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.



The coordinates are 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:

X (Column), Y (Row) or,
X (Row), Y (Column).

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 must 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 above had been displayed in this order, where X:593 is a row and Y:4816 is a column, you would have had to transpose the coordinates to 4816, 593.

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
<pre>-- Defective Pixel Map, -- Date: 5.18.2020, -- Model#: SFP-C6440M-RF, -- Serial#: LAC001, :Table, -- Column (X) , Row (Y) 701, 1017 100, 1018 4325, 1019 2241, 1020 458, 1021 1712, 1053 914, 1067 3954, 1546 2516, 1670 3451, 3331 1111, 4149 95, 4364 594, 4817 433, 4828</pre> <p style="border: 1px solid red; padding: 5px; display: inline-block;">Row coordinates are in ascending order (increasing Y values).</p>	<pre>-- Defective Pixel Map, -- Date: 5.18.2020, -- Model#: SFP-C6440M-RF, -- Serial#: LAC001, :Table, -- Column (X) , Row (Y) 650, 1017 698, 1017 701, 1017 100, 1018 4325, 1019 2241, 1020 458, 1021 1712, 1053 f914, 1067 3954, 1546 2516, 1670 3451, 3331 1111, 4149 95, 4364 433, 4828</pre> <p style="border: 1px solid red; padding: 5px; display: inline-block;">Column coordinates are in ascending order (increasing X values).</p>

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.

Creating a DPM/HPM Using a Text Editor

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: 5.18.2020,
-- Model#: SFP-C6440M,
-- 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 1024 and in HPM list is 4096.

To create a DPM or HPM file:

1. Identify defective or hot pixels (refer to the sections [Finding Defective Pixels](#) and [Finding Hot Pixels](#)).

IMPORTANT: When creating a new pixel map, you need to get all defective pixel visible. Make sure that the *DefectivePixelCorrection* and *BadPixelCorrection* are set to Off in the Data Correction menu of the software GUI, so the camera does not correct the known pixel defects.

2. Locate and adjust defective pixels' coordinates (refer to the section [Locating and adding pixel coordinates](#), **STEP1 – STEP3**).
3. Place pixels' coordinates into the pixel map and save the file (refer to the section [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
```

Creating a DPM Using Imperx Toolkit

1. Set *DefectPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *BadPixelCorrection* is set to Factory.
3. Make sure that *TriggerMode* and *ExposureMode* are set to Off, and the camera resolution is set to maximum.
4. Capture an image (or series of images) 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) and Save the image(s) in RAW format.
5. In the IpxToolkit main window, navigate to the saved RAW file(s) and open it.
6. On the **Image Properties** tab:
 - Set **Setup Mode** to Manual.
 - Set **Device Type** GigE Vision.
 - Set **Width** and **Height** to the RAW image's vertical and horizontal size respectively.
 - Set Pixel Type to the Pixel Format of the RAW image.
The options are Mono8, Mono10, or Mono12 for a monochrome camera and RGB8, RGB10, or RGB12 for a color camera.
 - Click **Apply**.
7. Select **Tools > DPM/HPM Utility**.
8. On the **Dark & Bright** tab, navigate to the saved RAW file(s) and open it.
9. Move the **Dark** slider to the value that you want to be the maximum luminosity for the dark pixels.
The pixels are treated as dark if their luminosity is lower than the Dark limit.
10. Move the **Bright** slider to the value that you want to be the minimum luminosity for the bright pixels.
The pixels are treated as bright if their luminosity is higher than the Bright limit.
11. Click **Start**.
The dark and bright pixels are added to the **List of Defected Pixels** table.
The maximum number of pixels in the DMP is 1024.
