ximea

xiMU

[ksi-mjuː] or [sai-mjuː]

• MU003TG-SY-UC Time of Flight Camera

XIMEA Cameras •
Technical Manual •
Version v260408 •

Introduction

About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

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

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

This document is subject to change without notice.

About XIMEA

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

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

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

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

Contact XIMEA

XIMEA is a worldwide operating company

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Standard conformity

Camera Sub-Assemblies

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

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

RoHS conformity

Figure 1: Standard conformity RoHS logo

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

WEEE conformity

Figure 2: Standard conformity WEEE logo

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

GenICam GenTL API

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

Disclaimer

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

Helpful links

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

Contents

1 xiMU camera series

1.1 What is MU003TG-SY-UC

The xiMU ToF camera is based on the Sony IMX556 time-of-flight sensor. This sensor is sensitive in both the visible (VIS) and near-infrared (NIR) spectrum.

Each pixel of the sensor is internally composed of two charge storage nodes (commonly referred to as A and B halves). During operation, the incoming light signal is distributed between these two halves in synchronisation with the modulation/control signal that is typically used to drive the illumination source. This synchronized operation enables phase-based signal separation required for time-of-flight measurements.

From the interface perspective, it is possible to access the original pixel data. Depending on the selected configuration, the sensor can output:

- Only pixel A
- Only pixel B
- Both A and B as two separate images
- A combined result such as A + B or A - B

This means that RAW image data can be obtained directly from the sensor interface. A dedicated TOF plugin in our xiCamtool viewer application enables the calculation and visualization of depth maps.

Because the sensor is also sensitive to visible light, it is technically possible to capture a standard grayscale image using the same device. However, the sensor architecture and illumination scheme are optimized primarily for time-of-flight measurements. Simultaneously acquiring high-quality depth data and high-quality VIS imaging typically requires different exposure conditions, illumination characteristics, and optical filtering. Operating the system in a configuration intended to provide both outputs at the same time may therefore result in reduced performance or image quality for one or both data streams.

For applications that require both precise depth measurement and high-quality visible imaging, it is recommended to use a standard camera in addition to the ToF camera.

Data transfer, camera control, and power supply are handled via a USB 3 interface using a Micro-Coaxial I-PEX Cabline SS connector.

The camera has also Micro-Coaxial I-PEX Cabline V connector for connection to VCSEL-based illumination subsystems. This connector supports control, and high-speed signaling required for synchronized illumination operation. The camera module itself does not integrate the illumination unit or a band-pass filter.

Please note that to obtain image data suitable for reliable depth calculation, a properly matched illumination source and lens assembly with an appropriate narrow band-pass optical filter are required. These external components can be necessary to achieve sufficient signal quality and ambient light suppression.

The camera is supplied as standard with an integrated C-mount lens adapter and can alternatively be provided with an integrated S-mount lens adapter to support different optical requirements.

1.2 Camera applications

- Robotics
- Industrial automation
- Machine vision
- Autonomous systems
- Logistics and warehousing
- Smart manufacturing
- Human-machine interaction
- Safety and monitoring systems
- Automotive sensing
- Spatial mapping and measurement
- Smart infrastructure
- Security systems
- Consumer electronics
- Research and development

1.3 Model nomenclature

MUxxxyT-ZZ[-OPT]

MU: xiMU family name

xxx: resolution in 0.1 Mpx. e.g. 4.2 Mpx Resolution: xxx = 042

y: Color sensing
T: Time of Flight (ToF)

T: Sensor technology
G: Global shutter

ZZ: Vendor of the sensor
SY: Sony

[-OPT]: Connector options / additional information
UC: USB 3.1 Gen1 microCoax connector

1.4 Models and sensors overview

Camera model	Sensor model	Sensor type	Filter	Resolution [px]	Pixel size [µm]
MU003TG-SY-UC	Sony IMX556	Time-of-Flight	None	640 × 480	10

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

1.5 Accessories overview

Item P/N	Description
CBL-U3-PSD-UC-0M10	Cable IPEX Cabline-SS 14-14 Pos. TL100mm 50 Ohm AWG40 1:1
CBL-U3-PSD-UC-0M25	Cable IPEX Cabline-SS 14-14 Pos. TL250mm 50 Ohm AWG40 1:1
CBL-U3-PSD-UC-0M50	Cable IPEX Cabline-SS 14-14 Pos. TL500mm 45 Ohm AWG38 1:1
CBL-U3-PSD-UC-1M0	Cable IPEX Cabline-SS 14-14 Pos. TL1000mm 45 Ohm AWG38 1:1
CBL-IPEX-EQ-10P-0M15	Cable IPEX-EQ Cabline V 10-10 Pos. TL150mm 50 Ohm AWG40 1:1
CBL-0151340401	Power cable between VCSEL-SLIM-W and XS-5P-U3-UC-TC, 4 pos. PicoBlade 100 mm
VCSEL-SLIM-W	VCSEL-EGA2000-850-W SLIM Illumination Board SubAssembly[1]
ADPT-U3-UC-U3-UB	Adapter board to connect USB3 camera featuring microCoax interface
XS-5P-U3-UC-TC	Multi-functional USB hub, downstream 5x microCoax, upstream USB Type-C
MECH-XS-5P-BASE-N	Base platform for modular vision systems
MQ-BRACKET-T	xiQ series tripod mounting bracket, 5.5 mm thick
MQ-BRACKET-T-THICK	xiQ series tripod mounting bracket, 9.5 mm thick

[1] Power cable to barrel connector for VCSEL-SLIM-W (CBL-PB4-PWR-0M15) is included in the product

Table 2: xiMU ToF accessories

The XIMEA ToF camera can be integrated as the core component of a modular vision system that may be expanded with additional components such as optical cameras, lenses, VCSEL illumination, USB hubs, and mechanical accessories (mounts, coolers, plates, etc.), as illustrated in the image below.

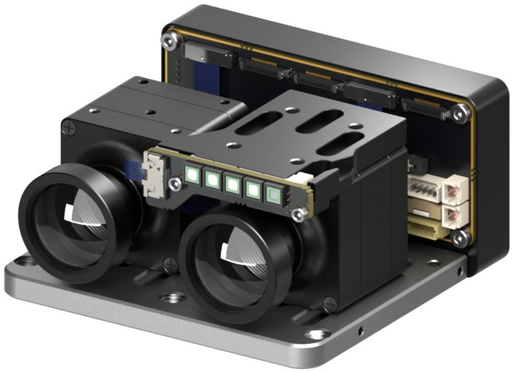


Figure 3: Example of ToF modular system

1.6 Camera connection diagram

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

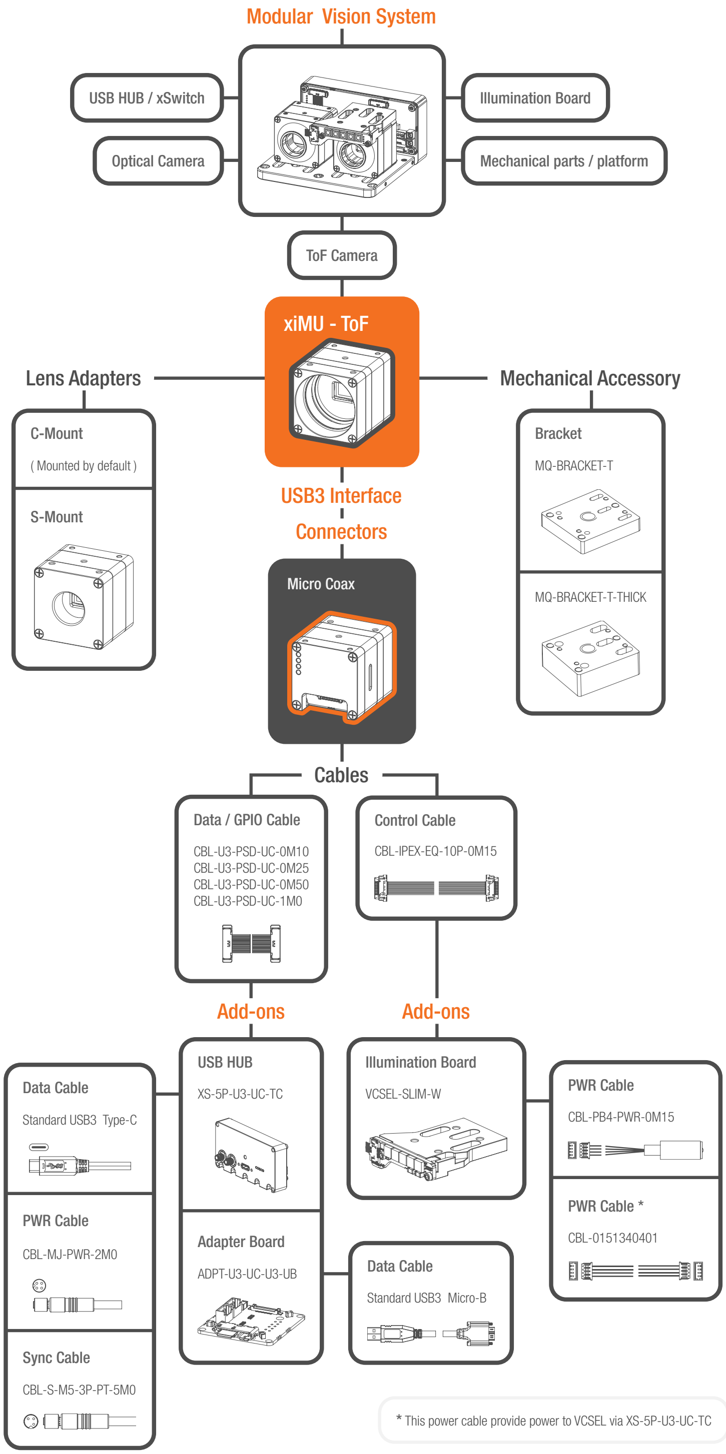


Figure 4: Diagram of accessories and specific connections for the ToF camera

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
5 V	0.45 W	1.80 W	2.00 W

[1]Supported voltage 4.5 - 5.5V; Camera only (illumination power excluded)

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

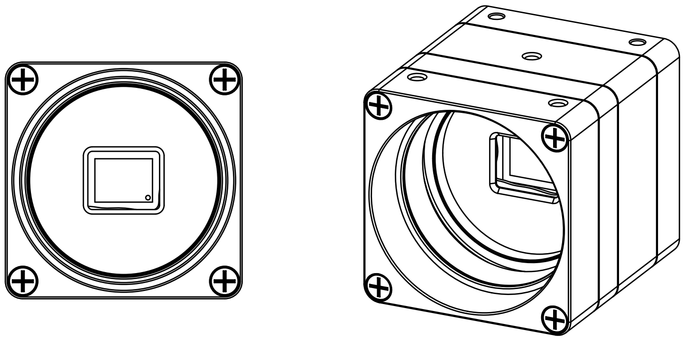


Figure 5: Lens mount adapter C-mount

The xiMU ToF camera includes a C-mount lens adapter as part of its standard configuration.

