



xIMU

[ksi-mju:] or [sai-mju:]

- Subminiature USB camera series

XIMEA Cameras •
Technical Manual •
Version v241209 •

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.

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Standard conformity

CE conformity



Figure 1: Standard conformity CE logo

The camera models listed below, equipped with the USB Type-C adapter (XIMEA P/N: ADPT-MU-CX3-TC-V), comply with the EC EMC Directive 2014/30/EU requirements for electromagnetic compatibility.

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

UKCA conformity



Figure 2: Standard conformity UKCA logo

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

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

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

FCC conformity



Figure 3: Standard conformity FCC logo

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

Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

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

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

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

RoHS conformity



Figure 4: Standard conformity RoHS logo

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

WEEE conformity



Figure 5: Standard conformity WEEE logo

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

GenICam GenTL API



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

Disclaimer

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

Helpful links

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

Contents

About this manual	2
About XIMEA	2
Contact XIMEA	2
Standard conformity	3
Helpful links	5
1 xiMU camera series	9
1.1 What is xiMU	9
1.2 Advantages	9
1.3 Camera applications	10
1.4 Common features	10
1.5 Model nomenclature	11
1.6 Models and sensors overview	12
1.7 Accessories overview	13
2 Hardware specification	14
2.1 Power supply	14
2.1.1 Power input	14
2.2 General specification	15
2.2.1 Environment	15
2.3 Lens mount	16
2.3.1 S-mount	16
2.4 Mounting points	17
2.4.1 Screws	17
2.5 Optical path	18
2.6 Sensor and camera characteristics	21
2.6.1 Sensor and camera parameters	21
2.6.2 Image quality parameters	22
2.6.3 Sensor read-out modes	24
2.6.4 Quantum efficiency curves	27
2.7 Mechanical characteristics	29
2.7.1 Dimensions and mass	29
2.7.2 Dimensional drawings	30
2.8 Camera interface	32
2.9 Digital inputs / outputs (GPIO) interface	33
2.9.1 Non-isolated digital lines (connected to sensor as well) - Digital Input-Output 1.8V logic (INOUT)	37
2.9.2 Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)	38
2.10 Accessories	39
2.10.1 ME-ADPT-MU-T-KIT	39
2.10.2 ME-ADPT-MU-17x17-T	40
2.10.3 ADPT-MU-CX3-FL / ADPT-MU-17x17-CX3-FL	41
2.10.4 ADPT-MU-CX3-TC-V / ADPT-MU-17x17-CX3-TC-V	47
2.10.5 ADPT-MU-CX3-UC / ADPT-MU-17x17-CX3-UC	54
2.10.6 BOB-MQ-FL	59
3 General features	60
3.1 Camera features	60
3.1.1 ROIs – Region of interest	60
3.1.2 Downsampling modes	60
3.1.3 Image data output formats	61
3.2 Acquisition modes	64
3.2.1 Free-Run	64
3.2.2 Trigger controlled acquisition/exposure	64
3.3 Exposure time	67
3.4 Gain	67
3.5 Dual ADC modes	68
3.5.1 Non-combined mode	69
3.5.2 Combined mode	70

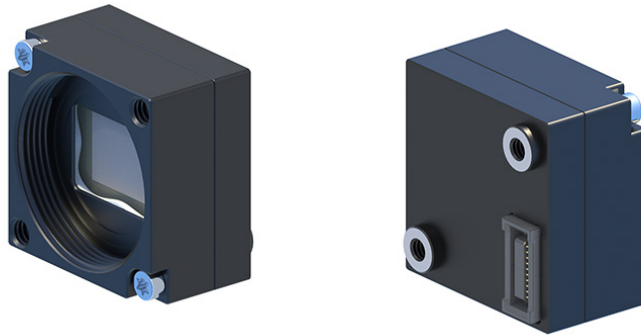
3.6	Sensor Shutter Modes	71
3.6.1	Global Reset Release Mode	71
3.6.2	Rolling Shutter Mode	72
3.6.3	How to Freeze the Motion	73
3.7	API Features	74
3.7.1	Exposure – Auto gain	74
3.7.2	White balance	74
3.7.3	Gamma	74
3.7.4	Sharpness	74
3.7.5	Color correction matrix	74
3.7.6	Sensor defect correction	74
4	Operation	75
4.1	System requirements	75
4.1.1	Software requirements	75
4.1.2	Hardware requirements	75
4.2	XIMEA software packages	76
4.2.1	XIMEA Windows software package	76
4.2.2	XIMEA Linux software package	79
4.2.3	XIMEA macOS software package	81
4.3	XIMEA CamTool	84
4.4	XIMEA control panel	85
4.5	Supported vision libraries	86
4.5.1	MathWorks MATLAB	86
4.5.2	MVTec HALCON	86
4.5.3	National Instruments LabVIEW vision library	86
4.5.4	OpenCV	86
4.6	Programming	87
4.6.1	Standard interface	87
4.6.2	xiAPI	87
5	Appendix	91
5.1	Troubleshooting and support	91
5.1.1	Worldwide support	91
5.1.2	Before contacting technical support	91
5.2	Frequently Asked Questions	91
5.3	Product service request (PSR)	92
5.3.1	Step 1 – Contact support	92
5.3.2	Step 2 – Create product service request (PSR)	92
5.3.3	Step 3 – Wait for Product Service Request (PSR) approval	92
5.3.4	Step 4 – Sending the camera to XIMEA	92
5.3.5	Step 5 – Waiting for service conclusion	92
5.3.6	Step 6 – Waiting for return delivery	93
5.4	Safety instructions and precautions	94
5.4.1	Disassembly	94
5.4.2	Mounting / Screws	94
5.4.3	Connections	94
5.4.4	Power supply	94
5.4.5	Environment / protection against water	94
5.4.6	Recommended light conditions	94
5.4.7	Protection of optical components	95
5.4.8	Mechanical loads	95
5.4.9	Camera / lens cleaning	95
5.4.10	Protect against static discharge (Electrostatic discharge (ESD))	95
5.4.11	Safety instruction for board level cameras	95
5.5	Warranty	96
5.5.1	Disclaimer of Warranty	96
5.6	Standard Terms & Conditions of XIMEA GmbH	97
5.7	List of Trademarks	103

5.8 Copyright 103
Glossary..... 104
List of figures 105
List of tables 107



1 xiMU camera series

1.1 What is xiMU



xiMU is a subminiature USB Industrial camera family with outstanding features:

This camera series include models with IMX568 and IMX675 sensors from Sony's 3rd Generation Pregius™ family and AR2020 from onsemi with a resolution range, starting from 5 Mpx and going up to almost 20 Mpx with pixel sizes reaching down to 1.4 μm. With the minimal form factor of 15 x 15 mm these cameras occupy the status of the smallest industrial USB3 cameras worldwide.

It is possible to choose from various USB3 interface options. USB-C for standard and easy connections, flat-flex or micro-coaxial cables and connectors for tight integrations or flexible cable runs.

Weighing in at a mere 5 grams and low power consumption of 1 watt minimizes heat generation and simplifies integration.

1.2 Advantages

- Compact and Lightweight** Weighs only 5 grams, ideal for space-constrained applications
- Low Power Consumption** Consumes just 1 watt, minimizing heat generation and simplifying integration
- High-Resolution Options** Offers resolutions from 5 to 19.6 Mpix, suitable for detailed imaging needs
- Versatile Sensor Choices** Choose from Sony™ or Onsemi™ sensors up to 20 Mpix, tailored to your application requirements
- Global Shutter Options** Ensures optimal performance in fast-moving or high-speed scenarios
- Flexible Connectivity** Supports multiple USB3 interfaces including USB-C for easy connections and flat-flex or micro-coaxial for tight integrations
- Precision Pixel Sizes** Features pixel sizes as small as 1.4 μm for high precision in imaging tasks
- Wide Range of Applications** Suitable for industrial inspection, automation, medical imaging, and scientific research

1.3 Camera applications

- 3D scanning
- Robotic Arms
- Material and Life science Microscopy
- Ophthalmology and Retinal imaging
- Medical Imaging
- Flat panel inspection
- Dental
- Kiosks
- Security
- Biometrics
- UAV
- Photogrammetry
- Surveying
- Eye tracking

1.4 Common features

Sensor Technology	CMOS
Acquisition Modes	continuous, software trigger, hardware trigger
Partial Image Readout	ROI, decimation and binning modes supported
Color image processing	host based de-bayering, sharpening, gamma, color matrix, true color CMS
Hot/blemish pixels correction	on camera storage of 5000+ pixel coordinates, host assisted correction
Auto adjustments	auto white balance, auto gain, auto exposure
Flat field corrections	host assisted pixel level shading and lens corrections
Image Data and Control Interface	USB standard type-C, flat ribbon or micro-coaxial for embedded integration
General Purpose I/O	4 non-isolated I/O (without adapter)
Synchronization	hardware trigger input, software trigger, exposure active, frame active, trigger ready, exposure active pulse, busy
Housing and lens mount	standard S-mount (M12), two lens mount adapters available
Environment	operating 0 to 50 °C on housing, RH 80 % non-condensing, -25 to 60 °C storage
Operating systems	Windows, Linux Ubuntu, MacOS
Software support	xiAPI SDK, adapters and drivers for various image processing packages

1.5 Model nomenclature

MUxxxT-ZZ

MU: xiMU family name

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

y: Color sensing

C: color model

M: black & white model

T: Sensor technology

R: Rolling shutter

G: Global shutter

Z: Vendor of the sensor

SY: Sony

ON: OnSemi

1.6 Models and sensors overview

Camera model	Sensor model	Sensor type	Filter	Resolution [px]	Pixel size [μm]
MU050CR-SY	Sony IMX675	Color	BayerRG	2592 \times 1960	2.0
MU050MR-SY	Sony IMX675	Monochrome	None	2592 \times 1960	2.0
MU051CG-SY	Sony IMX568	Color	BayerBG	2472 \times 2064	2.74
MU051MG-SY	Sony IMX568	Monochrome	None	2472 \times 2064	2.74
MU196CR-ON	OnSemi AR2020	Color	BayerGB	5120 \times 3840	1.4
MU196MR-ON	OnSemi AR2020	Monochrome	None	5120 \times 3840	1.4

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
ADPT-MU-CX3-TC-V-KIT	Type-C USB adapter for MU CX3 based cameras ¹
ADPT-MU-17X17-CX3-TC-V	Type-C USB adapter for MU 17 × 17 mm cameras ¹
ADPT-MU-CX3-FL-KIT	Flex line adapter horizontal for MU CX3-based cameras ²
ADPT-MU-CX3-FV-KIT	Flex line adapter vertical for MU CX3 based cameras ²
ADPT-MU-17X17-CX3-FV	Flex line adapter for MU 17 × 17 mm cameras ²
ADPT-MU-CX3-UC-KIT	Micro coax adapter for MU CX3 based cameras (I-PEX Cabline SS Micro Coax) ³
ADPT-MU-17X17-CX3-UC	Micro coax adapter for MU 17 × 17 mm cameras (I-PEX Cabline SS Micro Coax) ³
BOB-MQ-FL	USB 3.0 Flexline adapter breakout board with Micro USB3.0 connector
ADPT-U3-UC-U3-UB	USB 3.0 micro coax adapter breakout board with Micro USB3.0 connector
ME-ADPT-MU-17x17-T-KIT	Tripod Bracket for MU 17 × 17 mm cameras with Screws Kit
ME-ADPT-MU-T-KIT	Tripod Bracket for MU cameras with Screws Kit
ME-LA-MU-M12-M	Lens M12 Adapter - thread length 4.9 mm
ME-LA-MU-M12-L	Lens M12 Adapter - thread length 7.9 mm

¹lo cables - CBL-S-M5-3P-PT-5M0, CBL-S-M5-3P-PT-5M0-S

²mating cables CBL-MQ-FL-0M1, CBL-MQ-FL-0M25, CBL-USB3FLEX-0M10, CBL-USB3FLEX-0M25, CBL-USB3FLEX-0M50

³mating cables CBL-U3-PSD-UC-0M10, CBL-U3-PSD-UC-0M25, CBL-U3-PSD-UC-0M50, CBL-U3-PSD-UC-1M0

Table 2: xiMU accessories

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:
MU050CR-SY

MU050MR-SY

Supply Voltage ¹	Consumption idle	Consumption typical	Consumption maximum
5 V	0.38 W	0.75 W	0.79 W

¹Supported voltage 4.5 - 5.5V

Table 3: Power consumption of the specific models

Power consumption of:
MU051CG-SY

MU051MG-SY

Supply Voltage ¹	Consumption idle	Consumption typical	Consumption maximum
5 V	0.94 W	0.96 W	0.98 W

¹Supported voltage 4.5 - 5.5V

Table 4: Power consumption of the specific models

Power consumption of:
MU196CR-ON

MU196MR-ON

Supply Voltage ¹	Consumption idle	Consumption typical	Consumption maximum
5 V	0.42 W	0.82 W	0.86 W

¹Supported voltage 4.5 - 5.5 V

Table 5: Power consumption of the specific models

2.1.1 Power input

The required power voltage input is in the range 4.5 to 5.5V. The power supply should be rated for the specific camera model power consumption.

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 70 °C
Relative Humidity, non-condensing	RH	80 %

Table 6: Environment

Housing temperature must not exceed 65 °C.

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

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

2.3 Lens mount

2.3.1 S-mount

There are two lens mount adapters available (S-Mount, M12 x 0.5 thread). To install the adapter, ensure compatibility with your camera. Securely screw in the adapter, then verify optimal image quality. Regularly inspect the adapter for wear or misalignment. Keep it clean and handle it carefully to avoid damage. For more information about the S-mount lens adapter, contact our [Support team](#).

ME-LA-MU-M12-M

The lens adapter has a geometric back-focal distance of 8 mm, measured from the top of the flange to the top of the sensor die.

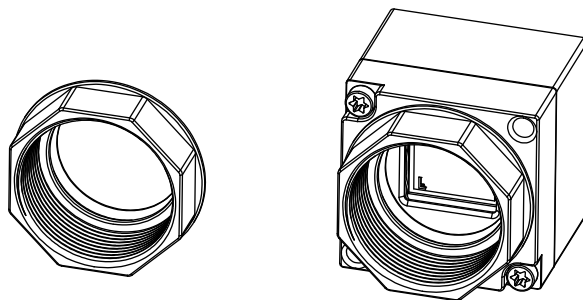


Figure 6: Lens mount adapter S-mount (M12-M) (left), camera with adapter (right)

ME-LA-MU-M12-L

The lens adapter has a geometric back-focal distance of 11 mm, measured from the top of the flange to the top of the sensor die.

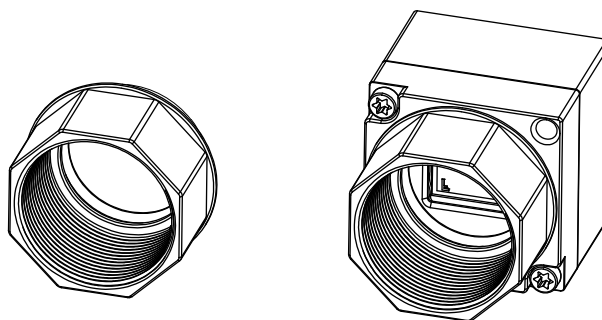


Figure 7: Lens mount adapter S-mount (M12-L) (left), camera with adapter (right)

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

2.4 Mounting points

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

Specific mounting information can be found in the dimensional drawings of the camera models located in section [Dimensional drawings](#).

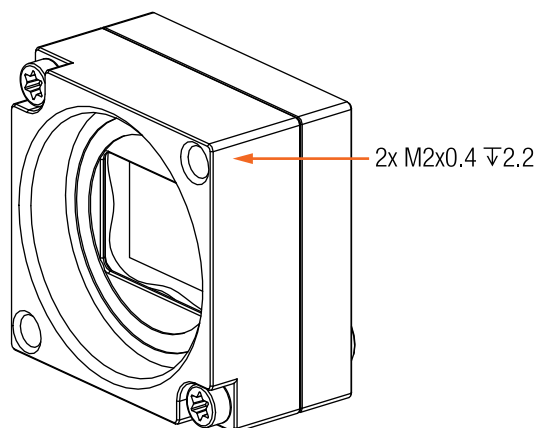


Figure 8: xiMU camera mounting points

2.4.1 Screws

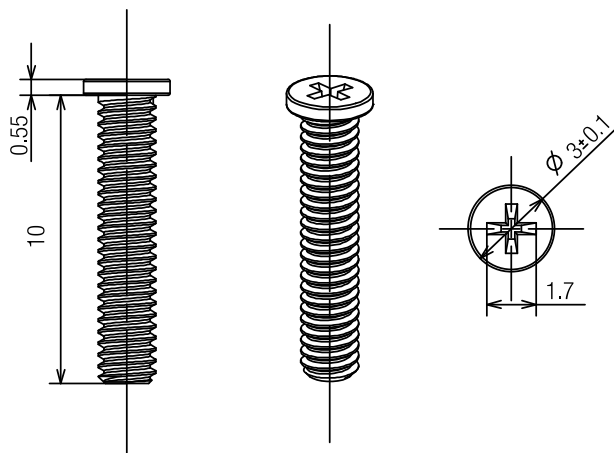


Figure 9: M2 mounting screws

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

Table 7: 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:
MU050CR-SY

MU050MR-SY

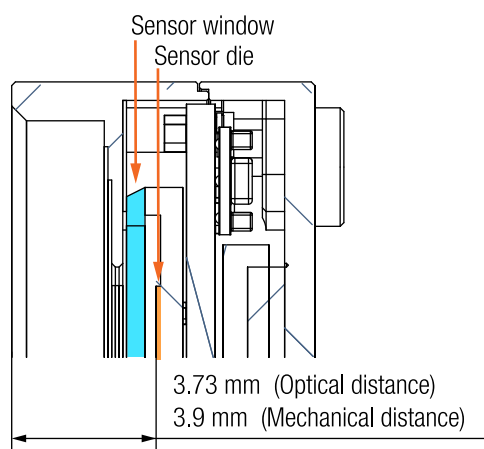


Figure 10: Cross section of MU050xR-SY camera models

Cross-section corresponding to:
MU051CG-SY

MU051MG-SY

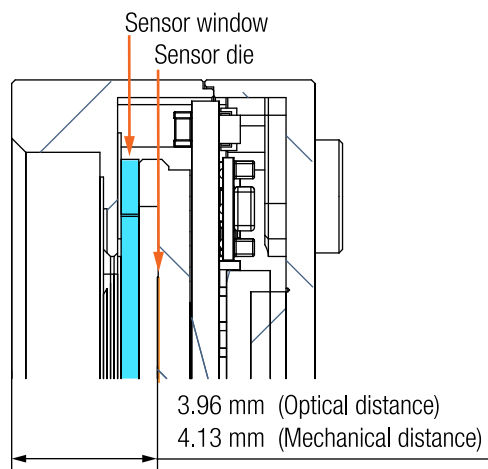


Figure 11: Cross section of MU051xG-SY camera models

Cross-section corresponding to:
MU196CR-ON

MU196MR-ON

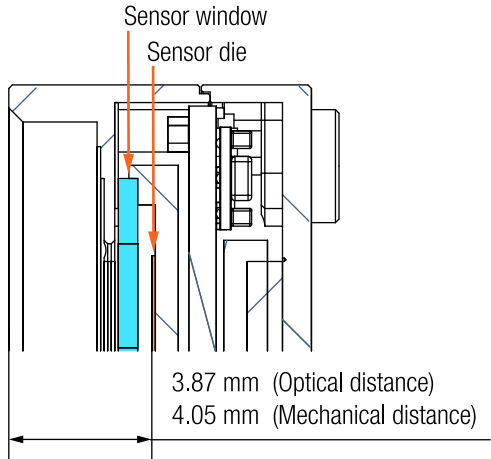


Figure 12: Cross section of MU196xR-ON camera models

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

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

2.6 Sensor and camera characteristics

2.6.1 Sensor and camera parameters

Sensor parameters of:
MU050CR-SY

MU050MR-SY

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	2592 x 1960	[px]
Active area size (H X V)	5.2 x 3.9	[mm]
Sensor diagonal	6.5	[mm]
Pixel size (H x V)	2.0 x 2.0	[μ m]