12. Fill out the **Camera** and **Serial#** fields and click **Save to File**.

Creating an HPM Using Imperx Toolkit

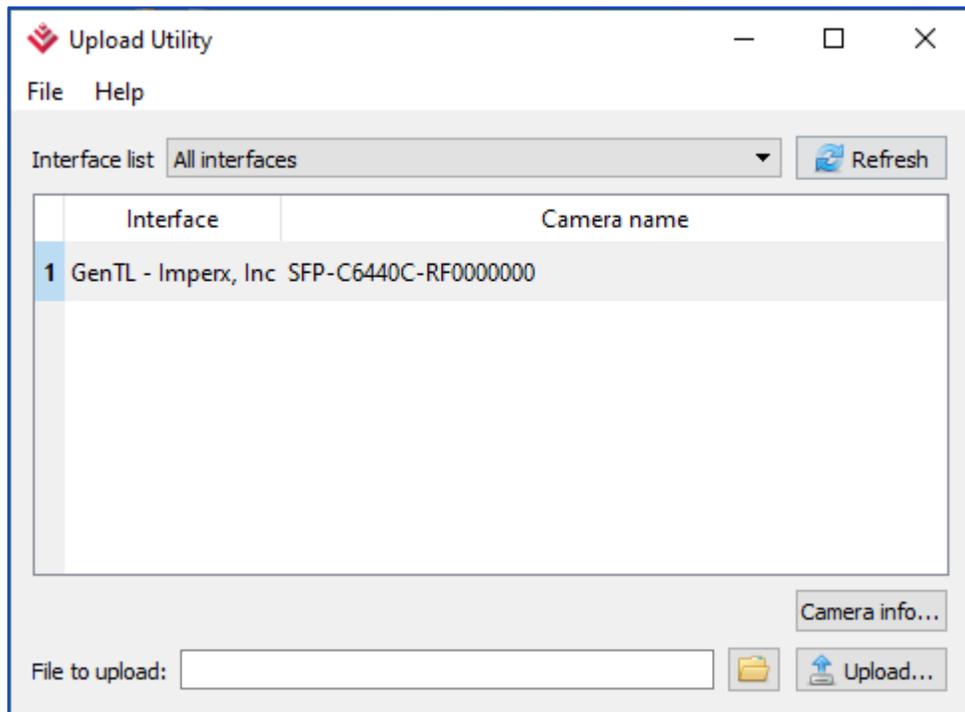
1. Set *BadPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *DefectivePixelCorrection* is set to Factory.
3. Set the longest exposure time and slowest frame rate expected.
4. Cover a lens with a lens cap or dismount the lens and put on a dust cap on the.
5. Run the camera for at least 45 minutes at ambient temperature around 18–22 °C or higher.
6. Capture an image (or series of images) and save it in RAW format.
7. In the IpxToolkit main window, navigate to the saved RAW file(s) and open it.
8. On the **Image Properties** tab:
 - Set **Setup Mode** to Manual.
 - Set **Device Type** to GigE Vision.
 - Set **Width** and **Height** to the RAW image's vertical and horizontal size respectively.
 - Set **Pixel Type** to the Pixel Format of the RAW image.
The options are Mono8, Mono10, or Mono12 for a monochrome camera and RGB8, RGB10, or RGB12 for a color camera.
 - Click **Apply**.
9. Select **Tools > DPM/HPM Utility**.
10. On the **Hot** tab, navigate to the saved RAW file(s) and open it.
11. Move the **Threshold** slider to the value that you want to be the minimum luminosity for the hot pixels.
The pixels are treated as hot if their luminosity is higher than the Threshold limit.
12. Click **Start**.
The dark and bright pixels are added to the **List of Defected Pixels** table.
The maximum number of pixels in HPM is 4096.
13. Fill out the **Camera** and **Serial#** fields and click **Save to File**.

Uploading DPM / HPM Files

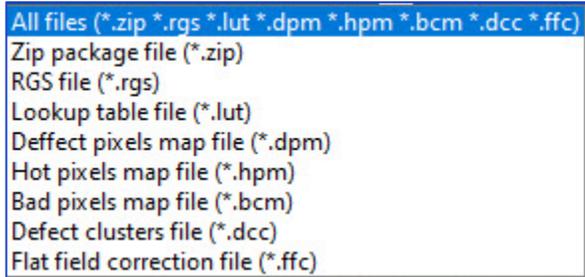
After saving the maps, you can upload them to the camera using the Imperx **Upload Utility**. The Upload Utility enables uploads of DPM, HPM, and other files to your camera.

