xiX

[ksi-xː] or [sai-exː]

PCI Express cameras for integration

XIMEA Cameras

Technical Manual

Version v260402

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

XIMEA is a worldwide operating company

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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 12.5 Mpx to 47.5 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 x4 Gen2 (20 Gbit/s) cameras (60 × 60 mm) can be used with active Canon EF-mount.

1.2 Advantages

Industry standard interface	PCI Express
Small	perfect size and customization options for Embedded vision system applications
Powerful	20 Gbit/s interface using standard PCI Express hardware
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, 4x 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.

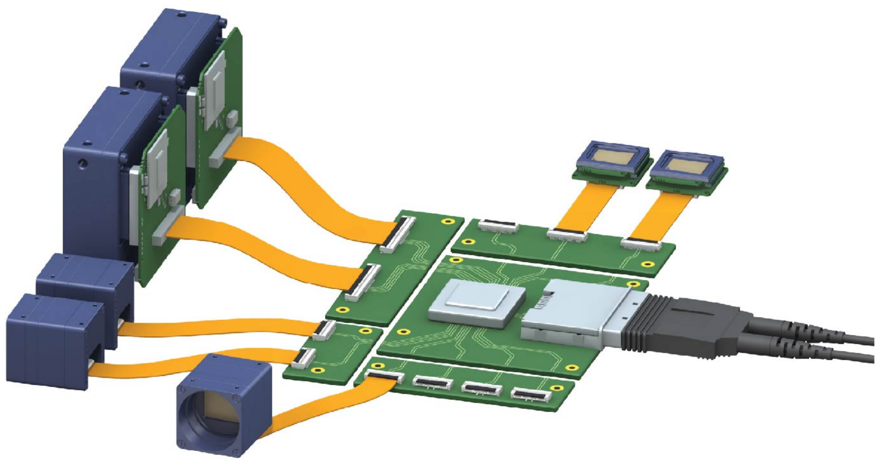


Figure 3: Example of aggregation of many camera in to one cable

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.

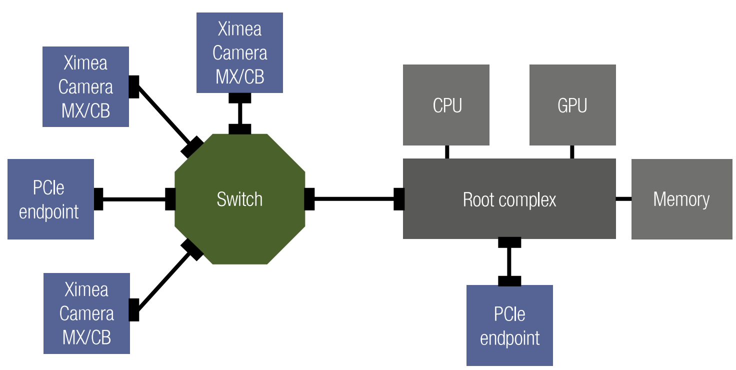


Figure 4: PCI express topology

Highlights

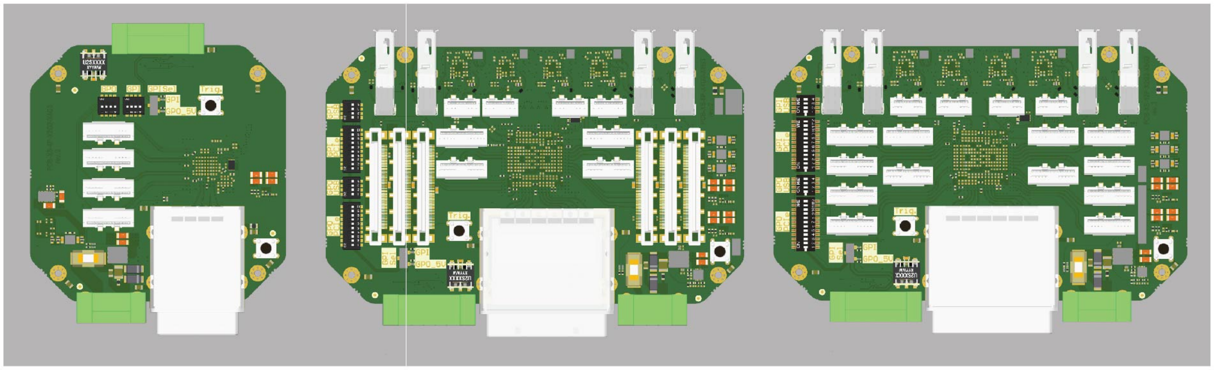
- Maximum compactness: smallest form factor cameras and mini connectors allow closest sensor-to-sensor proximity
- Aggregation into one high bandwidth upstream (up to 64Gbit/s)
- Full utilization of PCIe architecture with point-to-point connection and direct memory access
- Use of standard components 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.



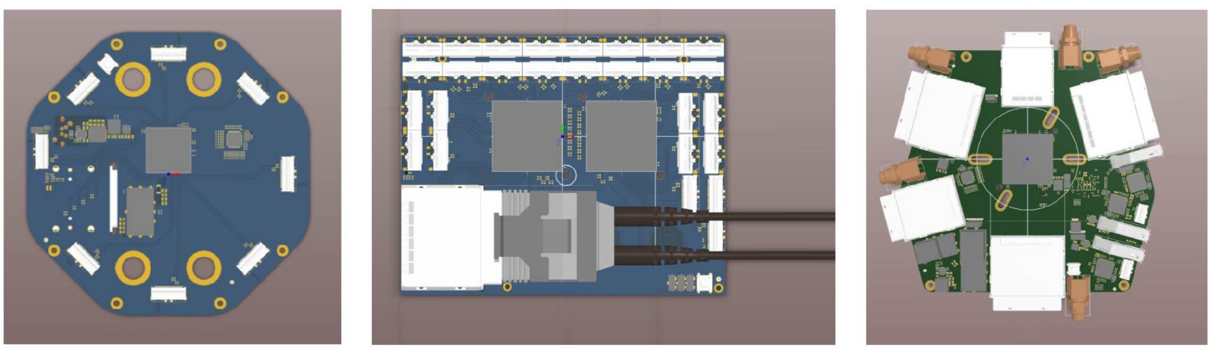
Downstream 4x PCIe x2 Gen2 10Gb/s
Upstream 1x PCIe x4 Gen3 32Gb/s

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
G:	global shutter
zz:	Vendor of the sensor
zz = CM:	CMOSIS
XaGb:	
a = 4	Number of PCIe lanes used
b = 2	PCIe generation
[-OPT]:	Connector options
OPT = FL:	flex line variant, connector parallel to board, semi-housed
OPT = FV:	flex line variant, connector perpendicular to board, semi-housed

1.7 Models and sensors overview

Camera model	Sensor model	Sensor type	Filter	Resolution [px]	Pixel size [µm]
MX120CG-CM-X4G2-FL	CMOSIS CMV12000	Color	BayerGB	4096 × 3072	5.5
MX120CG-CM-X4G2-FV	CMOSIS CMV12000	Color	BayerGB	4096 × 3072	5.5
MX120MG-CM-X4G2-FL	CMOSIS CMV12000	Monochrome	None	4096 × 3072	5.5
MX120MG-CM-X4G2-FV	CMOSIS CMV12000	Monochrome	None	4096 × 3072	5.5
MX200CG-CM-X4G2-FL	CMOSIS CMV20000	Color	BayerRG	5120 × 3840	6.4
MX200CG-CM-X4G2-FV	CMOSIS CMV20000	Color	BayerRG	5120 × 3840	6.4
MX200MG-CM-X4G2-FL	CMOSIS CMV20000	Monochrome	None	5120 × 3840	6.4
MX200MG-CM-X4G2-FV	CMOSIS CMV20000	Monochrome	None	5120 × 3840	6.4
MX500CG-CM-X4G2-FL	CMOSIS CMV50000	Color	BayerBG	7920 × 6004	4.6
MX500CG-CM-X4G2-FV	CMOSIS CMV50000	Color	BayerBG	7920 × 6004	4.6
MX500MG-CM-X4G2-FL	CMOSIS CMV50000	Monochrome	None	7920 × 6004	4.6
MX500MG-CM-X4G2-FV	CMOSIS CMV50000	Monochrome	None	7920 × 6004	4.6

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-MX-X4G2-0M20	0.2 m flat ribbon cable for PCIe Gen 2 x4
CBL-MX-X4G2-0M30	0.3 m flat ribbon cable for PCIe Gen 2 x4
CBL-MX-X4G2-0M40	0.4 m flat ribbon cable for PCIe Gen 2 x4
ADPT-MX-X2G2-X4G2	Breakout board from X2G2 flat ribbon to X4G2 ribbon (both directions)
ADPT-MX-X4G2-IPASS-HOST-Fx[1]	Breakout board from iPass X4G2 to X4G2 flat ribbon
ADPT-MX-X4G2-IPASS-TARGET-Fx[1]	Breakout board from X4G2 flat ribbon cable to iPass X4G2
ADPT-MX-X4G2-M2-Fx[1]	Breakout board from M.2 to X4G2 ribbon cable
ADPT-MX-X4G2-MINI-PCIE-Fx[1]	Breakout board from Mini PCIe to X4G2 flat ribbon
ADPT-MX-X4G2-PCIE-Fx[1]	Breakout board from PCIe to X4G2 flat ribbon
MECH-60MM-BRACKET-T	xiX X4G2 series tripod mounting bracket
MECH-60MM-EF-ADAPTER-KIT[2]	Canon EF Lens Mount Adapter Kit

[1] Adapters are available with a vertical (-FV) or horizontal orientation (-FL) of the flat ribbon connector.
[2] 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

[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

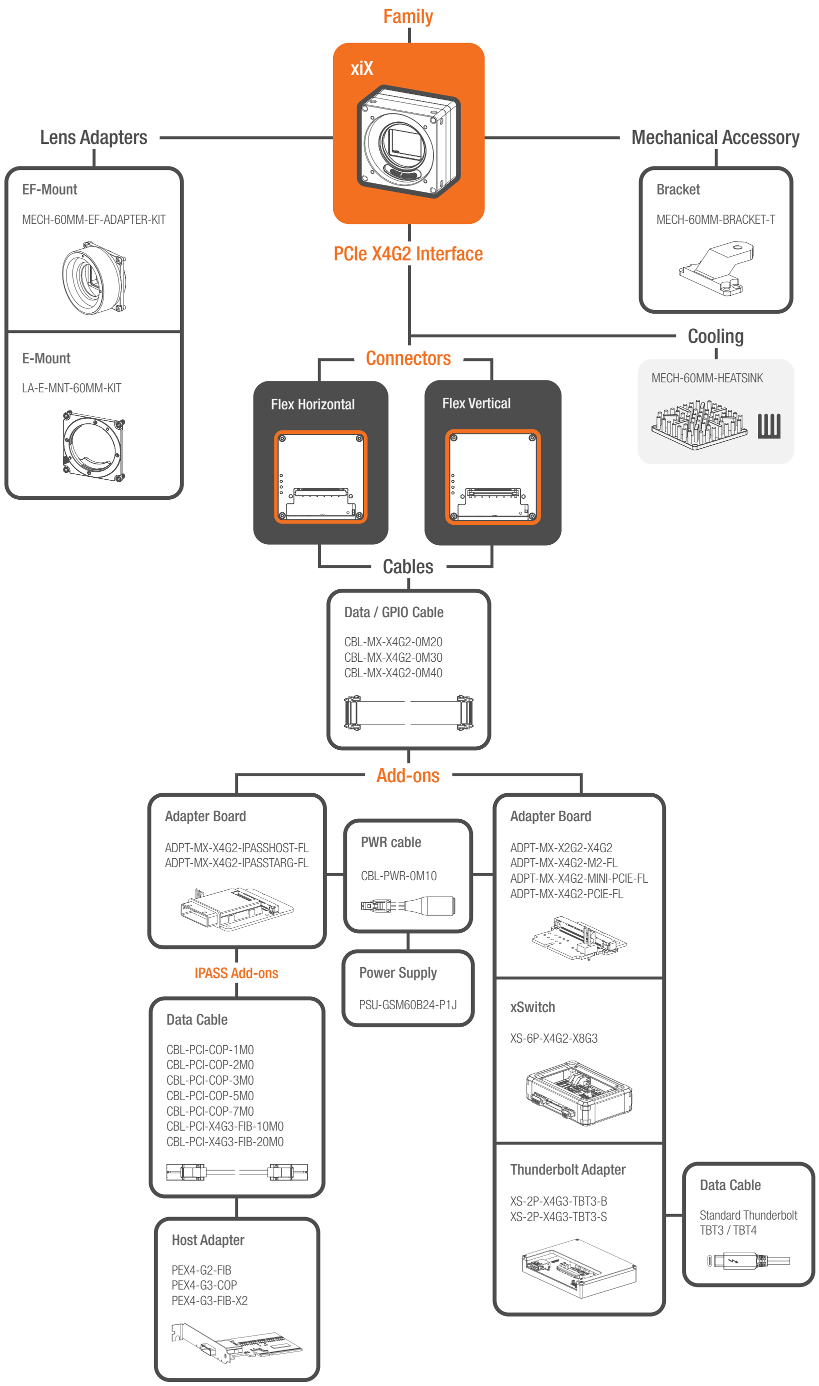


Figure 7: Diagram of accessories and specific connections for the xiX camera family

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:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
24 V	7.4 W	10 W	10 W

[1]Supported voltage 12 - 24 V

Table 4: Power consumption of the specific models

Power consumption of:

MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
24 V	6.6 W	9 W	9.0 W

[1]Supported voltage 12 - 24 V

Table 5: Power consumption of the specific models

Power consumption of:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
12 V	9.0 W	9.0 W	9.5 W

[1]Supported voltage 12 - 24 V

Table 6: 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 7: 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

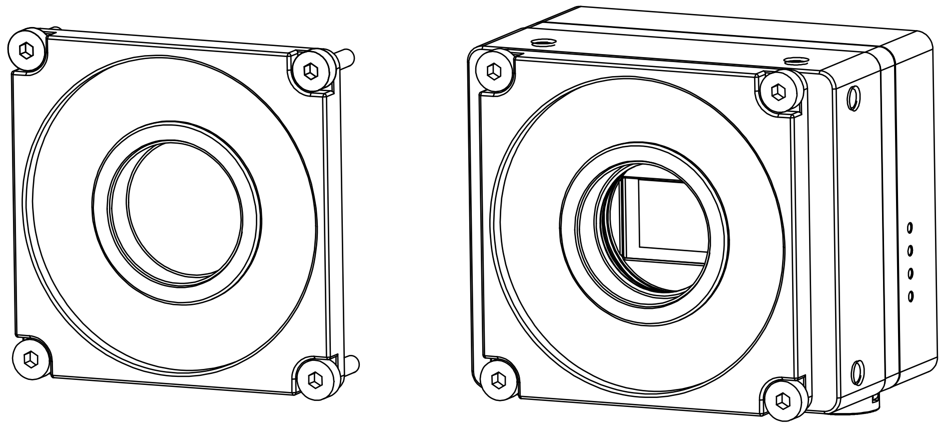


Figure 8: Lens mount adapter C-Mount 60mm (left) , camera with adapter (right)

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

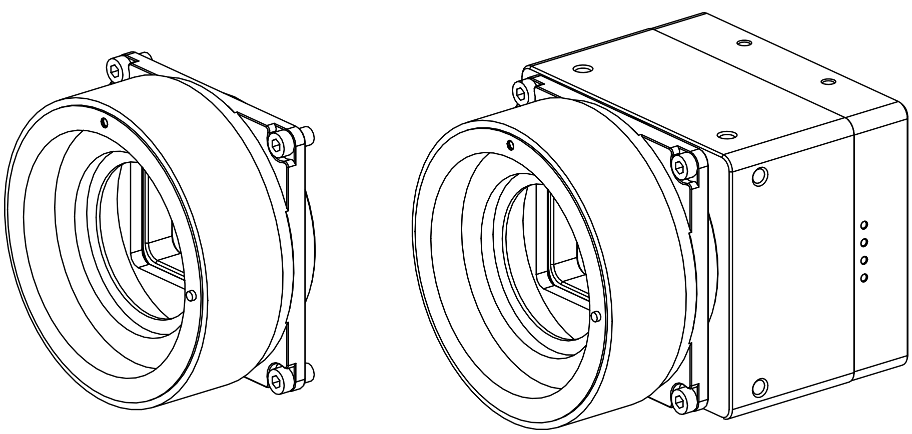


Figure 9: Lens mount adapter EF-mount (left) , camera with adapter (right)

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.