Table 8: Sensor parameters of the specific models

Sensor parameters of:
MU051CG-SY

MU051MG-SY

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	2472 x 2064	[px]
Active area size (H X V)	6.773 x 5.655	[mm]
Sensor diagonal	8.8	[mm]
Pixel size (H x V)	2.74 x 2.74	[μ m]

Table 9: Sensor parameters of the specific models

Sensor parameters of:
MU196CR-ON

MU196MR-ON

Description	Value	Unit
Technology	CMOS	None
Pixel resolution (H x V)	5120 x 3840	[px]
Active area size (H X V)	7.17 x 5.37	[mm]
Sensor diagonal	9.0	[mm]
Pixel size (H x V)	1.4 x 1.4	[μ m]

Table 10: Sensor parameters of the specific models

2.6.2 Image quality parameters

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

Image quality parameters of:
MU050CR-SY

MU050MR-SY

Mode		10 bit	12 bit	Low noise
Sensor bit/px	[bit/px]	10	12	12
Dual ADC	-	-	-	Non-Comb.
Gain Ratio	[dB]	None	None	30.0
Parameters				
Temporal dark noise	[e.]	5.0	4.15	0.75
Absolute sensitivity threshold	[e.]	5.5	4.65	1.25
Saturation capacity	[ke.]	10.85	10.92	10.85
Dynamic range	[dB]	65.9	67.42	78.81
MAX Signal-to-noise ratio	[dB]	40.45	40.48	40.46
Overall system gain	[e./DN]	11.47	2.88	0.17
Dark current	[e./s]	3.37	2.09	1.78
Dark current meas. temp.	[°C]	49.2	49.9	52.4
DSNU	[e.]	0.52	0.47	0.58
PRNU	[%]	0.61	0.6	0.6
Linearity error	[%]	2.19	2.6	2.5

Table 11: Image quality parameters of the specific models

Image quality parameters of:
MU051CG-SY

Mode		8 bit	10 bit	12 bit
Sensor bit/px	[bit/px]	8	10	12
Parameters				
Temporal dark noise	[e.]	5.12	5.18	2.69
Absolute sensitivity threshold	[e.]	5.62	5.68	3.19
Saturation capacity	[ke.]	2.2	9.29	9.01
Dynamic range	[dB]	51.87	64.29	69.04
MAX Signal-to-noise ratio	[dB]	33.4	39.81	39.72
Overall system gain	[e./DN]	9.63	9.93	2.41
Dark current	[e./s]	4.23	4.57	3.82
Dark current meas. temp.	[°C]	49.8	50.1	49.9
DSNU	[e.]	0.75	0.88	0.64
PRNU	[%]	0.6	0.53	0.53
Linearity error	[%]	0.11	0.09	0.09

Table 12: Image quality parameters of the specific models

Image quality parameters of:
MU051MG-SY

Mode		8 bit	10 bit	12 bit	12 bit binning 2x2
Binning (H x V)	-	1 x 1	1 x 1	1 x 1	2 x 2
Sensor bit/px	[bit/px]	8	10	12	12
Parameters					
Temporal dark noise	[e.]	5.14	5.19	2.65	2.75
Absolute sensitivity threshold	[e.]	5.64	5.69	3.15	3.25
Saturation capacity	[ke.]	2.18	9.28	8.98	8.85
Dynamic range	[dB]	51.71	64.28	69.13	68.67
MAX Signal-to-noise ratio	[dB]	33.35	39.92	39.79	39.54
Overall system gain	[e./DN]	9.68	9.97	2.4	2.41
Dark current	[e./s]	2.69	4.03	3.15	12.54
Dark current meas. temp.	[°C]	50.4	49.9	50.0	49.9
DSNU	[e.]	0.73	0.85	0.57	0.75
PRNU	[%]	0.49	0.42	0.42	0.4
Linearity error	[%]	0.42	0.16	0.14	0.21

Table 13: Image quality parameters of the specific models

Image quality parameters of:
MU196CR-ON

MU196MR-ON

Mode		Regular	Low noise	High dynamic range
Sensor bit/px	[bit/px]	12	12	12
Dual ADC	-	-	-	Combined
Analog gain	[dB]	0.0	27.0	0.0
Parameters				
Temporal dark noise	[e.]	6.85	1.41	2.09
Absolute sensitivity threshold	[e.]	7.35	1.91	2.59
Saturation capacity	[ke.]	8.1	0.28	7.72
Dynamic range	[dB]	60.89	43.28	69.47
MAX Signal-to-noise ratio	[dB]	39.28	24.56	39.0
Overall system gain	[e./DN]	2.14	0.08	2.06
Dark current	[e./s]	2.91	2.55	2.61
Dark current meas. temp.	[°C]	52.8	53.8	51.5
DSNU	[e.]	1.77	0.95	0.92
PRNU	[%]	0.54	0.94	0.51
Linearity error	[%]	4.38	6.11	2.29

Table 14: Image quality parameters of the specific models

2.6.3 Sensor read-out modes

Sensor Read-out modes of:
MU050CR-SY

MU050MR-SY

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Maximum frame rate ¹
1 x 1	-	10	2592 x 1960	10	30.0
1 x 1	-	12	2592 x 1960	12	25.0
Bin.2 x 2	-	12	1296 x 980	12	80.1
1 x 1	Non-Comb.	12	2592 x 1960	12	12.5
Bin.2 x 2	Non-Comb.	12	1296 x 980	12	37.5

¹Maximum frame rate was measured using the transport format at maximum bandwidth 396.0 MB/s

Table 15: Sensor read-out modes of the specific models

Sensor Read-out modes of:
MU051CG-SY

Downsampling (H x V)	Sensor bit/px	Resolution (W x H)	Transport bit/px	Maximum frame rate ¹
1 x 1	8	2472 x 2064	8	48.9
1 x 1	10	2472 x 2064	10	40.0
1 x 1	12	2472 x 2064	12	33.9
Dec.2 x 2	8	1224 x 1032	8	170.3
Dec.2 x 2	10	1224 x 1032	10	142.8
Dec.2 x 2	12	1232 x 1032	12	122.8

¹Maximum frame rate was measured using the transport format at maximum bandwidth 396.0 MB/s

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

Sensor Read-out modes of:
MU051MG-SY

Downsampling (H x V)	Sensor bit/px	Resolution (W x H)	Transport bit/px	Maximum frame rate ¹
1 x 1	8	2472 x 2064	8	48.9
1 x 1	10	2472 x 2064	10	40.0
1 x 1	12	2472 x 2064	12	33.9
Dec.2 x 2	8	1224 x 1032	8	168.6
Dec.2 x 2	10	1224 x 1032	10	141.6
Dec.2 x 2	12	1232 x 1032	12	122.2
Bin.2 x 2	8	1224 x 1032	8	168.6
Bin.2 x 2	10	1224 x 1032	10	141.6
Bin.2 x 2	12	1232 x 1032	12	122.2

¹Maximum frame rate was measured using the transport format at maximum bandwidth 396.0 MB/s

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

Sensor Read-out modes of:
MU196CR-ON

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Maximum frame rate ¹
1 x 1	-	8	5112 x 3840	8	14.6
1 x 1	-	10	5112 x 3840	10	11.7
1 x 1	-	12	5112 x 3840	12	9.8
Bin.2 x 2	-	8	2544 x 1920	8	56.0
Bin.2 x 2	-	10	2544 x 1920	10	45.4
Bin.2 x 2	-	12	2544 x 1920	12	38.1
Bin.4 x 4	-	8	1272 x 960	8	199.8
Bin.4 x 4	-	10	1272 x 960	10	164.9
Bin.4 x 4	-	12	1272 x 960	12	140.4
1 x 1	Combined	8	5112 x 3840	8	6.9
1 x 1	Combined	10	5112 x 3840	10	6.9
1 x 1	Combined	12	5112 x 3840	12	6.9
Bin.2 x 2	Combined	8	2544 x 1920	8	13.5
Bin.2 x 2	Combined	10	2544 x 1920	10	13.6
Bin.2 x 2	Combined	12	2544 x 1920	12	13.6
Bin.4 x 4	Combined	8	1272 x 960	8	25.6
Bin.4 x 4	Combined	10	1272 x 960	10	25.9
Bin.4 x 4	Combined	12	1272 x 960	12	26.2

¹Maximum frame rate was measured using the transport format at maximum bandwidth 396.0 MB/s

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

Sensor Read-out modes of:
MU196MR-ON

Downsampling (H x V)	Dual ADC	Sensor bit/px	Resolution (W x H)	Transport bit/px	Maximum frame rate ¹
1 x 1	-	8	5112 x 3840	8	14.6
1 x 1	-	10	5112 x 3840	10	11.7
1 x 1	-	12	5112 x 3840	12	9.8
Dec.2 x 2	-	8	2544 x 1920	8	56.0
Dec.2 x 2	-	10	2544 x 1920	10	45.4
Dec.2 x 2	-	12	2544 x 1920	12	38.1
Dec.4 x 4	-	8	1272 x 960	8	199.8
Dec.4 x 4	-	10	1272 x 960	10	164.9
Dec.4 x 4	-	12	1272 x 960	12	140.4
Bin.2 x 2	-	8	2544 x 1920	8	56.0
Bin.2 x 2	-	10	2544 x 1920	10	45.4
Bin.2 x 2	-	12	2544 x 1920	12	38.1
Bin.4 x 4	-	8	1272 x 960	8	199.8
Bin.4 x 4	-	10	1272 x 960	10	164.9
Bin.4 x 4	-	12	1272 x 960	12	140.4
1 x 1	Combined	8	5112 x 3840	8	6.9
1 x 1	Combined	10	5112 x 3840	10	6.9
1 x 1	Combined	12	5112 x 3840	12	6.9
Bin.2 x 2	Combined	8	2544 x 1920	8	13.5
Bin.2 x 2	Combined	10	2544 x 1920	10	13.6
Bin.2 x 2	Combined	12	2544 x 1920	12	13.6
Bin.4 x 4	Combined	8	1272 x 960	8	25.6
Bin.4 x 4	Combined	10	1272 x 960	10	25.9
Bin.4 x 4	Combined	12	1272 x 960	12	26.2

¹Maximum frame rate was measured using the transport format at maximum bandwidth 396.0 MB/s