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. If the utility does not detect the camera, click **Refresh** to restart the device collection.
3. Select the camera to update if more than one appears.



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



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. Make sure that *DefectivePixelCorrection* and *BadPixelCorrection* are set to **User** so that the camera uses the maps you loaded.
8. Retake images as described in sections [Finding Defective Pixels](#) and [Finding Hot Pixels](#) to make sure that all defective and hot pixels are now corrected.

Appendix C: Look Up Tables

Creating an LUT Using a Text Editor

You can use any ASCII text editor, such as Notepad or similar, to create a custom LUT. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, rename the file 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.

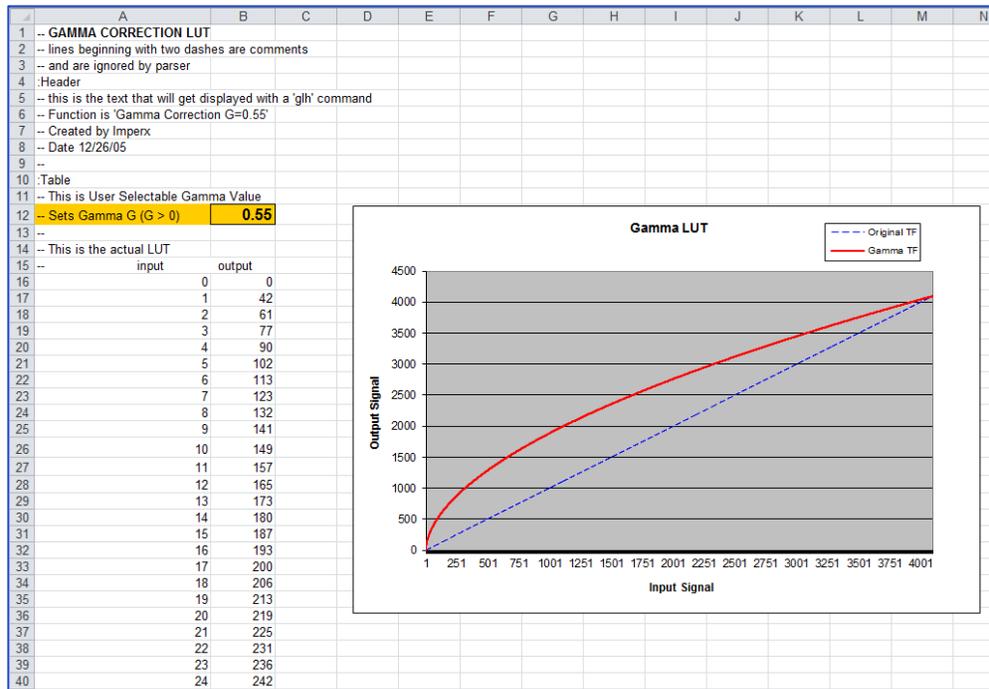
The format of the .lut file is as follows:

```
-- 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 1/14/20,  
:Table,  
-- input output,  
    0,4095  
    1,4094  
    2,4093  
    3,4092  
    4,4091  
    :  
4095,0
```

Creating an LUT Using Microsoft Excel

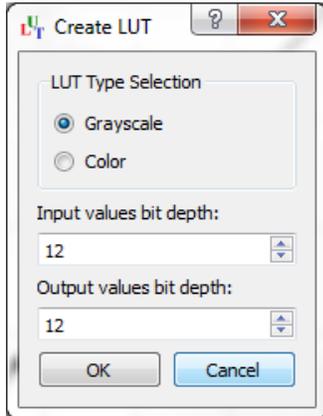
The LUT file can be created in Excel as follows:

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.