2.3.2 S-mount

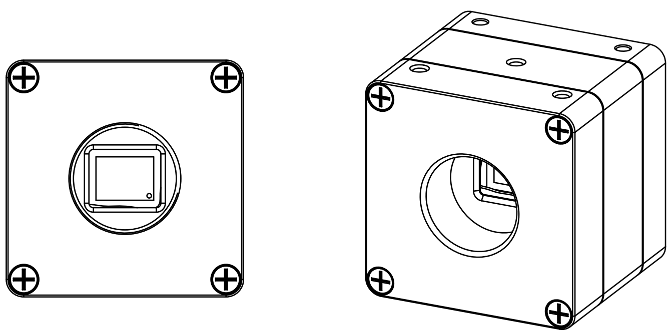


Figure 6: Lens mount adapter S-mount

The xiMU ToF camera can be supplied with an integrated S-mount lens adapter. Please contact the XIMEA Support team for further information. Please note that the camera depth with the S-mount is 23.67 mm (compared to 28.67 mm for the standard C-mount configuration)

2.4 Mounting points

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

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

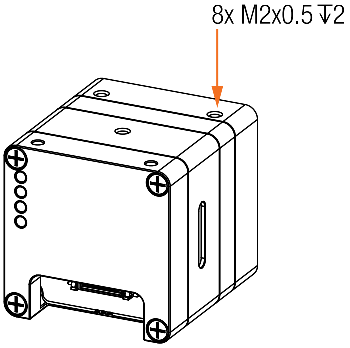


Figure 7: ToF camera mounting points

2.4.1 M2 Mounting screws

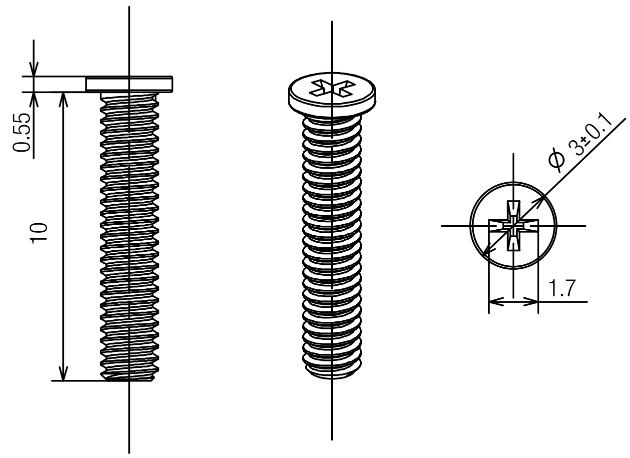


Figure 8: M2 mounting screws

Item	Material	Surface	Thread	Driver	Avail. lengths
Value	Steel	Black zinc	M2	PH 00	3 to 24 mm

Table 5: M2 screw description

Never exceed a maximum torque of 0.3 N m when fastening the M2 mounting screws.

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)

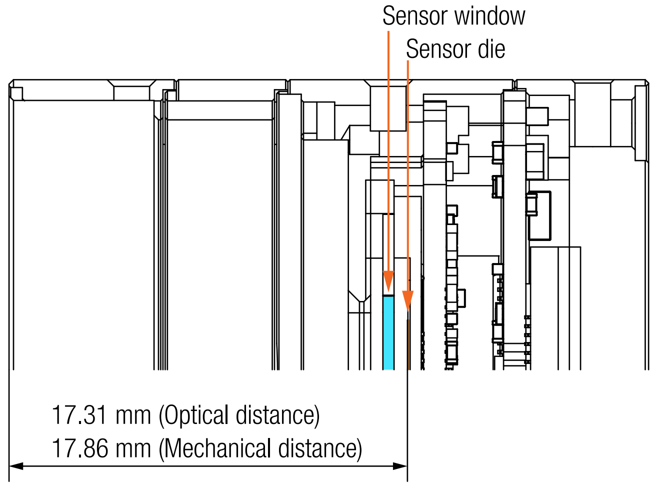


Figure 9: Cross section of MU003TG-SY-UC

Sensor window	Value
Thickness	0.5 mm
Distance to from the top of sensor window to sensor die	1.1 mm (+/- 0.2 mm)

Table 6: Sensor window details

2.6 Sensor and camera characteristics

2.6.1 Sensor and camera parameters

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

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	640 x 480	[px]
Active area size (H X V)	6.4 x 4.8	[mm]
Sensor diagonal	8.0	[mm]
Pixel size (H x V)	10 x 10	[μm]

Table 7: Sensor parameters of the specific models

2.6.2 Image quality parameters

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

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

Mode		A	A + B	B
ADC resolution	[bit]	12	12	12
Saturation capacity	[ke-]	138.29	271.82	134.54
Dynamic range	[dB]	64.78	67.72	64.62
SNR Max	[dB]	51.51	54.44	51.34
Gain 1/K	[e-/DN]	92.14	90.86	91.27
Median read noise	[e-]	79.35	111.28	78.57
DSNU	[e-]	1162.73	1716.06	1152.79
PRNU	[%]	5.88	4.56	5.73
Linearity	[%]	1.59	1.4	1.27
Camera parameters				
Exposure time (EXP)	[µs]		0.25 to 1000	
Refresh rate (MMR)	[fps]	60	60	60

Table 8: Image quality parameters of the specific models

2.6.3 Sensor read-out modes

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

Sensor Read-out modes of:
all models in this manual (refer to the table Models and sensors overview)

TOF mode	TOF phases	Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	Phases per second	Frame rate[1]
A / B / A-B / A+B	1 / 2 / 4	1 x 1	12	640 x 480	12	60 / 120 / 240	60.0
A / B / A-B / A+B	1 / 2 / 4	Bin.2 x 2	12	320 x 240	12	60 / 120 / 240	60.0
A / B / A-B / A+B	1 / 2 / 4	Bin.4 x 4	12	160 x 120	12	60 / 120 / 240	60.0
A&B	1 / 2 / 4	1 x 1	12	640 x 480	12	60 / 120 / 200	60.0 / 50.0
A&B	1 / 2 / 4	Bin.2 x 2	12	320 x 240	12	60 / 120 / 240	60.0
A&B	1 / 2 / 4	Bin.4 x 4	12	160 x 120	12	60 / 120 / 240	60.0

[1] Frame rate was tested using the transport format at Frame rate limit 60 FPS.

Table 9: Sensor read-out modes of the specific models

2.6.4 Quantum efficiency curves

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

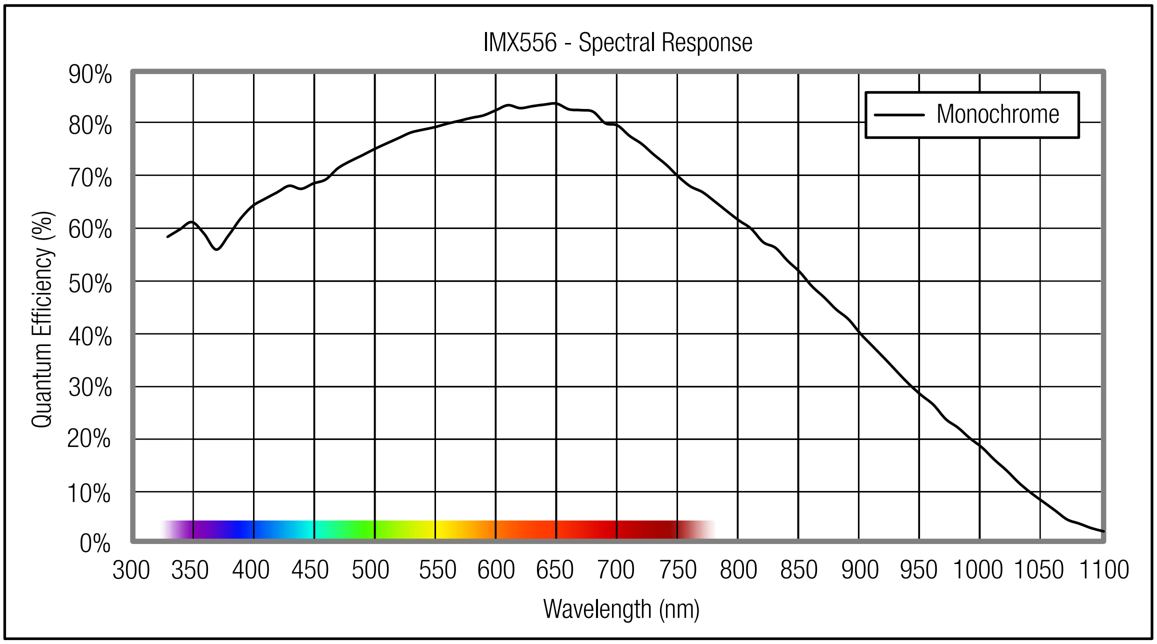


Figure 10: Graph quantum efficiency of Sony IMX556

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

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

Width [W]	Height [H]	Depth [D]	Mass[1] [M]
26.4 mm	26.4 mm	28.67 mm	31 g

[1] without adapters

Table 10: 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)

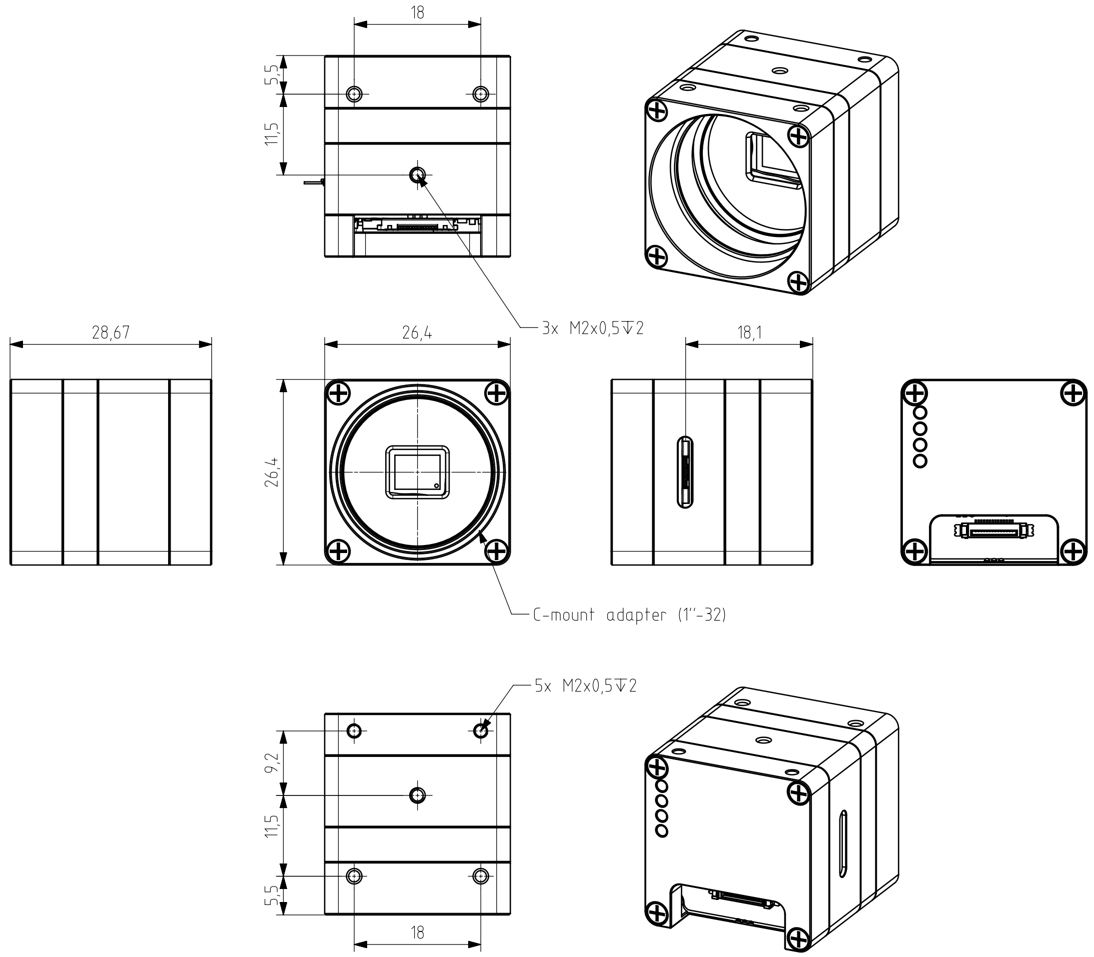


Figure 11: Dimensional drawing of MU003TG-SY-UC with C-mount

2.8 User interface – LEDs

LED	Color	Defaults	Note
1	Red	On	User configurable
2	Green	Off	User configurable
3	Blue	Off	User configurable
4	Orange	Off	User configurable

Table 11: LED output description during camera power up

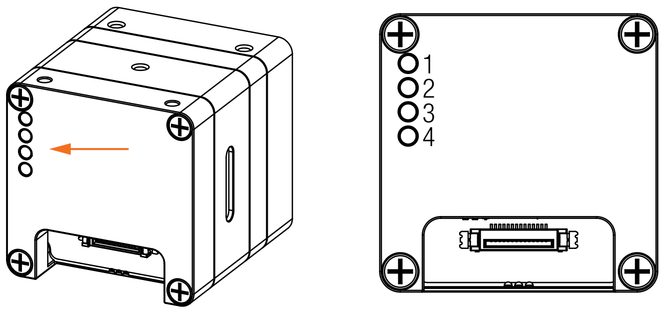


Figure 12: Position of LEDs on ToF camera

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

Status	LED1	LED2	LED3	LED4
OFF	Off	Off	Off	Off
Power	Off	Off	On	On
Boot up finished	Off	Off	Off	On

Table 12: LED statuses during boot sequence

2.9 Camera interface

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

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

2.9.1 Micro-Coaxial Cabline SS connector

The USB 3.1 Micro-Coaxial connector is used for data transfer, camera control and power, also -UC MU camera has two in-outs (GPIO) available through the same Micro-Coaxial connector (see section Digital inputs / outputs (GPIO) interface for pinout description).