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

2.6.4 Quantum efficiency curves

Quantum efficiency curves for:
MU050CR-SY

MU050MR-SY

Quantum efficiency data are currently not available for IMX675 sensor

Figure 13: Graph quantum efficiency of Sony IMX675

Quantum efficiency curves for:
MU051CG-SY

MU051MG-SY

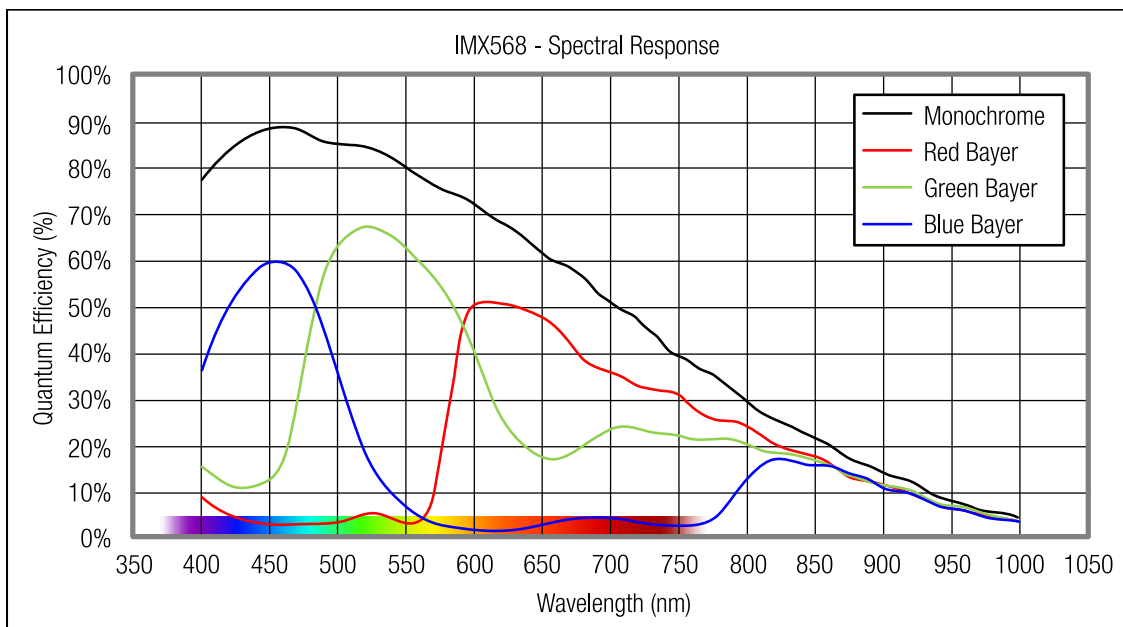


Figure 14: Graph quantum efficiency of Sony IMX568

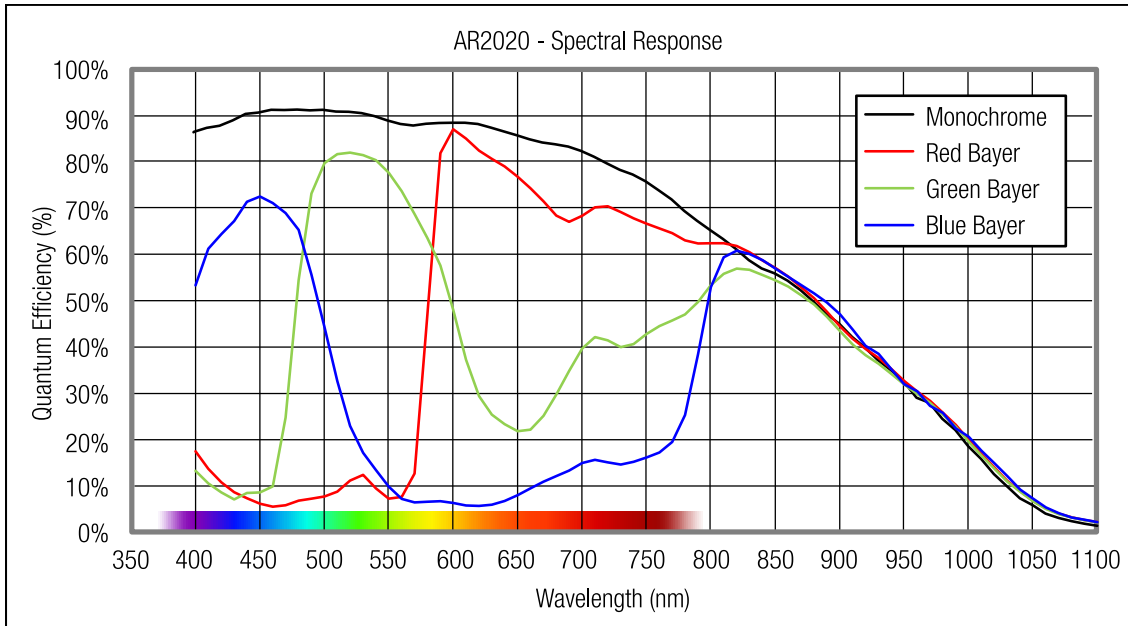


Figure 15: Graph quantum efficiency of OnSemi AR2020

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

Dimensions and mass of:
MU050CR-SY

MU050MR-SY

Width [W]	Height [H]	Depth ¹ [D]	Mass ¹ [M]
15.0 mm	15.0 mm	9.0 mm	3.3 g

¹without adapters

Table 20: Camera parameters of the specific models

Dimensions and mass of:
MU051CG-SY

MU051MG-SY

Width [W]	Height [H]	Depth ¹ [D]	Mass ¹ [M]
17.0 mm	17.0 mm	9.4 mm	4.65 g

¹without adapters

Table 21: Camera parameters of the specific models

Dimensions and mass of:
MU196CR-ON

MU196MR-ON

Width [W]	Height [H]	Depth ¹ [D]	Mass ¹ [M]
15.0 mm	15.0 mm	9.4 mm	3.2 g

¹without adapters

Table 22: Camera parameters of the specific models

2.7.2 Dimensional drawings

Dimensional drawings of:
MU051CG-SY

MU051MG-SY

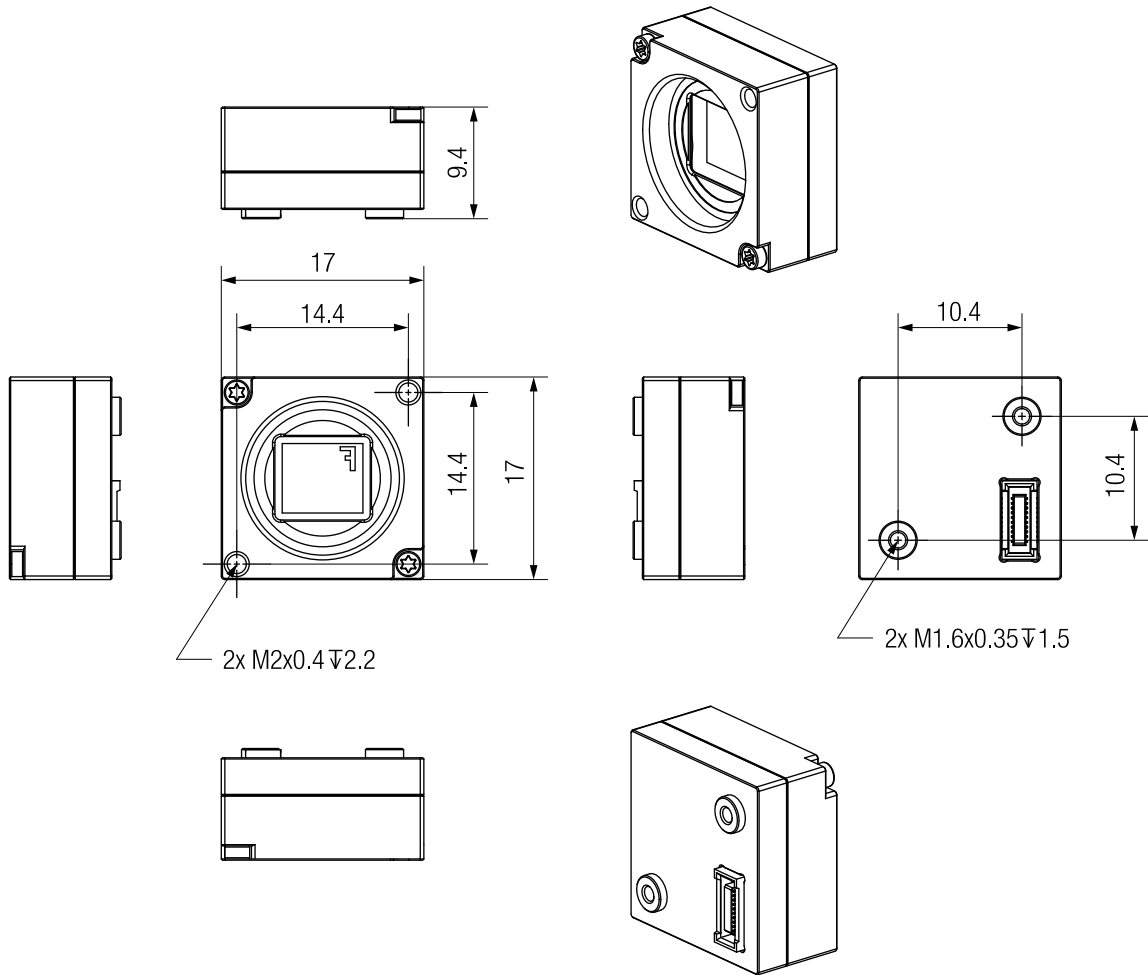


Figure 16: Dimensional drawings of MU051xG-SY

Dimensional drawings of:
MU050CR-SY
MU196MR-ON

MU050MR-SY

MU196CR-ON

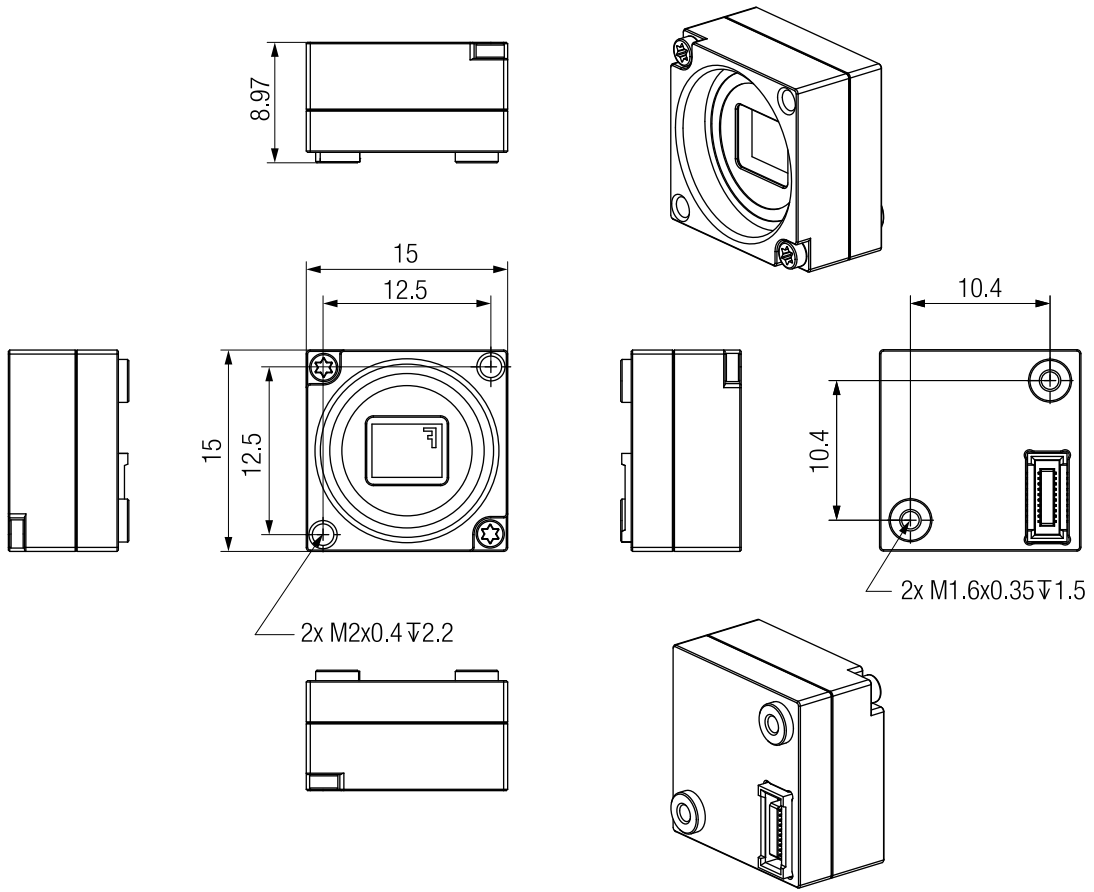


Figure 17: Dimensional drawings of MU196xR-ON and MU050xR-SY

2.8 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**)

See section **Digital inputs / outputs (GPIO) interface** for pinout description.

Item	Value
Connector	I/O & Hirose Receptacle DF40HC(3.5)-20DS-0.4V(51)
Signals	Power, USB3.0 data lines, Digital Inputs and Outputs
Mating Connectors	Hirose plug DF40C-20DP-0.4V

Table 23: Data mating connector description

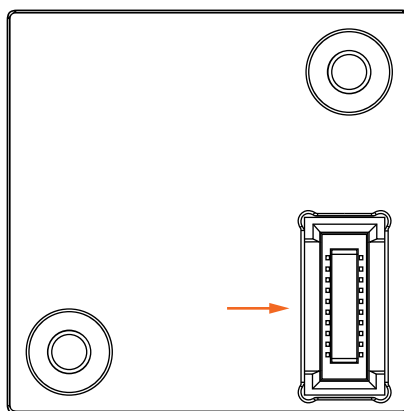


Figure 18: Data connector location

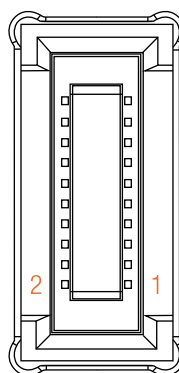


Figure 19: Data connector pinning

2.9 Digital inputs / outputs (GPIO) interface

The description of the GPIO interface below applies to:
 MU051CG-SY MU051MG-SY

Item	Value
Connector	I/O & Hirose Receptacle DF40HC(3.5)-20DS-0.4V(51)
Signals	Power, USB3.0 data lines, Digital Inputs and Outputs
Mating Connectors	Hirose plug DF40C-20DP-0.4V

Table 24: GPIO mating connector description

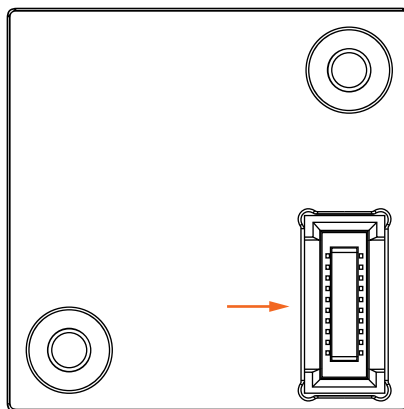


Figure 20: IO connector location

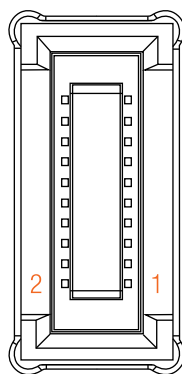


Figure 21: IO connector pinning

Pin	Name	GPI/GPO index API	Type
1	GX1	1/1	Non-isolated digital lines (connected to sensor as well) - Digital Input-Output 1.8V logic (INOUT)
2	SGND	None	None
3	GX2	2/2	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
4	GND	None	None
5	GX3	3/3	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
6	SS_RX_N	None	None
7	GX4	4/4	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
8	SS_RX_P	None	None
9	SCL	None	None
10	GND	None	None
11	SDA	None	None
12	SS_TX_P	None	None
13	GND	None	None
14	SS_TX_N	None	None
15	SS_D_P	None	None
16	GND	None	None
17	SS_D_N	None	None
18	VBUS	None	Power input
19	GND	None	None
20	VBUS	None	Power input

Table 25: I/O connector pin assignment

Note: To reduce fluctuations on disconnected input pins, connect all unused inputs to ground using a 100k Ω resistor, if necessary.

For cameras with adapters, please refer to the IO pin assignment and specifications of the particular adapter (ADPT-MU-CX3-FL / ADPT-MU-17x17-CX3-FL, ADPT-MU-CX3-TC-V / ADPT-MU-17x17-CX3-TC-V or ADPT-MU-CX3-UC / ADPT-MU-17x17-CX3-UC).

The description of the GPIO interface below applies to:

MU050CR-SY
MU196MR-ON

MU050MR-SY

MU196CR-ON

Item	Value
Connector	I/O & Hirose Receptacle DF40HC(3.5)-20DS-0.4V(51)
Signals	Power, USB3.0 data lines, Digital Inputs and Outputs
Mating Connectors	Hirose plug DF40C-20DP-0.4V

Table 26: GPIO mating connector description

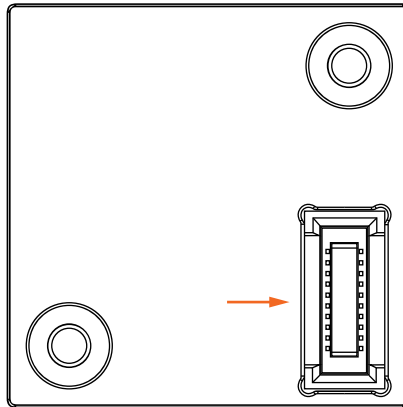


Figure 22: IO connector location

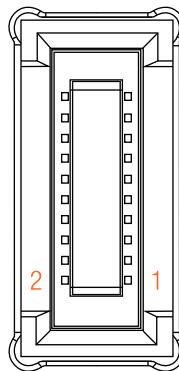


Figure 23: IO connector pinning

Pin	Name	GPI/GPO index API	Type
1	GX1	1/1	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
2	SGND	None	None
3	GX2	2/2	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
4	GND	None	None
5	GX3	3/3	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
6	SS_RX_N	None	None
7	GX4	4/4	Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)
8	SS_RX_P	None	None
9	SCL	None	None
10	GND	None	None
11	SDA	None	None
12	SS_TX_P	None	None
13	GND	None	None
14	SS_TX_N	None	None
15	SS_D_P	None	None
16	GND	None	None
17	SS_D_N	None	None
18	VBUS	None	Power input
19	GND	None	None
20	VBUS	None	Power input

Table 27: I/O connector pin assignment

Note: To reduce fluctuations on disconnected input pins, connect all unused inputs to ground using a 100k Ω resistor, if necessary.

For cameras with adapters, please refer to the IO pin assignment and specifications of the particular adapter (ADPT-MU-CX3-FL / ADPT-MU-17x17-CX3-FL, ADPT-MU-CX3-TC-V / ADPT-MU-17x17-CX3-TC-V or ADPT-MU-CX3-UC / ADPT-MU-17x17-CX3-UC).

2.9.1 Non-isolated digital lines (connected to sensor as well) - Digital Input-Output 1.8V logic (INOUT)

The description of non-isolated digital lines below applies to:
 MU051CG-SY MU051MG-SY

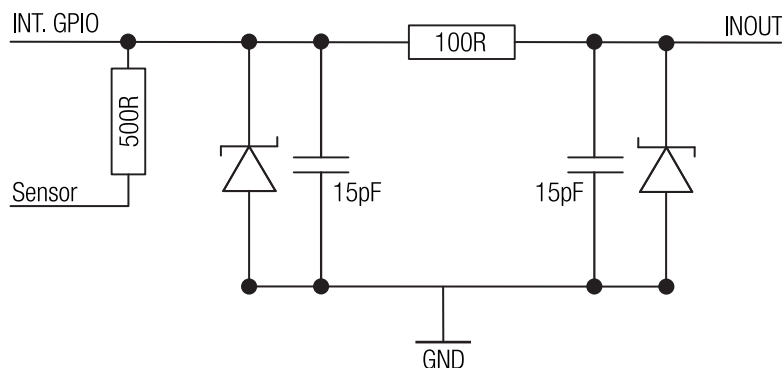


Figure 24: Non-isolated input/output, interface schematic with sensor

Item	Parameter	Note
Maximal input voltage	2 V DC	None
Common pole	YES	None
Effect of incorrect input terminal connection	Reverse voltage can damage the camera	None
Effects when withdrawing/inserting input module under power	May damage camera electronics	None
Protection	ESD and EMI protection	ESD IEC 61000-4-2 (Level 4), EMI PI-filter (R = 100 Ohm, CTO-TAL = 30 pF)
Maximal output sink current	2 mA	None
Inductive loads	false	None
Output Level logical 0	< 0.2 V	Load 100kOhm
Output Level logical 1	> 1.5 V	Load 100 kOhm
Output delay - rising edge	10 ns	Load 100kOhm/10pF threshold 1.4 V
Output delay - falling edge	10 ns	Load 100kOhm/10pF threshold 0.5 V
Input Impedance- minimum	600 Ohm	None
Input Level for logical 0	< 0.4 V	None
Input Level for logical 1	> 1.4 V	None
Input debounce filter	NO	None
Input delay - rising edge	10 ns	VINPUT=1.8 V
Input delay - falling edge	10 ns	VINPUT=1.8 V

Table 28: General info for non-isolated digital in/out trigger lines which are connected directly to sensor

2.9.2 Non-isolated digital lines - Digital Input-Output 1.8V logic (INOUT)

The description of non-isolated digital lines below applies to:
 MU050CR-SY
 MU196MR-ON

MU050MR-SY

MU196CR-ON

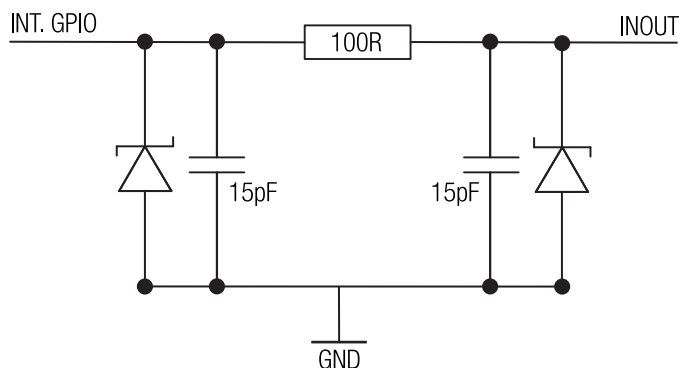


Figure 25: Non-isolated input/output, interface schematic

	Item	Parameter	Note
	Maximal input voltage	2 V DC	None
	Common pole	YES	None
	Effect of incorrect input terminal connection	Reverse voltage can damage the camera	None
	Effects when withdrawing/inserting input module under power	May damage camera electronics	None
	Protection	ESD and EMI protection	ESD IEC 61000-4-2 (Level 4), EMI PI-filter (R = 100 Ohm, CTO-TAL = 30 pF)
	Maximal output sink current	2 mA	None
	Inductive loads	false	None
	Output Level logical 0	< 0.2 V	Load 100kOhm
	Output Level logical 1	> 1.5 V	Load 100 kOhm
	Output delay - rising edge	10 ns	Load 100kOhm/10pF threshold 1.4 V
	Output delay - falling edge	10 ns	Load 100kOhm/10pF threshold 0.5 V
	Input Impedance- minimum	15 kOhm	None
	Input Level for logical 0	< 0.4 V	None
	Input Level for logical 1	> 1.4 V	None
	Input debounce filter	NO	None
	Input delay - rising edge	10 ns	VINPUT=1.8 V
	Input delay - falling edge	10 ns	VINPUT=1.8 V

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

2.10 Accessories

2.10.1 ME-ADPT-MU-T-KIT

xiMU series tripod mounting bracket with screws.

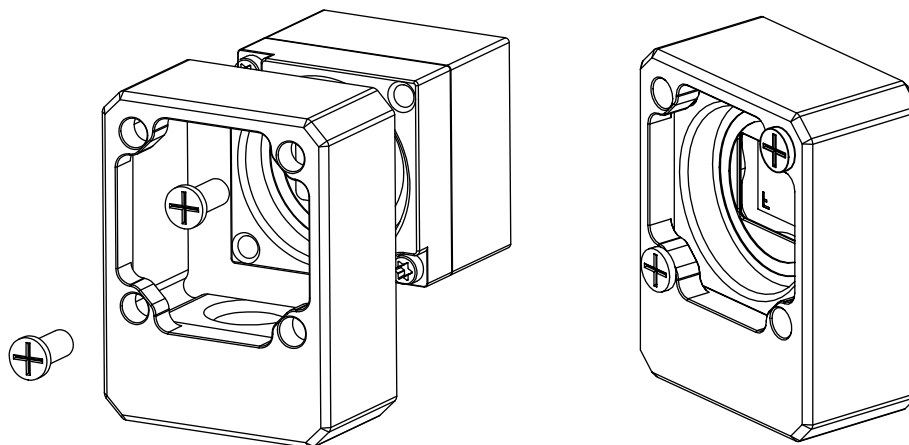


Figure 26: Images of camera with ME-ADPT-MU-T

Use 2x SROB-M2x4-CUST screws (included) for mounting. The camera can be mounted in all four orientations in the bracket.