Creating an LUT Using Imperx Toolkit

1. On the Tools tab, open LUT Manager utility.
2. Create a new LUT file. On the Create LUT dialog box, select the LUT type, set the input and output bit depth to 12, and click **OK**.



3. Click **Customize** under the LUT plot.
4. Click **More**, set **Curve type** to Dots and **Formula** to User.
5. Type in a formula for the new LUT (see below).
The following operands and operations are available:

Operation	Description
+	Addition
-	Substraction
*	Multiplication
/	Division
^	Raise to the power of
cos()	Cosine function
sin()	Sine function
tan()	Tangent function
acos()	Arc-Cosine function
asin()	Arc-Sine function
atan()	Arc-Tangent function
sqrt()	Square root
ln()	Log natural
exp()	Exponent

Operator	Description
x	x-value
pi	Mathematical constant approximately 3.1415926535897932

6. For a color camera, you can set a transfer function for each channel. Use R, G, and B tabs on the left to switch between the channels.
7. To save the LUT file, go to **File > Save as....**

Example

A modified sigmoid function can be used to enhance low contrast images. The modified sigmoid function is given below:

$$F(x) = \frac{1}{1 + e^{-a(x-b)}}$$

where **x** is the input pixel value.

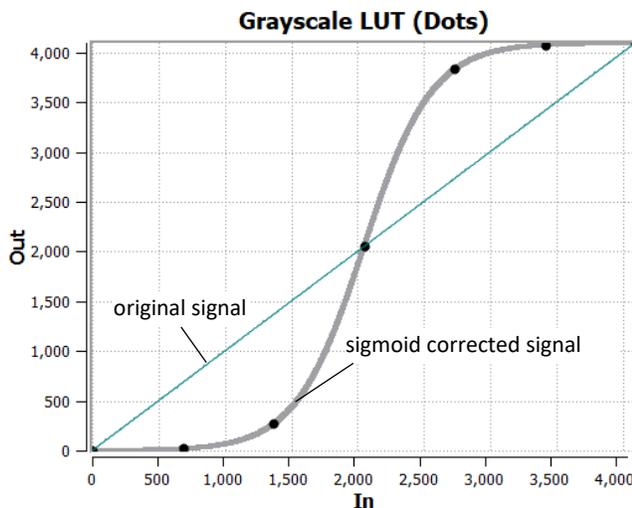
a is a contrast factor. It determines the steepness of the curve (0.5 – low gain; 10 -high gain).

b is a threshold level. It determines a sigmoid’s midpoint. A midpoint is the brightness of input pixels that is used as a reference. If the brightness of an input pixel is higher than a midpoint, the output pixel value is increased. Otherwise, the output pixel value is decreased.

