ximea

xiX-Xtreme

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

- Fast PCIe cameras with Sony Pregius S sensors

Ximea cameras •
Technical Manual •
Version v240625 •

Introduction

About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

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

www.ximea.com/support

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

This document is subject to change without notice.

About XIMEA

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

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

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

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

Contact XIMEA

XIMEA is a worldwide operating company

Headquarters, Sales worldwide	Sales America	R&D, Production
XIMEA GmbH Am Mittelhafen 16 48155 Münster Germany	XIMEA Corp. 12600 W Colfax Ave., Suite A-130 Lakewood, CO 80215 USA	XIMEA s.r.o. Lesná 52 900 33 Marianka Slovakia
Tel: +49 (251) 202 408-0 Fax: +49 (251) 202 408-99	Tel: +1 (303) 389-9838 Fax: +1 (303) 202-6350	Tel: +421 (2) 205 104 26 Fax: +421 (2) 205 104 27

Web	www.ximea.com
General inquiries	info@ximea.com
Sales	sales@ximea.com
Support	XIMEA Support

Standard conformity

CE conformity

Figure 1: Standard conformity CE logo

The camera models listed below comply with the requirements of the EC EMC Directive 2014/30/EU regarding the electromagnetic compatibility of equipment.

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 (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

GENICAM

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.

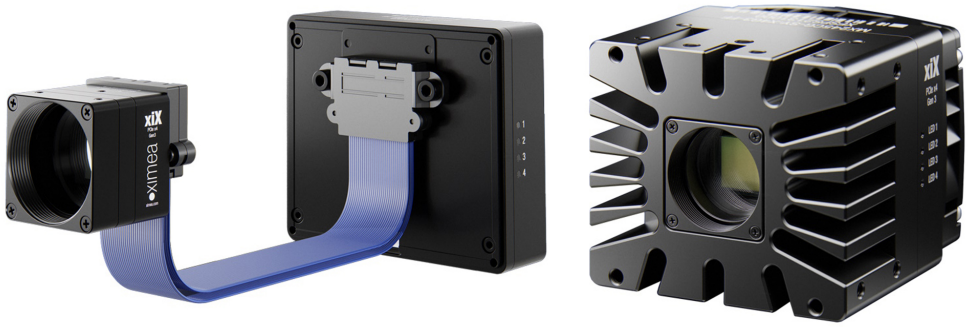
Helpful links

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

Contents

1 xiX-Xtreme camera series

1.1 What is xiX-Xtreme



xiX-Xtreme **[ksi-x-treme: or sai-ex:tri:m]** 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]
MX161MG-SY-X4G3-FF	Sony IMX532	Monochrome	None	5328 × 3040	2.74
MX161CG-SY-X4G3-FF	Sony IMX532	Color	BayerBG	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-IO-0M10	IO pig tail cable 10 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

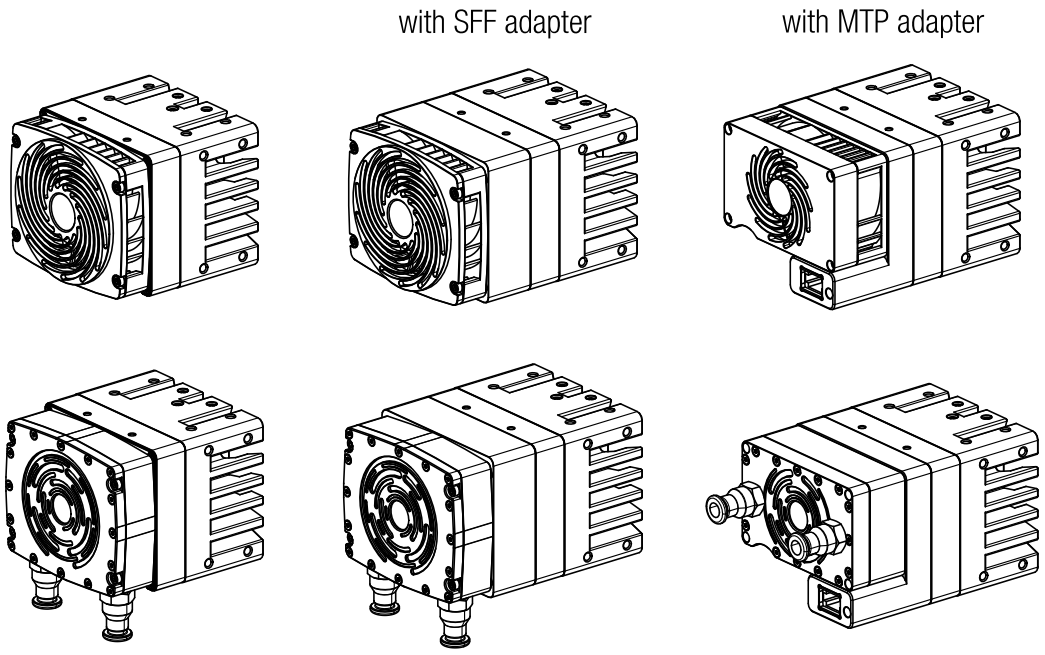


Figure 6: camera with accessory/cooling options

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

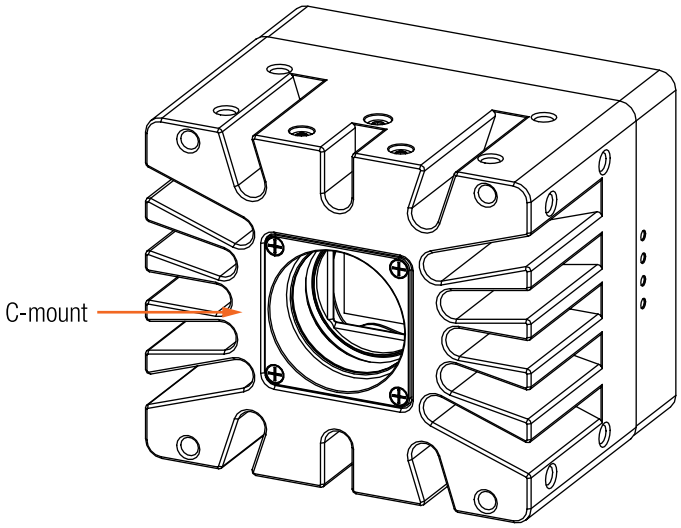


Figure 7: Lens mount adapter C-mount for xiX-Xtreme camera models

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. Never exceed the maximum torque when fastening the mounting screws.

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

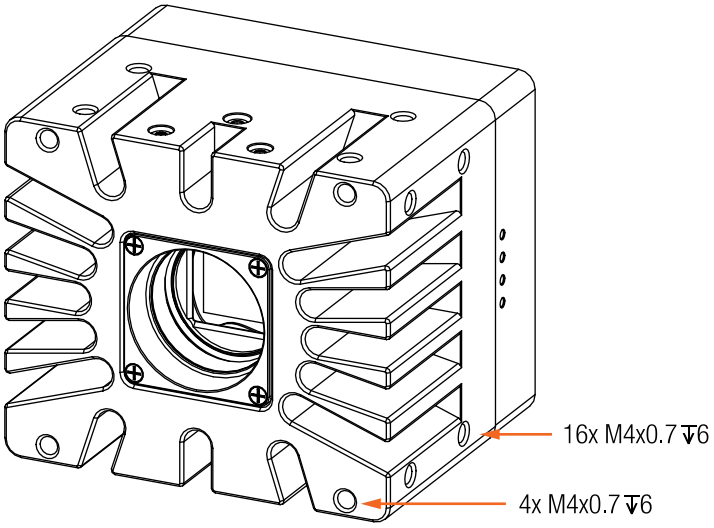


Figure 8: xiX-Xtreme camera mounting points

2.4.1 Screws

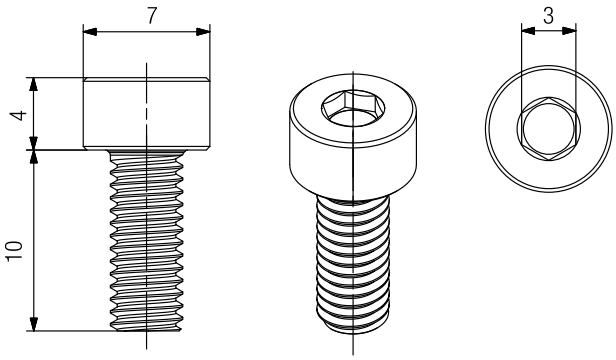


Figure 9: M4 mounting screws

Item	Value
Material	Stainless steel
Surface	Polished
Thread	M4 Full thread
Driver	IMBUS 3.0
Avail. lengths	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).

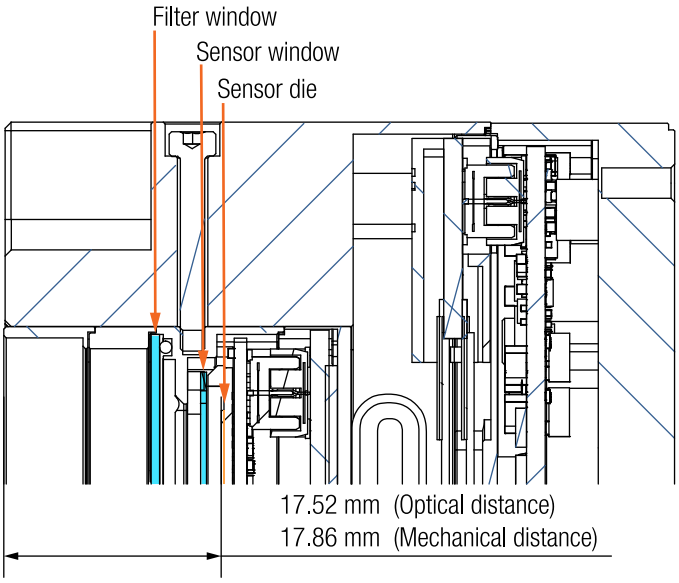


Figure 10: Cross section of MX161/203/245xG-SY-X4G3-FF camera models

The following filter window is implemented in MX161MG-SY-X4G3-FF, MX245MG-SY-X4G3-FF and MX203MG-SY-X4G3-FF.

Filter	Coating	Thickness
Filter BK7	ARx2	1.1 mm

Table 6: BK7 filter window parameter

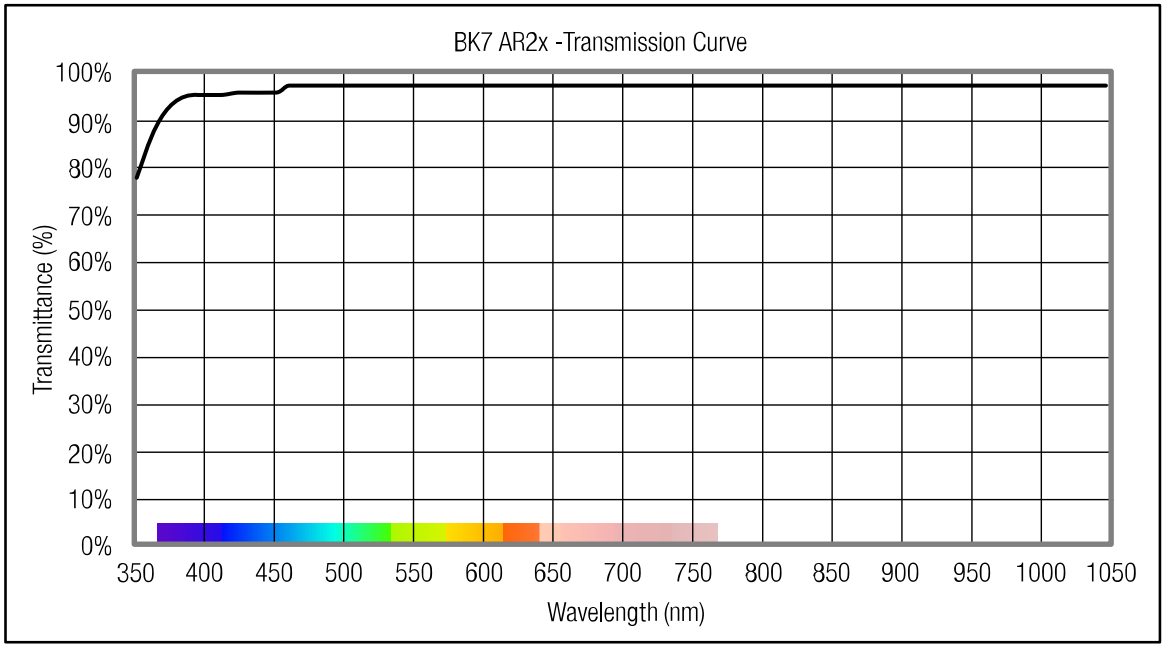


Figure 11: Filter glass BK7 AR2x Transmission Curve

The following filter window is implemented in MX203CG-SY-X4G3-FF, MX245CG-SY-X4G3-FF and MX161CG-SY-X4G3-FF.

	Filter	Coating	Thickness
	IR Filter IR650	ARx2	1.1 mm

Table 7: IR650 filter window parameter

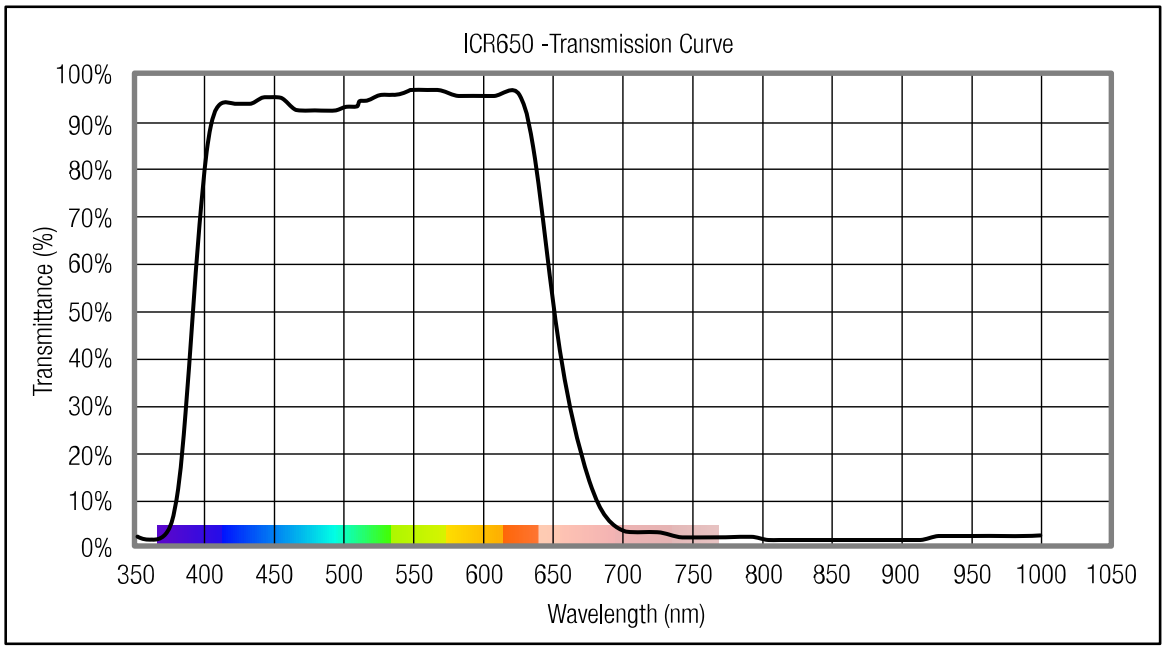


Figure 12: Filter glass ICR650 Transmission Curve

2.6 Sensor and camera characteristics

2.6.1 Sensor and camera parameters

Sensor parameters of MX161MG-SY-X4G3-FF and MX161CG-SY-X4G3-FF.

Sensor parameter							
Technology		CMOS BSI					
Shutter type		Global shutter					
Pixel resolution (H x V)	px	5328 × 3040					
Active area size (H X V)	mm	14.58 × 8.31					
Sensor diagonal	mm	16.78					
Optical Format	”	1.1					
Pixel size (H x V)	µm	2.74 × 2.74					
Image quality parameters							
Mode		Standard			Dual ADC		
ADC resolution	bit	8	10	12	8	10	12
Saturation capacity	ke^-	2.37	9.56	9.28	2.34	9.88	9.35
Dynamic range	dB	53.37	65.38	70.58	61.13	71.85	72.65
SNR Max	dB	33.75	39.81	39.68	33.69	39.95	39.71
Conversion gain	e^-/LSB_{16}	0.62	2.52	2.38	0.04	0.16	0.15
Median read noise	e^-	4.55	4.61	2.21	1.3	1.92	1.6
Dark current	e^-/s	2.06	2.06	1.21	1.74	2.24	2.12
DSNU	e^-	0.52	0.52	0.45	0.4	0.54	0.6
PRNU	%	0.7	0.64	0.66	0.64	0.63	0.65
Linearity	%	0.68	0.43	0.54	0.72	0.44	0.88
Camera parameters							
Exposure time (EXP)[1]	µs	4 to 30 000 000					
Analog gain range	dB	0 to 24					
Refresh rate (MMR)	fps	160.43	153.67	112.0	81.74	78.49	56.89
Pwr. consumption	W	14.6					
Pwr. consumption max	W	14.9					

[1]Defined for maximal bandwidth. Minimal exposure and exposure step (Line Period) could be calculated in: Camera performance calculator

Table 8: sensor and camera parameters

Sensor parameters of MX203CG-SY-X4G3-FF.

Sensor parameter							
Technology		CMOS BSI					
Shutter type		Global shutter					
Pixel resolution (H x V)	px	4512 × 4512					
Active area size (H X V)	mm	12.34 × 12.34					
Sensor diagonal	mm	17.45					
Optical Format	”	1.1					
Pixel size (H x V)	µm	2.74 × 2.74					
Image quality parameters							
Mode		Standard			Dual ADC		
ADC resolution	bit	8	10	12	8	10	12
Saturation capacity	ke^-	2.36	9.76	9.31	2.29	9.07	8.64
Dynamic range	dB	53.35	65.61	71.8	60.92	71.7	72.6
SNR Max	dB	33.73	39.89	39.69	33.6	39.58	39.37
Conversion gain	e^-/LSB_{16}	0.62	2.51	2.4	0.14	0.14	0.14
Median read noise	e^-	4.55	4.6	1.85	1.28	1.74	1.42
Dark current	e^-/s	2.28	2.52	1.5	2.3	2.18	2.11
DSNU	e^-	0.51	0.52	0.83	0.41	0.49	0.56
PRNU	%	0.88	0.78	0.81	0.77	0.77	0.79
Linearity	%	0.31	0.26	0.64	0.7	0.45	0.97
Camera parameters							
Exposure time (EXP)[1]	µs	5 to 30 000 000					
Analog gain range	dB	0 to 24					
Refresh rate (MMR)	fps	110.15	105.77	76.74	55.58	53.38	36.65
Pwr. consumption	W	14.6					
Pwr. consumption max	W	14.9					

[1]Defined for maximal bandwidth. Minimal exposure and exposure step (Line Period) could be calculated in: Camera performance calculator

Table 9: sensor and camera parameters

Sensor parameters of MX203MG-SY-X4G3-FF.

Sensor parameter							
Technology		CMOS BSI					
Shutter type		Global shutter					
Pixel resolution (H x V)	px	4512 × 4512					
Active area size (H X V)	mm	12.34 × 12.34					
Sensor diagonal	mm	17.45					
Optical Format	”	1.1					
Pixel size (H x V)	µm	2.74 × 2.74					
Image quality parameters							
Mode		Standard			Dual ADC		
ADC resolution	bit	8	10	12	8	10	12
Saturation capacity	ke^-	2.36	9.76	9.31	2.29	9.07	8.64
Dynamic range	dB	53.35	65.61	71.8	60.92	71.7	72.6
SNR Max	dB	33.73	39.89	39.69	33.6	39.58	39.37
Conversion gain	e^-/LSB_{16}	0.62	2.51	2.4	0.14	0.14	0.14
Median read noise	e^-	4.55	4.6	1.85	1.28	1.74	1.42
Dark current	e^-/s	2.28	2.52	1.5	2.3	2.18	2.11
DSNU	e^-	0.51	0.52	0.83	0.41	0.49	0.56
PRNU	%	0.88	0.78	0.81	0.77	0.77	0.79
Linearity	%	0.31	0.26	0.64	0.7	0.45	0.97
Camera parameters							
Exposure time (EXP)[1]	µs	5 to 30 000 000					
Analog gain range	dB	0 to 24					
Refresh rate (MMR)	fps	10.15	105.77	76.74	55.58	53.38	36.65
Pwr. consumption	W	14.6					
Pwr. consumption max	W	14.9					

[1] Defined for maximal bandwidth. Minimal exposure and exposure step (Line Period) could be calculated in: Camera performance calculator

Table 10: sensor and camera parameters

Sensor parameters of MX245CG-SY-X4G3-FF and MX245MG-SY-X4G3-FF.