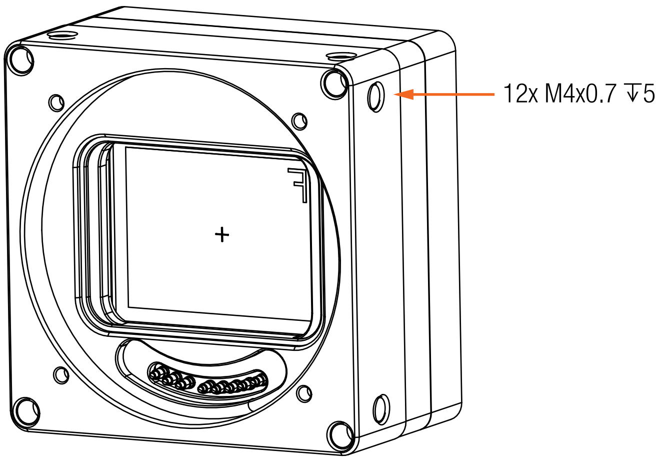


Figure 10: xiX-X4G2/X8G3 camera mounting points

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:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

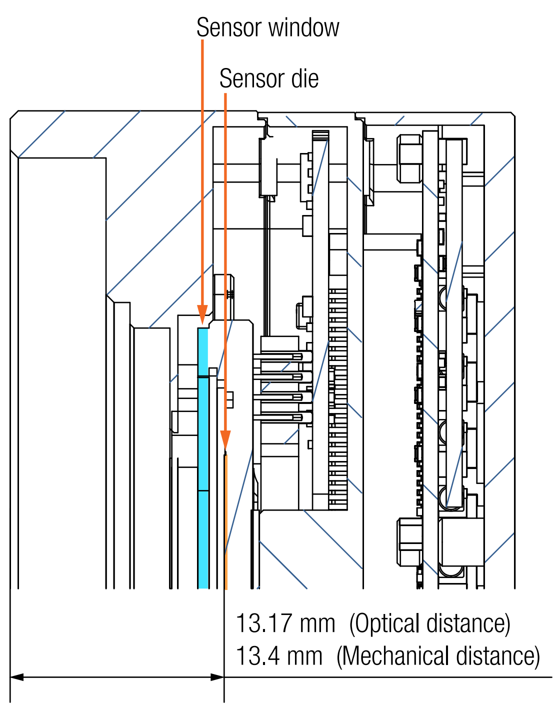


Figure 11: Cross section of MX120/500xG-CM-X4G2-Fx camera models

Sensor window	Value
Thickness	0.7 mm (+/- 0.05 mm)
Distance to sensor die	1 mm (+/- 0.20 mm)

Table 8: Sensor window details

Cross-section corresponding to:

MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

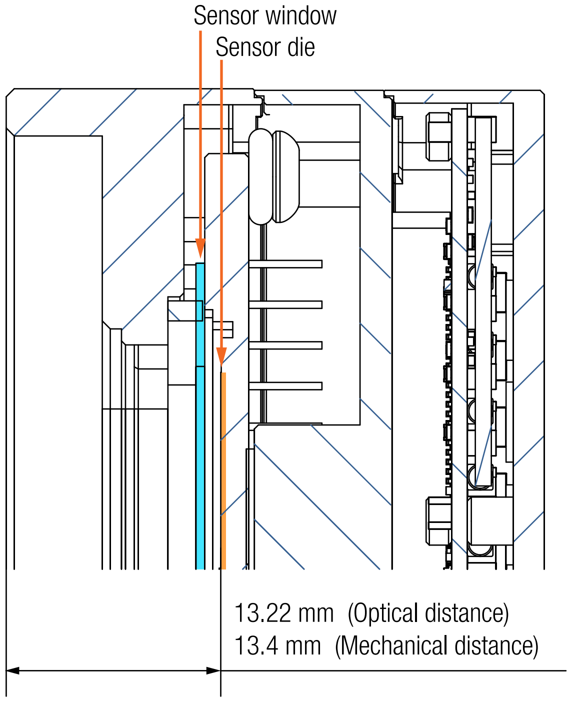


Figure 12: Cross section of MX200xG-CM-X4G2-Fx camera models

Sensor window	Value
Thickness	0.7 mm (+/- 0.05 mm)
Distance to sensor die	1.03 mm (+/- 0.17 mm)

Table 9: Sensor window details

Cross-section corresponding to:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

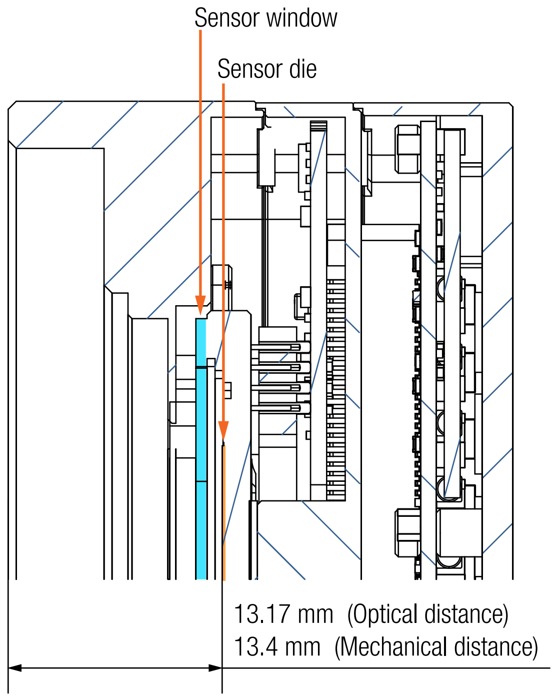


Figure 13: Cross section of MX120/500xG-CM-X4G2-Fx camera models

Sensor window	Value
Thickness	0.7 mm (+/- 0.05 mm)
Distance to sensor die	0.93 mm (+/- 0.20 mm)

Table 10: 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:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	4096 x 3072	[px]
Active area size (H X V)	22.5 x 16.9	[mm]
Sensor diagonal	28.2	[mm]
Pixel size (H x V)	5.5 x 5.5	[µm]

Table 11: Sensor parameters of the specific models

Sensor parameters of:

MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	5120 x 3840	[px]
Active area size (H X V)	32.8 x 24.6	[mm]
Sensor diagonal	41.0	[mm]
Pixel size (H x V)	6.4 x 6.4	[µm]

Table 12: Sensor parameters of the specific models

Sensor parameters of:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	7920 x 6004	[px]
Active area size (H X V)	36.4 x 27.6	[mm]
Sensor diagonal	45.7	[mm]
Pixel size (H x V)	4.6 x 4.6	[µm]

Table 13: 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:
MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	13.44
Absolute sensitivity threshold	[e_-]	13.94
Saturation capacity	[ke_-]	9.9
Dynamic range	[dB]	57.03
MAX Signal-to-noise ratio	[dB]	40.33
Overall system gain	[e_-/DN]	2.96
Dark current	[e_-/s]	380.07
Dark current meas. temp.	[°C]	41.7
DSNU	[e_-]	31.98
PRNU	[%]	1.28
Linearity error	[%]	2.84

Table 14: Image quality parameters of the specific models

Image quality parameters of:
MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	13.44
Absolute sensitivity threshold	[e_-]	13.94
Saturation capacity	[ke_-]	10.0
Dynamic range	[dB]	57.06
MAX Signal-to-noise ratio	[dB]	40.32
Overall system gain	[e_-/DN]	3.02
Dark current	[e_-/s]	1126.8
Dark current meas. temp.	[°C]	50.1
DSNU	[e_-]	27.05
PRNU	[%]	1.81
Linearity error	[%]	2.1

Table 15: Image quality parameters of the specific models

Image quality parameters of:
MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	9.84
Absolute sensitivity threshold	[e_-]	10.34
Saturation capacity	[ke_-]	14.97
Dynamic range	[dB]	63.16
MAX Signal-to-noise ratio	[dB]	41.79
Overall system gain	[e_-/DN]	4.09
Dark current	[e_-/s]	633.08
Dark current meas. temp.	[°C]	38.8
DSNU	[e_-]	25.61
PRNU	[%]	2.75
Linearity error	[%]	0.67

Table 16: Image quality parameters of the specific models

Image quality parameters of:
MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	10.68
Absolute sensitivity threshold	[e_-]	11.18
Saturation capacity	[ke_-]	16.65
Dynamic range	[dB]	63.31
MAX Signal-to-noise ratio	[dB]	42.14
Overall system gain	[e_-/DN]	4.52
Dark current	[e_-/s]	1250.86
Dark current meas. temp.	[°C]	44.5
DSNU	[e_-]	27.08
PRNU	[%]	1.44
Linearity error	[%]	1.49

Table 17: Image quality parameters of the specific models

Image quality parameters of:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	8.18
Absolute sensitivity threshold	[e_-]	8.68
Saturation capacity	[ke_-]	13.38
Dynamic range	[dB]	63.75
MAX Signal-to-noise ratio	[dB]	41.55
Overall system gain	[e_-/DN]	3.53
Dark current	[e_-/s]	10.65
Dark current meas. temp.	[°C]	47.1
DSNU	[e_-]	27.45
PRNU	[%]	1.19
Linearity error	[%]	2.34

Table 18: Image quality parameters of the specific models

Image quality parameters of:

MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

Mode		12 bit
Sensor bit/px	[bit/px]	12
Parameters		
Temporal dark noise	[e_-]	8.41
Absolute sensitivity threshold	[e_-]	8.91
Saturation capacity	[ke_-]	13.72
Dynamic range	[dB]	63.75
MAX Signal-to-noise ratio	[dB]	41.65
Overall system gain	[e_-/DN]	3.58
Dark current	[e_-/s]	11.78
Dark current meas. temp.	[°C]	46.6
DSNU	[e_-]	27.01
PRNU	[%]	1.05
Linearity error	[%]	1.68

Table 19: 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:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Frame rate[1]
1 x 1	8	4096 x 3072	8	138.2
Dec.1 x 2	8	4096 x 1536	8	271.1
Dec.2 x 2	8	2048 x 1536	8	542.2
Bin.2 x 2	8	2048 x 1536	8	200.8
1 x 1	10	4096 x 3072	10	110.7
Dec.1 x 2	10	4096 x 1536	10	218.0
Dec.2 x 2	10	2048 x 1536	10	436.0
Bin.2 x 2	10	2048 x 1536	10	267.8
1 x 1	12	4096 x 3072	12	92.2
Dec.1 x 2	12	4096 x 1536	12	181.2
Dec.2 x 2	12	2048 x 1536	12	357.8
Bin.2 x 2	12	2048 x 1536	12	267.1

[1]Frame rate was measured using the transport format at bandwidth limit 1750.0 MB/s

Table 20: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Frame rate[1]
1 x 1	12	5120 x 3840	12	32.3
Dec.1 x 2	12	5120 x 1920	12	64.2
Dec.1 x 4	12	5120 x 960	12	126.8

[1]Frame rate was measured using the transport format at bandwidth limit 1750.0 MB/s

Table 21: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Frame rate[1]
1 x 1	12	7920 x 6004	8	30.9
1 x 1	12	7920 x 6004	10	29.2
1 x 1	12	7920 x 6004	12	24.4
1 x 1	12	7920 x 6004	16	18.3
Dec.2 x 1	12	3960 x 6004	12	30.9
Dec.1 x 2	12	7920 x 3002	12	48.4
Dec.2 x 2	12	3960 x 3000	12	61.4
Bin.2 x 2	12	3960 x 3000	12	30.8

[1] Frame rate was measured using the transport format at bandwidth limit 1750.0 MB/s

Table 22: Sensor read-out modes of the specific models

2.6.4 Quantum efficiency curves

Quantum efficiency curves for:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