Item	Value
Connector	CONN I-PEX Cabline SS Micro Coax Cable Receptacle, 14-position (CONN-20374-R14E-31)
Signals	USB 3.1 Gen1 (SuperSpeed), USB 2.0, Power, I/O
Mating Connector	Cable-side I-PEX Cabline SS 14-position plug
Mating Cable	XIMEA PN: CBL-U3-PSD-UC-0M10, CBL-U3-PSD-UC-0M25,CBL-U3-PSD-UC-1M0

Table 13: Micro-Coaxial Cabline SS connector general description

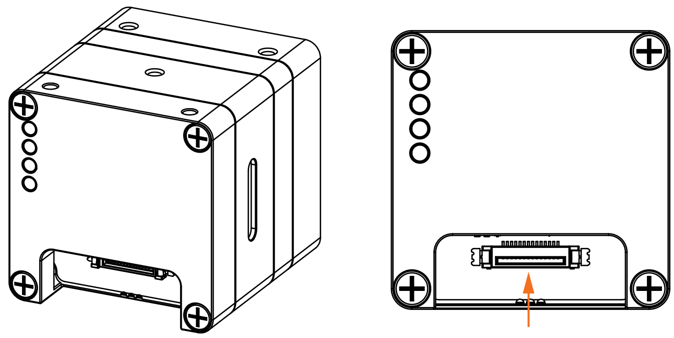


Figure 13: Micro-Coaxial Cabline SS connector location

2.9.2 Micro-Coaxial Cabline V connector

The I-PEX Cabline V micro-coax connector is a compact, high-density interface used for illumination subsystems. It provides a 5 V power supply, high-speed LVDS differential signals for VCSEL switching, and a low-speed I2C bus for telemetry and illumination control. This connector is used to connect a VCSEL (vertical-cavity surface-emitting laser)-based illumination board (e.g. VCSEL-SLIM-W).

Item	Value
Connector	CONN I-PEX Cabline V Micro Coax Cable Receptacle, 10-position (CONN-20347-310E-12R)
Signals	Power (5 V), High-speed LVDS, Low-speed I2C
Mating Connector	Cable side IPEX-EQ Cabline V 10-10 Pos micro-coax plug
Mating Cable	CBL-IPEX-EQ-10P-0M15

Table 14: Micro-Coaxial I-PEX Cabline V connector general description

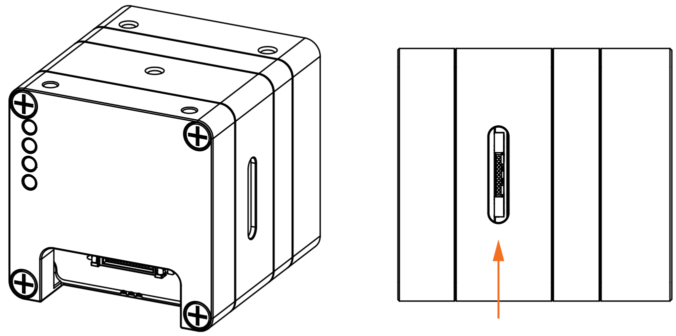


Figure 14: Micro-Coaxial I-PEX Cabline V connector location

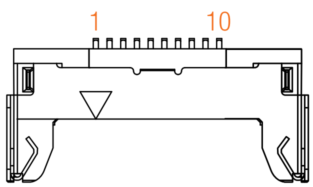


Figure 15: Micro-Coaxial I-PEX Cabline V connector pinning

Pin	Name	Type
1	VCC5V0	Power for the driver circuitry and telemetric ICs
2	None	None
3	LED_p	High speed LVDS switching signal for illumination (VCSEL)
4	LED_n	High speed LVDS switching signal for illumination (VCSEL)
5	I2C_SDA	Low speed communication bus for telemetrics and illumination adjustment
6	I2C_SCL	Low speed communication bus for telemetrics and illumination adjustment
7	None	None
8	None	None
9	None	None
10	VCC5V0	Power for the driver circuitry and telemetric ICs

Table 15: Micro-Coaxial Cabline V connector pin assignment

2.10 Digital inputs / outputs (GPIO) interface

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

Item	Value
Connector	CONN I-PEX Cabline SS Micro Coax Cable Receptacle, 14-position (CONN-20374-R14E-31)
Signals	USB 3.1 Gen1 (SuperSpeed), USB 2.0, Power, I/O
Mating Connector	Cable-side I-PEX Cabline SS 14-position plug
Mating Cable	XIMEA PN: CBL-U3-PSD-UC-0M10, CBL-U3-PSD-UC-0M25,CBL-U3-PSD-UC-1M0

Table 16: Micro-Coaxial Cabline SS connector general description

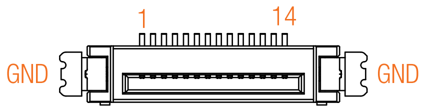


Figure 16: IO connector pinning

Pin	Name	GPI/GPO index API	Type
1	VBUS	None	Power input
2	VBUS	None	Power input
3	INOUT2	2/2	Non-isolated digital lines - Digital Input-Output 3.3 V logic (INOUT)
4	OUT2	-/4	Non-isolated Digital Output (OUT)
5	SSRX+	None	SuperSpeed receiver differential pair
6	SSRX-	None	SuperSpeed receiver differential pair
7	D+	None	USB 2.0 differential pair
8	D-	None	USB 2.0 differential pair
9	SSTX+	None	SuperSpeed transmitter differential pair
10	SSTX-	None	SuperSpeed transmitter differential pair
11	INOUT1	1/1	Non-isolated digital lines - Digital Input-Output 3.3 V logic (INOUT)
12	OUT1	-/3	Non-isolated Digital Output (OUT)
13	VBUS	None	Power input
14	VBUS	None	Power input
	GND		Ground

Table 17: I/O connector pin assignment

2.10.1 Non-isolated Digital Output (OUT)

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

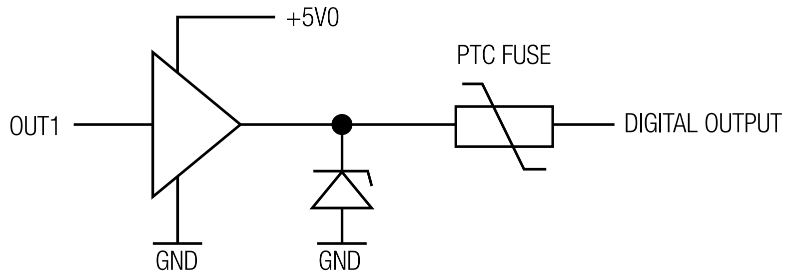


Figure 17: Non-isolated digital output, interface schematic

Item	Parameter	Note[1]
Common pole	YES	None
Effects when withdrawing/inserting input module under power	May damage camera electronics	None
Protection	ESD and short circuit[2]	None
Maximal output sink current	20 mA	None
Inductive loads	NO	None
Output Level logical 0	< 0.8 V	Load 100 kΩ
Output Level logical 1	> 4.5 V	Load 100 kΩ
Output delay - rising edge	< 20 ns	Load 100 kΩ treshold 1.5 V
Output delay - falling edge	< 20 ns	Load 100 kΩ treshold 0.5 V

[1] Note that the GPO signals are routed through unidirectional level translators, therefore High Impedance GPO mode setting is not supported
[2] ESD HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV, CDM JESD22-C101E exceeds 1000 V

Table 18: General info for non-isolated digital output

2.10.2 Non-isolated digital lines - Digital Input-Output 3.3 V logic (INOUT)

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

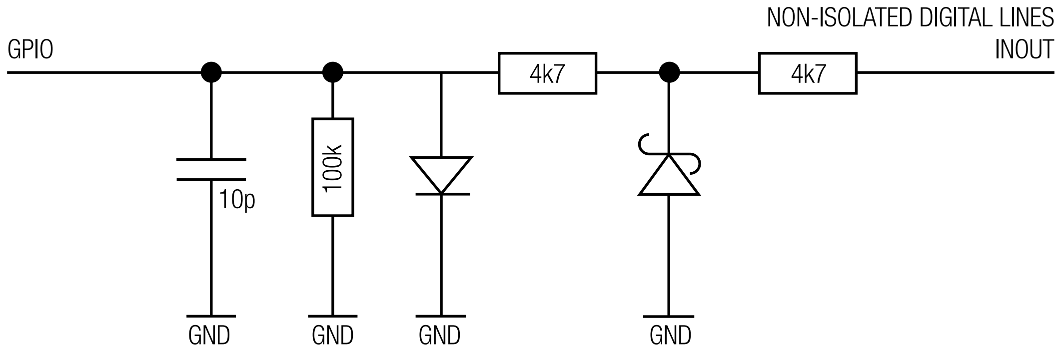


Figure 18: Non-isolated digital input/output, interface schematic

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	Reverse voltage	None
Input Impedance- minimum	15 kΩ	None
Input Level for logical 0	< 0.3 V	None
Input Level for logical 1	> 1.3 V	None
Input debounce filter	NO	None
Input delay - rising edge	300 ns	VINPUT=2 V
Input delay - falling edge	450 ns	VINPUT=2 V

Table 19: General info for non-isolated digital in/out trigger lines

2.11 Accessories

2.11.1 CBL-U3-PSD-UC-0M10 / CBL-U3-PSD-UC-0M25 / CBL-U3-PSD-UC-0M50 / CBL-U3-PSD-UC-1M0

This is a USB 3.1 Gen1 Micro-Coaxial cable with a length of 0.10 m / 0.25 m / 0.5 m / 1 m, designed for use with xiMU and xiC cameras. Micro-Coax cable features an I-PEX Cabline SS 14-position connector and uses AWG38 wires for USB 3 data, 5 V power supply, and GPIOs. The cable is highly flexible and easy to route, and it allows triggering and output signaling from the camera.

Figure 19: CBL-U3-PSD-UC-xM

2.11.2 CBL-IPEX-EQ-10P-0M15

CBL-IPEX-EQ-10P-0M15 is an I-PEX EQ Cabline V cable with a 10-position to 10-position configuration. The cable is intended for connecting VCSEL-based illumination boards such as VCSEL-SLIM-W to the camera.

