ximea

xiX-64
[ksi-xː] or [sai-exː]

● High-Speed cameras with PCIe Gen 3

Introduction

About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

We hope that this manual can answer your questions, but should you have any further queries or if you wish to claim a service or warranty case, please contact your local dealer or refer to XIMEA Support on our website: www.ximea.com/support

The purpose of this document is to provide a description of XIMEA Cameras and to describe the correct way to install related software, drivers and run it successfully. Please read this manual thoroughly before operating your new XIMEA Cameras for the first time. Please follow all instructions and observe the warnings.

This document is subject to change without notice.

About XIMEA

XIMEA is one of the worldwide leaders for innovative camera solutions with a 30-year history of research, development and production of digital image acquisition systems. Based in Slovakia, Germany and the US, with a global distributor network, XIMEA offers their cameras worldwide. In close collaboration with customers XIMEA has developed a broad spectrum of technologies and cutting-edge, highly competitive products.

XIMEA's camera centric technology portfolio comprises a broad spectrum of digital technologies, from data interfaces such as USB 2.0, USB 3.1 and PCIe to cooled digital cameras with CCD, CMOS and sCMOS sensors, as well as X-ray cameras.

XIMEA has three divisions – generic machine vision and integrated vision systems, scientific imaging and OEM/custom.

Our broad portfolio of cameras includes thermally stabilized astronomy and x-ray cameras, as well as specialty cameras for medical applications, research, surveillance and defense.

Contact XIMEA

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Standard conformity

Camera Sub-Assemblies

The "semi" housed camera models do not comply with CE/FCC/Class A limits (Canada) regulations. The system integrator (customer) is liable for compliance with CE/FCC/ Class A limits (Canada) regulations.

This text applies to
all models in this manual (refer to the table Models and sensors overview)

RoHS conformity

Figure 1: Standard conformity RoHS logo

The products described in this technical manual comply with the RoHS-3 (Restriction of Hazardous Substances) Directive 2015/863/EU.

WEEE conformity

Figure 2: Standard conformity WEEE logo

The products described in this technical manual comply with the WEEE (Waste Electrical and Electronic Equipment) Directive 2012/19/EU.

GenICam GenTL API

The GenICam/GenTL standard offers a device-agnostic interface for the acquisition of images and other data types, as well as for communication with devices. This enables each XIMEA camera to function as a GenTL Producer, facilitating the capture of images through a standardized transport layer interface.

Disclaimer

This document and the technical data contained herein are for descriptive purposes only and not binding. They are not to be construed as warranted characteristics or guarantees of properties, quality or durability in the legal sense. Specifications are subject to change without notice. The information contained in this document is provided "as is" without warranty of any kind.

Helpful links

XIMEA Homepage	http://www.ximea.com/
XIMEA Support	https://www.ximea.com/support/wiki/allprod/Contact_Support
Frequently Asked Questions	http://www.ximea.com/support/wiki/allprod/Frequently_Asked_Questions
Knowledge Base	http://www.ximea.com/support/wiki/allprod/Knowledge_Base
XIMEA Software Package	https://www.ximea.com/support/wiki/apis/APIs#Software-packages
Vision Libraries	http://www.ximea.com/support/projects/vision-libraries/wiki
XIMEA General Terms & Conditions	http://www.ximea.com/en/corporate/generaltc

Contents

1 xiX camera series

1.1 What is xiX

xiX is an ultra-compact PCI express industrial camera family with outstanding features:

- Extremely small footprint

- Sensors: Nearly every sensor installed into any XIMEA camera is also available in the xiX line, which provides a higher bandwidth connection to support the full speed potential for every sensor. Resolutions from 26.2 Mpx to 65.4 Mpx are utilized from every sensor manufacturer we do business with.

The impetus behind the xiX family is having the option to utilize multiple cabling systems to transmit data, power and trigger signals. This is ideal for embedded and high-density applications. Most standard connectors - like iPass, USB and Type-C - are much bigger than the high-density connectors utilized in the xiX lines.

PCIe x8 Gen3 cameras (70 × 60 mm) featuring either an active Canon EF-mount or C-mount lens adapter.

1.2 Advantages

Industry standard interface	PCI Express
Small	perfect size and customization options for Embedded vision system applications
Fast	high speed, high frame rate
Robust	full metal "semi-housed"
Connectivity	programmable opto-isolated I/O, and non-isolated digital input and output, 4 status LEDs
Compatibility	support for Windows, Linux and MacOS, various Image Processing Libraries
Software interfaces	GenICam / GenTL and highly optimized xiAPI SDK
Economical	excellent value and price, low TCO and fast ROI
Low latency	minimum latency and CPU load

1.3 Camera applications

- Automation
- High speed inspection
- Ultra-fast 3D scanning
- Material and Life science microscopy
- Ophthalmology and Retinal imaging
- Broadcasting
- Fast process capture, e.g. golf club swings
- Aerial Imaging
- Miniature and fast robotic arms
- Mobile devices
- In-situ optical inspection camera
- Ophthalmology and retinal imaging
- Intelligent Transportations Systems (ITS) and traffic monitoring
- VR and AR
- Cinematography
- Sports
- Unmanned and autonomous vehicles
- UAV / Droness

1.4 Common features

Sensor Technology	CMOS, Global shutter
Acquisition Modes	continuous, software and hardware trigger, fps limiting, triggered exposure and burst
Partial Image Readout	ROI, Skipping and Binning modes supported (model specific)
Color image processing	host based de-bayering, sharpening, gamma, color matrix, true color CMS
Hot/blemish pixels correction	on camera storage of up to 5000 px coordinates, host assisted correction
Auto adjustments	auto white balance, auto gain, auto exposure
Flat field corrections	host assisted pixel level shading and lens corrections
Image Data and Control Interface	Ribbon cable and breakout board options for various cabling options such as fiber optic or iPass
General Purpose I/O	2x opto-isolated input, 2x opto-isolated output, and 4 nonisolated bidirectional I/O, 4X user configurable LEDs
Signal conditioning	programmable debouncing time
Synchronization	hardware trigger input, software trigger, exposure strobe output, busy output
Housing and lens mount	C-mount, and Canon EF mount, customizations available
Power requirements	typically, external power supply required of 12 to 24 V DC
Environment	operating 0 to 50 °C on housing, RH 80 % non-condensing, −25 to 60 °C storage
Operating systems	Windows, Linux Ubuntu, MacOS
Software support	xiAPI SDK, adapters and drivers for various image processing packages
Firmware updates	Firmware can be updated in the field, and is free of charge

1.5 What is xSWITCH?

Utilizing PCIe as a camera interface offers unique camera aggregation options, at extremely high bandwidths: multiple cameras can be efficiently connected and their respective data streams bundled into a single copper or fiber optic cable connection to a host computer, writing directly to memory (DMA) at 64 Gbit/s. Flat-flex cables between the cameras and the xSWITCH allow the most compact integration in tight spaces.

Figure 3: Example of aggregation of many camera in to one cable
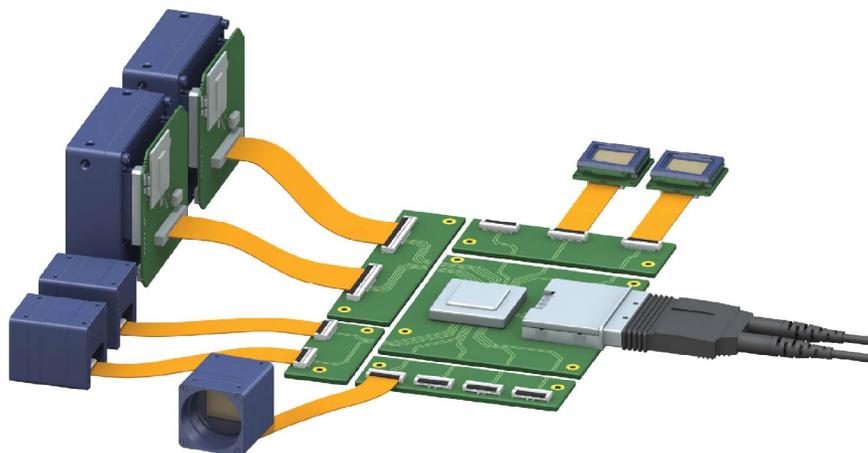
PCIe allows multi camera assembly in to one cable stream with other end connected to expansion slot in host computer. It is possible to chain several PCIe switches to create optimal infrastructure. Together with the cameras it is also possible to populate PCIe switch downstream ports with other controllers, like USB 3.0, UART, etc.
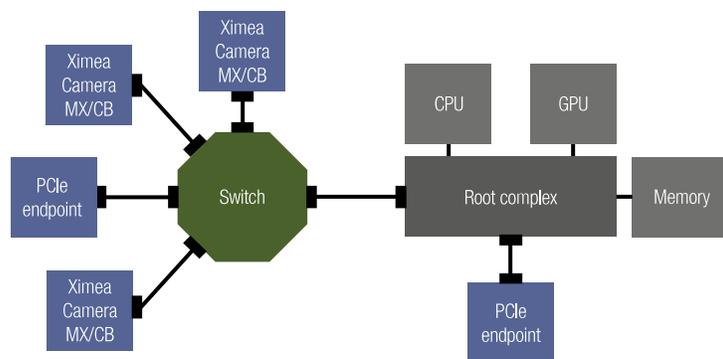
Figure 4: PCI express topology

Highlights

- Maximum compactness: smallest form factor cameras and mini connectors allow closest sensor-to-sensor proximity

- Aggregation into one high bandwidth upstream (up to 64Gbit/s)

- Full utilization of PCIe architecture with point-to-point connection and direct memory access

- Use of standard components allows simple assembly for the creation of a custom platform

- No need for external or additional expansion backplanes

- Multiple example types of xSWITCH board are already designed

- Shape of the board can be tailored precisely to application requirements

- Benefit from XIMEA´s unique experience and expertise in the field of PCIe

Mix and match

- Connect multiple various camera models and types of cameras to a single computer

- Select from wide range of sensor resolutions and frame rates

- Combine housed and board level camera types

- Choice of different number of PCIe lanes and PCIe standards (2, 4, 8 lanes / Gen2 or Gen3)

- Choice of various connectors: flat-flex option, board to board or iPass

- Choose between flat-flex connectors with vertical or horizontal orientation

- Bridge small or large distances of >100 m by selecting copper cable or optical fiber cable

1.5.1 xSWITCH examples

Several standard switches are available for embedded design.

Downstream 4x PCIe x2 Gen2 10Gb/s
Upstream 1x PCIe x4 Gen3 32Gb/s

Downstream 6x PCIe x4 Gen2 20Gb/s
4x PCIe x2 Gen2 10Gb/s
4x USB 3.1 Gen1 5Gb/s (USB A)
4x USB 3.1 Gen1 5Gb/s (FLEX)
Upstream 1x PCIe x8 Gen3 64Gb/s

Downstream 12x PCIe x2 Gen2 10Gb/s
4x USB 3.1 Gen1 5Gb/s (USB A)
4x USB 3.1 Gen1 5Gb/s (FLEX)
Upstream 1x PCIe x8 Gen3 64Gb/s
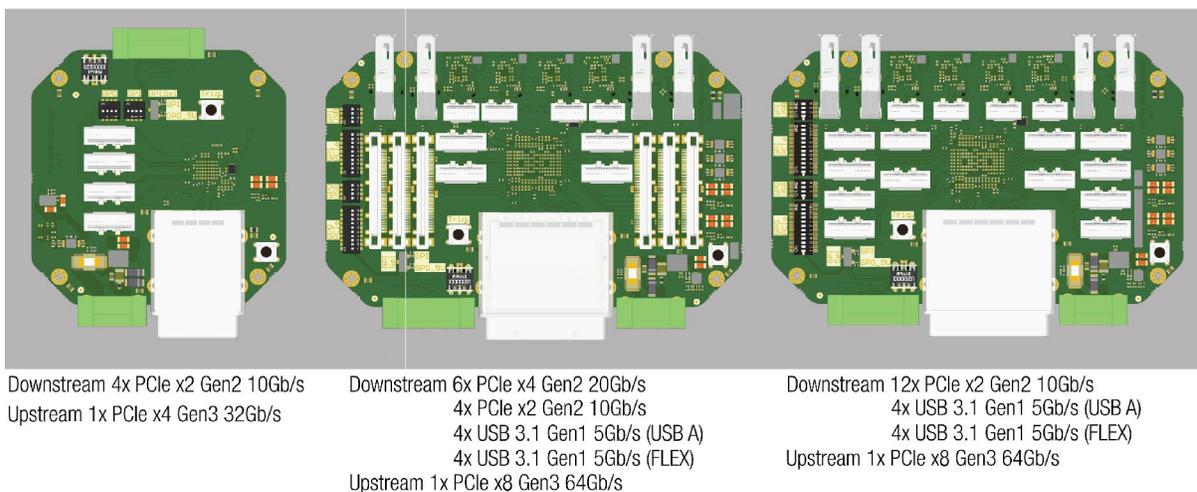
Figure 5: Variations of standard switches for embedded vision systems

XIMEA also provides a PCB design where quantity, type, location and orientation of PCIe connectors can be varied to optimize the building of multi-camera systems. Multiple variations of these PCB designs already exist based on the concept of empowering rapid customization of the final assembly and thus enabling most daring of customer applications.
For more information please contact our sales: info@ximea.com

Downstream 8x x2 Gen2 10Gb/s
Upstream 1x x8 Gen3 64Gb/s

Downstream 27x x2 Gen2 10Gb/s
Upstream 1x x8 Gen3 64Gb/s

Downstream 2x x8 Gen3 64Gb/s
2x x4 Gen3 32Gb/s
5x USB3.0 5Gb/s
Upstream 1x x8 Gen3 64Gb/s
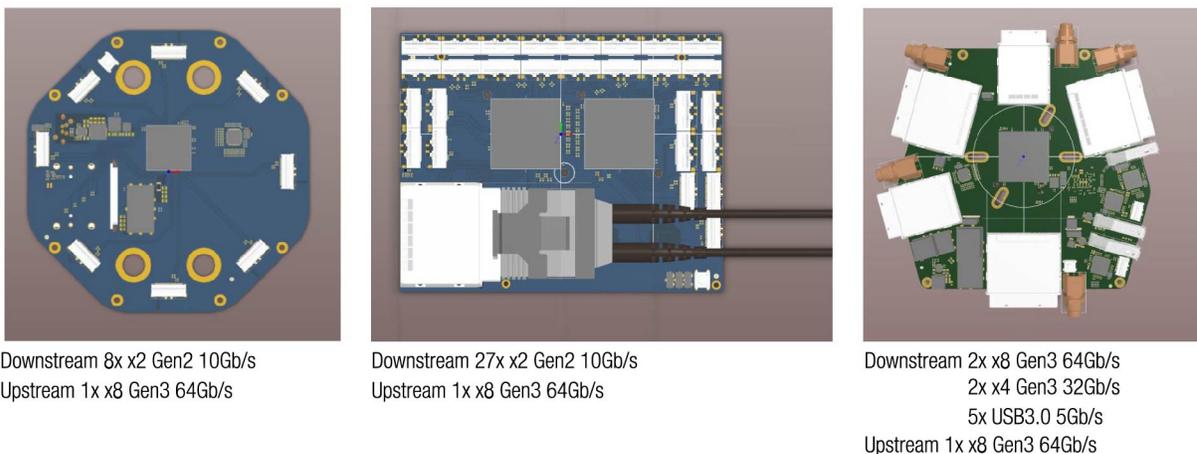
Figure 6: Variations of switches for embedded vision systems

1.6 Model nomenclature

xiX family	MXxxxyG-zz-XaGb[-OPT]

MX:	xiX family name

xxx:	resolution in 0.1 Mpx. e.g. 1.3 Mpx Resolution: xxx = 013

y:	Color sensing
y = C:	color model
y = M:	black & white model
y = R:	IR extended

G:	global shutter

zz:	Vendor of the sensor
zz = GP:	GPixel

XaGb:	
a = 8	Number of PCIe lanes used
b = 3	PCIe generation

[-OPT]:	Connector options
OPT = FF:	FireFly variant, compact FireFly connectors, semi-housed

1.7 Models and sensors overview

Camera model	Sensor model	Sensor type	Filter	Resolution [px]	Pixel size [μm]
MX262CG-GP-X8G3-FF	GPixel GMAX0505	Color	BayerGB	5120 × 5120	2.5
MX262MG-GP-X8G3-FF	GPixel GMAX0505	Monochrome	None	5120 × 5120	2.5
MX262RG-GP-X8G3-FF	GPixel GMAX0505 Red Fox	Monochrome-NIR	None	5120 × 5120	2.5
MX654CG-GP-X8G3-FF	GPixel GMAX3265	Color	BayerGB	9344 × 7000	3.2
MX654MG-GP-X8G3-FF	GPixel GMAX3265	Monochrome	None	9344 × 7000	3.2

Table 1: List of camera models and their respective sensor models and filters

1.8 Accessories overview

The following accessories are available:

Item P/N	Description
CBL-PB4-PWR-0M15	Power cable with barrel connector 15 cm long
CBL-PB6-IO-0M10	IO pig tail cable 10cm long
CBL-ECUE-X4G3-1M0	1 m FIREFLY™ cable for PCIe Gen 3 x8 (-FF)
CBL-ECUE-X4G3-2M0	2 m FIREFLY™ cable for PCIe Gen 3 x8 (-FF)
CBL-ECUE-X4G3-3M0	3 m FIREFLY™ cable for PCIe (-FF)
MECH-60MM-EF-ADAPTER-KIT[1]	Canon EF Lens Mount Adapter Kit
MECH-60MM-BRACKET-T-KIT	MECH Tripod Bracket 60mm with Screws Kit
CB-X8G3-WAT-COOLER-KIT	Heatsink Water Cooler for X8G3 cameras with screws Kit
CB-X8G3-FAN-COOLER-KIT	Heatsink Fan Cooler for X8G3 cameras with screws Kit
ADPT-MX-X8G3-FF-X8G3-MTP	MTP Adapter for MX-X8G3-FF camera
ADPT-MX-X8G3-FF-X8G3-SFF	SFF Adapter for MX-X8G3-FF
ADPT-1/2/4P-X4G3-FF-X4/8G3-MTP	PCIe Adapter FireFly to MTP

[1]This kit is sold separately, however it is possible to order assembling during production. These assemblies are sold separately. Additional assemblies purchased along with a camera can be added to the order at time of purchase for assembly with camera head.

Table 2: List of accessories available for xiX cameras

Item	P/N
A-MECH-60MM-EF-ADAPTER-KIT[1]	Assembly Service for MECH-60MM-EF-ADAPTER-KIT
A-CB-X8G3-FAN-COOLER-KIT	Assembly Service for CB-X8G3-FAN-COOLER-KIT

[1]Available only for 60 mm larger sized models.