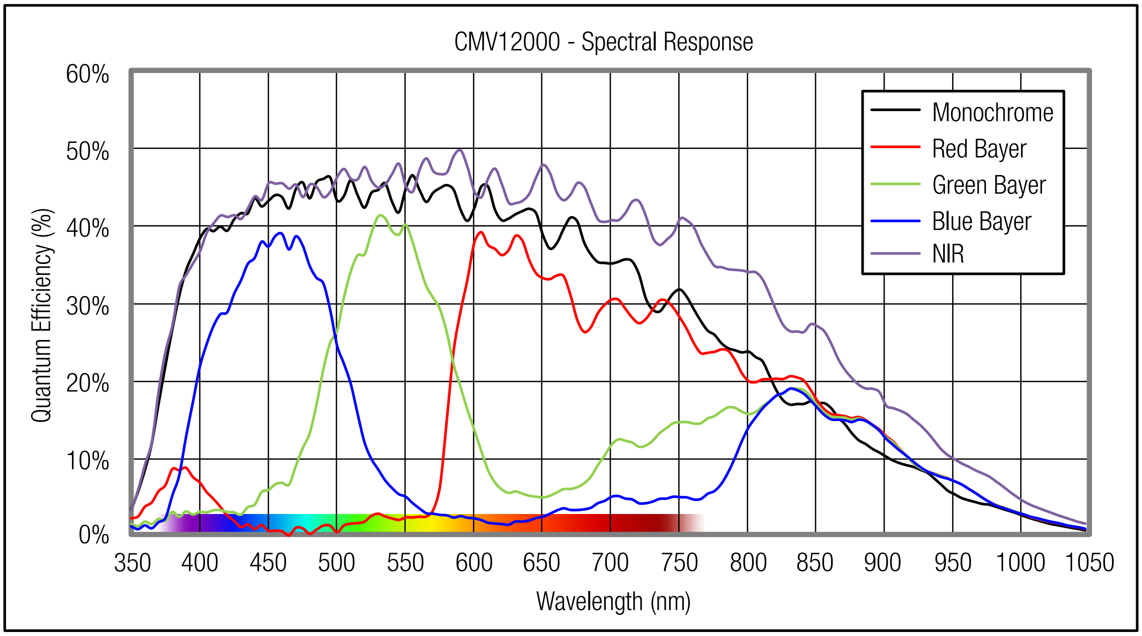


Figure 14: Graph quantum efficiency of CMOSIS CMV12000

Quantum efficiency curves for:

MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

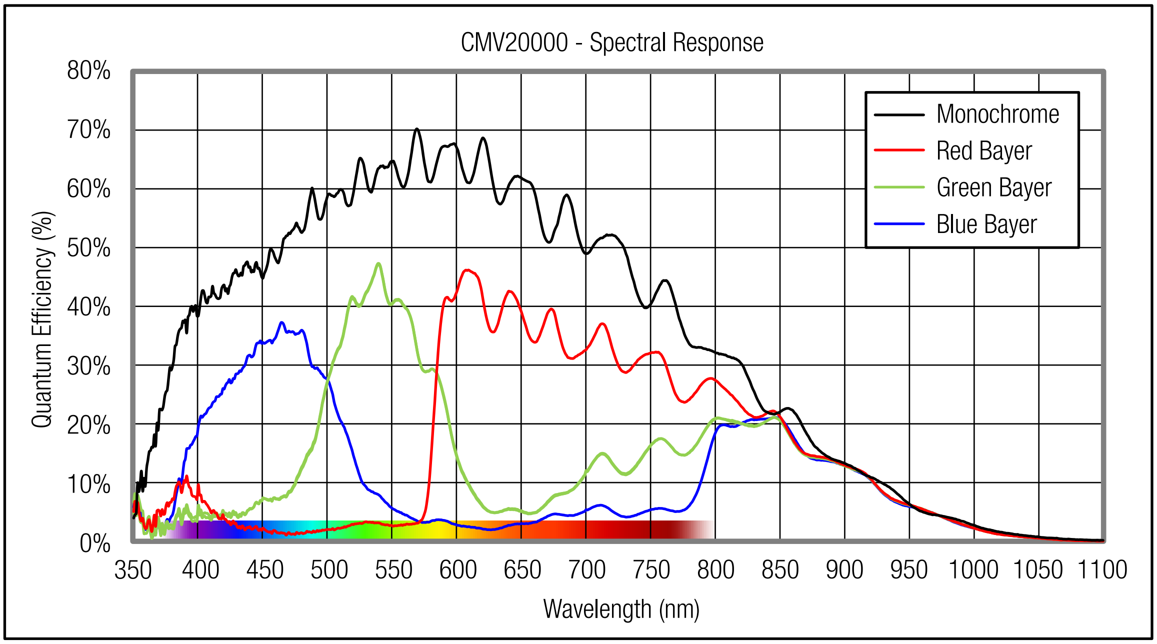


Figure 15: Graph quantum efficiency of CMOSIS CMV20000

Quantum efficiency curves for:

MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

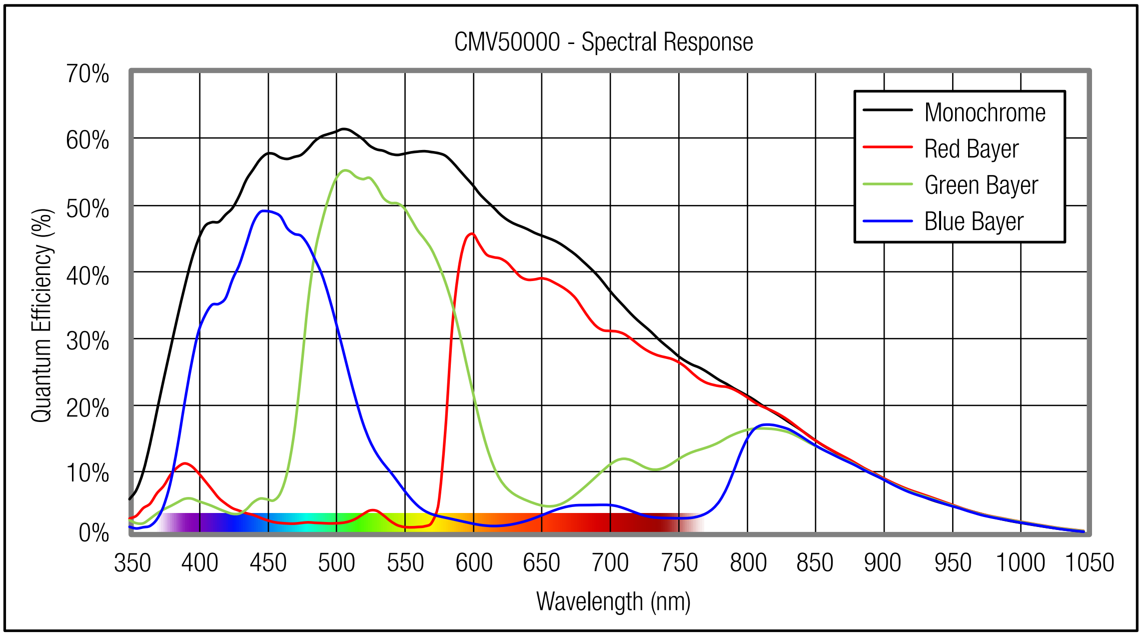


Figure 16: Graph quantum efficiency of CMOSIS CMV50000

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

Dimensions and mass of:
MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
60 mm	60 mm	31.6 mm	151 g

[1] without adapters

Table 23: Camera parameters of the specific models

Dimensions and mass of:
MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
60 mm	60 mm	33.6 mm	156 g

[1] without adapters

Table 24: Camera parameters of the specific models

Dimensions and mass of:
MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
60 mm	60 mm	33.4 mm	179 g

[1] without adapters

Table 25: Camera parameters of the specific models

2.7.2 Dimensional drawings

Dimensional drawings of:

MX120CG-CM-X4G2-FL MX120MG-CM-X4G2-FL

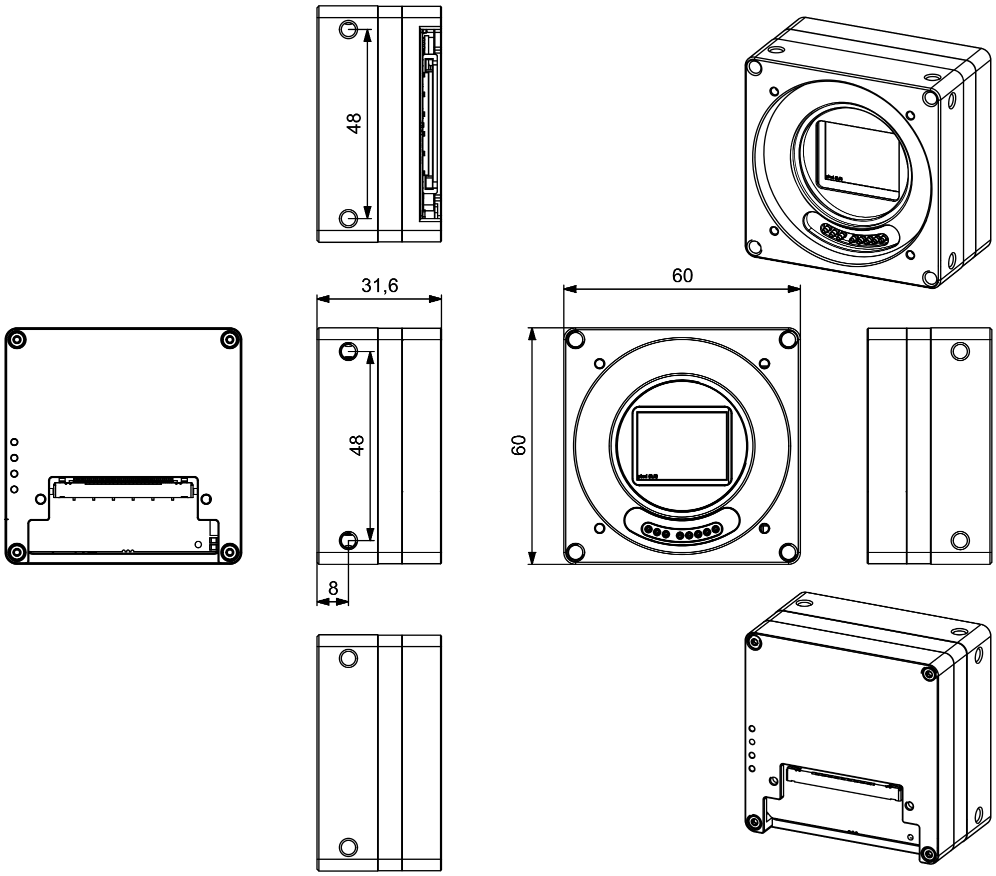


Figure 17: Dimensional drawing of MX120xG-CM-X4G2-FL

Dimensional drawings of:

MX120CG-CM-X4G2-FV MX120MG-CM-X4G2-FV

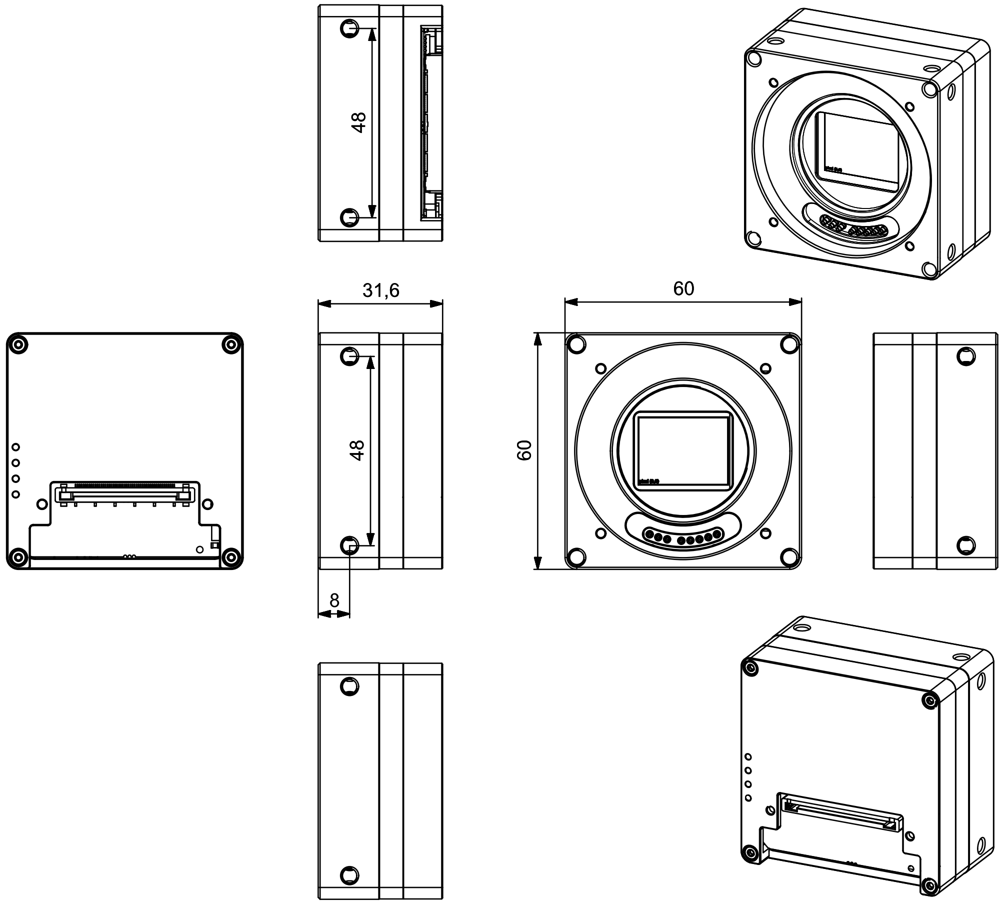


Figure 18: Dimensional drawing of MX120xG-CM-X4G2-FV

Dimensional drawings of:

MX200CG-CM-X4G2-FL MX200MG-CM-X4G2-FL

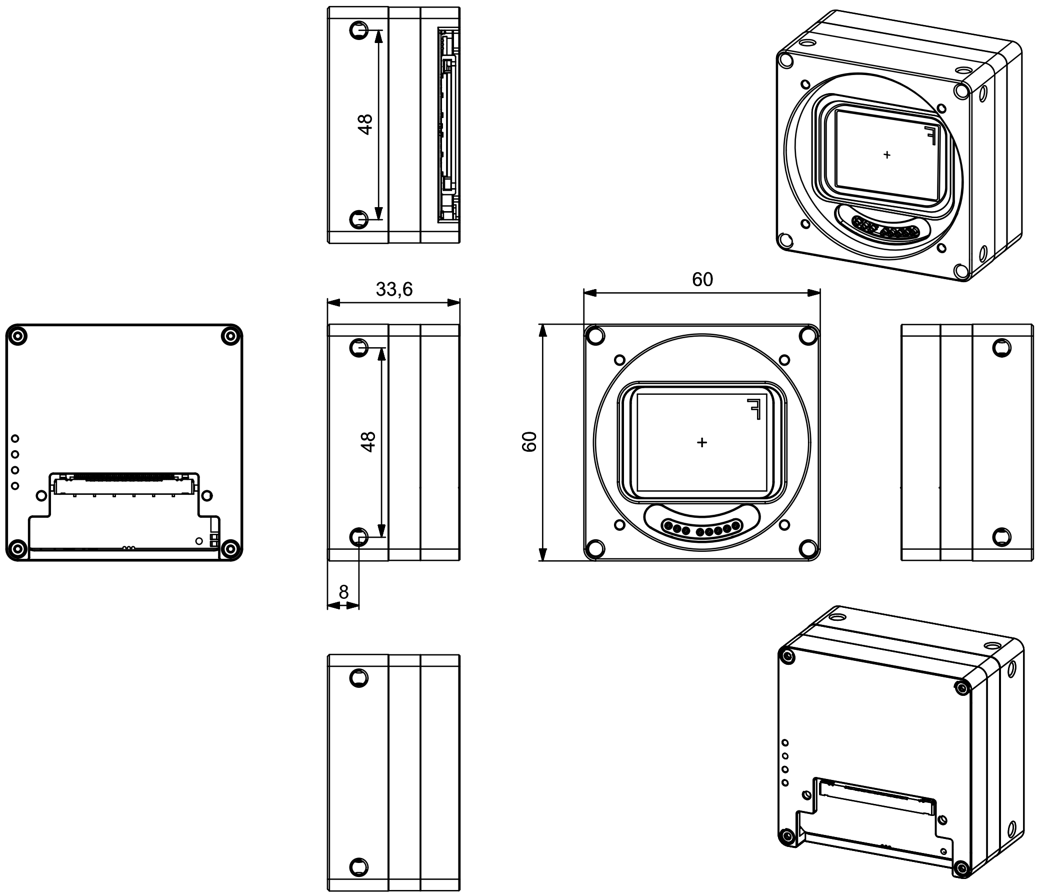


Figure 19: Dimensional drawing of MX200xG-CM-X4G2-FL

Dimensional drawings of:

MX200CG-CM-X4G2-FV MX200MG-CM-X4G2-FV

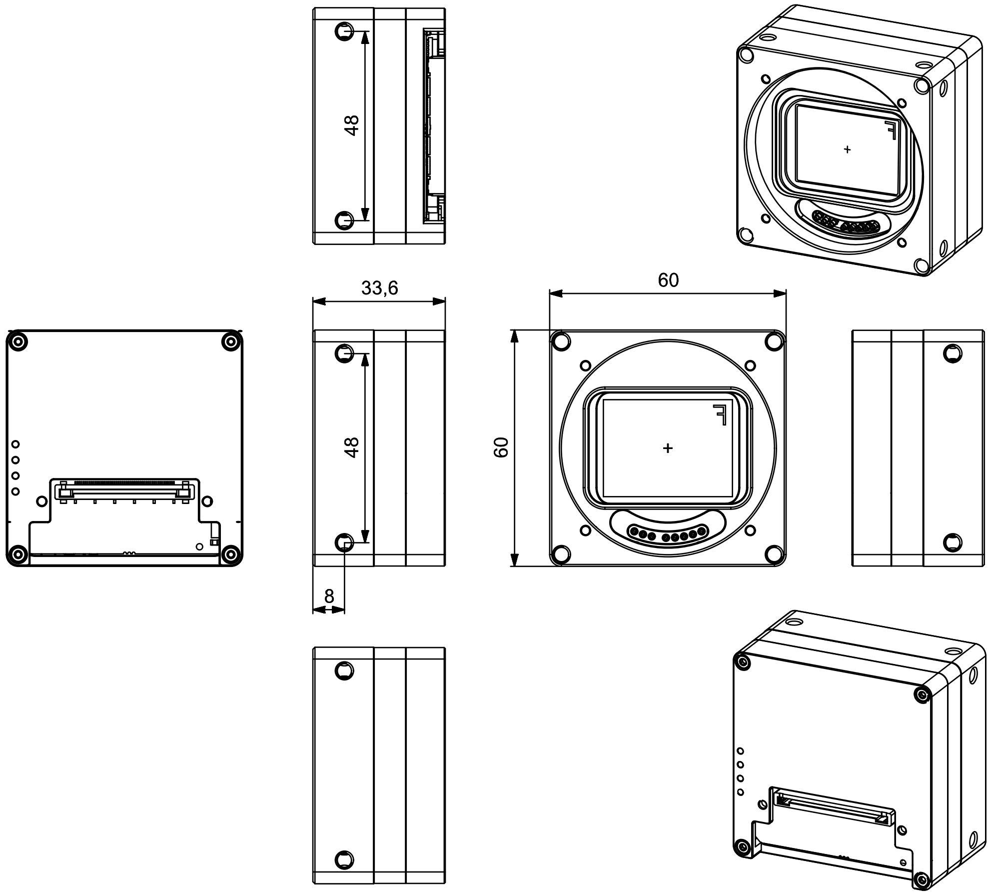


Figure 20: Dimensional drawing of MX200xG-CM-X4G2-FV

Dimensional drawings of:

MX500CG-CM-X4G2-FV MX500MG-CM-X4G2-FV

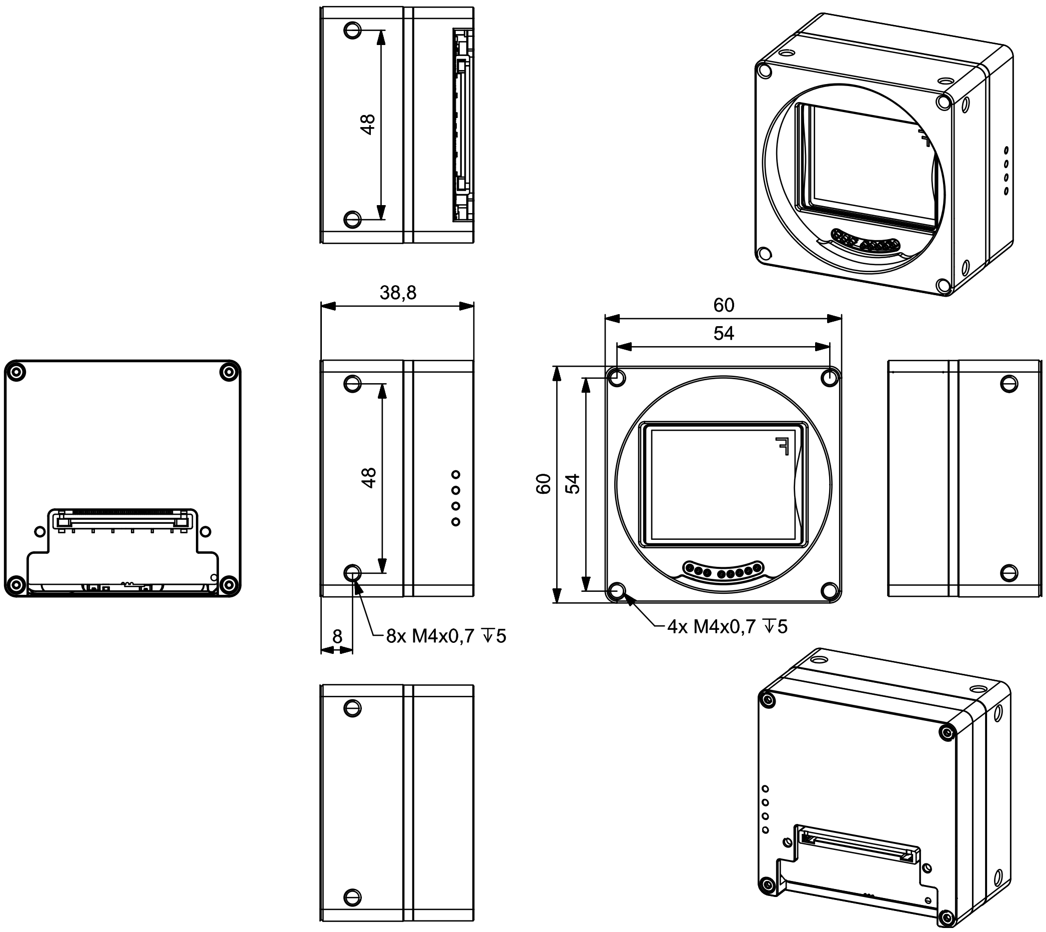


Figure 21: Dimensional drawing of MX500xG-CM-X4G2-FV

Dimensional drawings of:

MX500CG-CM-X4G2-FL MX500MG-CM-X4G2-FL

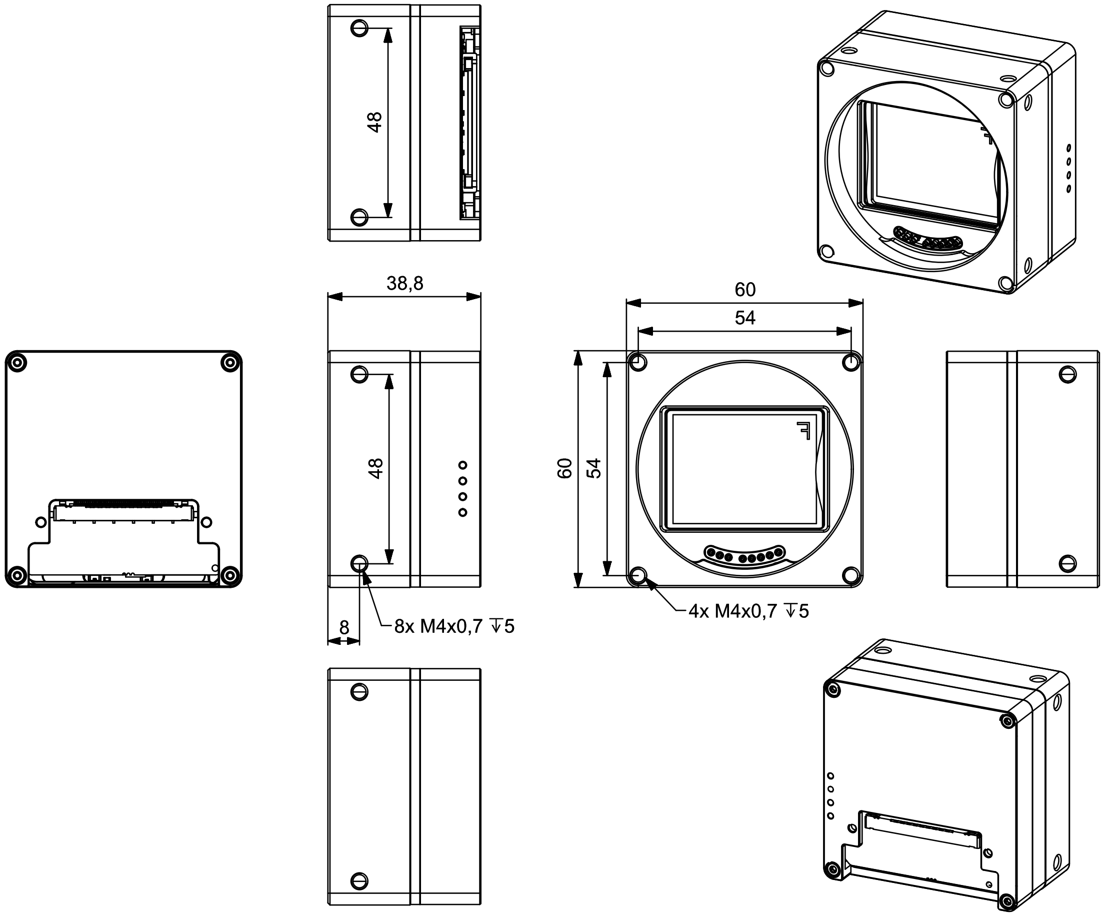


Figure 22: Dimensional drawing of MX500xG-CM-X4G2-FL

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 26: LED output description during camera power up

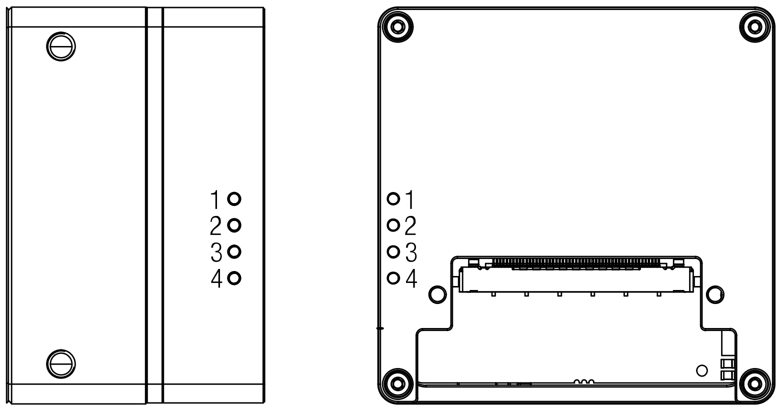


Figure 23: Position of LEDs on xiX X4G2 camera

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 X4 Gen2	On	flash	flash	On
PCIe connected X4 Gen1	On	flash	flash	flash
PCIe connected x2(x1) Gen2	flash	flash	flash	On
PCIe connected x2(x1) 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 27: 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 / FFC interface

The interface connector is used for data transmission, camera control, power and IO. When inserting or detaching cables increased caution need to be taken, to prevent connector or cable damage. MX X4G2 interface cables are equipped with a locking mechanism. When locked, pulling the cable may lead to damage of the connector or camera. When connecting or disconnecting the cable, the power supply for the camera must be turned off.