Sensor parameter							
Technology		CMOS BSI					
Shutter type		Global shutter					
Pixel resolution (H x V)	px	5328 × 4608					
Active area size (H X V)	mm	14.58 × 12.6					
Sensor diagonal	mm	19.27					
Optical Format	”	1.2					
Pixel size (H x V)	µm	2.74 × 2.74					
Image quality parameters							
Mode		Standard			Dual ADC		
ADC resolution	bit	8	10	12	8	10	12
Saturation capacity	ke^-	2.4	9.89	9.41	2.32	9.89	9.4
Dynamic range	dB	53.63	65.66	70.6	61.57	72.18	72.91
SNR Max	dB	33.82	40.32	40.1	33.67	40.32	40.11
Conversion gain	e^-/LSB_{16}	0.61	2.51	2.4	0.04	0.16	0.15
Median read noise	e^-	4.49	4.64	2.23	1.31	1.85	1.56
Dark current	e^-/s	2.28	1.28	1.91	1.03	1.61	2.15
DSNU	e^-	0.78	0.52	0.64	0.4	0.54	0.65
PRNU	%	0.86	0.81	0.81	0.83	0.8	0.81
Linearity	%	0.74	0.46	1.02	0.89	0.48	0.97
Camera parameters							
Exposure time (EXP)[1]	µs	5 to 30 000 000					
Analog gain range	dB	0 to 24					
Refresh rate (MMR)	fps	107.9	103.7	75.2	54.6	52.4	38.0
Pwr. consumption	W	14.6					
Pwr. consumption max	W	14.9					

[1]Defined for maximal bandwidth. Minimal exposure and exposure step (Line Period) could be calculated in: Camera performance calculator

Table 11: sensor and camera parameters

2.6.2 Sensor read-out modes

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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

Table 12: Sensor read-out modes of the specific models

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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

Table 13: 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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

Table 14: 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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

Table 15: 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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

Table 16: 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	Maximum 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]Maximum frame rate was measured using the transport format at maximum bandwidth 3500.0 MB/s

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

2.6.3 Quantum efficiency curves

Quantum efficiency curves for MX161MG-SY-X4G3-FF and MX161CG-SY-X4G3-FF.

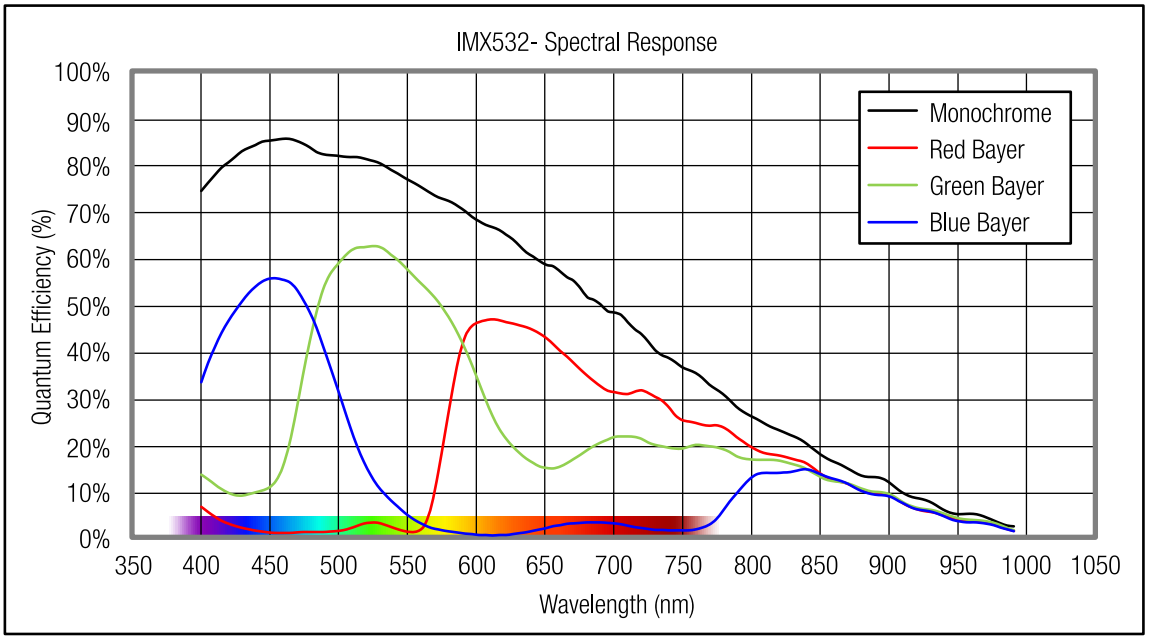


Figure 13: Graph quantum efficiency of Sony IMX532

Quantum efficiency curves for MX203CG-SY-X4G3-FF and MX203MG-SY-X4G3-FF.

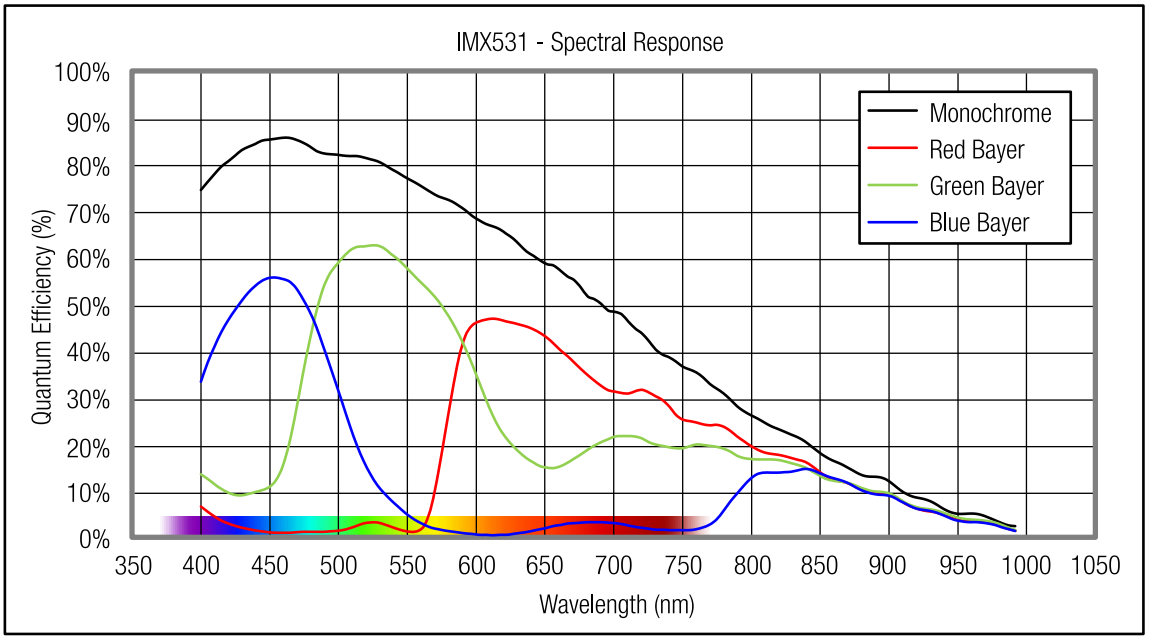


Figure 14: Graph quantum efficiency of Sony IMX531

Quantum efficiency curves for MX245CG-SY-X4G3-FF and MX245MG-SY-X4G3-FF.

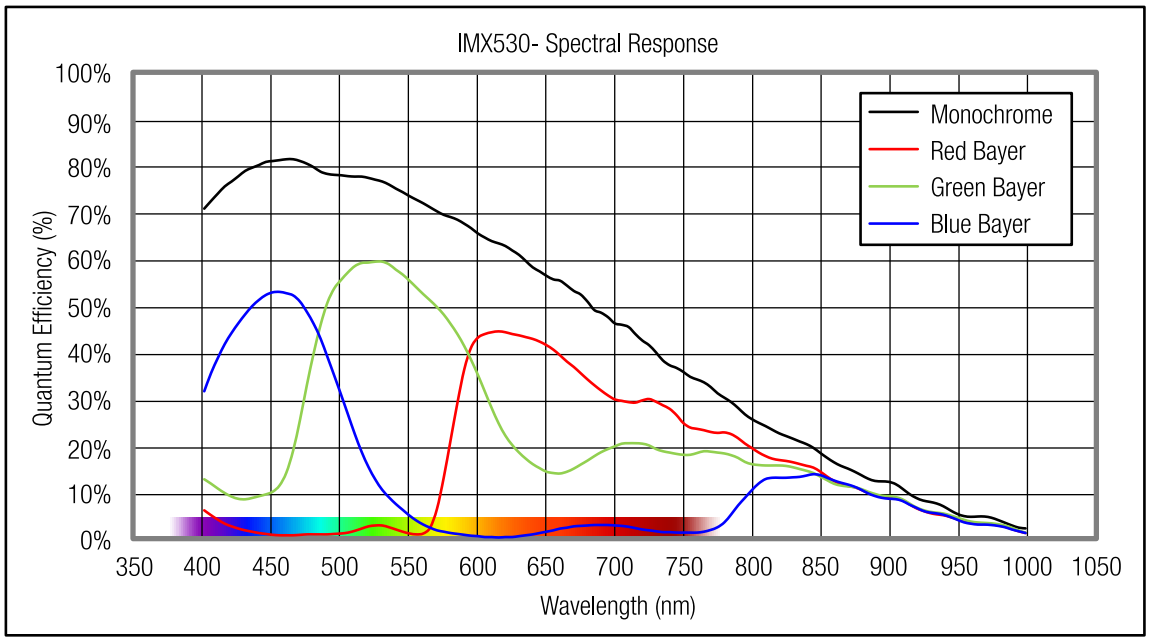


Figure 15: Graph quantum efficiency of Sony IMX530

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[1] [D]	Mass[1] [M]
70 mm	60 mm	55 mm	395 g

[1] without adapters

Table 18: 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).

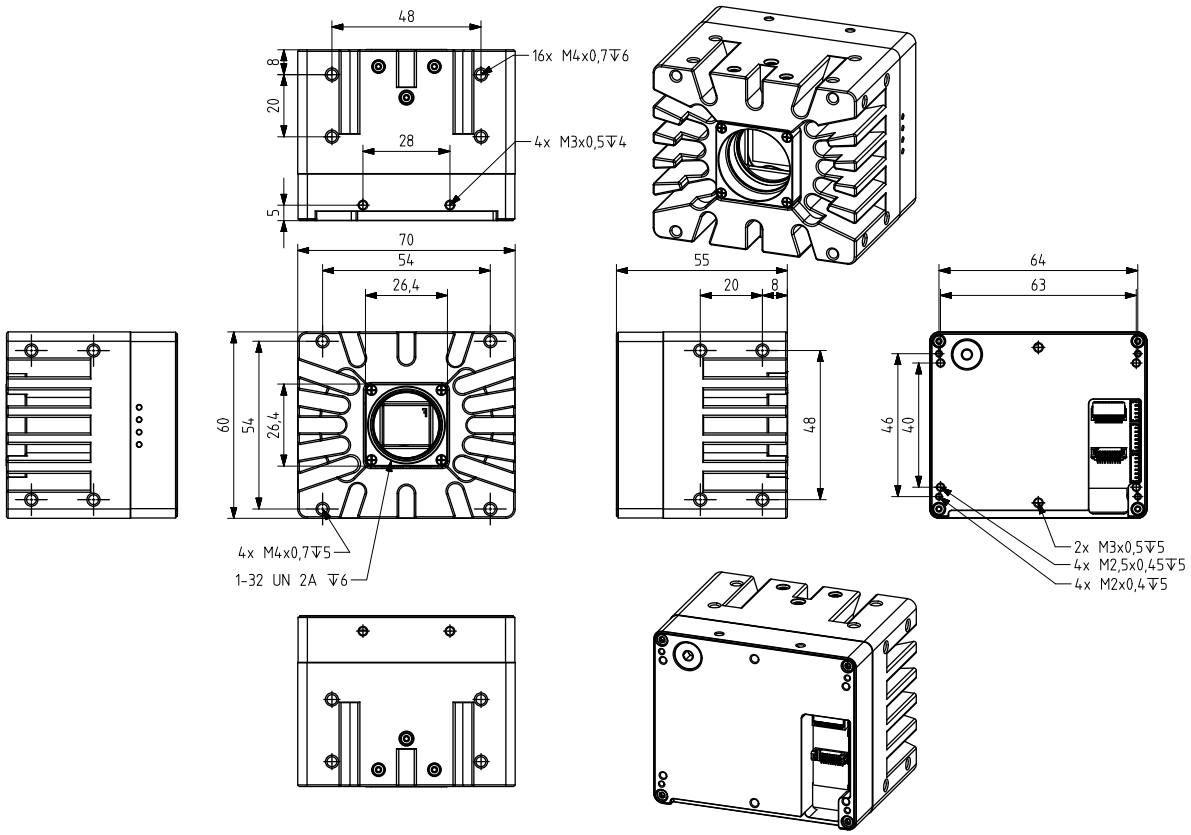


Figure 16: dimensional drawings

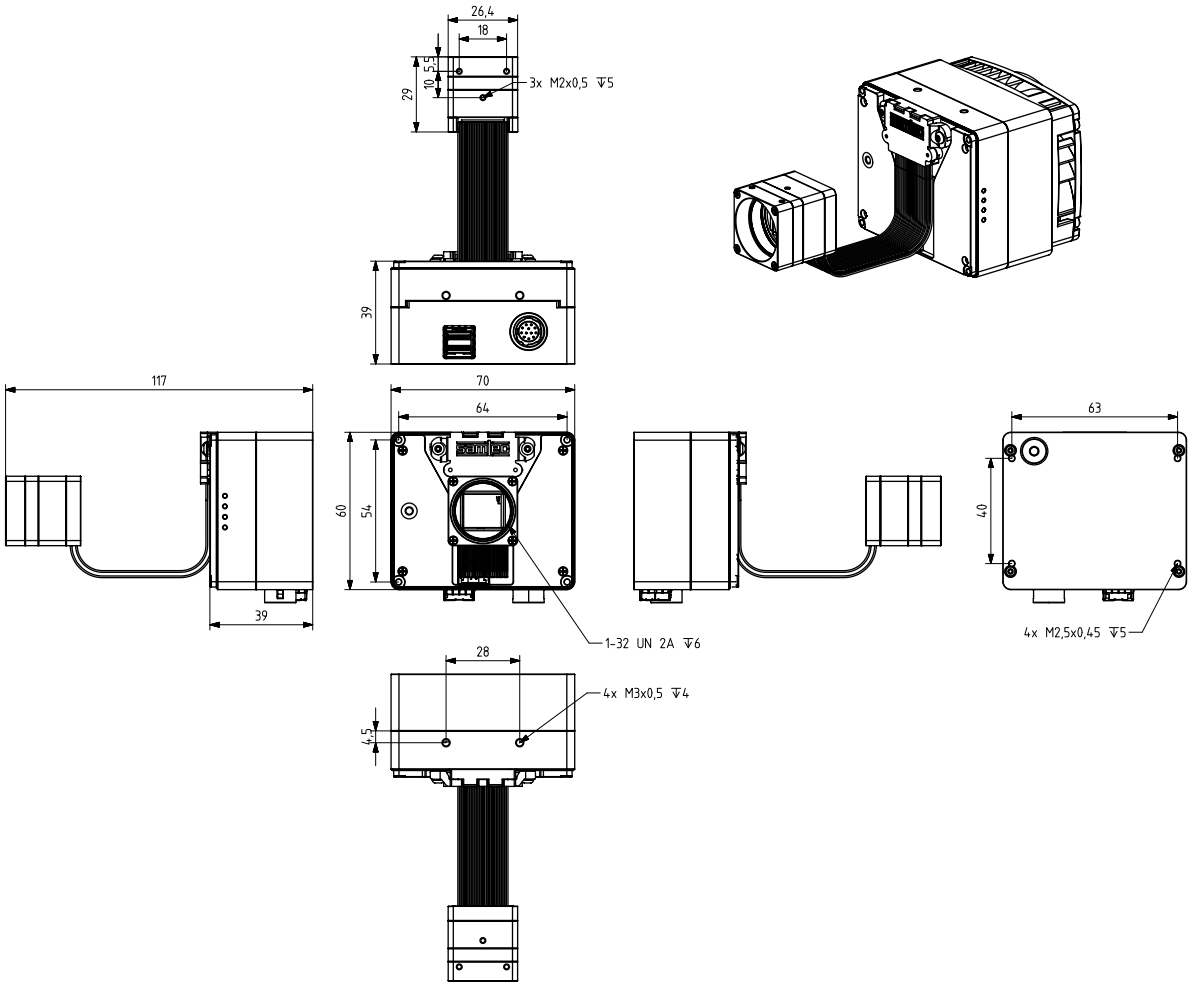


Figure 17: dimensional drawing camera with detached sensor sub-assembly

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 19: LED output description during camera power up

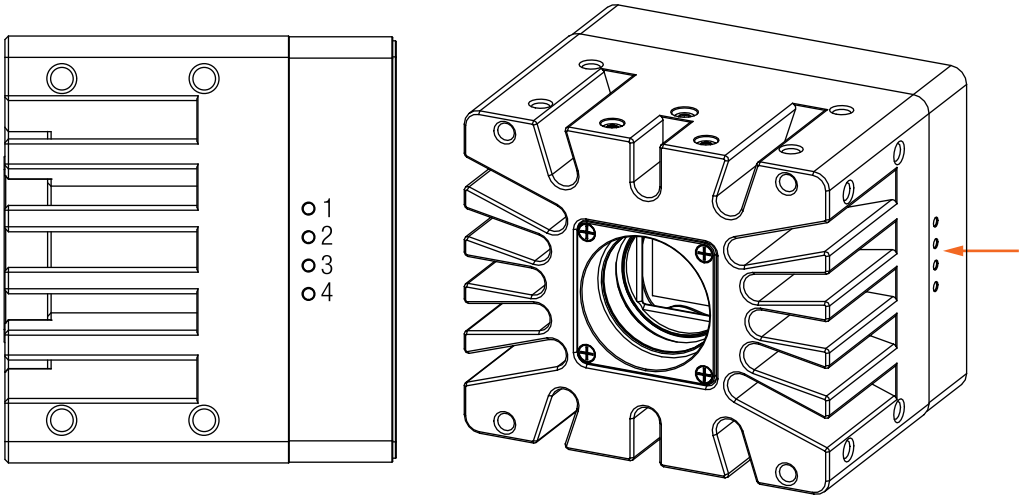


Figure 18: Position of LEDs on xiX-Xtreme camera

LED statuses during boot sequence

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 20: LED output description during camera power up

The table above applies to all models in this manual (refer to the table Models and sensors overview).

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).