Table 3: Assembly options

1.9 Camera connection diagram

The diagram below shows the basic relationships between cameras and accessories based on their connectors and features. For detailed information about the products shown, visit our webpage, where the diagram includes reference links to the individual product pages:
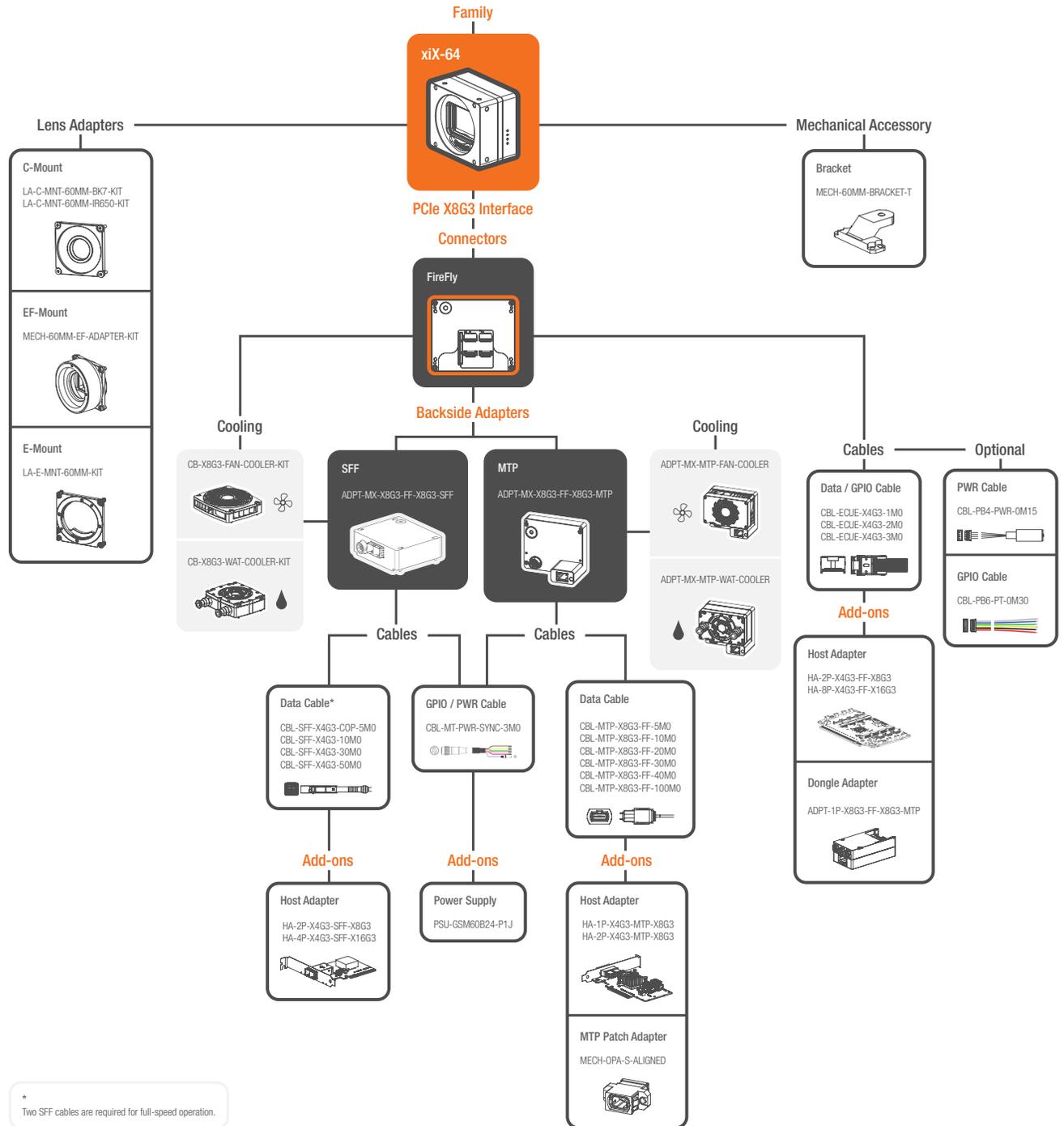
XIMEA diagram

Family

xiX-64

Lens Adapters

Mechanical Accessory

C-Mount
LA-C-MNT-60MM-BK7-KIT
LA-C-MNT-60MM-IR650-KIT

Bracket
MECH-60MM-BRACKET-T

EF-Mount
MECH-60MM-EF-ADAPTER-KIT

E-Mount
LA-E-MNT-60MM-KIT

PCIe X8G3 Interface

Connectors

FireFly

Cooling

Backside Adapters

Cooling

Cables

Optional

CB-X8G3-FAN-COOLER-KIT

SFF
ADPT-MX-X8G3-FF-X8G3-SFF

MTP
ADPT-MX-X8G3-FF-X8G3-MTP

ADPT-MX-MTP-FAN-COOLER

Data / GPIO Cable
CBL-ECUE-X4G3-1M0
CBL-ECUE-X4G3-2M0
CBL-ECUE-X4G3-3M0

PWR Cable
CBL-PB4-PWR-0M15

CB-X8G3-WAT-COOLER-KIT

ADPT-MX-MTP-WAT-COOLER

GPIO Cable
CBL-PB6-PT-0M30

Add-ons

Host Adapter
HA-2P-X4G3-FF-X8G3
HA-8P-X4G3-FF-X16G3

Cables

Cables

Data Cable*
CBL-SFF-X4G3-COP-5M0
CBL-SFF-X4G3-10M0
CBL-SFF-X4G3-30M0
CBL-SFF-X4G3-50M0

GPIO / PWR Cable
CBL-MT-PWR-SYNC-3M0

Data Cable
CBL-MTP-X8G3-FF-5M0
CBL-MTP-X8G3-FF-10M0
CBL-MTP-X8G3-FF-20M0
CBL-MTP-X8G3-FF-30M0
CBL-MTP-X8G3-FF-40M0
CBL-MTP-X8G3-FF-100M0

Dongle Adapter
ADPT-1P-X8G3-FF-X8G3-MTP

Add-ons

Add-ons

Add-ons

Host Adapter
HA-2P-X4G3-SFF-X8G3
HA-4P-X4G3-SFF-X16G3

Power Supply
PSU-GSM60B24-P1J

Host Adapter
HA-1P-X4G3-MTP-X8G3
HA-2P-X4G3-MTP-X8G3

MTP Patch Adapter
MECH-OPA-S-ALIGNED

*
Two SFF cables are required for full-speed operation.

Figure 7: Diagram of accessories and specific connections for the xiX-64 camera family

2 Hardware specification

2.1 Power supply

The power consumption table can consist of several values:

Supply voltage: Voltage used for measuring the power consumption.

Idle: The average power consumption when the camera is powered, but not opened/initialized in software.

Typical: The average power consumption during streaming in the most power-intensive mode, (typically the one with the highest frame rate).

Maximum: The highest power consumption peak recorded during streaming in the most power-intensive mode, (measured using a current probe).

Power consumption of:

MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
24 V	12.8 W	13.6 W	14 W

[1]Supported voltage 12 - 24 V

Table 4: Power consumption of the specific models

Power consumption of:

MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
24 V	15.4 W	16.7 W	17.3 W

[1]Supported voltage 12 - 24 V

Table 5: Power consumption of the specific models

2.1.1 Power input

Depending on the accessories used, cameras with a FireFly interface can be powered either through their respective sync cable or the FireFly connector. The xiX cameras with a flex interface are powered via a flex cable from an external power supply of 12 to 24 V, with power consumption up to a maximum of 10 W (excluding the power needed for the lens). See section Camera interface.

The flex and FireFly interface cables for the cameras are equipped with a locking mechanism. When locked, pulling the cable may damage the connector or the camera. All cables must be connected while the system power is off. After powering the camera or recycling the power, the host system must be turned on or restarted.

2.2 General specification

2.2.1 Environment

Description	Symbol	Value
Optimal ambient temperature operation	T_{opt}	10 to 25 °C
Ambient temperature operation	T_{max}	0 to 50 °C
Ambient temperature for storage and transportation	$T_{storage}$	−25 to 60 °C
Relative Humidity, non-condensing	RH	80 %

Table 6: Environment

Housing temperature must not exceed 65 °C.

Note: The following parameters are not guaranteed if the cameras are operated outside the optimum range:

- Dark current
- Dynamic Range
- Linearity
- Acquisition
- Readout noise
- S/N ratio
- Durability

2.3 Lens mount

2.3.1 C-mount
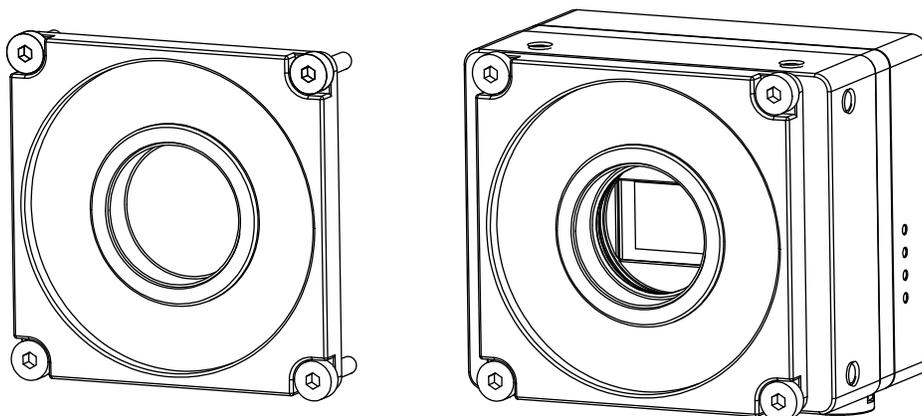
Figure 8: Lens mount adapter C-Mount 60mm (left) , camera with adapter (right)

Camera models, featuring a 4/3" or smaller sensor format, are compatible with a C-mount lens adapter, which is securely fastened in the front mount holes using four M4 screws. For further details, please refer to section LA-C-MNT-60MM-xxx-KIT.

The mentioned lens adapter can optionally be included in:
all models in this manual (refer to the table Models and sensors overview)

2.3.2 EF-mount
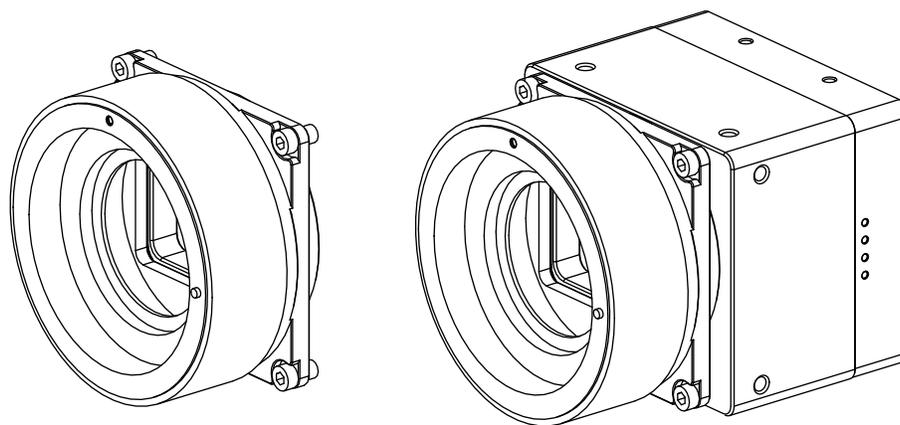
Figure 9: Lens mount adapter EF-mount (left) , camera with adapter (right)

The cameras are optionally delivered with or without an outer EF-Mount Adapter. This adapter, when active, enables remote control over aperture, focus, and image stabilization, and is securely mounted to the camera using four M4x6 screws. The distance between the outer EF-Mount Adapter and the active sensor surface is 44 mm, and when no EF-Mount Adapter is included, it is 13.78 mm. Refer to MECH-60MM-EF-ADAPTER for more information.

The mentioned lens adapter can be optionaly included in:
all models in this manual (refer to the table Models and sensors overview)

2.4 Mounting points

The mounting points available to the customer are shown below. Use only the designated threaded holes for mounting the camera. Utilize only the specified screws and torques when fastening.

Specific mounting information can be found in the dimensional drawings of the camera models located in section Dimensional drawings.
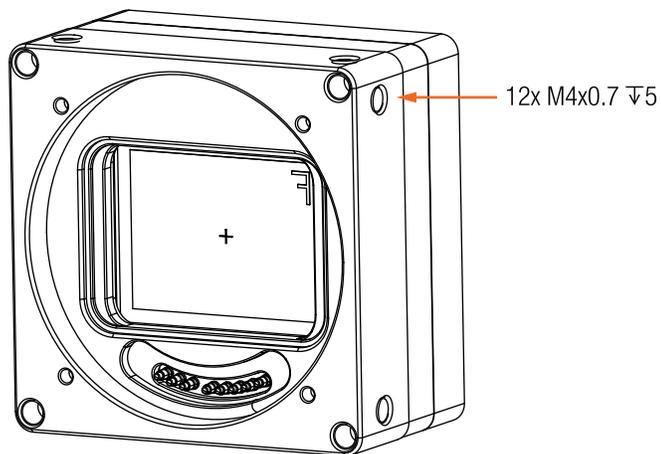

12x M4x0.7 ⍌5

Figure 10: xiX-X4G2/X8G3 camera mounting points

2.5 Optical path

The optical path in cameras defines the course traversed by light from the observed object to the image captured by the sensor. It involves complex interactions with components (e.g. lenses).

The flange focal distance (FFD) or optical distance is the distance between a lens's mounting flange and a camera's sensor plane. In standard setups, it assumes that only air fills the space between the lens and the sensor. However, the introduction of additional elements like windows or filters can alter the focal plane through refraction, requiring an adjusted FFD for proper alignment.

The presence or absence of a filter or sensor window in the camera depends on the camera model. The distance from the flange to the sensor is designed (refer to the camera cross-section image below for visual information).

Do not use compressed air to clean the camera as this could push dust particles into the camera or potentially cause damage (e.g.scratches).

Note: The general tolerance of the mechanical distance from the top of the sensor to the front part of the camera is +/- 0.15 mm.

Cross-section corresponding to:

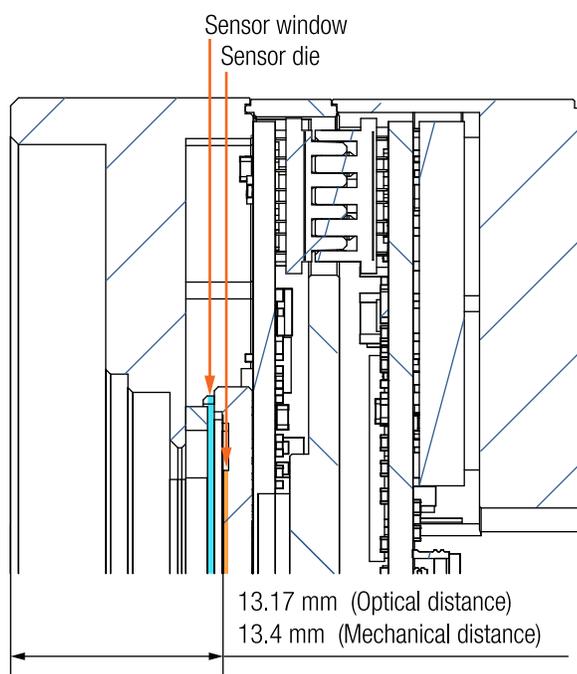MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF

Sensor window
Sensor die

13.17 mm (Optical distance)
13.4 mm (Mechanical distance)

Figure 11: Cross section of MX262xG-GP-X8G3-FF camera models

Sensor window	Value
Thickness	0.7 mm (+/- 0.05 mm)

Table 7: Sensor window details

Cross-section corresponding to:

MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF
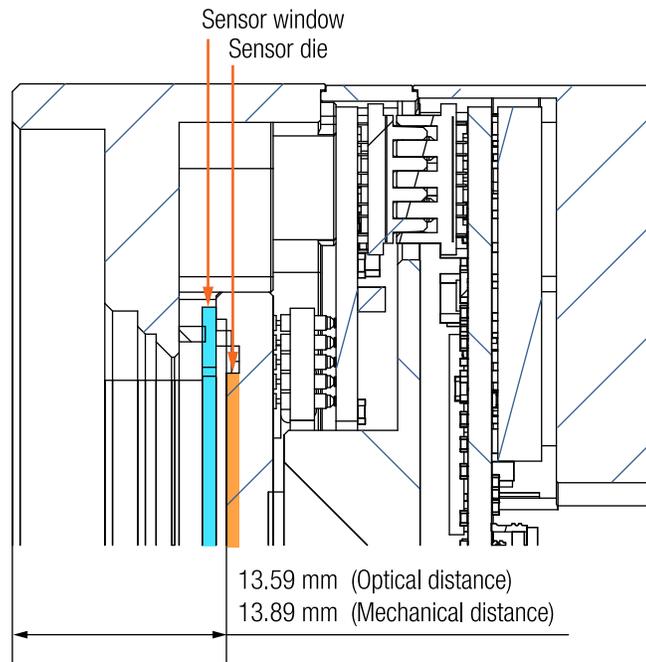
Sensor window
Sensor die

13.59 mm (Optical distance)
13.89 mm (Mechanical distance)

Figure 12: Cross section of MX654xG-GP-X8G3-FF camera models

Sensor window	Value
Thickness	0.90 mm (+/- 0.345 mm)

Table 8: Sensor window details

The following text applies to:
all models in this manual (refer to the table Models and sensors overview)

Ximea does not add any filter window. All windows are provided by the sensor vendor.

2.6 Sensor and camera characteristics

2.6.1 Sensor and camera parameters

Sensor parameters of:
MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	5120 x 5120	[px]
Active area size (H X V)	12.8 x 12.8	[mm]
Sensor diagonal	18.1	[mm]
Pixel size (H x V)	2.5 x 2.5	[µm]

Table 9: Sensor parameters of the specific models

Sensor parameters of:
MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	9344 x 7000	[px]
Active area size (H X V)	29.9 x 22.4	[mm]
Sensor diagonal	37.4	[mm]
Pixel size (H x V)	3.2 x 3.2	[µm]

Table 10: Sensor parameters of the specific models

2.6.2 Image quality parameters

The image quality parameters listed below represent typical values for these camera models.
Minor variations may occur between different units of the same model.

Image quality parameters of:
MX262CG-GP-X8G3-FF

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	2.72
Absolute sensitivity threshold	[e_-]	3.22
Saturation capacity	[ke_-]	4.68
Dynamic range	[dB]	63.24
MAX Signal-to-noise ratio	[dB]	35.89
Overall system gain	[e_-/DN]	1.21
Dark current	[e_-/s]	3.42
Dark current meas. temp.	[°C]	40.7
DSNU	[e_-]	0.89
PRNU	[%]	1.0
Linearity error	[%]	0.54

Table 11: Image quality parameters of the specific models

Image quality parameters of:
MX262MG-GP-X8G3-FF

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	2.68
Absolute sensitivity threshold	[e_-]	3.18
Saturation capacity	[ke_-]	4.51
Dynamic range	[dB]	63.01
MAX Signal-to-noise ratio	[dB]	35.6
Overall system gain	[e_-/DN]	1.19
Dark current	[e_-/s]	7.25
Dark current meas. temp.	[°C]	45.7
DSNU	[e_-]	1.07
PRNU	[%]	1.11
Linearity error	[%]	0.32

Table 12: Image quality parameters of the specific models

Image quality parameters of:
MX262RG-GP-X8G3-FF

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	2.65
Absolute sensitivity threshold	[e_-]	3.15
Saturation capacity	[ke_-]	4.57
Dynamic range	[dB]	63.25
MAX Signal-to-noise ratio	[dB]	35.64
Overall system gain	[e_-/DN]	1.2
Dark current	[e_-/s]	5.34
Dark current meas. temp.	[°C]	40.7
DSNU	[e_-]	0.97
PRNU	[%]	0.98
Linearity error	[%]	0.46

Table 13: Image quality parameters of the specific models

Image quality parameters of:
MX654CG-GP-X8G3-FF

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	5.47
Absolute sensitivity threshold	[e_-]	5.97
Saturation capacity	[ke_-]	10.52
Dynamic range	[dB]	64.91
MAX Signal-to-noise ratio	[dB]	40.34
Overall system gain	[e_-/DN]	2.75
Dark current	[e_-/s]	6.91
Dark current meas. temp.	[°C]	41.1
DSNU	[e_-]	3.29
PRNU	[%]	1.2
Linearity error	[%]	1.41

Table 14: Image quality parameters of the specific models

Image quality parameters of:
MX654MG-GP-X8G3-FF

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	5.36
Absolute sensitivity threshold	[e_-]	5.86
Saturation capacity	[ke_-]	9.92
Dynamic range	[dB]	64.31
MAX Signal-to-noise ratio	[dB]	40.1
Overall system gain	[e_-/DN]	2.73
Dark current	[e_-/s]	7.0
Dark current meas. temp.	[°C]	40.6
DSNU	[e_-]	3.2
PRNU	[%]	0.78
Linearity error	[%]	1.42

Table 15: Image quality parameters of the specific models

2.6.3 Sensor read-out modes

Note: Since the minimum and maximum exposure times depend on the sensor read-out mode used, we recommend checking the exposure range in the Camera Model Frame Rate Calculator of the specific model.