In the LUT Manager window, type in the following formula under the *Formula* control (with a=4 and b=2):

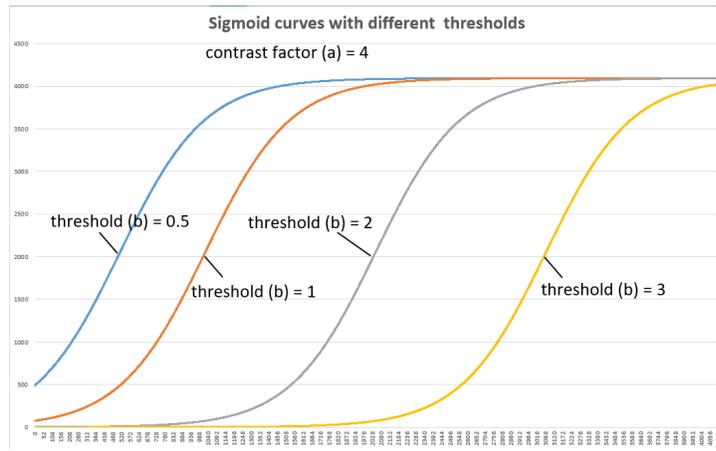
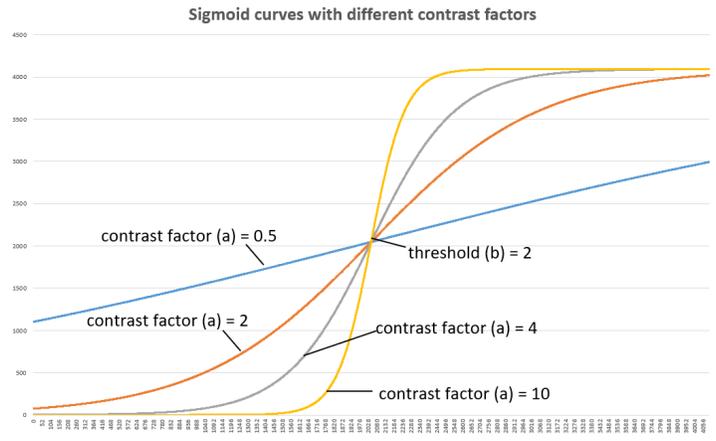
```
4095*(1/(1+(exp(-4*(x/(4095/4)-2))))))
```

The function is scaled so that the input and output pixel values are within the range from 0 to 4095 (for a 12-bit image).



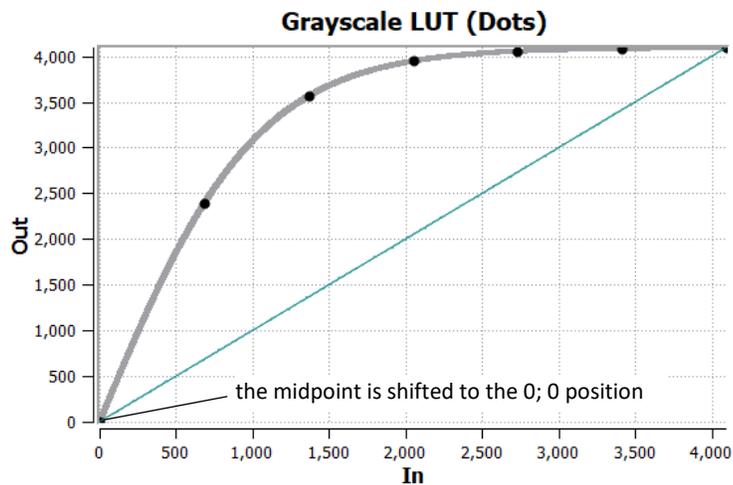
To adjust the overall brightness and contrast of the image, use both threshold and contrast factor parameters. The threshold value controls the amount of brightness, and the contrast factor controls the difference between pixels.