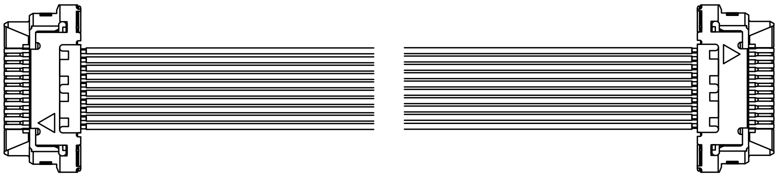


Figure 20: CBL-IPEX-EQ-10P-0M15

2.11.3 VCSEL-SLIM-W

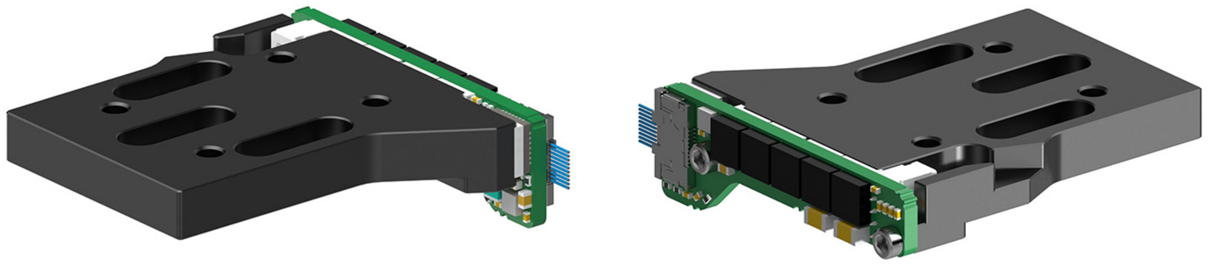


Figure 21: Isometric view of VCSEL-SLIM-W

The VCSEL-SLIM-W is a Vertical-Cavity Surface-Emitting Laser (VCSEL) illumination board designed for use with XIMEA ToF cameras, providing controlled illumination required for time-of-flight depth sensing. The power cable CBL-PB4-PWR-0M15 for supplying the VCSEL-SLIM-W is delivered together with the illumination board.

VCSEL type:

- EGA2000-850-W Industrial High-Power Flood Illuminator

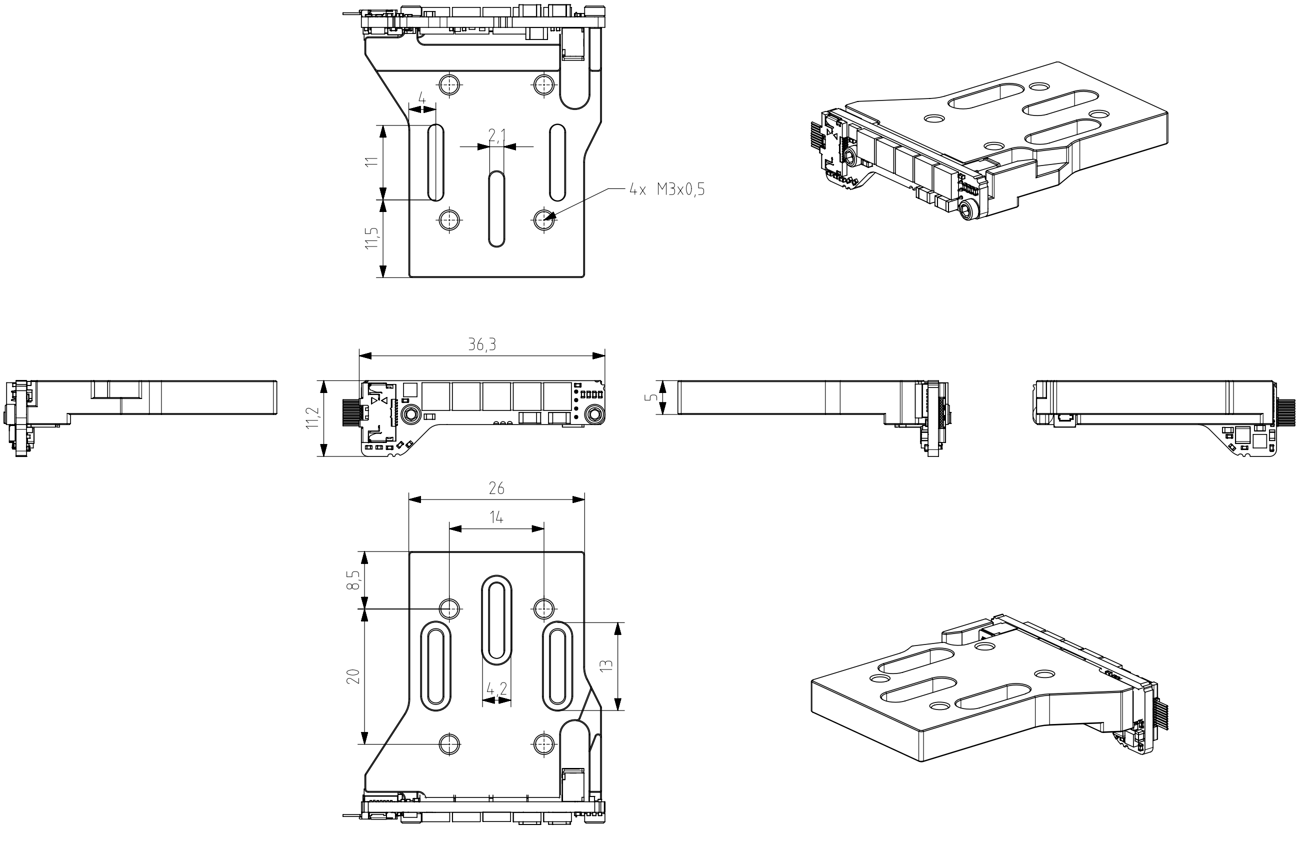


Figure 22: Dimensional drawing of VCSEL-SLIM-W

2.11.4 XS-5P-U3-UC-TC

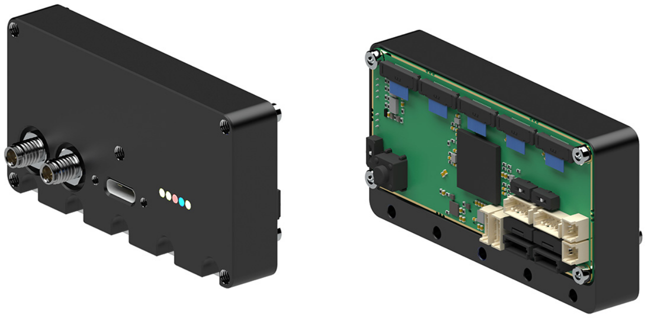


Figure 23: Isometric view of XS-5P-U3-UC-TC

XS-5P-U3-UC-TC is multi-functional USB hub featuring five downstream-facing USB 3 Micro Coax connectors and one upstream-facing USB 3.2 Gen1 (5 Gbps) Type-C connector. The USB hub includes five configurable LEDs for status indication, as well as a dedicated power and I/O connector that supports synchronization functions.

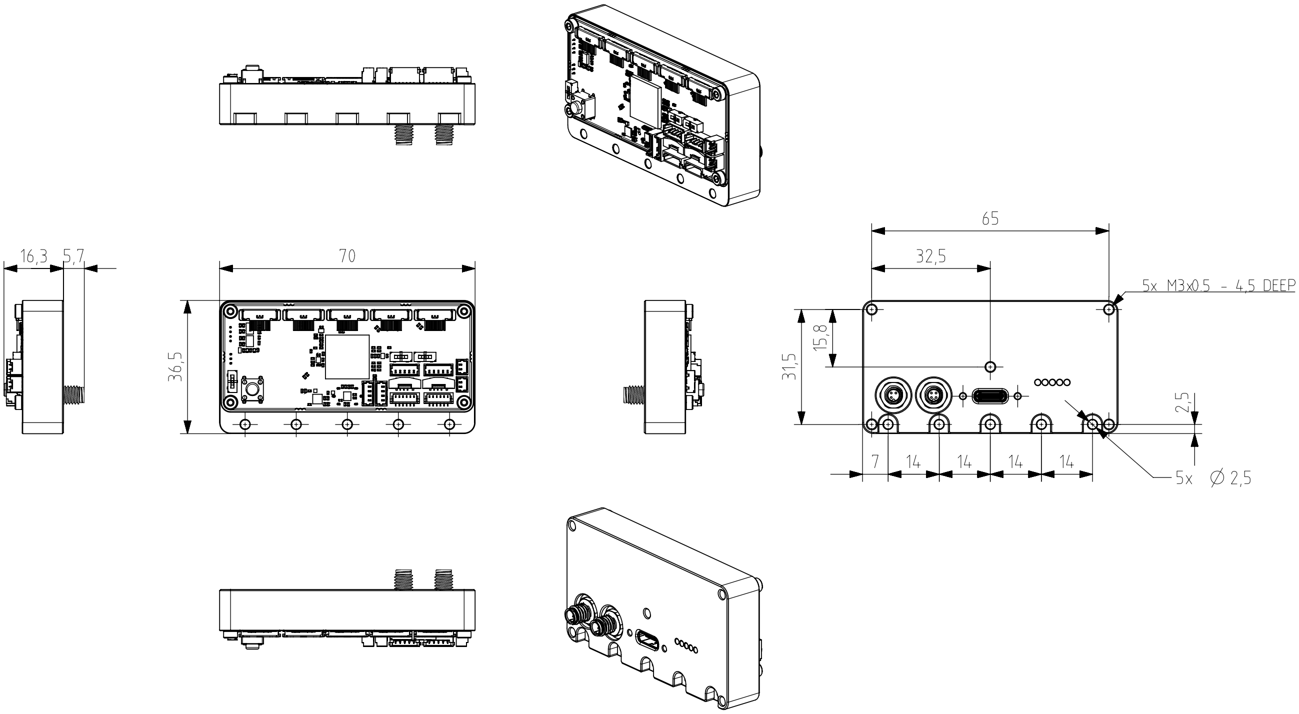


Figure 24: Dimensional drawing of XS-5P-U3-UC-TC

XS-5P-U3-UC-TC USB HUB can be used toghether with VCSEL-SLIM-W as part of a modular vision systems. In this case VCSEL can be powered via USB HUB with CBL-0151340401 power cable. Power connector for VCSEL is located on the image below.

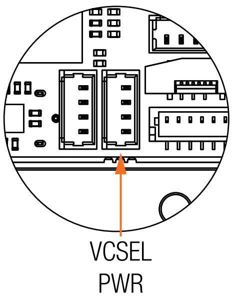


Figure 25: VCSEL power connector location on XS-5P-U3-UC-TC

2.11.5 MECH-XS-5P-BASE-N

Figure 26: Isometric view of MECH-XS-5P-BASE-N

Base platform for modular vision systems. Mounting holes on the side of the platform are designed to mount the XS-5P-U3-UC-TC USB hub.