Item	Value
Connector	JAE FI-RE51S-HF-R1500 (-FL), JAE FI-RE51S-VF-R1300 (-FV)
Signals	PCIe x4 Gen2, power, IO
Mating Connectors	CBL-MX-X4G2-0M10 (-0M25,-0M50)

Table 28: FFC interface mating connector description

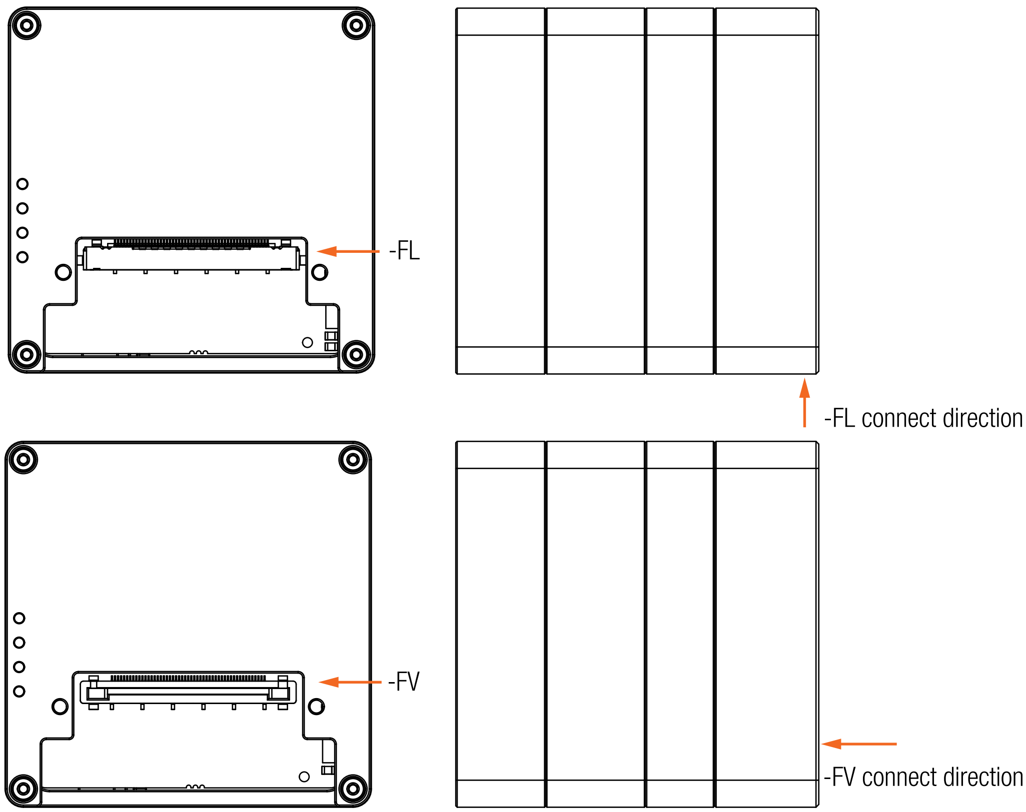


Figure 24: FFC connector location

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)

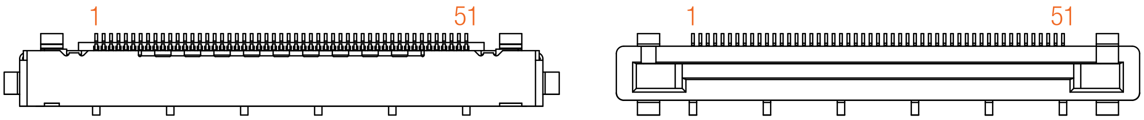


Figure 25: FFC interface connector pinout

Pin	Name	GPI/GPO index API	Type
1	GND	None	Ground return
2	IN1	1/-	Optically isolated Digital Input (IN)
3	IN_OUT_GND	None	Ground for opto-isolated Inputs
4	IN2	2/-	Optically isolated Digital Input (IN)
5	GND	None	Ground return
6	INOUT1	3/3	Non-isolated digital lines - Digital Input-Output (INOUT)
7	INOUT2	4/4	Non-isolated digital lines - Digital Input-Output (INOUT)
8	NC	None	None
9	GND	None	Ground return
10	NC	None	None
11	NC	None	None
12	GND	None	Ground return
13	PCIe_PERP_0	None	PCIe RX differential pair 0
14	PCIe_PERN_0	None	PCIe RX differential pair 0
15	GND	None	Ground return
16	PCIe_PERP_1	None	PCIe RX differential pair 1
17	PCIe_PERN_1	None	PCIe RX differential pair 1
18	GND	None	Ground return
19	PCIe_PERP_2	None	PCIe RX differential pair 2
20	PCIe_PERN_2	None	PCIe RX differential pair 2
21	GND	None	Ground return
22	PCIe_PERP_3	None	PCIe RX differential pair 3
23	PCIe_PERN_3	None	PCIe RX differential pair 3
24	GND	None	Ground return
25	PWR	None	Power input
26	PWR	None	Power input
27	PWR	None	Power input
28	GND	None	Ground return
29	PCIe_PETP_0	None	PCIe TX differential pair 0

Table 29: FFC interface connector pin assignment

Pin	Name	GPI/GPO index API	Type
30	PCIe_PETN_0	None	PCIe TX differential pair 0
31	GND	None	Ground return
32	PCIe_PETP_1	None	PCIe TX differential pair 1
33	PCIe_PETN_1	None	PCIe TX differential pair 1
34	GND	None	Ground return
35	PCIe_PETP_2	None	PCIe TX differential pair 2
36	PCIe_PETN_2	None	PCIe TX differential pair 2
37	GND	None	Ground return
38	PCIe_PETP_3	None	PCIe TX differential pair 3
39	PCIe_PETN_3	None	PCIe TX differential pair 3
40	GND	None	Ground return
41	PCIe_REFCLK_P	None	PCIe reference clock diff. pair
42	PCIe_REFCLK_N	None	PCIe reference clock diff. pair
43	GND	None	Ground return
44	PCIe_RST0_N_IN	None	PCIe reset
45	INOUT3	5/5	Non-isolated digital lines - Digital Input-Output (INOUT)
46	INOUT4	6/6	Non-isolated digital lines - Digital Input-Output (INOUT)
47	GND	None	Ground return
48	OUT2	-/2	Optically isolated Digital Output (OUT)
49	IN_OUT_GND	None	Ground for opto-isolated Outputs
50	OUT1	-/1	Optically isolated Digital Output (OUT)
51	GND	None	Ground return

Table 30: FFC 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)

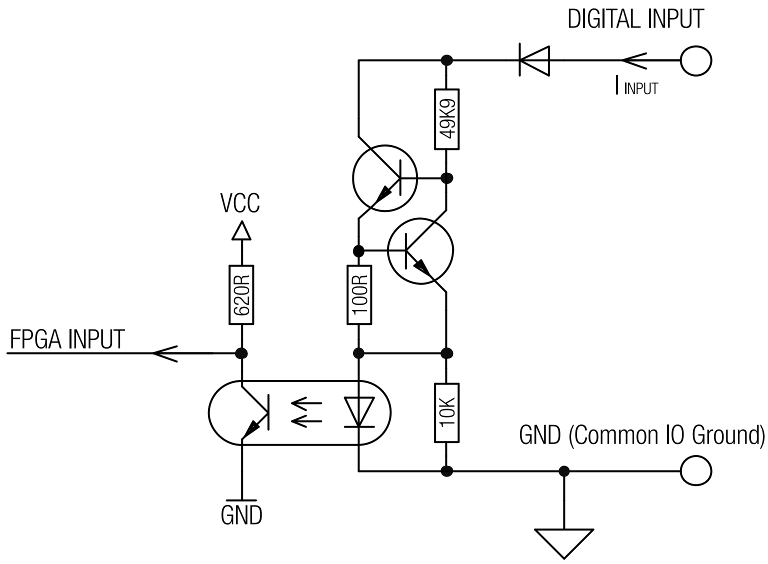


Figure 26: Digital input, interface schematic

Item	Parameter	Note
Maximal input voltage	24 V DC	None
Common pole	YES	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	10 m	None
Input Level for logical 0	Voltage < 2.0 V / Current < 0.5 mA	None
Input Level for logical 1	Voltage > 4.0 V / Current > 2 mA	None
Input debounce filter	NO	None
Input delay - rising edge	1.7+-0.2 µs	VINPUT=10 V,TAMBIENT=25 °C
Input delay - falling edge	10.7+-0.2 µs	VINPUT=10 V,TAMBIENT=25 °C
External trigger mapping	YES	None
Input functions	Trigger	Rising or falling edge are supported for trigger

Table 31: 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)

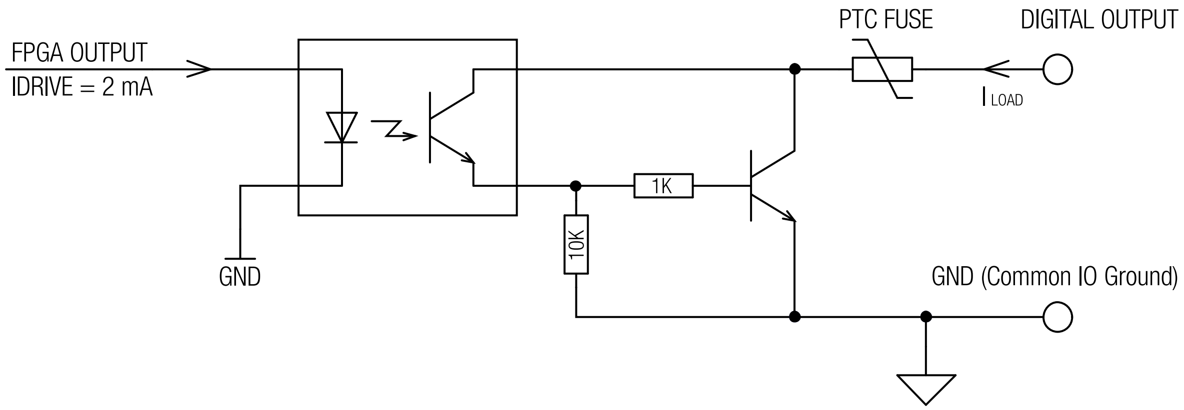


Figure 27: Digital output, interface schematic

Item	Parameter	Note
Maximal open circuit voltage	24 V DC	None
Output port type	Open collector NPN	None
Common pole	YES	OUT GND
Protection	short-circuit / over-current / Reverse voltage	None
Protection circuit	PTC Resettable Fuse	None
Maximal sink current	25 mA	None
Trip current	50 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 - rising edge	51 µs	VOUTPUT=10 V,TAMBIENT=25 °C
Output delay - falling edge	0.8 µs	VOUTPUT=10 V,TAMBIENT=25 °C
Strobe output mapping	YES	None

Table 32: 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 33: General info for non-isolated digital in/out trigger lines

2.11 Accessories

2.11.1 CBL-MX-X4G2-xM

20 cm / 30 cm / 40 cm flex ribbon cable.

MX X4G2 cameras can be connected to host via 51pin flex cable. For connecting to different host via vast range of adapters.

Figure 28: CBL-MX-X4G2-xM

When inserting or detaching cables, increased caution must be taken to prevent damage to the connector or cable. MX X4G2 interface cables are equipped with a locking mechanism. When locked, pulling the cable may cause damage to the connector or camera. When connecting or disconnecting the cable, the camera's power supply must be turned off.

Note: It is important that the power is turned off when inserting/detaching the cable. Connecting a camera to a powered host can cause destruction of the camera.

2.11.2 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.

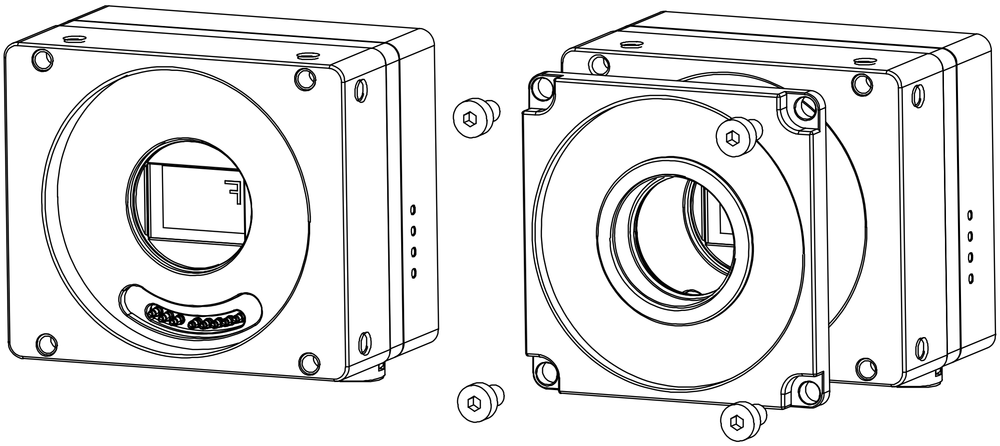


Figure 29: Camera without and with C-mount LA-C-MNT-60MM-KIT lens adapter

2.11.3 MECH-60MM-EF-ADAPTER

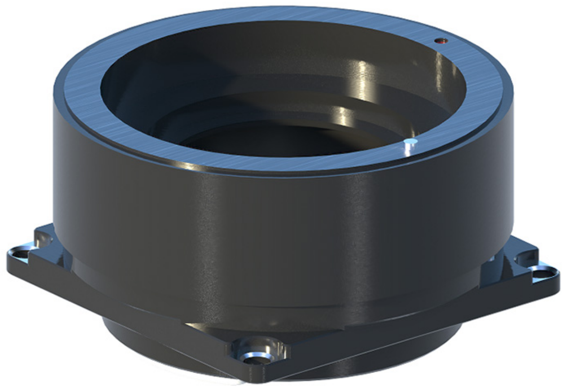


Figure 30: MECH-60MM-EF-ADAPTER

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.

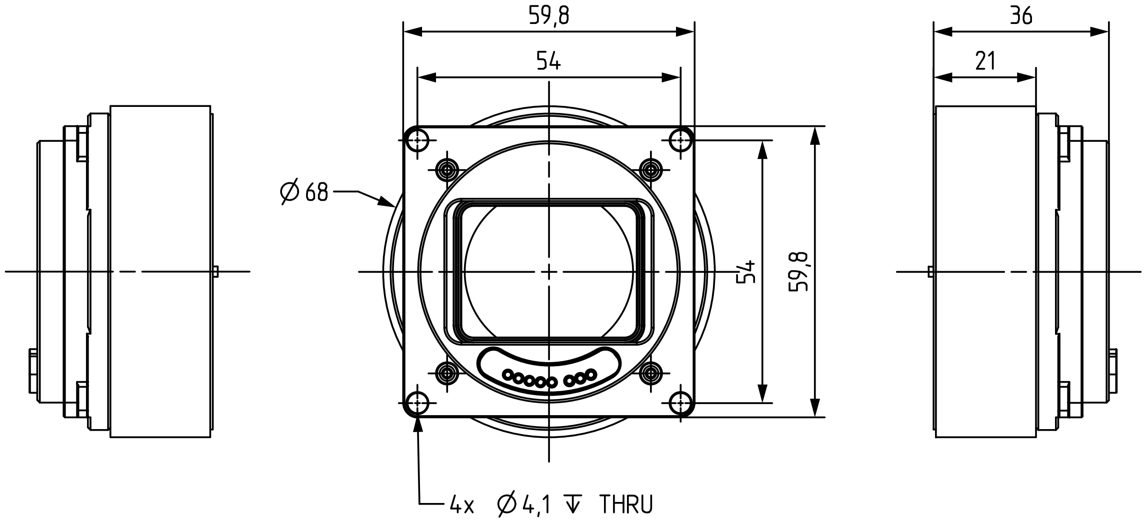


Figure 31: Dimensional drawing of MECH-60MM-EF-ADAPTER

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 34: Mechanical parameters of MECH-60MM-EF-ADAPTER

2.11.4 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).