The sigmoid curves with varied threshold and contrast factor parameters are shown below:



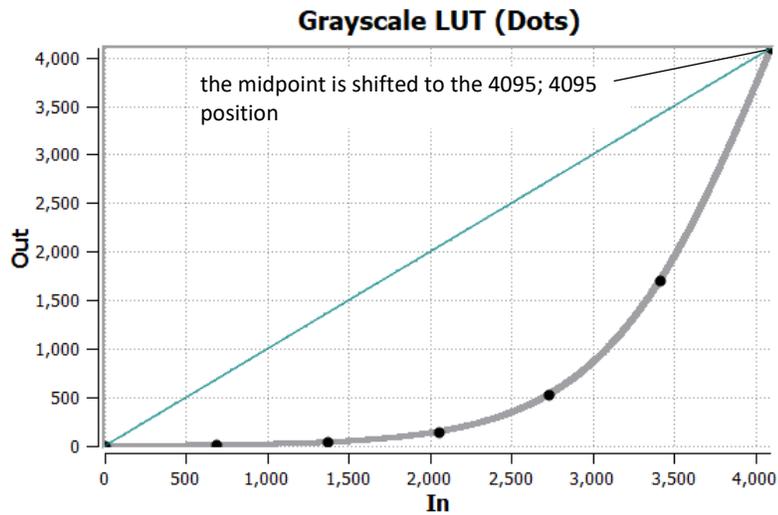
To apply a convex part of the curve within the range from 0 to 4095, use the following formula:

$$2*4095*(1/(1+(\exp(-2*(x/(4095/4))))))-0.5$$



To apply a concave part of the curve within the range from 0 to 4095, use the following formula:

$$2*4095*(1/(1+(\exp(-2*(x/(4095/4)-4))))))$$

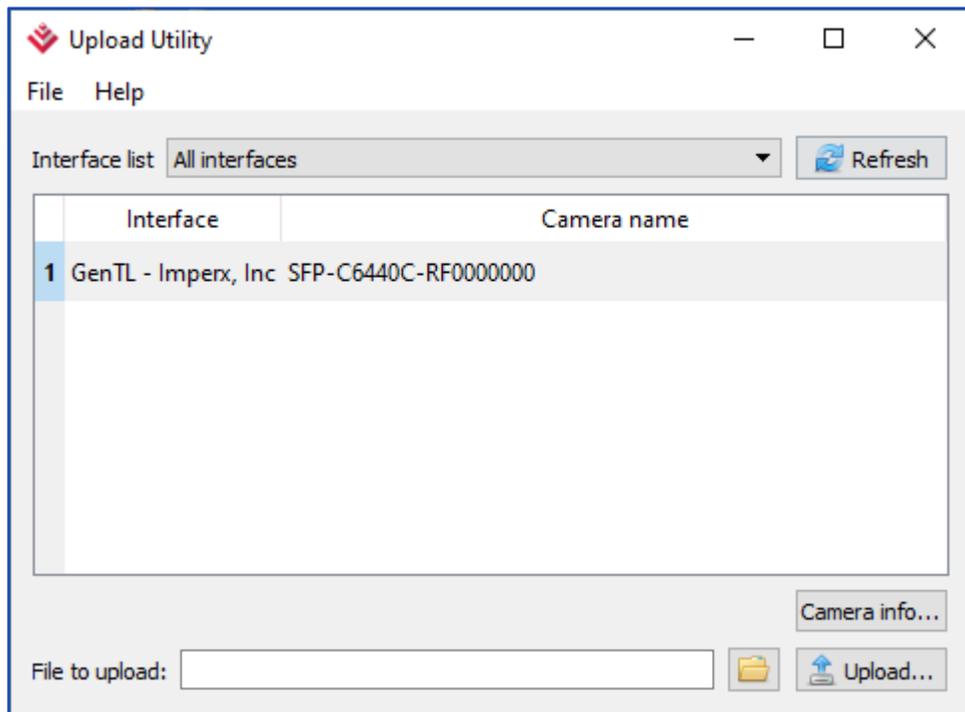


Uploading the LUT File

After saving the LUT into the .lut file, you can upload it into the camera using the Imperx **Upload Utility**.

To upload the LUT file:

1. Connect and power up your camera.
2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera. If the utility does not detect the camera, click **Refresh** to restart the device collection.
3. Select the camera to update if more than one appears.



4. Browse for the .lut file, select it, and click **Upload**.
Select to which camera's LUT (LUT1–LUT4) to upload the .lut file you created.
Wait for the upload to finish.
5. After the upload is completed, do power cycle the camera.
6. After the camera re-starts, start the software GUI and select **Data Correction**.
7. Set *LUTEnable* to the LUT you uploaded.
The camera then uses the LUT you uploaded.