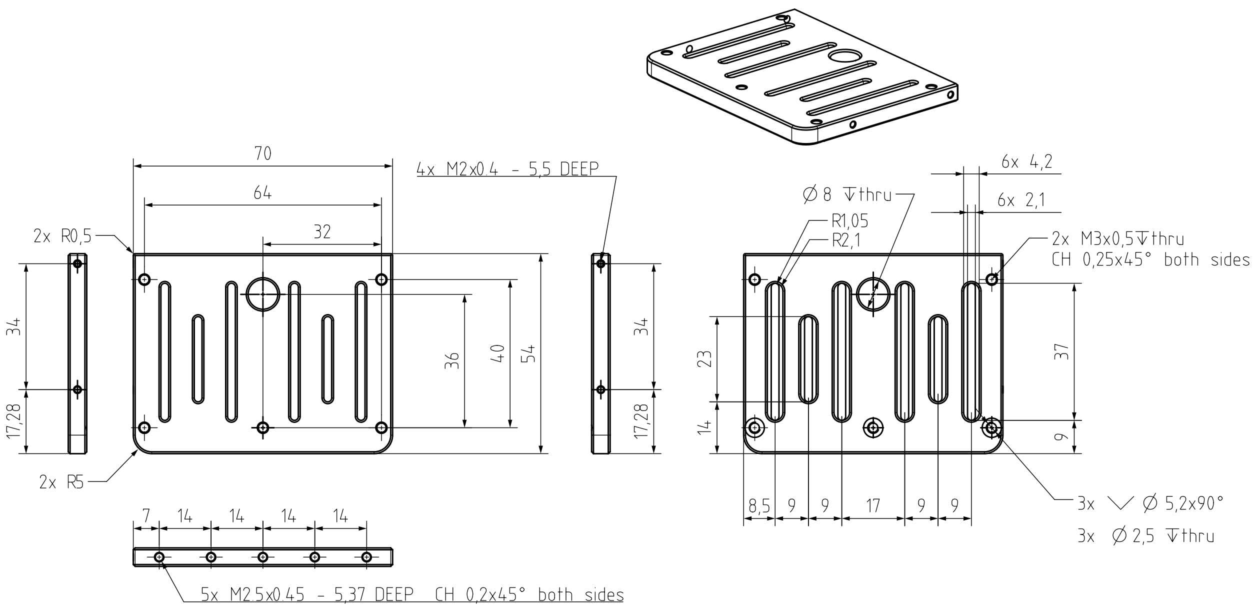


Figure 27: Dimensional drawing of MECH-XS-5P-BASE-N platform

Width [W]	Height [H]	Depth [D]	Mass [M]
70 mm	54 mm	5 mm	49 g

Table 20: Parameters of MECH-XS-5P-BASE-N

2.11.6 ADPT-U3-UC-U3-UB

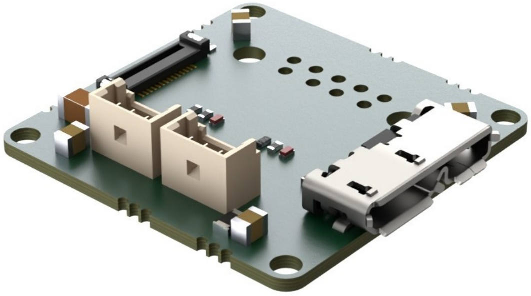


Figure 28: Isometric view of ADPT-U3-UC-U3-UB

This breakout board adapter converts Micro-Coax to Micro USB 3 Type-B. ADPT-U3-UC-U3-UB is suitable for xiMU and xiC cameras and features a Micro-B connector for standard USB 3 cables, as well as GPIO pins for synchronization.

The standard product does not include a USB-A connector, but this is available as a custom option.

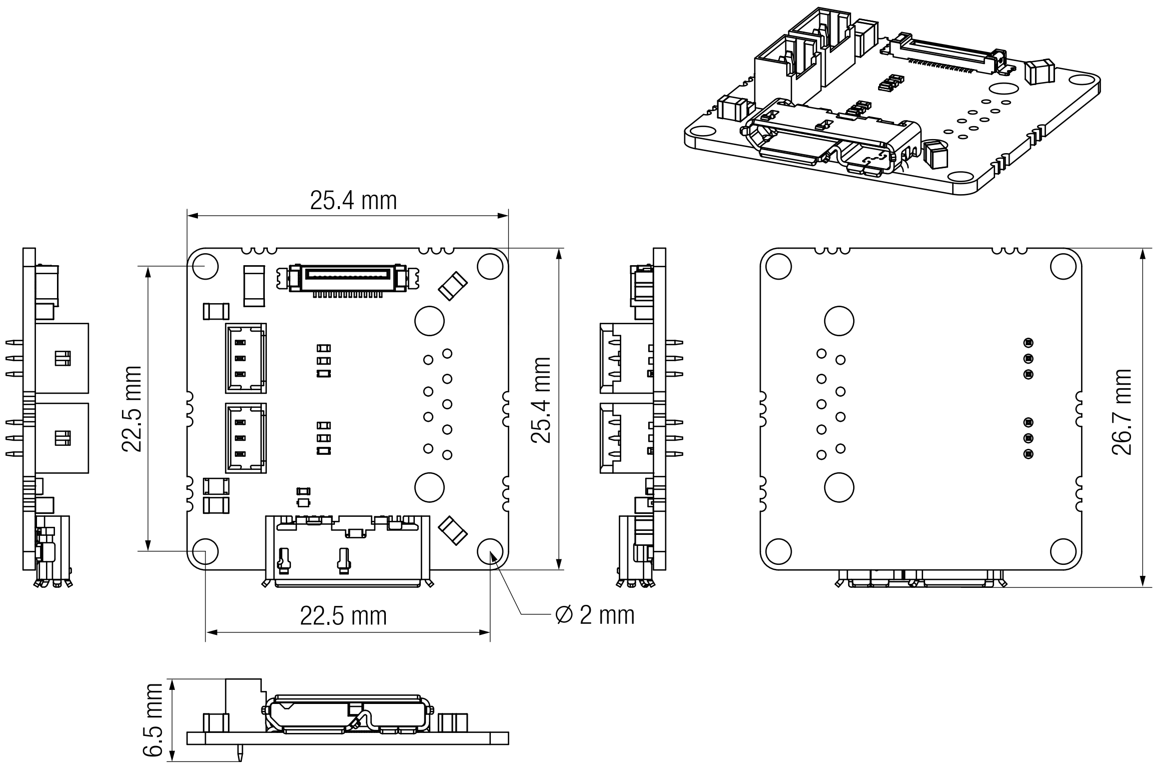


Figure 29: ADPT-U3-UC-U3-UB dimensional drawing

Width [W]	Height [H]	Depth [D]	Mass [M]
25.4 mm	26.7 mm	6.5 mm	6.4 g

Table 21: Dimensions and mass of ADPT-U3-UC-U3-UB

2.11.7 MQ-BRACKET-T

Figure 30: 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

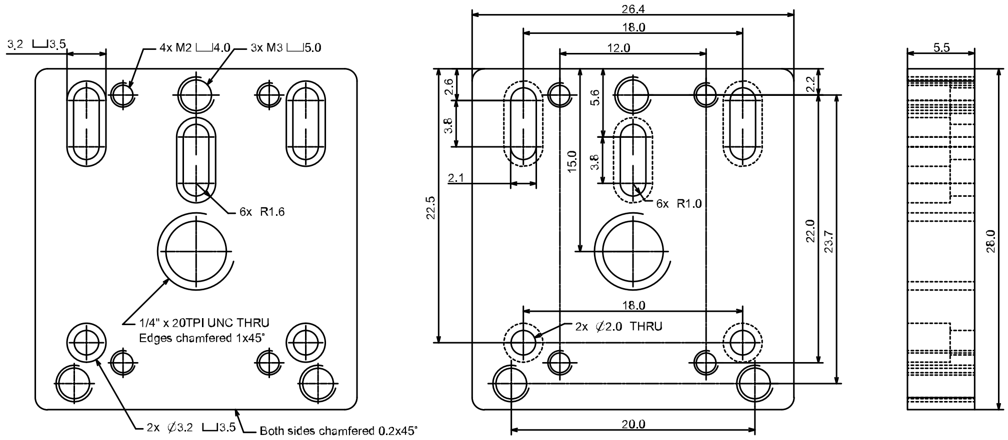


Figure 31: MQ-BRACKET-T dimensional drawing

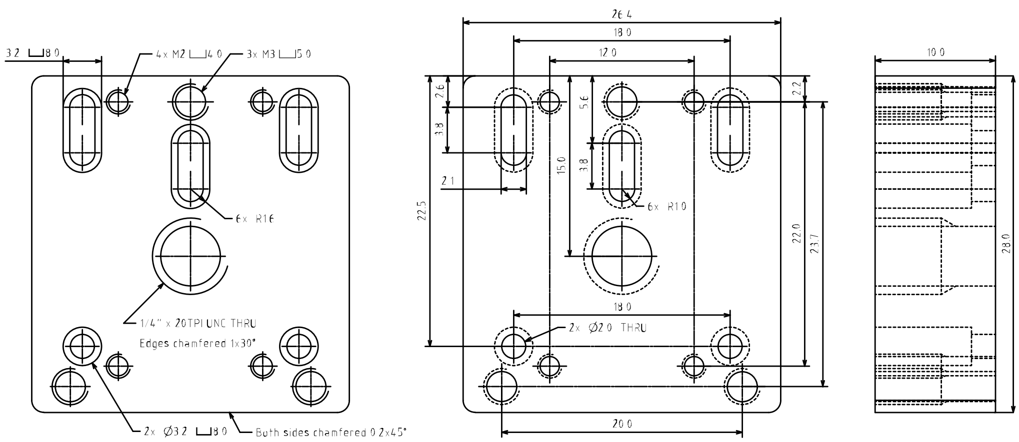


Figure 32: MQ-BRACKET-T thick dimensional drawing

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

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity][1,2]
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2]
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW8X2	8 bits per pixel raw data from sensor(2 components in a row).
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_RAW16X2	16 bits per pixel raw data from sensor(2 components in a row)
XI_FRM_TRANSPORT	Data from transport layer (e.g. packed). Depends on data on the transport layer[3]

[1] Higher CPU processing is required when this mode is selected because color filter array processing is implemented on PC. This processing is serialized when multiple cameras is used at once. The most effective way to get data from camera is to use XI_RAW8, where no additional processing is done in API.
[2] On monochromatic cameras the black level is not subtracted in XI_MONO8 and XI_MONO16 formats by Image Processing in xiAPI, so black level remains the same as in RAW format.
[3] When using Transport Data Format, the Image Processing block from XiAPI Image Data Flow is skipped and therefore the Transport format is the most effective data format in terms of CPU and RAM usage.

Table 22: 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).

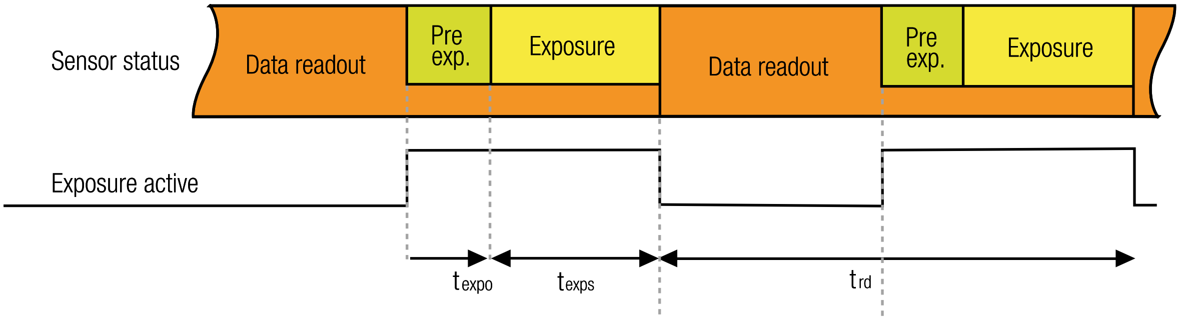


Figure 33: Acquisition mode - free run

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

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

3.2.2 Trigger controlled acquisition/exposure

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

Software trigger

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

Hardware trigger

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

Triggered mode - Burst of frames

For more information please see: Frame Burst Modes

Frame Burst Start

In this mode each trigger pulse triggers defined number of exposed frames.