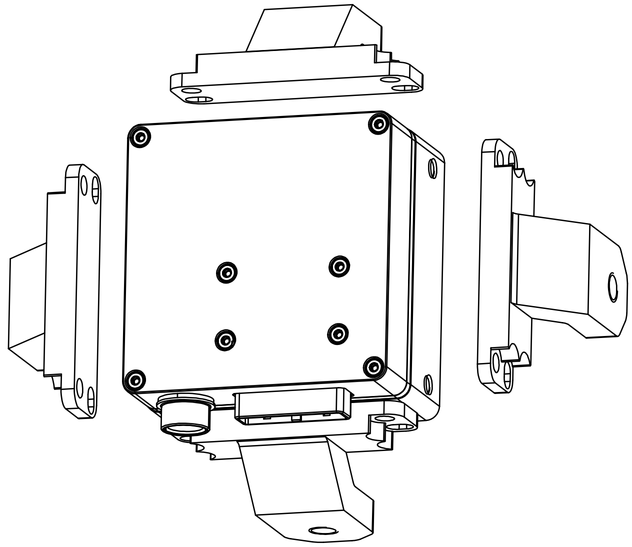


Figure 32: MECH-60MM-BRACKET-T

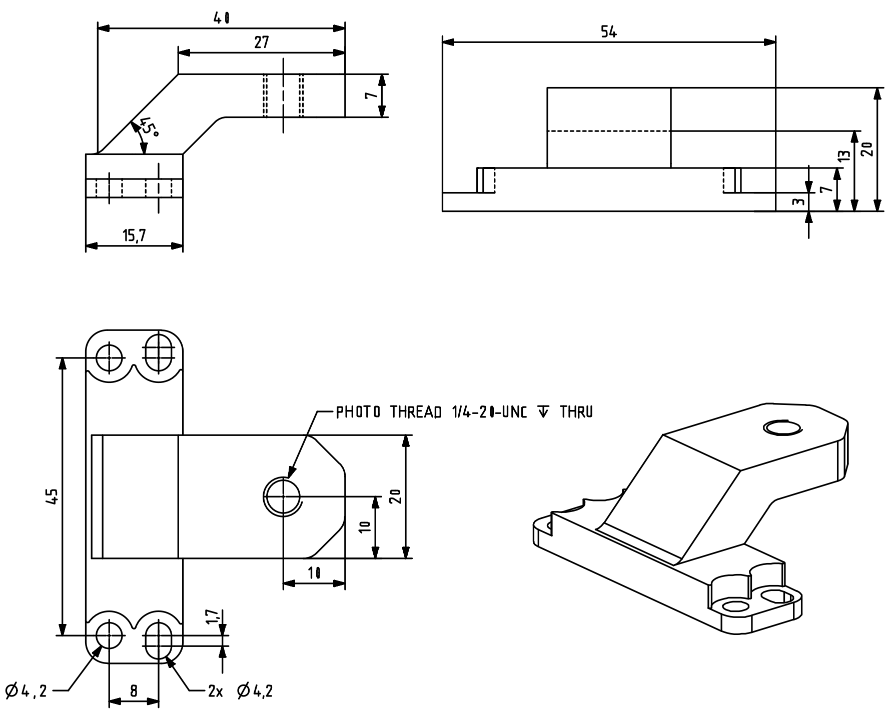


Figure 33: Dimensional drawing of MECH-60MM-BRACKET-T

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

Table 35: Parameters of MECH-60MM-BRACKET-T

2.11.5 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:

MX120CG-CM-X4G2-FL MX120CG-CM-X4G2-FV MX200CG-CM-X4G2-FL MX200CG-CM-X4G2-FV
MX500CG-CM-X4G2-FL MX500CG-CM-X4G2-FV

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 XI_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 36: Image data output formats

This table is applicable to:

MX120MG-CM-X4G2-FL MX120MG-CM-X4G2-FV MX200MG-CM-X4G2-FL MX200MG-CM-X4G2-FV
MX500MG-CM-X4G2-FL MX500MG-CM-X4G2-FV

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 XI_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 37: 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).

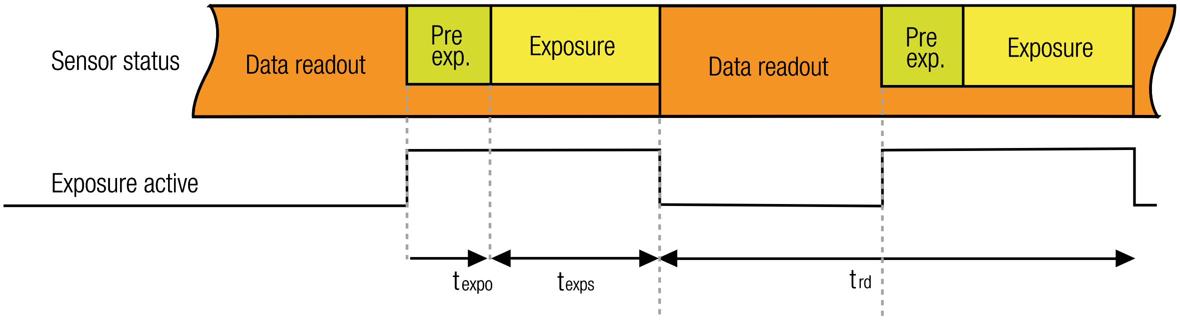


Figure 34: Acquisition mode - free run

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 $\sim$ 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

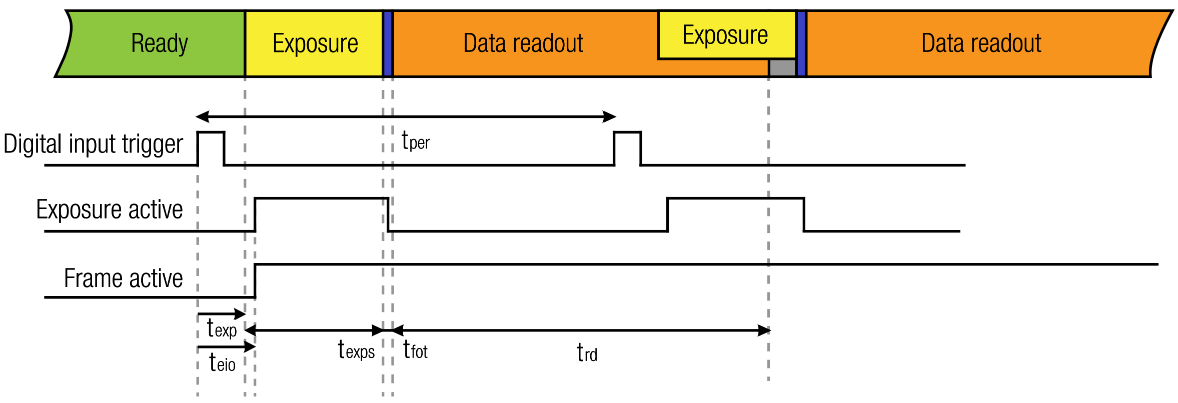


Figure 35: Acquisition mode - triggered with overlap

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.

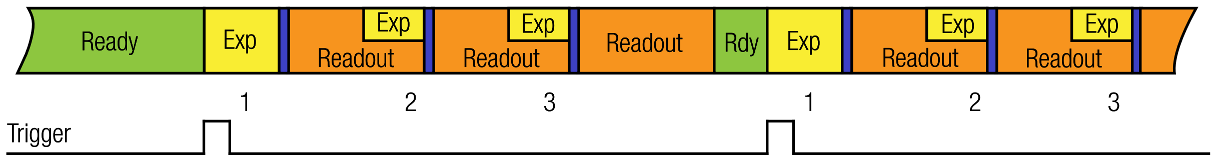


Figure 36: Triggered burst of frames – frame burst start

Frame Burst Active

If trigger is level-sensitive, it can be used to control image acquisition.

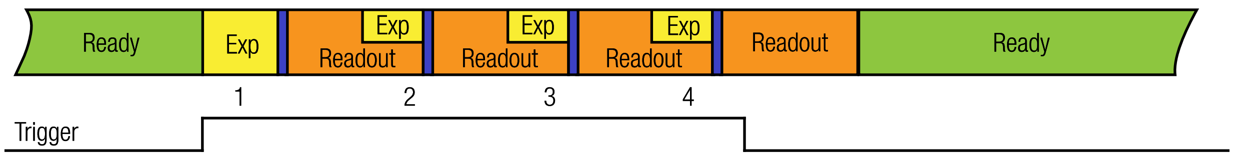


Figure 37: Triggered burst of frames – frame burst active

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

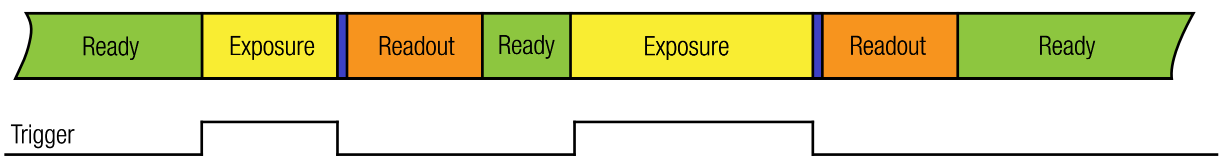


Figure 38: Exposure defined by trigger pulse length

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):

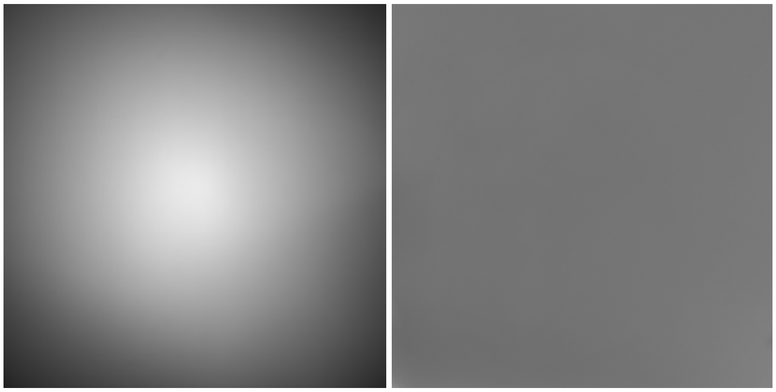


Figure 39: Flat field correction - images comparison

Acquisition of calibration images

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

Figure 40: 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.

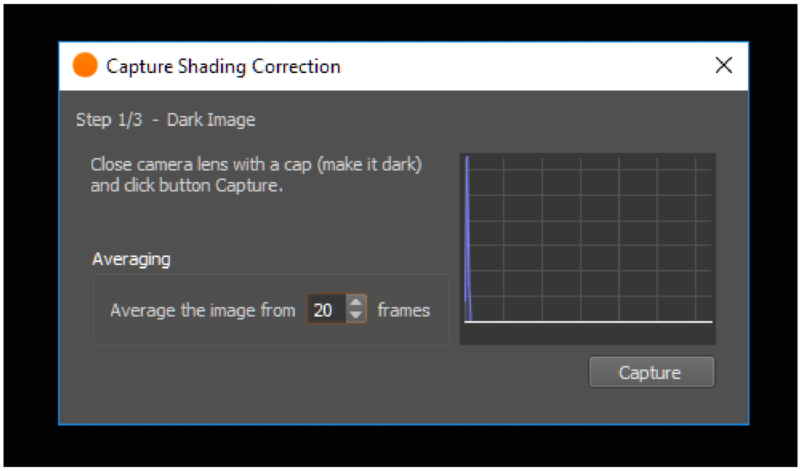


Figure 41: Flat field correction - Dark image

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.

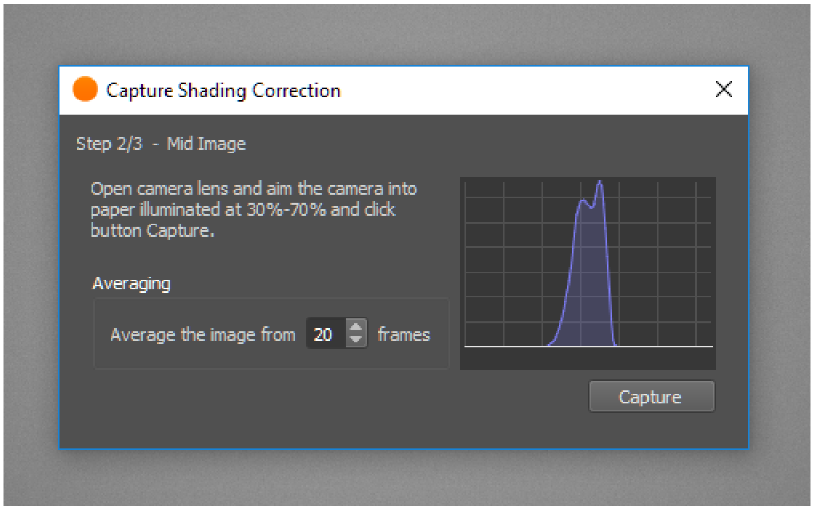


Figure 42: Flat field correction - Mid- saturated image

Save TIFF files

Save the new preset how it be displayed in CamTool.

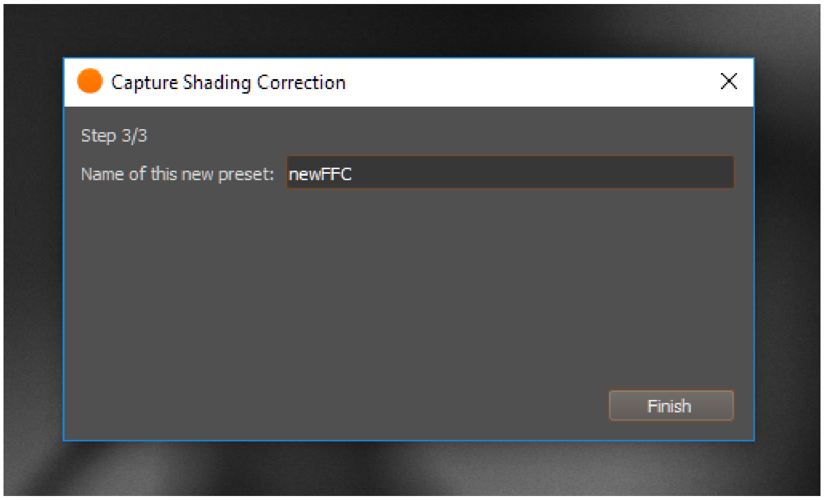


Figure 43: Flat field correction - new preset

To verify calibration, FFC can be also enabled in CamTool by clicking on created preset

Figure 44: 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

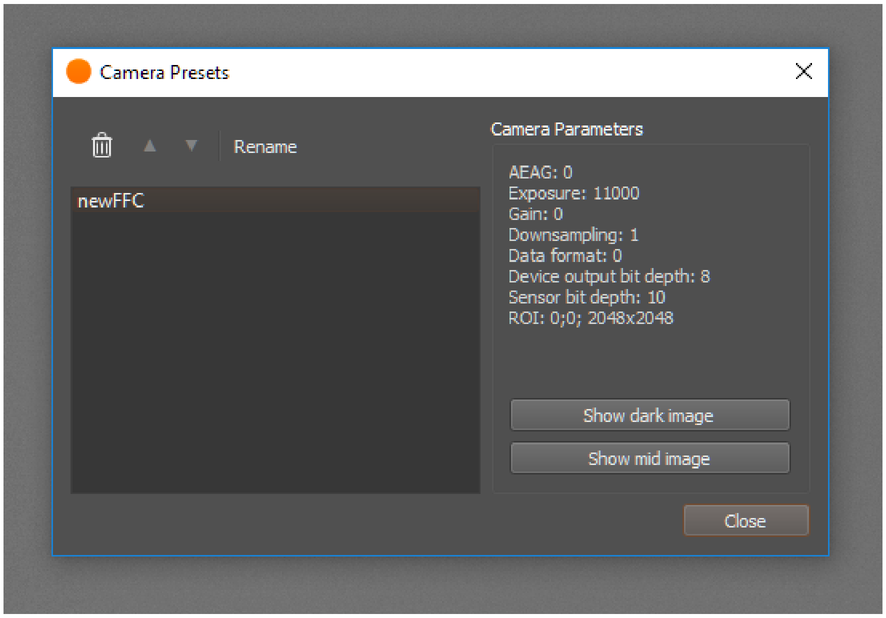


Figure 45: Flat field correction - FFC management

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.