Note: It is important that the power is turned off when inserting/detaching the cable. Connecting camera to powered host can cause destruction of camera. For cameras with ADPT-MX-X4G3-FF-X4G3-MTP and ADPT-MX-X4G3-FF-X4G3-SFF adapters please refer to section ADPT-MX-X4G3-FF-X4G3-SFF and ADPT-MX-X4G3-FF-X4G3-MTP

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 21: Firefly interface mating connector description

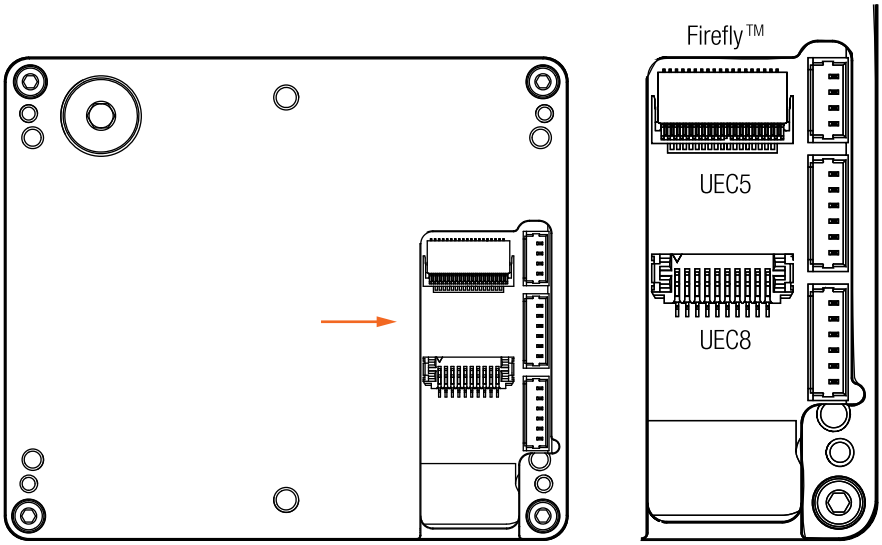


Figure 19: PCIe / FireFly connector location

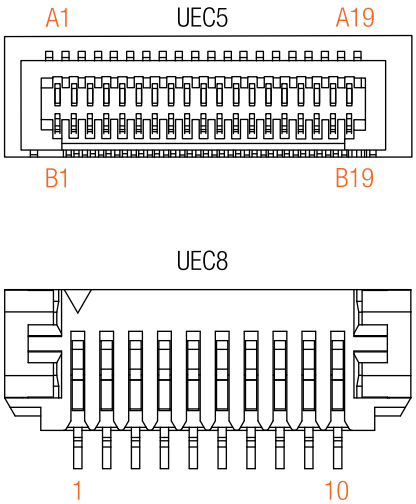


Figure 20: PCIe / FireFly connector pinning

Pinout FireFly UEC8 connector

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	OUT1	Optically isolated Digital Output (OUT)
10	VCC_RX	Power output

Table 22: FireFly connector pin assignment

Pinout FireFly UEC5 connector

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	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

2.10 Digital inputs / outputs (GPIO) interface

The description of the GPIO interface is applicable to all models in this manual (refer to the table Models and sensors overview).

Pcie / FireFly connector IO pinout

Pin	Name	GPI/GPO index API	Type
Pinout FireFly UCC8 connector			
9	OUT1	-/1	Optically isolated Digital Output (OUT)
Pinout FireFly UEC5 connector			
A8	IN1	1/-	Optically isolated Digital Input (IN)
B8	OUT1	-/1	Optically isolated Digital Output (OUT)

Table 23: Firefly connector I/O pin assignment

IO connectors pinout

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 24: GPIO mating connector description

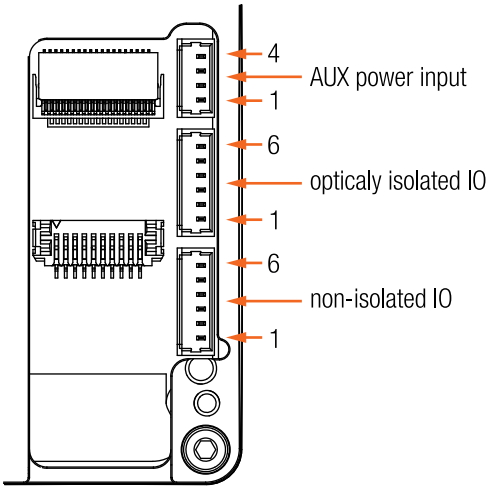


Figure 21: IO connectors position

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 25: 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 26: I/O connector pin assignment

2.10.1 Optically isolated digital inputs

General info

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 27: General info for optically isolated digital input

2.10.2 Optically isolated digital outputs

General info

Item	Parameter	Note
Maximal open circuit voltage	24 V DC	None
Output port type	Open collector NPN	None
Common pole	True	OUT GND
Protection	short-circuit / over-current / Reverse voltage	None
Protection circuit	PTC Resettable Fuse	None
Maximal sink current	36 mA	None
Trip current	71 mA	Self-restarting when failure mode current disconnected
Inductive loads	false	None
Effect of incorrect output terminal connection	Protected against reverse voltage connection	None
Maximal output dropout	1 V	Sink current 25 mA
Output delay - ON -> OFF	26us	VOUTPUT=10 V, TAMBIENT=25 °C
Output delay - OFF -> ON	1.5us	VOUTPUT=10 V, TAMBIENT=25 °C
Strobe output mapping	True	None

Table 28: General info for optically isolated digital output

2.10.3 Non-isolated digital lines

General info

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	false	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	false	Signal inversion supported

Table 29: General info for non-isolated digital in/out trigger lines

2.11 Accessories

2.11.1 CBL-PB4-PWR-0M15

Figure 22: CBL-PB4-PWR-0M15

Power cable with barrel connector 15 cm long

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

Table 30: connectors CBL-PB4-PWR-0M15

2.11.2 CBL-PB6-IO-xM

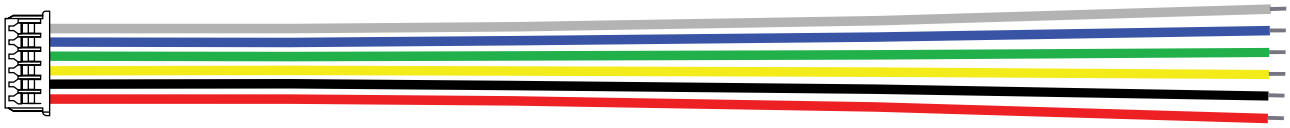


Figure 23: CBL-PB6-IO-xM

IO pig tail cable 10 cm long.

Manufacturer	Model	Description
Molex	86053248	6 pin Pico Blade connector

Table 31: connectors CBL-PB6-IO-0M10

2.11.3 CBL-ECUE-X4G3-xM

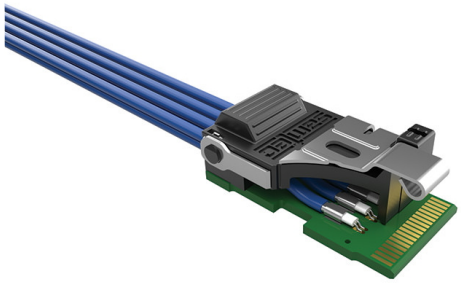


Figure 24: CBL-ECUE-X4G3-xM

BL-ECUE-X4G3-xM Cable Micro Assembly, Low-Profile FireFly, 30 cm, 100 cm, 200 cm. FireFly copper cables - Bidirectional and flexible. PCIe Gen3 x4 lanes with 14 Gbps Both sides are equipped with locking mechanism.

MX X4G3 cameras can be connected to host via cable with FireFly connector. The EMI/EMC performance should be evaluated by customer. For connecting to different host via vast range of adapters. Please see website Cameras Adapters

2.11.4 CBL-HQCD-xM

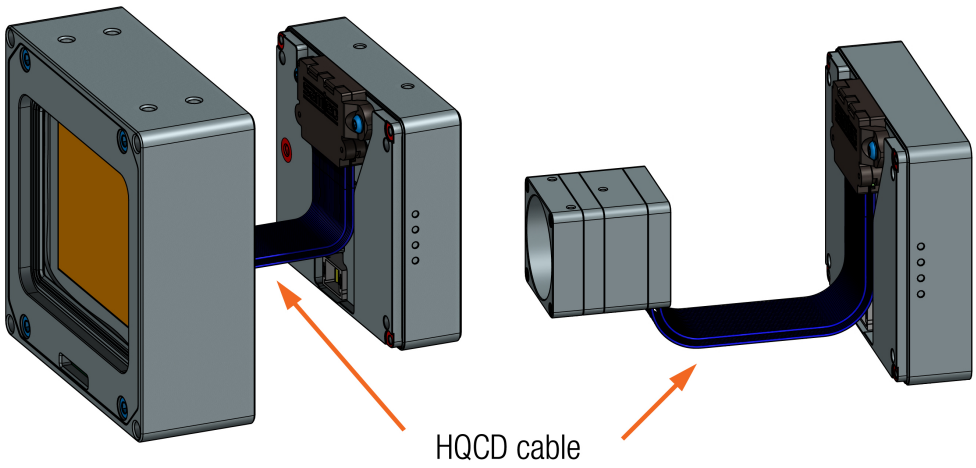


Figure 25: HQCD cable

All xiX-Xtreme cameras in the manual have front and rear sub-assembly detached option. Please check the Accessories overview for supported lengths of the HQCD cables.

2.11.5 CB-X8G3-FAN-COOLER

Figure 26: CB-X8G3-FAN-COOLER

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

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

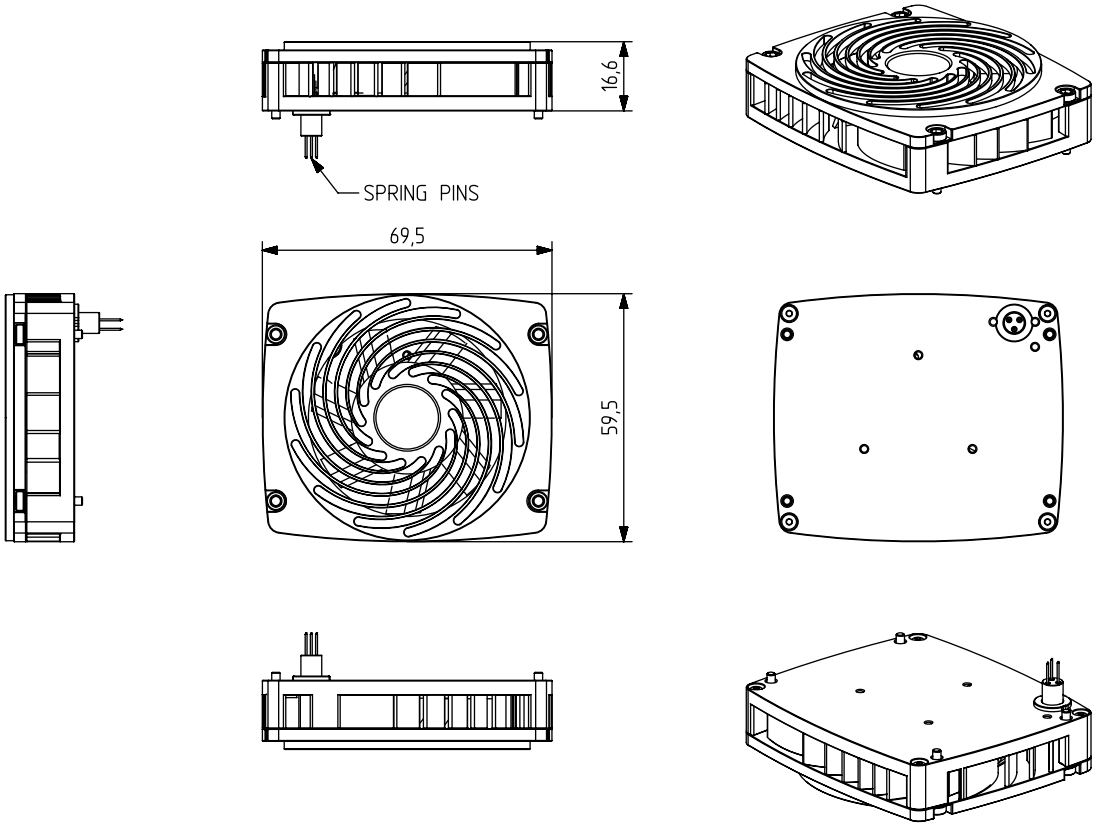


Figure 27: mounting fan cooling element CB-X8G3-FAN-COOLER

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

Table 32: Mechanical parameters of CB-X8G3-FAN-COOLER

2.11.6 CB-X8G3-WAT-COOLER-KIT

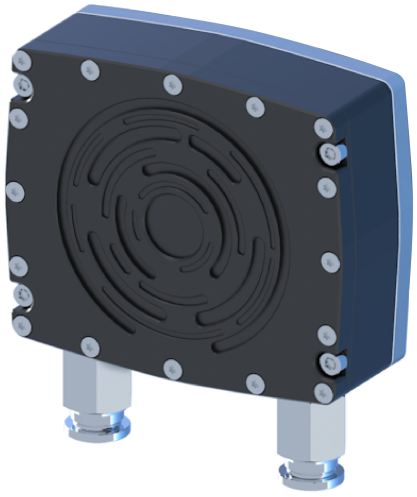


Figure 28: CB-X8G3-WAT-COOLER

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

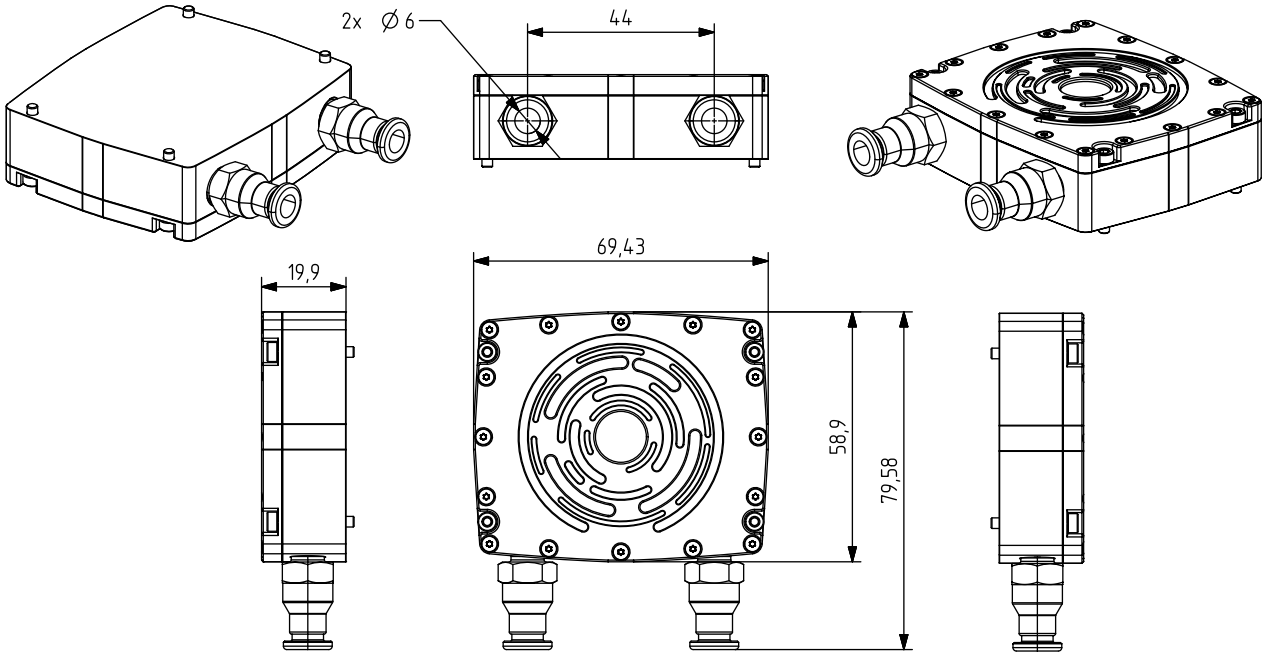


Figure 29: CB-X8G3-WAT-COOLER-KIT drawing

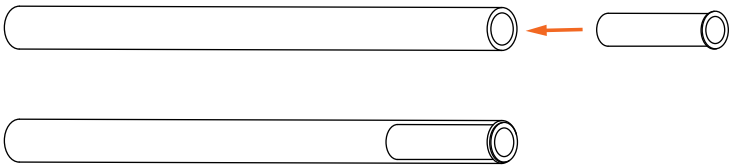
Connecting and disconnecting the tubes

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

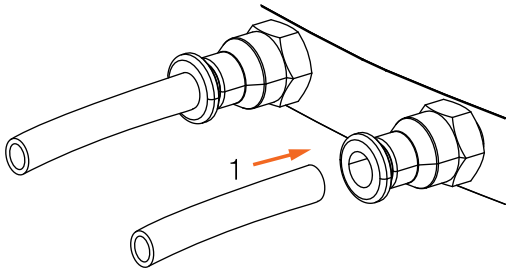
XIMEA has conducted tests and endorses the use of PISCO brand tubes (part number UCQ06-2F-20-C) along with insert rings (part number WR0640) for creating secure and leak-proof connections. The recommended procedure for connecting and disconnecting tubes is as follows

Connecting

- Begin by inserting the insert rings into the tubes.



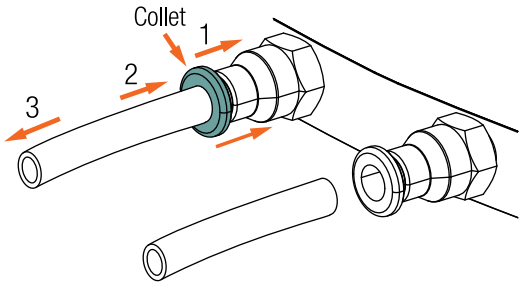
- Ensure the camera is powered off. Then, insert the tube into the Push-In Fitting until it is fully seated. The collet/release ring will automatically secure the tube, and the elastic sleeve will form a seal around it.



- Gently pull on the tube to verify it is securely fixed and cannot be removed easily.
- Start water supply and inspect for any leaks.
- If no leaks are detected, it is safe to power on the camera.

Disonnecting

- Turn off the camera and halt the water supply.
- Press the collet (release ring) towards the fitting (Step 1).
- While keeping the collet pressed, gently push the tube further into the fitting (Step 2), then pull it out to disconnect (Step 3).



2.11.7 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).