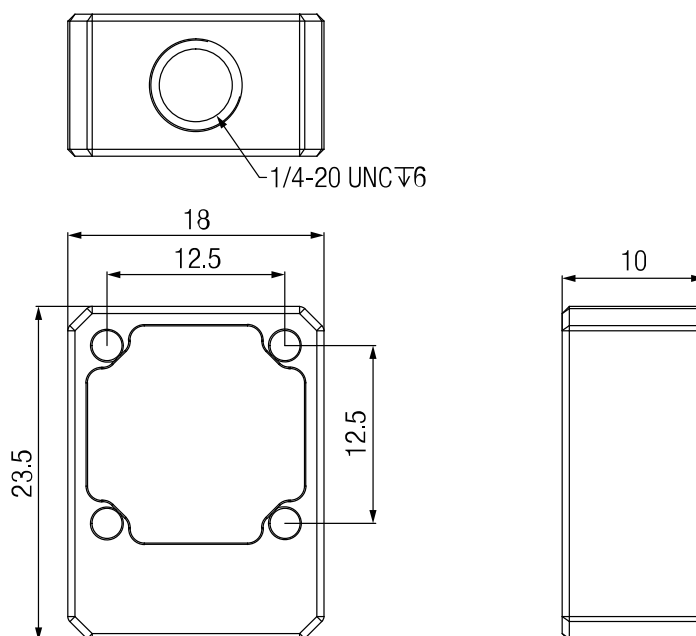


Figure 27: Dimensional drawing of ME-ADPT-MU-T

Width [W]	Height [H]	Depth [D]	Mass [M]	Material
23.5 mm	18 mm	10 mm	4.6 g	Machined aluminum alloy

Table 30: Mechanical parameters of ME-ADPT-MU-T

2.10.2 ME-ADPT-MU-17x17-T

Tripod adapter for MU cameras with housing 17 × 17 mm. Use 2x SROB-M2X3-CUST screws (included) for mounting. The camera can be mounted in all four orientations in the bracket.

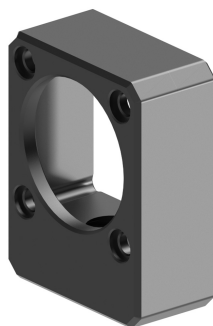


Figure 28: Image of ME-ADPT-MU-17x17-T

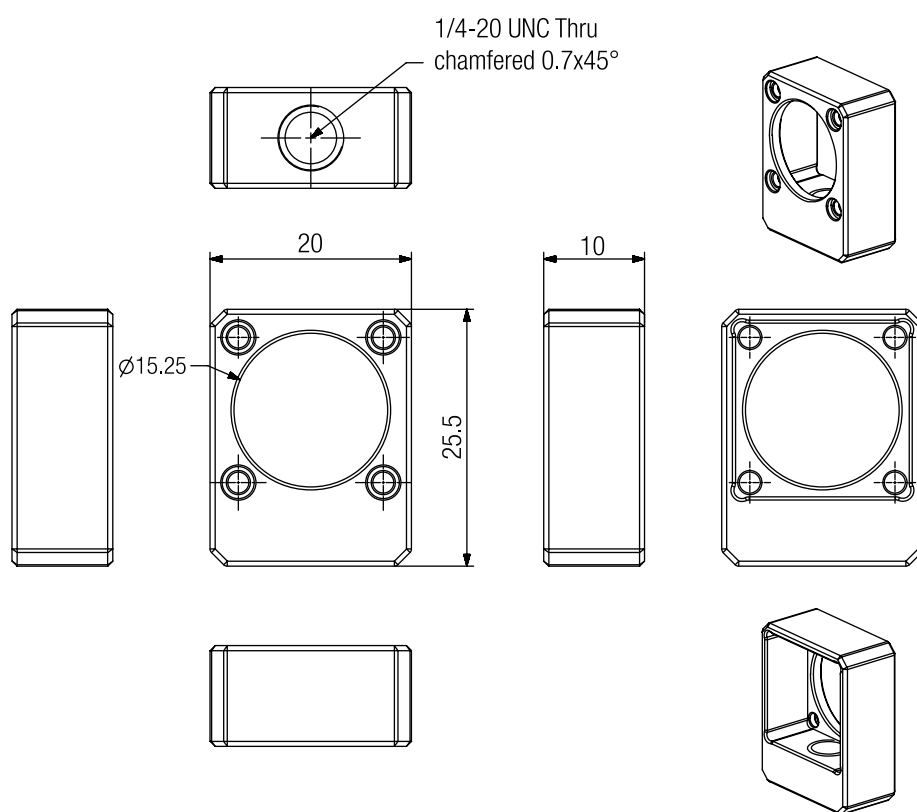


Figure 29: Dimensional drawing of ME-ADPT-MU-17x17-T

Width [W]	Height [H]	Depth [D]	Mass [M]	Material
20 mm	25.5 mm	10 mm	5.7 g	Machined aluminum alloy

Table 31: Mechanical parameters of ME-ADPT-MU-17x17-T

2.10.3 ADPT-MU-CX3-FL / ADPT-MU-17x17-CX3-FL

Item	Value
Connector	Molex 502244-15300 (-FL), Molex 502231-1500 (-FV)
Signals	USB 3.1 Gen1, power, IO
Mating cables	CBL-MQ-FL-0M1, CBL-MQ-FL-0M25, CBL-USB3FLEX-0M10, CBL-USB3FLEX-0M25, CBL-USB3FLEX-0M50

Table 32: ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors description

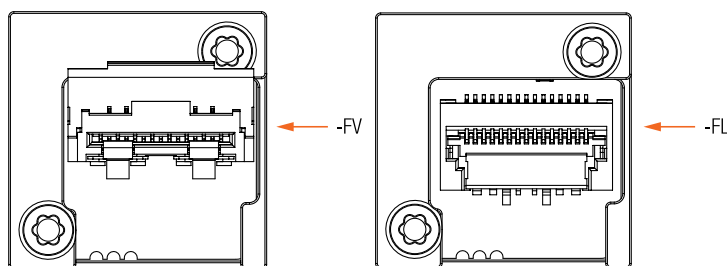


Figure 30: Flex connectors location ADPT-MU-CX3-FL / ADPT-MU-CX3-FV

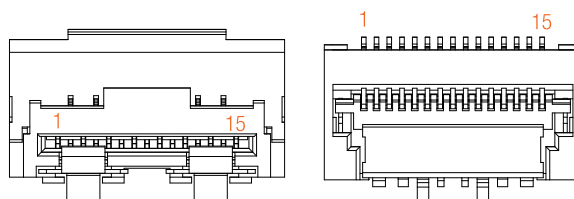


Figure 31: ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors pinout

Pin	Signal	GPI/GPO index API	Description
1	GND	None	Ground for power return and for SuperSpeed signal return
2	SSRX-	None	SuperSpeed receiver differential pair; Accepted SSRX+
3	SSRX+	None	SuperSpeed receiver differential pair; Accepted SSRX-
4	GND	None	Ground for power return and for SuperSpeed signal return
5	SSTX+	None	SuperSpeed transmitter differential pair; Accepted SSTX-
6	SSTX-	None	SuperSpeed transmitter differential pair; Accepted SSTX+
7	GND	None	Ground for power return and for SuperSpeed signal return
8	D+	None	USB 2.0 differential pair
9	D-	None	USB 2.0 differential pair
10	GND	None	Ground for power return and for SuperSpeed signal return
11	VBUS	None	5 V Power input
12	VBUS	None	5 V Power input
13	OUT1	-/1	Non isolated TTL Output
14	IN/OUT GND	None	Common pole (IO Ground)
15	INOUT1	2/2	Non isolated Input/Output (<0.3 Low; > 1.3 High)
Ground pins	SGND	None	Shield of FPC cable connected to shield of host controller

Table 33: ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors pin assignment

GPIO

Digital Input/Output (INOUT)

Item	Parameter / Note
Maximal input voltage	24 V DC
Common pole	YES
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	no damage, no lost data
Protection	Reverse voltage
Input Impedance- minimum	15 k Ω
Input Level for logical 0	< 0.3 V
Input Level for logical 1	> 1.3 V
Input debounce filter	NO
Input delay - rising edge	<300 ns / VINPUT=2 V
Input delay - falling edge	<450 ns / VINPUT=2 V
Output Impedance- minimum	15 k Ω
Output Level for logical 0	< 0.3 V, Rload = 100 k Ω
Output Level for logical 1	> 1.6 V, Rload = 100 k Ω
Output delay - rising edge	<100 μ s, Rload = 100 k Ω , AMBIENT=25 °C
Output delay - falling edge	<100 μ s, Rload = 100 k Ω , AMBIENT=25 °C

Table 34: General info for digital input, ADPT-MU-CX3-FL / ADPT-MU-CX3-FV adapters

Digital Output (OUT)

Item	Parameter / Note ¹
Common pole	YES
Effects when withdrawing/inserting input module under power	May damage camera electronics
Protection	ESD and short circuit ²
Maximal output sink current	20 mA
Inductive loads	NO
Output Level logical 0	< 0.8 V, Load 100 k Ω
Output Level logical 1	> 4.5 V, Load 100 k Ω
Output delay - rising edge	<20 ns, Load 100 k Ω threshold 1.5 V
Output delay - falling edge	<20 ns, Load 100 k Ω threshold 0.5 V

¹Note that the GPO signals are routed through unidirectional level translators, therefore High Impedance GPO mode setting is not supported

²ESD HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV; CDM JESD22-C101E exceeds 1000 V

Table 35: General info for digital output, ADPT-MU-CX3-FL / ADPT-MU-CX3-FV adapters

Dimensional drawings

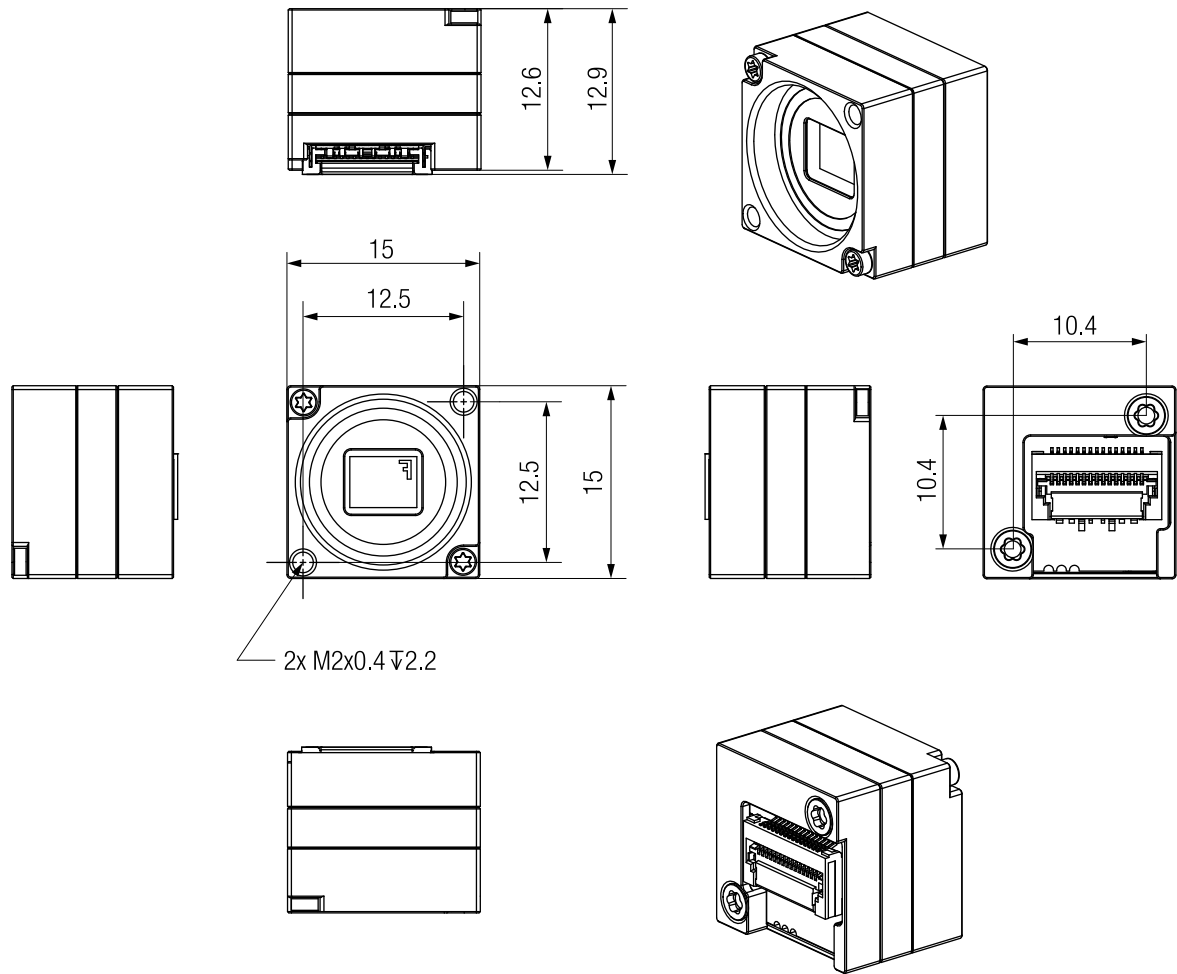


Figure 32: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-FL adapter

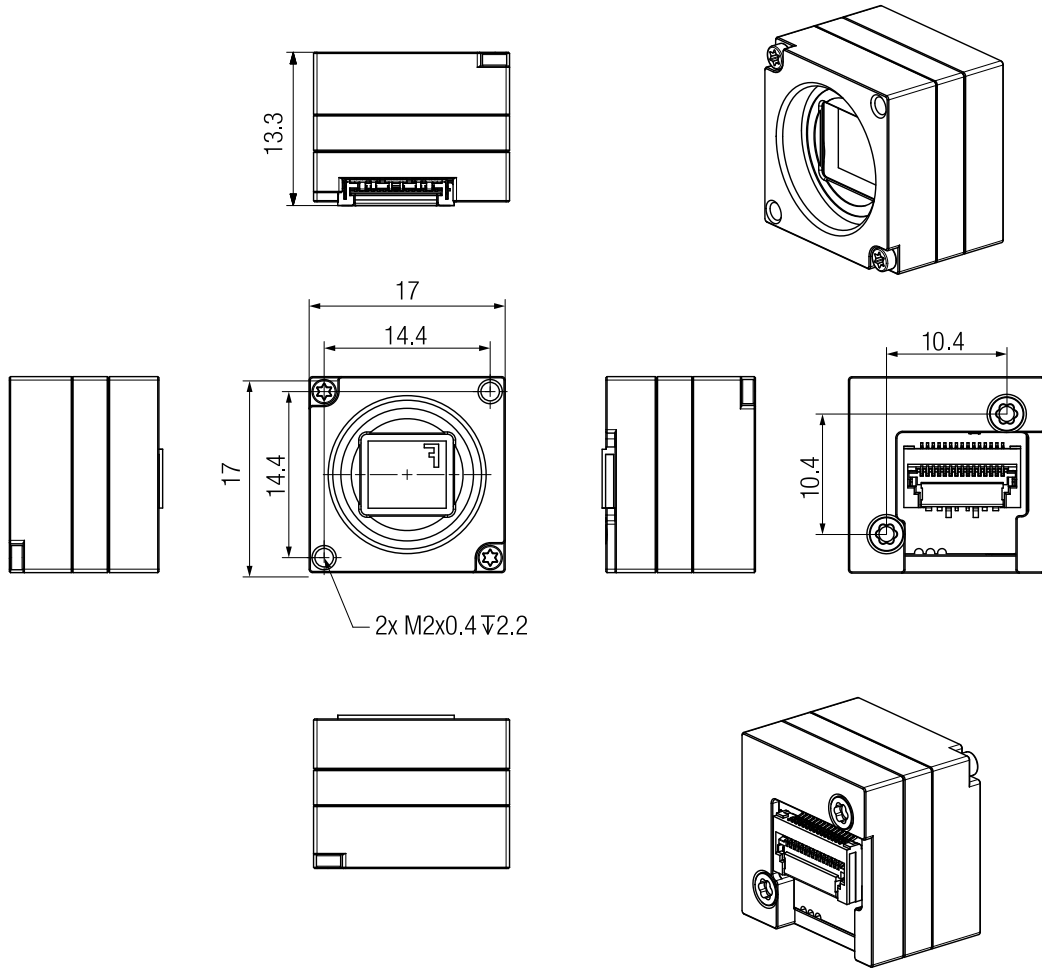


Figure 33: Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-FL adapter

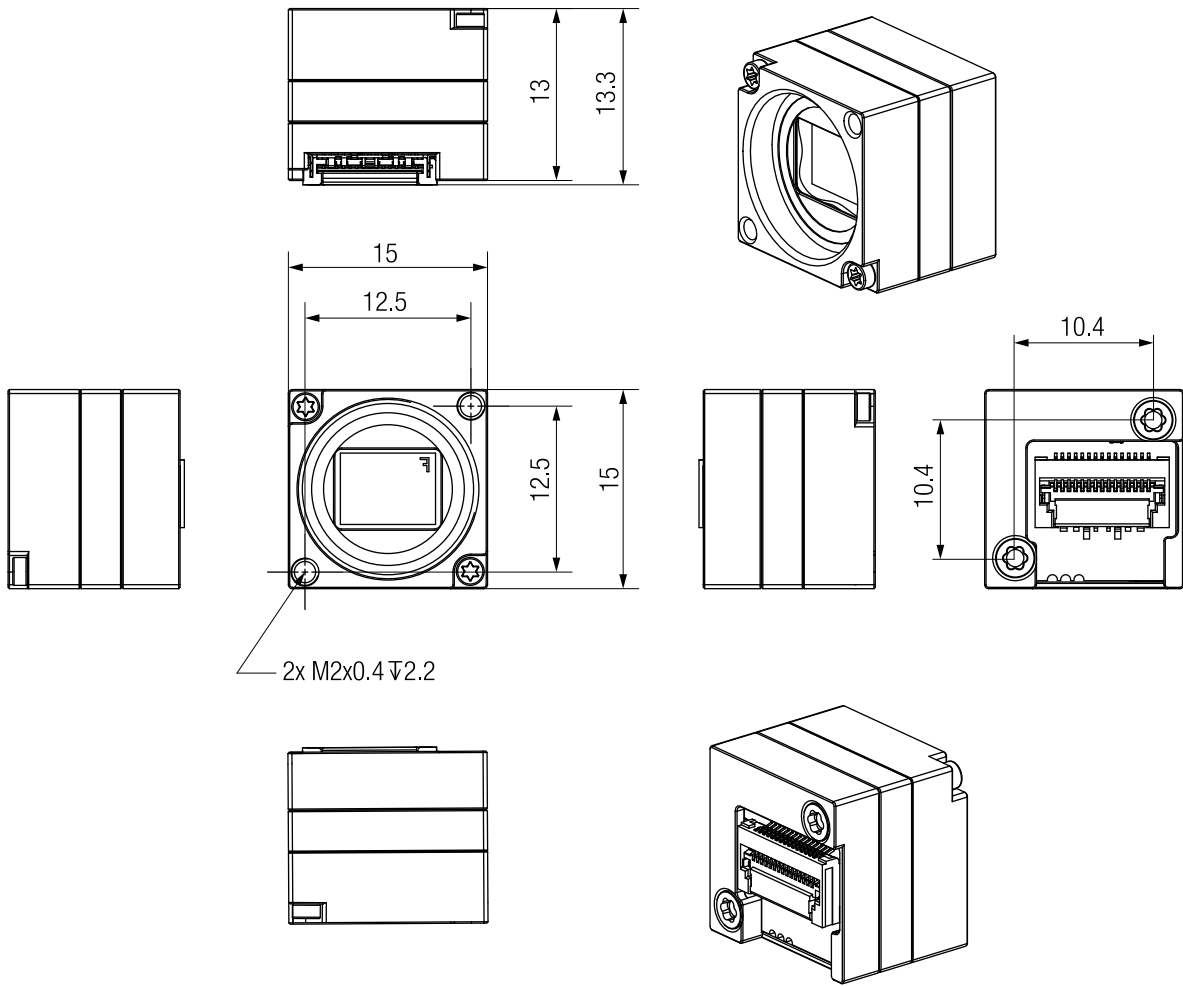


Figure 34: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-FL adapter

Connecting the components

- camera with adapter ADPT-MU-CX3-TC-FV / Adapter ADPT-MU-CX3-TC-FL (or 17 mm version)
- CBL-MQ-FL-0M1 or CBL-MQ-FL-0M25
- host adapter (e.g. BOB-MQ-FL)
- host PC