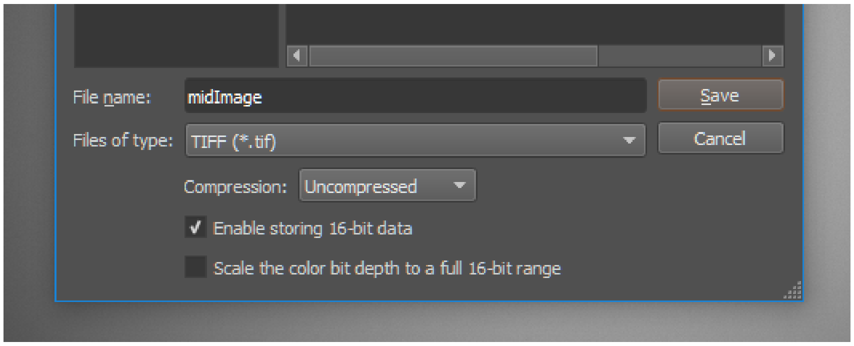


Figure 46: Flat field correction - Safe TIFF

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.

3.5.8 HDR

Some sensors offer the ability to acquire images with a higher dynamic range than the value presented in the specification. High dynamic range can be achieved by several means as part of the sensor output. The feature supported by some cameras (see Sensor and camera parameters) is a piecewise linear response, a so-called multiple slope integration.

The dynamic range of a linear image sensor is limited by the saturation of the pixel. Different light intensities are shown in the figure below. All blue marked light intensities cause different signal levels and can be separated without saturation. All red marked intensities cause an overexposure and the info about the different light intensity above 100% is lost.

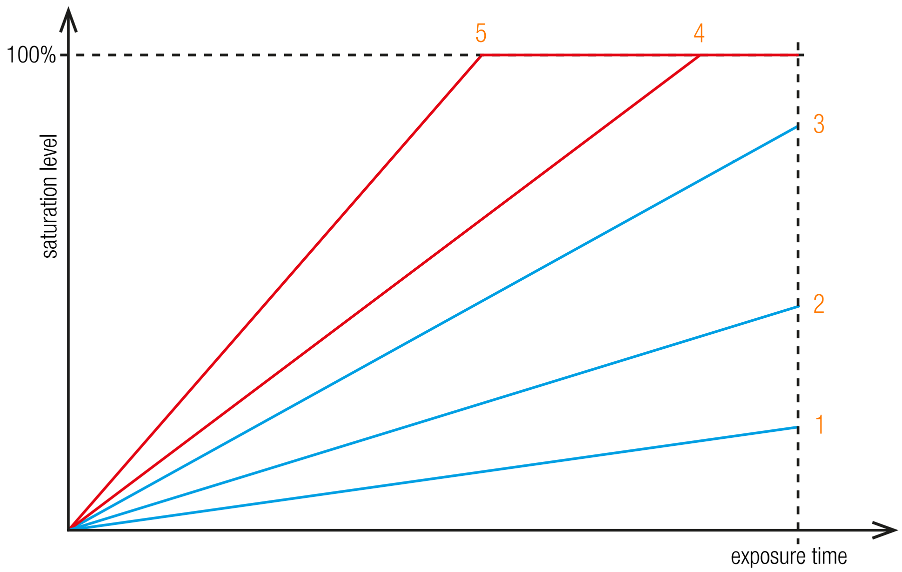


Figure 47: Saturation example without HDR

The dynamic range can be increased by dividing the integration (exposure time) in two or three phases (slopes), with different maximum saturation levels. The camera supports the dividing in three slopes.

To use this kind of HDR method the user has to define two pairs of parameters: (T1, SL1) and (T2, SL2).

- T1 and T2 define portions of the total exposure time and the length of the three timing phases
- SL1 and SL2 define portions of the sensor saturation, so called kneepoint1 and kneepoint2

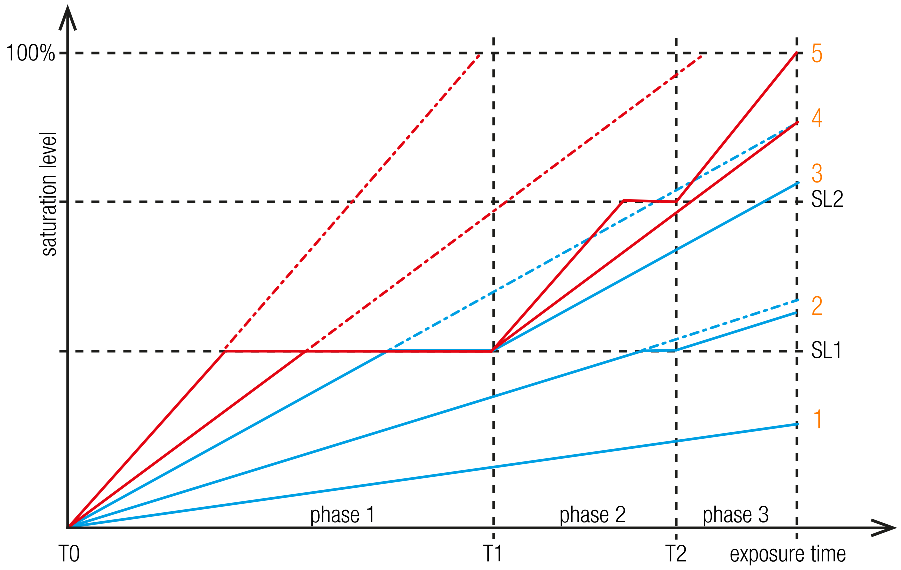


Figure 48: Saturation example with HDR

Description of the multiple slope integration

Phase 1

- All pixels are integrated until they reach the defined saturation level of kneepoint1 (SL1)
- If the saturation level of kneepoint1 is reached, the integration stops. SL1 is the maximum saturation level for all pixels in this phase

Phase 2

- All pixels are integrated until they reach the defined saturation level of kneepoint2 (SL2)
- If the saturation level of kneepoint2 is reached, the integration stops. SL2 is the maximum saturation level for all pixels in this phase

Phase 3

- All pixels are integrated until the exposure time is reached. The pixel saturation may reach the maximum saturation level

The main idea of this method is to reach an approx. logarithmic saturation curve. In order to achieve this goal phase2 always has a smaller slope than phase1 and phase3 smaller than phase 2. Thus, the signal response during phase1 is higher as during phase2. And the signal increase during phase2 is higher than during phase3.

As a result, darker pixels can be integrated during the complete integration time and the full sensor sensitivity can be exploited. Brighter pixels are limited at the knee points and lose a part of their integration time.

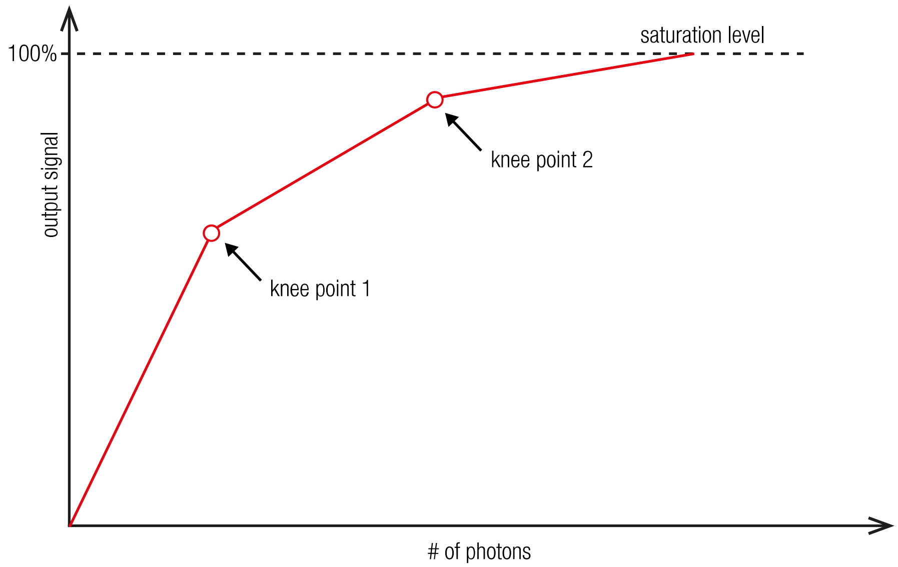


Figure 49: HDR approx logarithmic saturation curve

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

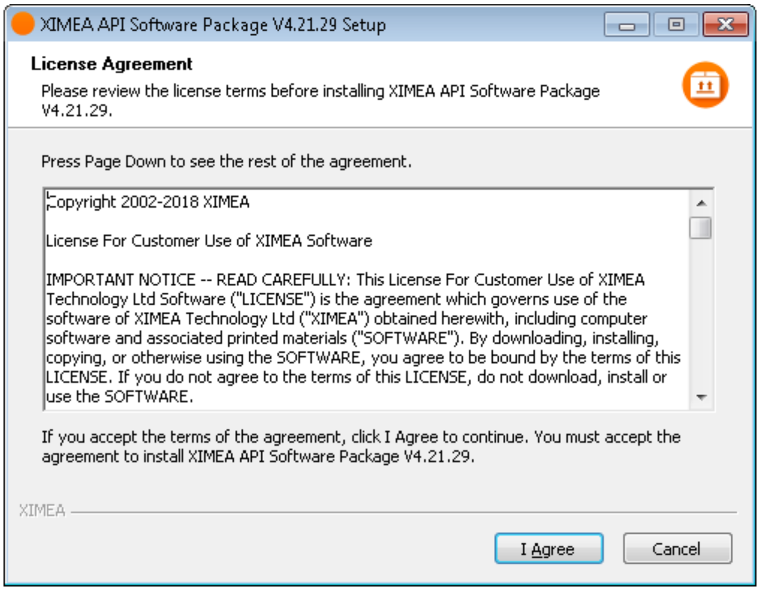
The package contains:

- 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

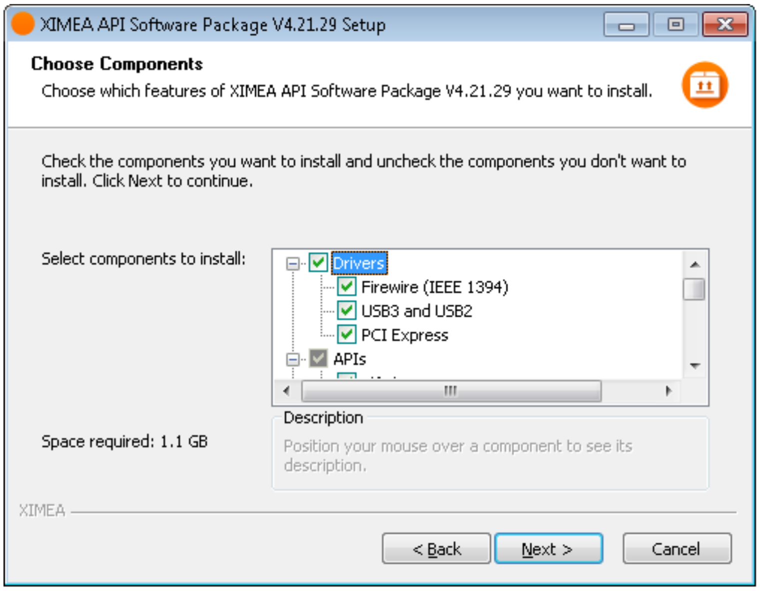
Installation

- 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

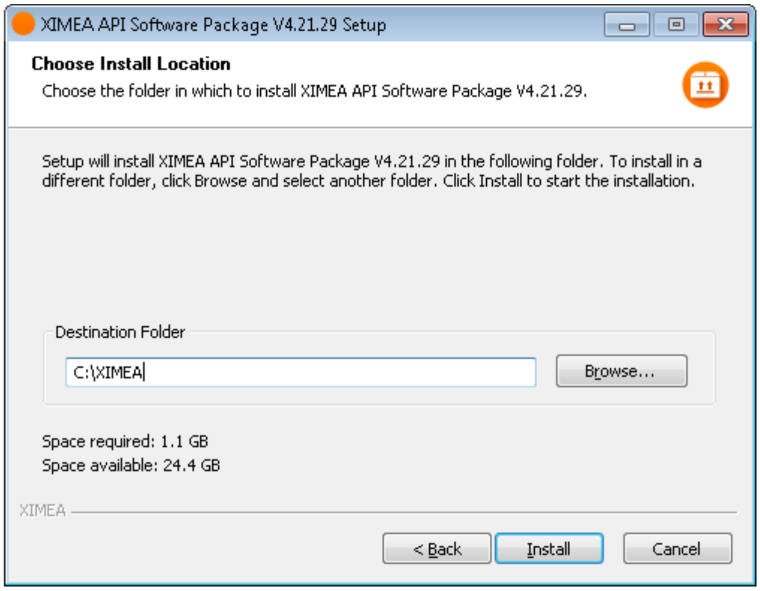
  Be sure that you have administrator privileges or start the Installer with administrator rights (right click and select “run as administrator”):



