ximea



xiX-Xtreme

[ksi-x-treme:] or [sai-ex:tri:m]

- Fast PCIe cameras with Sony Pregius S sensors

XIMEA Cameras •
Technical Manual •
Version v260902 •

Introduction

About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

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

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

This document is subject to change without notice.

About XIMEA

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

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

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

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

Contact XIMEA

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Standard conformity

CE conformity



Figure 1: Standard conformity CE logo

The camera models listed below, equipped with the SFF-8644 adapter (XIMEA P-N: ADPT-MX-X4G3-FF-X4G3-SFF), comply with the EC EMC Directive 2014/30/EU requirements for electromagnetic compatibility.

The measurements and testing were conducted using a 5-meter PCIe SFF-8644 copper cable and a 10-meter SFF-8644 fiber optic cable.

Certified camera models include
all models in this manual (refer to the table Models and sensors overview)

UKCA conformity



Figure 2: Standard conformity UKCA logo

We declare that the products listed below comply with the requirements of Directive 2014/35/EU (Low Voltage Directive) and Directive 2014/30/EU (Electromagnetic Compatibility).

All tests are based on EU rules and standards valid before January 1, 2021 (Brexit). The harmonized EU product standards were converted into UK designated standards on exit day. Based on that, these products are UKCA compliant.

Certified camera models include
all models in this manual (refer to the table Models and sensors overview)

FCC conformity



Figure 3: Standard conformity FCC logo

The camera models listed below have been tested and found to comply with Part 15 of the FCC rules, which states that:

Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the users will be required to correct the interference at their own expense.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment under the above jurisdictions. The shielded interface cable recommended in this manual must be used with this equipment to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

Certified camera models include
all models in this manual (refer to the table Models and sensors overview)

RoHS conformity

Figure 4: 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 5: 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

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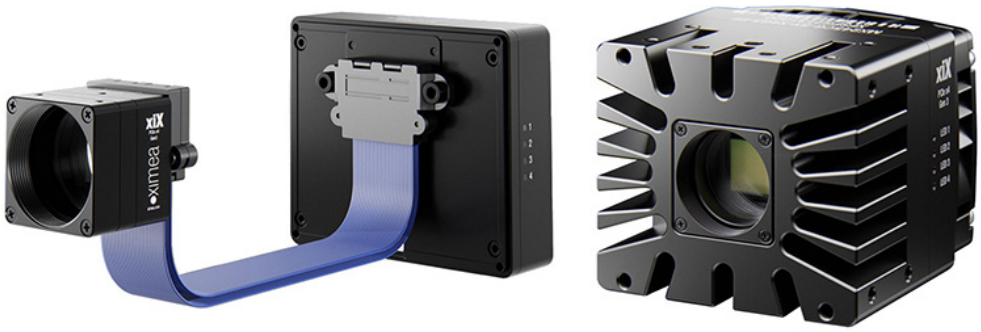
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1 xiX-Xtreme camera series

1.1 What is xiX-Xtreme



xiX-Xtreme is the high-speed PCI express camera family with detachable sensor heads:

- Sony Pregius S sensors with 16.1 Mpx, 20.3 Mpx, and 24.5 Mpx
- Super-fast 32 Gbit/s data throughput to ensure 105 fps 24.5 Mpx up to 159 fps 16.1 Mpx enabled by PCIe X4G3
- The detachable sensor heads measure only 26 × 26 × 33 mm
  - Sensor module is separable from camera electronics over distances up to 1 m
- Special sensor features like Dual ADC (HDR mode), short shutter interval time, and others

The xiX-Xtreme cameras offer the opportunity to reach the full sensor specifications while still keeping the smallest possible form factor. Our innovative approach separates the sensor head from the readout electronics, facilitating integration into the most confined spaces. This separation not only optimizes spatial utility but also drastically reduces heat accumulation at the sensor, lowering noise levels and enhancing image quality. The pixel size of 2.74 µm helps to use C-mount lenses thus further improving the cost-effectivity and enabling miniature size for mobile and multiple camera systems.

1.2 Advantages

Lightweight	facilitates increased performance of robotic arms and gimbals or UAV / UAS
Efficient	low power consumption and heat dissipation
Robust	sturdy full metal jacket, no sheet metal covers
Adaptable	customization options via Board level or connectors allow easy integration into OEM solutions
Economical	removes bulky constructions and accessories saving energy and space at better prices
Simplistic	straightforward way for easy multiple camera system, no workarounds, no frame grabbers

1.3 Camera applications

- automation
- ultra-fast 3D scanning
- miniature and fast robotic arms
- mobile devices
- in-situ optical inspection camera
- material and life science microscopy
- ophthalmology and retinal imaging
- broadcasting
- fast process capture, e.g. golf club swings
- Intelligent Transportations Systems (ITS) and traffic monitoring
- VR and AR
- cinematography
- sports
- unmanned vehicles
- UAV / drones etc

1.4 Common features

Acquisition modes	global shutter
Image data formats	8 bit, 10 bit, 12 bit RAW pixel data
Sensor technology	CMOS
Sensor versions	backside illuminated (BSI)
Partial image readout	ROI, Skipping and Binning modes supported (model specific)
Interface	PCI Express standard cable connector compliant to PCI Express external cabling specifications
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 - this feature is being developed and tested
General purpose I/O	I/O 1x opto-isolated input, 1x opto-isolated output, and 4x non-isolated bidirectional I/O, 4x user configurable LEDs
Synchronization	hardware trigger input, software trigger, exposure strobe output, busy output
Housing and lens mount Standard	C-mount
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 libraries
Firmware updates	field firmware update through xiCOP tool

1.5 Model nomenclature

xi-Xtreme MXxxxyT-zz-X4G3-FF

MX xiX family name

xxx: resolution in 0.1 MPixel. E.g. 2.3 MPixel Resolution: xxx = 023

y: Color sensing
C: color model
M: black & white model

T: Sensor technology
G: Global shutter

zz: Vendor of the sensor
SY: Sony

X4G3: Number of PCIe lanes used, 4 for these cameras
PCIe generation, currently at Gen 3 for these cameras

FF: FireFly cable connection

1.6 Models and sensors overview

Camera model	Sensor model	Sensor type	Filter	Resolution [px]	Pixel size [µm]
MX161CG-SY-X4G3-FF	Sony IMX532	Color	BayerBG	5328 × 3040	2.74
MX161MG-SY-X4G3-FF	Sony IMX532	Monochrome	None	5328 × 3040	2.74
MX203CG-SY-X4G3-FF	Sony IMX531	Color	BayerBG	4512 × 4512	2.74
MX203MG-SY-X4G3-FF	Sony IMX531	Monochrome	None	4512 × 4512	2.74
MX245CG-SY-X4G3-FF	Sony IMX530	Color	BayerBG	5328 × 4608	2.74
MX245MG-SY-X4G3-FF	Sony IMX530	Monochrome	None	5328 × 4608	2.74

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

1.7 Accessories overview

The following accessories are available:

Item P/N	Description
CBL-PB4-PWR-0M15	Power cable with barrel connector 15 cm long
CBL-PB6-PT-0M30	IO pig tail cable 30 cm long
CBL-ECUE-X4G3-0M30	Cable Micro Assembly, Low-Profile FireFly, 30 cm
CBL-ECUE-X4G3-1M0	Cable Micro Assembly, Low-Profile FireFly, 100 cm
CBL-ECUE-X4G3-2M0	Cable Micro Assembly, Low-Profile FireFly, 200 cm
HA-1/2P-X4G3-MTP/FF-X8G3	Ximea PCIe Dual FireFly x4 Gen 3 Host Adapter Card
ADPT-1/2/4P-X4G3-FF-X4/8G3-MTP	PCIe Adapter FireFly to MTP
ADPT-MX-X4G3-FF-X4G3-MTP	MTP Adaptor for MX-X4G3-FF camera
CB-X8G3-FAN-COOLER-KIT	Heatsink Fan Cooler for X8G3 cameras with screws Kit
CB-X8G3-WAT-COOLER-KIT	Heatsink Water Cooler for X8G3 cameras with screws Kit
CBL-HQCD-0M15	Highspeed Coaxial HQCD cable, 15 cm length
CBL-HQCD-0M50	Highspeed Coaxial HQCD cable, 50 cm length
CBL-HQCD-1M0	Highspeed Coaxial HQCD cable, 100 cm length
MECH-60MM-BRACKET-T-KIT	MECH Tripod Bracket 60 mm with Screws Kit
MQ-BRACKET-T-KIT	MQ series tripod mounting bracket TYP B with Screws Kit[1]

[1] In case of only small sensor board housing

Table 2: Accessories overview

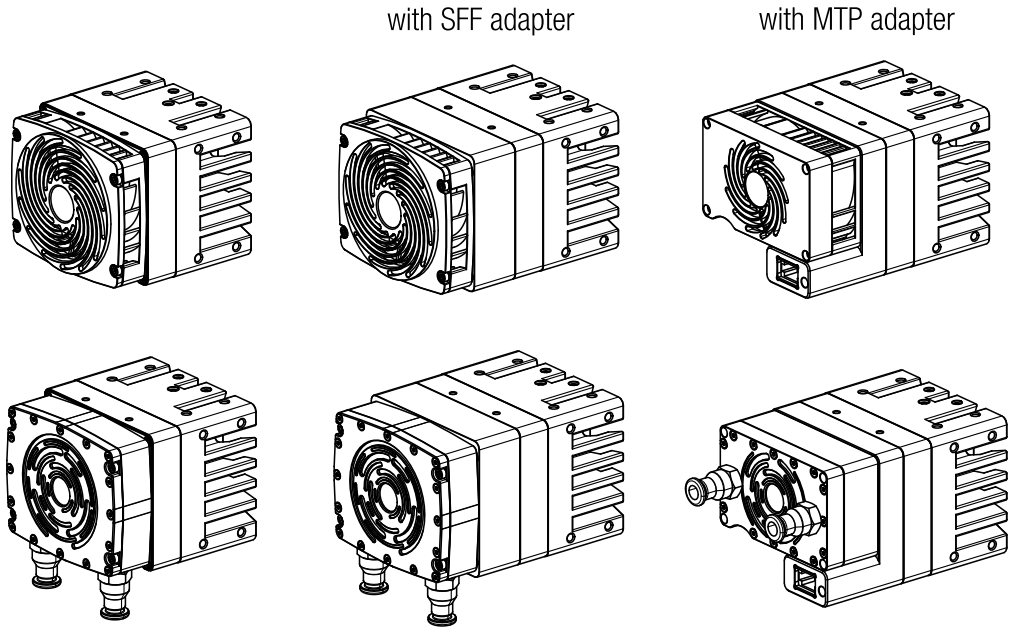


Figure 6: Camera with accessory/cooling options

1.8 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

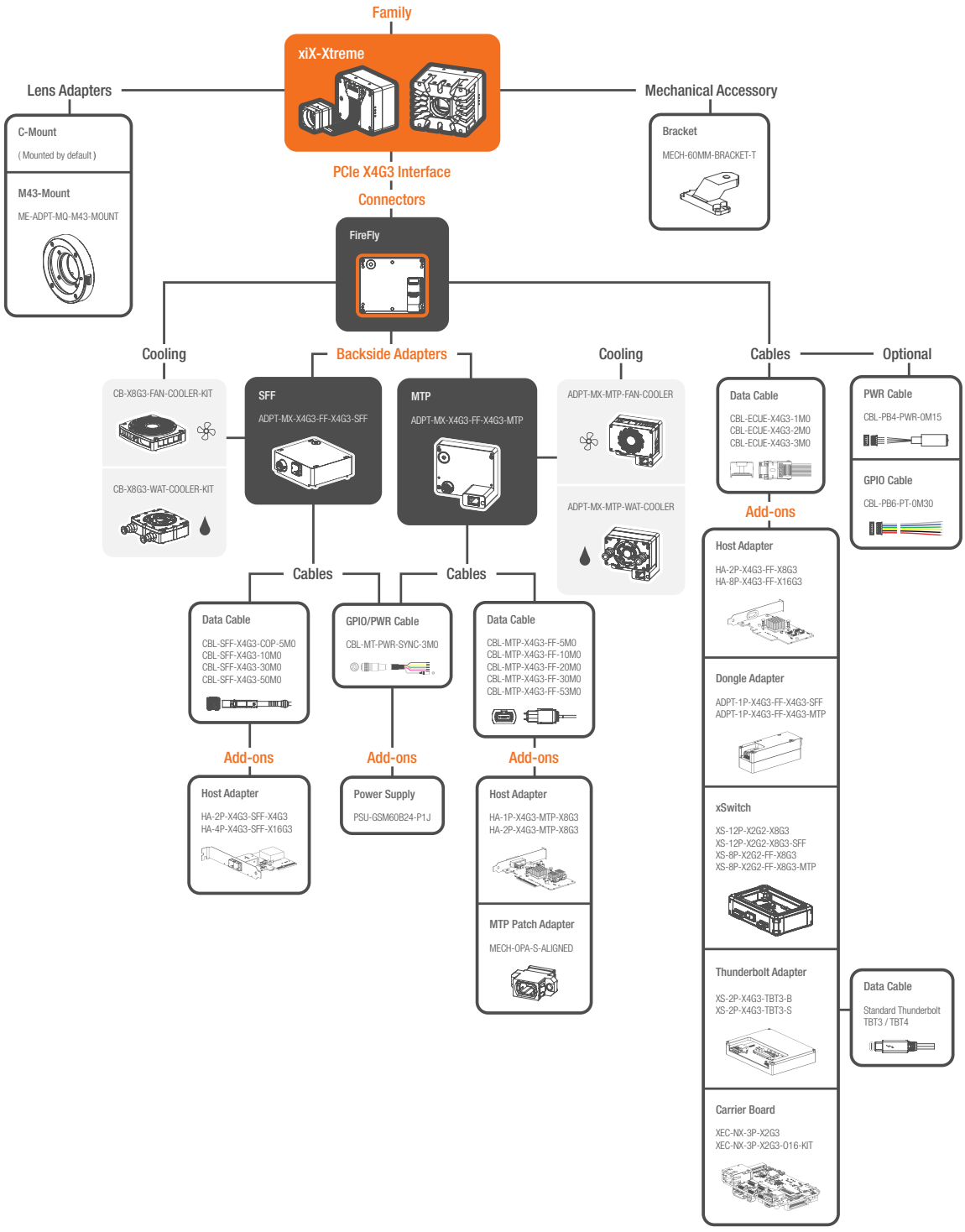


Figure 7: Diagram of accessories and specific connections for the xiX-Xtreme camera family

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

Supply Voltage[1]	Consumption idle	Consumption typical	Consumption maximum
12 V	9.65 W	14.3 W	14.6 W

[1]Supported voltage 12 - 24 V

Table 3: Power consumption of the specific models

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 4: 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

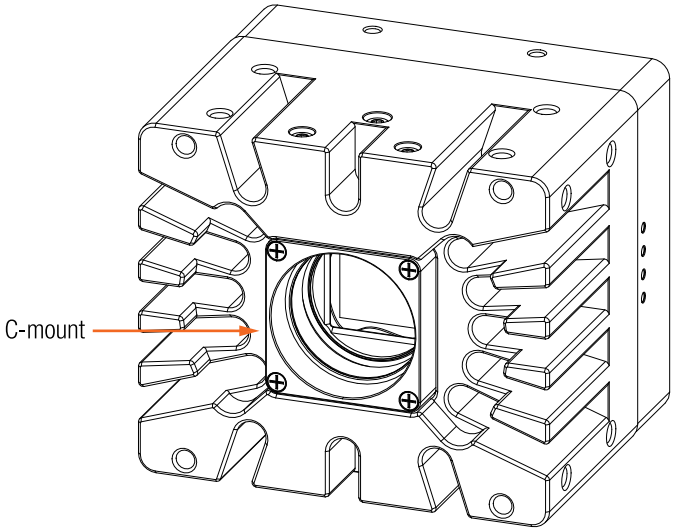


Figure 8: Lens mount adapter C-mount for xiX-Xtreme camera models

The maximum difference between the flange focal distance and back focal distance for C-mount lenses must not exceed 6 mm. Otherwise, there is a risk of damaging the protective glass inside the camera or limiting the capability to focus to infinity.

The mentioned lens adapter is 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.

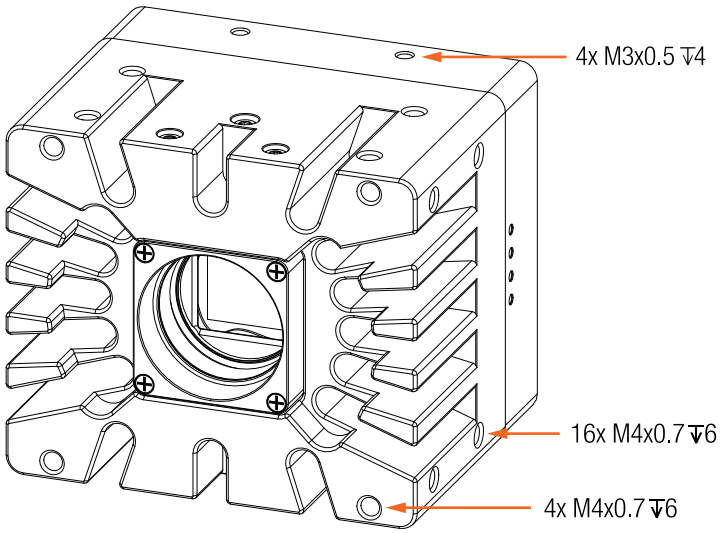


Figure 9: xiX-Xtreme camera mounting points

2.4.1 M4 Mounting screws

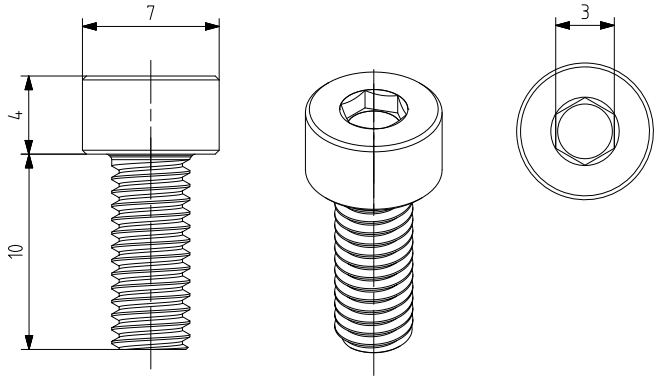


Figure 10: M4 mounting screws

Item	Material	Surface	Thread	Driver	Avail. lengths
Value	Stainless steel	Polished	M4 Full thread	INBUS 3.0	6 to 40 mm

Table 5: M4 screw description

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).