Sensor Read-out modes of:

MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Frame rate[1]
1 x 1	10	5120 x 5120	8	150.3
Dec.1 x 2	10	5120 x 2560	8	298.8
Dec.1 x 4	10	5120 x 1280	8	590.5
1 x 1	10	5120 x 5120	10	150.3
Dec.1 x 2	10	5120 x 2560	10	298.8
Dec.1 x 4	10	5120 x 1280	10	590.5
1 x 1	12	5120 x 5120	12	41.8
Dec.1 x 2	12	5120 x 2560	12	83.4
Dec.1 x 4	12	5120 x 1280	12	165.6

[1]Frame rate was measured using the transport format at bandwidth limit 7000.0 MB/s

Table 16: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Frame rate[1]
1 x 1	10	9344 x 7000	8	71.1
Dec.1 x 2	10	9344 x 3500	8	141.6
Dec.1 x 4	10	9344 x 1750	8	280.9
1 x 1	10	9344 x 7000	10	71.1
Dec.1 x 2	10	9344 x 3500	10	141.6
Dec.1 x 4	10	9344 x 1750	10	280.9
1 x 1	12	9344 x 7000	12	31.6
Dec.1 x 2	12	9344 x 3500	12	62.9
Dec.1 x 4	12	9344 x 1750	12	124.7

[1]Frame rate was measured using the transport format at bandwidth limit 7000.0 MB/s

Table 17: Sensor read-out modes of the specific models

2.6.4 Quantum efficiency curves

Quantum efficiency curves for:

MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF
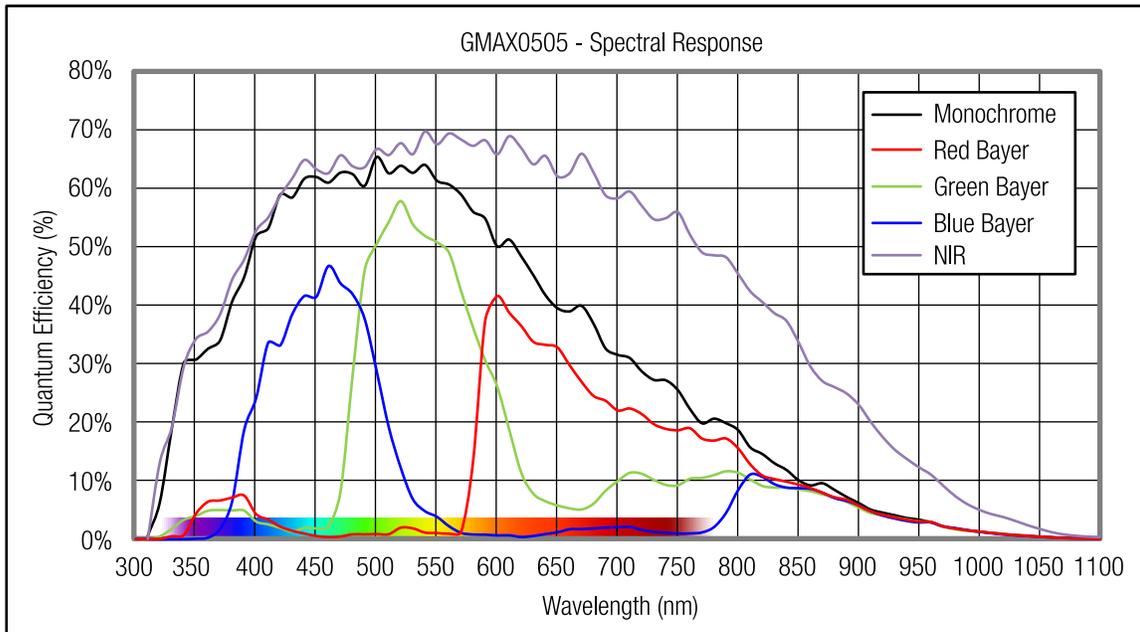
Figure 13: Graph quantum efficiency of GPixel GMAX0505

Quantum efficiency curves for:

MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF
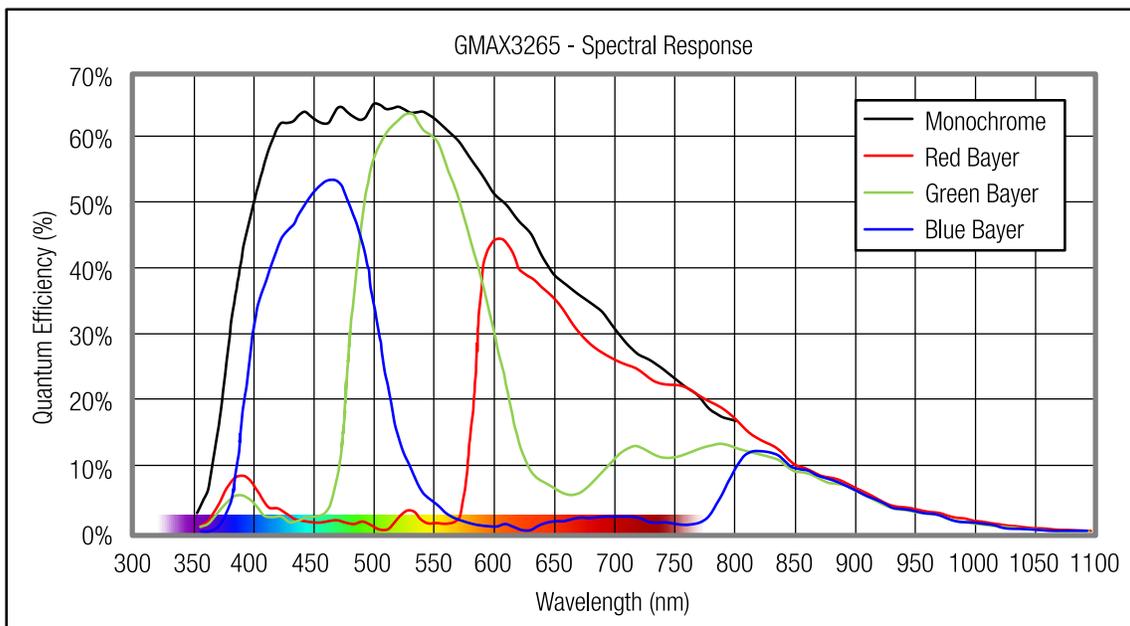
Figure 14: Graph quantum efficiency of GPixel GMAX3265

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

Dimensions and mass of:

| MX262CG-GP-X8G3-FF | MX262MG-GP-X8G3-FF | MX262RG-GP-X8G3-FF |

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
70 mm	60 mm	36.1 mm	236 g

[1]without adapters

Table 18: Camera parameters of the specific models

Dimensions and mass of:

| MX654CG-GP-X8G3-FF | MX654MG-GP-X8G3-FF |

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
70 mm	60 mm	41.8 mm	269 g

[1]without adapters

Table 19: Camera parameters of the specific models

2.7.2 Dimensional drawings

Dimensional drawings of:

MX262CG-GP-X8G3-FF   MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF
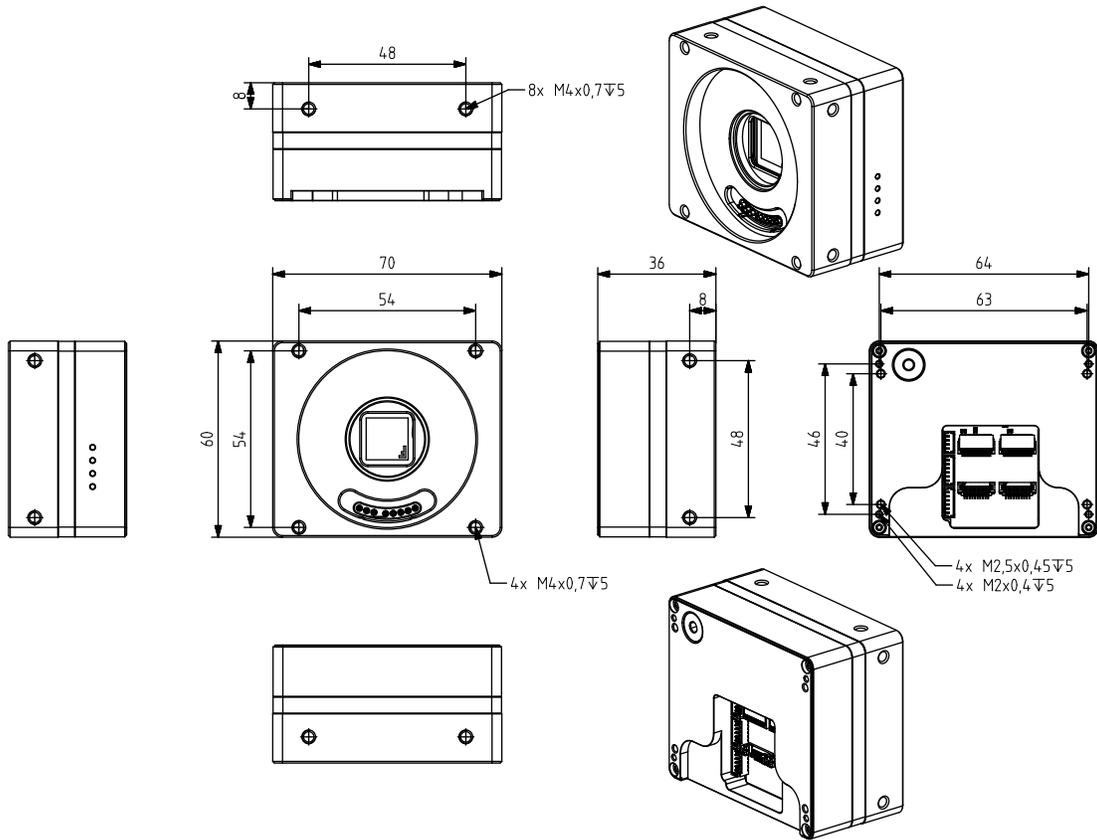
Figure 15: Dimensional drawing of MX262xG-GP-X8G3-FF

Dimensional drawings of:

MX654CG-GP-X8G3-FF   MX654MG-GP-X8G3-FF
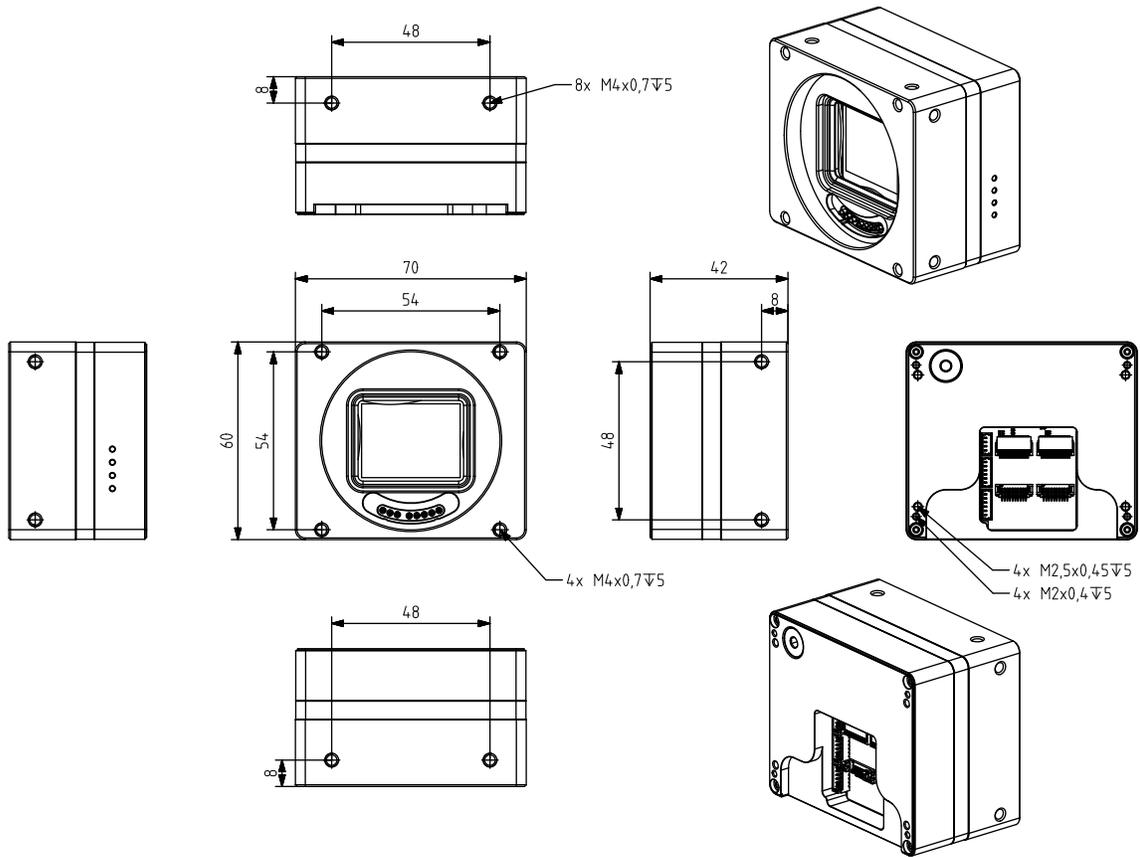
Figure 16: Dimensional drawing of MX654xG-GP-X8G3-FF

2.8 User interface – LEDs

LED	Color	Defaults	Note
1	Green	PCIe Lanes	User configurable
2	Red	PCIe Clock Present	User configurable
3	Blue	PCIe Clock Present	User configurable
4	Orange	PCIe Link Speed	User configurable

Table 20: LED output description during camera power up
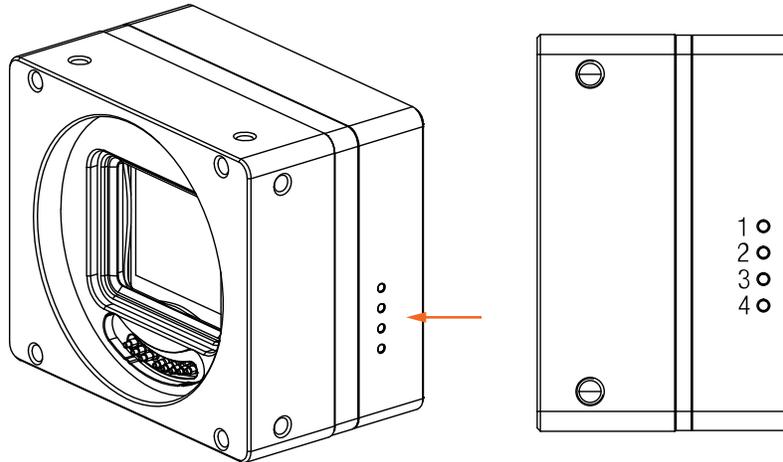
Figure 17: Position of LEDs on xiX X8G3 camera

LED statuses during boot sequence of:
all models in this manual (refer to the table Models and sensors overview)

Status	LED 1	LED 2	LED 3	LED 4
Off	Off	Off	Off	Off
Power	On	Off	Off	Off
Camera booted no PCIe	Off	Off	On	On
Factory firmware loaded[1]	flash	flash	flash	flash
PCIe connected X8 Gen3	On	flash	flash	On
PCIe connected X8 Gen2(Gen1)	On	flash	flash	flash
PCIe connected x4(x2 or x1) Gen3	flash	flash	flash	On
PCIe connected x4(x2 or x1) Gen2(Gen1)[1]	flash	flash	flash	flash

[1]Factory firmware is loaded when the functional firmware is corrupted. It has limited capability and is used to restore the functional firmware. To identify if the golden firmware is loaded pleas start xiCOP. See: XIMEA control panel.

Table 21: LED statuses during boot sequence

2.9 Camera interface

NOTE: It is important that the power is turned off when inserting/detaching the cable. General ESD precautions need to be applied. Failing this requirement may lead to camera damage.

The following section applies to:
all models in this manual (refer to the table Models and sensors overview)

2.9.1 PCIe / FireFly interface (X8G3)

The interface connector is used for data transmission, camera control, power and IO (see section Digital inputs / outputs (GPIO) interface for IO connector pinout description).

Item	Value
Connector	Samtec (UEC5-019-1-H-D-RA-1-A + UCC8-010-1-H-S-1-A)
Signals	PCIe x4 Gen3; IO[1]
Mating Connectors	CBL-ECUE-X4G3-1M0, CBL-ECUE-X4G3-2M0

[1]Spare signals in cable are used for isolated IO signaling. These signals are accessible in xSwitch XS-8P-X2G2-FF-X8G3 or in FIREFLY to iPass adapter ADPT-MX-X4G2-FF-IPASS

Table 22: FireFly interface mating connector description
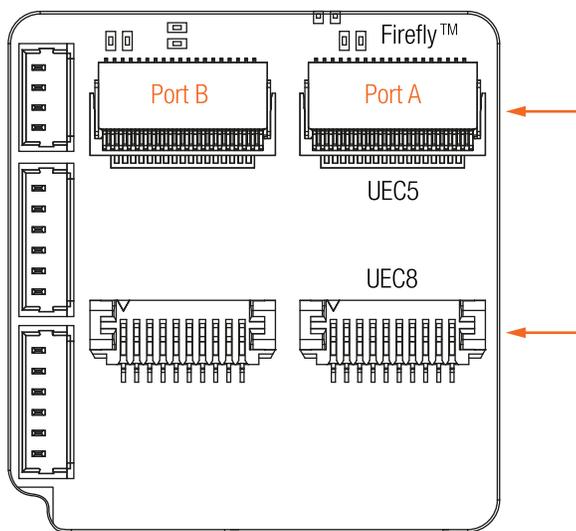
Figure 18: PCIe / FireFly connector location

A1   UEC5   A19

B1   B19

UEC8

1   10
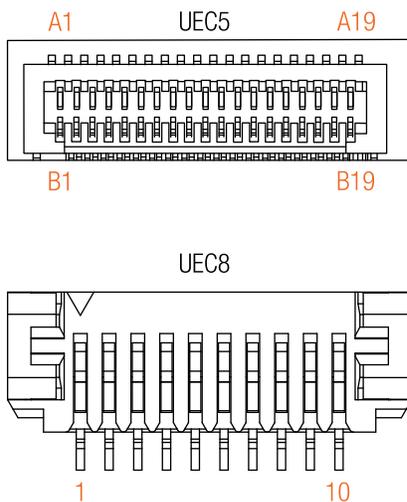
Figure 19: PCIe / FireFly connector pinout (MX X8G3)

Pin	Name	Type
1	VCC_TX	Power output
2	GND	Ground
3	NC	None
4	NC	None
5	PCIe_RST0_N_IN	PCIe reset
6	NC	None
7	NC	None
8	NC	None
9	GND	Ground
10	VCC_RX	Power output

Table 23: FireFly UCC8 connector (Port A/B) pin assignment

Pin	Name	Type	Pin	Name	Type
A1	GND	Signal and power ground	B1	GND	Signal and power ground
A2	PCIe_PETP_2	PCIe TX differential pair 2	B2	PCIe_PETP_3	PCIe TX differential pair 3
A3	PCIe_PETN_2	PCIe TX differential pair 2	B3	PCIe_PETN_3	PCIe TX differential pair 3
A4	GND	Signal	B4	GND	Signal and power ground
A5	PCIe_PETP_1	PCIe TX differential pair 1	B5	PCIe_PETP_0	PCIe TX differential pair 0
A6	PCIe_PETN_1	PCIe TX differential pair 1	B6	PCIe_PETN_0	PCIe TX differential pair 0
A7	GND	Signal and power ground	B7	GND	Signal and power ground
A8	IN1	Optically isolated Digital Input (IN)	B8	OUT1	Optically isolated Digital Output (OUT)
A9	IN_GND	Ground for opto-isolated Inputs	B9	OUT_GND	Ground for opto-isolated Outputs
A10	GND	Signal and power ground	B10	GND	Signal and power ground
A11	PCIe_RST0_N_IN	PCIe reset	B11	PWR	Power input
A12	NC	None	B12	PWR	Power input
A13	GND	Signal and power ground	B13	GND	Signal and power ground
A14	PCIe_PERN_2	PCIe RX differential pair 2	B14	PCIe_PERN_3	PCIe RX differential pair 3
A15	PCIe_PERP_2	PCIe RX differential pair 2	B15	PCIe_PERP_3	PCIe RX differential pair 3
A16	GND	Signal and power ground	B16	GND	Signal and power ground
A17	PCIe_PERN_1	PCIe RX differential pair 1	B17	PCIe_PERN_0	PCIe RX differential pair 0
A18	PCIe_PERP_1	PCIe RX differential pair 1	B18	PCIe_PERP_0	PCIe RX differential pair 0
A19	GND	Signal and power ground	B19	GND	Signal and power ground