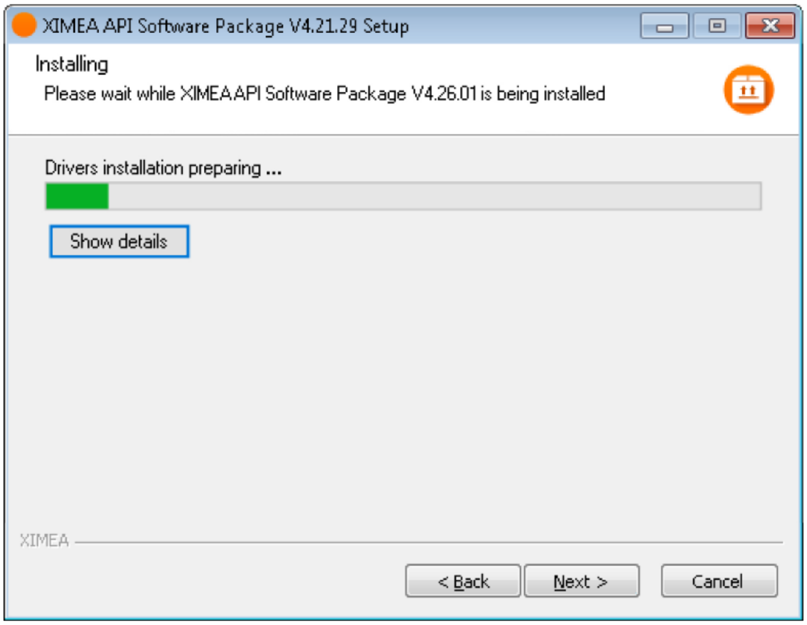
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



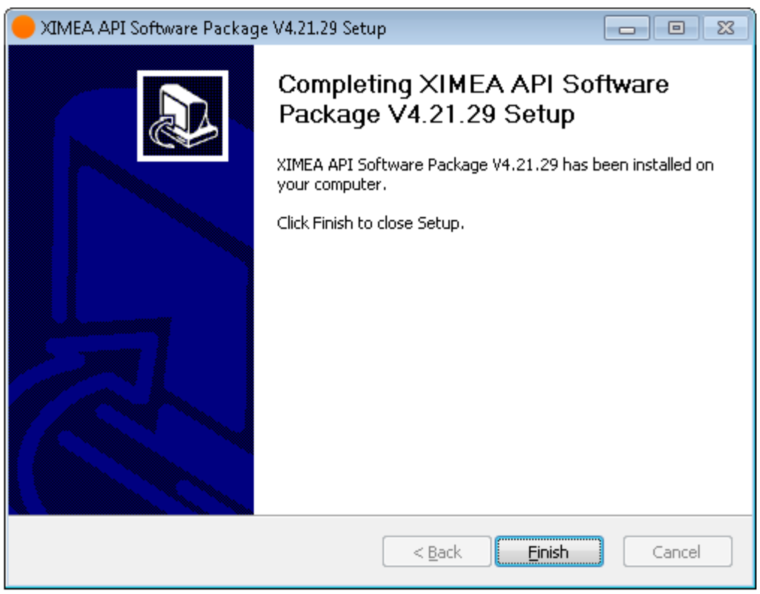
- Specify the install location - you can leave the default location or change it to your desired location



- 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`

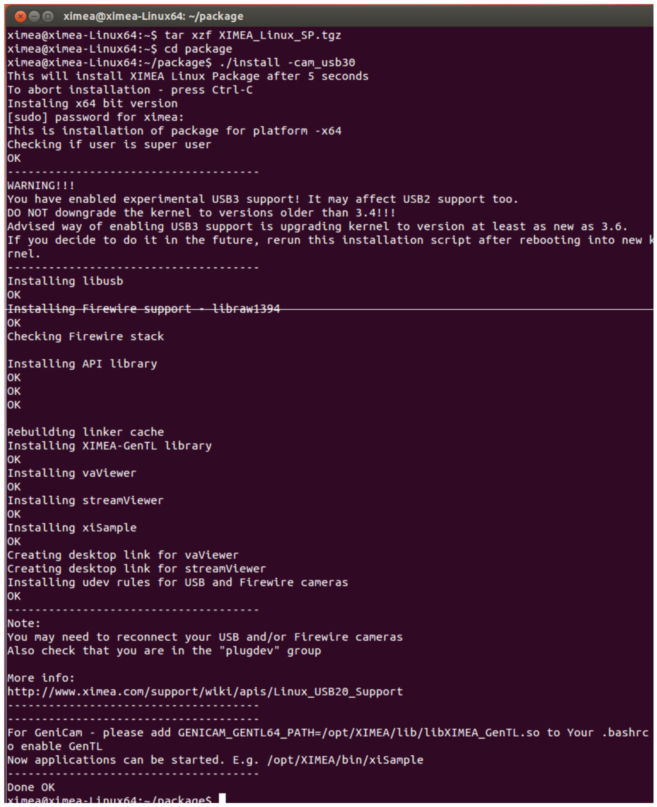
- Untar

  `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
Instaling 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 k
rnel.
------------------------------------
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:

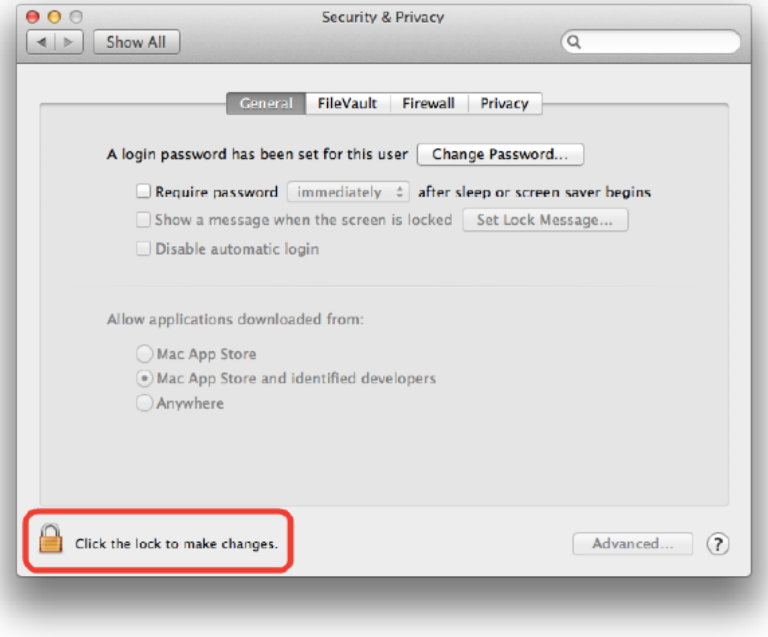
- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
  - xiSample - sample showing basic image acquisition in xiAPI

Installation

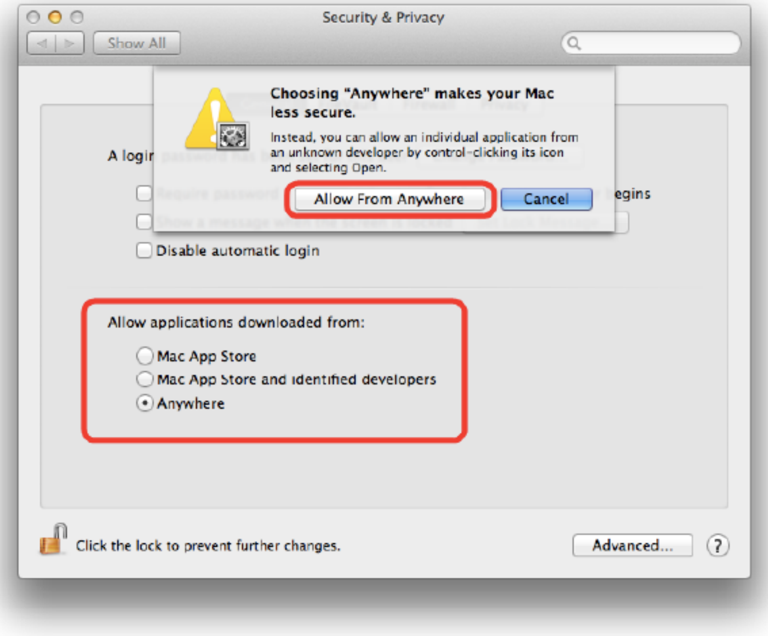
Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- 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.

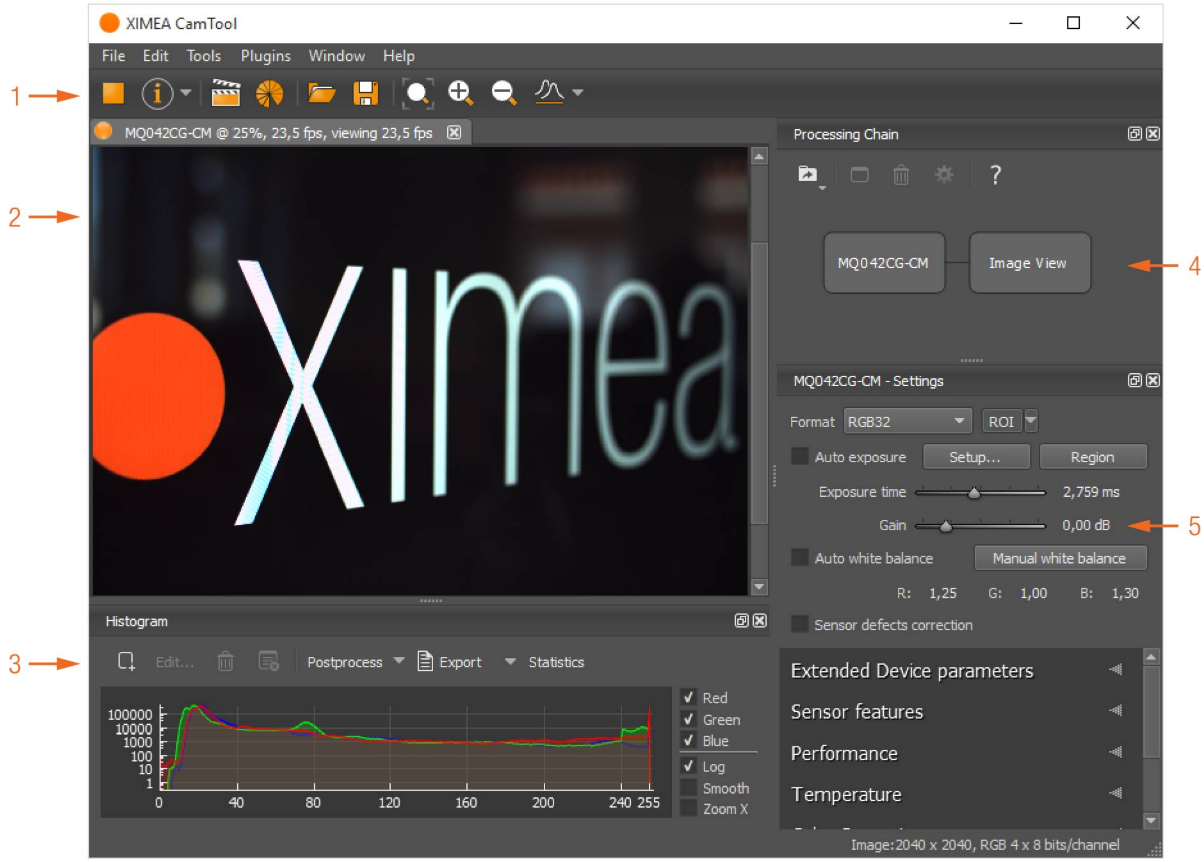


Figure 50: CamTool preview

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

Table 38: 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.

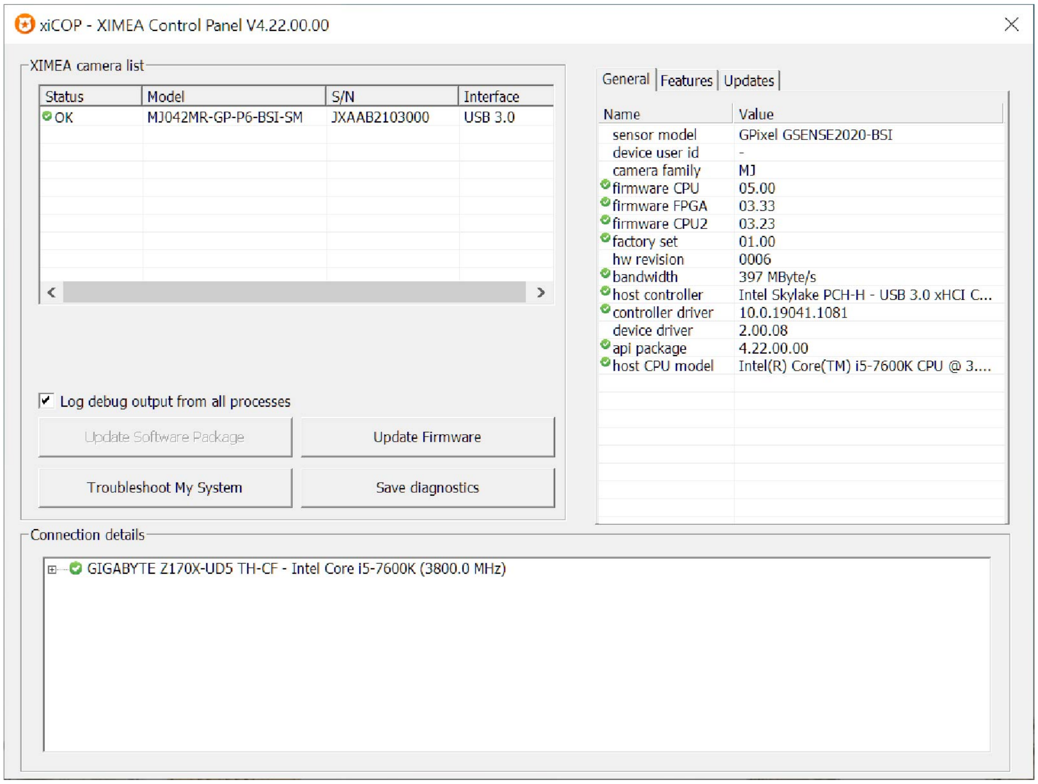


Figure 51: xiCOP example

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.

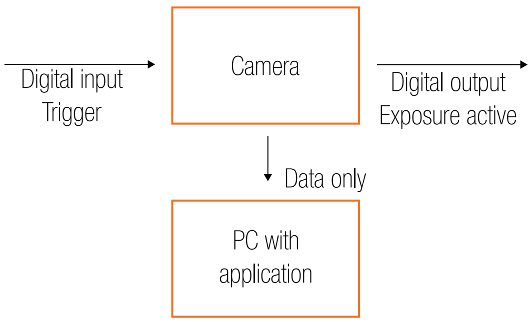


Figure 52: GPIO scheme

```
        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 39: 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 55

CMOS Complementary Metal-Oxide-Semiconductor 56

DMA Direct Memory Access 9

ESD Electrostatic discharge 40

FPGA Field Programmable Gate Array 50

FPS Frame Per Second 53

PCB Printed Circuit Board (same as PWB) 11

PSR Product Service Request 82

ROI Region Of Interest 50

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