Cross-section corresponding to:
all models in this manual (refer to the table Models and sensors overview)

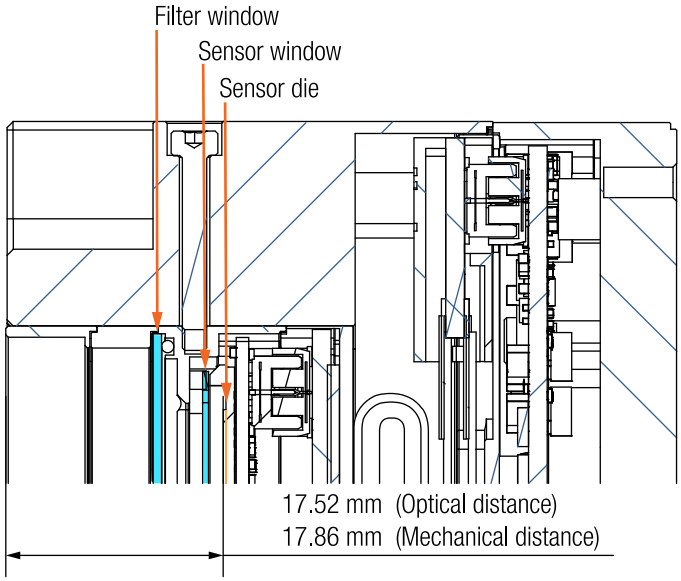


Figure 11: Cross section of MX161/203/245xG-SY-X4G3-FF camera models

Sensor window	Value
Thickness	0.5 mm
Distance to sensor die	1.2 mm (+/- 0.10 mm)

Table 6: Sensor window details

The following filter window is implemented in:

MX161CG-SY-X4G3-FF MX203CG-SY-X4G3-FF MX245CG-SY-X4G3-FF

	Filter	Coating	Thickness
	IR Filter IR650	ARx2	1.1 mm

Table 7: IR650 filter window parameter

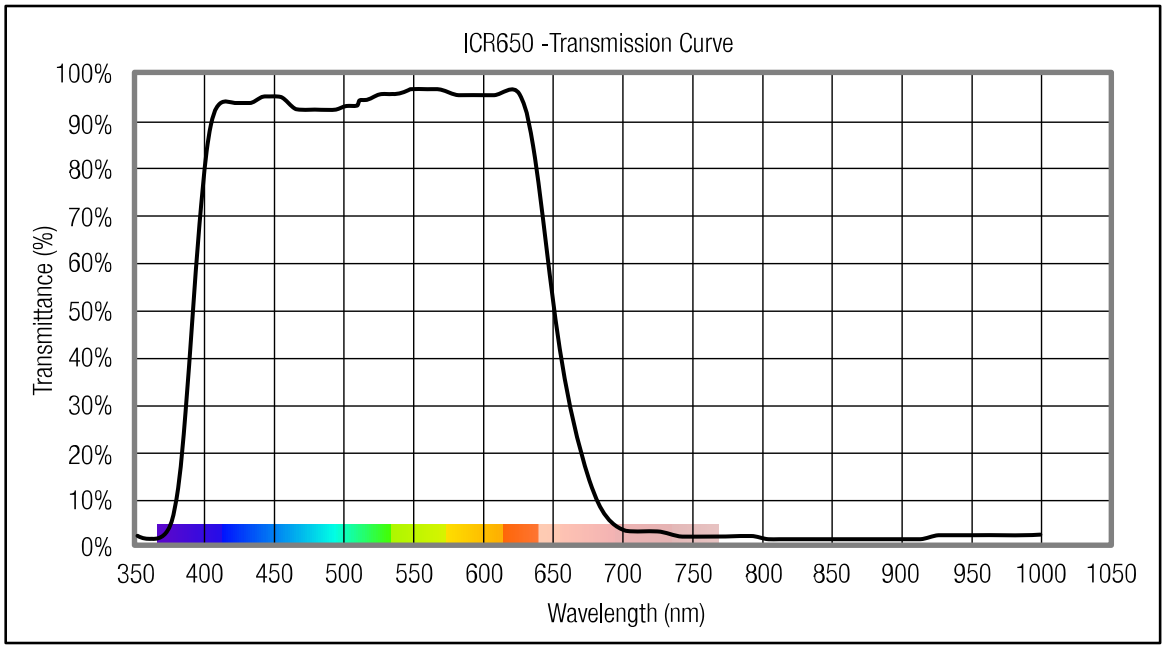


Figure 12: Filter glass ICR650 Transmission Curve

The following filter window is implemented in:

MX161MG-SY-X4G3-FF MX203MG-SY-X4G3-FF MX245MG-SY-X4G3-FF

	Filter	Coating	Thickness
	Filter BK7	ARx2	1.1 mm

Table 8: BK7 filter window parameter

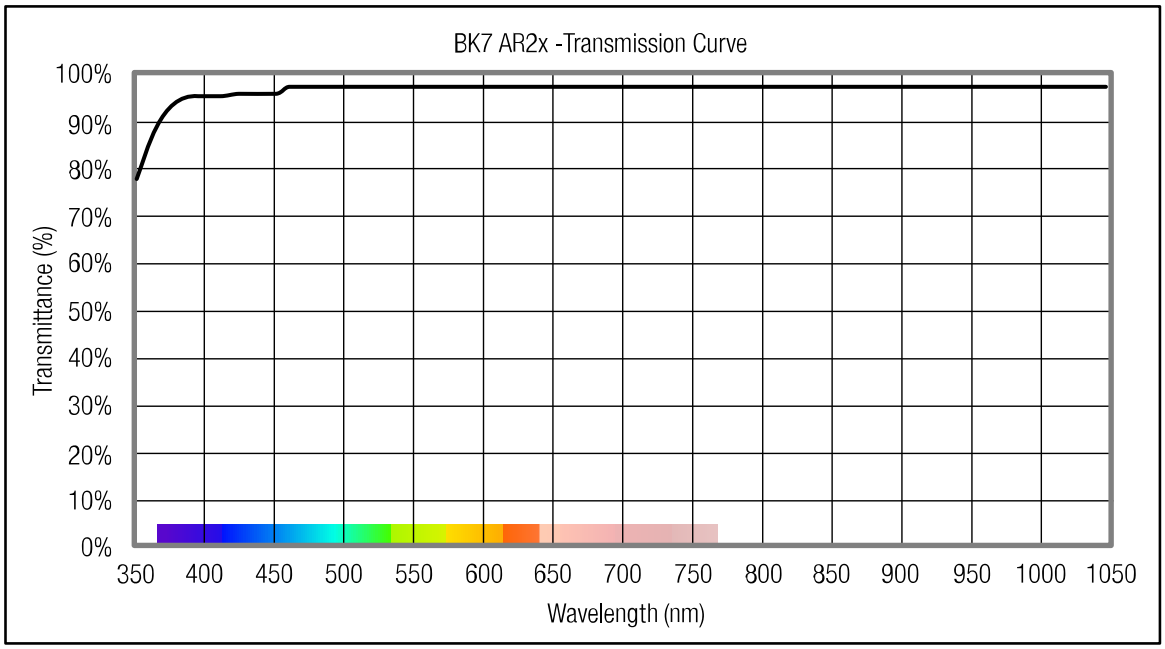


Figure 13: Filter glass BK7 AR2x Transmission Curve

2.6 Sensor and camera characteristics

2.6.1 Sensor and camera parameters

Sensor parameters of:
MX161CG-SY-X4G3-FF MX161MG-SY-X4G3-FF

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	5328 x 3040	[px]
Active area size (H X V)	14.58 x 8.31	[mm]
Sensor diagonal	16.8	[mm]
Pixel size (H x V)	2.74 x 2.74	[µm]

Table 9: Sensor parameters of the specific models

Sensor parameters of:
MX203CG-SY-X4G3-FF MX203MG-SY-X4G3-FF

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	4512 x 4512	[px]
Active area size (H X V)	12.34 x 12.34	[mm]
Sensor diagonal	17.5	[mm]
Pixel size (H x V)	2.74 x 2.74	[µm]

Table 10: Sensor parameters of the specific models

Sensor parameters of:
MX245CG-SY-X4G3-FF MX245MG-SY-X4G3-FF

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	5328 x 4608	[px]
Active area size (H X V)	14.58 x 12.6	[mm]
Sensor diagonal	19.3	[mm]
Pixel size (H x V)	2.74 x 2.74	[µm]

Table 11: 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:
MX161CG-SY-X4G3-FF MX203CG-SY-X4G3-FF

Mode		8 bit	10 bit	12 bit	Dual ADC 8 bit	Dual ADC 10 bit	Dual ADC 12 bit
Sensor bit/px	[bit/px]	8	10	12	8	10	12
Dual ADC	-	-	-	-	Non-Comb.	Non-Comb.	Non-Comb.
Gain Ratio	[dB]	None	None	None	24.0	24.0	24.0
Parameters							
Temporal dark noise	[e^-]	4.53	5.12	2.21	1.66	2.02	1.65
Absolute sensitivity threshold	[e^-]	5.03	5.62	2.71	2.16	2.52	2.15
Saturation capacity	[ke^-]	2.37	9.98	9.28	2.35	10.02	9.32
Dynamic range	[dB]	53.45	64.98	70.71	60.73	71.94	72.68
MAX Signal-to-noise ratio	[dB]	33.74	40.19	39.96	33.72	40.23	39.96
Overall system gain	[e^-/DN]	9.88	10.23	2.38	0.04	0.16	0.15
Dark current	[e^-/s]	1.55	1.01	1.11	1.4	1.71	1.39
Dark current meas. temp.	[°C]	39.0	39.4	39.8	39.5	39.5	40.3
DSNU	[e^-]	0.5	0.82	0.42	0.41	0.61	0.53
PRNU	[%]	0.77	0.73	0.73	0.76	0.73	0.72
Linearity error	[%]	0.45	0.22	0.53	0.66	0.17	0.82

Table 12: Image quality parameters of the specific models

Image quality parameters of:
MX161MG-SY-X4G3-FF MX203MG-SY-X4G3-FF

Mode		8 bit	10 bit	12 bit	Dual ADC 8 bit	Dual ADC 10 bit	Dual ADC 12 bit
Sensor bit/px	[bit/px]	8	10	12	8	10	12
Dual ADC	-	-	-	-	Non-Comb.	Non-Comb.	Non-Comb.
Gain Ratio	[dB]	None	None	None	24.0	24.0	24.0
Parameters							
Temporal dark noise	[e^-]	4.55	5.19	2.25	1.62	2.02	1.7
Absolute sensitivity threshold	[e^-]	5.05	5.69	2.75	2.12	2.52	2.2
Saturation capacity	[ke^-]	2.38	10.07	9.49	2.34	10.07	9.46
Dynamic range	[dB]	53.43	64.92	70.71	60.86	71.94	72.62
MAX Signal-to-noise ratio	[dB]	33.73	40.32	40.1	33.71	40.35	40.14
Overall system gain	[e^-/DN]	9.95	10.28	2.42	0.04	0.16	0.15
Dark current	[e^-/s]	1.73	1.1	1.17	1.76	2.17	2.05
Dark current meas. temp.	[°C]	39.3	39.3	39.9	39.9	39.4	40.1
DSNU	[e^-]	0.51	0.83	0.48	0.44	0.66	0.57
PRNU	[%]	0.63	0.61	0.62	0.58	0.58	0.6
Linearity error	[%]	0.63	0.25	0.59	0.56	0.18	0.85

Table 13: Image quality parameters of the specific models

Image quality parameters of:
MX245CG-SY-X4G3-FF

Mode		8 bit	10 bit	12 bit	Dual ADC 8 bit	Dual ADC 10 bit	Dual ADC 12 bit
Sensor bit/px	[bit/px]	8	10	12	8	10	12
Dual ADC	-	-	-	None	Non-Comb.	Non-Comb.	Non-Comb.
Gain Ratio	[dB]	None	None	None	24.0	24.0	24.0
Parameters							
Temporal dark noise	[e^-]	4.63	5.25	2.23	1.67	2.07	1.73
Absolute sensitivity threshold	[e^-]	5.13	5.75	2.73	2.17	2.57	2.23
Saturation capacity	[ke^-]	2.37	10.09	9.33	2.37	10.16	9.41
Dynamic range	[dB]	53.4	64.87	70.69	60.73	71.93	72.49
MAX Signal-to-noise ratio	[dB]	33.72	40.37	40.0	33.75	40.36	40.08
Overall system gain	[e^-/DN]	10.05	10.38	2.4	0.04	0.16	0.15
Dark current	[e^-/s]	1.91	0.97	0.87	1.56	1.82	2.06
Dark current meas. temp.	[°C]	39.0	39.4	38.2	39.7	39.9	41.4
DSNU	[e^-]	0.52	0.86	0.84	0.44	0.7	0.6
PRNU	[%]	0.73	0.68	0.74	0.69	0.63	0.65
Linearity error	[%]	0.67	0.27	0.7	0.66	0.16	0.5

Table 14: Image quality parameters of the specific models

Image quality parameters of:
MX245MG-SY-X4G3-FF

Mode		8 bit	10 bit	12 bit	Dual ADC 8 bit	Dual ADC 10 bit	Dual ADC 12 bit
Sensor bit/px	[bit/px]	8	10	12	8	10	12
Dual ADC	-	-	-	None	Non-Comb.	Non-Comb.	Non-Comb.
Gain Ratio	[dB]	None	None	None	24.0	24.0	24.0
Parameters							
Temporal dark noise	[e^-]	4.58	5.25	2.24	1.65	2.07	1.73
Absolute sensitivity threshold	[e^-]	5.08	5.75	2.74	2.15	2.57	2.23
Saturation capacity	[ke^-]	2.37	9.95	9.35	2.36	10.07	9.49
Dynamic range	[dB]	53.36	64.88	70.67	60.85	71.94	72.59
MAX Signal-to-noise ratio	[dB]	33.73	40.36	40.15	33.74	40.45	40.18
Overall system gain	[e^-/DN]	9.87	10.27	2.39	0.04	0.16	0.15
Dark current	[e^-/s]	1.65	0.9	0.74	1.55	1.7	1.79
Dark current meas. temp.	[°C]	38.5	38.4	37.3	38.8	38.8	40.0
DSNU	[e^-]	0.52	0.95	0.58	0.46	0.74	0.65
PRNU	[%]	0.68	0.61	0.61	0.62	0.6	0.61
Linearity error	[%]	0.61	0.25	0.73	0.54	0.17	0.45

Table 15: Image quality parameters of the specific models

2.6.3 Sensor read-out modes

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

Sensor Read-out modes of:
MX161CG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	5328 x 3040	8	160.4
Dec.2 x 2	-	8	2656 x 1520	8	310.8
1 x 1	-	10	5328 x 3040	10	154.1
Dec.2 x 2	-	10	2656 x 1520	10	298.5
1 x 1	-	12	5328 x 3040	12	112.0
Dec.2 x 2	-	12	2656 x 1520	12	218.3
1 x 1	Combined	8	5328 x 3040	8	56.6
1 x 1	Combined	12	5328 x 3040	12	56.6
1 x 1	Non-Comb.	8	5328 x 3040	8	81.7
1 x 1	Non-Comb.	10	5328 x 3040	10	78.5
1 x 1	Non-Comb.	12	5328 x 3040	12	56.9

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

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

Sensor Read-out modes of:
MX161MG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	5328 x 3040	8	160.4
Dec.2 x 2	-	8	2656 x 1520	8	560.7
Bin.2 x 2	-	8	2656 x 1520	8	560.7
1 x 1	-	10	5328 x 3040	10	154.1
Dec.2 x 2	-	10	2656 x 1520	10	528.5
Bin.2 x 2	-	10	2656 x 1520	10	528.5
1 x 1	-	12	5328 x 3040	12	112.0
Dec.2 x 2	-	12	2656 x 1520	12	417.2
Bin.2 x 2	-	12	2656 x 1520	12	417.2
1 x 1	Combined	8	5328 x 3040	8	56.6
1 x 1	Combined	12	5328 x 3040	12	56.6
1 x 1	Non-Comb.	8	5328 x 3040	8	81.7
1 x 1	Non-Comb.	10	5328 x 3040	10	78.5
1 x 1	Non-Comb.	12	5328 x 3040	12	56.9

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

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

Sensor Read-out modes of:
MX203CG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	4512 x 4512	8	110.1
Dec.2 x 2	-	8	2256 x 2256	8	215.5
1 x 1	-	10	4512 x 4512	10	105.8
Dec.2 x 2	-	10	2256 x 2256	10	207.0
1 x 1	-	12	4512 x 4512	12	76.7
Dec.2 x 2	-	12	2256 x 2256	12	150.8
1 x 1	Combined	8	4512 x 4512	8	38.6
1 x 1	Combined	12	4512 x 4512	12	38.6
1 x 1	Non-Comb.	8	4512 x 4512	8	55.8
1 x 1	Non-Comb.	10	4512 x 4512	10	53.6
1 x 1	Non-Comb.	12	4512 x 4512	12	38.8

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

Table 18: Sensor read-out modes of the specific models

Sensor Read-out modes of:
MX203MG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	4512 x 4512	8	110.1
Dec.2 x 2	-	8	2256 x 2256	8	411.6
Bin.2 x 2	-	8	2256 x 2256	8	411.6
1 x 1	-	10	4512 x 4512	10	105.8
Dec.2 x 2	-	10	2256 x 2256	10	396.6
Bin.2 x 2	-	10	2256 x 2256	10	396.6
1 x 1	-	12	4512 x 4512	12	76.7
Dec.2 x 2	-	12	2256 x 2256	12	291.8
Bin.2 x 2	-	12	2256 x 2256	12	291.8
1 x 1	Combined	8	4512 x 4512	8	38.6
1 x 1	Combined	12	4512 x 4512	12	38.6
1 x 1	Non-Comb.	8	4512 x 4512	8	55.8
1 x 1	Non-Comb.	10	4512 x 4512	10	53.6
1 x 1	Non-Comb.	12	4512 x 4512	12	38.8

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

Table 19: Sensor read-out modes of the specific models

Sensor Read-out modes of:
MX245CG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	5328 x 4608	8	107.9
Dec.2 x 2	-	8	2664 x 2304	8	211.3
1 x 1	-	10	5328 x 4608	10	103.6
Dec.2 x 2	-	10	2664 x 2304	10	202.9
1 x 1	-	12	5328 x 4608	12	75.2
Dec.2 x 2	-	12	2664 x 2304	12	147.8
1 x 1	Combined	8	5328 x 4608	8	37.9
1 x 1	Combined	12	5328 x 4608	12	37.9
1 x 1	Non-Comb.	8	5328 x 4608	8	54.7
1 x 1	Non-Comb.	10	5328 x 4608	10	52.5
1 x 1	Non-Comb.	12	5328 x 4608	12	38.0

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

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

Sensor Read-out modes of:
MX245MG-SY-X4G3-FF

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Frame rate[1]
1 x 1	-	8	5328 x 4608	8	107.9
Dec.2 x 2	-	8	2664 x 2304	8	387.9
Bin.2 x 2	-	8	2664 x 2304	8	387.9
1 x 1	-	10	5328 x 4608	10	103.6
Dec.2 x 2	-	10	2664 x 2304	10	365.1
Bin.2 x 2	-	10	2664 x 2304	10	365.1
1 x 1	-	12	5328 x 4608	12	75.2
Dec.2 x 2	-	12	2664 x 2304	12	286.2
Bin.2 x 2	-	12	2664 x 2304	12	286.2
1 x 1	Combined	8	5328 x 4608	8	37.9
1 x 1	Combined	12	5328 x 4608	12	37.9
1 x 1	Non-Comb.	8	5328 x 4608	8	54.7
1 x 1	Non-Comb.	10	5328 x 4608	10	52.5
1 x 1	Non-Comb.	12	5328 x 4608	12	38.0

[1]Frame rate was measured using the transport format at bandwidth limit 3500.0 MB/s