Table 24: FireFly UEC5 connector (Port A) pin assignment

Pin	Name	Type	Pin	Name	Type
A1	GND	Signal and power ground	B1	GND	Signal and power ground
A2	PCIe_PETP_6	PCIe TX differential pair 6	B2	PCIe_PETP_7	PCIe TX differential pair 7
A3	PCIe_PETN_6	PCIe TX differential pair 6	B3	PCIe_PETN_7	PCIe TX differential pair 7
A4	GND	Signal	B4	GND	Signal and power ground
A5	PCIe_PETP_5	PCIe TX differential pair 5	B5	PCIe_PETP_4	PCIe TX differential pair 4
A6	PCIe_PETN_5	PCIe TX differential pair 5	B6	PCIe_PETN_4	PCIe TX differential pair 4
A7	GND	Signal and power ground	B7	GND	Signal and power ground
A8	IN2	Optically isolated Digital Input (IN)	B8	OUT2	Optically isolated Digital Output (OUT)
A9	IN_GND	Ground for opto-isolated Inputs	B9	OUT_GND	Ground for opto-isolated Outputs
A10	GND	Signal and power ground	B10	GND	Signal and power ground
A11	PCIe_RST0_N_IN	PCIe reset	B11	PWR	Power input
A12	NC	None	B12	PWR	Power input
A13	GND	Signal and power ground	B13	GND	Signal and power ground
A14	PCIe_PERN_6	PCIe RX differential pair 6	B14	PCIe_PERN_7	PCIe RX differential pair 7
A15	PCIe_PERP_6	PCIe RX differential pair 6	B15	PCIe_PERP_7	PCIe RX differential pair 7
A16	GND	Signal and power ground	B16	GND	Signal and power ground
A17	PCIe_PERN_5	PCIe RX differential pair 5	B17	PCIe_PERN_4	PCIe RX differential pair 4
A18	PCIe_PERP_5	PCIe RX differential pair 5	B18	PCIe_PERP_4	PCIe RX differential pair 4
A19	GND	Signal and power ground	B19	GND	Signal and power ground

Table 25: FireFly UEC5 connector (Port B) pin assignment

2.10 Digital inputs / outputs (GPIO) interface

The description of the GPIO interface below applies to:
all models in this manual (refer to the table Models and sensors overview)

	Pin	Name	GPI/GPO index API	Type
Pinout FireFly UEC5 connector (Port A)				
	A8	IN1	1/-	Optically isolated Digital Input (IN)
	B8	OUT1	-/1	Optically isolated Digital Output (OUT)
Pinout FireFly UEC5 connector (Port B)				
	A8	IN2	2/-	Optically isolated Digital Input (IN)
	B8	OUT2	-/2	Optically isolated Digital Output (OUT)

Table 26: FireFly connector I/O pin assignment

Item	Value
Connector	1x 4 pin Pico Blade
Signals	AUX power input
Mating Connectors	Molex Molex 0510210400
Connector	2x 6 pin Pico Blade
Signals	Optically isolated IO, Non isolated IO
Mating Connectors	Molex 0510210600

Table 27: Power and GPIO mating connector description
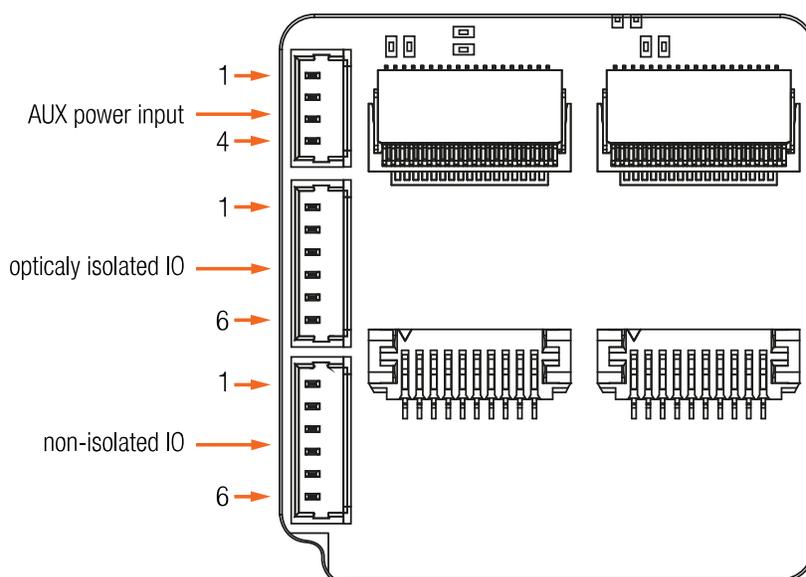
Figure 20: Power and IO connectors position

Pin	Name	Type
1	GND	Power ground
2	PWR_IN	Power input
3	PWR_IN	Power input
4	GND	Power ground

Table 28: Power connector pin assignment

Pin	Name	GPI/GPO index API	Type
Optically isolated IO pin assignment			
1	IN1	1/-	Optically isolated Digital Input (IN)
2	IN_GND	None	Common pole for optically isolated inputs
3	IN2	2/-	Optically isolated Digital Input (IN)
4	OUT1	-/1	Optically isolated Digital Output (OUT)
5	OUT_GND	None	Common pole for optically isolated outputs
6	OUT2	-/2	Optically isolated Digital Output (OUT)
Non-isolated IO pin assignment			
1	INOUT1	3/3	Non-isolated digital lines - Digital Input-Output (INOUT)
2	GND	None	Common pole for non-isolated IO (same as power GND)
3	INOUT2	4/4	Non-isolated digital lines - Digital Input-Output (INOUT)
4	INOUT3	5/5	Non-isolated digital lines - Digital Input-Output (INOUT)
5	GND	None	Common pole for non-isolated IO (same as power GND)
6	INOUT4	6/6	Non-isolated digital lines - Digital Input-Output (INOUT)

Table 29: I/O connector pin assignment

2.10.1 Optically isolated Digital Input (IN)

The description of optically isolated digital input below applies to:
all models in this manual (refer to the table Models and sensors overview)

Item	Parameter	Note
Maximal input voltage	24 V DC	None
Common pole	True	IN GND
Effect of incorrect input terminal connection	Reverse voltage polarity protected	None
Effects when withdrawing/inserting input module under power	no damage, no lost data	None
Maximal recommended cable length	10m	None
Input Level for logical 0	Voltage < 2.5 V / Current < 1 mA	None
Input Level for logical 1	Voltage > 4.0 V / Current > 1 mA	None
Input debounce filter	False	None
Input delay - rising edge	1+-0.2 µs	VINPUT=10 V,TAMBIENT=25 °C
Input delay - falling edge	5+-0.2 µs	VINPUT=10 V,TAMBIENT=25 °C
External trigger mapping	True	None
Input functions	Trigger	Rising or falling edge are supported for trigger

Table 30: General info for optically isolated digital input

2.10.2 Optically isolated Digital Output (OUT)

The description of optically isolated digital output below applies to:
all models in this manual (refer to the table Models and sensors overview)

Item	Parameter	Note
Maximal open circuit voltage	24 V DC	None
Output port type	Open collector NPN	None
Common pole	True	OUT GND
Protection	short-circuit / over-current / Reverse voltage	None
Protection circuit	PTC Resettable Fuse	None
Maximal sink current	36 mA	None
Trip current	71 mA	Self-restarting when failure mode current disconnected
Inductive loads	NO	None
Effect of incorrect output terminal connection	Protected against reverse voltage connection	None
Maximal output dropout	1 V	Sink current 25 mA
Output delay - ON -> OFF	26us	VOUTPUT=10 V,TAMBIENT=25 °C
Output delay - OFF -> ON	1.5us	VOUTPUT=10 V,TAMBIENT=25 °C
Strobe output mapping	True	None

Table 31: General info for optically isolated digital output

2.10.3 Non-isolated digital lines - Digital Input-Output (INOUT)

The description of non-isolated digital lines below applies to:
all models in this manual (refer to the table Models and sensors overview)

Item	Parameter	Note
Maximal input voltage	24 V DC	None
Common pole	YES	None
Effect of incorrect input terminal connection	Reverse voltage polarity protected	None
Effects when withdrawing/inserting input module under power	no damage, no lost data	None
Protection	short-circuit / over-current / Reverse voltage	None
Maximal output sink current	30 µA	Maximal advised load = 60 kΩ
Inductive loads	NO	None
Output Level logical 0	< 0.4 V	Load 100 kΩ
Output Level logical 1	> 2.5 V	Load 100 kΩ
Output delay - rising edge	400 ns	Load 100 kΩ threshold 2 V
Output delay - falling edge	450 ns	Load 100 kΩ threshold 0.5 V
Input Impedance- minimum	15 kΩ	None
Input Level for logical 0	< 0.7 V	None
Input Level for logical 1	> 2.4 V	None
Input debounce filter	NO	None
Input delay - rising edge	750 ns	VINPUT=5 V
Input delay - falling edge	1200 ns	VINPUT=5 V
Input functions	Trigger	Rising or falling edge are supported for trigger
Output functions	NO	Signal inversion supported

Table 32: General info for non-isolated digital in/out trigger lines

2.11 Accessories

2.11.1 CBL-PB4-PWR-0M15

Power cable with barrel connector 15 cm long.

Figure 21: CBL-PB4-PWR-0M15

Manufacturer	Model	Description
Molex	86053120	4 pin Pico Blade connector
NINIGI	PC-GP2.1N	Barrel connector 5.5/2.1

Table 33: CBL-PB4-PWR-0M15 description

2.11.2 CBL-PB6-IO-0M10

Figure 22: CBL-PB6-IO-xM

IO pig tail cable 10 cm long.

Manufacturer	Model	Description
Molex	86053248	6 pin Pico Blade connector

Table 34: Connectors CBL-PB6-IO-0M10

2.11.3 CBL-ECUE-X4G3-1M0/2M0/3M0

Figure 23: CBL-ECUE-X4G3-1M0

The FireFly copper cables are bidirectional and flexible. PCIe Gen3 x4 lanes with 14 Gbps. Both sides are equipped with locking mechanism. Please check the Accessories overview for supported lengths of the FireFly cables.

Cameras can be connected to host via cable with FireFly connector. The EMI/EMC performance should be evaluated by customer. For connecting to different host via vast range of adapters, please see our website Cameras Adapters

2.11.4 CB-X8G3-WAT-COOLER-KIT
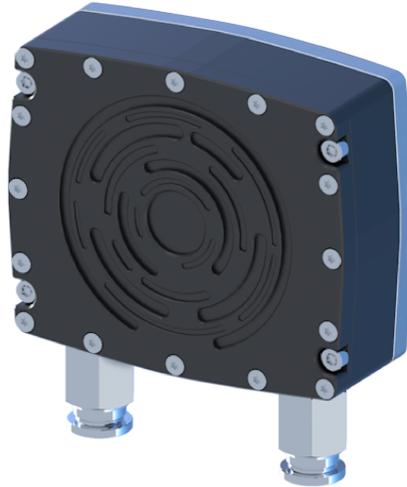
Figure 24: CB-X8G3-WAT-COOLER

A heatsink water cooler from anodized aluminum with a screws kit is available for X8G3/X4G3 cameras. This water cooling option is designed to prevent vibrations and can be conveniently mounted on the backside of the camera.

1   SSC6 - M5 quick coupler with airtight washer for 6 mm tubes (water rated)
2   6061 aluminum housing with optimized ater flow and cooling abilities
3   airtight sealing (tested at 10 bars)
4   M 2.5 x 18 screws for mounting cooler
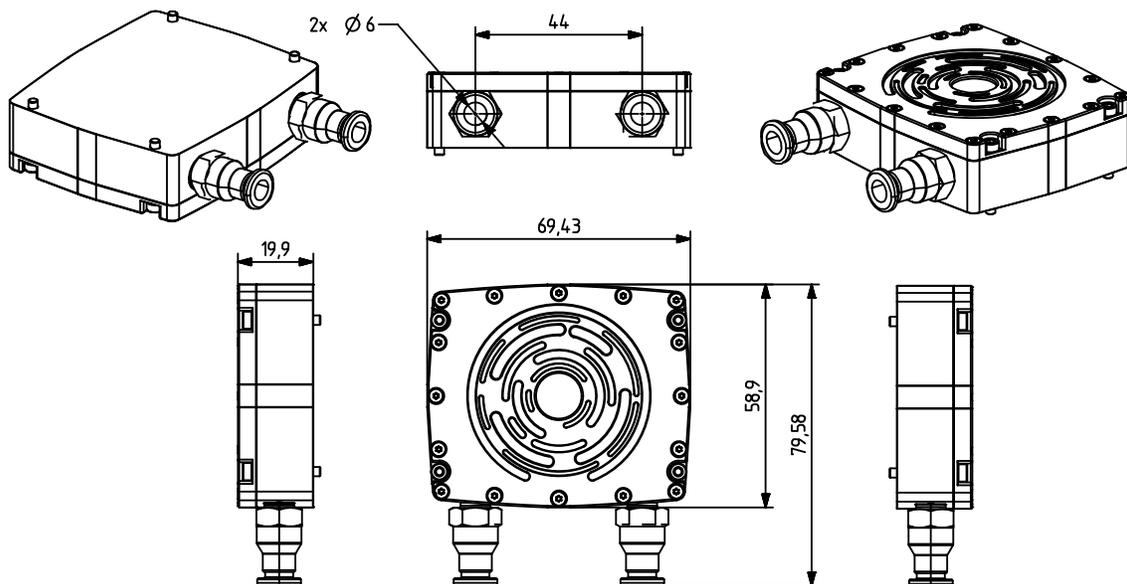
Figure 25: Dimensional drawing of CB-X8G3-WAT-COOLER-KIT

Connecting and disconnecting the tubes

There are various 6 mm OD tubes available from multiple manufacturers that can be used with the camera. It is recommended to consult the websites of the push-in fitting manufacturer for a list of compatible tubes and specific tube specifications necessary to ensure a leak-free connection. Adherence to their provided installation instructions is crucial. Always conduct a leak inspection after making tube connections. XIMEA disclaims any liability for damages resulting from improper installation. Following these guidelines correctly is vital for protecting your equipment and ensuring its peak performance.

XIMEA has conducted tests and endorses the use of PISCO brand tubes (part number UCQ06-2F-20-C) along with insert rings (part number WR0640) for creating secure and leak-proof connections. The recommended procedure for connecting and disconnecting tubes is as follows

Connecting

- Begin by inserting the insert rings into the tubes.
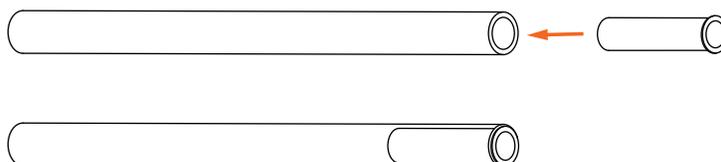
- Ensure the camera is powered off. Then, insert the tube into the Push-In Fitting until it is fully seated. The collet/release ring will automatically secure the tube, and the elastic sleeve will form a seal around it.
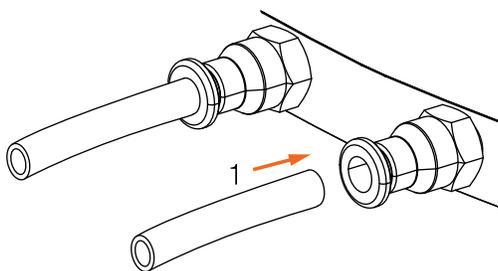
- Gently pull on the tube to verify it is securely fixed and cannot be removed easily.

- Start water supply and inspect for any leaks.

- If no leaks are detected, it is safe to power on the camera.

Disonnecting

- Turn off the camera and halt the water supply.

- Press the collet (release ring) towards the fitting (Step 1).

- While keeping the collet pressed, gently push the tube further into the fitting (Step 2), then pull it out to disconnect (Step 3).
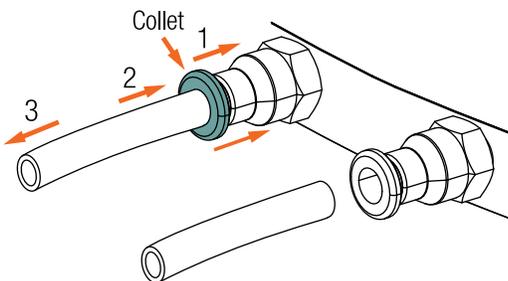
2.11.5   CB-X8G3-FAN-COOLER

Figure 26: CB-X8G3-FAN-COOLER

The camera needs to have proper cooling to ensure optimal performance. A fan cooling element can be included with the camera. This fan module is designed to provide air cooling for the camera and can be mounted on the backside of the camera.