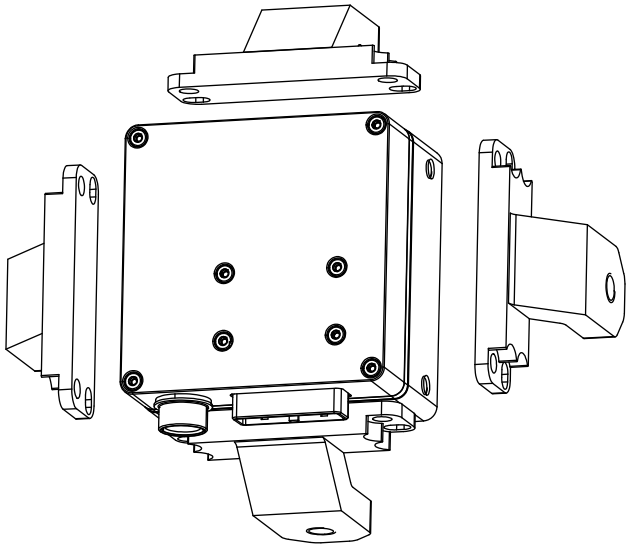


Figure 30: MECH-60MM-BRACKET-T

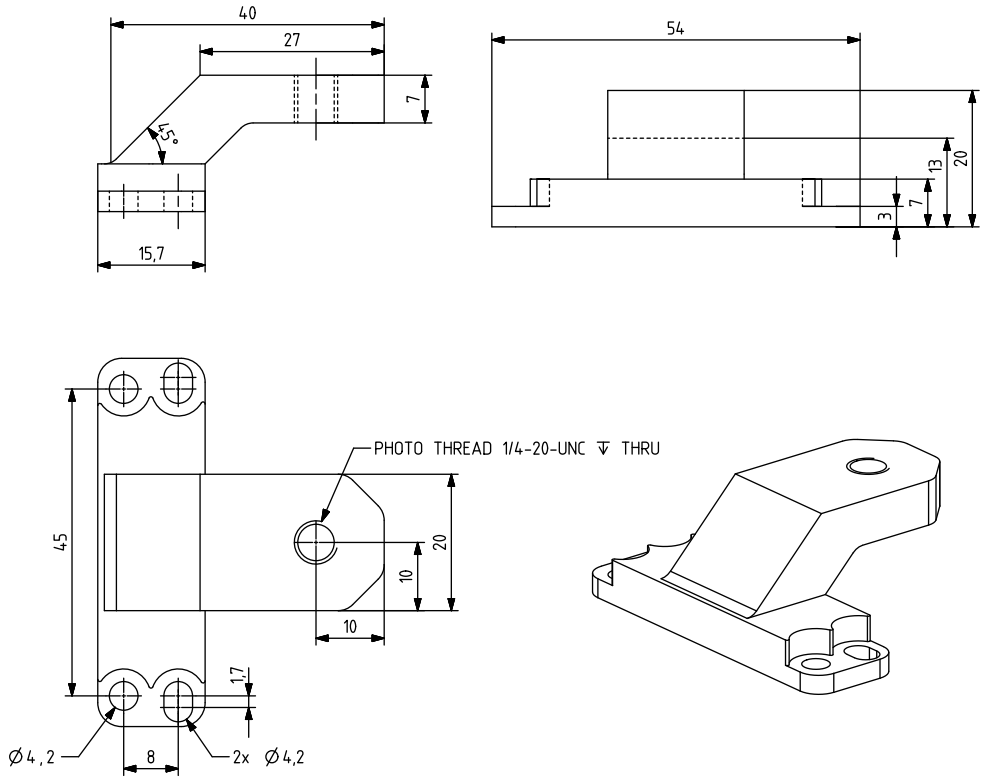


Figure 31: MECH-60MM-BRACKET-T drawing

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

Table 33: Parameters of MECH-60MM-BRACKET-T

2.11.8 MQ-BRACKET-T

Figure 32: 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

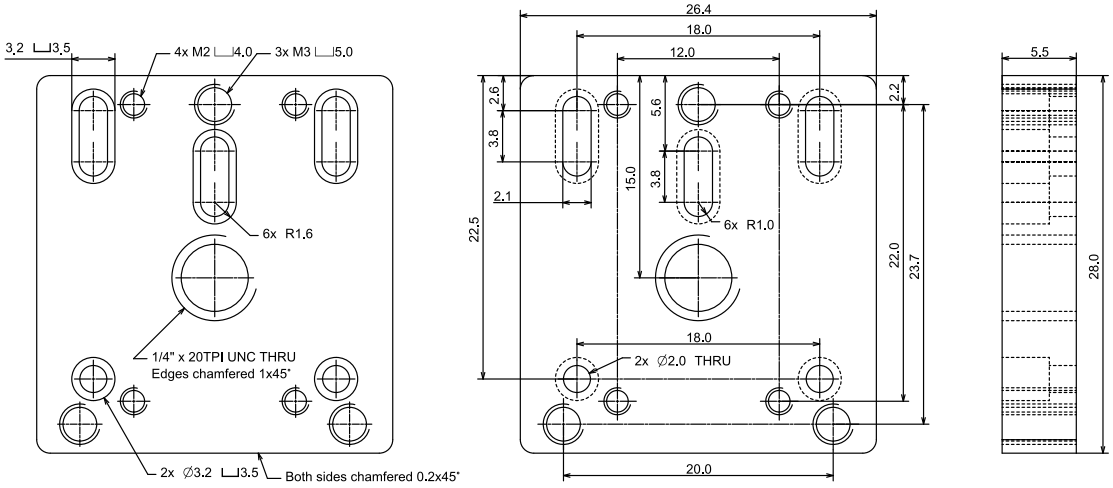


Figure 33: MQ-BRACKET-T dimensional drawing

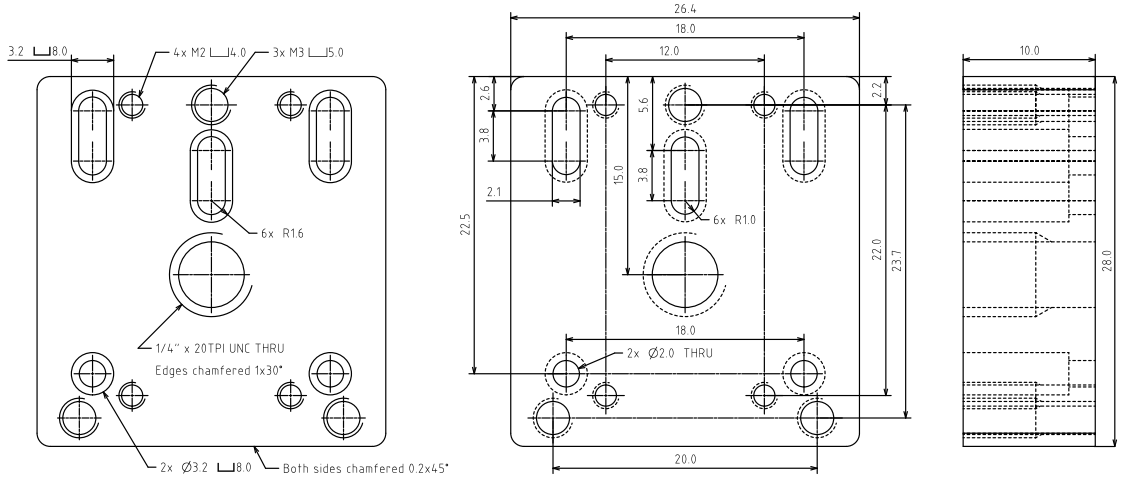


Figure 34: MQ-BRACKET-T thick dimensional drawing

2.11.9 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.

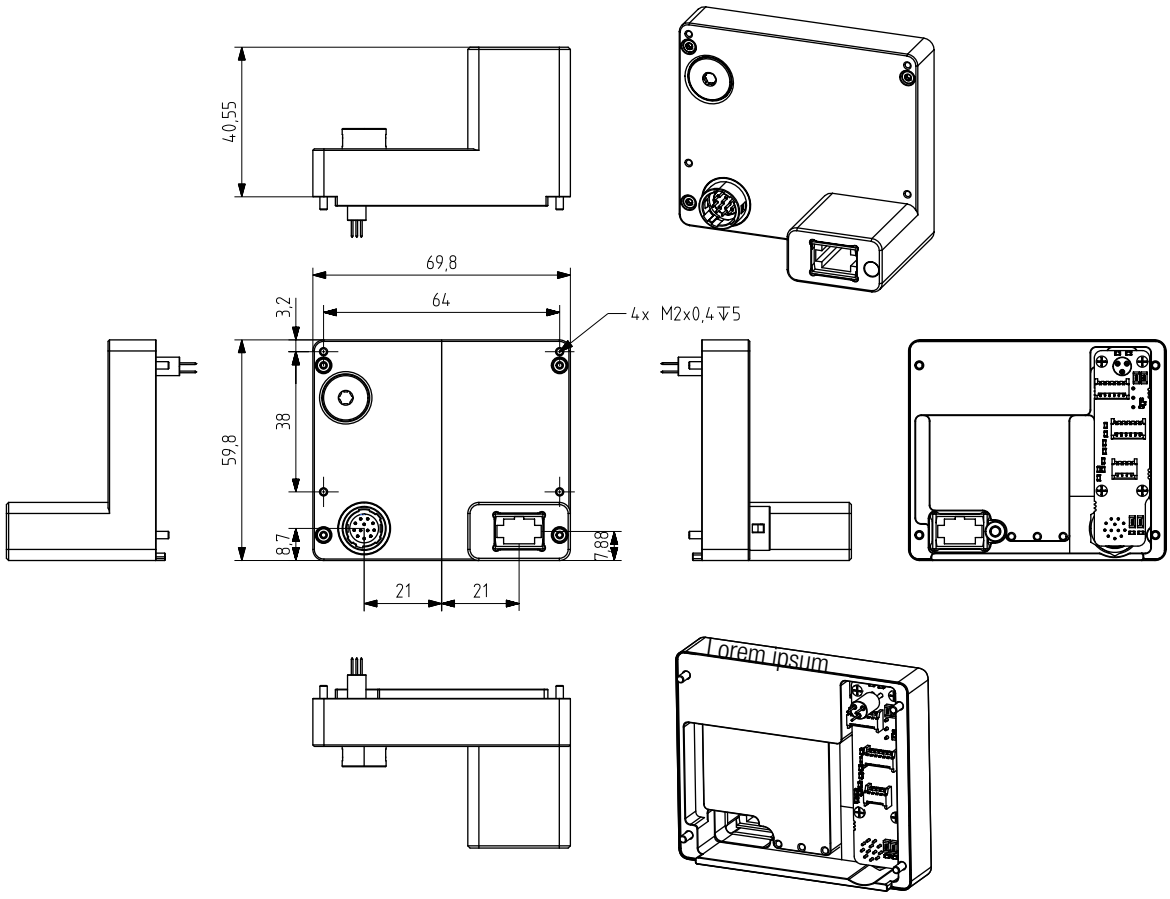


Figure 35: ADPT-MX-X4G3-FF-X4G3-MTP dimensional drawing

IO connector pinning

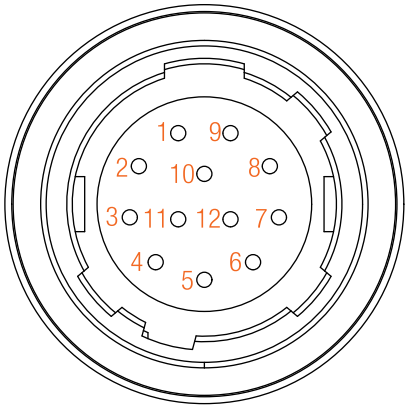


Figure 36: ADPT-MX-X4G3-FF-X4G3-MTP IO connector

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

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

Table 34: ADPT-MX-X4G3-FF-X4G3-MTP IO pin assigment

ADPT-MX-MTP-FAN-COOLER

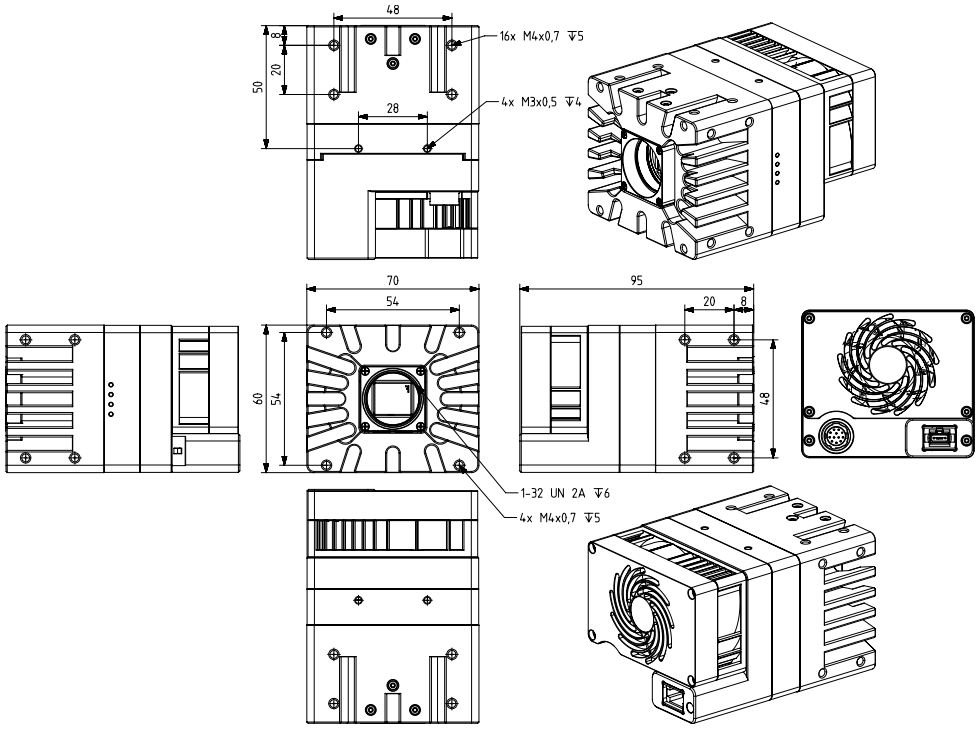


Figure 37: dimensional drawing MX161|203|245xG-SY-X4G3-xxx

ADPT-MX-MTP-WAT-COOLER

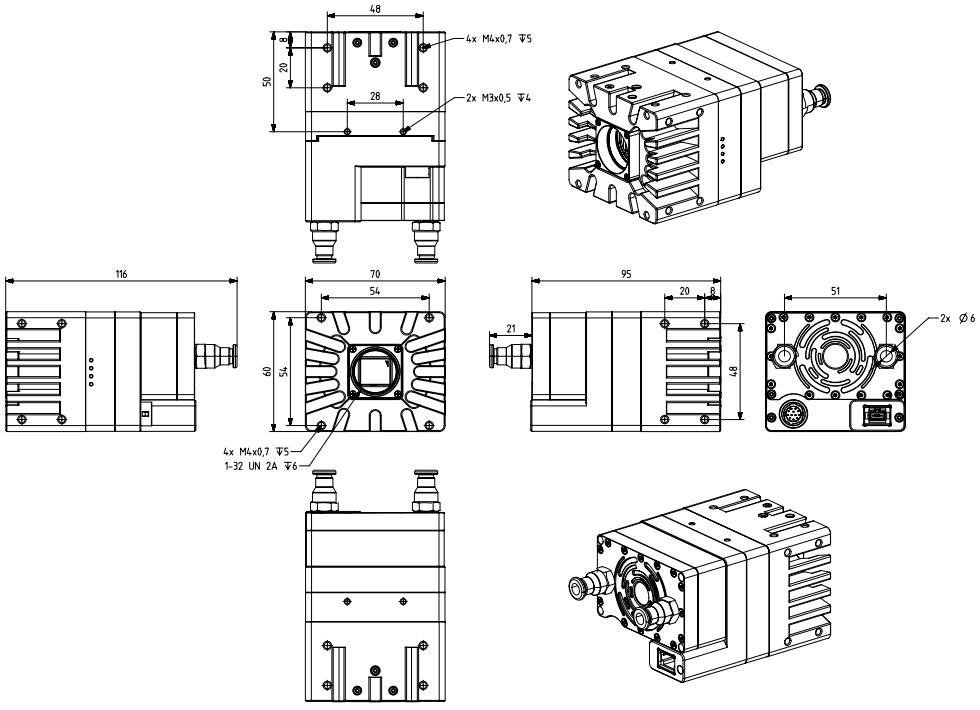
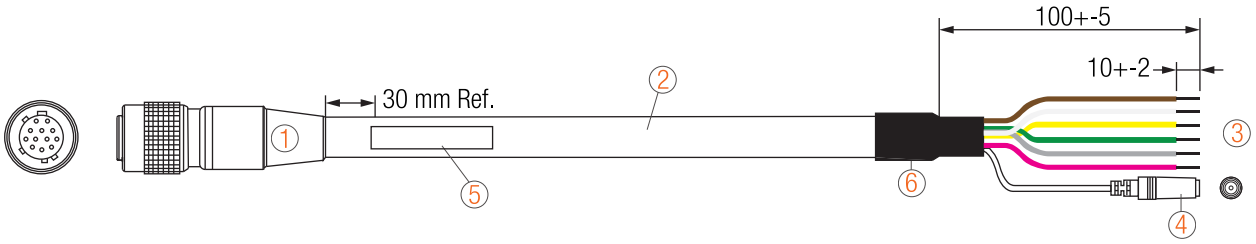


Figure 38: dimensional drawing MX161|203|245xG-SY-X4G3-xxx-MTP-WATERCOOLED

2.11.10 CBL-MT-PWR-SYNC-3M0

The following is a description of the sync/power cable.
Get the latest information on available accessories at:PCI Express Cameras



sync + power cable, components

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

Wiring diagram CBL-MT-POWER-SYNC-3M0

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	NOUT4

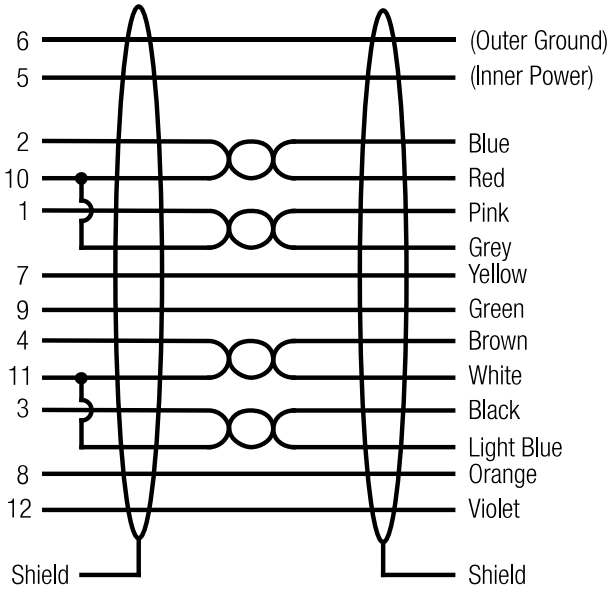
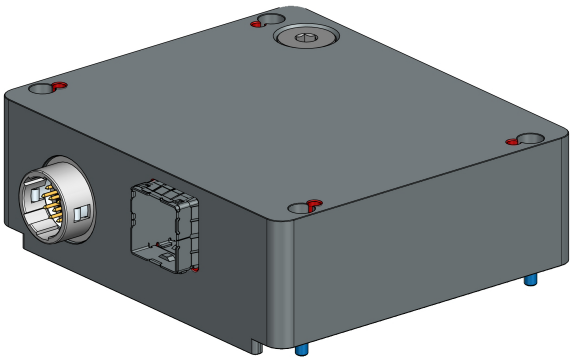