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

2.6.4 Quantum efficiency curves

Quantum efficiency curves for:
MX161CG-SY-X4G3-FF MX161MG-SY-X4G3-FF

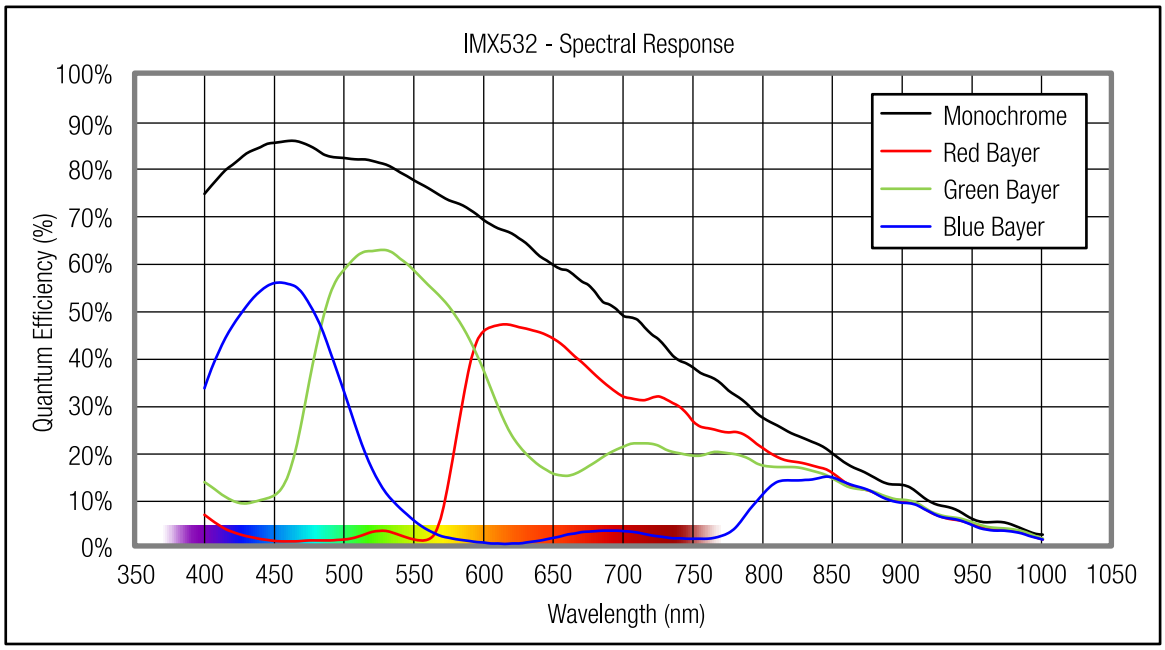


Figure 14: Graph quantum efficiency of Sony IMX532

Quantum efficiency curves for:
MX203CG-SY-X4G3-FF MX203MG-SY-X4G3-FF

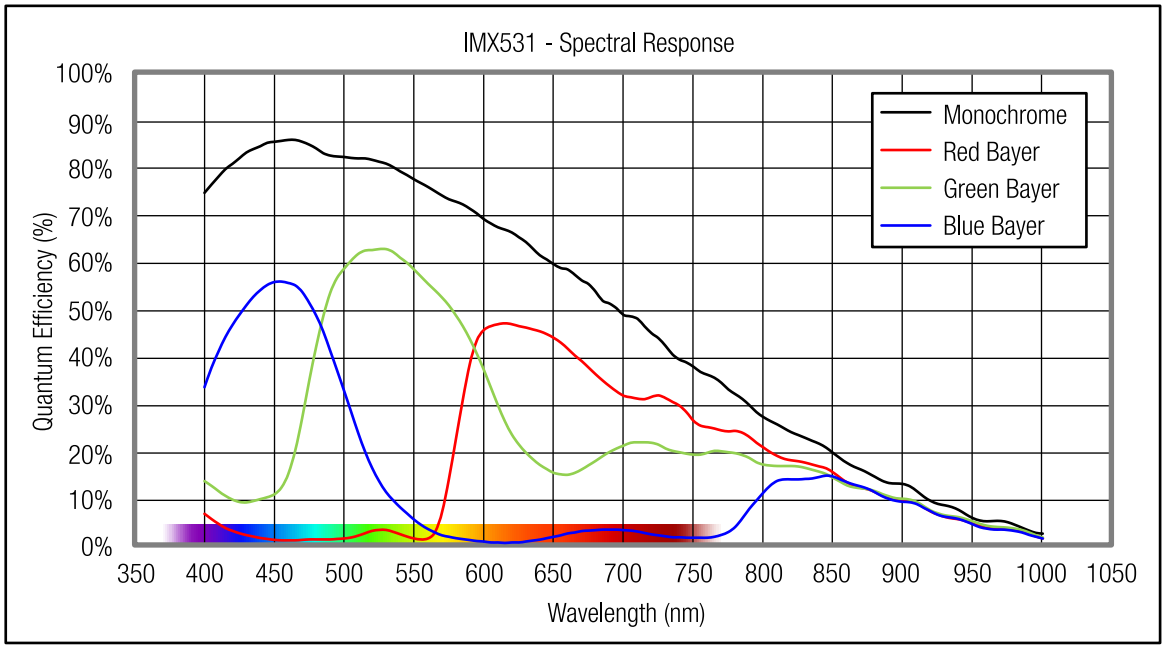


Figure 15: Graph quantum efficiency of Sony IMX531

Quantum efficiency curves for:
MX245CG-SY-X4G3-FF MX245MG-SY-X4G3-FF

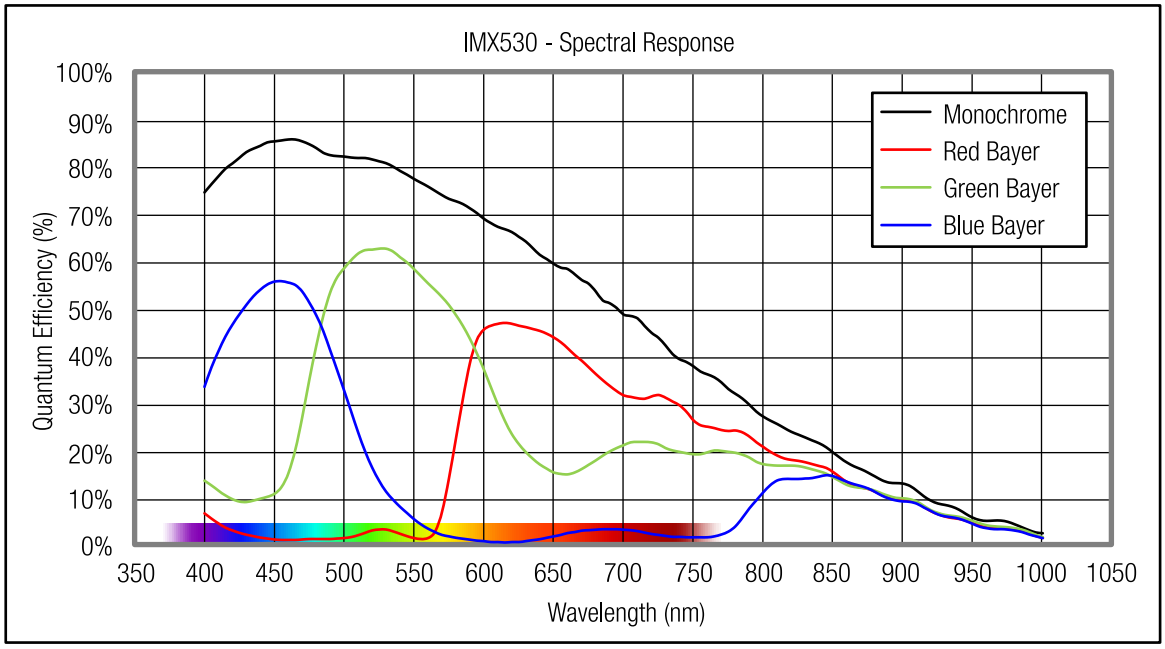


Figure 16: Graph quantum efficiency of Sony IMX530

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

Dimensions and mass of:
all models in this manual (refer to the table Models and sensors overview)

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
70 mm	60 mm	55 mm	395 g

[1] without adapters

Table 22: Camera parameters of the specific models

2.7.2 Dimensional drawings

Dimensional drawings of:
all models in this manual (refer to the table Models and sensors overview)

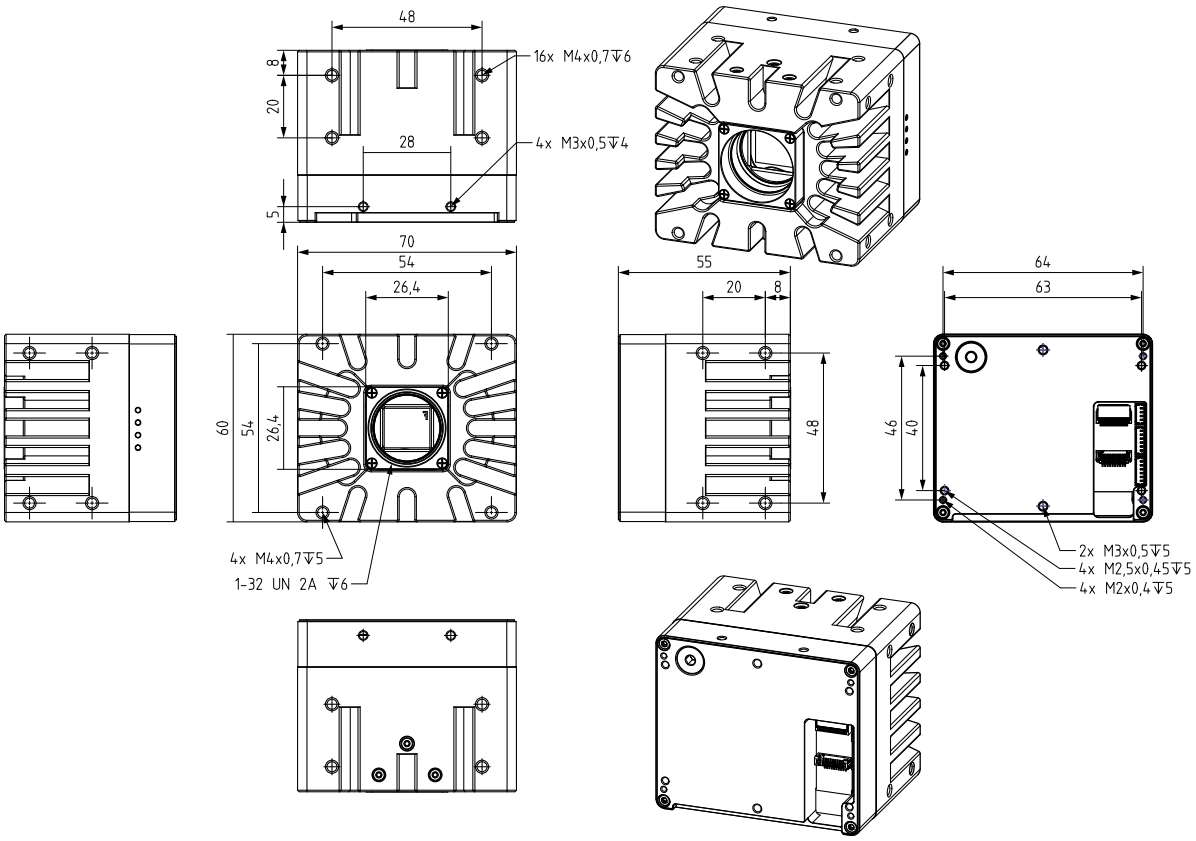


Figure 17: Dimensional drawing of MX161/203/245xR-SY-X4G3-xxx

Dimensional drawings of:
all models in this manual (refer to the table Models and sensors overview)

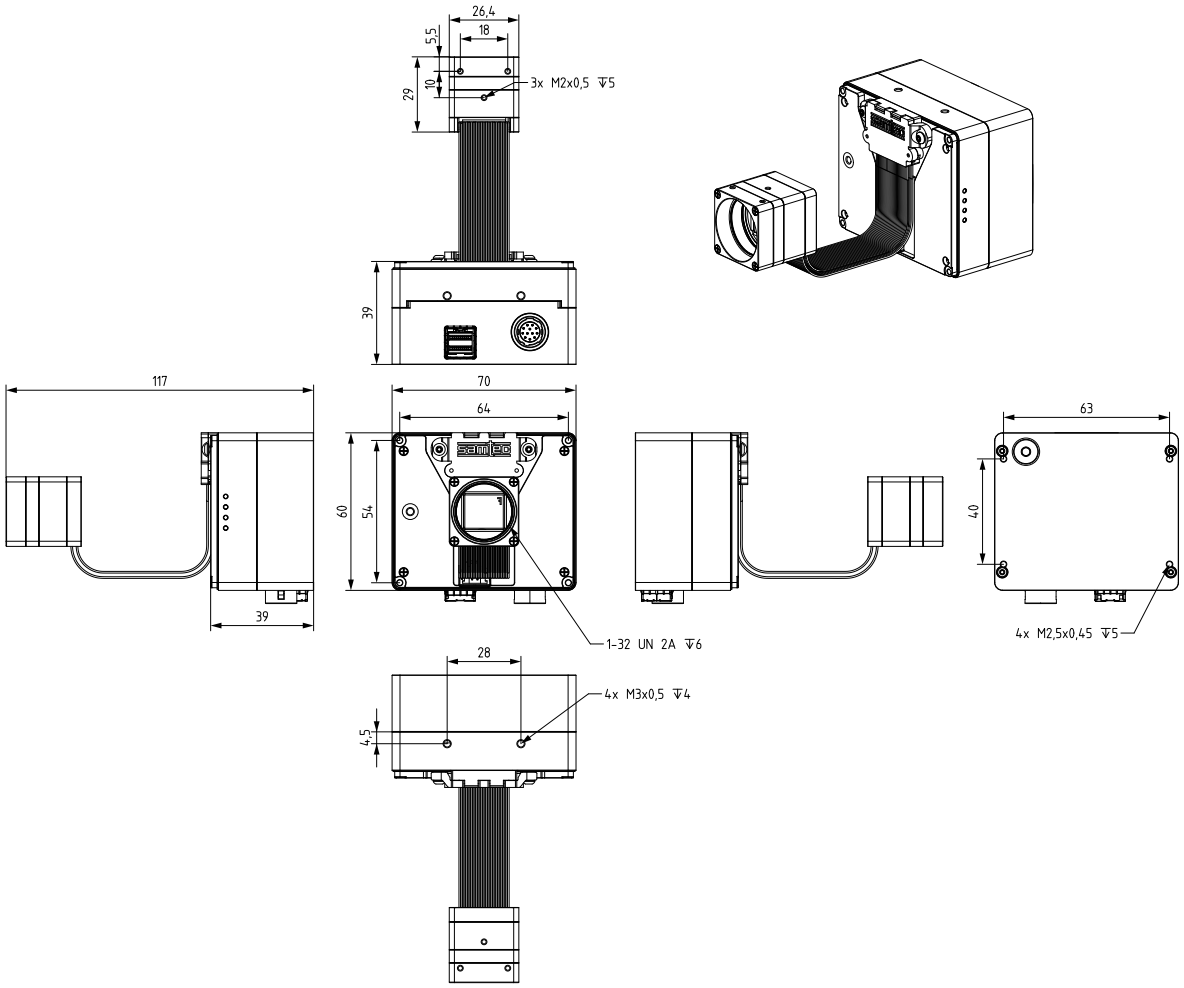


Figure 18: Dimensional drawing of MX161/203/245xR-SY-X4G3-xxx with detached sensor sub-assembly

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 23: LED output description during camera power up

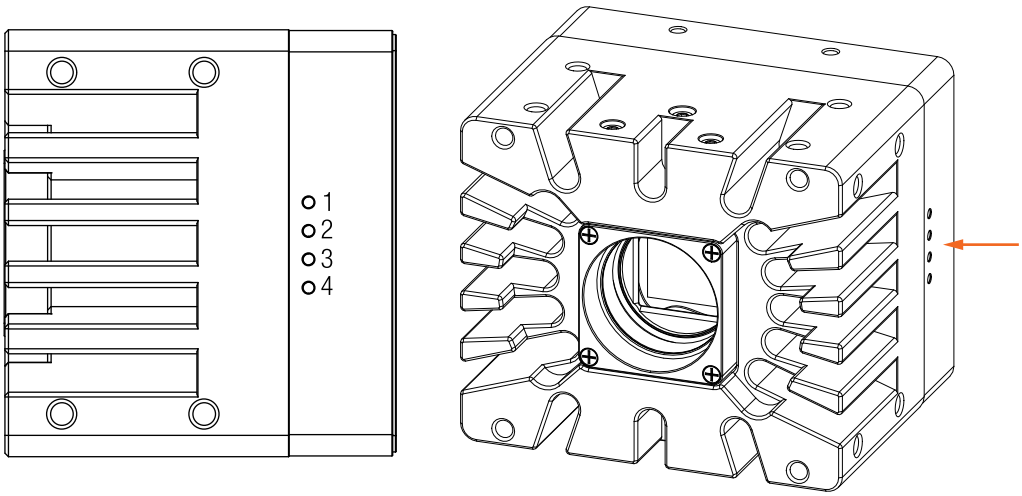


Figure 19: Position of LEDs on xiX-Xtreme camera

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 connection	Off	Off	On	On
Recovery firmware loaded[1]	flash	flash	flash	flash
PCIe connected X4 Gen3	On	flash	flash	On
PCIe connected (X2 or X1) Gen3	flash	flash	flash	On

[1]To identify, if the recovery firmware is loaded, please start xiCOP. See XIMEA control panel

Table 24: LED statuses during boot sequence

2.9 Camera interface

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

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

2.9.1 PCIe / FireFly interface

The interface connector is used for data transmission, camera control, power and IO (see section Digital inputs / outputs (GPIO) interface for IO connector pinout description). To prevent camera damage, always ensure the power is turned off before inserting or detaching the cable. For cameras with the ADPT-MX-X4G3-FF-X4G3-MTP or ADPT-MX-X4G3-FF-X4G3-SFF adapter, refer to the appropriate adapter section.

Item	Value
Connector	Samtec (UEC5-019-1-H-D-RA-1-A + UCC8-010-1-H-S-1-A)
Signals	PCIe 4 Gen3; Power input; Optoisolated IO
Mating Connectors	Samtec ECUE, PCUO

Table 25: Firefly interface mating connector description

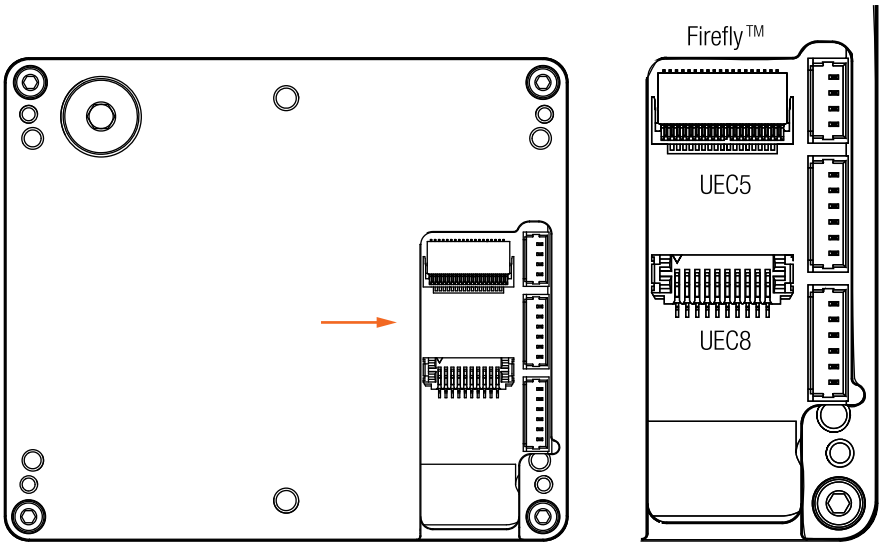


Figure 20: PCIe / FireFly connector location

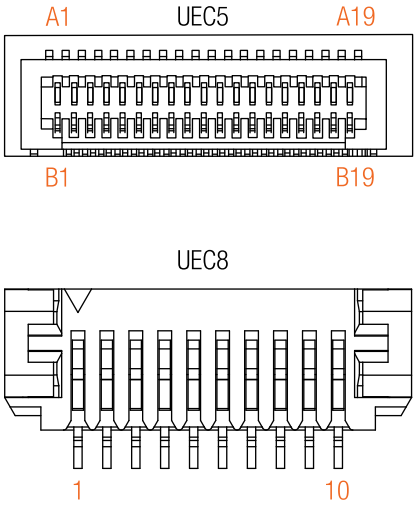


Figure 21: PCIe / FireFly connector pinout

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

Table 26: FireFly UEC8 connector pin assignment

Pin	Name	Type	Pin	Name	Type
A1	GND	Signal and power ground	B1	GND	Signal and power ground
A2	PCIe_PETN_2	PCIe TX differential pair 2	B2	PCIe_PETN_3	PCIe TX differential pair 3
A3	PCIe_PETP_2	PCIe TX differential pair 2	B3	PCIe_PETP_3	PCIe TX differential pair 3
A4	GND	Signal and power ground	B4	GND	Signal and power ground
A5	PCIe_PETN_1	PCIe TX differential pair 1	B5	PCIe_PETN_0	PCIe TX differential pair 0
A6	PCIe_PETP_1	PCIe TX differential pair 1	B6	PCIe_PETP_0	PCIe TX differential pair 0
A7	GND	Signal and power ground	B7	GND	Signal and power ground
A8	IN1	Optically isolated Digital Input (IN)	B8	OUT1	Optically isolated Digital Output (OUT)
A9	IN1_GND	Ground for opto-isolated Input 1	B9	OUT1_GND	Ground for opto-isolated Output 1
A10	GND	Signal and power ground	B10	GND	Signal and power ground
A11	PCIe_RST0_N_IN	PCIe reset	B11	PWR	Power input
A12	NC	None	B12	PWR	Power input
A13	GND	Signal and power ground	B13	GND	Signal and power ground
A14	PCIe_PERP_2	PCIe RX differential pair 2	B14	PCIe_PERN_3	PCIe RX differential pair 3
A15	PCIe_PERN_2	PCIe RX differential pair 2	B15	PCIe_PERP_3	PCIe RX differential pair 3
A16	GND	Signal and power ground	B16	GND	Signal and power ground
A17	PCIe_PERP_1	PCIe RX differential pair 1	B17	PCIe_PERN_0	PCIe RX differential pair 0
A18	PCIe_PERN_1	PCIe RX differential pair 1	B18	PCIe_PERP_0	PCIe RX differential pair 0
A19	GND	Signal and power ground	B19	GND	Signal and power ground

Table 27: FireFly UEC5 connector pin assignment

2.10 Digital inputs / outputs (GPIO) interface

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

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

Table 28: Firefly connector I/O pin assignment

Connector	Signals	Mating Connectors
4 pin Pico Blade	AUX power input	Molex 0510210400
6 pin Pico Blade	Optically isolated IO	Molex 0510210600
6 pin Pico Blade	Non isolated IO	Molex 0510210600

Table 29: GPIO mating connector description

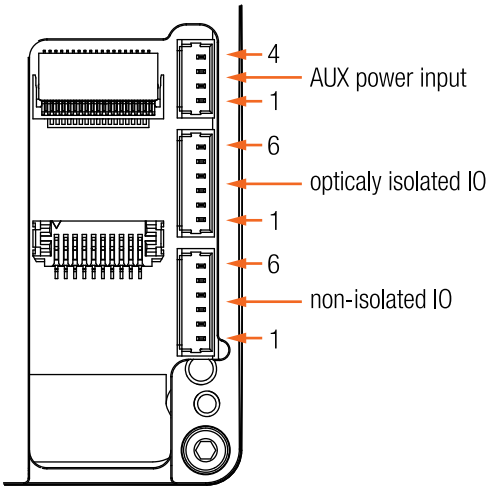


Figure 22: IO connectors position

	Pin	Name	Type
AUX power input pin assignment			
	1	GND	Power ground
	2	PWR_IN	Power input
	3	PWR_IN	Power input
	4	GND	Power ground

Table 30: Power connector pin assignment

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

Table 31: I/O connector pin assignment

2.10.1 Optically isolated Digital Input (IN)

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

Item	Parameter	Note
Maximal input voltage	24 V DC	None
Common pole	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	10m	None
Input Level for logical 0	Voltage < 1.2 V / Current < 0.3 mA	None
Input Level for logical 1	Voltage > 3.3 V / Current > 1 mA	None
Input debounce filter	No	None
Input delay - rising edge	0.1 µs	VINPUT=10 V,TAMBIENT=25 °C
Input delay - falling edge	5 µs	VINPUT=10 V,TAMBIENT=25 °C
External trigger mapping	YES	None
Input functions	Trigger	Rising or falling edge are supported for trigger

Table 32: General info for optically isolated digital input

2.10.2 Optically isolated Digital Output (OUT)

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

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

Table 33: 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	YES	Off, On, Exposure active, Frame active; Signal inversion supported[1]

[1]Functions may vary depending on camera model

Table 34: General info for non-isolated digital in/out trigger lines

2.11 Accessories

2.11.1 CBL-PB4-PWR-0M15

Power cable with barrel connector 15 cm long.