Cables CBL-MQ-FL-xxx have marked ends. It is important to connect the end marked “CAM” to the camera and the end marked “BOB” to the host or adapter. Swapped orientation can cause damage to the camera.

Adapter connectors are equipped with a locking mechanism. When locked, pulling the cable may lead to damage to the connector or the camera. When manipulating the cable, the power supply for the camera must be turned off.

- Step 1.** Open the lock on the connector.
- Step 2.** Insert flex cable (e.g. CBL-MQ-FL-0M1) to the camera.
- Step 3.** Close the connector lock.
- Step 4.** Connect cable to the host adapter BOB-MQ-FL.
- Step 5.** Connect host adapter to pc via USB cable.
- Step 6.** Turn on the computer.

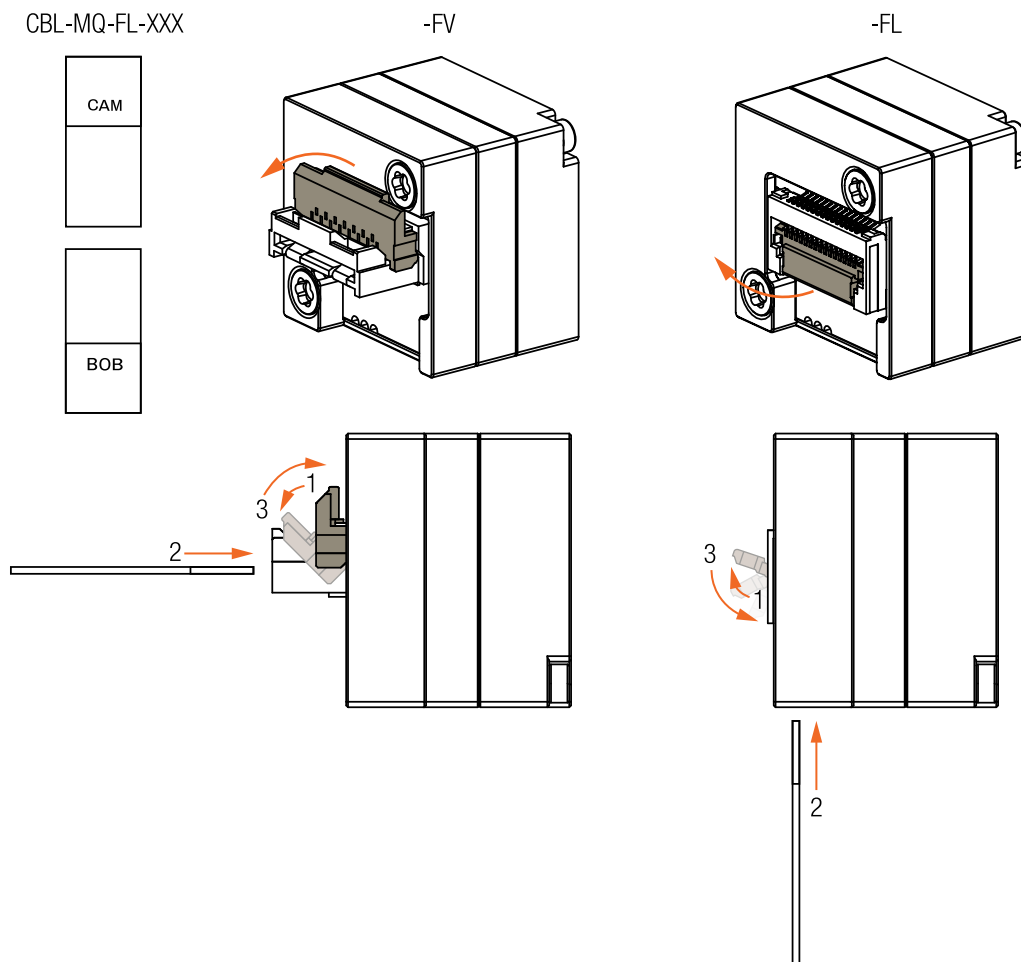


Figure 35: Connecting steps, camera with ADPT-MU-CX3-TC-FV / ADPT-MU-CX3-TC-FL adapter

For detaching the flex cable, open the lock on the connector, gently pull the flex cable in the direction opposite to how it was inserted, and close the connector lock.

2.10.4 ADPT-MU-CX3-TC-V / ADPT-MU-17x17-CX3-TC-V

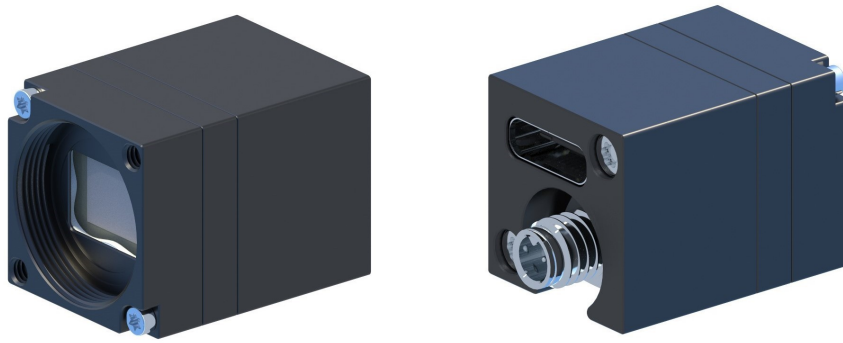


Figure 36: Isometric view of ADPT-MU-TC-V

Adapter with Type-C USB 3 connector and 3pin M5 IO connector.

Num.	Connector
1	USB 3.1 Gen1 Type-C
2	IO connector

Table 36: ADPT-MU-CX3-TC-V connectors

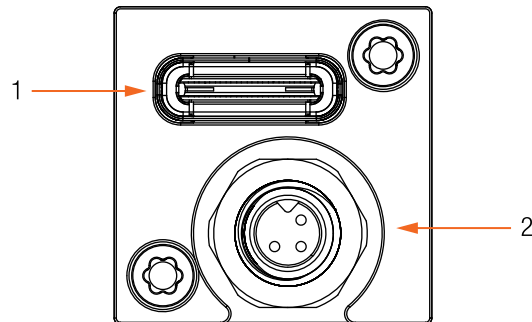


Figure 37: ADPT-MU-CX3-TC-V connectors location

Item	Value
Connector	USB Type-C
Signal	USB 3.1 Gen1, power
Mating cables	Cables specified by USB Type-C specification

Table 37: ADPT-MU-CX3-TC-V USB3 Type-C connector description

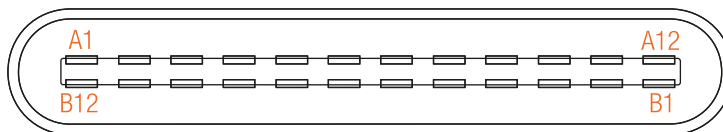


Figure 38: ADPT-MU-CX3-TC-V USB3 Type-C connector pinout

Pin	Signal	Description	Pin	Signal	Description
A1	GND	Ground return	B12	GND	Ground return
A2	SSTXp1	SuperSpeed differential pair #1, TX, pos.	B11	SSRXp1	SuperSpeed differential pair #2, RX, pos.
A3	SSTXn1	SuperSpeed differential pair #1, TX, neg.	B10	SSRXn1	SuperSpeed differential pair #2, RX, neg.
A4	V-BUS	Bus power	B9	VBUS	Bus power
A5	CC1	Configuration channel	B8	SBU2	Sideband use (SBU)
A6	Dp1	Non-SuperSpeed diff. pair, position 1, pos.	B7	Dn2	Non-SuperSpeed diff. pair, position 2, neg.
A7	Dn1	Non-SuperSpeed diff. pair, position 1, neg.	B6	Dp2	Non-SuperSpeed diff. pair, position 2, pos.
A8	SBU1	Sideband use (SBU)	B5	CC2	Configuration channel
A9	VBUS	Bus power	B4	VBUS	Bus power
A10	SSRXn2	SuperSpeed differential pair #4, RX, neg.	B3	SSTXn2	SuperSpeed differential pair #3, TX, neg.
A11	SSRXp2	SuperSpeed differential pair #4, RX, pos.	B2	SSTXp2	SuperSpeed differential pair #3, TX, pos.
A12	GND	Ground return	B1	GND	Ground return

Table 38: ADPT-MU-CX3-TC-V USB3 type-C connector pin assignment

Item	Value
Connector	Binder 09 3105 81 03
Signal	Digital Input and Output
Mating connectors	Binder 77 3550 0000 40003-0x000
Ximea PN	CBL-S-M5-3P-PT-5M0

Table 39: ADPT-MU-CX3-TC-V GPIO connector description

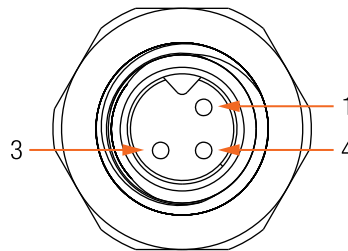


Figure 39: ADPT-MU-CX3-TC-V IO connector pinout

Pin	Name	GPI/GPO index API	Description
1	GPIO_GND	None	Common ground for Input and Output
3	INOUT	2/2	Nonisolated Input/Output
4	OUT	-/1	Nonisolated TTL Output

Table 40: GPIO connector pin assignment

Digital Input/Output (INOUT)

Item	Parameter / Note
Maximal input voltage	24 V DC
Common pole	YES
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	no damage, no lost data
Protection	Reverse voltage
Input Impedance- minimum	15 k Ω
Input Level for logical 0	< 0.3 V
Input Level for logical 1	> 1.3 V
Input debounce filter	NO
Input delay - rising edge	<300 ns / VINPUT=2 V
Input delay - falling edge	<450 ns / VINPUT=2 V
Output Impedance- minimum	15 k Ω
Output Level for logical 0	< 0.3 V, Rload = 100 k Ω
Output Level for logical 1	> 1.6 V, Rload = 100 k Ω
Output delay - rising edge	<100 μ s, Rload = 100 k Ω , AMBIENT=25 °C
Output delay - falling edge	<100 μ s, Rload = 100 k Ω , AMBIENT=25 °C

Table 41: General info for digital input / output, ADPT-MU-CX3-TC-V adapter

Digital Output (OUT)

Item	Parameter / Note ¹
Common pole	YES
Effects when withdrawing/inserting input module under power	May damage camera electronics
Protection	ESD and short circuit ²
Maximal output sink current	20 mA
Inductive loads	NO
Output Level logical 0	< 0.8 V, Load 100 k Ω
Output Level logical 1	> 4.5 V, Load 100 k Ω
Output delay - rising edge	<20 ns, Load 100 k Ω threshold 1.5 V
Output delay - falling edge	<20 ns, Load 100 k Ω threshold 0.5 V

¹Note that the GPO signals are routed through unidirectional level translators, therefore High Impedance GPO mode setting is not supported

²ESD HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV; CDM JESD22-C101E exceeds 1000 V