Figure 39: Wiring cable CBL-MT-POWER-SYNC-3M0

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



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

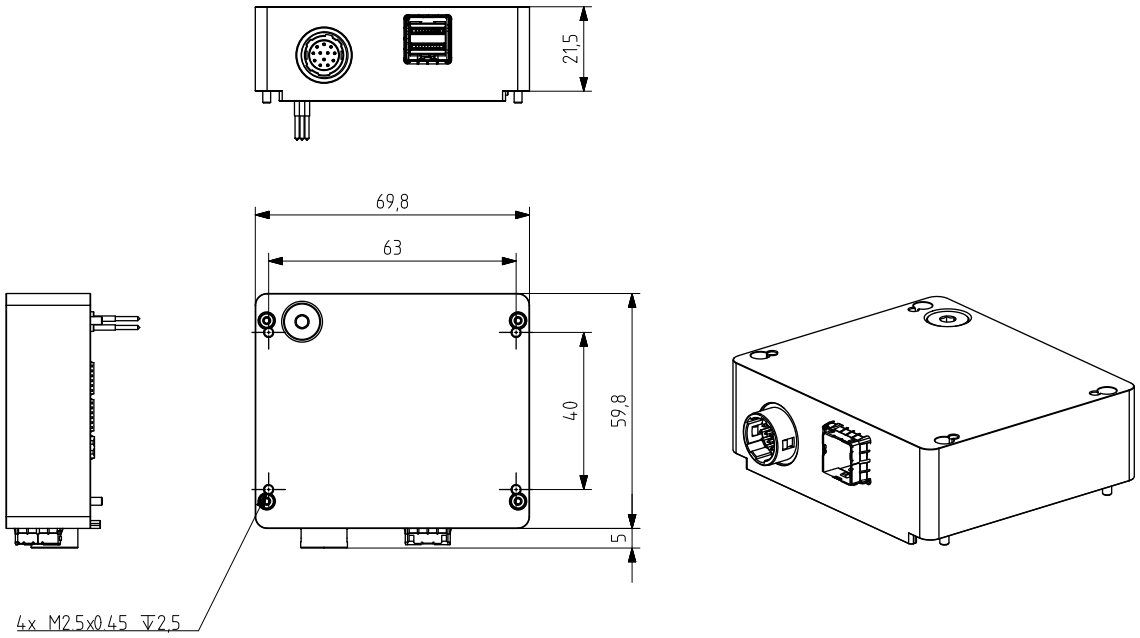


Figure 40: ADPT-MX-X4G3-FF-X4G3-SFF dimensional drawing

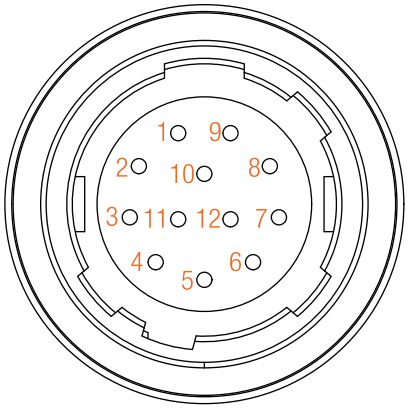


Figure 41: ADPT-MX-X4G3-FF-X4G3-SFF IO connector

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

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

Table 35: ADPT-MX-X4G3-FF-X4G3-SFF IO pin assigment

ADPT-MX-SFF-FAN-COOLER

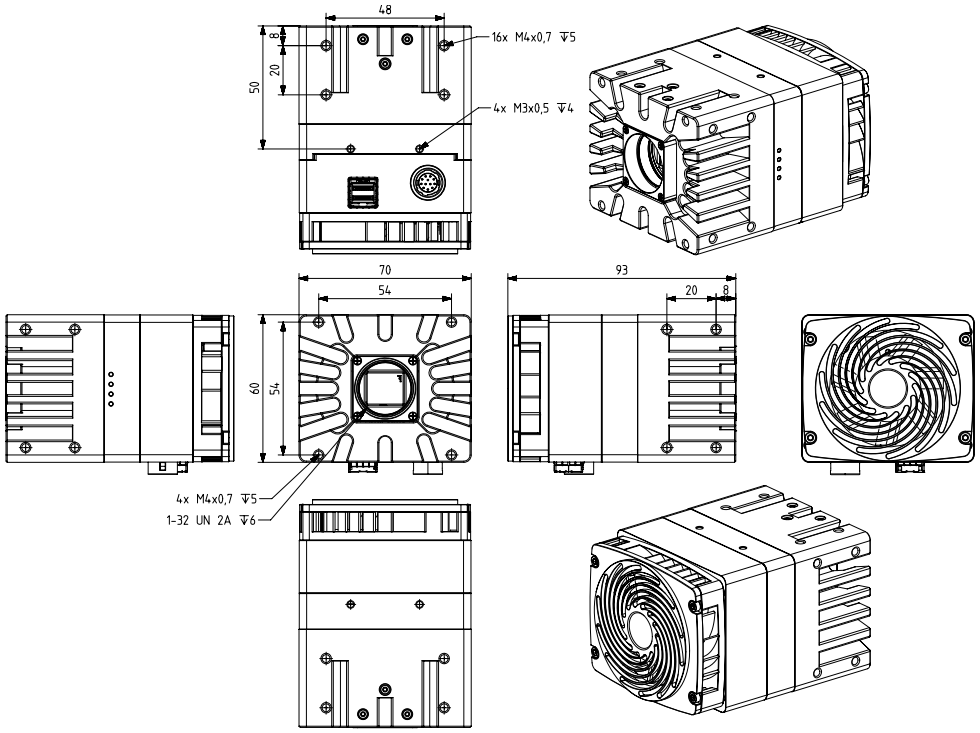


Figure 42: dimensional drawing MX161|203|245xG-SY-X4G3-xxx-SFF-AIRCOOLED

ADPT-MX-SFF-WAT-COOLER

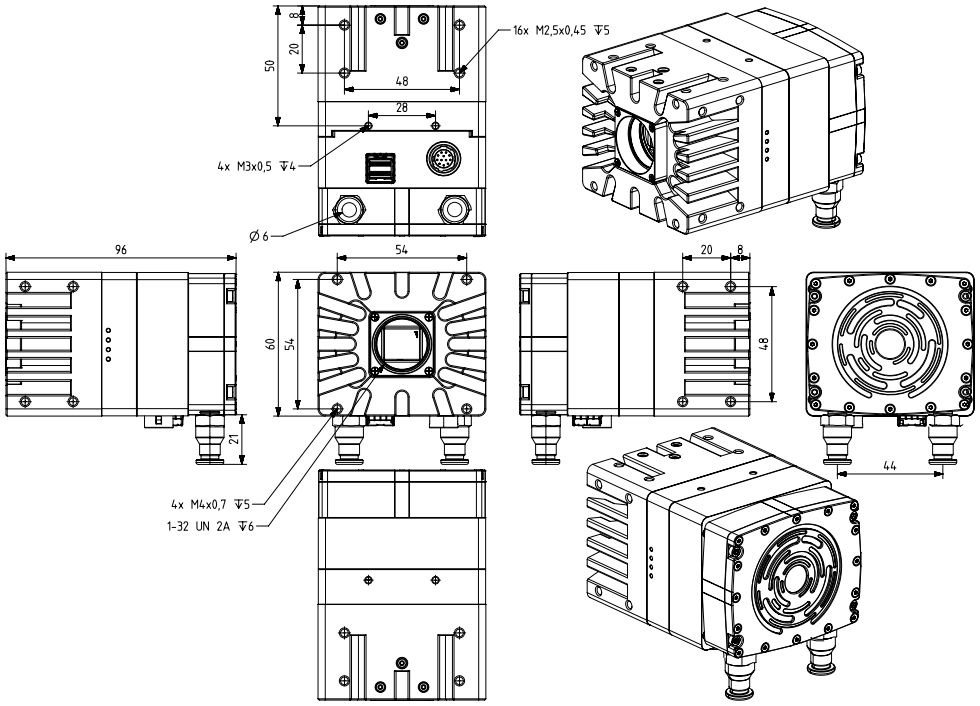
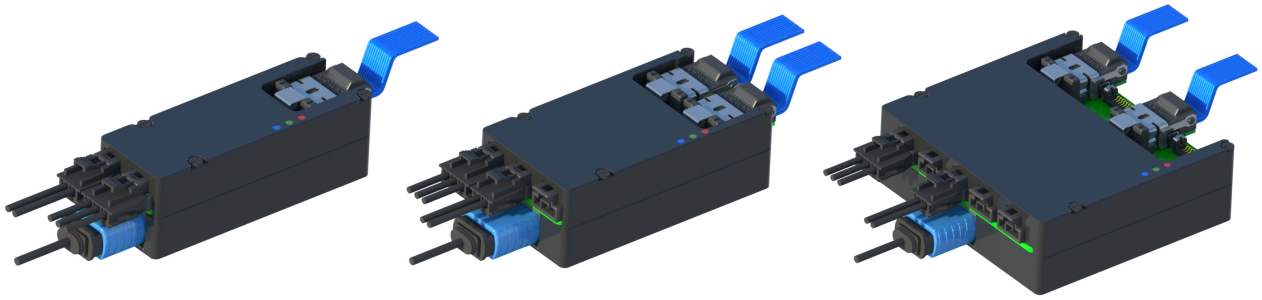


Figure 43: dimensional drawing MX161|203|245xG-SY-X4G3-xxx-SFF-WATERCOOLED

2.11.12 FireFly 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

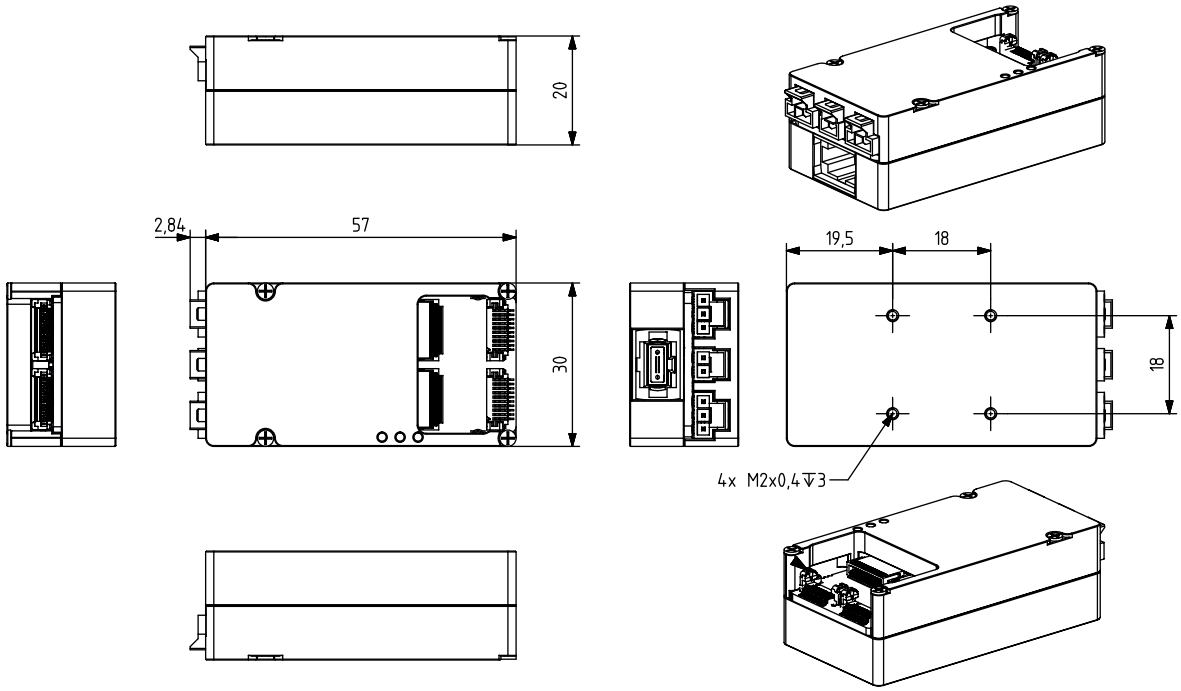


Figure 44: ADPT-1P-X4G3-FF-X4G3-MTP dimensional drawings

ADPT-1P-X8G3-FF-X8G3-MTP / ADPT-2P-X2G3-FF-X4G3-MTP

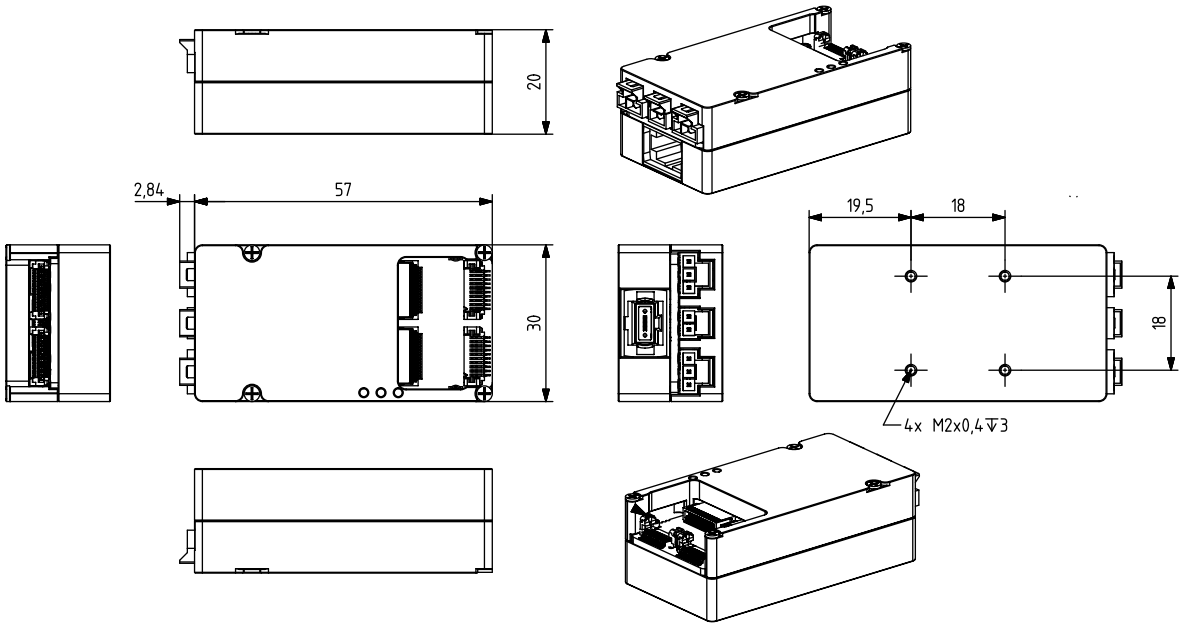


Figure 45: ADPT-1P-X8G3-FF-X8G3-MTP and ADPT-2P-X2G3-FF-X4G3-MTP dimensional drawings

ADPT-4P-X2G3-FF-X8G3-MTP

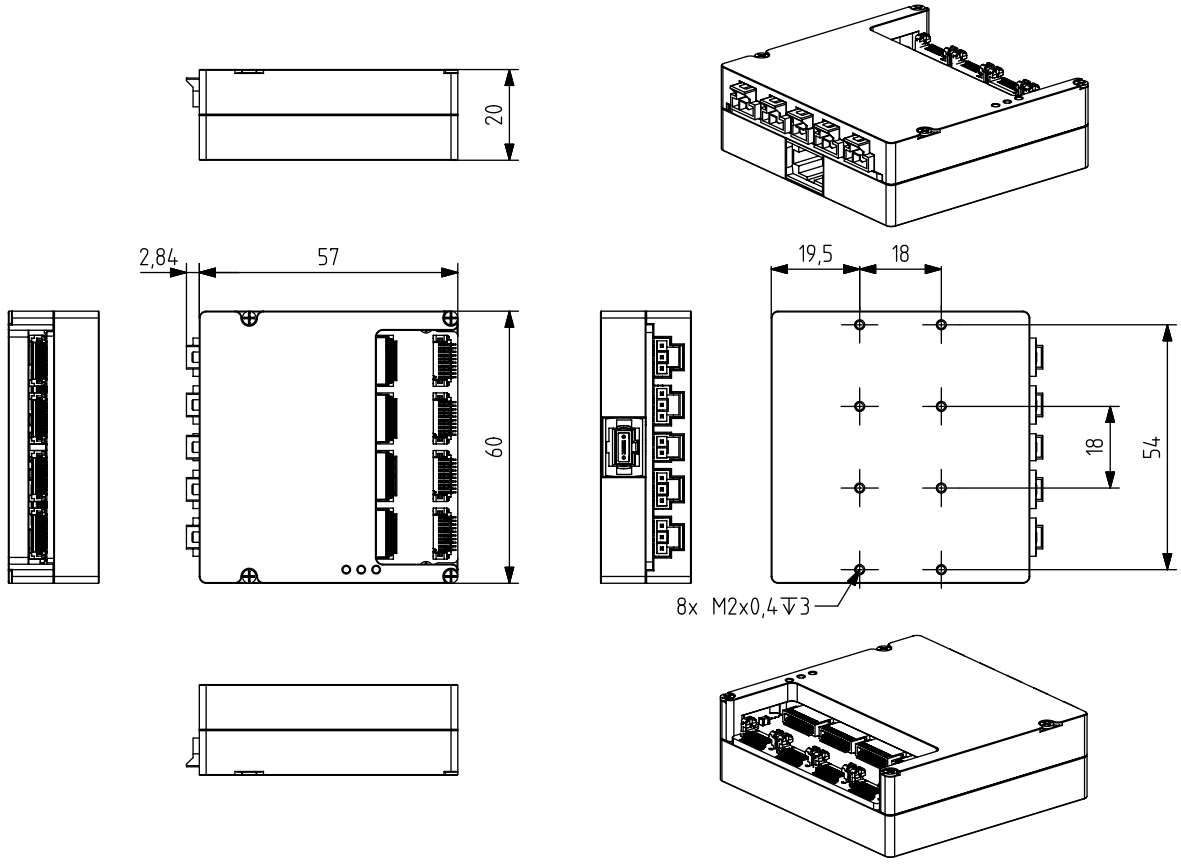
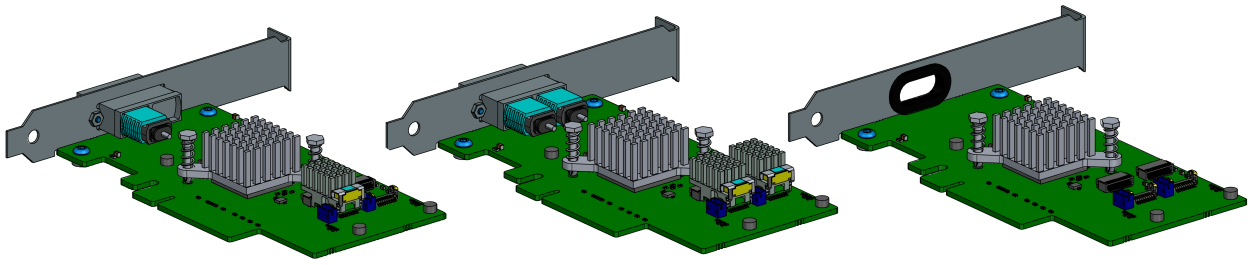


Figure 46: ADPT-4P-X2G3-FF-X8G3-MTP dimensional drawings

2.11.13 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.



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.

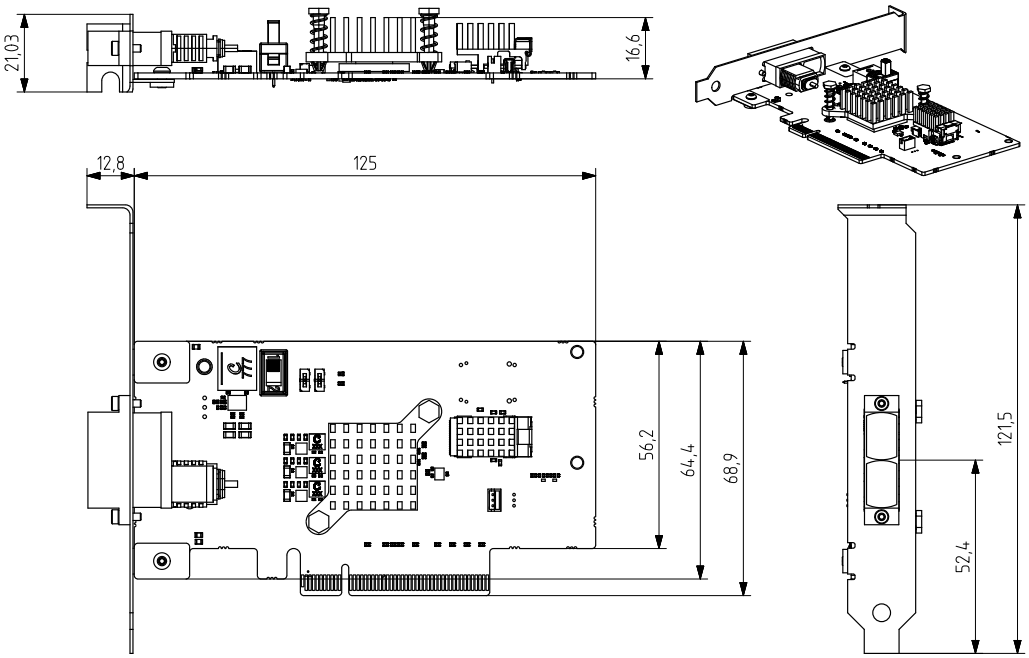


Figure 47: dimensions of host adapter HA-1P-X4G3-MTP-X8G3

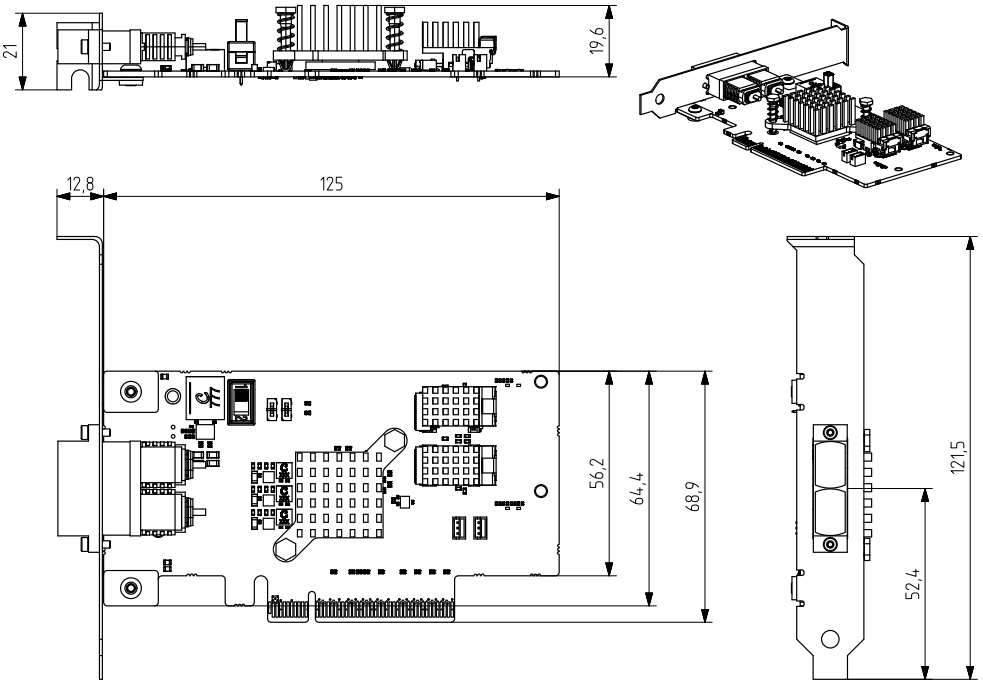


Figure 48: dimensions of host adapter HA-2P-X4G3-MTP-X8G3

HA-2P-X4G3-FF-X8G3

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

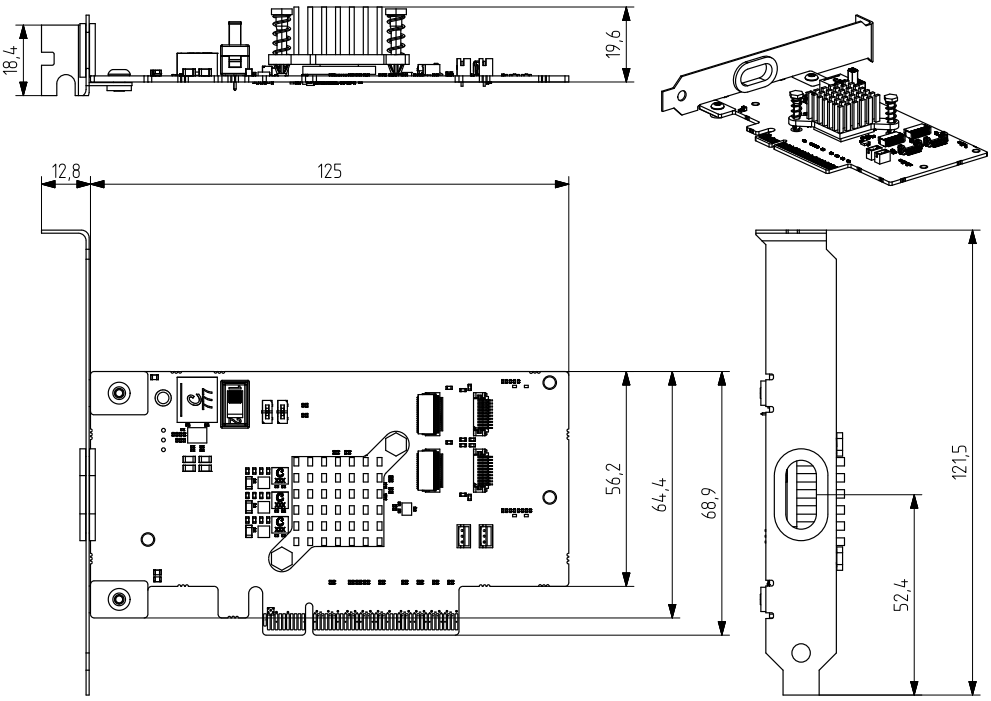


Figure 49: dimensions of host adapter HA-2P-X4G3-FF-X8G3

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

Mode	Description
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
xI_RGB24	RGB data format. [Blue][Green][Red][2]
xI_RGB32	RGBA data format. [Blue][Green][Red][0][2]
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]...[2]
xI_RGB16_PLANAR	RGB16 planar data format
xI_FRM_TRANSPORT_DATA	Data from transport layer (e.g. packed). Depends on data on the transport layer[3]