Figure 23: CBL-PB4-PWR-0M15

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

Table 35: CBL-PB4-PWR-0M15 description

2.11.2 CBL-PB6-PT-0M30



Figure 24: CBL-PB6-PT-0M30

IO pig tail cable 30 cm long.

Manufacturer	Model	Description
Molex	2181120603	6 pin Pico Blade connector

Table 36: CBL-PB6-PT-0M30 description

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

The FireFly copper cables are bidirectional and flexible. PCIe Gen3 x4 lanes with performance to 28 Gbps, 12 differential pairs. Both sides are equipped with locking mechanism. The cable is available in 1 m ,2 m, and 3 m lengths. The EMI/EMC performance should be evaluated by customer.

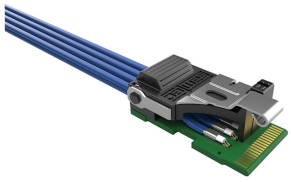


Figure 25: CBL-ECUE-X4G3-1M0

2.11.4 HQCD Cable



Figure 26: X4G3 cameras with HQCD cable

The xiX X4G3 camera models from xiX-XL and xiX-Xtreme camera families feature a detachable rear sub-assembly option.

This innovative housing concept with detachable sensor head optimizes heat dissipation to improve the image quality and simplify integration into tight spaces. The sensor head is connected to the rear sub-assembly using an HQCD cable.

See table below for the supported HQCD cable lengths.



Figure 27: HQCD cable

Cable PN	Description
HQCD-030-06.00-STR-TTL-1B	Highspeed Coaxial HQCD cable, 6 inch - 15 cm length, screw mount both ends
HQCD-030-20.00-STR-TTL-1B	Highspeed Coaxial HQCD cable, 20 inch - 50 cm length, screw mount both ends
HQCD-030-40.00-STR-TTL-1B	Highspeed Coaxial HQCD cable, 40 inch - 100 cm length, screw mount both ends
HQCD-030-80.00-STR-TTL-1B	Highspeed Coaxial HQCD cable, 80 inch - 200 cm length, screw mount both ends

Table 37: HQCD cable - available lengths

Note: Detaching the rear sub-assembly is not a standard customer procedure. Please take care not to damage the camera, cables, or related components during detaching or reattaching of the rear sub-assembly. If you require the camera with the rear sub-assembly detached, please contact our XIMEA support team.

Detaching rear sub-assembly

If you intend to detach the camera rear sub-assembly yourself, follow the steps below to ensure correct handling:

Step 1. Locate the M2 screws on the back side of the rear sub-assembly.

Step 2. Remove the M2 screws and set them aside.

Step 3. Carefully pull the rear sub-assembly straight away from the camera housing.

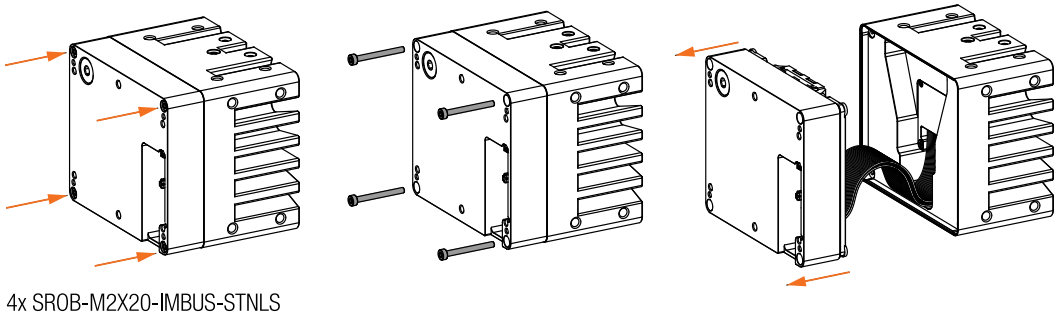


Figure 28: Detaching rear sub-assembly

ATTENTION: ESD rings are located on the inner side of the mounting holes. These rings may become loose or fall out when the sub-assembly is removed. Collect all four ESD rings and M2 screws, and store them in a safe place for future re-installation.

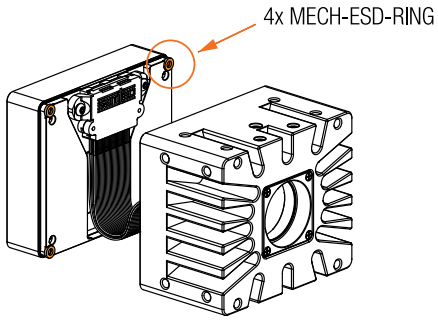


Figure 29: ESD rings

Note: If your camera is equipped with a water / air cooler kit module (CB-X8G3-WAT-COOLER-KIT or CB-X8G3-FAN-COOLER-KIT), you must remove it first.

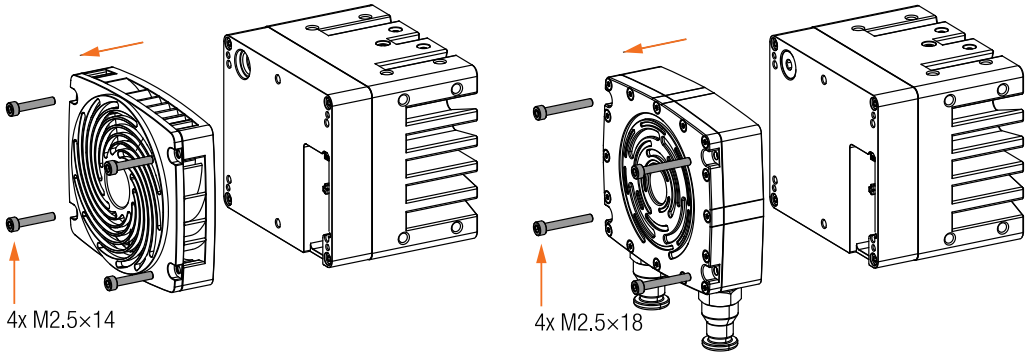


Figure 30: Detaching heatsink

ATTENTION: When removing or inserting the fan assembly, it's important to be careful not to damage the spring pins that connect the cooling unit to the camera electronics, see image below.

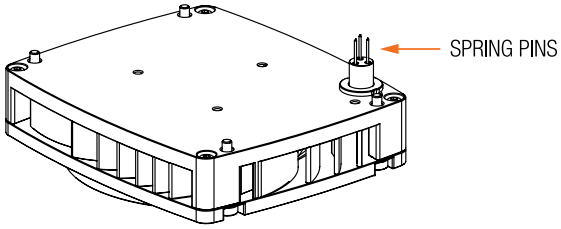


Figure 31: CB-X8G3-FAN-COOLER-KIT spring pins

2.11.5 CB-X8G3-FAN-COOLER



Figure 32: CB-X8G3-FAN-COOLER

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

To attach or detach the fan module, you will need a hex 2.0 screwdriver and four M2.5x14 screws. When removing or inserting the fan assembly, it's important to be careful not to damage the spring pins that connect the cooling unit to the camera electronics.

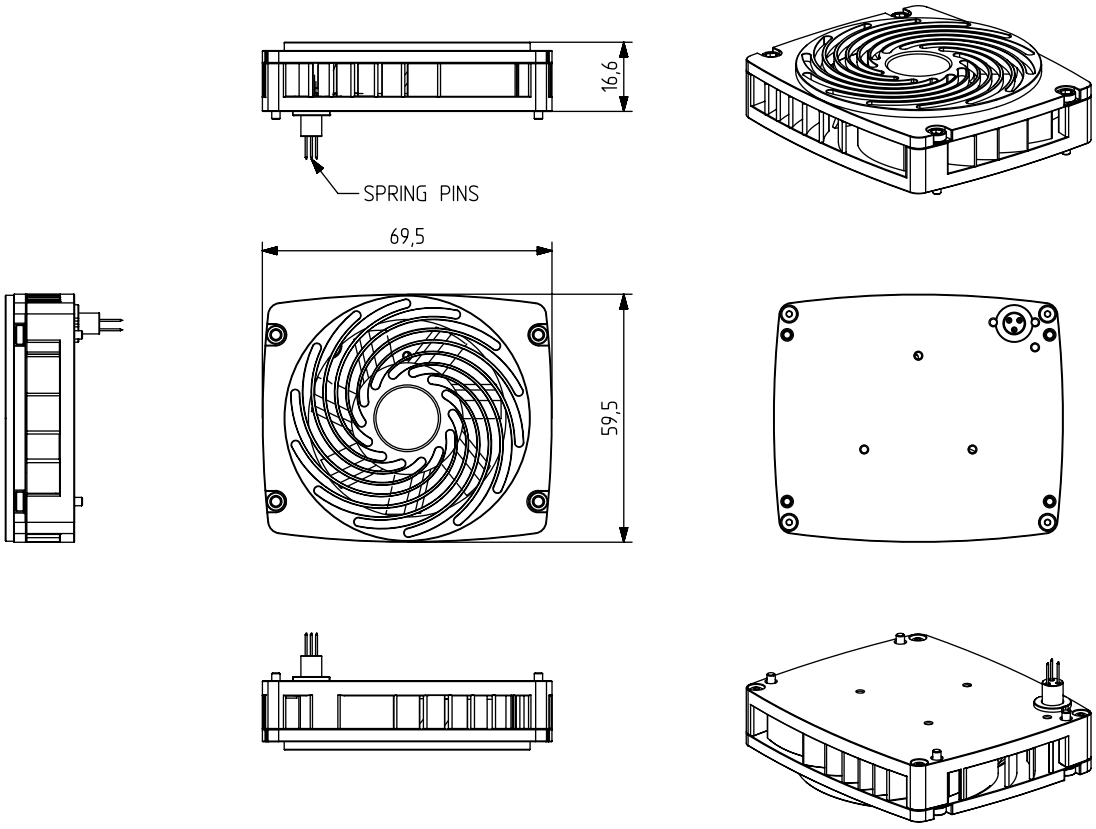


Figure 33: Dimensional drawing of CB-X8G3-FAN-COOLER

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

Table 38: Mechanical parameters of CB-X8G3-FAN-COOLER

2.11.6 CB-X8G3-WAT-COOLER-KIT



Figure 34: CB-X8G3-WAT-COOLER

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

1 SSC6 - M5 quick coupler with airtight washer for 6 mm tubes (water rated)

2 6061 aluminum housing with optimized ater flow and cooling abilities

3 airtight sealing (tested at 10 bars)

4 M 2.5 x 18 screws for mounting cooler

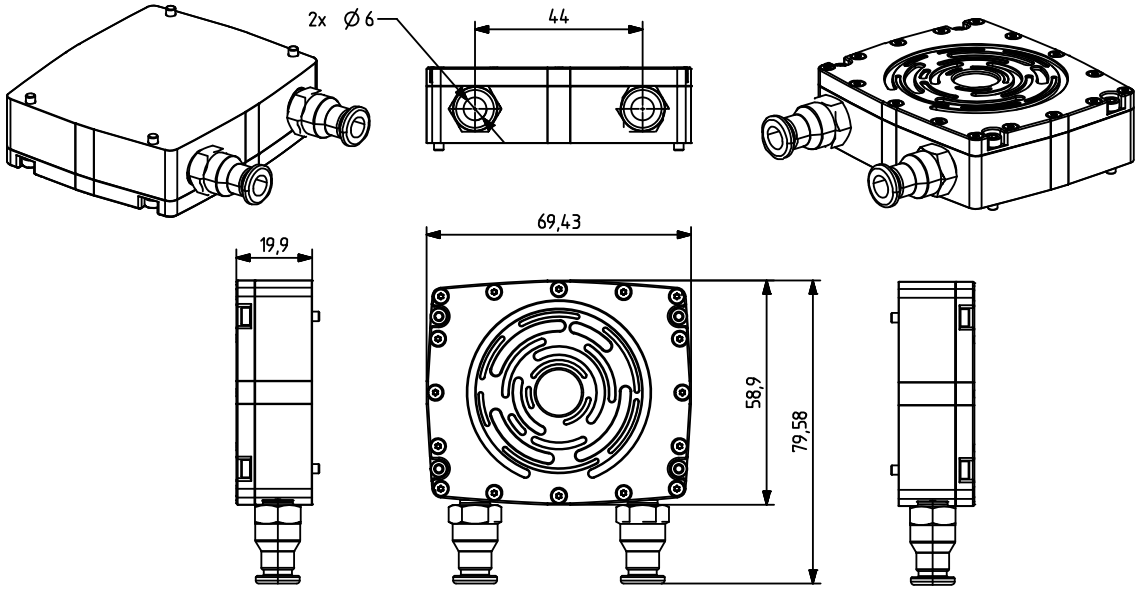


Figure 35: Dimensional drawing of CB-X8G3-WAT-COOLER-KIT

2.11.7 Water cooler tube connection

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

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

Please refer to the pictures and steps below for the correct connection of the water cooler.

Ring inserting

The insert ring is designed to prevent deformation of the tube. A soft tube can be connected to the Fitting.

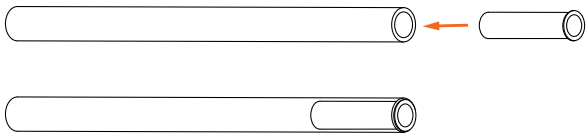


Figure 36: Inserting the ring into the tube

Tube insertion

Insert the tube into the Push-In Fitting until it reaches the end. The collet will secure the tube automatically, while the elastic sleeve creates a seal around it.

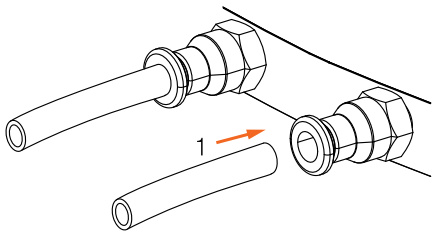


Figure 37: Tube insertion

Tube disconnection

To disconnect the tube, simply push the collet. Ensure that the water supply is halted before disconnecting the tube.

Step 1. Push the collet.

Step 2. Pull the tube out.

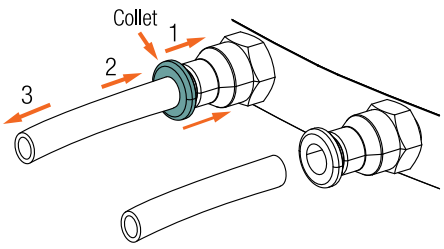


Figure 38: Tube disconnection

2.11.8 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).

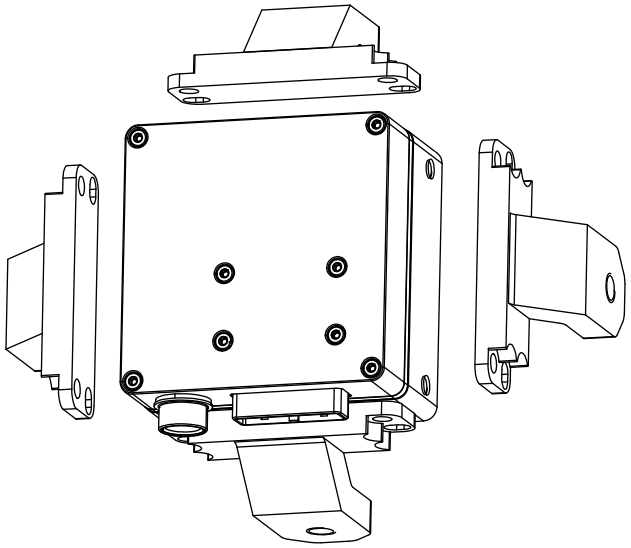


Figure 39: MECH-60MM-BRACKET-T

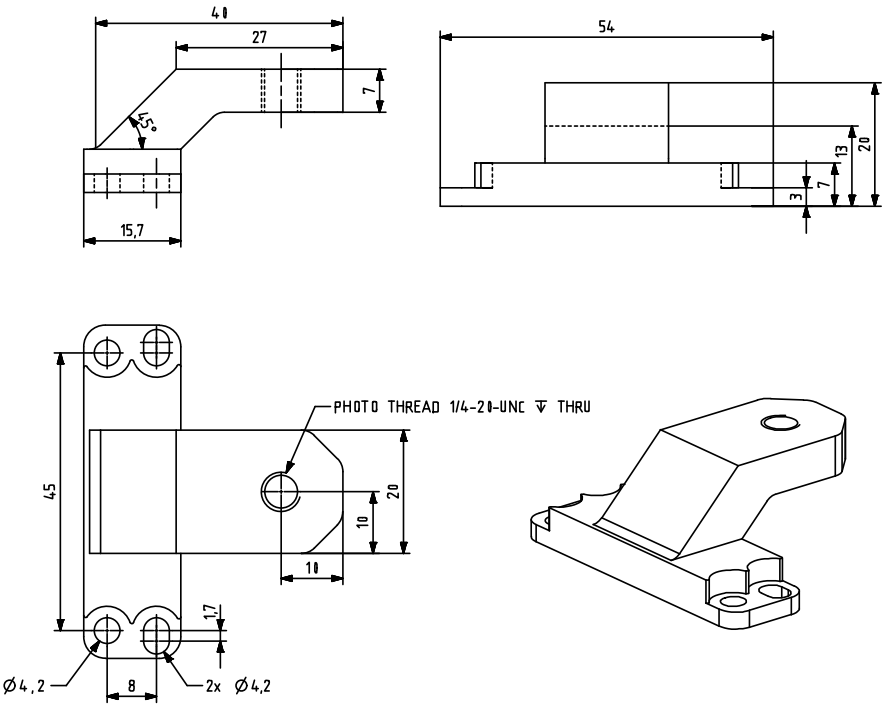


Figure 40: Dimensional drawing of MECH-60MM-BRACKET-T

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

Table 39: Parameters of MECH-60MM-BRACKET-T

2.11.9 MQ-BRACKET-T



Figure 41: MQ-BRACKET-T

Tripod mounting bracket with 1/4-20 thread. Use 4x SROB-M2x4-CUST screws for mounting. Bracket can be mounted on the bottom or top side of the camera. Brackets are delivered as kit with respective screws. There are two variants. Standard MQ-BRACKET-T-KIT with height of 5.5 mm and thick MQ-BRACKET-T-THICK-KIT for use with lenses with diameter > 37 mm37

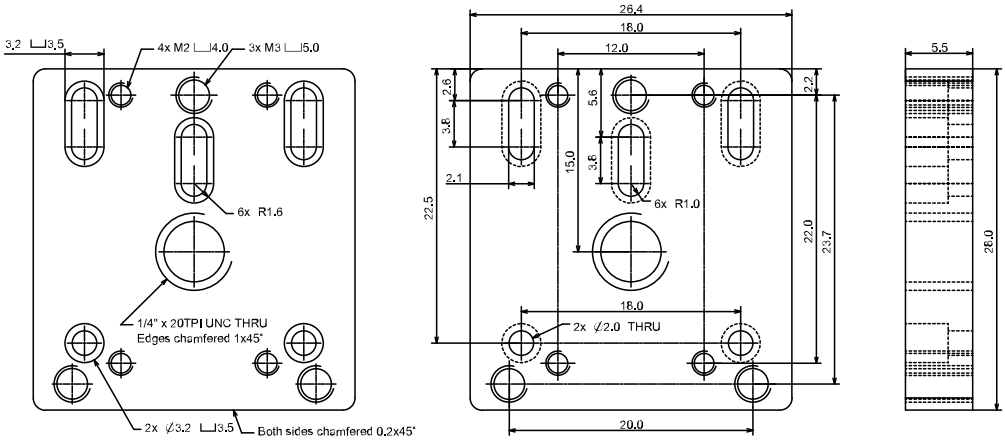


Figure 42: MQ-BRACKET-T dimensional drawing

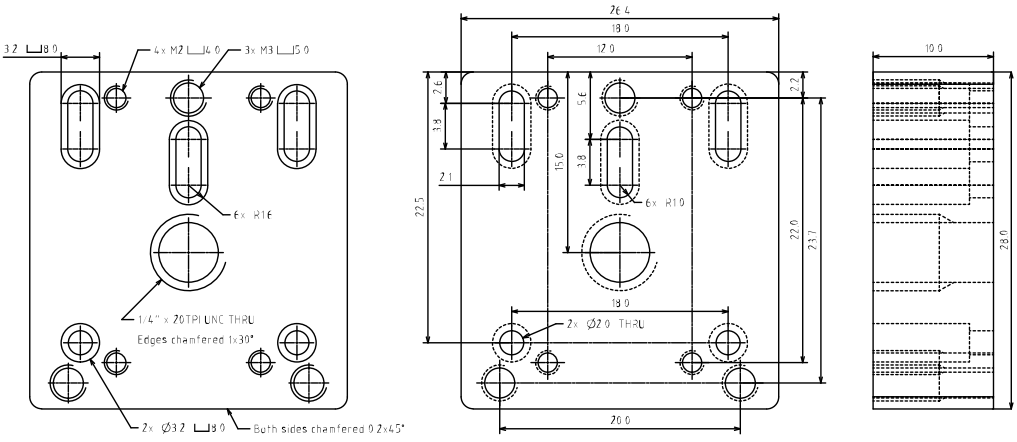


Figure 43: MQ-BRACKET-T thick dimensional drawing

2.11.10 ADPT-MX-X4G3-FF-X4G3-MTP



Figure 44: Connected ADPT-MX-X4G3-FF-X4G3-MTP

Back part attachment to connect XIMEA Firefly cameras to MTP cable. Converts 1x PCIe Gen3 x4 camera. The camera adapter also offers power and IO connectors for synchronization and triggering.