To attach or detach the fan module, you will need a hex 2.0 screwdriver and four M2.5x14 screws. When removing or inserting the fan assembly, it's important to be careful not to damage the spring pins that connect the cooling unit to the camera electronics.
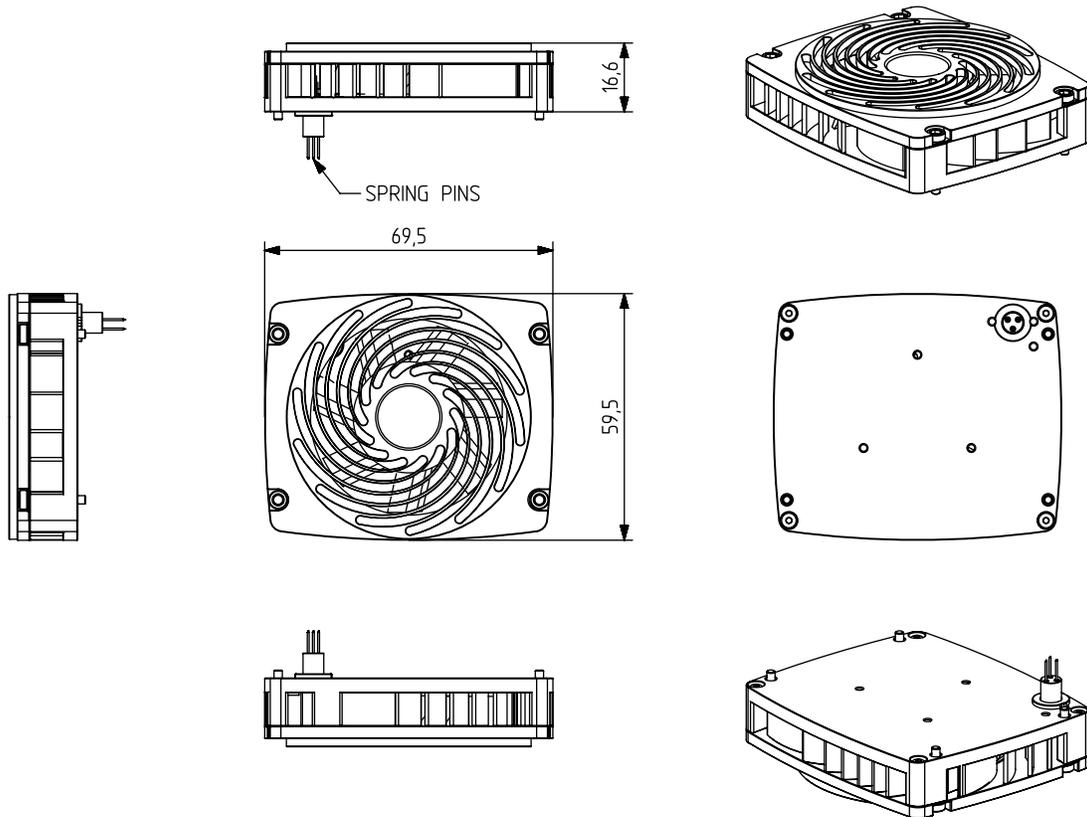
Figure 27: Dimensional drawing of CB-X8G3-FAN-COOLER

Width [W]	Height [H]	Depth [D]	Mass [M]
60 mm	70 mm	17 mm	20 g

Table 35: Mechanical parameters of CB-X8G3-FAN-COOLER

2.11.6 MECH-60MM-BRACKET-T

Bracket is made of solid high quality anodized aluminum. All threads are milled and all edges chamfered. Use 2x M4 screws provided with bracket as a kit for mounting. Bracket can be mounted on the bottom or side of the camera (depending on the camera model).
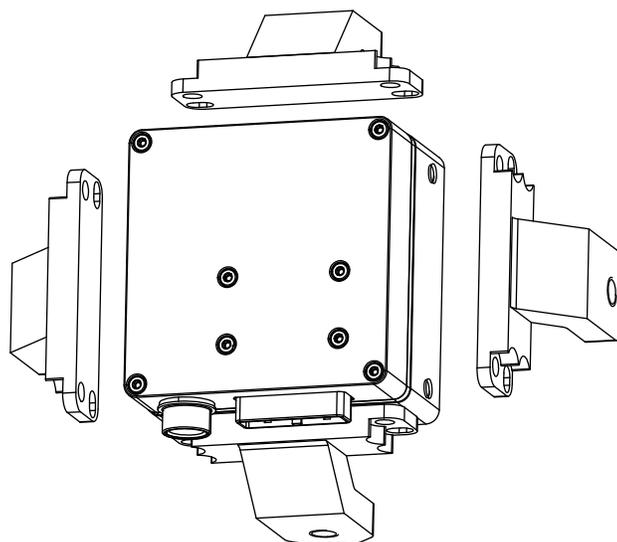
Figure 28: MECH-60MM-BRACKET-T
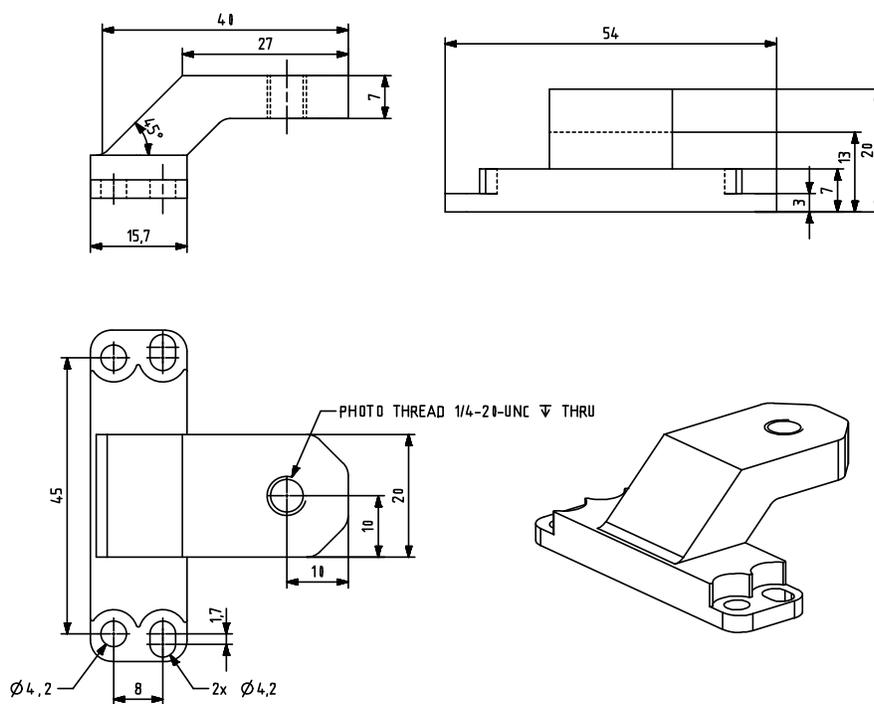
Figure 29: Dimensional drawing of MECH-60MM-BRACKET-T

Width [W]	Height [H]	Depth [D]	Mass [M]
54 mm	20 mm	40 mm	20 g

Table 36: Parameters of MECH-60MM-BRACKET-T
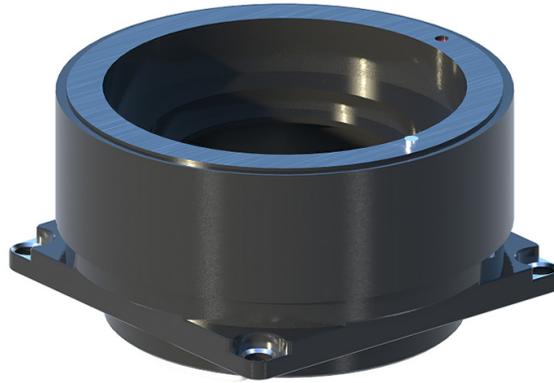
Figure 30: MECH-60MM-EF-ADAPTER

Cameras feature an active control interface for lenses with a CANON EF-mount. Integration of such lenses requires the MECH-60MMEF-ADAPTER, which securely attaches to the camera using four front mount holes. The necessary screws are included in the MECH-60MM-EF-ADAPTER-KIT, available for purchase from XIMEA. Additionally, the camera can be assembled with this adapter during production if requested along with the camera order (A-MECH-60MM-EF-ADAPTER-KIT).

Note: To be used with standard Canon Mount Lenses. Use 4x M4x6 or standard M4 screws for attaching the camera. The nominal flange focal distance from the front of the adapter to the active area in the sensor is 44.00 mm + / - 0.2 mm.
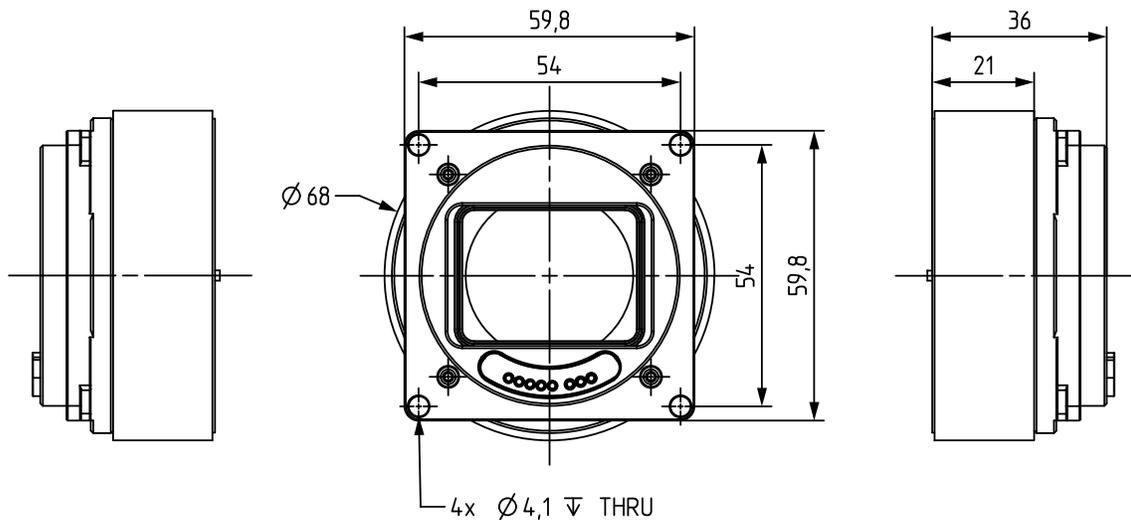
Figure 31: Dimensional drawing of MECH-60MM-EF-ADAPTER

Width [W]	Height [H]	Depth [D]	Mass [M]	Material
80 mm	80 mm	12.25 mm	30 g	Machined aluminum alloy[1]

[1] anodized to black color

Table 37: Mechanical parameters of MECH-60MM-EF-ADAPTER

2.11.8 LA-C-MNT-60MM-xxx-KIT

The C-mount lens adapter can be assembled during production if the operation is ordered along with the camera (A-LA-C-MNT-60MM-KIT). The mechanical dimensions of the LA-C-MNT-60MM-KIT are designed for the use of filter glass with a thickness of 1 mm and a refraction index of 1.4-1.55. Without the filter glass, the correct optical flange focal distance is not achieved.
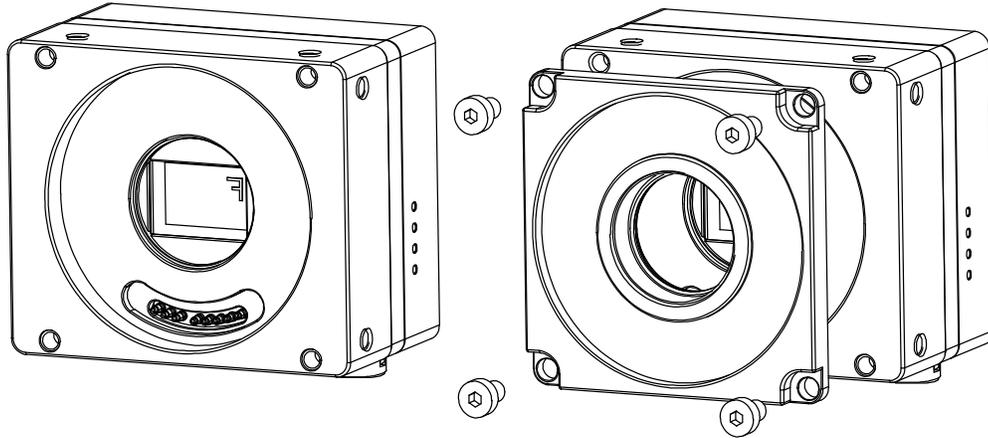
Figure 32: Camera without and with C-mount LA-C-MNT-60MM-KIT lens adapter

Back part attachment to connect XIMEA Firefly cameras to MTP cable. Converts 1x PCIe Gen3 x4 camera. The camera adapter also offers power and IO connectors for synchronization and triggering.
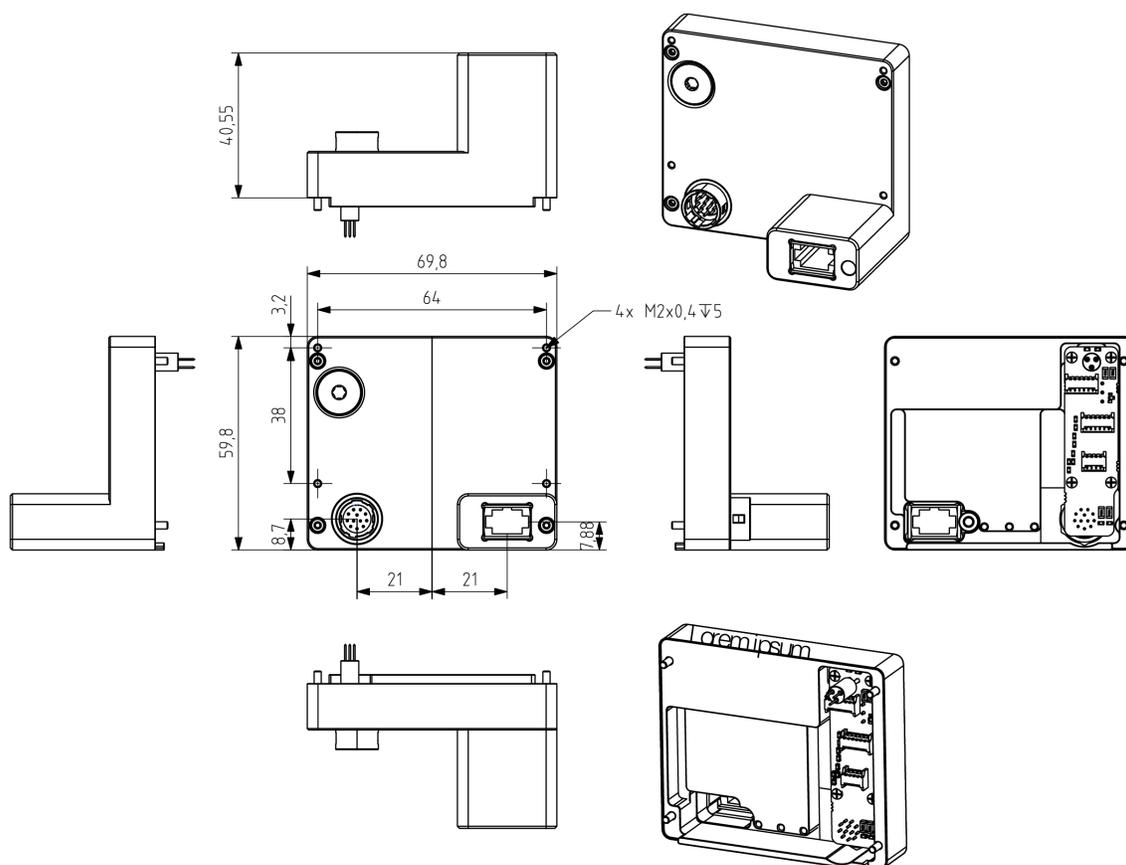
Figure 33: ADPT-MX-X4G3-FF-X4G3-MTP dimensional drawing

IO connector pinning
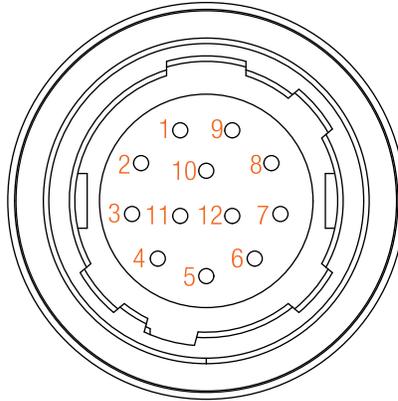
Figure 34: ADPT-MX-X4G3-FF-X4G3-MTP IO connector

The IO pins of the adapter are connected to the corresponding IO pins on the FireFly camera, based on their names.

Pin	Name	Signal
1	IN2	Opto-isolated Input 2
2	IN1	Opto-isolated Input 1
3	OUT2	Opto-isolated Output 2
4	OUT1	Opto-isolated Output 1
5	AUX PWR	Power supply input
6	GND	External grounds for power and non-isolated I/O
7	INOUT1	Non-isolated I/O
8	INOUT3	Non-isolated I/O
9	INOUT2	Non-isolated I/O
10	IN GND	Ground for Opto-Isolated Inputs (IN1, IN2)
11	OUT GND	Ground for Opto-Isolated Out (OUT1, OUT2)
12	INOUT4	Non-isolated I/O

Table 38: ADPT-MX-X4G3-FF-X4G3-MTP IO pin assigment

2.11.10 ADPT-MX-X8G3-FF-X8G3-SFF

Back part attachment to connect XIMEA Firefly cameras to SFF cable. Converts 2x PCIe Gen3 x8 camera. The camera adapter also offers power and IO connectors for synchronization and triggering.
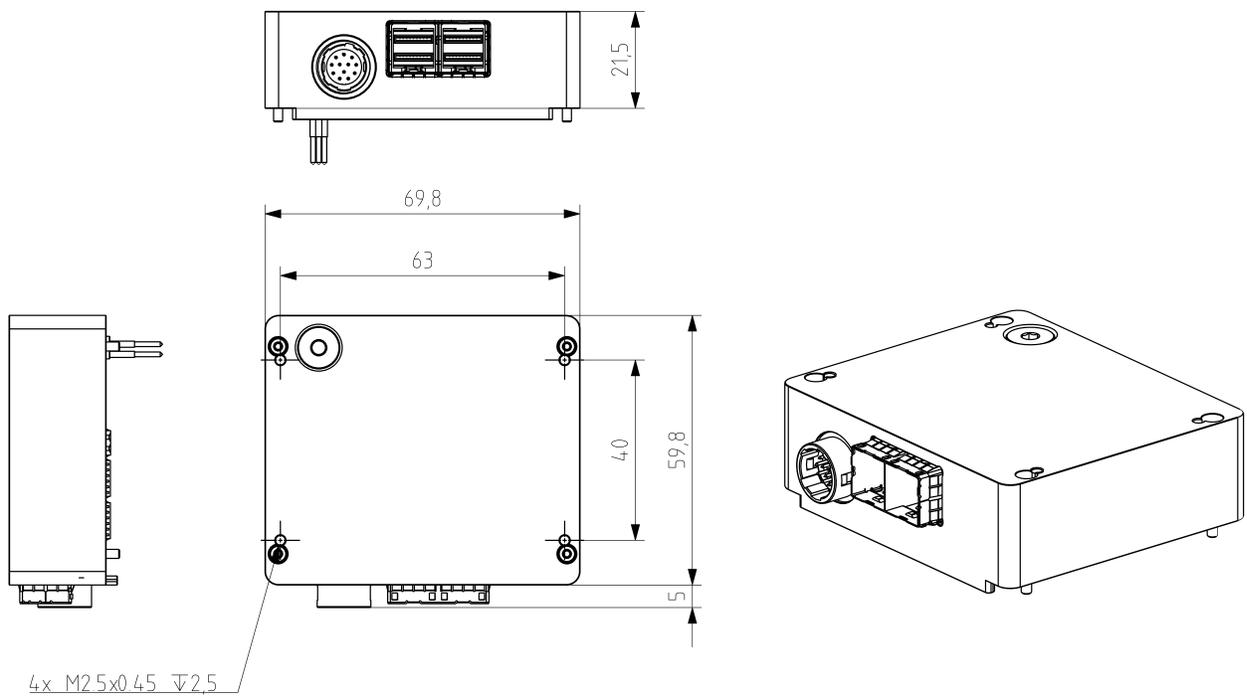
Figure 35: Dimensional drawing of ADPT-MX-X8G3-FF-X8G3-SFF

Width [W]	Height [H]	Depth [D]	Mass [M]	Material and technology
69.8 mm	59.8 mm	21.5 mm	137.6 g	Machined Aluminum alloy

Table 39: Parameters and mass of ADPT-MX-X8G3-FF-X8G3-SFF

IO connector pinning
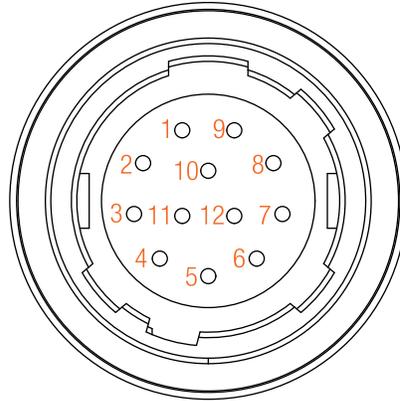
Figure 36: ADPT-MX-X8G3-FF-X8G3-SFF IO connector

The IO pins of the adapter are connected to the corresponding IO pins on the FireFly camera, based on their names.

Pin	Name	Signal
1	IN2	Opto-isolated Input 2
2	IN1	Opto-isolated Input 1
3	OUT2	Opto-isolated Output 2
4	OUT1	Opto-isolated Output 1
5	AUX PWR	Power supply input
6	GND	External grounds for power and non-isolated I/O
7	INOUT1	Non-isolated I/O
8	INOUT3	Non-isolated I/O
9	INOUT2	Non-isolated I/O
10	IN GND	Ground for Opto-Isolated Inputs (IN1, IN2)
11	OUT GND	Ground for Opto-Isolated Out (OUT1, OUT2)
12	INOUT4	Non-isolated I/O

Table 40: ADPT-MX-X8G3-FF-X8G3-SFF IO pin assigment

2.11.11   PCIe host adapter cards

Ximea offers several host adapter cards.
Please check our website for the latest information on available cards for your PC:

- XIMEA Host Adapters

- XIMEA Adapter Boards

3 General features

3.1 Camera features

3.1.1 ROIs – Region of interest

ROI, also called area-of-interest (AOI) or windowing, allows the user to specify a sub-area of the original sensor size for read-out. ROI can be set by specifying the size (width and height) as well as the position (based on upper left corner) of the of the sub-area.

3.1.2 Downsampling modes

Downsampling describes the possibility of reducing the image resolution without affecting the sensors physical size, i.e. without reducing the physical size of the sensing area. This feature is useful when optics are used, that are particularly fitted to a certain sensor size and if it is necessary to maintain the full image circle on the sensor.