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

[2]On monochromatic cameras the black level is not subtracted in XI_MONO8 and XI_MONO16 formats by Image Processing in xiAPI, so black level remains the same as in RAW format.

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

Table 36: Image data output formats

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).

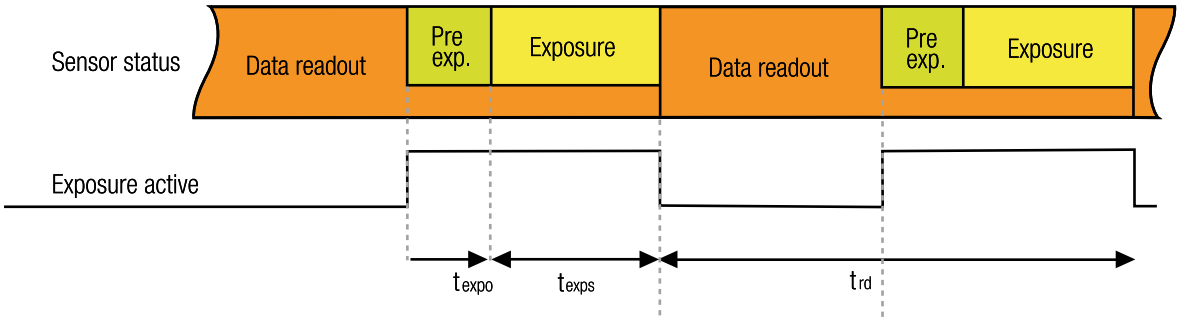


Figure 50: Acquisition mode - free run

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, see Optically isolated digital 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 described in Optically isolated digital inputs. 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.

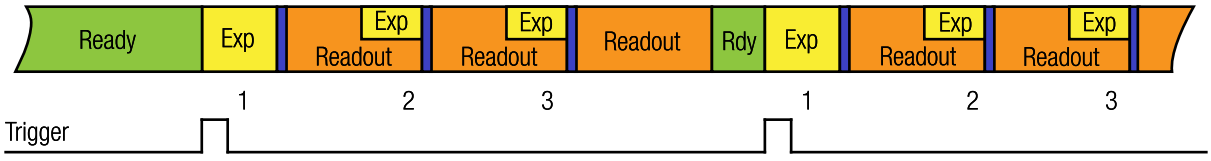


Figure 51: Triggered burst of frames – frame burst start

Frame Burst Active

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

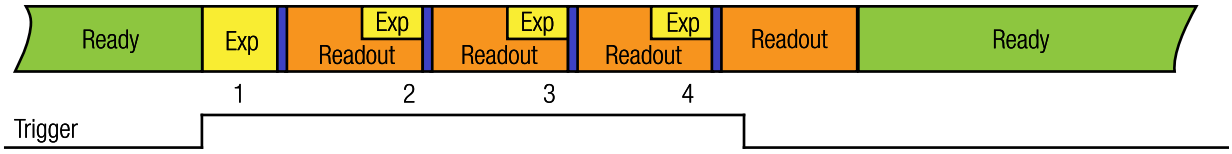


Figure 52: Triggered burst of frames – frame burst active

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

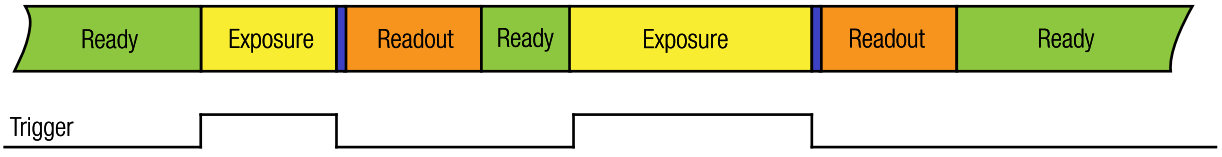


Figure 53: Exposure defined by trigger pulse length

Short interval shutter mode

Cameras based on the IMX530, IMX531, IMX532, IMX540, IMX541 and IMX542 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.

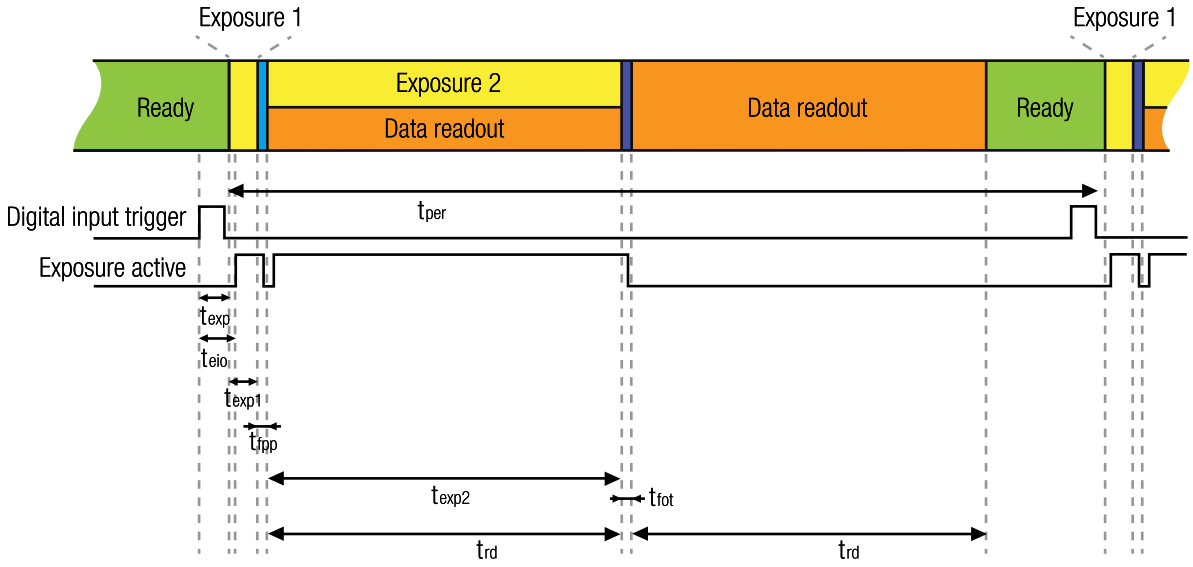


Figure 54: short interval shutter mode – triggered

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

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

Cameras based on the IMX530, IMX531, IMX532 sensors support Dual ADC readout modes. In these modes a single exposed frame can be read out twice via different readout channels resulting in two images with different analog gain settings. The high gain (HG) image has a lower readout noise and therefore offers better signal to noise ratio (SNR) in the low light regions of the scene. On the other hand, the low gain (LG) image offers higher SNR in the well illuminated regions of the scene as it utilizes the larger (or the whole) portion of the full well capacity.

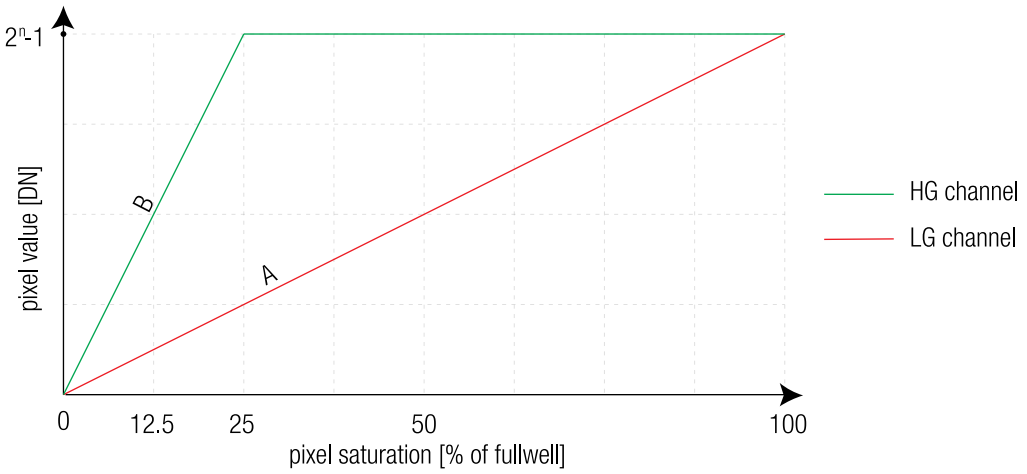


Figure 55: Dual ADC non-combined without merging

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 Non-combined mode

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's CPU and is optimized for processor's with x86 architecture.

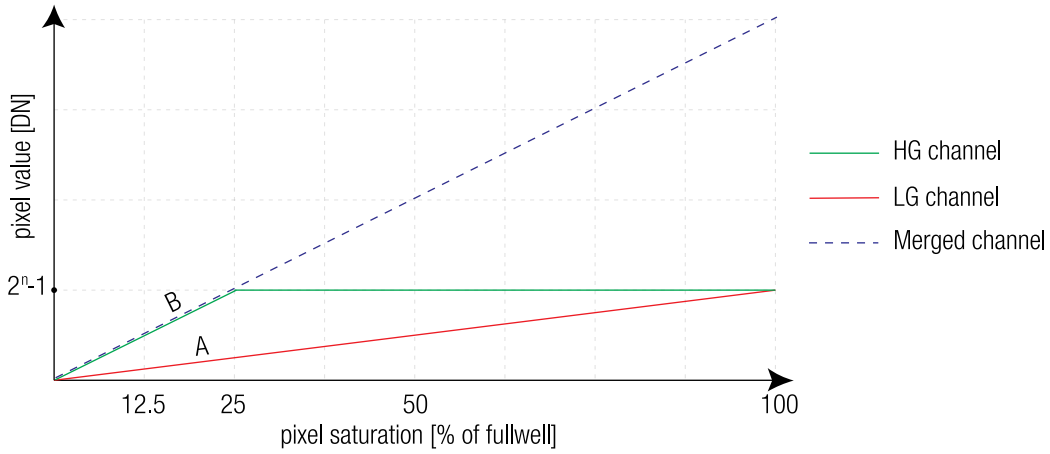


Figure 56: Dual ADC non-combined with merging

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);
```

3.5.2 Combined mode

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.

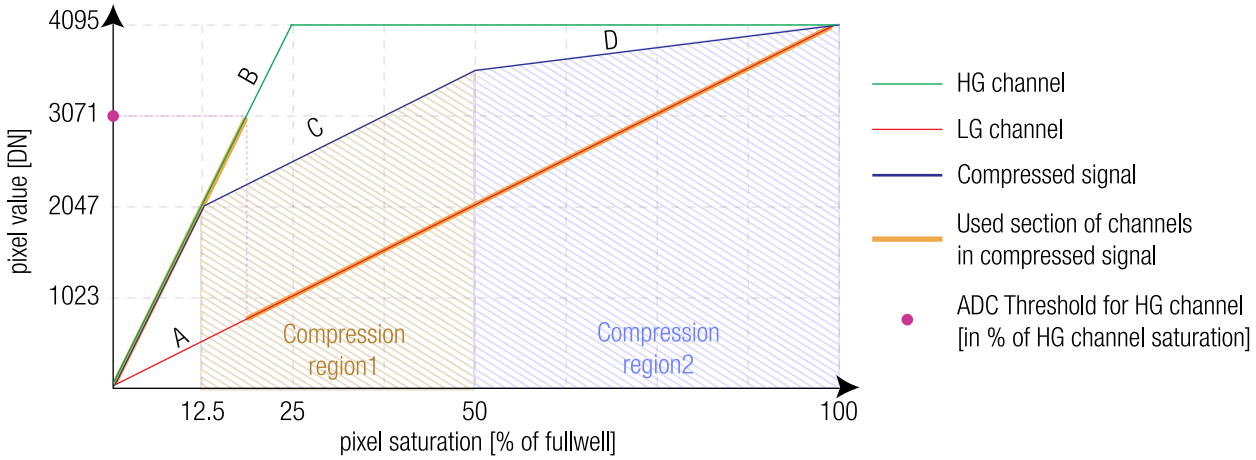


Figure 57: Dual ADC combined mode

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 12dB
// 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);
```

3.6 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.

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 page: API - Application Programming Interfaces

4.1.2 Hardware requirements

The XIMEA cameras are compatible with PCI express Generation 2 & 3.
Please note details and the most recent info at: PCI Express cameras

System configuration

Recommended system configuration:

For best processing performance and bandwidth, we recommend using the following system configuration. This is essential when using the higher resolution models for achieving maximum frame rate.

CPU:	Intel i7 or better
RAM:	8GB RAM or more
Disc Space:	400 MB of free disc space
Video:	NVIDIA or Radeon graphics card 128MB or integrated on CPU

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

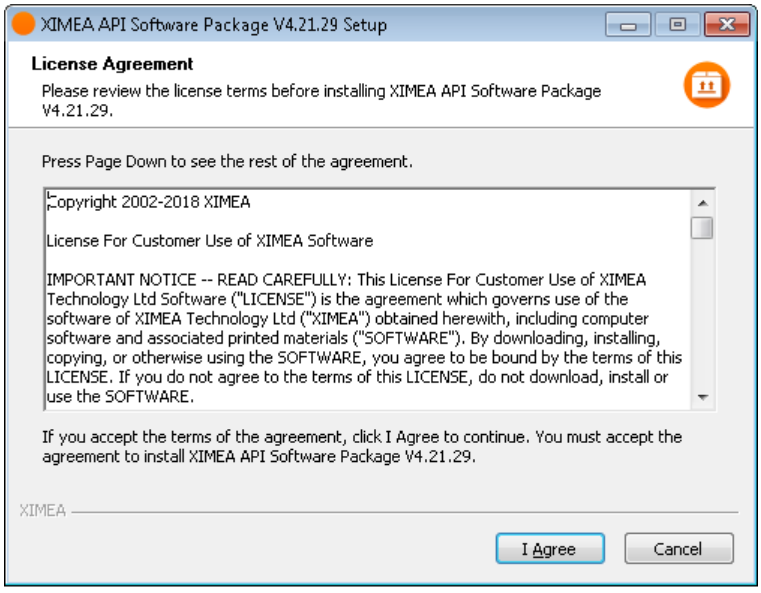
The package contains:

- 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

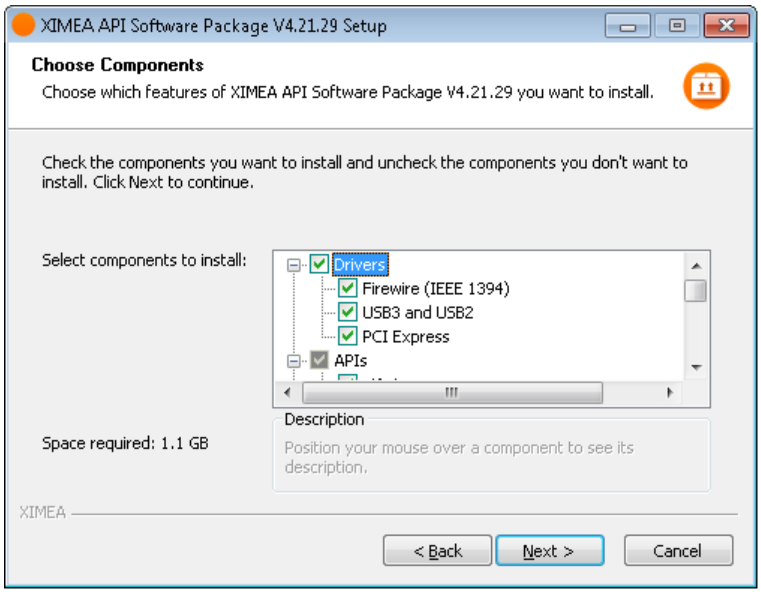
Installation

- 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

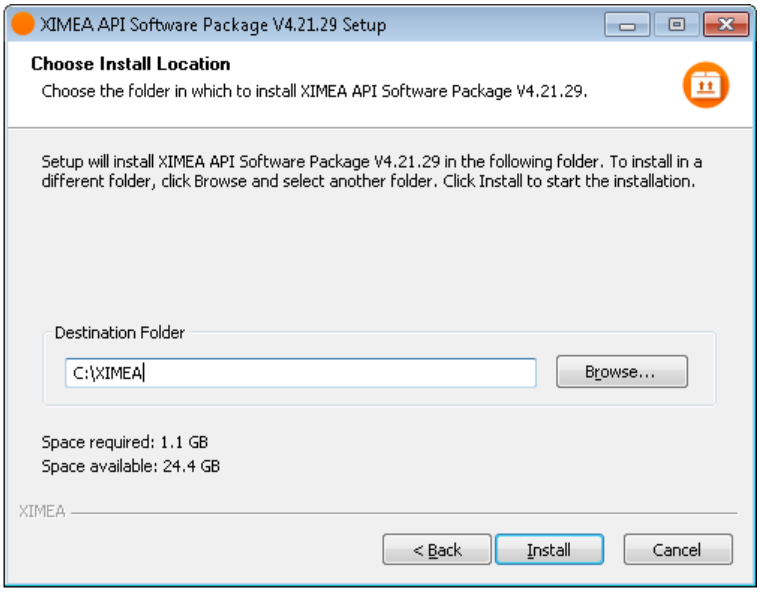
  Be sure that you have administrator privileges or start the Installer with administrator rights (right click and select “run as administrator”):