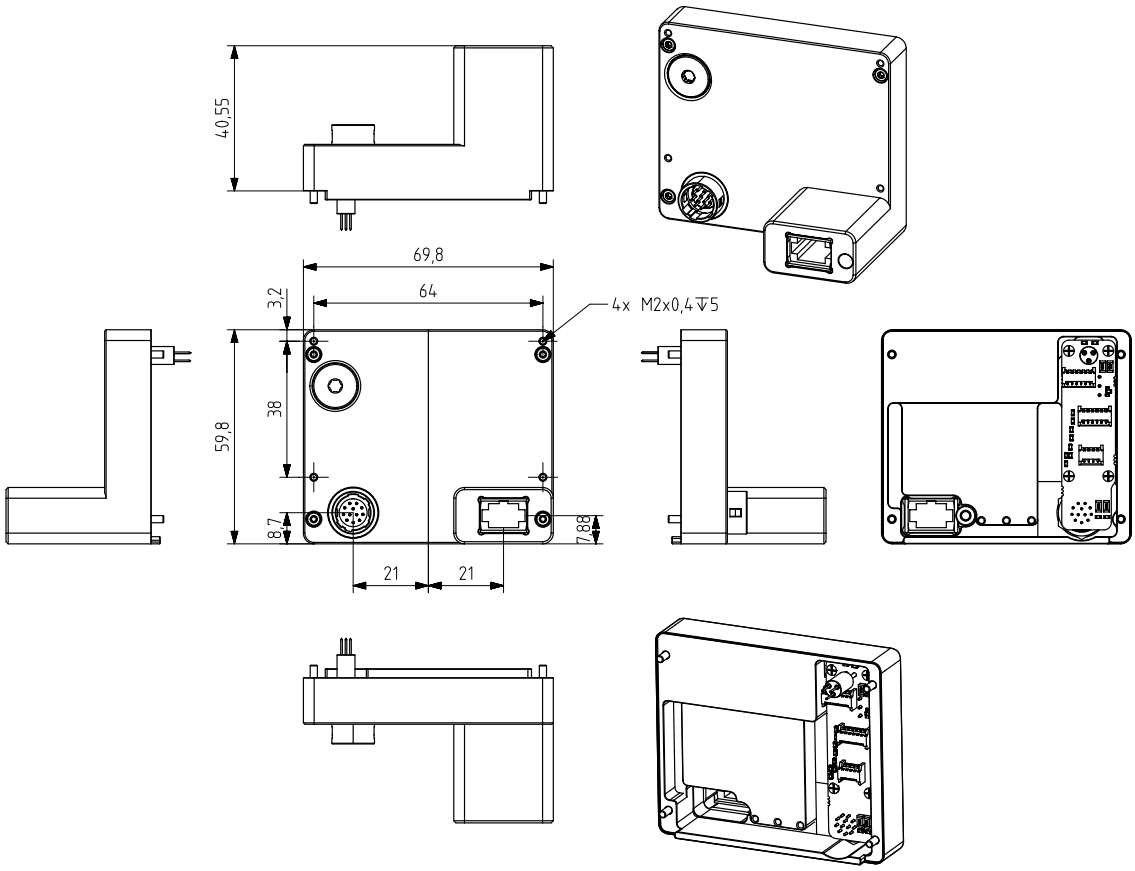


Figure 45: ADPT-MX-X4G3-FF-X4G3-MTP dimensional drawing

ADPT-MX-MTP-FAN-COOLER

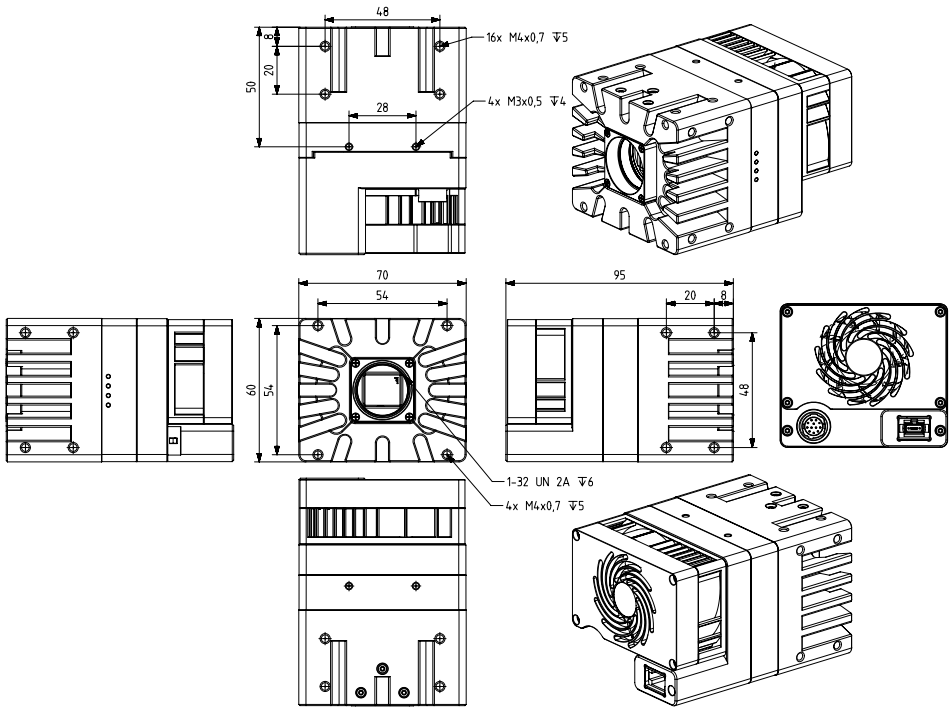


Figure 46: Dimensional drawing MX161|203|245xG-SY-X4G3-xxx

ADPT-MX-MTP-WAT-COOLER

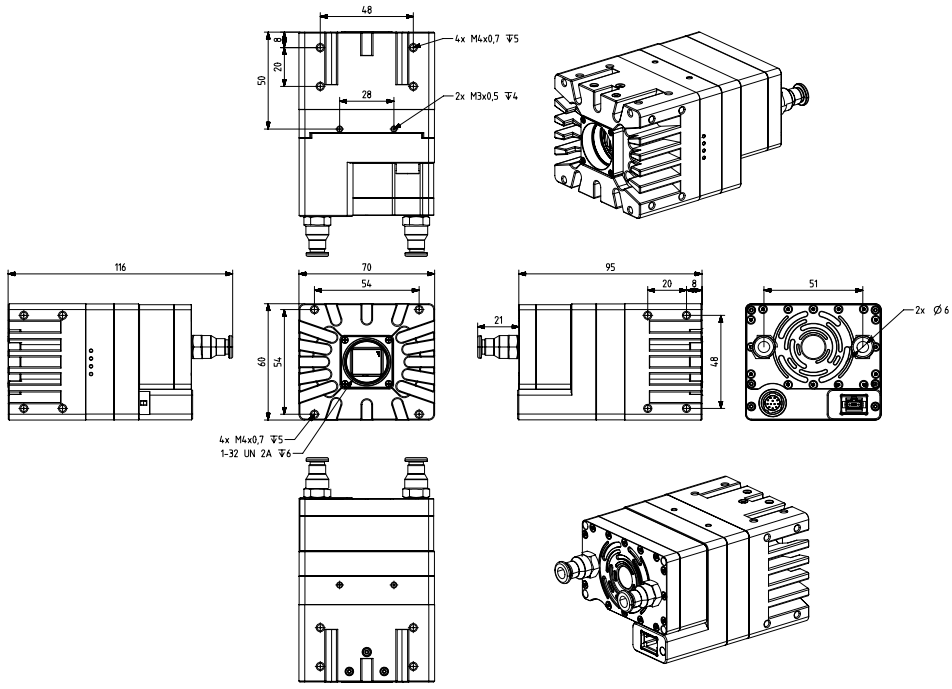


Figure 47: Dimensional drawing MX161|203|245xG-SY-X4G3-xxx-MTP-WATERCOOLED

2.11.11 ADPT-MX-X4G3-FF-X4G3-SFF

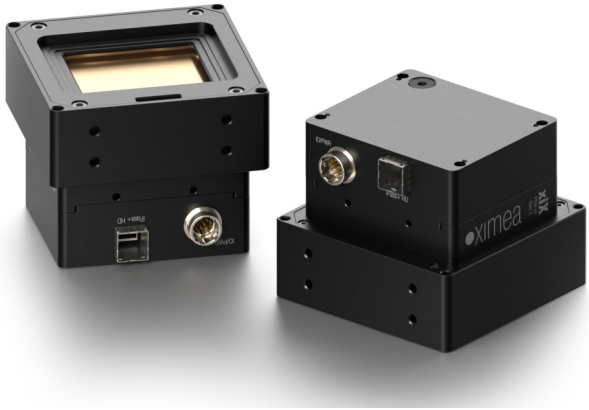


Figure 48: ADPT-MX-X4G3-FF-X4G3-SFF

Back part attachment to connect XIMEA Firefly cameras to SFF-8644 cable. Converts 1x PCIe Gen3 x4 camera.

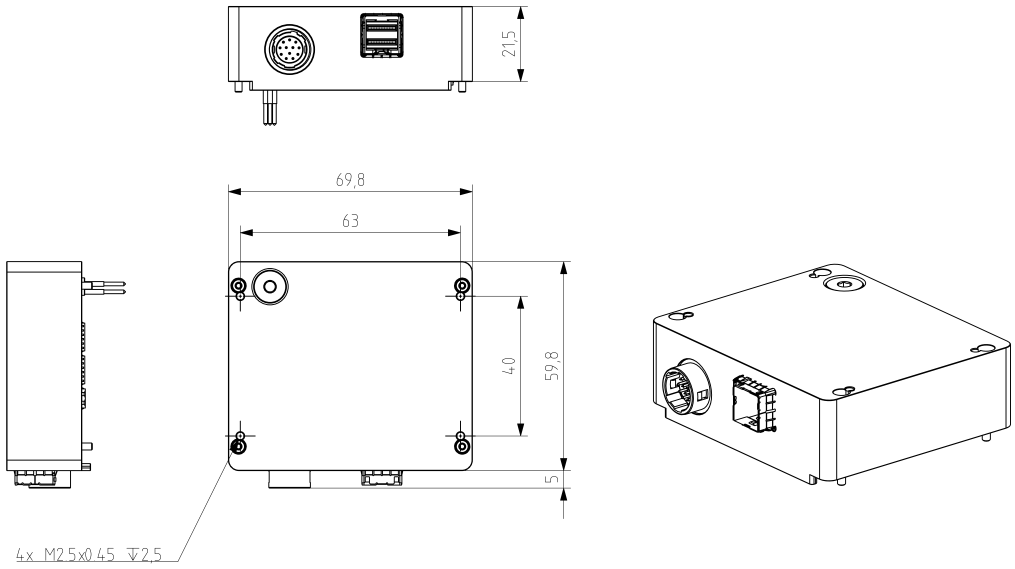


Figure 49: ADPT-MX-X4G3-FF-X4G3-SFF dimensional drawing

ADPT-MX-SFF-FAN-COOLER

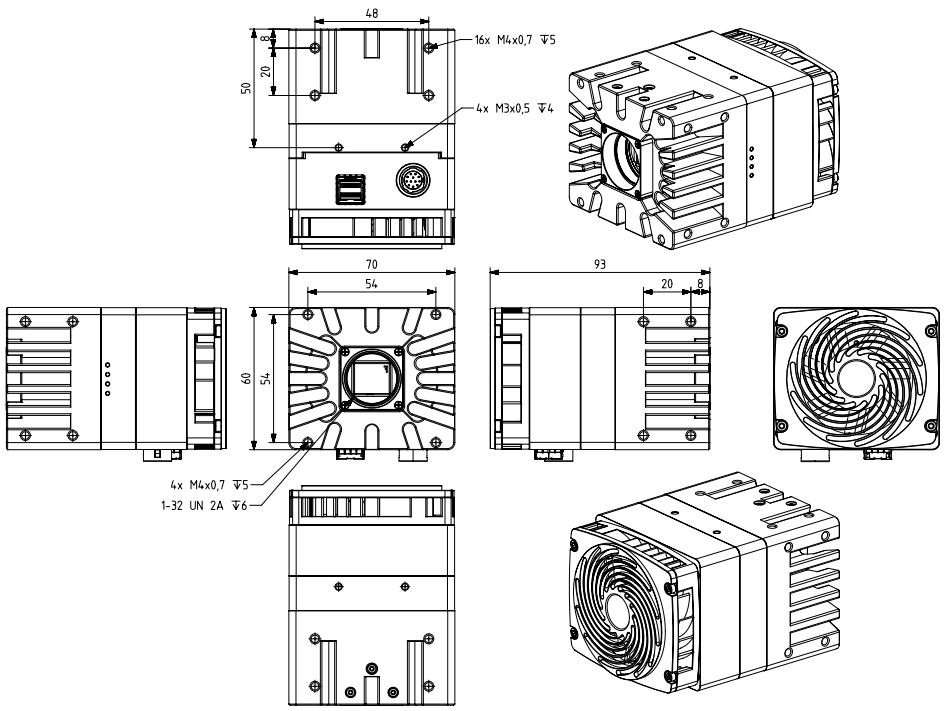


Figure 50: Dimensional drawing MX161|203|245xG-SY-X4G3-xxx-SFF-AIRCOOLED

ADPT-MX-SFF-WAT-COOLER

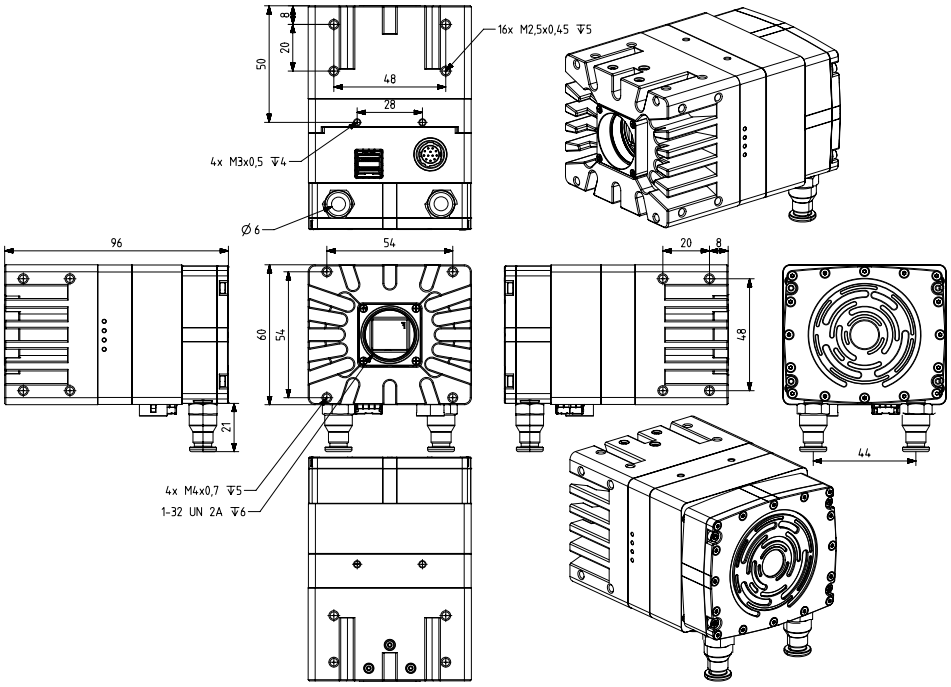


Figure 51: Dimensional drawing MX161|203|245xG-SY-X4G3-xxx-SFF-WATERCOOLED

2.11.12 GPIO connector for ADPT-MX-X4G3-FF-X4G3-MTP/SFF

Item	Value
Connector	I/O and Power 12-pin Alysium 60-30-1112
Signals	Opto-isolated trigger input and non-isolated I/O plus camera power
Mating Connectors	Alysium 60-41-1012, 60-41-1112, 60-01-1012, 60-01-1112, 60-03-1012, 60-03-1112
Mating Cable	Ximea PN: CBL-MT-PWR-SYNC-3M0 for 3 m cable

Table 40: GPIO connector general description

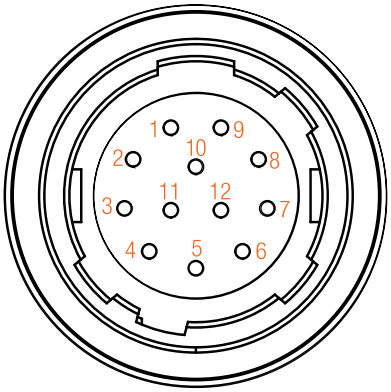


Figure 52: GPIO connector pinout

Pin	Name	GPI/GPO index API	Type
1	IN2	2/-	Optically isolated Digital Input (IN)
2	IN1	1/-	Optically isolated Digital Input (IN)
3	OUT2	-/2	Optically isolated Digital Output (OUT)
4	OUT1	-/1	Optically isolated Digital Output (OUT)
5	AUX PWR	None	Power input
6	GND	None	External grounds for power and non-isolated I/O
7	INOUT1	3/3	Non-isolated digital lines - Digital Input-Output (INOUT)
8	INOUT3	5/5	Non-isolated digital lines - Digital Input-Output (INOUT)
9	INOUT2	4/4	Non-isolated digital lines - Digital Input-Output (INOUT)
10	IN GND	None	Ground for Opto-Isolated Inputs
11	OUT GND	None	Ground for Opto-Isolated Out
12	INOUT4	6/6	Non-isolated digital lines - Digital Input-Output (INOUT)