Downsampling can be achieved in two ways: binning and decimation.
Binning/decimation selector selects which binning/decimation engine is used (Sensor, FPGA, CPU). After setting of selector, multiple parameters could be get or set for the selected unit.

They can be divided into:

Patterns   define the horizontal/vertical pattern how photo-sensitive cells are combined (mono or bayer)

Values   reduce the horizontal or vertical resolution of the image by the specified horizontal/vertical downsampling factor

Modes   in case of binning set the mode used to combine horizontal/vertical photo-sensitive cells together (sum or average)

Binning

When binning is applied, the image is divided into cluster of k*l pixels, where all pixels in each cluster are interpolated and result in the value of one output pixel. For example, a 2*2 binning produces 2*2-pixel clusters and results in images with ¼ of the original resolution.

Decimation – Skipping

When decimation is chosen, only every n-th pixel is used to create the output image. For example, with a 2x1 vertical skipping, every odd number line is used and every even number line is skipped, resulting in an image with half its original vertical resolution. Skipping is a faster downsampling mode, but also introduces more aliasing effects.

3.1.3 Image data output formats

All modes are provided by the xiAPI or standard interfaces using the xiAPI (please see Programming). Each camera model supports several Image Data Output Formats.

This table is applicable to:

MX262MG-GP-X8G3-FF   MX262RG-GP-X8G3-FF   MX654MG-GP-X8G3-FF

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_FRM_TRANSPORT	Data from transport layer (e.g. packed). Depends on data on the transport layer[3]

[1]Higher CPU processing is required when this mode is selected because color filter array processing is implemented on PC. This processing is serialized when multiple cameras is used at once. The most effective way to get data from camera is to use XI_RAW8, where no additional processing is done in API.

[2]On monochromatic cameras the black level is not subtracted in XI_MONO8 and Xl_MONO16 formats by Image Processing in xiAPI, so black level remains the same as in RAW format.

[3]When using Transport Data Format, the Image Processing block from XiAPI Image Data Flow is skipped and therefore the Transport format is the most effective data format in terms of CPU and RAM usage.

Table 41: Image data output formats

This table is applicable to:

MX262CG-GP-X8G3-FF   MX654CG-GP-X8G3-FF

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_RGB16_PLANAR	RGB16 planar data format
XI_RGB24	RGB data format. [Blue][Green][Red][1]
XI_RGB32	RGBA data format. [Blue][Green][Red][0][1]
XI_RGB48	RGB data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high][1]
XI_RGB64	RGBA data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high][0][0][1]
XI_RGB_PLANAR	RGB planar data format. [Red][Red]...[Green][Green]...[Blue][Blue]...[1]
XI_FRM_TRANSPORT	Data from transport layer (e.g. packed). Depends on data on the transport layer[3]

[1]Higher CPU processing is required when this mode is selected because color filter array processing is implemented on PC. This processing is serialized when multiple cameras is used at once. The most effective way to get data from camera is to use XI_RAW8, where no additional processing is done in API.

[2]On monochromatic cameras the black level is not subtracted in XI_MONO8 and Xl_MONO16 formats by Image Processing in xiAPI, so black level remains the same as in RAW format.

[3]When using Transport Data Format, the Image Processing block from XiAPI Image Data Flow is skipped and therefore the Transport format is the most effective data format in terms of CPU and RAM usage.

Table 42: Image data output formats

3.2 Acquisition modes

3.2.1 Free-Run

Also known as continuous acquisition. In this mode the sensor delivers a constant stream of image data at the maximum speed available by the current bandwidth, without any external trigger. Each image exposure is sequentially started automatically when possible.

For all sensors the exposure of the next frame overlaps with the data readout of the previous frame.
This Overlap mode gives the highest number of frames per second (FPS).
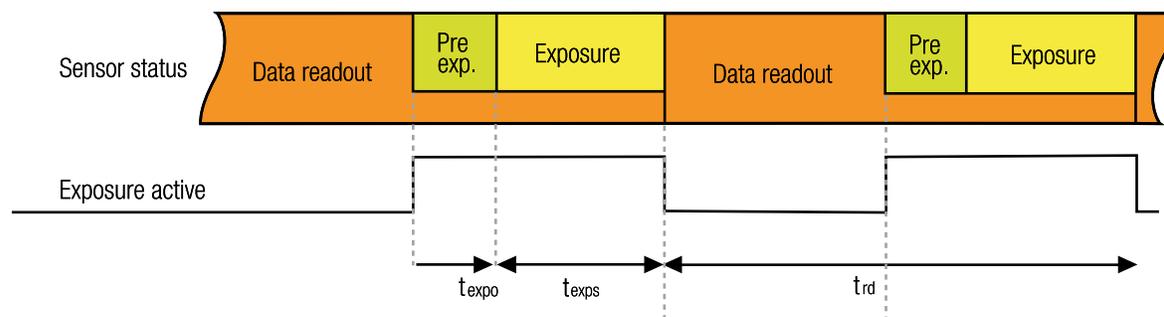
Figure 37: Acquisition mode - free run

The frame rate in free run mode depends inversely on the frame time. In general the frame time roughly equals to the readout time or to the exposure time, depending on which one of the two is larger. This means that when exposure time is larger than the readout time, the frame rate gradually decreases with increasing exposure time (frame_rate ~ $1/t\_exp$).

In this mode the timing depends on the Exposure Time and Data Readout Time. In situation when the exposure time is comparable or longer than readout time, the exposure active signal might have constant active level during acquisition. This might be caused also by different propagation delay for rising and falling edge of opto isolated outputs. Polarity inversion might help to make visible the separated exposure pulses. Some camera models support limiting of FPS. When set the camera will limit the frame rate so it does not exceed the set value. Please see: Frame_Rate_Control. This is also applicable in case of triggered acquisition.

3.2.2 Trigger controlled acquisition/exposure

Unlike in the free-run, each image exposure can also be triggered with an input trigger signal. In this mode, the sensor waits in stage until the trigger signal arrives. Only then, the exposure of first frame is started, which is followed by the data readout. XIMEA cameras supports several triggered modes along with single image exposure after one trigger. The trigger signal can be either edge sensitive or level sensitive. In the case of "level sensitive", it can be used to control length of exposure or acquisition itself. Generally trigger sources can be divided into two groups:

Software trigger

The trigger signal can be sent to the sensor using a software command. In this case, common system related latencies and jitter apply.

Hardware trigger

A hardware trigger can be sent to the sensor using the digital input. Triggering by hardware is usually used to reduce latencies and jitter in applications that require the most accurate timing. In this case rising edge of input signal is suggested as the delay of opto coupler is smaller as well as introduced jitter. Triggering by hardware is usually used to reduce latencies and jitter in applications that require the most accurate timing.

Triggered mode - Single frame

Sensors support exposure overlapped with readout. When the trigger period (t_{tper}) is longer than the exposure plus readout time, exposure is not overlapped with readout. However, when the trigger period is decreased, the sensor will expose the images in overlap mode. In this case, the frame active signal will be constantly active. The trigger period has to be long enough, so the exposure of next frame does not end sooner than readout of previous frame.

Sensor timing in Exposure Overlapped with Data Readout Mode
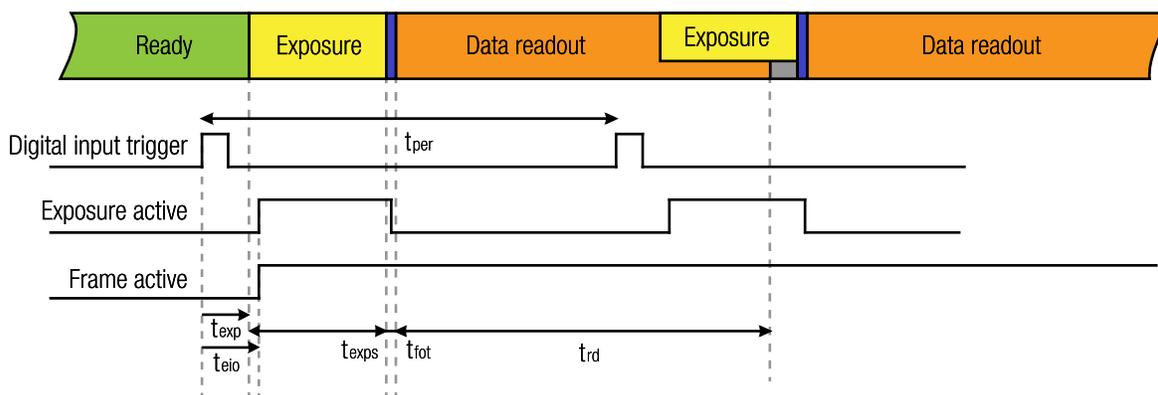
Figure 38: Acquisition mode - triggered with overlap

Description

t_{eio}	Trigger (Digital Input) to Exposure Active (Digital Output)
t_{exp}	Trigger (Digital Input) to start of exposure
t_{exps}	Current Exposure Time set (XI_PRM_EXPOSURE)
t_{fot}	Frame overhead time (FOT)
t_{rd}	readout time (Readout Time)
t_{row}	readout time of one row (Line period) depends on sensor settings

Conditions: Debounce on trigger input line and trigger delay are disabled.

The timing strongly depends on camera settings. Most of the times can be calculated using Camera performance calculator.

The delay between trigger input and start of exposure:

t_{delay} — Delay inside camera caused by internal electronics. This depends on input type. Please refer to: Optically isolated Digital Input (IN)

The output signaling is then delayed the delay introduced from the output electronic:

t_{odelay} — Delay inside camera caused by internal electronics. This depends on output type. Please refer to: Optically isolated Digital Output (OUT)

For minimum trigger period (t_{tper}) the following applies. The next trigger after one is processed needs to be applied so the end of the triggered exposure does not overlap with the readout of the previous frame.

$$t_{per} > \max(t_{rd}, t_{exp} + t_{fot})$$

Triggered mode - Burst of frames

For more information please see: Frame Burst Modes

Frame Burst Start

In this mode each trigger pulse triggers defined number of exposed frames.
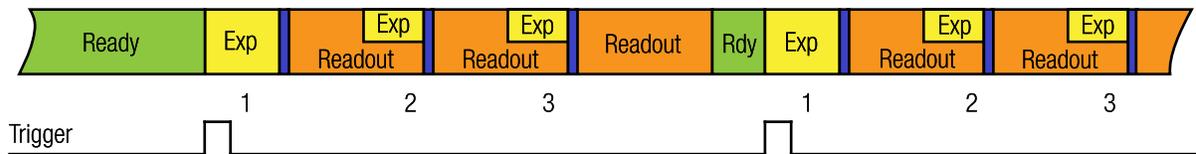
Figure 39: Triggered burst of frames – frame burst start

Frame Burst Active

If trigger is level-sensitive, it can be used to control image acquisition.
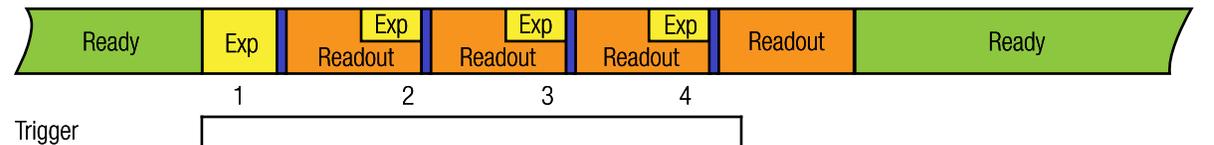
Figure 40: Triggered burst of frames – frame burst active

Triggered mode - Exposure defined by trigger pulse length

In this mode the exposure is defined by trigger pulse length. This can be used to achieve longer exposure than allowed by API. Also, it can be used to trigger several images in sequence with different exposure time. Exposure time is measured and reported in image metadata. Please see: Exposure Defined by Trigger Pulse Length

Figure 41: Exposure defined by trigger pulse length

3.3 Exposure time

Also known as shutter speed. This parameter defines the length of the integration period for each frame. Most CMOS sensors generate the exposure interval internally. For some it is possible to control it by external signaling. The sensor internal timing depends on the provided system clock. Most sensors use dividers to generate slower clocks for internal usage.

The minimum exposure time is defined mostly by row times, where the row time (T_R) is dependent on various internal settings. Very few sensors support exposure times equal to zero. There is a defined minimum exposure time as well as minimum steps between possible exposure times. There is also a maximum exposure time, defined by sensor architecture.

3.4 Gain

The gain value influences the analog-to-digital conversion process of the image sensor pipeline and acts as a multiplier of the output signal. Using gain values greater than 0 will increase the pixel intensities but may also increase the overall noise level. For some camera models the gain can be set in discrete steps only.

3.5　API Features

Host-assisted image processing features available in xiAPI

3.5.1　Exposure – Auto gain

When AEAG is used, every captured image is evaluated for its mean intensity. Based on the result, the exposure and gain values are modified with the objective to achieve a target intensity level for the following image. Further, the maximum applicable exposure and gain values can be defined. Since both, exposure and gain, have an influence on the intensity, the ratio between those two parameters in their contribution to the algorithm can also be set (exposure priority).

3.5.2　White balance

Only for color models: The white balance can be adjusted with three coefficients kR, kG and kB, one for each color channel. These coefficients can be set individually in order to increase or decrease each channel's contribution and therefore allow the user to control the color tint of the image.

Assisted manual white balance

This feature measures the white balance a single time and sets the white balance coefficient to achieve a mean grey (neutral) tint. The measurement is performed on the central rectangle of the image, with 1/8th of its width and height. The function expects a white sheet of paper exposed to 50% of the intensity values (8 Bit RGB values should be around 128) to be visible.

Auto White Balance

The white balance is measured across the full image for every 4th image that is acquired, and the white balance coefficients are set to to achieve a neutral colour tint.

3.5.3　Gamma

Only for color models: As a part of the color filtering process, it is possible to adjust the gamma level of the image. The adjustment can be set separately for the luminosity and the chromaticity.

3.5.4　Sharpness

Only for color models: As a part of the color filtering process, it is possible to adjust the sharpness of the image.

3.5.5　Color correction matrix

The color correction matrix is a 4x4-matrix which is applied on each pixel of an image in a host-assisted port-processing step. This Matrix can be used for example to adjust the brightness, contrast, and saturation.

3.5.6　Sensor defect correction

During the manufacturing process, every camera is tested for various type of defects and a list of the measured defect pixels is created and stored in the camera's non-volatile memory. This list is then used for the correction of acquired images during operation. The correction is inactive by default, but can be turned on by the user if a non-processed output is required.

3.5.7　Flat field correction

Flat field correction (FFC or shading correction) is a method to remove non-uniformities in the image caused by different sensitivities of the pixels and by distortions caused by optics. For XIMEA cameras this correction is applied in the image processing part of the image data flow diagram (it is performed on the host computer thus depending on the image size and CPU performance enabling it may cause increased processing time).

In order for the xiapi to calculate the gain and offset coefficients for each individual pixel, it is necessary to load calibration images (1 dark image and 1 mid-saturated image) before applying FFC in RAW8 or RAW16 format depending on desired output bit depth. To obtain optimal results, camera should be in the same setup (lens, device output bit depth, gain, ROI, downsampling, Zero ROT, light conditions...) during acquisition of calibration images and while using FFC.

Compare of camera output with shading (left) and after FFC enabled (right):
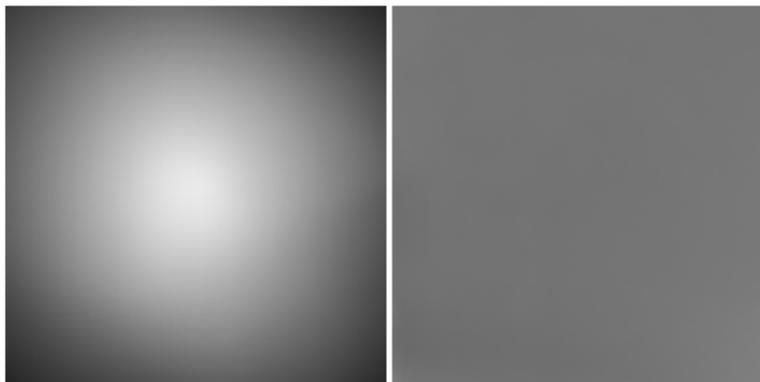
Figure 42: Flat field correction - images comparison

Acquisition of calibration images

The easiest way to acquire calibration images is by using **CamTool** guide:

Figure 43: Flat field correction - new FFC

Dark Image

Close camera lens with a cap (make it dark) and click button Capture. Average the image from set number of frames to suppress dynamic noise.
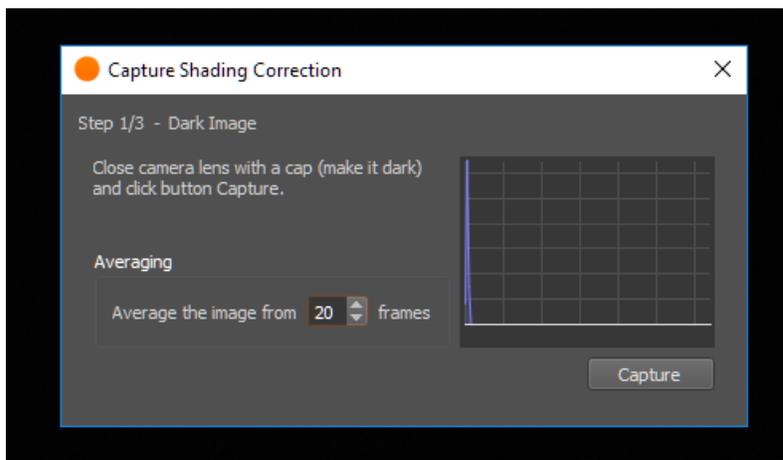
Figure 44: Flat field correction - Dark image

Mid-saturated image

Open camera lens and aim the camera into paper illuminated at 30-70% and click button Capture. Average the image from set number of frames. Image should be focused out of captured plane to reduce dust or other details in the scene.
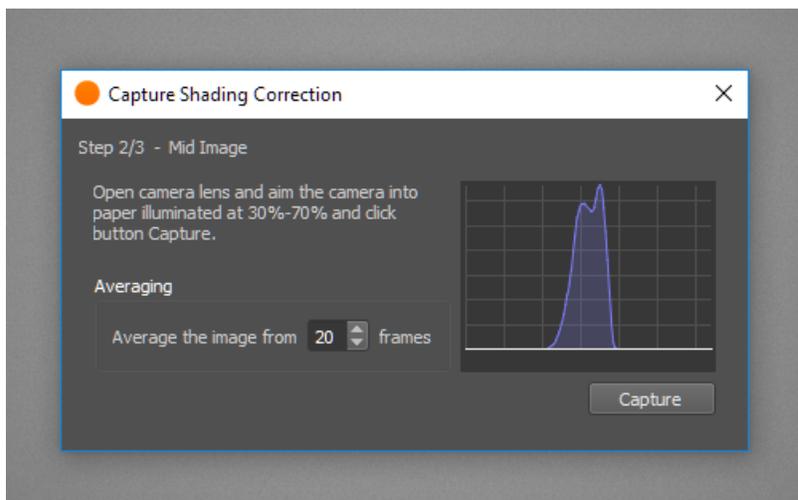
Figure 45: Flat field correction - Mid- saturated image

Save TIFF files

Save the new preset how it be displayed in CamTool.
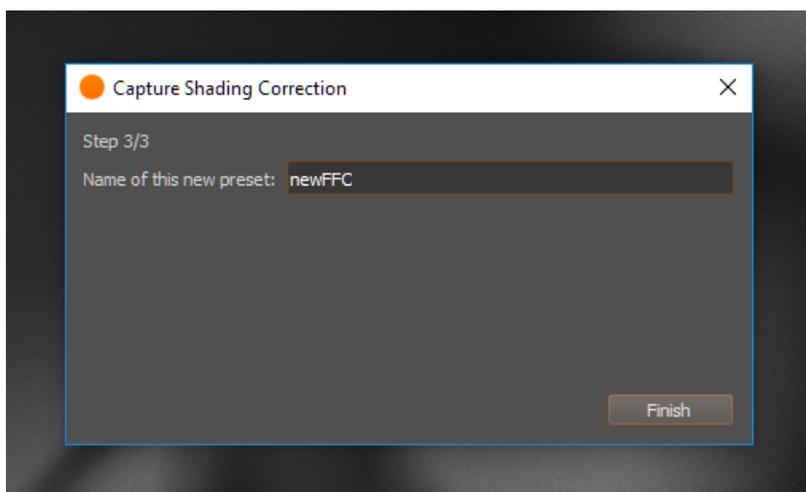
Figure 46: Flat field correction - new preset