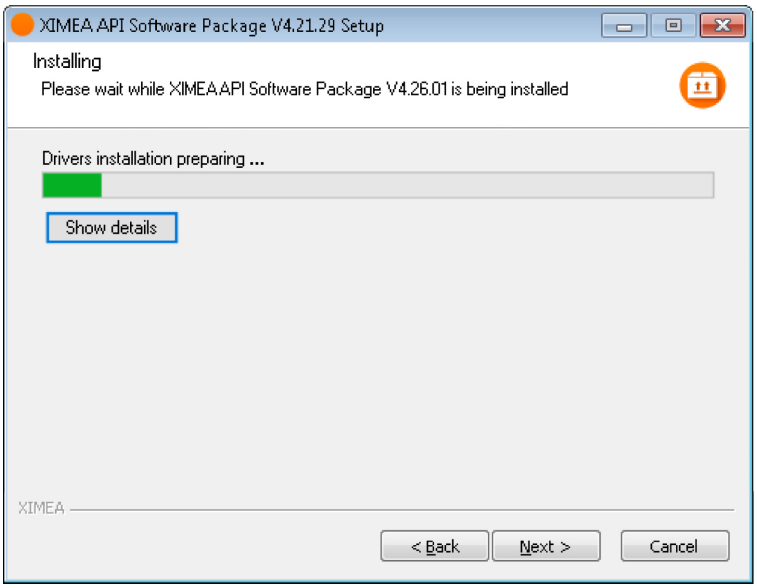
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



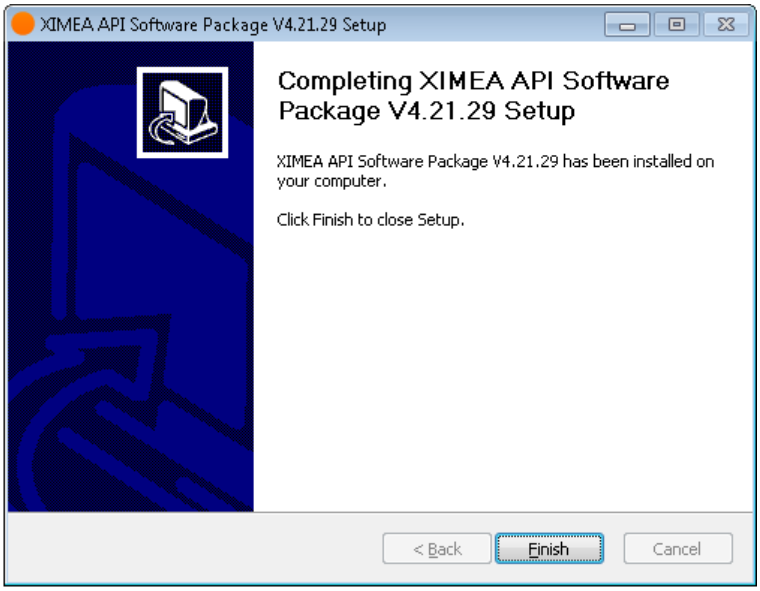
- Specify the install location - you can leave the default location or change it to your desired location



- 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

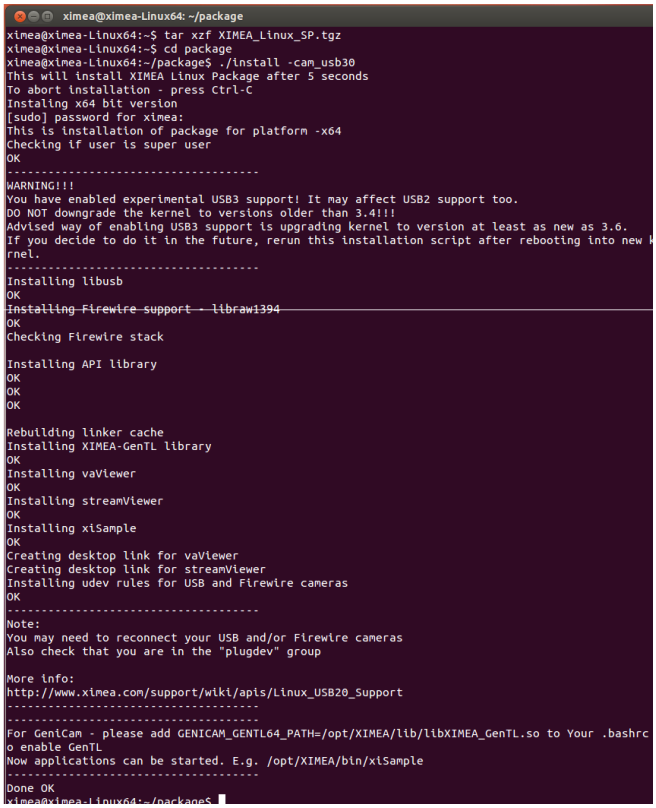
  ```
  wget http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz
  ```

- 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:

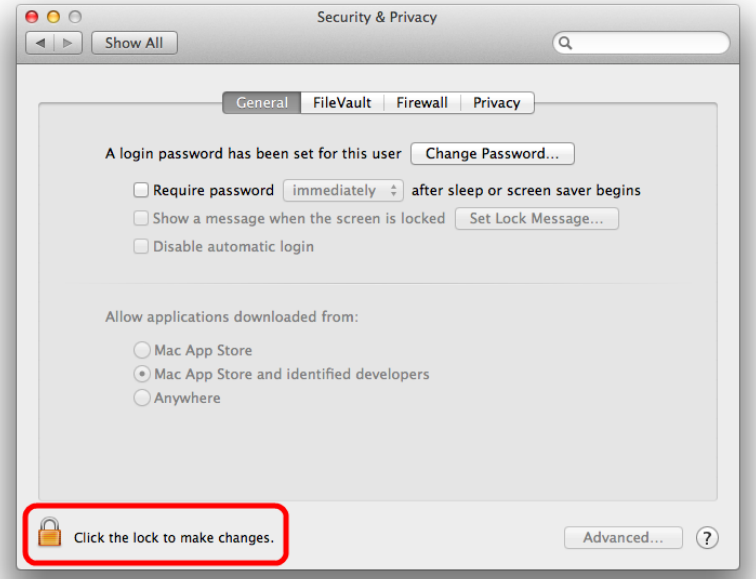
- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
  - xiSample - sample showing basic image acquisition in xiAPI

Installation

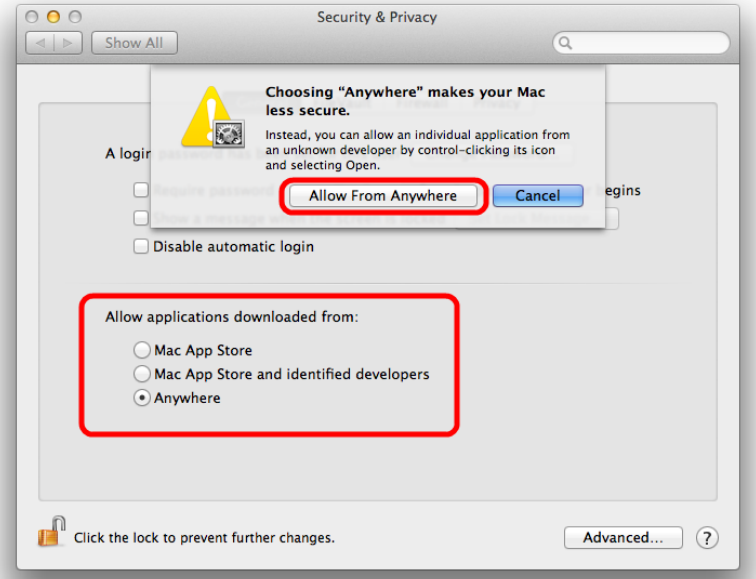
Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- 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:

  rhttp://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, refer to: CamTool

Figure 58: Camtool

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

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.

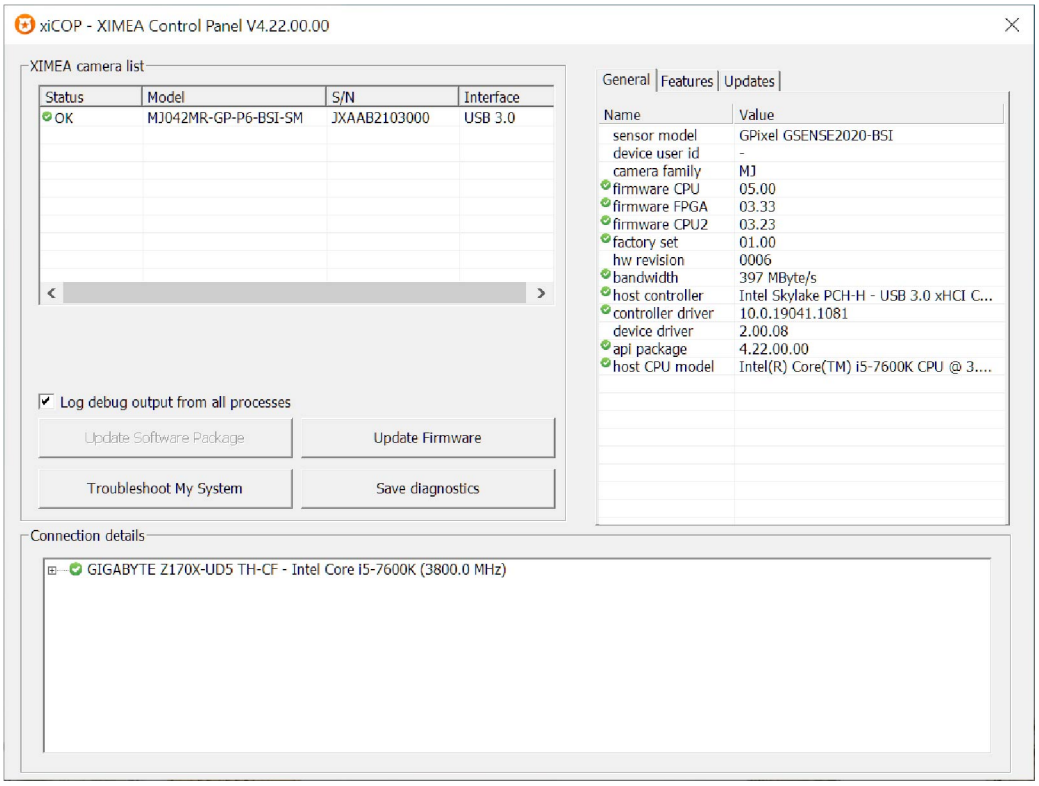


Figure 59: xiCOP example

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 web site:

http://www.ximea.com/support/projects/vision-libraries/wiki.

4.5.1 MathWorks MATLAB

MathWorks® is the leading developer and supplier of software for technical computing and Model-Based Design. More: http://www.mathworks.de/

https://www.ximea.com/support/wiki/vision-libraries/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 worldwide. More: http://www.mvtec.com/halcon/

https://www.ximea.com/support/wiki/vision-libraries/MVTec_HALCON

4.5.3 National Instruments LabVIEW vision library

LabVIEW is a graphical programming environment. More: http://www.ni.com/labview/

https://www.ximea.com/support/wiki/vision-libraries/National_Instruments_LabVIEW

4.5.4 OpenCV

OpenCV is an open-source library of programming functions mainly aimed at real time computer vision. More: https://opencv.org/

https://www.ximea.com/support/wiki/vision-libraries/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 http://www.emva.org/standards-technology/genicam/

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 http://www.ximea.com/support/wiki/apis/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.