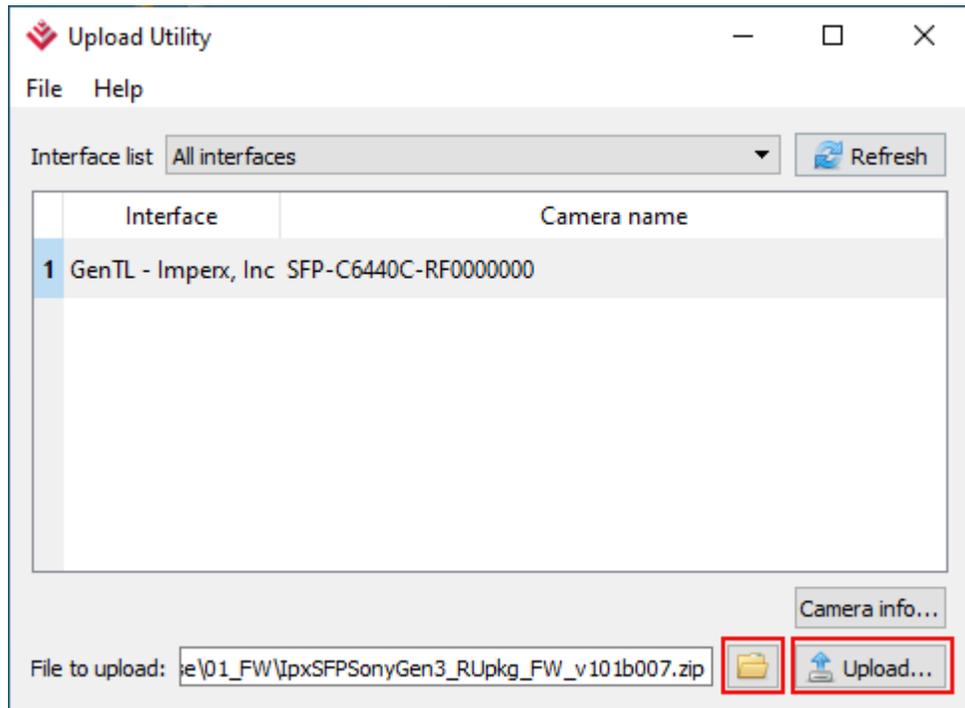
Appendix D: Updating Camera’s Firmware Using Upload Utility

Imperx provides a firmware update package upon request. The firmware update package is a .zip archive that contains following files:

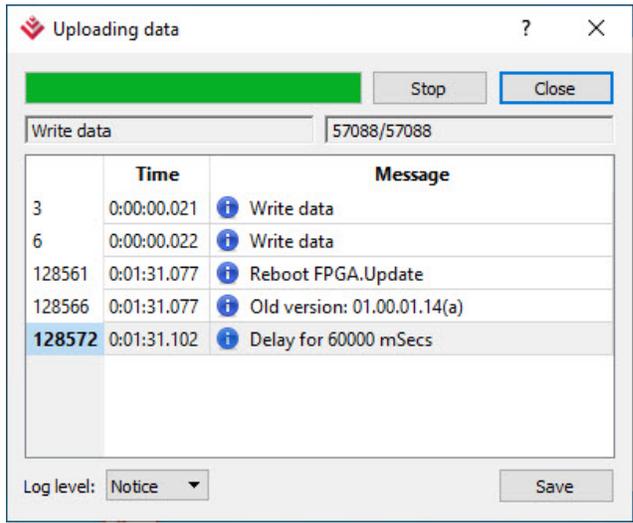
- .spi – application image for the camera’s FPGA
- .bin – application image for the camera’s RISC-V processor
- .txt – instructions for the Imperx Upload Utility

To update the camera’s firmware, follow the steps below:

1. Connect the camera to an external power supply (6 V–30 V) and turn on the power supply.
2. Start the Imperx Upload Utility and wait for the Upload Utility to detect the camera. If the utility does not detect the camera, click **Refresh** to restart the device collection
3. Select the camera, click , browse to a firmware update .zip archive, select it, and click **Upload**.



The data upload takes 1.5 minutes.



- Click **Close** when the data upload is finished and close the Upload Utility.