To verify calibration, FFC can be also enabled in CamTool by clicking on created preset
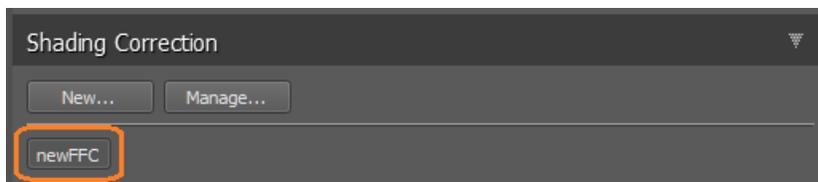
Figure 47: Flat field correction - Enabling FFC

In case of any issue, please double check that all dependent camera parameters (device output bit depth, ROI, downsampling, Zero ROT, exposure, gain...) are in the same setup as during acquisition of calibration images

---

To see calibration images and be able to save them, click on Manage, then choose preset from list. Camera parameters for that particular preset will be displayed. Click on show dark/mid image
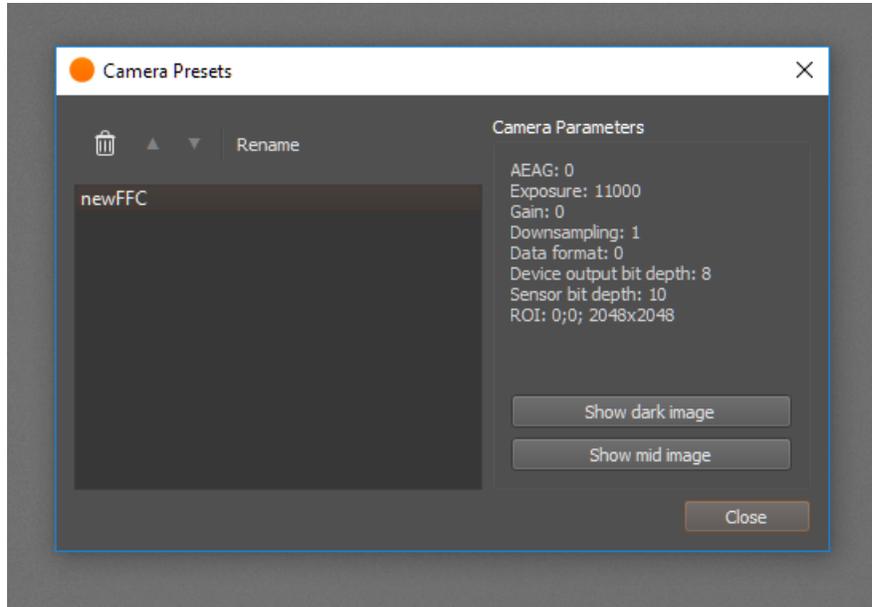
Figure 48: Flat field correction - FFC management

When images are shown in CamTool it is possible to save them by clicking on save icon in top toolbar. Images should be saved in uncompressed TIFF format to use in API.
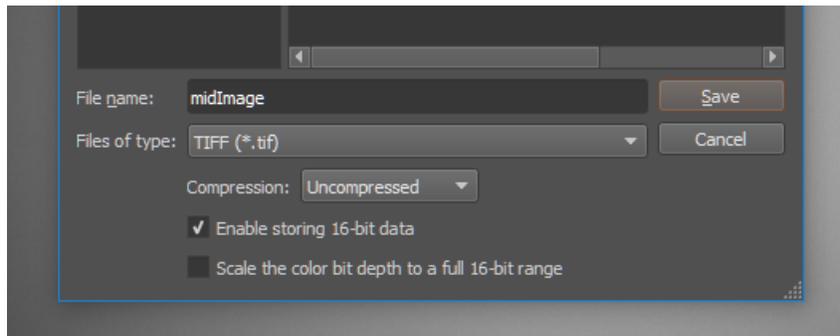
Figure 49: Flat field correction - Safe TIFF

Otherwise, calibration images from CamTool are stored in hidden AppData folder. It can be opened in Windows Run application by command:

`%LOCALAPPDATA%\xiCamTool\shading`

Calibration images might be also acquired in any other tool as long as the output is in TIFF format and with the same camera setup.

Applying FFC in xiAPI

xiAPI command sequence:

- Set all dependent camera parameters (device output bit depth, ROI, downsampling, Zero ROT, exposure, gain...) to be in the same setup as during acquisition of calibration images.
- Load dark image - XI_PRM_FFC_DARK_FIELD_FILE_NAME
  `size` - size of the file name - `strlen(file\_name)`.
- Load mid-saturated image - XI_PRM_FFC_FLAT_FIELD_FILE_NAME
  `size` - size of the file name - `strlen(file\_name)` (place both image files into project folder).

Note: Use the same image file for this parameter as for XI_PRM_FFC_DARK_FIELD_FILE_NAME for dark-field correction only. Processing will subtract the dark image only while using the unity (1.00) gain for correction.

- Enable XI_PRM_FFC.

Sample code:

```
xiSetParamInt(0, XI_PRM_NEW_PROCESS_CHAIN_ENABLE, XI_ON); // MU,MQ,MD camera families

xiOpenDevice(0, &xiH);
// set dependent camera params to same values as during calibration

xiSetParamString(xiH, XI_PRM_FFC_DARK_FIELD_FILE_NAME, "darkImage.tif", strlen("darkImage.tif"));
xiSetParamString(xiH, XI_PRM_FFC_FLAT_FIELD_FILE_NAME, "midImage.tif", strlen("midImage.tif"));
xiSetParamInt(xiH, XI_PRM_FFC, 1);
```

In FFCdemoWithOpenCV.cpp is FFC demonstrated in OpenCV+xiAPI example. FFC might be enabled or disabled by pressing any key while program is running.

4 Operation

For a proper operation of your camera there are certain requirements that have to be met. You can read more about these requirement as well as about the correct usage of camera in the following sections.

4.1 System requirements

4.1.1 Software requirements

Cameras are compatible with the following operating systems:

- Windows 10, 11
- Linux Ubuntu
- MacOS 10.8 or newer

All XIMEA cameras are compatible with the most advanced Vision and Image Processing Libraries. See chapter XIMEA Software Packages for more information about the options to access cameras, as well as a list of currently supported libraries and frameworks supported in Windows. For more information visit API - Application Programming Interfaces.

4.2 XIMEA software packages

4.2.1 XIMEA Windows software package

XIMEA API Software Package can be installed on: Microsoft Windows 10, 11.

Contents

The package contains:

- OS Drivers of all XIMEA camera types for OS Microsoft Windows, Windows Server 2008 R2 x86-64, Windows 10 32/64 bit
- APIs (xiAPI, xiAPI.NET, xiApiPython)
- Examples
- CamTool
- xiCOP
- GenTL Producer - for connection of GenTL Consumer applications
- Vision Libraries integration demonstrations:
  – NI LabView interface - xiLib

Installation

- Download and execute the XIMEA API Software Package installer (EXE-file, approximate size 100 MB): http://www.ximea.com/downloads/recent/XIMEA_Installer.exe
- Read the License Agreement
- Start the installer

  Be sure that you have administrator privileges or start the Installer with administrator rights
  (right click and select "run as administrator"):
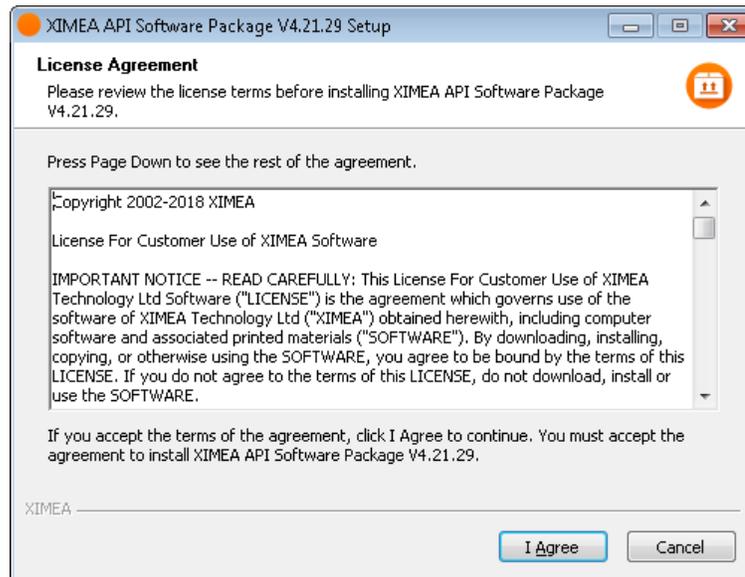
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked
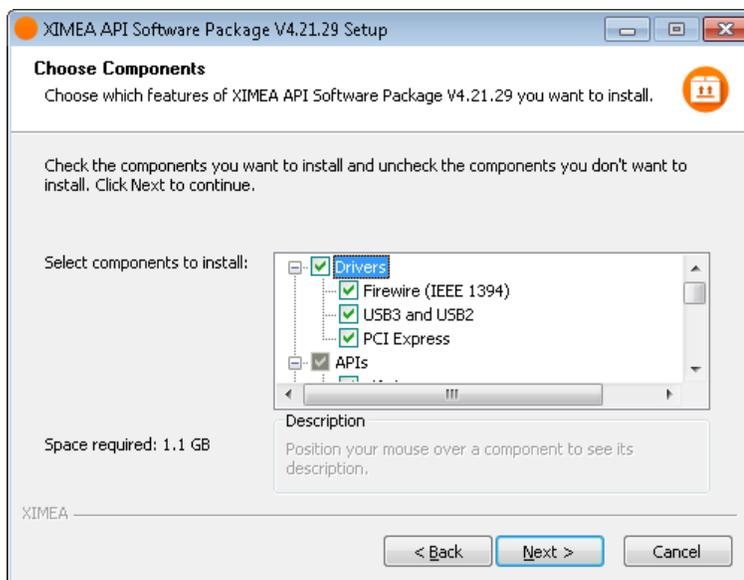
- Specify the install location - you can leave the default location or change it to your desired location
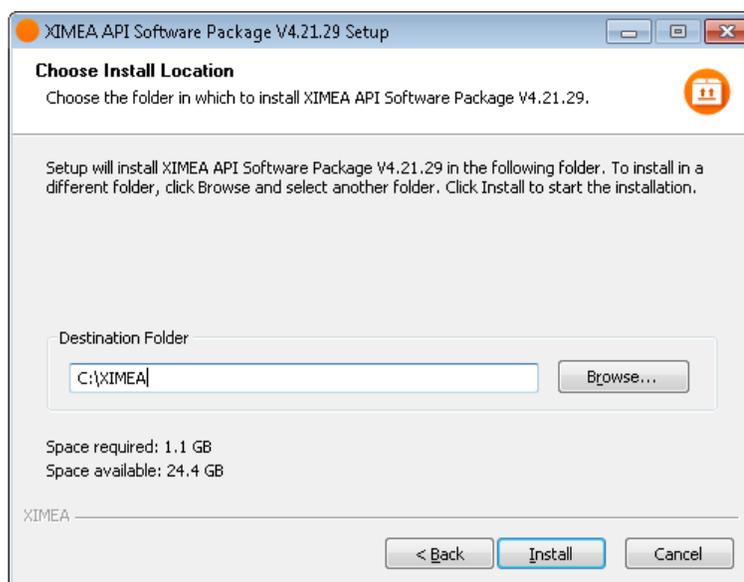
- Now the XIMEA API Software Package should start copying files, updating System Variables and installing drivers if necessary
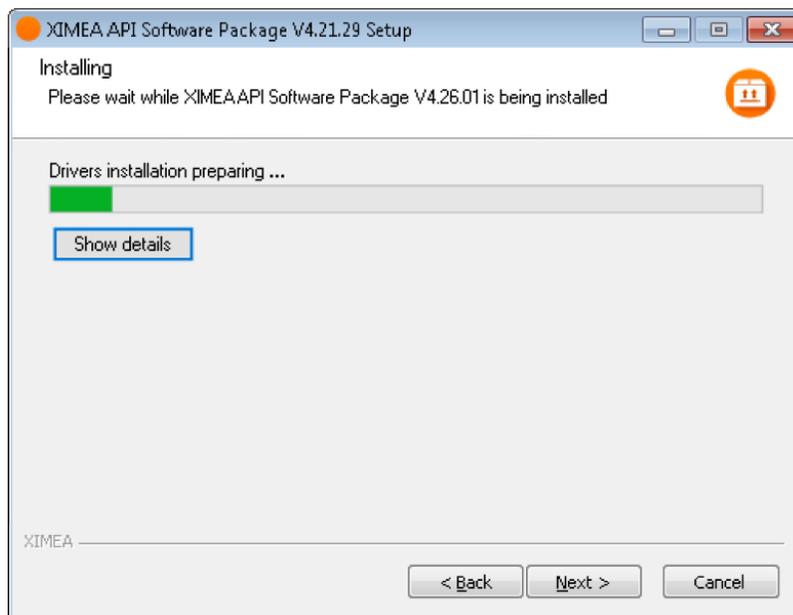
- Installation is completed
- Finish
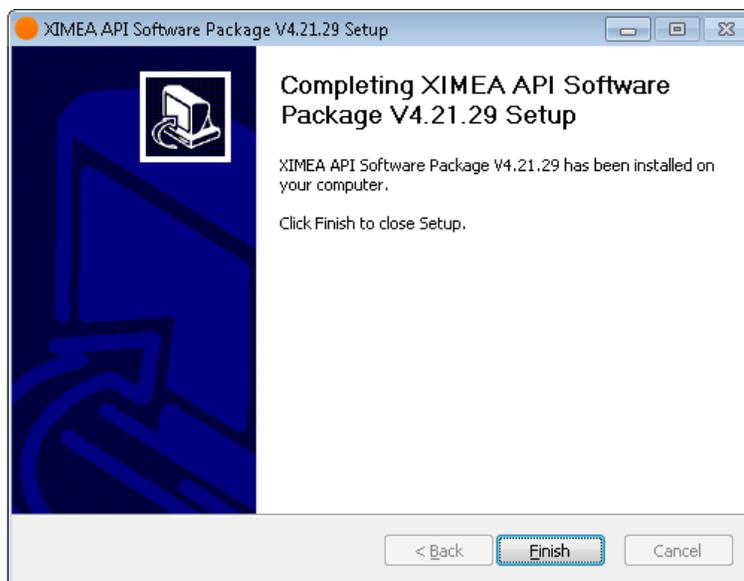
4.2.2 XIMEA Linux software package

XIMEA Linux Software Package is tarred installer with files that can be run on Linux Ubuntu 14.04 and 16.04 (32 and 64 Bit) and newer releases.

Contents

The package contains:

- Driver for XIMEA USB2 and USB3 cameras

- xiAPI

- XIMEA CamTool

- Examples:

  – xiSample - sample showing basic image acquisition in xiAPI

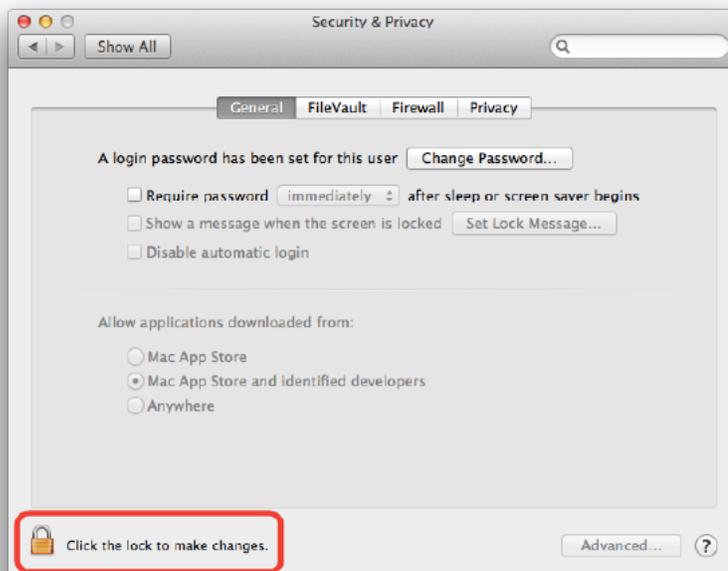## Instalation

- Download XIMEA Linux Software Package:

  http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz

  `wget http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz`

- Untar

  `tar xzf XIMEA_Linux_SP.tgz`

  `cd package`

- Start installation script

  `./install`


```
ximea@ximea-Linux64: ~/package
ximea@ximea-Linux64:~$ tar xzf XIMEA_Linux_SP.tgz
ximea@ximea-Linux64:~$ cd package
ximea@ximea-Linux64:~/package$ ./install -cam_usb30
This will install XIMEA Linux Package after 5 seconds
To abort installation - press Ctrl-C
Installing x64 bit version
[sudo] password for ximea:
This is installation of package for platform -x64
Checking if user is super user
OK
-------------------------------------
WARNING!!!
You have enabled experimental USB3 support! It may affect USB2 support too.
DO NOT downgrade the kernel to versions older than 3.4!!!
Advised way of enabling USB3 support is upgrading kernel to version at least as new as 3.6.
If you decide to do it in the future, rerun this installation script after rebooting into new kernel.
-------------------------------------
Installing libusb
OK
Installing Firewire support - libraw1394
OK
Checking Firewire stack

Installing API library
OK
OK
OK

Rebuilding linker cache
Installing XIMEA-GenTL library
OK
Installing vaViewer
OK
Installing streamViewer
OK
Installing xiSample
OK
Creating desktop link for vaViewer
Creating desktop link for streamViewer
Installing udev rules for USB and Firewire cameras
OK
-------------------------------------
Note:
You may need to reconnect your USB and/or Firewire cameras
Also check that you are in the "plugdev" group

More info:
http://www.ximea.com/support/wiki/apis/Linux_USB20_Support
-------------------------------------
-------------------------------------
For GeniCam - please add GENICAM_GENTL64_PATH=/opt/XIMEA/lib/libXIMEA_GenTL.so to Your .bashrc
o enable GenTL
Now applications can be started. E.g. /opt/XIMEA/bin/xiSample
-------------------------------------
Done OK
ximea@ximea-Linux64:~/package$
```

Note: If logged in user is not root, you will be asked for your password to get root access, because the installation runs with root account using sudo.

4.2.3 XIMEA macOS software package

XIMEA macOS Software Package is native DMG installer that can be run on macOS 10.8 (Mountain Lion) or newer.

Contents

The package contains:

- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
    - xiSample - sample showing basic image acquisition in xiAPI

Installation

Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- Open System Preferences application and click on Security & Privacy

---

- Click on the lock to allow changes to be made

- On the General Tab select the option Anywhere under Allow applications downloaded from:

- Download XIMEA macOS Software:

  http://www.ximea.com/downloads/recent/XIMEA_OSX_SP.dmg

- Mount it by double-clicking this file in Finde

- Run the install script to install XiAPI on your macOS system

- A window with package contents will open

Start XIMEA CamTool

- Connect camera
- Start Applications / XIMEA CamTool
- Start acquisition by clicking on orange triangle at upper left corner of CamTool

Short description

The CamTool is a cross-platform application showcasing the features of all XIMEA camera families. It runs on Windows, Linux, macOS systems offering a substantial imaging tool set, which can be further extended with custom modules using a plugin infrastructure. CamTool is based on Qt for the UI and xiAPI for the camera control. Its camera settings menu resembles the parameter set of the xiAPI.