Table 41: GPIO connector pin assignment

2.11.13 CBL-MT-PWR-SYNC-3M0

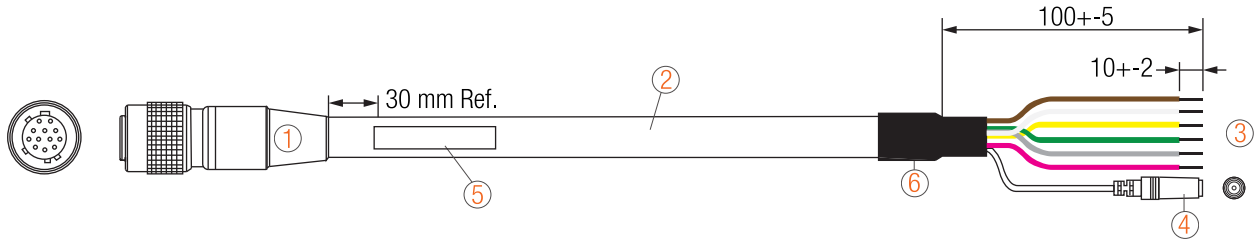


Figure 53: CBL-MT-PWR-SYNC-3M0 drawing

1 Series60 Female Circular Plug 60-01-1112 IO <BLK>
2 TBAUL20276 4STP#28 + 4C#28 + 2C#24 [OD=6.80mm] <BLK>
3 Process end with wire end stripped and tin soldered
4 DC power in socket female (OD5.5/ID2.1) <BLK>
5 Cable label
6 Heat shrinkable tube

Pin	1	2	3	4	5	6	7	8	9	10	11	12
Signal	IN2	IN1	OUT2	OUT1	AUX PWR	GND	INOUT1	INOUT3	INOUT2	IN GND	OUT GND	INOUT4

Table 42: CBL-MT-PWR-SYNC-3M0 pin assignment

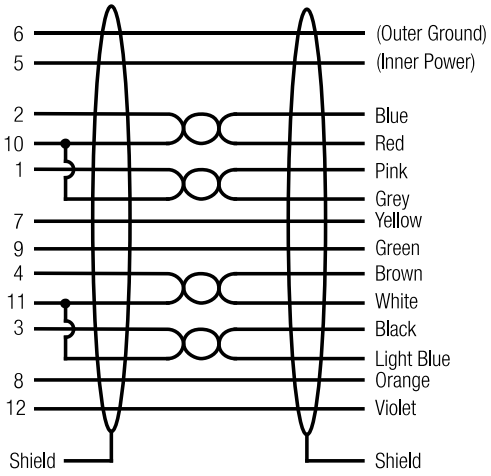


Figure 54: Wiring diagram of the CBL-MT-PWR-SYNC-3M0

2.11.14 FireFly MTP adapters

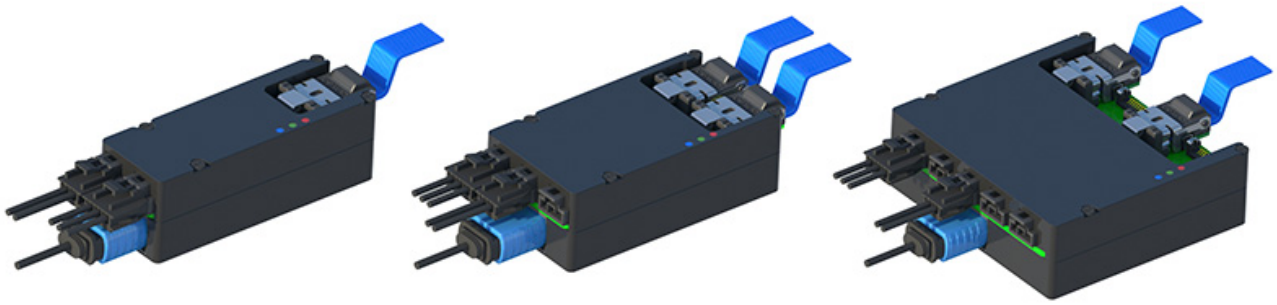


Figure 55: FireFly to MTP adapters

Adapter to connect XIMEA FireFly cameras to MTP cable.

The camera/s should be connected to these adapters over a FireFly ECUE copper cable (e.g. 10 cm - 3 m). The adapter has an integrated PCUO module, which allows connection to PC over optical MTP cable (e.g. 10 m). Adapters contain also connectors for power and GPI/GPO from the camera. The power cable is going to be bundled with the adapter delivery and sync cable is optional.

ADPT-1P-X4G3-FF-X4G3-MTP

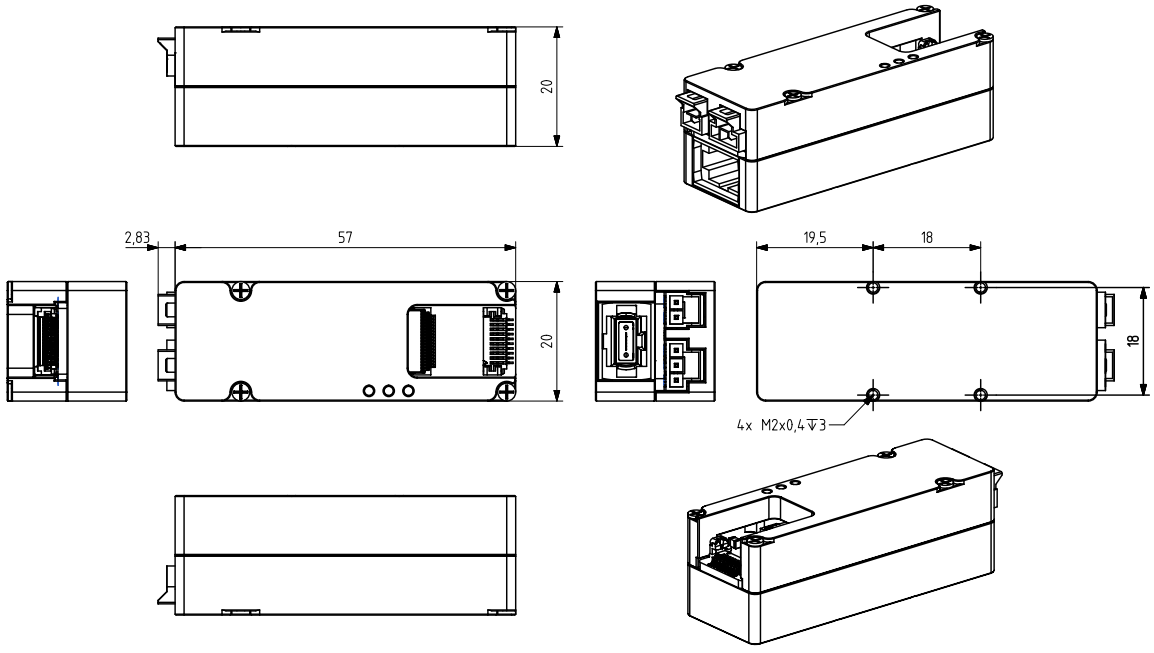


Figure 56: ADPT-1P-X4G3-FF-X4G3-MTP dimensional drawings

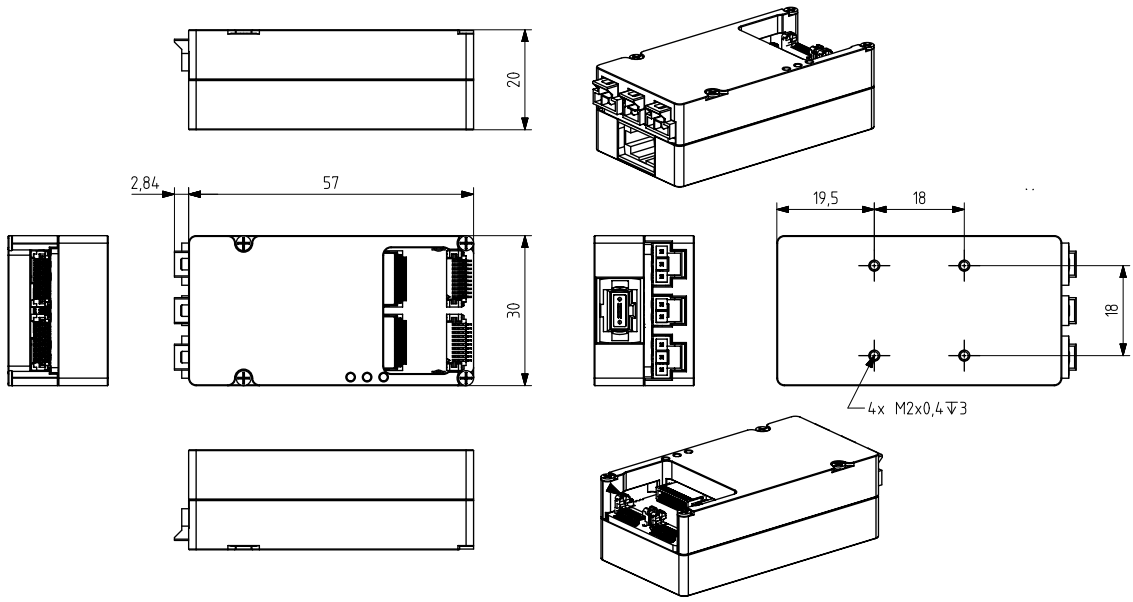


Figure 57: ADPT-1P-X8G3-FF-X8G3-MTP and ADPT-2P-X2G3-FF-X4G3-MTP dimensional drawings

2.11.15 PCIe host adapters

Supports PCIe Gen3 x4 lines and requires PCIe Gen.3 x8 slot on the computer side. Bandwidth of 32 Gbps. Cable lengths of up to 100 m.

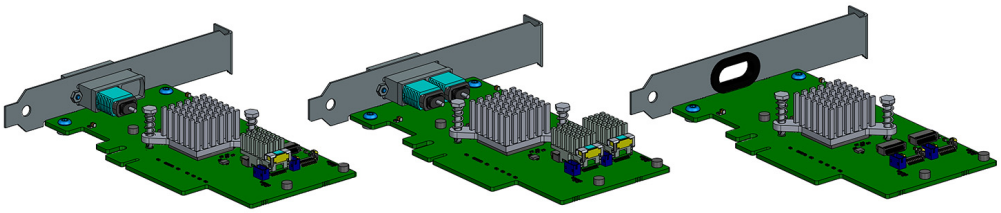


Figure 58: PCIe host adapters

HA-1P-X4G3-MTP-X8G3 / HA-2P-X4G3-MTP-X8G3

PCIe MTP Gen3 x4 Host Adapter - single or dual port for MTP fiber optic cables.

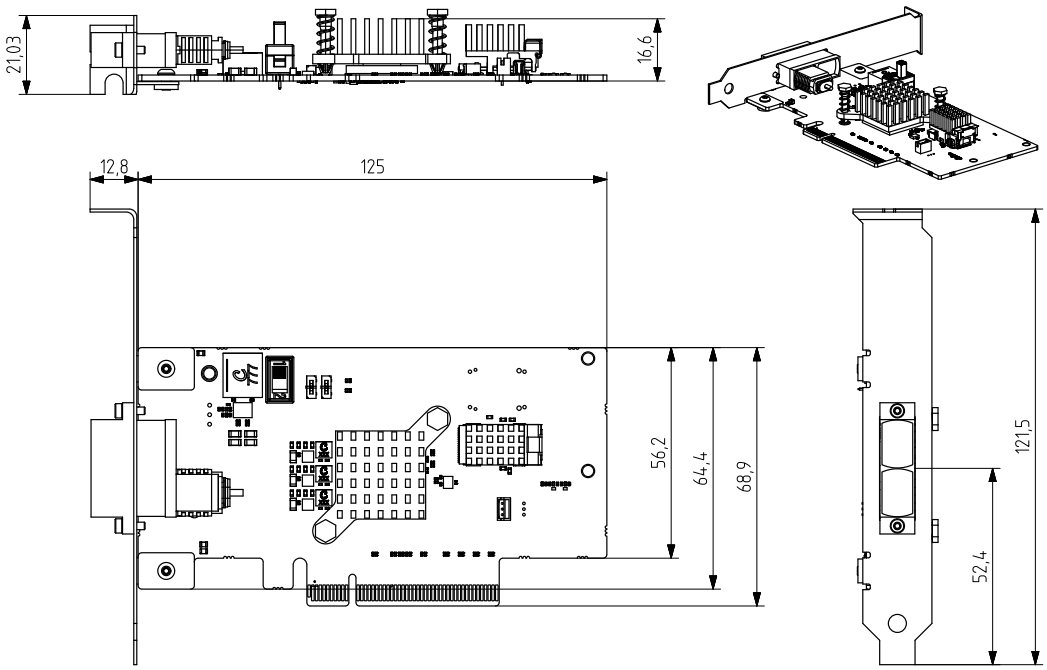


Figure 59: Dimensional drawing of host adapter HA-1P-X4G3-MTP-X8G3

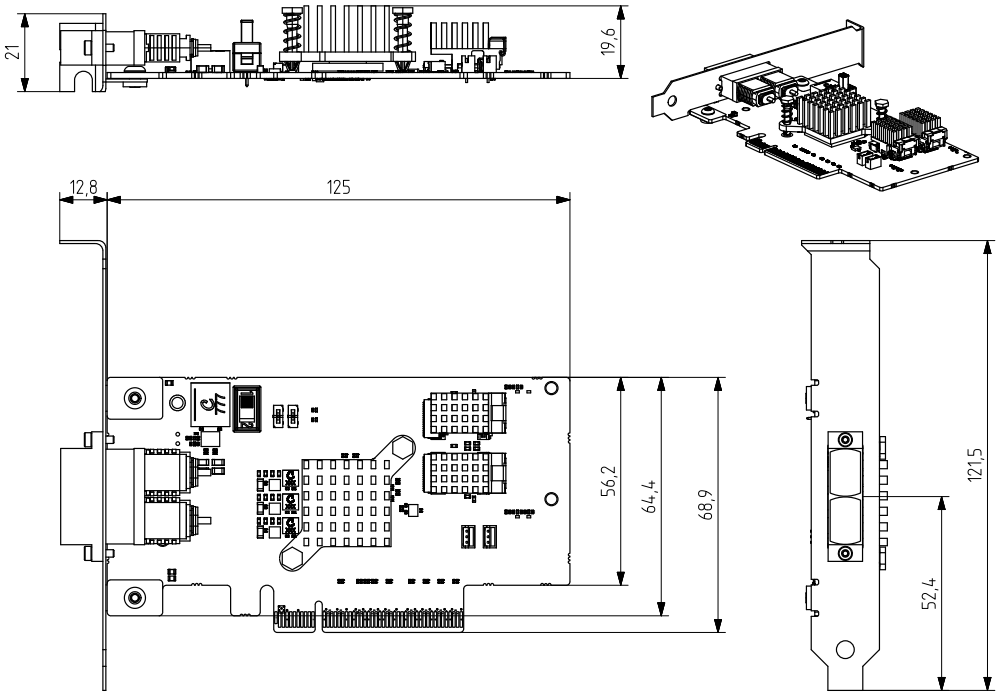


Figure 60: Dimensional drawing of host adapter HA-2P-X4G3-MTP-X8G3

HA-2P-X4G3-FF-X8G3

PCIe FireFly Host Adapter Dual - dual ports for Firefly cables.

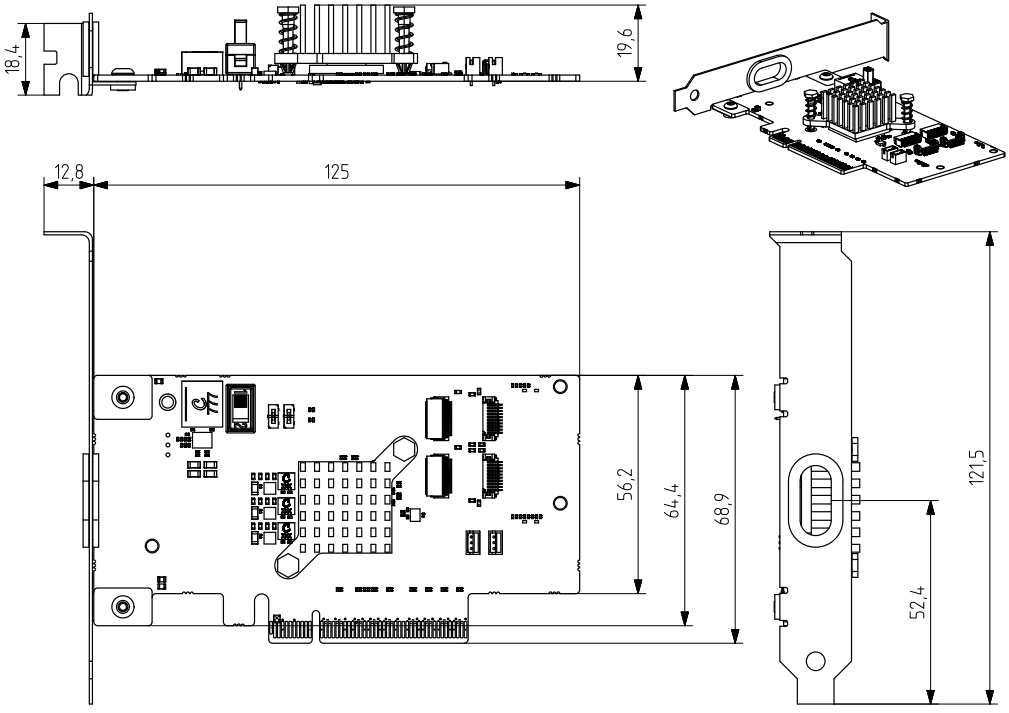


Figure 61: Dimensional drawing of host adapter HA-2P-X4G3-FF-X8G3

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:

MX161CG-SY-X4G3-FF MX203CG-SY-X4G3-FF MX245CG-SY-X4G3-FF

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW8X2	8 bits per pixel raw data from sensor(2 components in a row)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_RAW16X2	16 bits per pixel raw data from sensor(2 components in a row)
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 43: Image data output formats

This table is applicable to:

MX161MG-SY-X4G3-FF MX203MG-SY-X4G3-FF MX245MG-SY-X4G3-FF

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW8X2	8 bits per pixel raw data from sensor(2 components in a row)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_RAW16X2	16 bits per pixel raw data from sensor(2 components in a row)
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 44: 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).

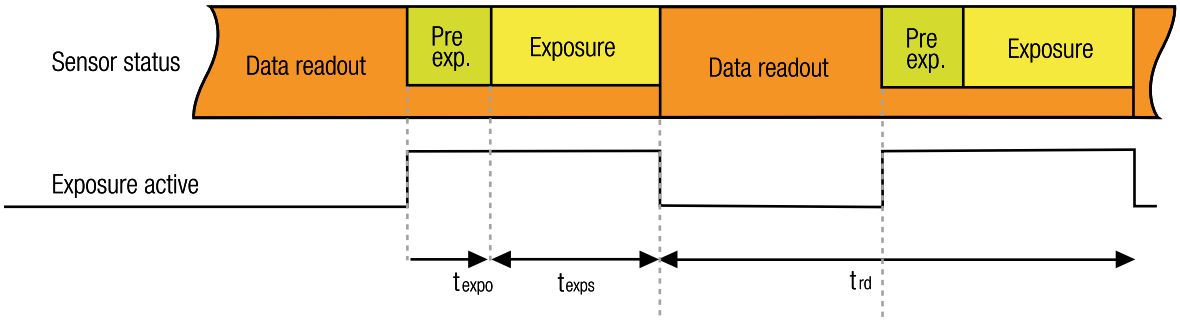


Figure 62: Acquisition mode - free run

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 - 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.