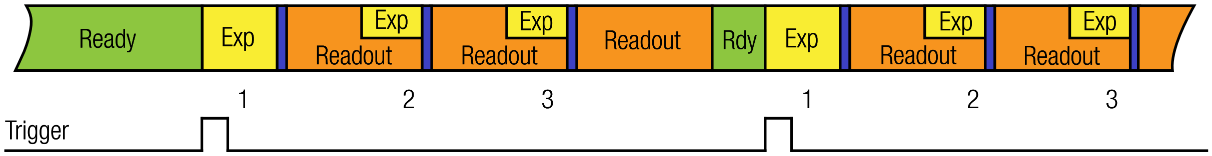


Figure 34: Triggered burst of frames – frame burst start

Frame Burst Active

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

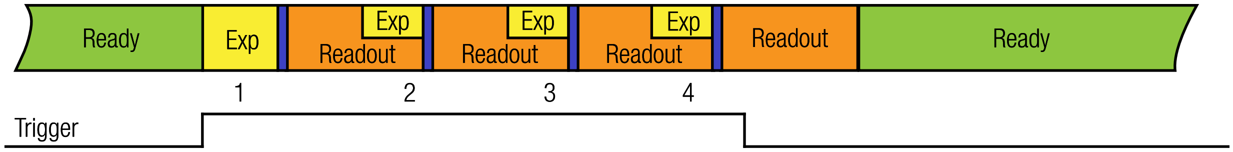


Figure 35: Triggered burst of frames – frame burst active

3.3 Exposure time

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

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

3.4 Gain

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

3.5 API Features

Host-assisted image processing features available in xiAPI

3.5.1 High conversion gain mode

Enables high conversion gain feature which applies additional gain to the signal at the pixel level. This leads to a reduction in read noise, a boost in sensitivity and signal-to-noise ratio, particularly in low-light situations. Consequently, the camera exhibits superior performance in dark environments, capturing images with minimal noise and enhanced detail.

3.5.2 Sensor defect correction

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

3.5.3 Flat field correction

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

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

Compare of camera output with shading (left) and after FFC enabled (right):

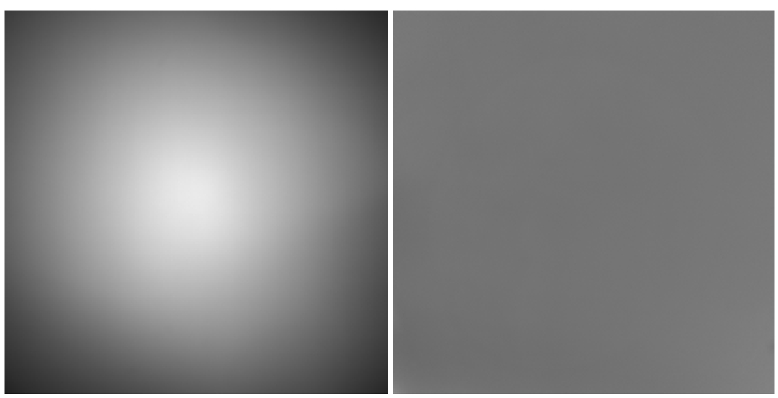


Figure 36: Flat field correction - images comparison

Acquisition of calibration images

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

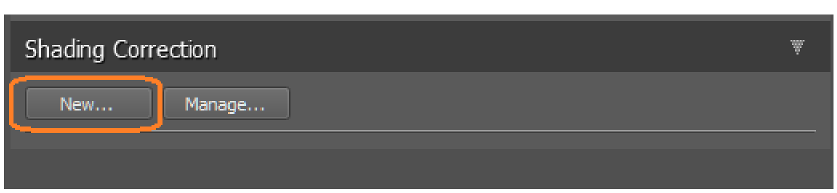


Figure 37: Flat field correction - new FFC

Dark Image

Close camera lens with a cap (make it dark) and click button Capture. Average the image from set number of frames to suppress dynamic noise.

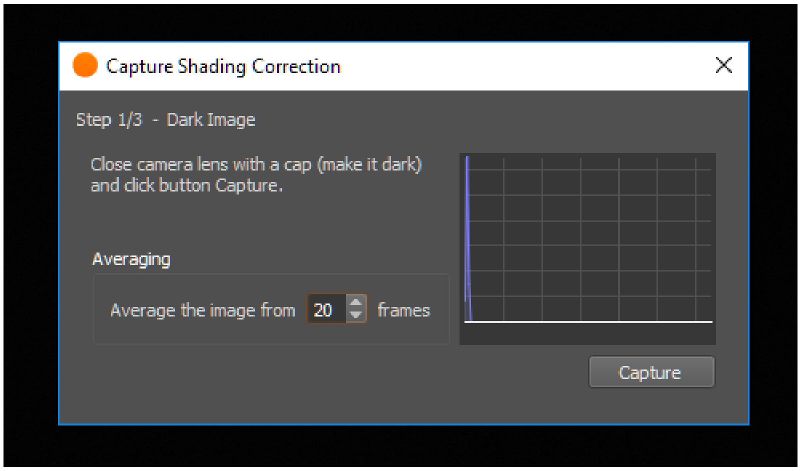


Figure 38: Flat field correction - Dark image

Mid-saturated image

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

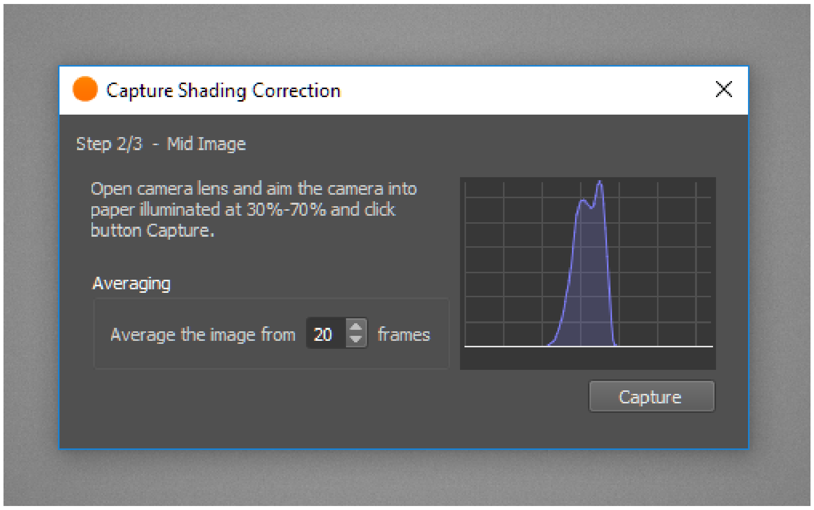


Figure 39: Flat field correction - Mid- saturated image

Save TIFF files

Save the new preset how it be displayed in CamTool.

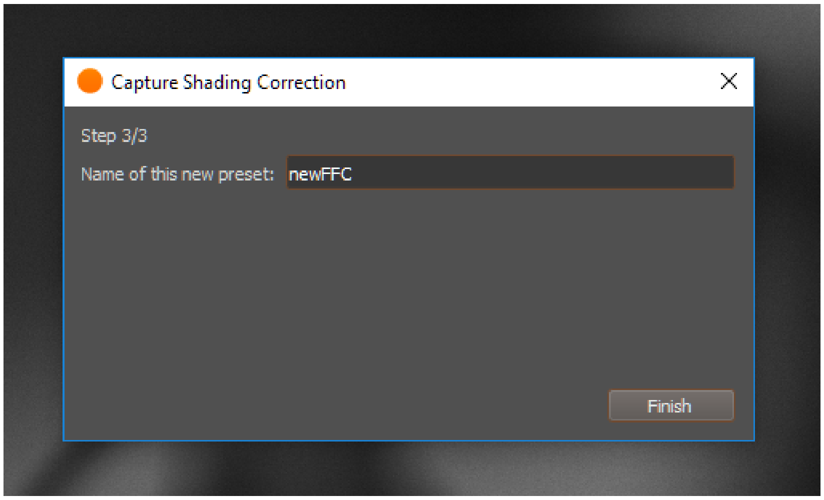


Figure 40: Flat field correction - new preset

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

Figure 41: Flat field correction - Enabling FFC

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

To see calibration images and be able to save them, click on Manage, then choose preset from list. Camera parameters for that particular preset will be displayed. Click on show dark/mid image

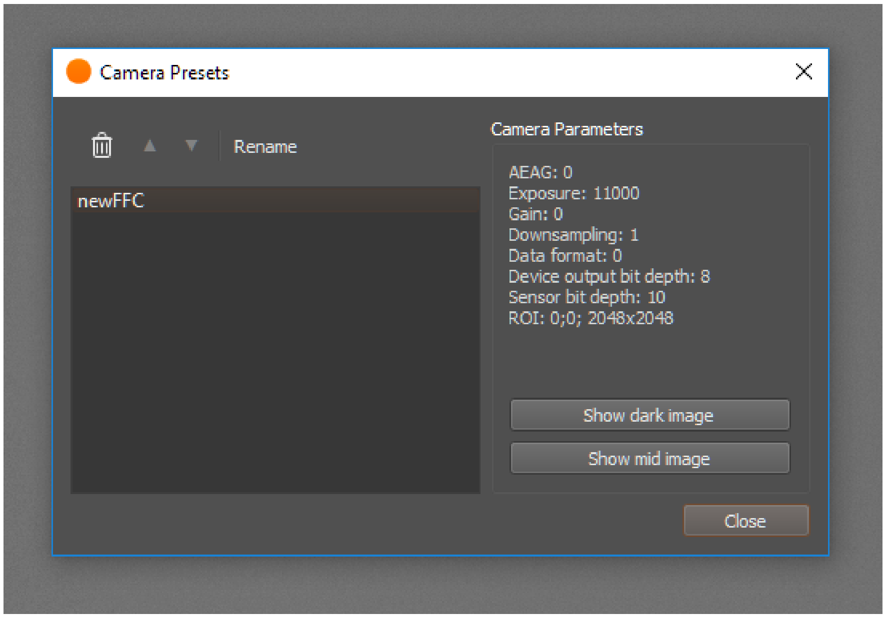


Figure 42: Flat field correction - FFC management

When images are shown in CamTool it is possible to save them by clicking on save icon in top toolbar. Images should be saved in uncompressed TIFF format to use in API.

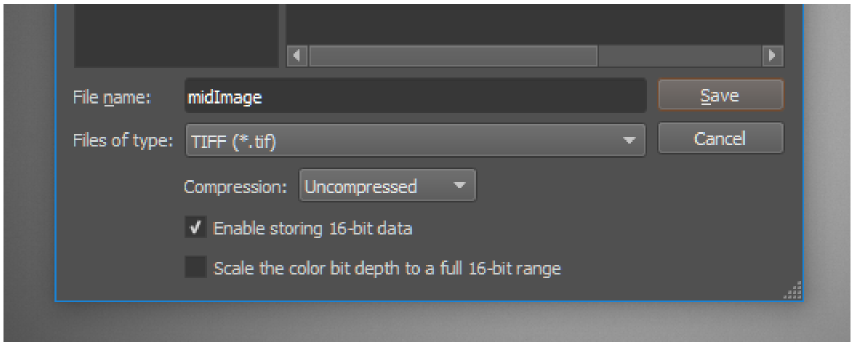


Figure 43: Flat field correction - Safe TIFF

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

`%LOCALAPPDATA%\xiCamTool\shading`

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

Applying FFC in xiAPI

xiAPI command sequence:

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

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

Sample code:

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

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

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

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

4 Operation

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

4.1 System requirements

4.1.1 Software requirements

Cameras are compatible with the following operating systems:

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

Windows Linux™ macOS

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

4.1.2 Hardware requirements

The XIMEA USB3 cameras are compatible with USB 3.1, USB 3.0 and USB 2.0. Please note, that the highest performance can only be achieved by using high performance USB 3.1 or USB 3.0 ports. Using a USB 2.0 port will lead to a limited frame rate.

Please note details and the most recent info on our website: USB3 Hardware Compatibility.