Table 42: General info for digital output, ADPT-MU-CX3-TC-V adapter

Dimensional drawings

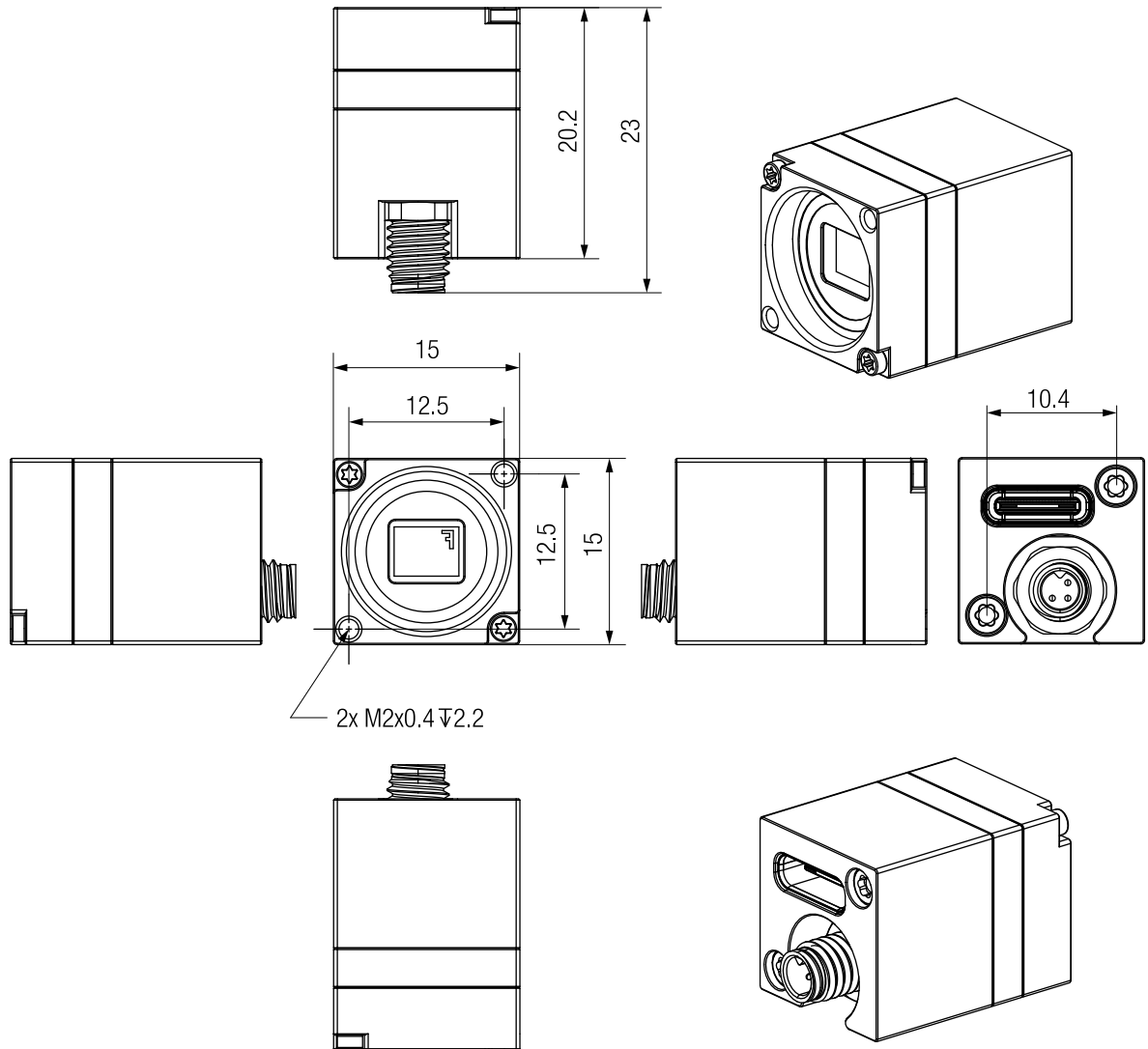


Figure 40: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-TC-V adapter

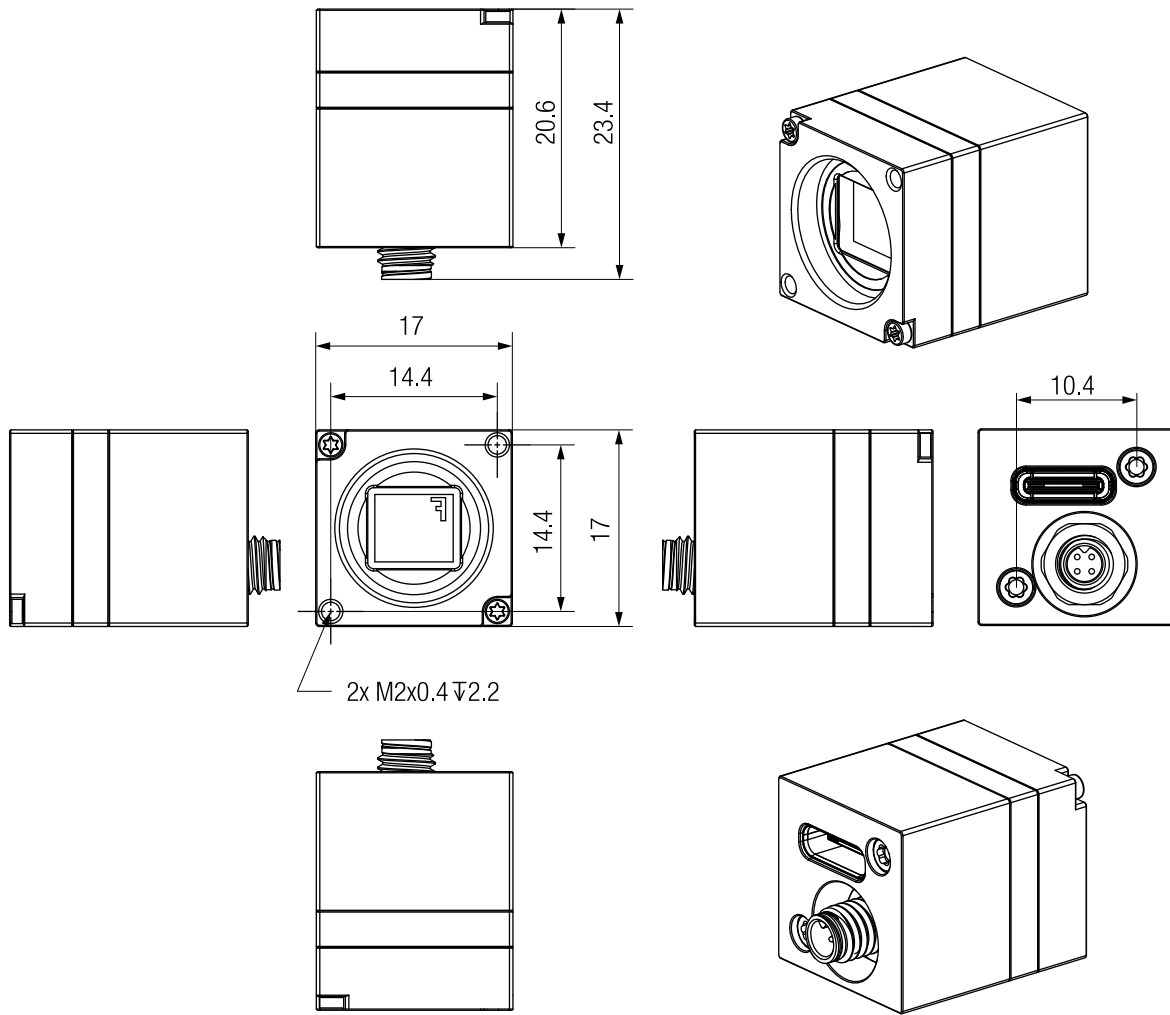


Figure 41: Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-TC-V adapter

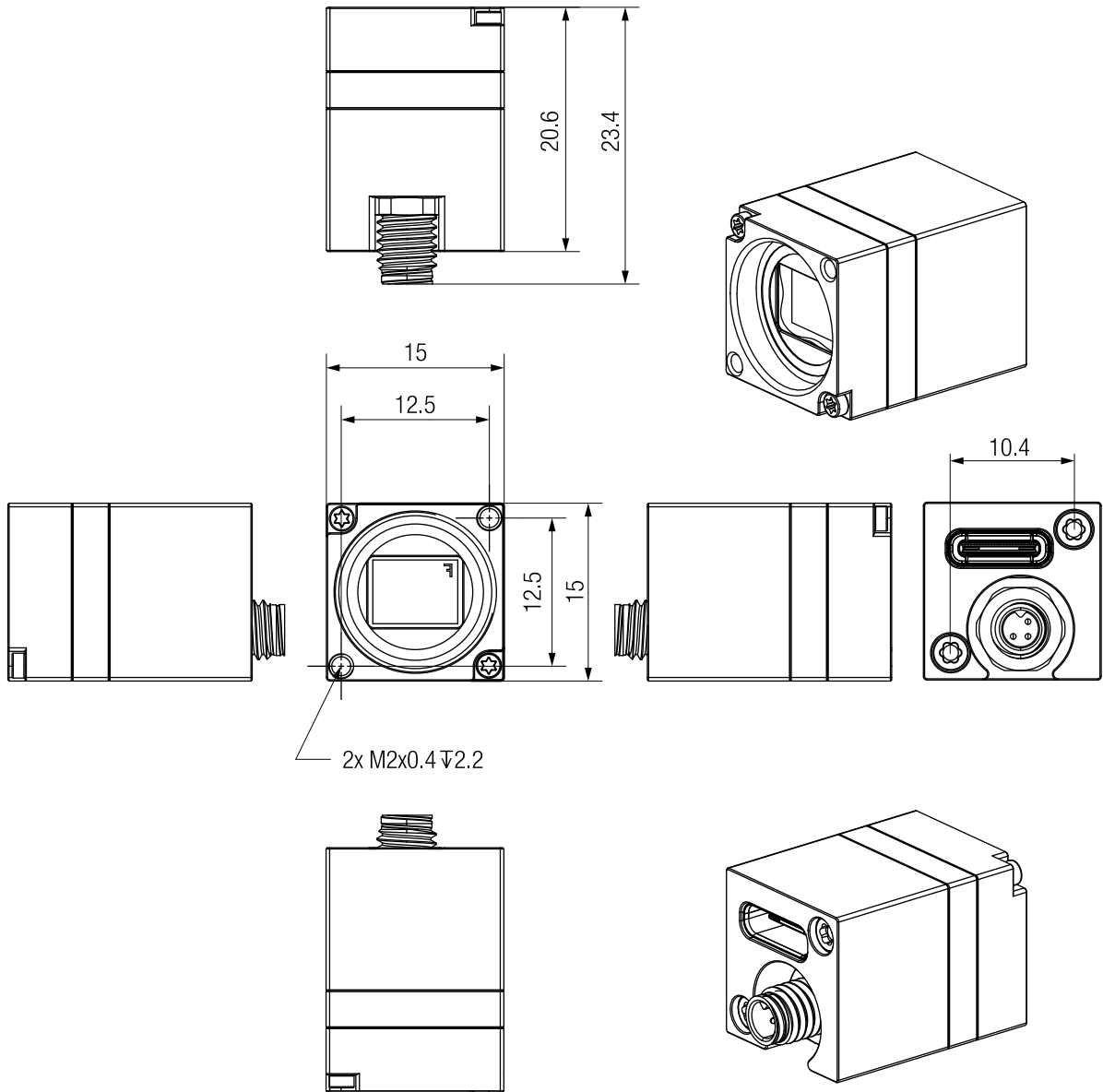


Figure 42: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-TC-V adapter

2.10.5 ADPT-MU-CX3-UC / ADPT-MU-17x17-CX3-UC

Item	Value
Connectors	Future Electronics 20374-R14E-31
Signals	USB 3.1 Gen1, power, IO
Mating cables	CBL-U3-PSD-UC-0M10, CBL-U3-PSD-UC-0M25, CBL-U3-PSD-UC-0M50, CBL-U3-PSD-UC-1M0

Table 43: ADPT-MU-CX3-UC connector description

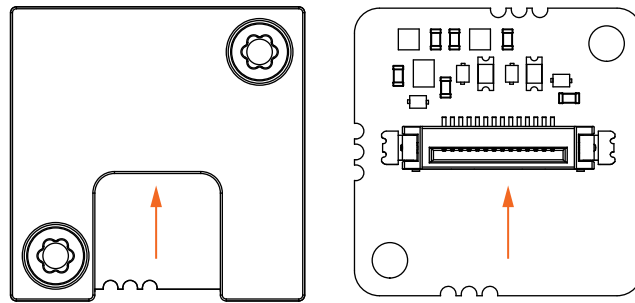


Figure 43: Location of connector

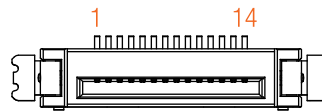


Figure 44: ADPT-MU-CX3-UC connector pinout

Pin	Signal	GPI/GPO index API	Description
1	VBUS	None	+5 V Power input
2	VBUS	None	+5 V Power input
3	INOUT2	4/4	Non-isolated Input/Output 2
4	OUT2	-/3	Non-isolated Output 2
5	SSRX+	None	SuperSpeed receiver differential pair
6	SSRX-	None	SuperSpeed receiver differential pair
7	D+	None	2.0 differential pair
8	D-	None	2.0 differential pair
9	SSTX+	None	SuperSpeed transmitter differential pair
10	SSTX-	None	SuperSpeed transmitter differential pair
11	INOUT1	2/2	Non-isolated Input/Output 1
12	OUT1	-/1	Non-isolated Output 1
13	VBUS	None	+5 V Power input
14	VBUS	None	+5 V Power input

Table 44: ADPT-MU-CX3-UC connector pin assignment

GPIO

Digital Input/Output (INOUT)

Item	Parameter / Note
Maximal input voltage	24V DC
Common pole	YES
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	no damage, no lost data
Protection	Reverse voltage
Input Impedance- minimum	15 k Ω
Input Level for logical 0	< 0.3 V
Input Level for logical 1	> 1.3 V
Input debounce filter	NO
Input delay - rising edge	< 300 ns, VINPUT=2 V
Input delay - falling edge	< 450 ns, VINPUT=2 V

Table 45: General info for digital input / output, ADPT-MU-CX3-UC adapter

Digital Output (OUT)

Item	Parameter / Note ¹
Common pole	YES
Effects when withdrawing/inserting input module under power	May damage camera electronics
Protection	ESD and short circuit ²
Maximal output sink current	20 mA
Inductive loads	NO
Output Level logical 0	< 0.8 V, Load 100 k Ω
Output Level logical 1	> 4.5 V, Load 100 k Ω
Output delay - rising edge	< 20 ns, Load 100 k Ω threshold 1.5 V
Output delay - falling edge	< 20 ns, Load 100 k Ω threshold 0.5 V

¹Note that the GPO signals are routed through unidirectional level translators, therefore High Impedance GPO mode setting is not supported

²ESD HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV; CDM JESD22-C101E exceeds 1000 V

Table 46: General info for digital output, ADPT-MU-CX3-UC adapter

Dimensional drawings

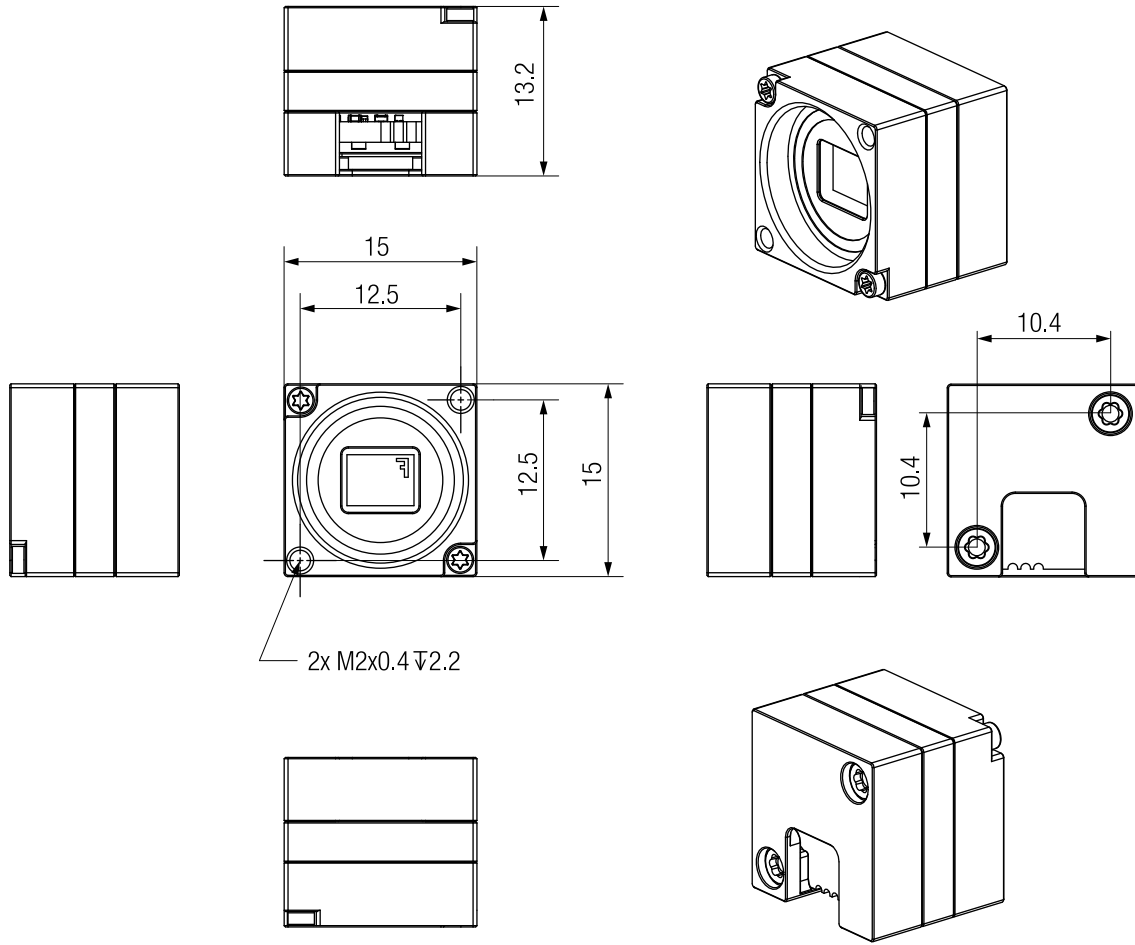


Figure 45: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-UC adapter

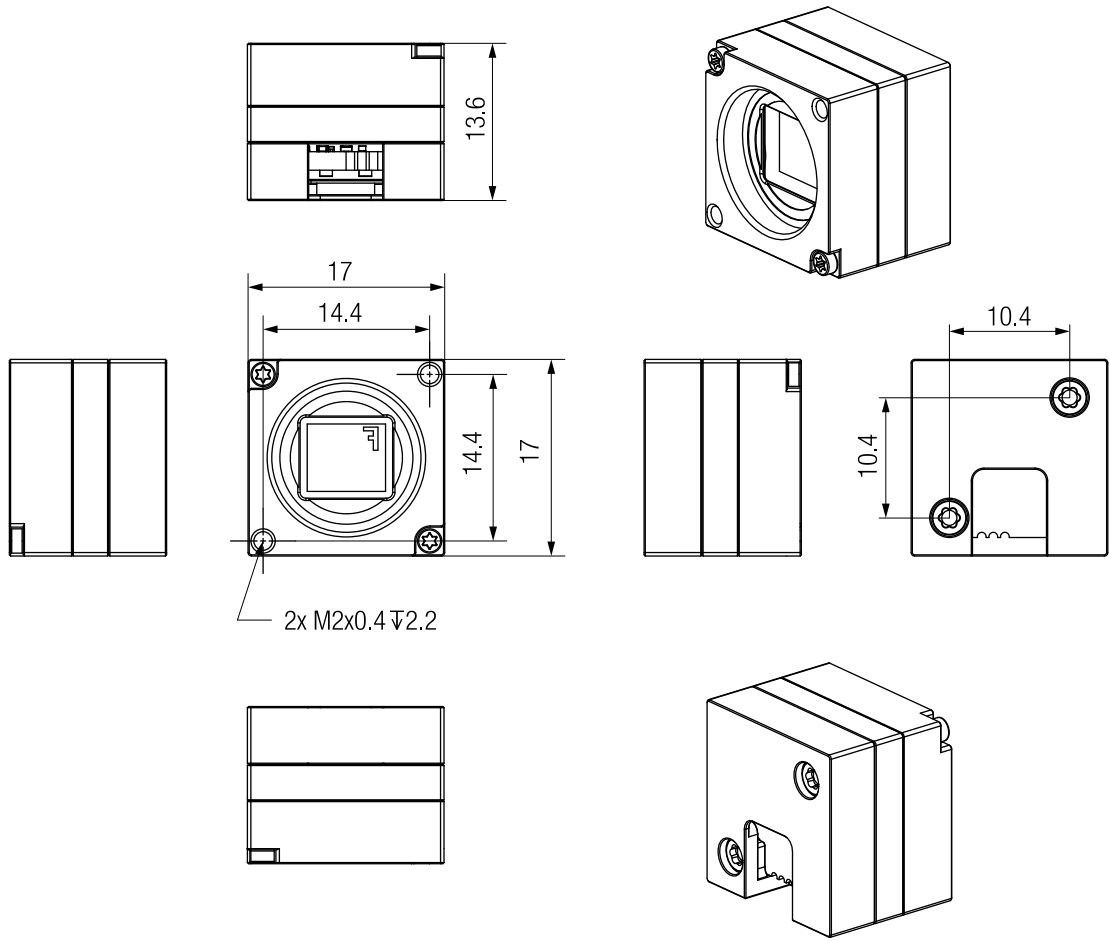


Figure 46: Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-UC adapter

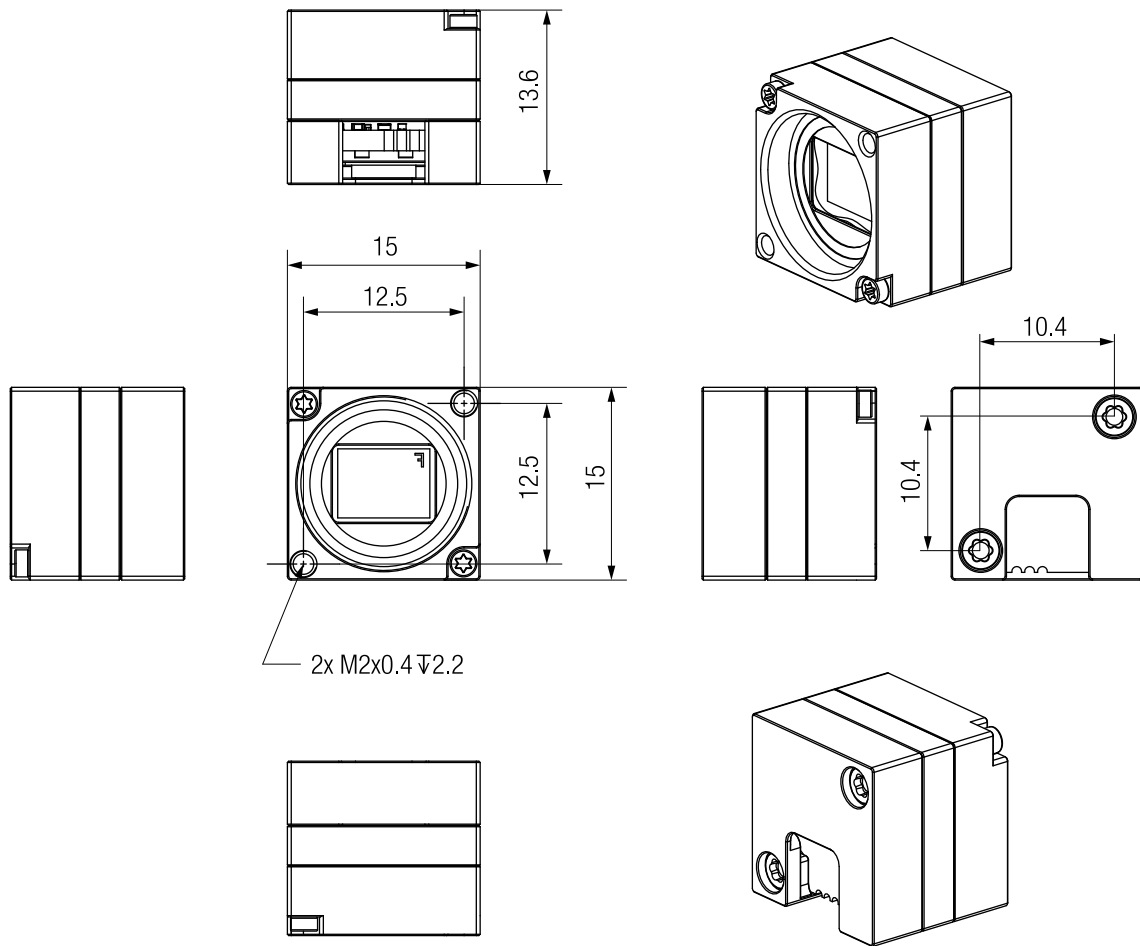


Figure 47: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-UC adapter

2.10.6 BOB-MQ-FL

Break Out Board, Simple Board Level. Enables access to the optoisolated input and output. FPC cable connector pinout is exactly mirrored from camera pinout.