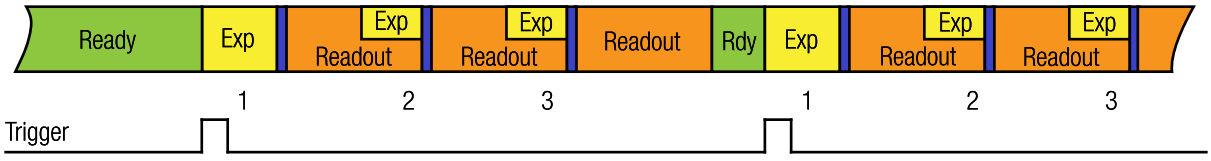


Figure 63: Triggered burst of frames – frame burst start

Frame Burst Active

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

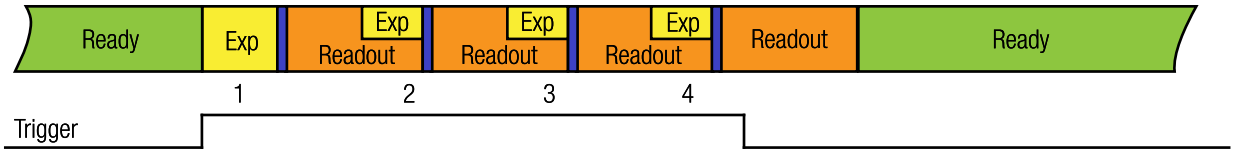


Figure 64: Triggered burst of frames – frame burst active

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

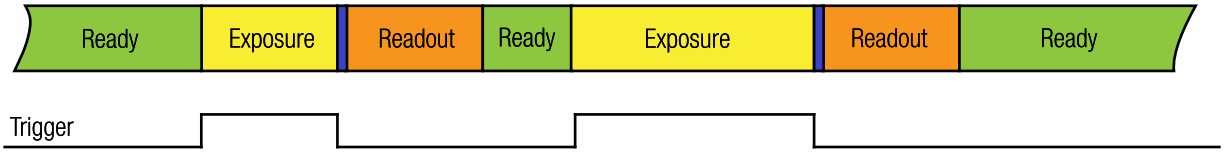


Figure 65: Exposure defined by trigger pulse length

Short interval shutter mode

Cameras based on the IMX530, IMX531, IMX532, IMX535, IMX536, IMX537 IMX540, IMX541, IMX542, IMX545, IMX546, and IMX547 sensors support short interval shutter mode. In this mode a pair of consecutive frames can be grabbed with virtually no gap between the end of the exposure of the first frame and start of the exposure of the second frame. This feature is particularly desired in Particle Image Velocimetry (PIV) because it allows positioning two laser pulses with short separation on sequential frames (frame straddling). This feature is supported in free run as well as in triggered acquisition modes. In triggered mode a single trigger will result in a pair of frames.

The lengths of the exposures of both frames are fixed and their exact values depend on the camera's settings (e.g., sensor data bit depth, bandwidth limit etc.). The first exposure (texp1) is in magnitude of hundreds of microseconds and the second exposure (texp2) equals to the readout time. The time between the end of the first exposure and start of the second exposure is very short. However, the sensor manufacturer recommends a period (Flash Prohibited Period) with a magnitude of 2 - 3 microseconds during which the flash should not be fired to ensure correct operation. This period is indicated in the exposure active signal which can be forwarded to the camera's digital output. Please note that it is recommended to use the non-isolated outputs of the camera with low capacitance IO cables to ensure low distortion of the output signal.

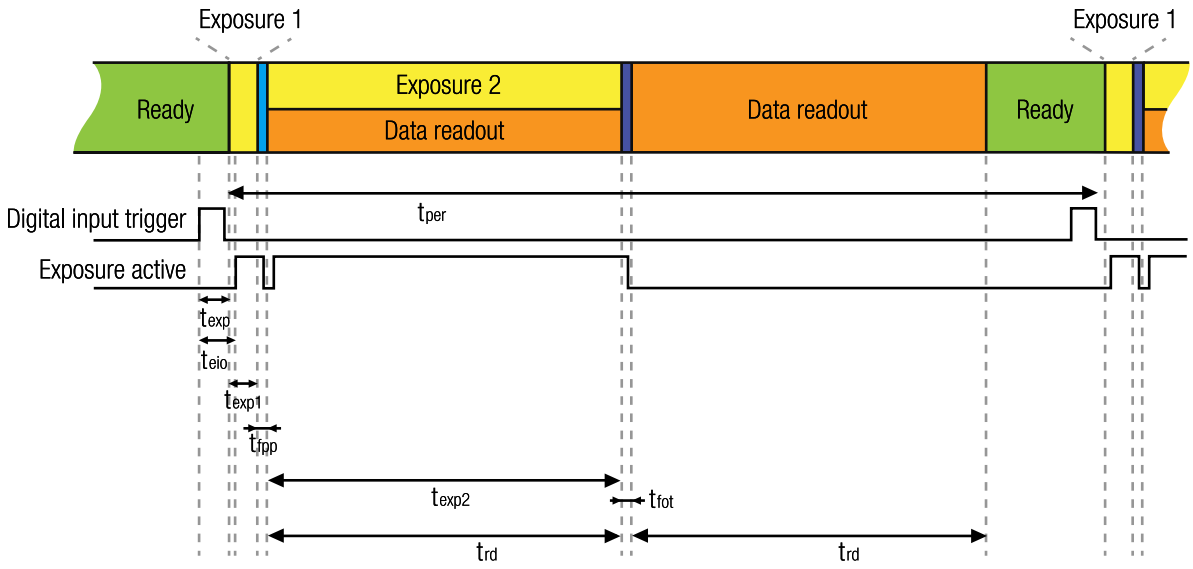


Figure 66: Short interval shutter mode – triggered

- t_{eio} Trigger (Digital Input) to Exposure Active (Digital Output)
- t_{exp} Trigger (Digital Input) to start of exposure
- t_{exp} 1 Exposure Time of the first image
- t_{exp} 2 Exposure Time of the second image
- t_{fpp} Flash Prohibited Period
- t_{fot} Frame overhead time (FOT)
- t_{rd} Readout Time

The timing strongly depends on camera settings.

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

$$t_{eio} = t_{exp} + t_{odelay}$$

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

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 Dual ADC modes

Dual ADC readout modes allow a single exposure to be processed through two distinct readout channels, producing two images with different analog gain settings. The high gain (HG) image benefits from reduced readout noise, resulting in an improved signal-to-noise ratio (SNR) in low-light areas of the scene. Conversely, the low gain (LG) image offers superior SNR in well-illuminated regions by effectively utilizing a larger portion, or the entirety, of the full well capacity.

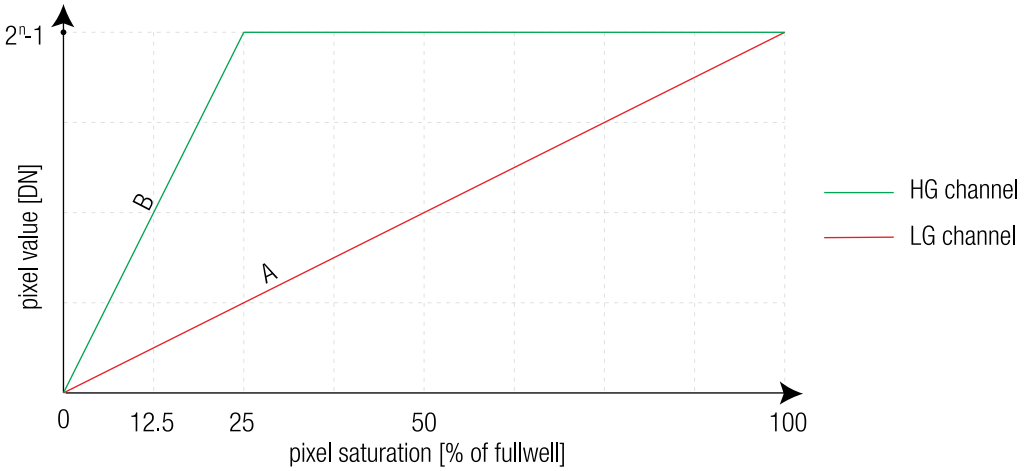


Figure 67: Dual ADC mode non-combined without merging

These two images can be either read out separately from the sensor (Non-combined mode) and transported to the host PC memory or combined in the sensor into a single HDR frame with a piecewise linear response (Combined mode).

```
// Set dual ADC mode to non-combined or combined
xiSetParamInt(xiH, XI_PRM_DUAL_ADC_MODE,XI_DUAL_ADC_MODE_NON_COMBINED);
// or
xiSetParamInt(xiH, XI_PRM_DUAL_ADC_MODE, XI_DUAL_ADC_MODE_COMBINED);
```

The gain parameter is used to define the analog gain of the low gain channel (slope A) and the dual ADC gain ratio parameter is used to adjust the offset/ratio of the analog gain of the high gain channel (slope B / slope A).

```
// Set gain selector to analog
xiSetParamInt(xiH, XI_PRM_GAIN_SELECTOR, XI_GAIN_SELECTOR_ANALOG_ALL);
// Set gain to arbitrary value
xiSetParamFloat(xiH, XI_PRM_GAIN, 0);
// Set gain ratio to arbitrary value
// depending on the gain value the range can be from 0--24 dB
// with 6 dB increment
xiSetParamFloat(xiH, XI_PRM_DUAL_ADC_GAIN_RATIO, 12);
```

3.5.1 Combined mode

Following camera models support Combined mode:
all models in this manual (refer to the table Models and sensors overview)

In the combined mode the HG and LG images are merged directly in the sensor. This mode usually gives a higher frame rate than the non-combined mode since instead of two (8 or 12 bit) values only one (8 or 12 bit) value is read out from the sensor and transported to the PC memory. There is also less processing overhead in the xiAPI library as the data are already merged in the sensor. Since the output data bit depth from the sensor is limited to the set ADC bit depth, the data is compressed in the sensor using a piecewise linear function.

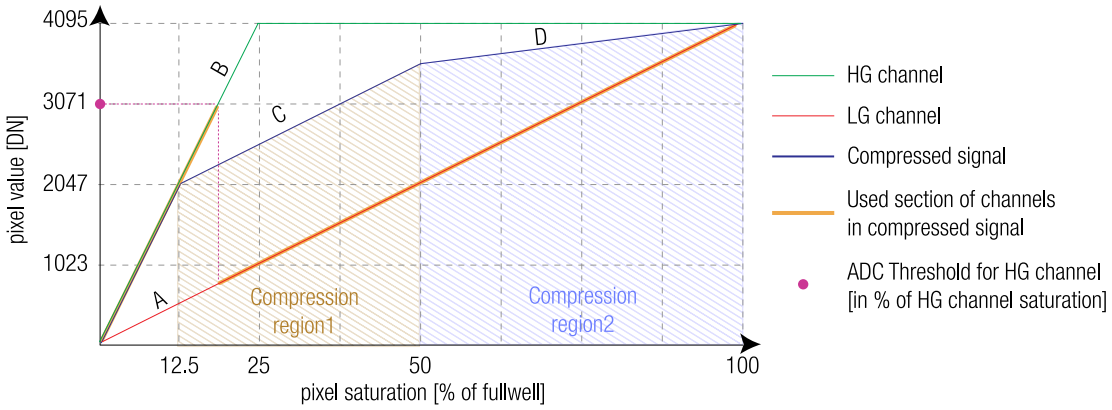


Figure 68: Dual ADC mode combined

The threshold of the usable range of the HG channel can be set using the dual ADC threshold parameter.

```
// define the upper threshold of the usable HG data
xiSetParamInt(xiH, XI_PRM_DUAL_ADC_THRESHOLD,3071);
```

The starting point of the region is defined as a percentage of the maximum ADC output (can be also interpreted as a percentage of full well capacity at the given analog gain setting). It has a logarithmic increment and can have values of 50,25,12.5 ... percent. The slope of the corresponding linear segment is defined as offset from the gain of the HG channel. The above diagram corresponds to the below settings:

```
// Slope B was defined earlier by setting ADC gain ratio to 12 dB
// Set up the start and gain (Slope C) of compression region 1
xiSetParamInt(xiH, XI_PRM_COMPRESSION_REGION_SELECTOR,1);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_START,12.5);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_GAIN,-12);

// Set up the start and gain (Slope D) of compression region 2
xiSetParamInt(xiH, XI_PRM_COMPRESSION_REGION_SELECTOR,2);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_START,50);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_GAIN,-24);
```

3.5.2 Non-combined mode

Following camera models support Non-combined mode:
all models in this manual (refer to the table Models and sensors overview)

In the non-combined mode both images are read out from the sensor and are transported to the host PC memory. Depending on the used image data format, these images can be either passed directly to the application or can be merged into a single linear output with extended dynamic range. The merging is performed in the xiAPI library running on the host computer CPU and is optimized for processors with x86 architecture.

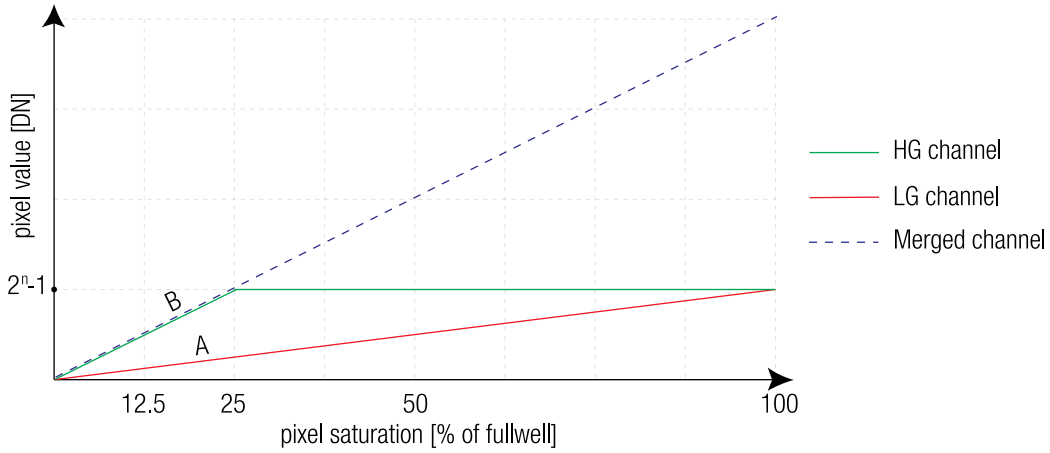


Figure 69: Dual ADC mode non-combined with merging

In case of RAW8X2, RAW16X2 or TRANSPORT_DATA image data format, for each pixel a sequence of LG and the HG channel values are passed to the application ([pixel 0 LG val, pixel 0 HG val, pixel 1 LG val, pixel 1 HG val, ...])

```
// Use X2 or transport format to deliver values from HG and LG channels
xiSetParamInt(xiH, XI_PRM_IMAGE_DATA_FORMAT,XI_RAW16X2);
// Set ADC bitdepth to desired value
xiSetParamInt(xiH, XI_PRM_SENSOR_DATA_BIT_DEPTH,12);
// Set image data bitdepth to desired value
xiSetParamInt(xiH, XI_PRM_IMAGE_DATA_BIT_DEPTH,12);
```

In case of all other image data formats, the data from the LG and HG channels are merged into a single linear output with extended dynamic range.

```
// or use any other formats to other to deliver merged from HG and
xiSetParamInt(xiH, XI_PRM_IMAGE_DATA_FORMAT,XI_RAW16);
// Set ADC bitdepth to desired value
xiSetParamInt(xiH, XI_PRM_SENSOR_DATA_BIT_DEPTH,12);
// Set image data bitdepth to desired value
xiSetParamInt(xiH, XI_PRM_IMAGE_DATA_BIT_DEPTH,16);
```

3.6 API Features

Host-assisted image processing features available in xiAPI

3.6.1 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).

3.6.2 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.

3.6.3 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.

3.6.4 Sharpness

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

3.6.5 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.

3.6.6 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.

3.6.7 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):

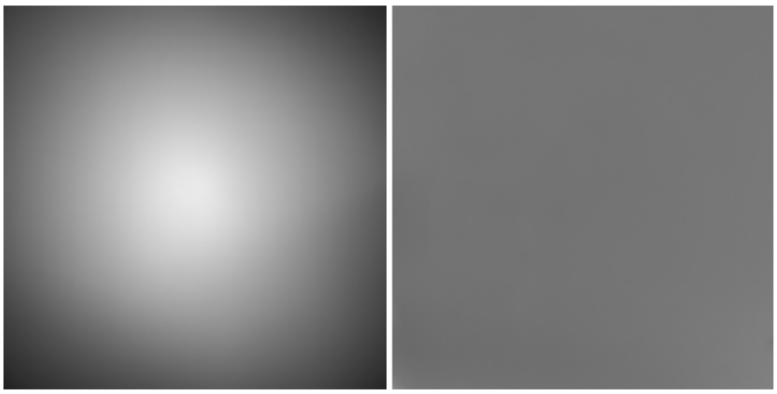


Figure 70: Flat field correction - images comparison

Acquisition of calibration images

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

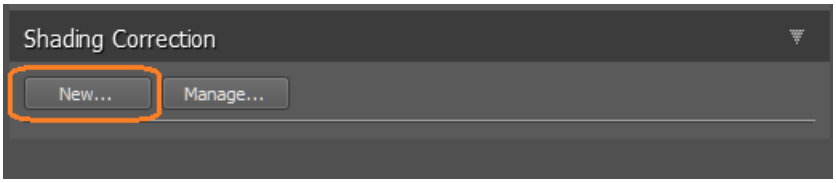


Figure 71: Flat field correction - new FFC

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.

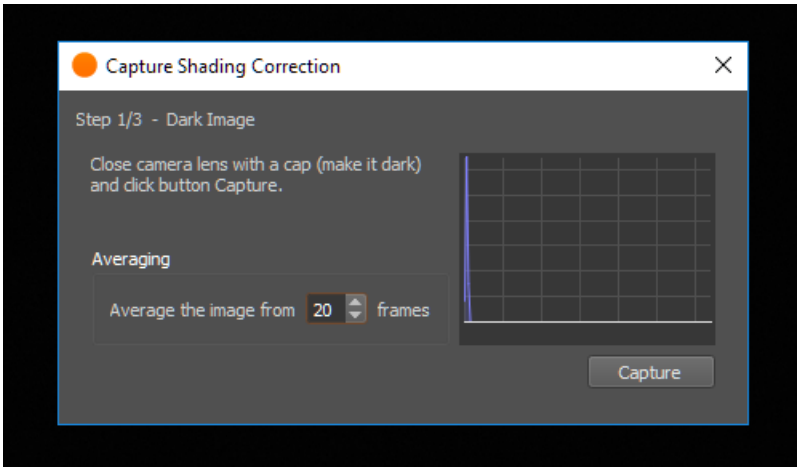


Figure 72: Flat field correction - Dark image

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.

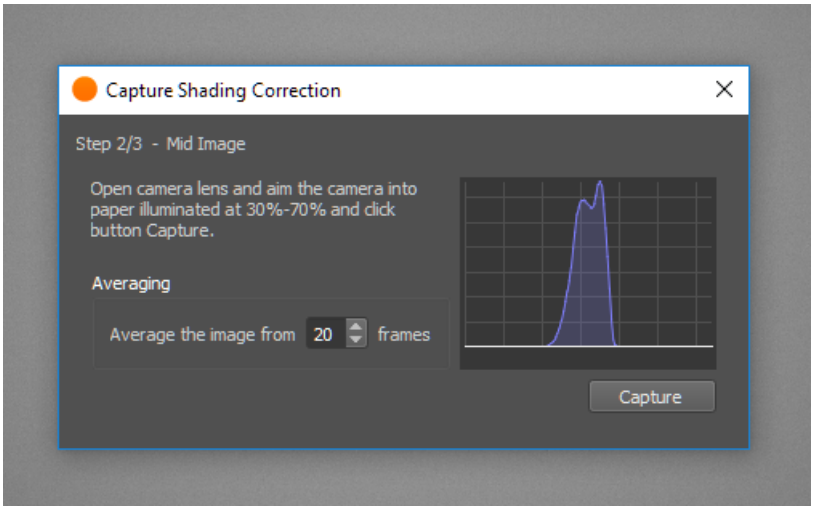


Figure 73: Flat field correction - Mid- saturated image

Save TIFF files

Save the new preset how it be displayed in CamTool.