4.2 XIMEA software packages

4.2.1 XIMEA Windows software package

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

Contents

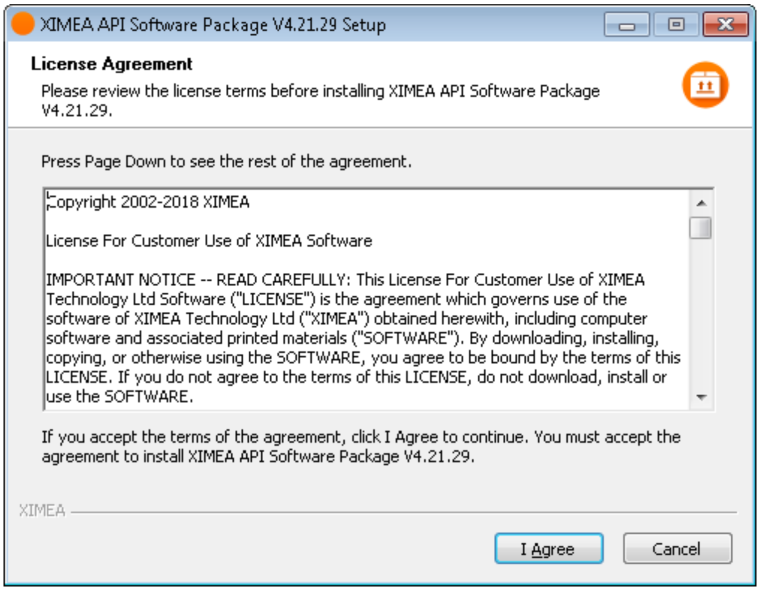
The package contains:

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

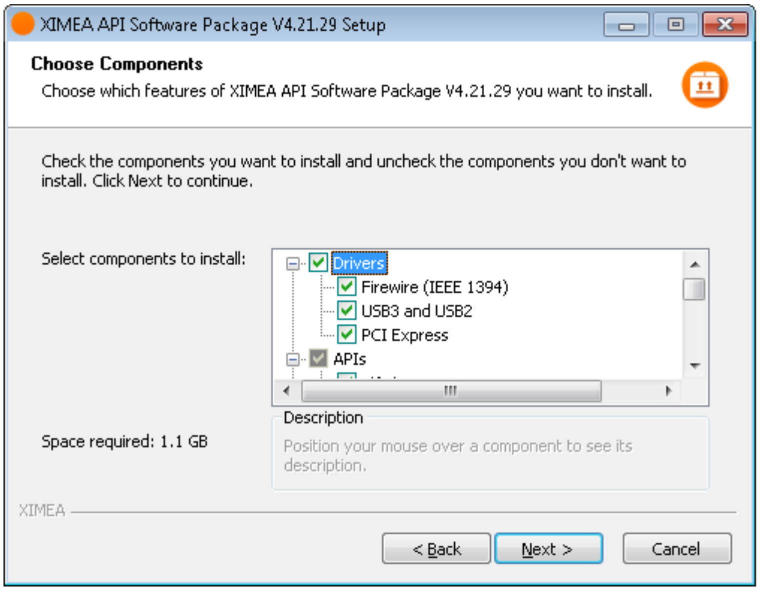
Installation

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

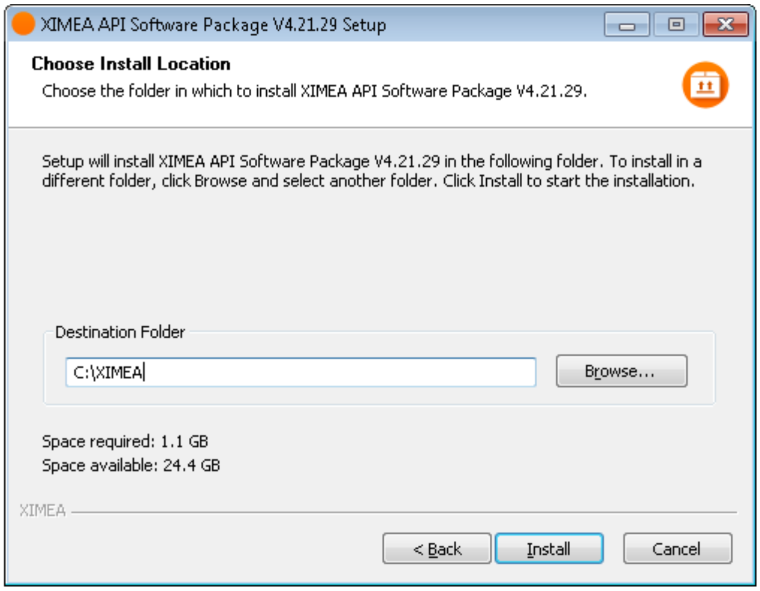
  Be sure that you have administrator privileges or start the Installer with administrator rights
  (right click and select "run as administrator"):



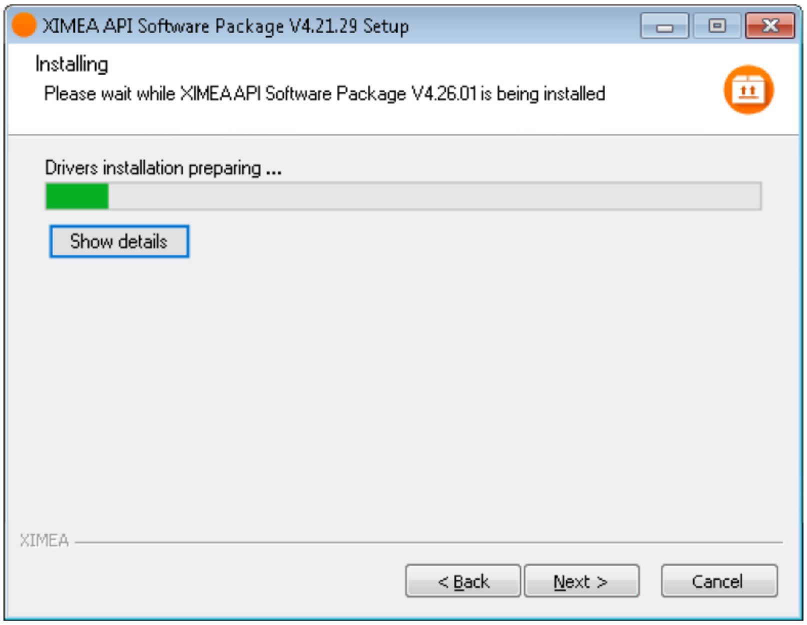
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



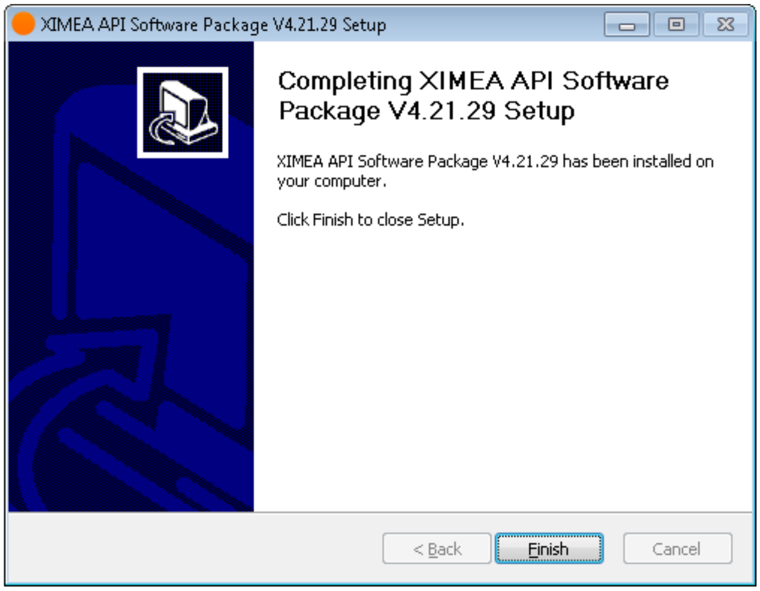
- Specify the install location - you can leave the default location or change it to your desired location



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



- Installation is completed
- Finish



4.2.2 XIMEA Linux software package

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

Contents

The package contains:

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

Instalation

- Download XIMEA Linux Software Package:

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

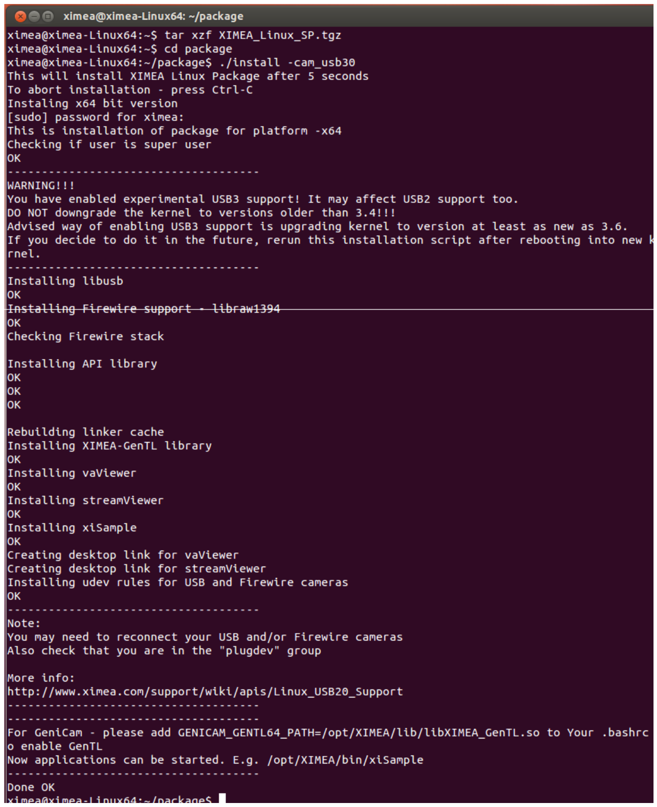
  ```
  wget http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz
  ```

- Untar

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

- Start installation script

  `./install`



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

Installing API library
OK
OK
OK

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

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

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

4.2.3 XIMEA macOS software package

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

Contents

The package contains:

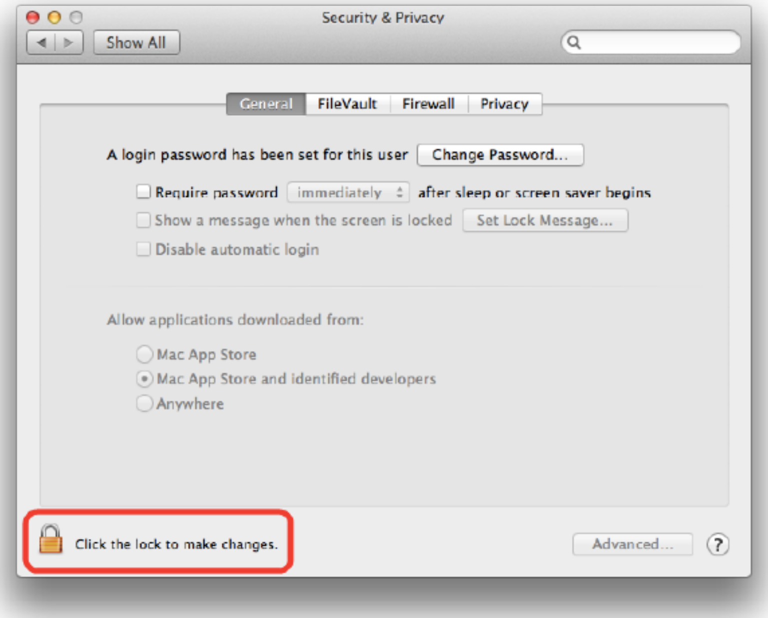
- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
  - xiSample - sample showing basic image acquisition in xiAPI