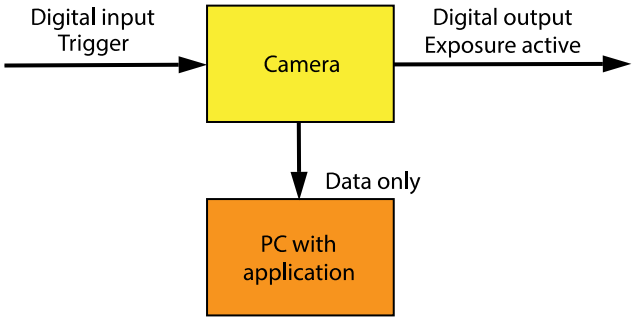


Figure 60: GPIO schematic

```
            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
  https://www.ximea.com/support/wiki/apis/XIMEA_Windows_Software_Package
- XIMEA Linux Software Package
  https://www.ximea.com/support/wiki/apis/XIMEA_Linux_Software_Package
- XIMEA macOS Software Package
  https://www.ximea.com/support/wiki/apis/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
  http://www.ximea.com/support/wiki/allprod/Frequently_Asked_Questions
- Knowledge Base
  http://www.ximea.com/support/wiki/allprod/Knowledge_Base

5.3 Product service request (PSR)

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

5.3.1 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 (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.

5.3.2 Step 2 – Create product service request (PSR)

- Read the XIMEA General Terms & Conditions at: http://www.ximea.com/en/corporate/generaltc
- Open the XIMEA Helpdesk at: https://desk.ximea.com/new-ticket
- Set field Department to “Service”
- Fill in all fields
- Confirm with the button “Submit”

5.3.3 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.

5.3.4 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.

5.3.5 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 37: service operations overview

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

5.3.6 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”.

5.4 Safety instructions and precautions

This chapter describes safety instructions and precautions valid for cameras. In order to avoid harm or damage your camera, please handle it as described in this manual, paying special attention to the following warnings:

5.4.1 Disassembly

There are no switches or parts inside the cameras that requires any kind of mechanical adjustment. Please note that the warranty is voided by opening the camera housing.

Do not disassemble the camera except removing lens mount (or removing cooling element if camera has one), see Lens mount.

5.4.2 Mounting / Screws

Use only the designated threaded holes for mounting the camera. Please note the camera / bracket drawings in chapter Mechanical characteristics.
Use only the specified screws and torques when fastening, see Mounting points.

5.4.3 Connections

Use only recommended connectors and cables. Please check the system requirements described in chapter System requirements.

5.4.4 Power supply

Use only the recommended electrical power supply. Camera can be bus powered or powered from external power supply, for detailed information see section Power supply .

5.4.5 Environment / protection against water

Use camera in acceptable environment only, please note the descriptions in section Environment. Protect the camera against contact with water. Do not let camera get wet.

Damage may be caused by:

- Overheating
- Contact with water
- Operation in an environment with condensing humidity
- Mechanical shock

5.4.6 Recommended light conditions

Do not expose the camera to light sources with intense energy, e.g. laser beams or X-ray.

Light intensity or exposure time exceeding the saturation of the sensor may damage the sensor irreparably. This may occur e.g. in the following situations:

- High-energy laser light hitting the sensor directly
- Bright light sources hitting the sensor directly (burn-in)
- Camera is exposed to X-rays

The warranty does not cover damaged cameras caused by X-ray applications or very high intensity light / laser light.

5.4.7 Protection of optical components

- Do not touch the optical components with hard or abrasive objects,
- when handling the camera, avoid touching the lenses and filter glasses,
- fingerprints or other impurities may affect the image quality and may damage the surfaces,
- mount / dismount lenses and additional filters only in a dust free environment.
- do not use compressed air as this could push dust into the camera (and lenses).

5.4.8 Mechanical loads

Avoid excessive shaking, throwing, dropping or any kind of mishandling of the device.

5.4.9 Camera / lens cleaning

- Use only optical quality tissue / cloth (dry cotton) a standard camera lens cleaning kit, if you must clean a lens or filter. Do not apply excessive force.
- Use only optics cleaner (e.g. 60 % ethyl alcohol, 40 % ether). Never use aggressive cleaners like gasoline or spirits. Such cleaners may destroy the surface.
- Do not use compressed air.

5.4.10 Protect against static discharge (ESD)

Image sensors and the PCB are easily damaged by static discharge (ESD).

- Please use anti-static gloves, clothes and materials. Also use conductive shoes.
- Wear an ESD protection wrist strap.
- Install a conductive mat on the floor and/or working table to prevent the generation of static electricity.

5.4.11 Safety instruction for board level cameras

Abuse or misapplication of the board level camera may result in limited warranty or cancelation of warranty. Due to the exposed electronics, special rules apply:

- Only qualified personnel are allowed to handle, install and operate the board level cameras.
- Board level cameras are delivered without housing. Handle the PCB and the sensor with care. Do not bend the boards. Do not touch the components or contacts on a board. Hold the board by its edges only.
- Protect the board level camera against static discharge (see Protect against static discharge (ESD) discharge (ESD)).
- Do not hold any components of your board level cameras against your clothing, even if you are wearing a wrist strap.
- Do not remove the board level camera from its anti-static packaging unless your body is grounded.
- To protect the boards from radiation of other modules or devices a housing or shielding may be required.
- Be sure that the board level camera has no contact to any electrical source before mounting or making connections to the board level camera.
- Do not connect or disconnect any cables or use the board level camera during an electrical storm.
- Avoid any mechanical forces to the board level cameras, especially torsional, tensile and compressive forces. Any of these forces may result in damage of the board level cameras.
- Always use clean boards.
- To protect the boards from dirt like dust or liquids always use the board level cameras in clean room environment or use a protective housing.

5.5 Warranty

In addition to the provisions of Article VIII of the Standard Terms & Conditions of XIMEA GmbH (see Standard Terms & Conditions of XIMEA GmbH) the following additions and specifications apply:

XIMEA warrants to the Original Purchaser that the Camera provided is guaranteed to be free from material and manufacturing defects for a period of two years. Should a unit fail during this period, XIMEA will, at its option, repair or replace the damaged unit. Repaired or replaced Products are covered for the remainder of the original Product warranty period.

Warranty is void if any proprietary labeling is removed. This warranty does not apply to units that, after being examined by XIMEA, have been found to have failed due to customer abuse, mishandling, alteration, improper installation or negligence. If the original camera module is housed within a case, removing the case for any purpose voids this warranty. This warranty does not apply to damage to any part of the optical path resulting from removal or replacement of the protective glass or filter over the camera, such as scratched glass or sensor damage. If the camera is disassembled, reworked or repaired by anyone other than a recommended service person, XIMEA or its suppliers will take no responsibility for the subsequent performance or quality of the camera.

XIMEA expressly disclaims and excludes all other warranties, express, implied and statutory, including, but without limitation, warranty of merchantability and fitness for a particular application or purpose. In no event shall XIMEA be liable to the Original Purchaser or any third party for direct, indirect, incidental, consequential, special or accidental damages, including without limitation damages for business interruption, loss of profits, revenue, data or bodily injury or death except in case of willful misconduct by XIMEA or employees of XIMEA.

5.5.1 Disclaimer of Warranty

In addition to the provisions of Article XII of the Standard Terms & Conditions of XIMEA GmbH (see Standard Terms & Conditions of XIMEA GmbH) the following apply:

Although XIMEA has taken care to ensure the accuracy of the information contained herein it accepts no responsibility for the consequences of any use thereof and also reserves the right to change the specification of goods without notice.

XIMEA does not assume any liability for damage that is the result of improper use of its products or failure to comply with the operating manuals or the applicable rules and regulations.

5.6 Standard Terms & Conditions of XIMEA GmbH

Printed here for your information is the version from May 2021. Please check the most current version at

XIMEA General Terms and Conditions

General Conditions
for the Supply of Products and Services of the Electrical and Electronics Industry ("Grüne Lieferbedingungen" – GL)*
for commercial transactions between businesses
recommended by ZVEI-Zentralverband Elektrotechnik- und Elektronikindustrie e. V.
as of January 2022 (with 24 months warranty period), and listed below

Article I: General Provisions

1. Legal relations between Supplier and Purchaser in connection with supplies and/or services of the Supplier (hereinafter referred to as "Supplies") shall be solely governed by the present GL. The Purchaser's general terms and conditions shall apply only if expressly accepted by the Supplier in writing. The scope of delivery shall be determined by the congruent mutual written declarations.

2. The Supplier herewith reserves any industrial property rights and/or copyrights and rights of use pertaining to its cost estimates, drawings and other documents (hereinafter referred to as "Documents"). The Documents shall not be made accessible to third parties without the Supplier's prior consent and shall, upon request, be returned without undue delay to the Supplier if the contract is not awarded to the Supplier. Sentences 1 and 2 shall apply mutatis mutandis to the Purchaser's Documents; these may, however, be made accessible to those third parties to whom the Supplier has rightfully subcontracted Supplies.

3. The Purchaser has the non-exclusive right to use standard software and firmware, provided that it remains unchanged, is used within the agreed performance parameters, and on the agreed equipment. Without express agreement the Purchaser may make one back-up copy of standard software.

4. Partial deliveries are allowed, unless they are unreasonable to accept for the Purchaser.

5. The term "claim for damages" used in the present GL also includes claims for indemnification for useless expenditure.

Article II: Prices, Terms of Payment, and Set-Off

1. Prices are ex works and excluding packaging; value added tax shall be added at the then applicable rate.

2. If the Supplier is also responsible for assembly or erection and unless otherwise agreed, the Purchaser shall pay the agreed remuneration and any incidental costs required, e. g. for traveling and transport as well as allowances.

3. Payments shall be made free Supplier's paying office.

4. The Purchaser may set off only those claims which are undisputed or non-appealable.

Article III: Retention of Title

1. The items pertaining to the Supplies ("Retained Goods") for which the purchase price claim is due immediately or for which a payment period of up to and including 30 days after delivery, delivery with installation/assembly or receipt of invoice has been agreed for the due date of the purchase price claim shall remain the property of the Supplier until payment has been made in total.

2. In all other cases, the items pertaining to the Supplies ("Retained Goods") shall remain the Supplier's property until each and every claim the Supplier has against the Purchaser on account of the business relationship has been fulfilled. If the combined value of the Supplier's security interests exceeds the value of all secured claims by more than 20 %, the Supplier shall release a corresponding part of the security interest if so requested by the Purchaser; the Supplier shall be entitled to choose which security interest it wishes to release.

3. For the duration of the retention of title, the Purchaser may not pledge the Retained Goods or use them as security, and resale shall be possible only for resellers in the ordinary course of their business and only on condition that the reseller receives payment from its customer or makes the transfer of property to the customer dependent upon the customer fulfilling its obligation to effect payment.

4. Should Purchaser resell Retained Goods, it assigns to the Supplier, already today, all claims it will have against its customers out of the resale, including any collateral rights and all balance claims, as security, without any subsequent declarations to this effect being necessary. If the Retained Goods are sold on together with other items and no individual price has been agreed with respect to the Retained Goods,

Purchaser shall assign to the Supplier such fraction of the total price claim as is attributable to the price of the Retained Goods invoiced by Supplier.

5. (a) Purchaser may process, amalgamate or combine Retained Goods with other items. Processing is made for Supplier. Purchaser shall store the new item thus created for Supplier, exercising the due care of a diligent business person. The new items are considered as Retained Goods.

(b) Already today, Supplier and Purchaser agree that if Retained Goods are combined or amalgamated with other items that are not the property of Supplier, Supplier shall acquire co-ownership in the new item in proportion of the value of the Retained Goods combined or amalgamated to the other items at the time of combination or amalgamation. In this respect, the new items are considered as Retained Goods.

(c) The provisions on the assignment of claims according to No. 4 above shall also apply to the new item. The assignment, however, shall only apply to the amount corresponding to the value invoiced by Supplier for the Retained Goods that have been processed, combined or amalgamated.

(d) Where Purchaser combines Retained Goods with real estate or movable goods, it shall, without any further declaration being necessary to this effect, also assign to Supplier as security its claim to consideration for the combination, including all collateral rights for the prorate amount of the value the combined Retained Goods have on the other combined items at the time of the combination.

6. Until further notice, Purchaser may collect assigned claims relating to the resale. Supplier is entitled to withdraw Purchaser's permission to collect funds for good reason, including, but not limited to delayed payment, suspension of payments, start of insolvency proceedings, protest or justified indications for overindebtedness or pending insolvency of Purchaser. In addition, Supplier may, upon expiry of an adequate period of notice disclose the assignment, realize the claims assigned and demand that Purchaser informs its customer of the assignment.

7. The Purchaser shall inform the Supplier forthwith of any seizure or other act of intervention by third parties. If a reasonable interest can be proven, Purchaser shall, without undue delay, provide Supplier with the information and/or Documents necessary to assert the claims it has against its customers.

8. Where the Purchaser fails to fulfill its duties, fails to make payment due, or otherwise violates its obligations the Supplier shall be entitled to rescind the contract and take back the Retained Goods in the case of continued failure following expiry of a reasonable remedy period set by the Supplier; the statutory provisions providing that a remedy period is not needed shall be unaffected. The Purchaser shall be obliged to return the Retained Goods. The fact that the Supplier takes back Retained Goods and/or exercises the retention of title, or has the Retained Goods seized, shall not be construed to constitute a rescission of the contract, unless the Supplier so expressly declares.

Article IV: Time for Supplies; Delay

1. Times set for Supplies shall only be binding if all Documents to be furnished by the Purchaser, necessary permits and approvals, especially concerning plans, are received in time and if agreed terms of payment and other obligations of the Purchaser are fulfilled. If these conditions are not fulfilled in time, times set shall be extended reasonably; this shall not apply if the Supplier is responsible for the delay.

2. If non-observance of the times set is due to:

(a) force majeure, such as mobilization, war, terror attacks, rebellion or similar events (e. g. strike or lockout);

(b) virus attacks or other attacks on the Supplier's IT systems occurring despite protective measures were in place that complied with the principles of proper care;

(c) hindrances attributable to German, US or otherwise applicable national, EU or international rules of foreign trade law or to other circumstances for which Supplier is not responsible; or

(d) the fact that Supplier does not receive its own supplies in due time or in due form such times shall be extended accordingly.

3. If the Supplier is responsible for the delay (hereinafter referred to as "Delay") and the Purchaser has demonstrably suffered a loss therefrom, the Purchaser may claim a compensation as liquidated damages of 0.5 % for every completed week of Delay, but in no case more than a total of 5 % of the price of that part of the Supplies which due to the Delay could not be put to the intended use.

4. Purchaser's claims for damages due to delayed Supplies as well as claims for damages in lieu of performance exceeding the limits specified in No. 3 above are excluded in all cases of delayed Supplies, even upon expiry of a time set to the Supplier to effect the Supplies. This shall not apply in cases of liability based on intent, gross negligence, or due to loss of life, bodily injury or damage to health. Rescission of the contract by the Purchaser based on statute is limited to cases where the Supplier is responsible for the delay. The above provisions do not imply a change in the burden of proof to the detriment of the Purchaser.

5. At the Supplier's request, the Purchaser shall declare within a reasonable period of time whether it, due to the delayed Supplies, rescinds the contract or insists on the delivery of the Supplies.

6. If dispatch or delivery, due to Purchaser's request, is delayed by more than one month after notification of the readiness for dispatch was given, the Purchaser may be charged, for every additional month commenced, storage costs of 0.5 % of the price of the items of the Supplies, but in no case more than a total of 5 %. The parties to the contract may prove that higher or, as the case may be, lower storage costs have been incurred.

Article V: Passing of Risk

1. Even where delivery has been agreed freight free, the risk shall pass to the Purchaser as follows:

(a) if the delivery does not include assembly or erection, at the time when it is shipped or picked up by the carrier. Upon the Purchaser's request, the Supplier shall insure the delivery against the usual risks of transport at the Purchaser's expense;

(b) if the delivery includes assembly or erection, at the day of taking over in the Purchaser's own works or, if so agreed, after a successful trial run.

2. The risk shall pass to the Purchaser if dispatch, delivery, the start or performance of assembly or erection, the taking over in the Purchaser's own works, or the trial run is delayed for reasons for which the Purchaser is responsible or if the Purchaser has otherwise failed to accept the Supplies.

Article VI: Assembly and Erection

Unless otherwise agreed in written form, assembly and erection shall be subject to the following provisions:

1. Purchaser shall provide at its own expense and in due time:

(a) all earth and construction work and other ancillary work outside the Supplier's scope, including the necessary skilled and unskilled labor, construction materials and tools;

(b) the equipment and materials necessary for assembly and commissioning such as scaffolds, lifting equipment and other devices as well as fuels and lubricants;

(c) energy and water at the point of use including connections, heating and lighting;

(d) suitable dry and lockable rooms of sufficient size adjacent to the site for the storage of machine parts, apparatus, materials, tools, etc. and adequate working and recreation rooms for the erection personnel, including sanitary facilities as are appropriate in the specific circumstances; furthermore, the Purchaser shall take all measures it would take for the protection of its own possessions to protect the possessions of the Supplier and of the erection personnel at the site;

(e) protective clothing and protective devices needed due to particular conditions prevailing on the specific site.

2. Before the erection work starts, the Purchaser shall unsolicitedly make available any information required concerning the location of concealed electric power, gas and water lines or of similar installations as well as the necessary structural data.

3. Prior to assembly or erection, the materials and equipment necessary for the work to start must be available on the site of assembly or erection and any preparatory work must have advanced to such a degree that assembly or erection can be started as agreed and carried out without interruption. Access roads and the site of assembly or erection must be level and clear.

4. If assembly, erection or commissioning is delayed due to circumstances for which the Supplier is not responsible, the Purchaser shall bear the reasonable costs incurred for idle times and any additional traveling expenditure of the Supplier or the erection personnel.

5. The Purchaser shall attest to the hours worked by the erection personnel towards the Supplier at weekly intervals and the Purchaser shall immediately confirm in written form if assembly, erection or commissioning has been completed.

6. If, after completion, the Supplier demands acceptance of the Supplies, the Purchaser shall comply therewith within a period of two weeks. The same consequences as upon acceptance arise if and when the Purchaser lets the two-week period expire or the Supplies are put to use after completion of agreed test phases, if any.

Article VII: Receiving Supplies

The Purchaser shall not refuse to receive Supplies due to minor defects.

Article VIII: Defects as to Quality

The Supplier shall be liable for defects as to quality ("Sachmängel", hereinafter referred to as "Defects",) as follows:

1. The Supplies are free from Defects if upon the passing of the risk they comply with the subjective requirements, the objective requirements and the installation requirements pursuant to Sec. 434 German Civil Code ("Bürgerliches Gesetzbuch"). 2 If the parties have agreed on the quality of the Supplies ("Beschaffenheitsvereinbarung"), the question whether the Supplies meet the objective requirements shall be determined exclusively by such agreement. 3 Sentence 2 shall not apply if the last contract in the supply chain is a sale of consumer goods.

2. Defective parts or defective services shall be, at the Supplier's discretion, repaired, replaced or provided again free of charge, provided that the reason for the Defect had already existed at the time when the risk passed.

3. Claims for repair or replacement are subject to a statute of limitations of 24 months calculated from the start of the statutory statute of limitations; the same shall apply mutatis mutandis in the case of rescission and reduction. This shall not apply: - where longer periods are prescribed by law according to Sec. 438 para. 1 No. 2 (buildings and things used for a building), and Sec. 634a para. 1 No. 2 (defects of a building) German Civil Code ("Bürgerliches Gesetzbuch"),

- in the case of intent,
- in the case of fraudulent concealment of the Defect or
- non-compliance with guaranteed characteristic ("Beschaffenheitsgarantie").

Claims for the reimbursement of expenses on the part of the Purchaser in accordance with Sec. 445a BGB (entrepreneur's right of recourse) shall likewise be subject to a statute of limitations of 24 months from the start of the statutory statute of limitations, provided the last contract in the supply chain is not a sale of consumer goods.

4. The legal provisions regarding suspension of the statute of limitations ("Ablaufhemmung", "Hemmung") and recommencement of limitation periods shall be unaffected. The suspension of the statute of limitations according to Sec. 445b para. 2 BGB (limitation of right of recourse) shall in any case end no later than 5 years after the date on which the Supplier delivered the concerned item to the seller. This shall not apply if the last contract in the supply chain is a sale of consumer goods or in cases that are according to No. 3 Sentence 2 above.

5. Notifications of Defect by the Purchaser shall be given in written form without undue delay.

6. In the case of claims for Defects, the Purchaser may withhold payments to an amount that is in a reasonable proportion to the Defect. The Purchaser has no right to withhold payments to the extent that its claim of a Defect is time-barred. Unjustified notifications of Defect shall entitle the Supplier to demand reimbursement of its expenses by the Purchaser.

7. The Supplier shall be given the opportunity to repair or to replace the defective good ("Nacherfüllung") within a reasonable period of time.

8. If repair or replacement is unsuccessful, the Purchaser is entitled to rescind the contract or reduce the remuneration; any claims for damages the Purchaser may have according to No. 10 shall be unaffected.

9. There shall be no claims based on Defect in cases of insignificant deviations from the agreed quality, of only minor impairment of usability, of natural wear and tear, or damage arising after the passing of risk from faulty or negligent handling, excessive strain, unsuitable equipment, defective civil works, inappropriate foundation soil, or claims based on particular external influences not assumed under the contract, or from non-reproducible software errors. Claims based on defects attributable to improper modifications, installation/ removal, or repair work carried out by the Purchaser or third parties and the consequences thereof are likewise excluded.

10. The Purchaser shall have no claim with respect to expenses incurred in the course of supplementary performance, to the extent that expenses are increased because the subjectmatter of the Supplies has subsequently been brought to another location than the Purchaser's branch office, unless doing so complies with the normal use of the Supplies. This applies accordingly to claims for the reimbursement of expenses on the part of the Purchaser in accordance with Sec. 445a BGB (entrepreneur's right of recourse), provided the last contract in the supply chain is not a sale of consumer goods.

11. The Purchaser's right of recourse against the Supplier pursuant Sec. 445a BGB (entrepreneur's right of recourse) is limited to cases where the Purchaser has not concluded an agreement with its customers exceeding the scope of the statutory provisions governing claims based on Defects.

12. The Purchaser shall have no claim for damages based on Defects. This shall not apply to the extent that a Defect has been fraudulently concealed, the guaranteed characteristics are not complied with, in the case of loss of life, bodily injury or damage to health, and/or intentionally or grossly negligent breach of contract on the part of the Supplier. The above provisions do not imply a change in the burden of proof to the detriment of the Purchaser. Any other or additional claims of the Purchaser exceeding the claims provided for in this Article VIII, based on a Defect, are excluded.

Article IX: Industrial Property Rights and Copyrights; Defects in Title

1. Unless otherwise agreed, the Supplier shall provide the Supplies in the country of the place of delivery only, without infringing any third-party industrial property rights and copyrights (hereinafter referred to as "IPR"). If a third party asserts a justified claim against the Purchaser based on an infringement of an IPR by the Supplies made by the Supplier and used in conformity with the contract, the Supplier shall be liable to the Purchaser within the time period stipulated in Article VIII No. 2 as follows:

(a) The Supplier shall choose whether to acquire, at its own expense, the right to use the IPR with respect to the Supplies concerned or whether to modify the Supplies such that they no longer infringe the IPR or replace them. If this would be impossible for the Supplier under reasonable conditions, the Purchaser may rescind the contract or reduce the remuneration pursuant to the applicable statutory provisions;

(b) The Supplier's liability to pay damages is governed by Article XII;

(c) The above obligations of the Supplier shall apply only if the Purchaser (i) immediately notifies the Supplier of any such claim asserted by the third party in written form, (ii) does not concede the existence of an infringement and (iii) leaves any protective measures and settlement negotiations to the Supplier's discretion. If the Purchaser stops using the Supplies in order to reduce the damage or for other good reason, it shall be obliged to point out to the third party that no acknowledgement of the alleged infringement may be inferred from the fact that the use has been discontinued.

2. Claims of the Purchaser shall be excluded if it is responsible for the infringement of an IPR.

3. Claims of the Purchaser are also excluded if the infringement of the IPR is caused by specifications made by the Purchaser, by a type of use not foreseeable by the Supplier or by the Supplies being modified by the Purchaser or being used together with products not provided by the Supplier.

4. In addition, with respect to claims by the Purchaser pursuant to No. 1 a) above, Article VIII Nos. 4, 5, 8, and 9 shall apply mutatis mutandis in the event of an infringement of an IPR.

5. Where other defects in title occur, Article VIII shall apply mutatis mutandis.

6. Any other claims of the Purchaser against the Supplier or its agents or any such claims exceeding the claims provided for in this Article IX, based on a defect in title, are excluded.

Article X: Conditional Performance

1. The performance of this contract is conditional upon that no hindrances attributable to German, US or otherwise applicable national, EU or international rules of foreign trade law or any embargos or other sanctions exist.

2. The Purchaser shall provide any information and Documents required for export, transport and import purposes.

Article XI: Impossibility of Performance; Adaptation of Contract

1. To the extent that delivery is impossible, the Purchaser is entitled to claim damages, unless the Supplier is not responsible for the impossibility. The Purchaser's claim for damages is, however, limited to an amount of 10 % of the value of the part of the Supplies which, owing to the impossibility, cannot be put to the intended use. This limitation shall not apply in the case of liability based on intent, gross negligence or loss of life, bodily injury or damage to health; this does not imply a change in the burden of proof to the detriment of the Purchaser. The Purchaser's right to rescind the contract shall be unaffected.

2. Where events within the meaning of Article IV No. 2 (a) to (c) substantially change the economic importance or the contents of the Supplies or considerably affect the Supplier's business, the contract shall be adapted taking into account the principles of reasonableness and good faith. To the extent this is not justifiable for economic reasons, the Supplier shall have the right to rescind the contract. The same applies if required export permits are not granted or cannot be used. If the Supplier intends to exercise its right to rescind the contract, it shall notify the Purchaser thereof without undue delay after having realized the repercussions of the event; this shall also apply even where an extension of the delivery period has previously been agreed with the Purchaser.

Article XII: Other Claims for Damages

1. Unless otherwise provided for in the present GL, the Purchaser has no claim for damages based on whatever legal reason, including infringement of duties arising in connection with the contract or tort.

2. This does not apply if liability is based on:

(a) the German Product Liability Act (“Produkthaftungsgesetz”);

(b) intent;

(c) gross negligence on the part of the owners, legal representatives or executives;

(d) fraud;

(e) failure to comply with a guarantee granted;

(f) negligent injury to life, limb or health; or

(g) negligent breach of a fundamental condition of contract (“wesentliche Vertragspflichten”).

However, claims for damages arising from a breach of a fundamental condition of contract shall be limited to the foreseeable damage which is intrinsic to the contract, provided that no other of the above case applies.

3. The above provision does not imply a change in the burden of proof to the detriment of the Purchaser.

Article XIII: Venue and Applicable law

1. If the Purchaser is a businessman, sole venue for all disputes arising directly or indirectly out of the contract shall be the Supplier’s place of business. However, the Supplier may also bring an action at the Purchaser’s place of business.

2. This contract and its interpretation shall be governed by German law, to the exclusion of the United Nations Convention on contracts for the International Sale of Goods (CISG).

Article XIV: Severability Clause

The legal invalidity of one or more provisions of this Agreement in no way affects the validity of the remaining provisions. This shall not apply if it would be unreasonably onerous for one of the parties to be obligated to continue the contract.

5.7 List of Trademarks

XIMEA, xiC, xiQ, xiMU, xiB, xiB-64, xiX, xiX-XL, xiX-Xtreme, xSWITCH, xPLATFORM, xEC, xEC2, xiCool, xiRAY, xiCe, xiSpec, xiFLY, xiD, xiJ, xiLAB, xiAPI, xiCamTool, xiCOP and CURRERA are trademarks or registered trademarks of XIMEA GmbH in Germany, Slovakia, USA and other countries.

Microsoft, Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Apple, the Apple logo, Macintosh, MacOS, OS X, Bonjour, the Bonjour logo and the Bonjour symbol are trademarks of Apple Computer, Inc.

Linux is a trademark of Linus Torvalds. Th e USB3 Vision is trademark owned by the AIA.

All other brands, service provision brands and logos referred to are brands, service provision brands and logos belonging to their respective owners.

5.8 Copyright

Glossary

ADC	Analog to Digital Converter 6, 20, 21, 22, 23, 64
API	Application Programming Interface 61
CMOS	Complementary Metal-Oxide-Semiconductor 9, 20, 21, 22, 23, 63
DSNU	Dark Signal Non-Uniformity 20, 21, 22, 23
ESD	Electrostatic discharge 6, 33, 87
FPGA	Field Programmable Gate Array 58
FPS	Frame Per Second 60
PCB	Printed Circuit Board (same as PWB) 87
PRNU	Photo Response Non-Uniformity 20, 21, 22, 23
PSR	Product Service Request 6, 85
ROI	Region Of Interest 58
SDK	Software Development Kit 9
SNR	Signal to Noise (Ratio) 20, 21, 22, 23

List of Figures

List of Tables

XIMEA GmbH
Am Mittelhafen 16 • 48155 Münster • Germany • www.ximea.com