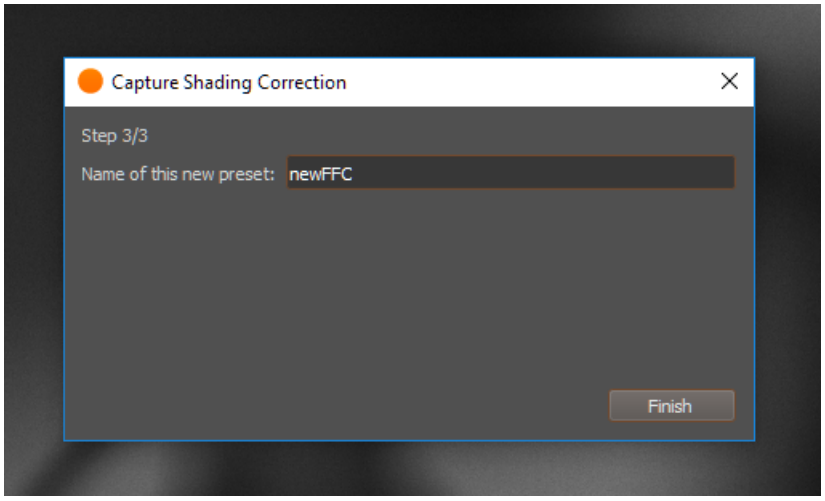


Figure 74: Flat field correction - new preset

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

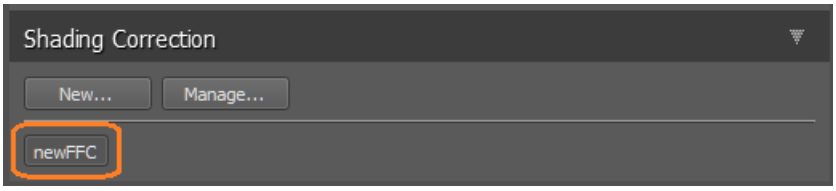


Figure 75: Flat field correction - Enabling FFC

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

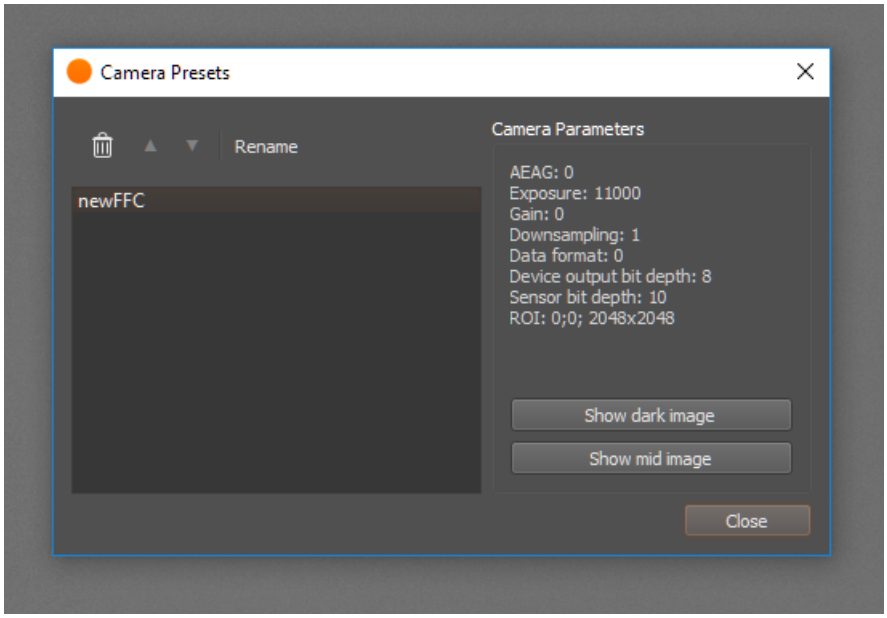


Figure 76: Flat field correction - FFC management

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.

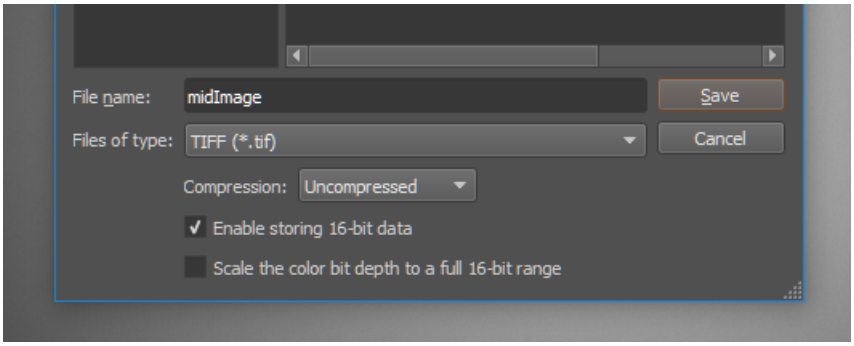


Figure 77: Flat field correction - Safe TIFF

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

`%LOCALAPPDATA%\xiCamTool\shading`

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

Applying FFC in xiAPI

xiAPI command sequence:

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

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

- Enable XI_PRM_FFC.

Sample code:

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

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

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

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

4 Operation

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

4.1 System requirements

4.1.1 Software requirements

Cameras are compatible with the following operating systems:

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



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

4.2 XIMEA software packages

4.2.1 XIMEA Windows software package

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

Contents

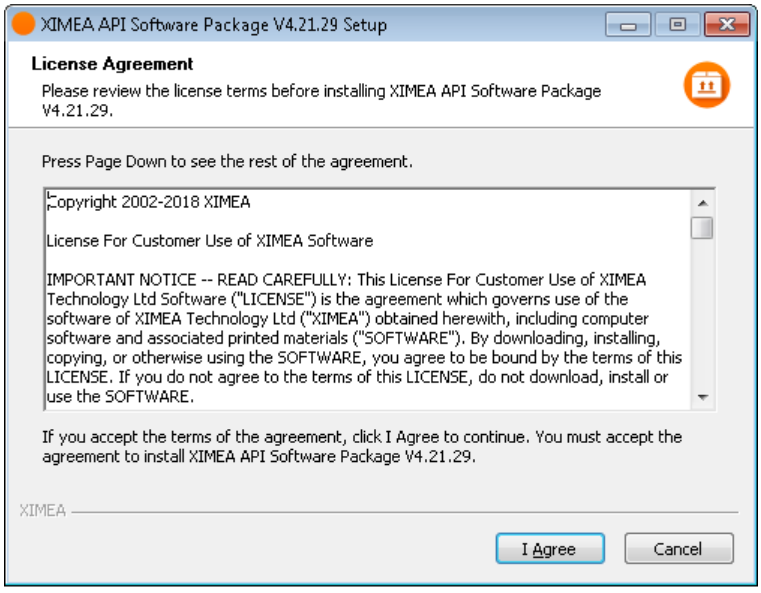
The package contains:

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

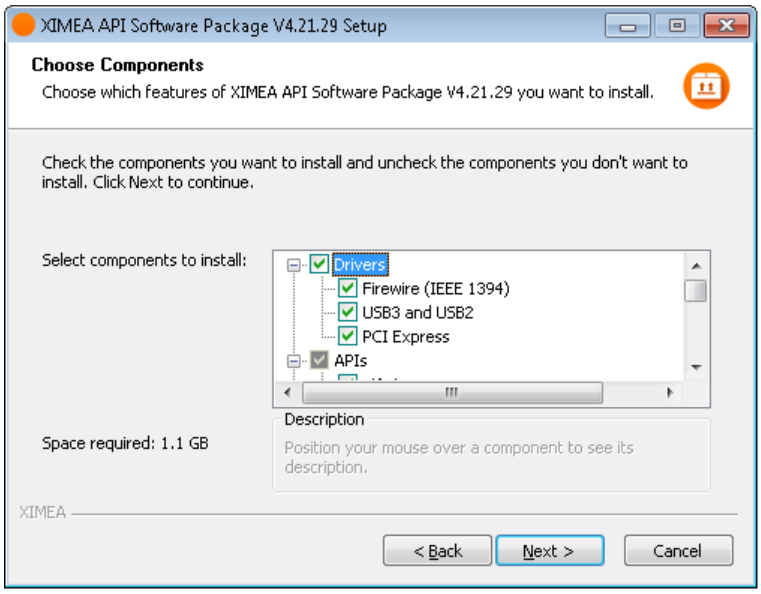
Installation

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

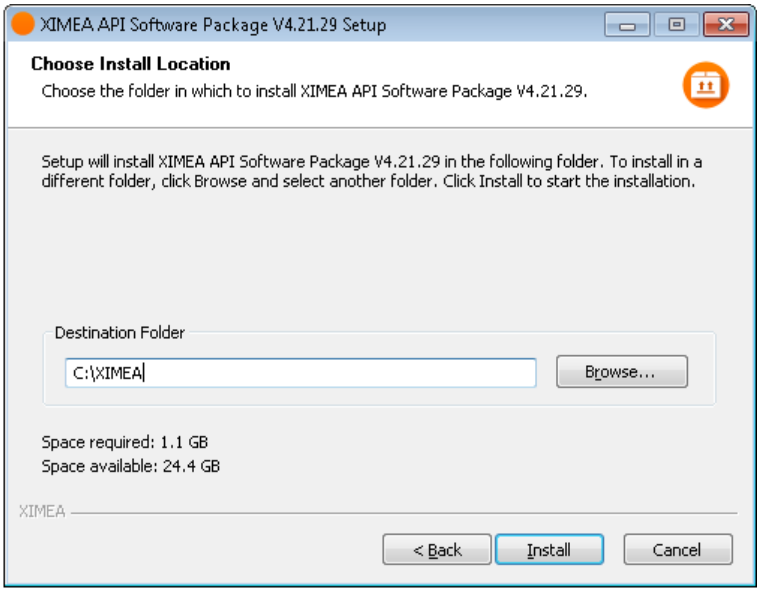
  Be sure that you have administrator privileges or start the Installer with administrator rights (right click and select “run as administrator”):



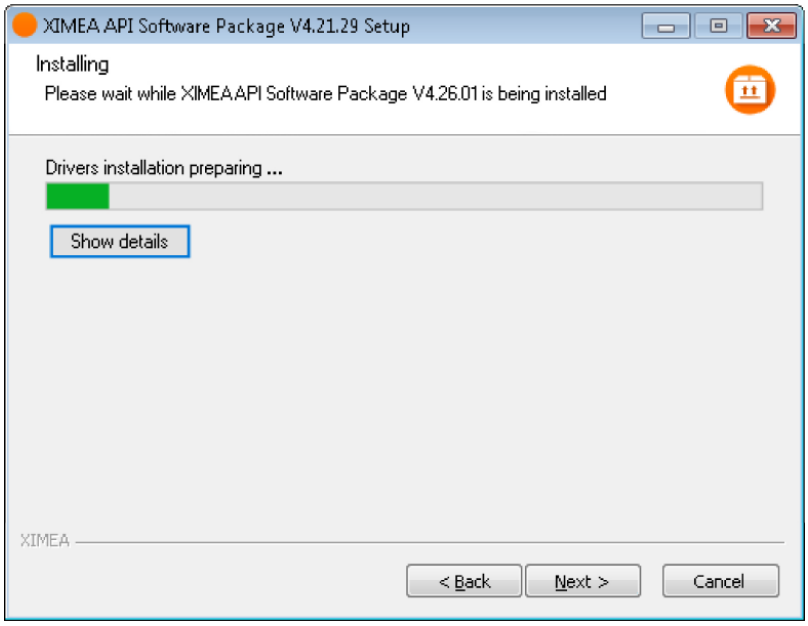
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



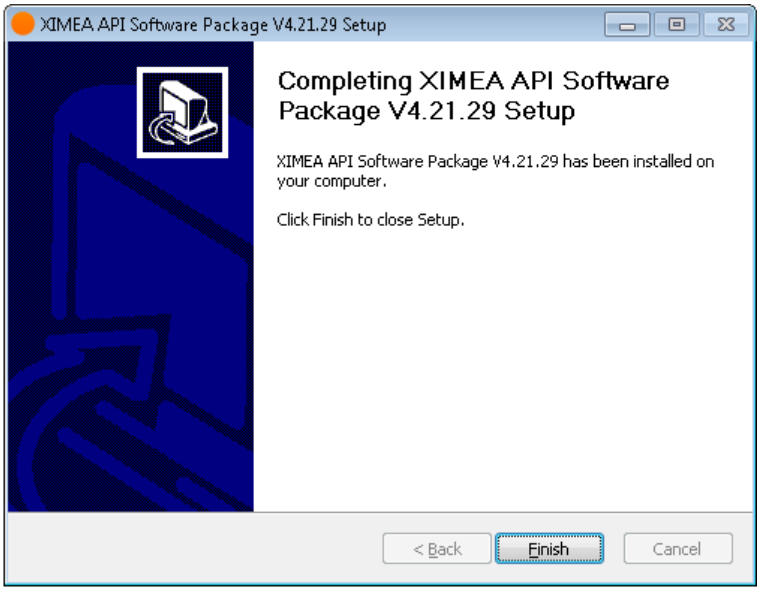
- Specify the install location - you can leave the default location or change it to your desired location



- Now the XIMEA API Software Package should start copying files, updating System Variables and installing drivers if necessary



- Installation is completed
- Finish



4.2.2 XIMEA Linux software package

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

Contents

The package contains:

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

Instalation

- Download XIMEA Linux Software Package:

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

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

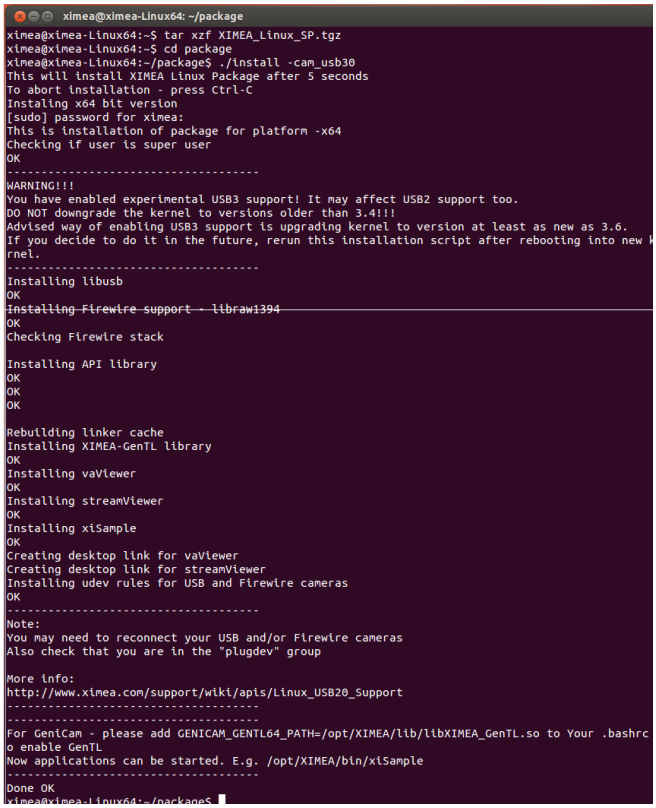


- Untar

  ```
  tar xzf XIMEA_Linux_SP.tgz
  cd package
  ```

- Start installation script

  ```
  ./install
  ```



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

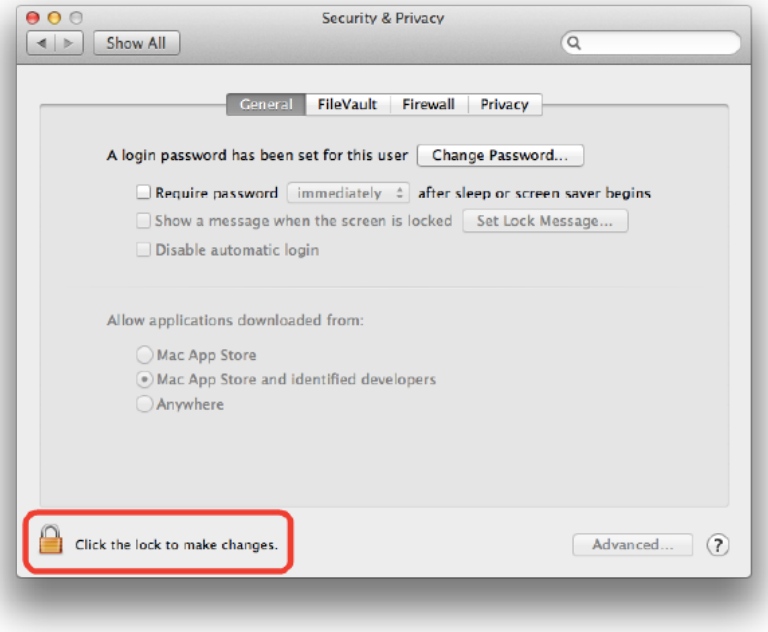
Installation

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.

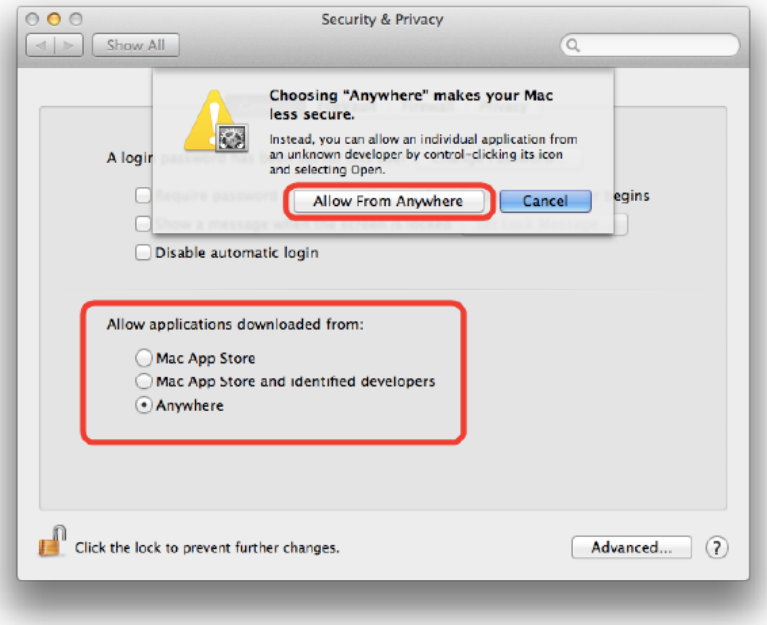
- Open System Preferences application and click on Security & Privacy



- 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 78: CamTool preview

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

Table 45: 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.

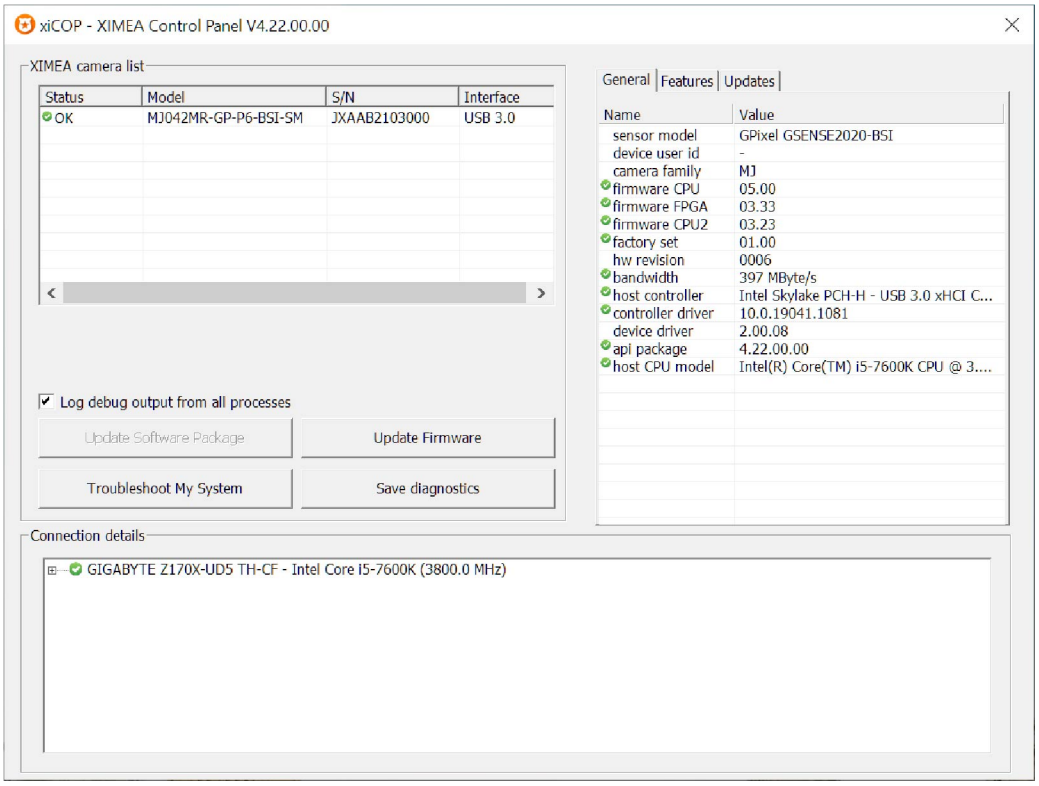


Figure 79: xiCOP example

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.

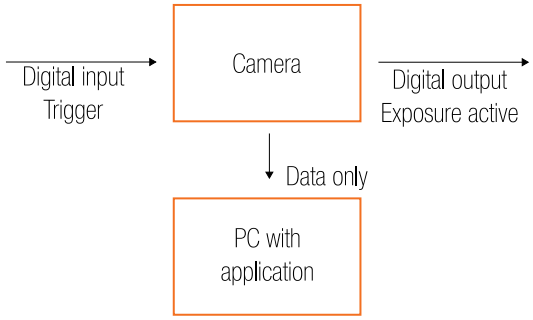


Figure 80: GPIO scheme

```
            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 46: 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

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CMOS	Complementary Metal-Oxide-Semiconductor 9, 66
ESD	Electrostatic discharge 34
FPGA	Field Programmable Gate Array 60
FPS	Frame Per Second 63
PSR	Product Service Request 92
ROI	Region Of Interest 60
SDK	Software Development Kit 9

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