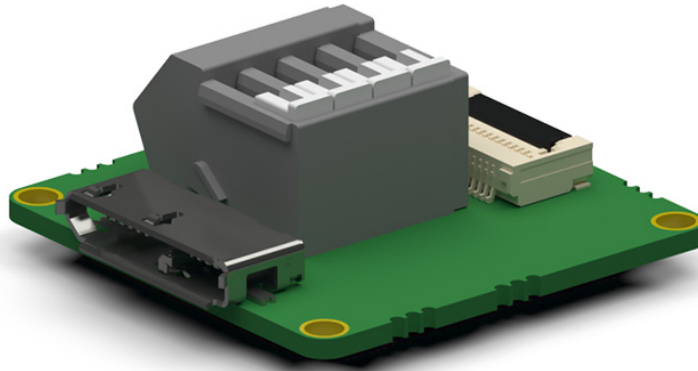


Figure 48: BOB-MQ-FL

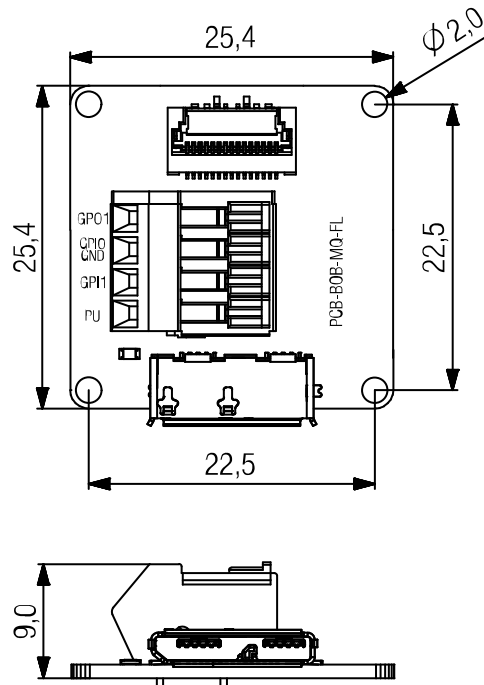


Figure 49: BOB-MQ-FL dimensions

Pin	Signal	Description
1	GPO1	Trigger/sync digital Output (GPO) - Open collector NPN – connected to pin 3 on Flex connector
2	GPIO	GND GPO1 and GPI1 common ground – connected to pin2 on Flex connector
3	GPI1	Trigger/sync digital Input (GPI) Current limited input – connected to pin1 on Flex connector
4	PU	Pull up 1 k Ω to GPO1 – Connect power supply up to 25 V if needed

Table 47: IO connector (WAGO 218-104), pin assignment

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 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 $k \times l$ 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 $\frac{1}{4}$ 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 2×1 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:
MU050CR-SY

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity] ^{1,2}
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB] ^{1,2}
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_RAW16X2	16 bits per pixel raw data from sensor(2 components in a row)
XI_RGB16_PLANAR	RGB16 planar data format
XI_RGB24	RGB data format. [Blue][Green][Red] ¹
XI_RGB32	RGBA data format. [Blue][Green][Red][0] ¹
XI_RGB48	RGB data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high] ¹
XI_RGB64	RGBA data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high][0][0] ¹
XI_RGB_PLANAR	RGB planar data format. [Red][Red]...[Green][Green]...[Blue][Blue]... ¹
XI_FRM_TRANSPORT	Data from transport layer (e.g. packed). Depends on data on the transport layer ³

¹Higher 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.

²On 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.

³When 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 48: Image data output formats

This table is applicable to:
MU050MR-SY

Mode	Description
XI_MONO8	8 bits per pixel. [Intensity] ^{1,2}
XI_MONO16	16 bits per pixel. [Intensity LSB] [Intensity MSB] ^{1,2}
XI_RAW8	8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output)
XI_RAW16	16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data
XI_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

¹Higher 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.

²On 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.

³When 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 49: Image data output formats

This table is applicable to:
MU051CG-SY

MU196CR-ON

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

¹Higher 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.

²On 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.

³When 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 50: Image data output formats

This table is applicable to:
MU051MG-SY

MU196MR-ON

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

¹Higher 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.

²On 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.

³When 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 51: 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).

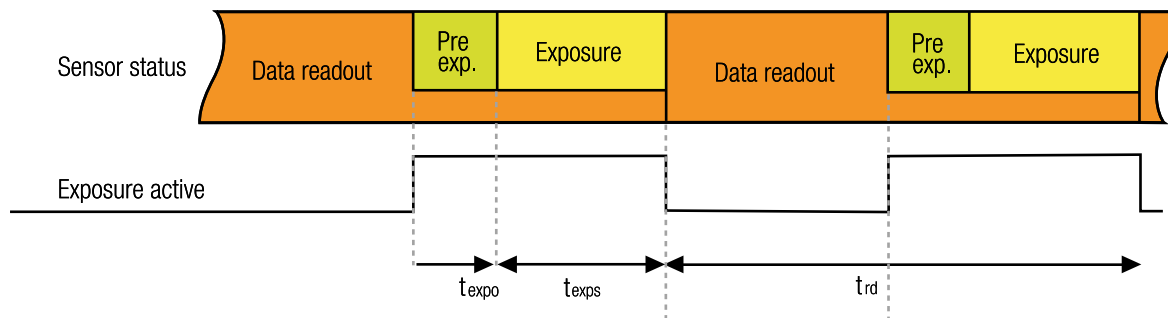


Figure 50: Acquisition mode - free run

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. 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.

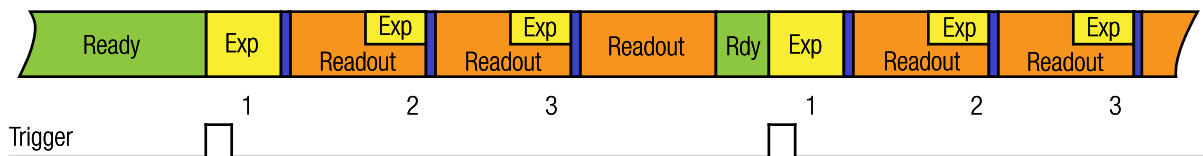


Figure 51: Triggered burst of frames – frame burst start

Frame Burst Active

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

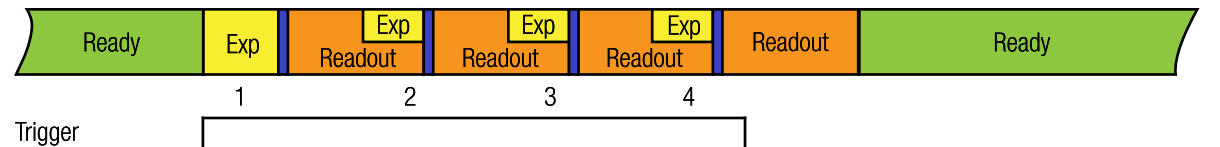


Figure 52: Triggered burst of frames – frame burst active

Triggered mode - Multiple exposures in one frame

This feature allows multiple exposures to be combined into a single frame. The number of exposures can be specified by the user by setting the `XI_PRM_EXPOSURE_BURST_COUNT` xiapi parameter. Once the specified number of exposures is completed, the readout of the frame begins. The feature supports two operational modes, which can be configured as needed based on the application requirements.

In this mode the number of exposures need to be defined.

The number of exposures can be defined using the xiApi parameter `XI_PRM_EXPOSURE_BURST_COUNT`. The readout of the frame starts after the last exposure period has finished.

It can operate in two modes:

Exposure defined by xiApi parameter “`XI_PRM_EXPOSURE`”

In this mode the trigger defines the start of the exposure, but the length of the exposure is defined by the `XI_PRM_EXPOSURE` xiApi parameter. Set exposure length using `XI_PRM_EXPOSURE` parameter and set `XI_PRM_TRG_SELECTOR` to `XI_TRG_SEL_EXPOSURE_START`.

```
// Set exposure
xiSetParamInt(xiH, XI_PRM_EXPOSURE, 1000);
// Set the number of times of exposure in one frame
xiSetParamInt(xiH, XI_PRM_EXPOSURE_BURST_COUNT, 5);
// Set trigger selector
xiSetParamInt(xiH, XI_PRM_TRG_SELECTOR, XI_TRG_SEL_EXPOSURE_START);
```

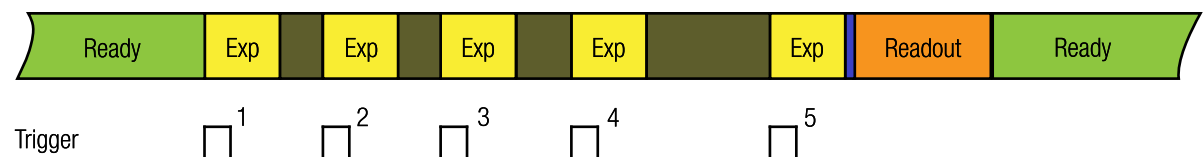


Figure 53: Multiple exposures - defined exposure time number - of exposures set to 5

Exposure is defined by length of trigger pulse

In this mode both the start of the exposure as well as the length of the exposure is defined by the trigger pulse. Set `XI_PRM_TRG_SELECTOR` to `XI_TRG_SEL_EXPOSURE_ACTIVE`. The exposure length will be defined by trigger pulse length.

```
// Set the number of times of exposure in one frame
xiSetParamInt(xiH, XI_PRM_EXPOSURE_BURST_COUNT, 5);
// Set trigger selector
xiSetParamInt(xiH, XI_PRM_TRG_SELECTOR, XI_TRG_SEL_EXPOSURE_ACTIVE);
```

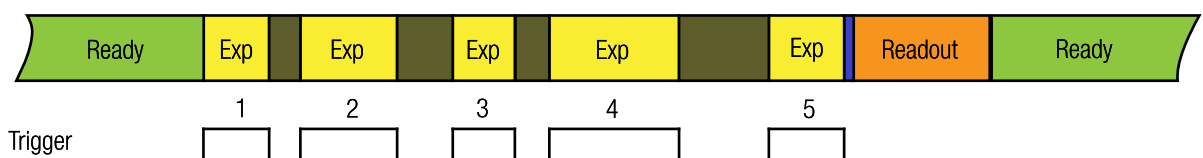


Figure 54: Multiple exposures - exposure time defined by trigger pulse length - number of exposures set to 5

In both above modes there is a short period (FOT) after each exposure during which the next exposure cannot start. In case of the cameras with IMX sensors this period is $11 \times$ line period.

3.3 Exposure time

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

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

3.4 Gain

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

3.5 Dual ADC modes

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

The following description is a general description of the feature. Not all dual ADC readout modes and corresponding parameters are necessarily supported by all of the camera models. Please refer to the [Sensor read-out modes](#) table for your camera model to check if dual ADC modes are supported and, if so, which ones are available.

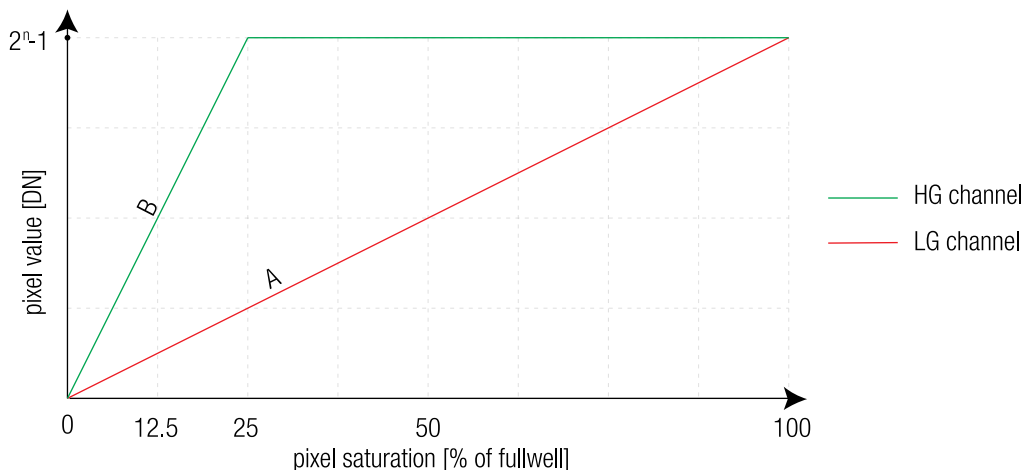


Figure 55: Dual ADC non-combined without merging

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

Following camera models support Non-combined mode: MU050CR-SY and MU050MR-SY.

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.

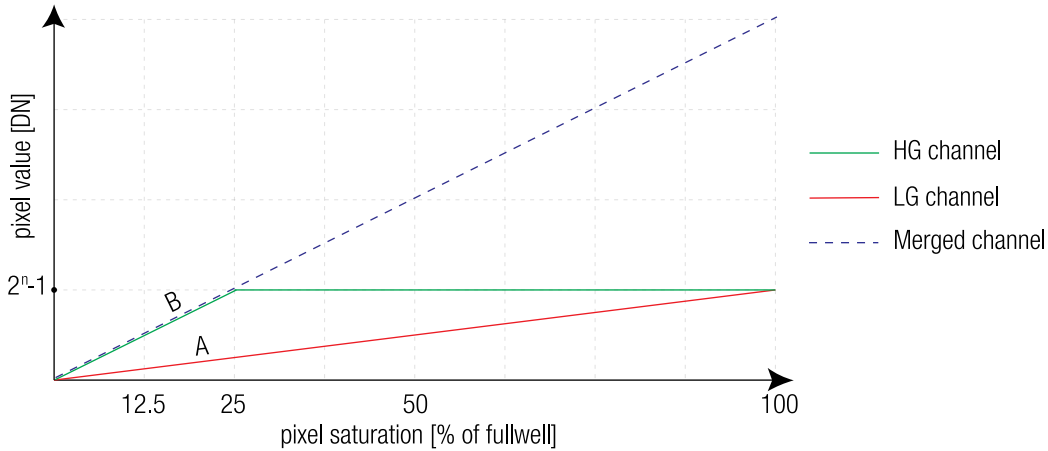


Figure 56: Dual ADC non-combined with merging

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

Following camera models support Combined mode: MU196CR-ON and MU196MR-ON.

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.

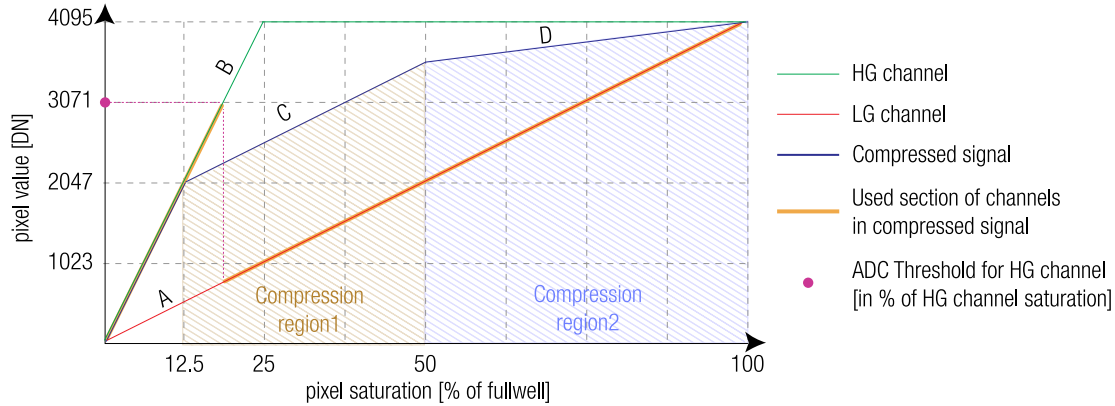


Figure 57: Dual ADC combined mode

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 12 dB
// Set up the start and gain (Slope C) of compression region 1
xiSetParamInt(xiH, XI_PRM_COMPRESSION_REGION_SELECTOR,1);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_START,12.5);
xiSetParamFloat(xiH, XI_PRM_COMPRESSION_REGION_GAIN,-12);

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

3.6 Sensor Shutter Modes

Cameras can be operated in two shutter modes, Rolling Shutter or Global Reset Release. The Rolling Shutter mode is used if the camera is operated in free-run mode. If the camera is triggered, either by hardware trigger or through software, the sensor uses the Global Reset Release mode.