4.3 XIMEA CamTool

CamTool allows to operate all connected cameras simultaneously. In this case all controls are layered for the cameras. Basic controls are placed as tabs in upper part of the window. Image window can be detached from application if needed. Amount of visible camera controls depend on visibility level which can be set in Edit → Options. For more information, please, visit our website page: CamTool.
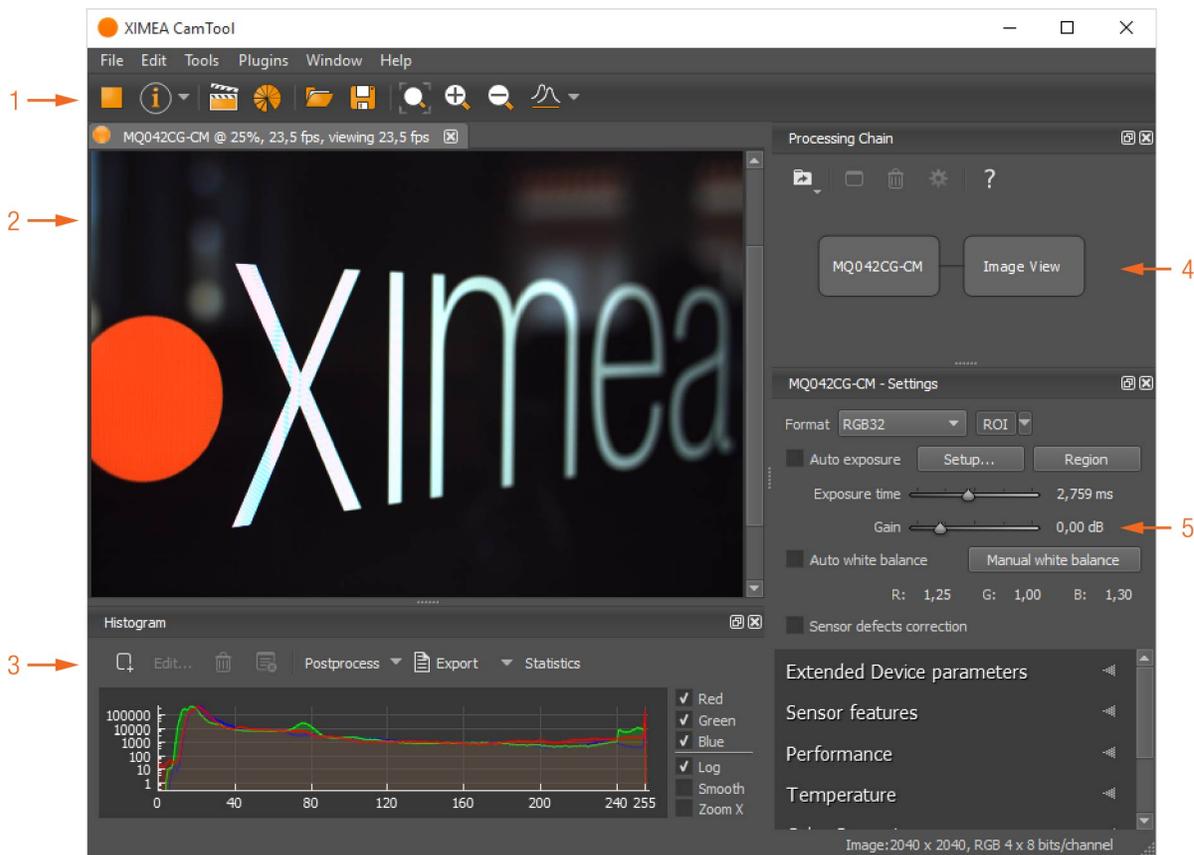
Figure 50: CamTool preview

Number	1	2	3	4	5
Description	Control panel	Image window	Analytics tools	Proccessing chain	Camera control

Table 43: CamTool layout

Functions

- To see live image from multiple XIMEA cameras connected
- Control the camera parameters
- Store of camera image and video
- Analyze the image properties
- Histogram and line profile
- Image averaging, image flip/mirror
- Software trigger timer, save/load camera and program settings
- LUT (Look up table)
- Lua scripting

4.4 XIMEA control panel

The XIMEA Control Panel (xiCOP), is a diagnostics and management tool for all XIMEA cameras.
xiCOP is available for Windows (32, 64-bit) and Linux (64-bit) operating system.
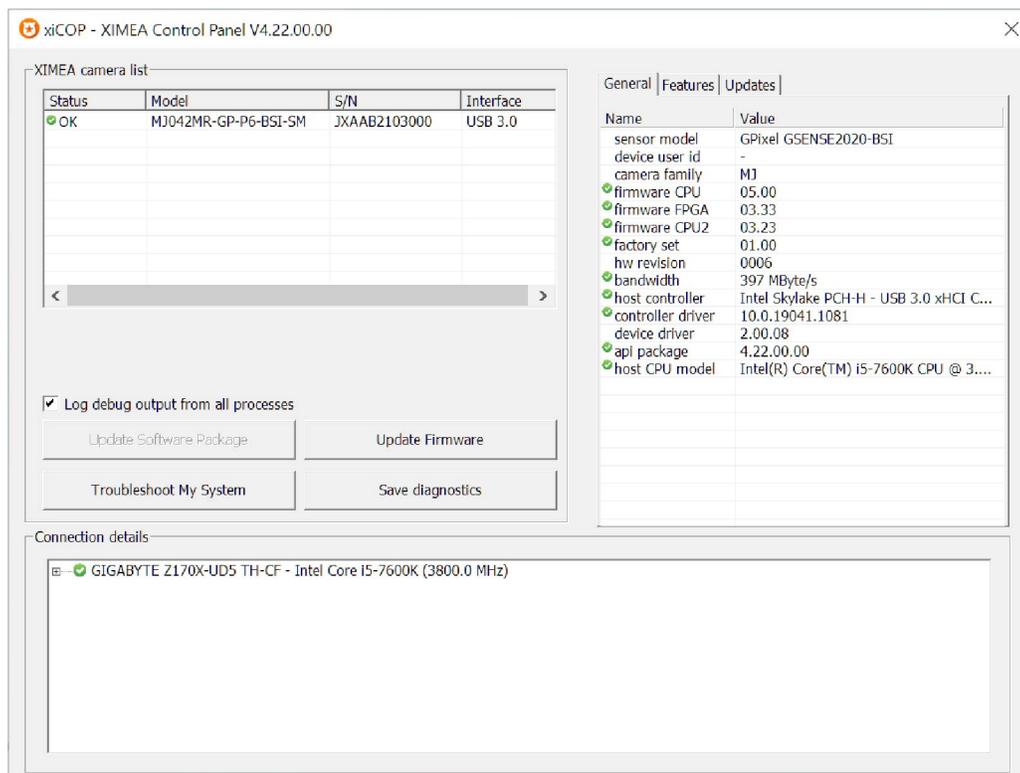
Figure 51: xiCOP example

Features

- Facilitates diagnostics of system performance bottlenecks
  xiCOP is capable of retrieving the system's hardware tree, thus problematic hardware configurations can be identified

- Diagnosis of firmware and software compatibility
  xiCOP checks relevant firmware and software versions and warns if a component is not up-to-date

- Lists all currently attached XIMEA devices and their features.

- Saves a diagnostic log and debug output which can be reviewed by technical support

- Suggests solution for diagnosed issues

- Allows setting of User IDs to XIMEA cameras

- One click to switch selected XIMEA cameras to USB3 Vision standard and back to XIMEA API

- One click update to the latest XIMEA API Software Package

- One click update of firmware in selected cameras

4.5 Supported vision libraries

All XIMEA cameras are compatible with the most advanced vision and image processing libraries. For GUI based software packages, the cameras can be directly accessed without the need of programming. Code libraries are generally used in conjunction with one of our APIs, in order to add additional functionality (e.g. image processing, communication, data storage).

For an up-to-date listing of the supported vision libraries and software packages, visit our website page: Vision Libraries.

4.5.1 MathWorks MATLAB

MathWorks® is the leading developer and supplier of software for technical computing and Model-Based Design. More on our website page: MathWorks MATLAB.

4.5.2 MVTec HALCON

HALCON is the comprehensive standard software for machine vision with an integrated development environment (IDE) that is used world-wide. More on our website page: MVTec HALCON.

4.5.3 National Instruments LabVIEW vision library

LabVIEW is a graphical programming environment. More on our website page: National Instruments LabVIEW Vision Library.

4.5.4 OpenCV

OpenCV is an open-source library of programming functions mainly aimed at real time computer vision. More on our website page: OpenCV

4.6 Programming

Depending on the target application, the user can choose between several ways of accessing and controlling the camera. These can be divided into two categories: a programmatic approach, through programming code, or an integrated approach, through a supported, GUI based software package. The programmatic approach is generally used for the development of a custom application or image processing pipeline. The integrated approach is favored, if the specific toolset of a certain software package is sufficient and the camera serves as an integrated capture device.

4.6.1 Standard interface

As an alternative to the proprietary API, the camera can be accessed through a set of standard interfaces. These interfaces decouple a specific hardware design (e.g. physical interface) of a camera from its control in software. Therefore, multiple camera classes and types can be used in a unified way.

GenICam/GenTL

GenICam/GenTL provides a camera-agnostic transport layer interface to acquire images or other data and to communicate with a device. Each camera serves as a GenTL Producer which can be accessed in all software packages that are compatible with the GeniCam standard, as well as through custom developments which implement this standard interface. For more information on programing according the GenICam standard, please visit the standard's website at www.emva.org.

4.6.2 xiAPI

xiAPI stands for XIMEA Application Programming Interface. It is a common interface for all XIMEA cameras.

Architecture

API is a software interface between the camera system driver and application.

- On Windows: xiAPI is compiled into xiapi32.dll or xiapi64.dll

- On Linux: xiAPI is compiled into /usr/lib/libm3api.so

Installation

xiAPI is part of all current XIMEA software packages for Windows, Linux and MacOS. For information on the software packages, see XIMEA Software Packages.

xiAPI functions description

The core of xiAPI consists of the following functions, which allow controlling of the camera functionality.

```
// get the number of discovered devices.
XI_RETURN xiGetNumberDevices(OUT DWORD *pNumberDevices);

// open interface
XI_RETURN xiOpenDevice(IN DWORD DevId, OUT PHANDLE hDevice);

// get parameter
XI_RETURN xiGetParam(IN HANDLE hDevice, const char* prm, void* val,
DWORD * size, XI_PRM_TYPE * type);

// set parameter
XI_RETURN xiSetParam(IN HANDLE hDevice, const char* prm, void* val,
DWORD size, XI_PRM_TYPE type);
```

```
// start the data acquisition
XI_RETURN xiStartAcquisition(IN HANDLE hDevice);

// acquire image and return image information
XI_RETURN xiGetImage(IN HANDLE hDevice, IN DWORD TimeOut, INOUT XI_IMG * img);

// stop the data acquisition
XI_RETURN xiStopAcquisition(IN HANDLE hDevice);

// close interface
XI_RETURN xiCloseDevice(IN HANDLE hDevice);
```

xiAPI parameters description

For a complete list of available parameters, please visit the xiAPI online manual at xiAPI Manual. All functions in xiAPI return status values in form of the XI_RETURN structure which is defined in xiApi.h. If a parameter is not supported by a certain camera, the return value will represent a respective error code (e.g. 106 - Parameter not supported).

Note: Since xiAPI is a unified programming interface for all of XIMEA's cameras, not all of the described parameters apply for every camera and sensor model.

xiAPI examples

Connect device

This example shows the enumeration of available devices. If any device was found the first device (with index 0) is opened.

```
HANDLE xiH = NULL;

// Get number of camera devices
DWORD dwNumberOfDevices = 0;
xiGetNumberDevices(&dwNumberOfDevices);

if (!dwNumberOfDevices)
{
 printf("No camera found\n");
}
else
{
// Retrieving a handle to the camera device
xiOpenDevice(0, &xiH);
}
```

Parameterize device

This example shows how an exposure time is set. Next, the maximum possible downsampling rate is retrieved and the result is set as new downsampling rate.

```
// Setting "exposure" parameter (10ms)
int time_us = 10000;
xiSetParam(xiH, XI_PRM_EXPOSURE, &time_us, sizeof(time_us), xiTypeInteger);

// Getting maxium possible downsampling rate
int dspl_max = 1;
xiGetParamInt(xiH, XI_PRM_DOWNSAMPLING XI_PRM_INFO_MAX, &dspl_max);

// Setting maxium possible downsampling rate
xiSetParamInt(xiH, XI_PRM_DOWNSAMPLING, dspl_max);
```

Acquire images

This example shows how the acquisition is started on the device with the handle xiH, ten images are acquired in a row and the acquisition is stopped.

```
        xiStartAcquisition(xiH);

#define EXPECTED_IMAGES 10
for (int images=0;images < EXPECTED_IMAGES;images++)
{
// getting image from camera
xiGetImage(xiH, 5000, &image);
printf("Image %d (%dx%d) received from camera\n", images,
(int)image.width, (int)image.height);
}
xiStopAcquisition(xiH);
```

Hardware trigger and exposure active output

In this setup each image is triggered by a Digital Input Trigger. After the image is triggered, it can be transferred using xiGetImage. This setup ensures a low latency between the trigger signal and image Exposure start.
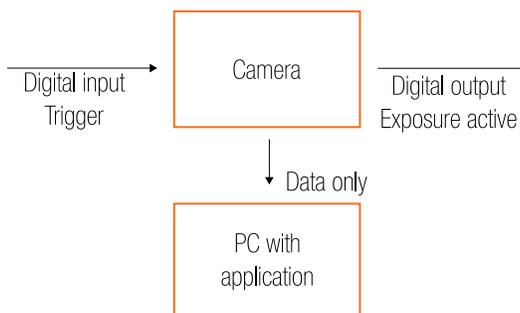
Figure 52: GPIO scheme

```
        HANDLE xiH;
xiOpenDevice(0, & xiH);

// select trigger source
xiSetParamInt(xiH, XI_PRM_TRG_SOURCE, XI_TRG_EDGE_RISING);

// select input pin 1 mode
xiSetParamInt(xiH, XI_PRM_GPI_SELECTOR, 1);
xiSetParamInt(xiH, XI_PRM_GPI_MODE, XI_GPI_TRIGGER)

// set digital output 1 mode
xiSetParamInt(xiH, XI_PRM_GPO_SELECTOR, 1);
xiSetParamInt(xiH, XI_PRM_GPO_MODE,  XI_GPO_EXPOSURE_ACTIVE);

xiStartAcquisition(handle1);

// Trigger signal should start image exposure within timeout
#define TIMEOUT_IMAGE_WAITING_MS 10000
xiGetImage(handle, TIMEOUT_IMAGE_WAITING_MS, &image);
// process image here…
```

xiAPI Auto Bandwidth Calculation

xiAPI uses Auto Bandwidth Calculation (ABC) before the opening of each camera by default. After the measurement, 90% of the measured value is used as the maximum allowed transfer speed of the camera to ensure the stability of transfer.

It is important to set this parameter to XI_OFF to ensure highest possible data transfer speed.
To disable ABC, the application should set parameter XI_PRM_AUTO_BANDWIDTH_CALCULATION to XI_OFF before the first xiOpenDevice is used. This setting disabled ABC and the camera stream is not limited.

xiAPI.NET

XIMEA Application Programming Interface for Dot Net - Microsoft Visual C#. xiAPI.NET is designed as a wrapper around xiAPI and therefore shares most of its functionality.

xiApiPython

Applications in Python can access XIMEA cameras using xiApiPython interface. It is a wrapper around xiAPI, which integrates camera features and capabilities into PYTHON.

5 Appendix

5.1 Troubleshooting and support

This chapter explains how to proceed, if you have issues in bringing your camera to proper operation.

At first, please make sure that you have installed the latest version of the following XIMEA software package, based on your OS:

- XIMEA Windows Software Package
- XIMEA Linux Software Package
- XIMEA macOS Software Package

Please make sure, that you have connected your camera with the appropriate XIMEA cable to an appropriate port. Ensure that the connections are carefully locked. Follow the instructions described in section 4.3 (run the camera with the Ximea CamTool). In case that you still have issues, please read the following chapters.

5.1.1 Worldwide support

We offer worldwide first level support to you by our partners. Please refer to your local dealer if you need technical support for your camera.

5.1.2 Before contacting technical support

There are several steps to take before contacting your local dealer for technical support. In case you cannot display images from your camera, please open the XIMEA xiCOP software (please see section 4.4). It will immediately start searching for connected cameras. Your camera will appear in the XIMEA camera list on the upper left side of the xiCOP window if it is connected properly and your USB interface meets the minimum system requirements described in section 4.1. If the camera does not appear, please proceed with the following steps:

Step 1   Click on the button "Troubleshoot My System" and follow the instructions that are suggested.

Step 2   If step 1 does not lead to a positive result, please click the button "Save diagnostics".
Keep the diagnostic file ready for providing it to support.

Step 3   Contact your local dealer where you bought the camera either by phone or by email for first level support.
They will decide if they can help you immediately or if more information is necessary for initiating the next steps.

5.2 Frequently Asked Questions

- Frequently Asked Questions
- Knowledge Base

5.3 Product service request (PSR)

If you experienced any unexpected behavior of your camera, please, follow the steps described below:

Step 1 – Contact support

If your camera is not working as expected, please, contact your local dealer for troubleshooting the product and determine the eligibility of a Product Service Request (Product Service Request (PSR)). In case you were asked to create a PSR by your local contact, please continue to Step 2.

NOTE: Your product must be UNDER WARRANTY in order to qualify for a free repair or replacement.

Step 2 – Create product service request (PSR)

- Read the XIMEA General Terms & Conditions
- Open the XIMEA Helpdesk
- Set field Department to "Service"
- Fill in all fields
- Confirm with the button "Submit"

Step 3 – Wait for PSR approval

Our support personnel will verify the PSR for validity. If your PSR is valid and no further information is required, the PSR will be approved within 3 business days. After that you will get a notification email contains the shipping instructions. When you received the PSR Approval email – please continue to Step 4. In case your PSR was rejected – please do not send the product to XIMEA.

Step 4 – Sending the camera to XIMEA

If possible, send the camera back in the original package. If not possible, please pack the camera in a way that it cannot be damaged during shipment and send it back as described in the PSR Approval email that you have received.

Step 5 – Waiting for service conclusion

Once we have received the camera, we will send you a notification. The XIMEA Service will then check the status of the camera that you have sent for a possible repair. Depending on warranty conditions, product status and agreement one of the following operations will be performed:

Operation	Repair costs paid by	Return delivery costs paid by
repaired in warranty	XIMEA	XIMEA
replaced in warranty	XIMEA	XIMEA
repaired for cost	Customer	Customer
not repaired and returned	—	Customer
not repaired and discarded if requested by customer	—	—

Table 44: Service operations overview

If the camera will be returned, you will receive the tracking number. In this case, please continue to Step 6.

Step 6 – Waiting for return delivery

After you have received the return shipment, please confirm it by changing the status of the PSR to "Received by customer".

NOTE: If you have any problems accessing the links below, please contact our Support Team at www.ximea.com.

5.4 Safety instructions and precautions

Safety instructions and precautions are available at the following XIMEA webpage: Safety instructions and precautions.

5.5 Warranty

Information about warranty is available at the following XIMEA webpage: Warranty.

5.6 Standard Terms & Conditions of XIMEA GmbH

The Standard Terms and Conditions are available at the following XIMEA webpage: General Terms and Conditions.

5.7 List of Trademarks

List of Trademarks is available at the following XIMEA webpage: List of Trademarks.

5.8 Copyright

All texts, pictures and graphics are protected by copyright and other laws protecting intellectual property. It is not permitted to copy or modify them for trade use or transfer, nor may they be used on websites.

Glossary

API	Application Programming Interface	57
CMOS	Complementary Metal-Oxide-Semiconductor	58
DMA	Direct Memory Access	9
ESD	Electrostatic discharge	33
FPGA	Field Programmable Gate Array	53
FPS	Frame Per Second	55
PCB	Printed Circuit Board (same as PWB)	11
PSR	Product Service Request	81
ROI	Region Of Interest	53

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