Installation

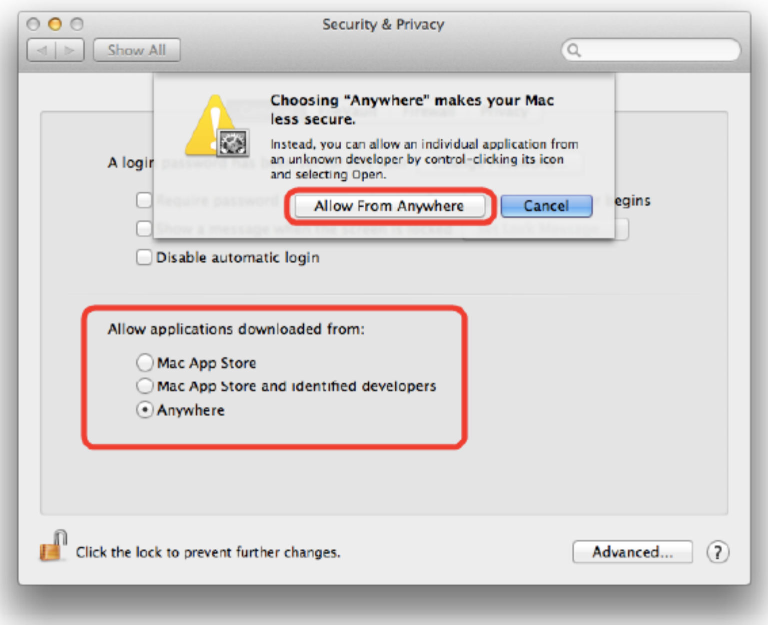
Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- Open System Preferences application and click on Security & Privacy

- Click on the lock to allow changes to be made



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



- Download XIMEA macOS Software:
  http://www.ximea.com/downloads/recent/XIMEA_OSX_SP.dmg
- Mount it by double-clicking this file in Finde
- Run the install script to install XiAPI on your macOS system
- A window with package contents will open

Start XIMEA CamTool

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

Short description

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

4.3 XIMEA CamTool

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

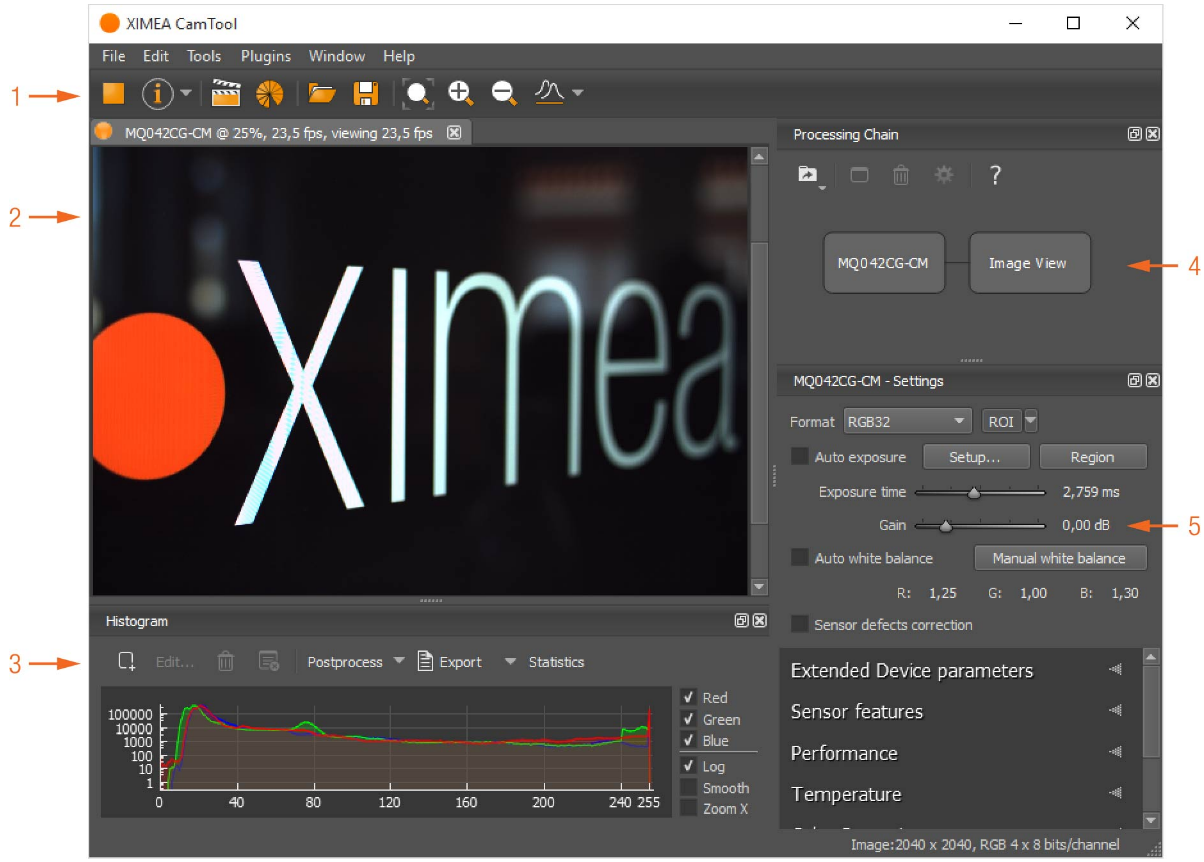


Figure 44: CamTool preview

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

Table 23: CamTool layout

Functions

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

4.4 XIMEA control panel

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

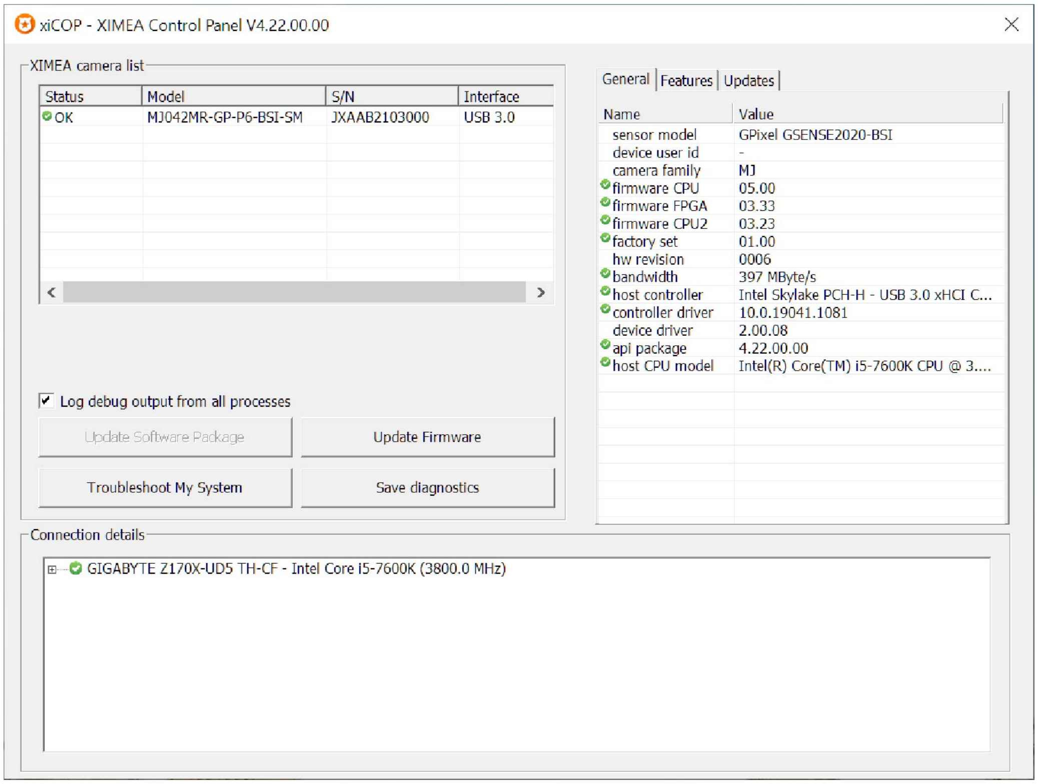


Figure 45: xiCOP example

Features

- Facilitates diagnostics of system performance bottlenecks
  xiCOP is capable of retrieving the system's hardware tree, thus problematic hardware configurations can be identified
- Diagnosis of firmware and software compatibility
  xiCOP checks relevant firmware and software versions and warns if a component is not up-to-date
- Lists all currently attached XIMEA devices and their features.
- Saves a diagnostic log and debug output which can be reviewed by technical support
- Suggests solution for diagnosed issues
- Allows setting of User IDs to XIMEA cameras
- One click to switch selected XIMEA cameras to USB3 Vision standard and back to XIMEA API
- One click update to the latest XIMEA API Software Package
- One click update of firmware in selected cameras

4.5 Supported vision libraries

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

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

4.5.1 MathWorks MATLAB

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

4.5.2 MVTec HALCON

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

4.5.3 National Instruments LabVIEW vision library

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

4.5.4 OpenCV

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

4.6 Programming

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

4.6.1 Standard interface

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

GenICam/GenTL

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

4.6.2 xiAPI

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

Architecture

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

- On Windows: xiAPI is compiled into xiapi32.dll or xiapi64.dll
- On Linux: xiAPI is compiled into /usr/lib/libm3api.so

Installation

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

xiAPI functions description

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

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

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

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

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

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

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

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

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

xiAPI parameters description

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

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

xiAPI examples

Connect device

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

```
HANDLE xiH = NULL;

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

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

Parameterize device

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

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

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

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

Acquire images

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

```
        xiStartAcquisition(xiH);

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

Hardware trigger and exposure active output

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

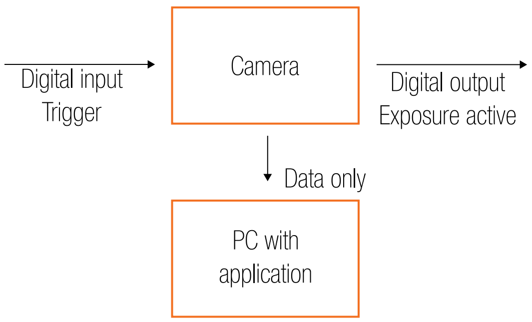


Figure 46: GPIO scheme

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

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

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

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

xiStartAcquisition(handle1);

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

xiAPI Auto Bandwidth Calculation

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

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

xiAPI.NET

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

xiApiPython

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

5 Appendix

5.1 Troubleshooting and support

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

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

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

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

5.1.1 Worldwide support

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

5.1.2 Before contacting technical support

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

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

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

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

5.2 Frequently Asked Questions

- Frequently Asked Questions
- Knowledge Base

5.3 Product service request (PSR)

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

Step 1 – Contact support

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

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

Step 2 – Create product service request (PSR)

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

Step 3 – Wait for PSR approval

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

Step 4 – Sending the camera to XIMEA

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

Step 5 – Waiting for service conclusion

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

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

Table 24: Service operations overview

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

Step 6 – Waiting for return delivery

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

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

5.4 Safety instructions and precautions

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

5.5 Warranty

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

5.6 Standard Terms & Conditions of XIMEA GmbH

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

5.7 List of Trademarks

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

5.8 Copyright

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

Glossary

ADC Analog to Digital Converter 18

CMOS Complementary Metal-Oxide-Semiconductor 39

DSNU Dark Signal Non-Uniformity 18

ESD Electrostatic discharge 24

FPGA Field Programmable Gate Array 35

FPS Frame Per Second 37

PRNU Photo Response Non-Uniformity 18

PSR Product Service Request 61

ROI Region Of Interest 35

SNR Signal to Noise (Ratio) 18

List of Figures

List of Tables

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