3.6.1 Global Reset Release Mode

Following camera models support Global Reset Release mode: MU196CR-ON and MU196MR-ON.

- Global reset of all photo diodes
- Integration stage

Transfer, conversion and readout line by line starts at the end of the integration of the first line. Not transferred line stays in integration stage until readout of particular line starts. This leads to different exposure time for individual lines. Each next line has exposure longer by readout of one line.



Figure 58: Global reset release mode - schematic

Because of the longer exposure of the lower lines they may show increased blurring if the object moves. To freeze the motion, a flash may be used. In contrast to rolling shutter mode the flash strobe does not need to be delayed.



Figure 59: Global reset release mode - image horizontally moved object

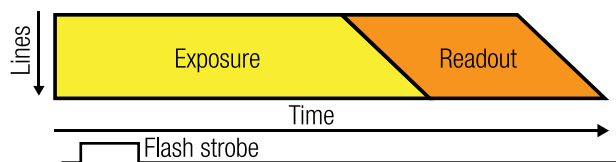


Figure 60: Global reset release mode with flash - schematic

3.6.2 Rolling Shutter Mode

Following camera models support Rolling Shutter mode: MU050CR-SY, MU050MR-SY, MU196CR-ON and MU196MR-ON.

- Line by line integration state
- Line by line transfer and readout

Integration of next line is delayed by readout time of one line

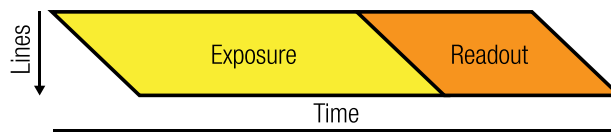


Figure 61: Rolling shutter mode - schematic

Because of the sequential start of the exposure, the rolling shutter mode may introduce artifacts effect if objects move. In the direction of the lines (horizontal) the image will be sheared. When moving in vertical direction, the object may appear longer or shorter. When the exposure is longer also motion blur may occur



Figure 62: Rolling shutter mode image of a horizontally moved object



Figure 63: Rolling shutter mode image of a horizontally moved object, long exposure time

Rolling shutter artifacts may be prevented by using a flash or stroboscopic light. The flash or strobe must occur when all lines are exposed simultaneously. The exact timing depends on sensor type and readout timing. In Rolling shutter mode all lines are triggered consecutively, and a strobe must be timed so that it does not start before all lines are open. The delay can be calculated from the highest frame rate and is $1/\text{fps}$. The strobe must also end before the first lines are closed again for exposure, which sets a lower limit for the exposure time, as can be seen in the figure above.

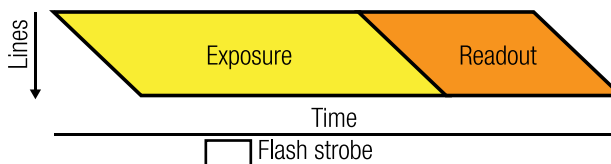


Figure 64: Rolling shutter mode with flash - schematic

3.6.3 How to Freeze the Motion

When a moving object (e.g. on a conveyor belt) is imaged with a longer exposure time, the resulting image will show Motion Blur. To avoid Motion Blur the short exposure times or flash illumination should be used.

Example of a setup with MU9 camera:

```
Sensor width (W) 0.0057m
2520 pixel horizontally (PX)
Field of view (FOV) 0.2m
Conveyor speed (CS) 0.1m/s
```

To contain Motion Blur to within one image pixel the following calculation for the flash light duration may be used:

```
Pixel distance (PD) W/PX -> 0.0057m/2592pixels = 2.2um.
Pixel distance recalculated FOVPD = FOV/PX = 0.2m/2592 = 77.2um
During exposure the object should not move more than 77.2um
Flash Time (FT) should be less than FOVPD/CS = 77.2um/0.1m/s = 0.772ms
```

3.7 API Features

Host-assisted image processing features available in xiAPI

3.7.1 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).

3.7.2 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 achieve a neutral colour tint.

3.7.3 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.

3.7.4 Sharpness

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

3.7.5 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.

3.7.6 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 requirements 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



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

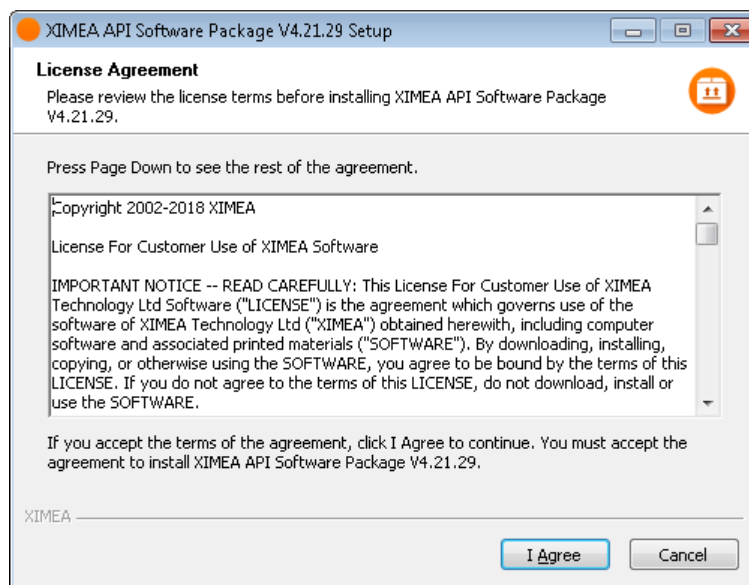
The package contains:

- 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

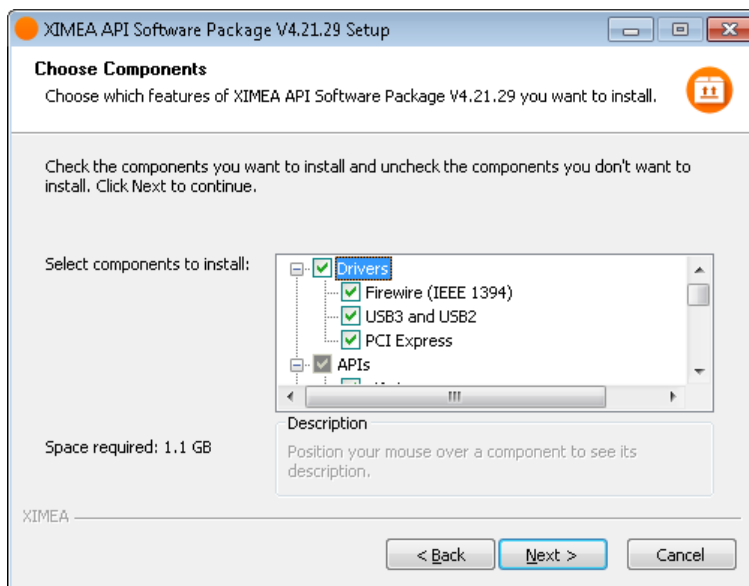
Installation

- 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

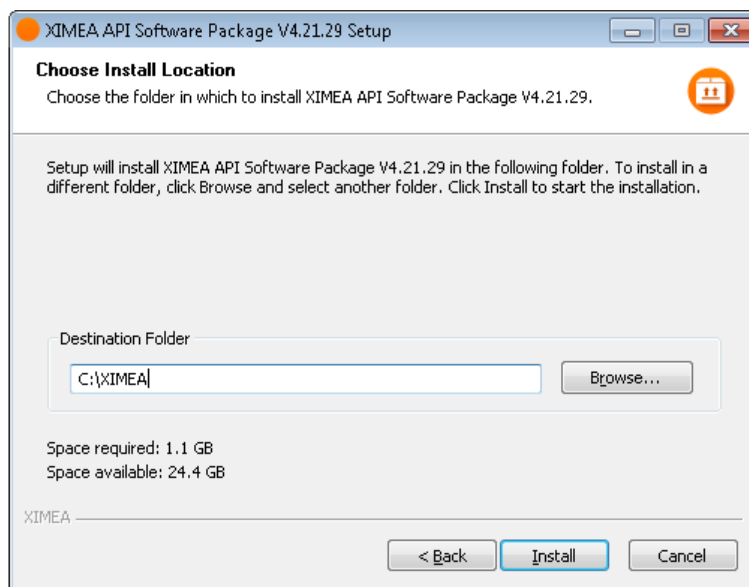
Be sure that you have administrator privileges or start the Installer with administrator rights (right click and select “run as administrator”):



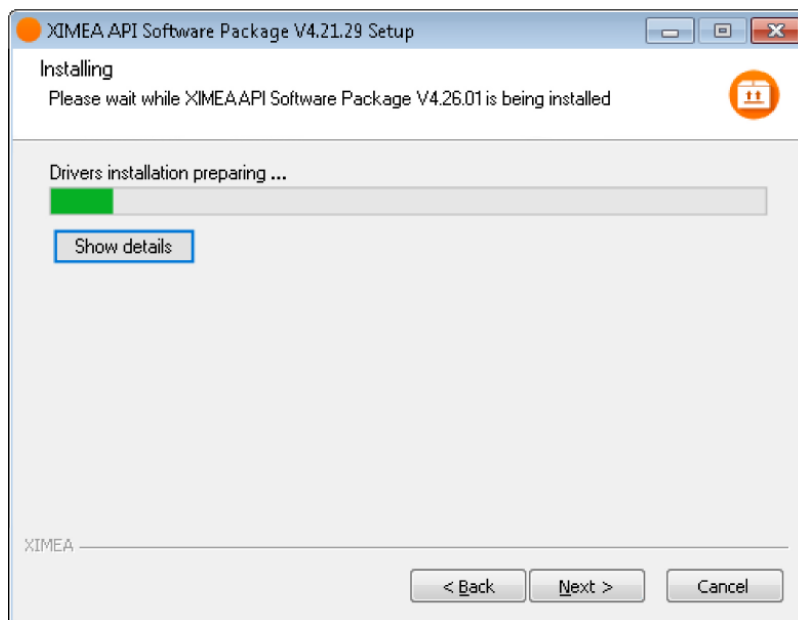
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



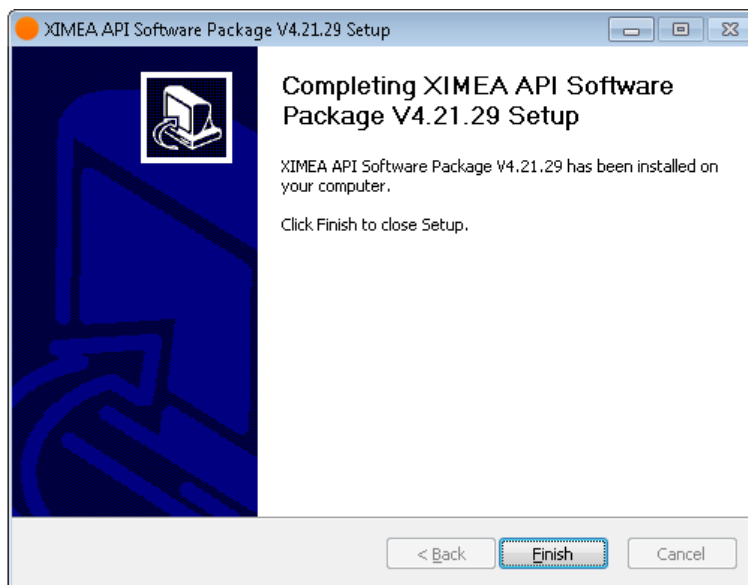
- Specify the install location - you can leave the default location or change it to your desired location



- 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

Installation

- 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
```



```
ximea@ximea-Linux64: ~
ximea@ximea-Linux64:~$ wget http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz
--2013-06-05 17:06:29-- http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz
Resolving www.ximea.com (www.ximea.com)... 91.143.80.251
Connecting to www.ximea.com (www.ximea.com)[91.143.80.251]:80... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: http://www.ximea.com/support/attachments/271/XIMEA_Linux_SP.tgz [following]
--2013-06-05 17:06:30-- http://www.ximea.com/support/attachments/271/XIMEA_Linux_SP.tgz
Connecting to www.ximea.com (www.ximea.com)[91.143.80.251]:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3885021 (3.7M) [application/octet-stream]
Saving to: `XIMEA_Linux_SP.tgz'

100%[=====] 3,885,021  2.09M/s  in 1.8s

2013-06-05 17:06:31 (2.09 MB/s) - `XIMEA_Linux_SP.tgz' saved [3885021/3885021]

ximea@ximea-Linux64:~$
```

- Untar

```
tar xzf XIMEA_Linux_SP.tgz
```

```
cd package
```

- Start installation script

`./install`

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

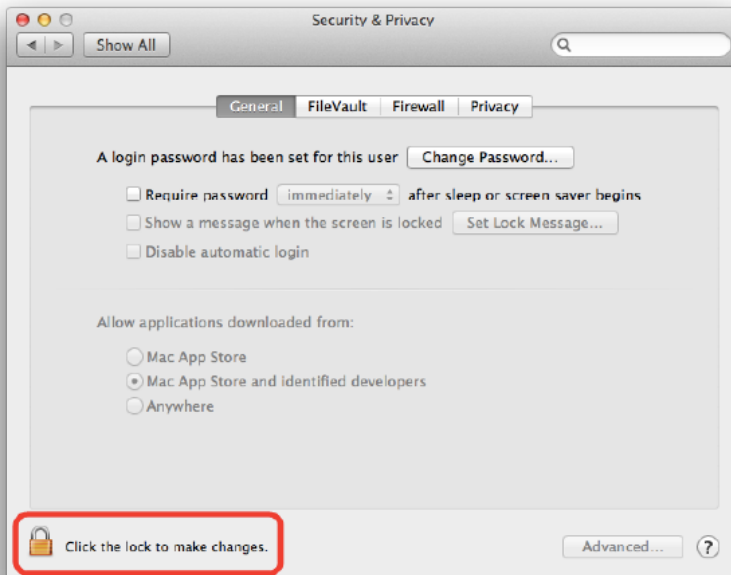
Installation

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 Finder
- 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 65: Camtool

Number	1	2	3	4	5
Description	Control panel	Image window	Analytics tools	Processing 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.

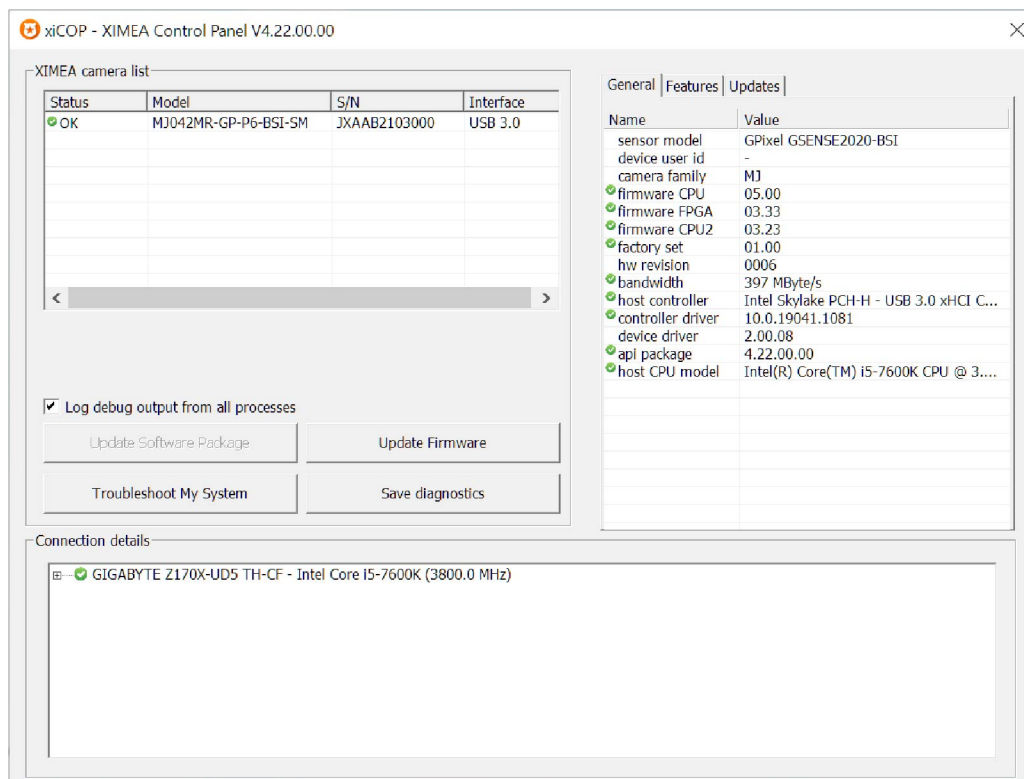


Figure 66: xiCOP example

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 programming 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 maximum possible downsampling rate
int dspl_max = 1;
xiGetParamInt(xiH, XI_PRM_DOWNSAMPLING XI_PRM_INFO_MAX, &dspl_max);

// Setting maximum 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.

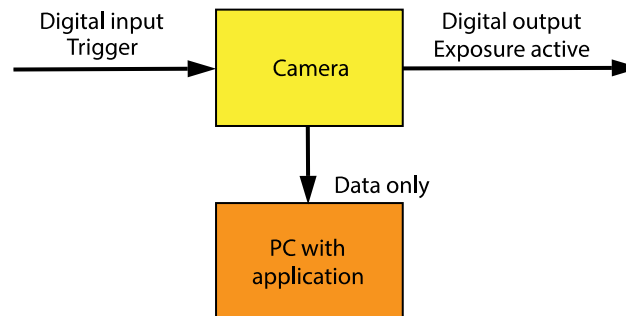


Figure 67: GPIO schematic

```

        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](#)
- [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:

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](#)
- Open the [XIMEA Helpdesk](#)
- 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 52: 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 January 2022. 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 (“Beschaffensvereinbarung”), 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 (“Beschaffensgarantie”).

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. The 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

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 6, 68
- CMOS** Complementary Metal-Oxide-Semiconductor 67
- ESD** Electrostatic discharge 7, 32, 95
- FPGA** Field Programmable Gate Array 60
- FPS** Frame Per Second 64
- PCB** Printed Circuit Board (same as PWB) 95
- PSR** Product Service Request 7, 92, 93
- ROI** Region Of Interest 60

List of Figures

1	Standard conformity CE logo	3
2	Standard conformity UKCA logo	3
3	Standard conformity FCC logo	3
4	Standard conformity RoHS logo	4
5	Standard conformity WEEE logo	4
6	Lens mount adapter S-mount (M12-M) (left), camera with adapter (right)	16
7	Lens mount adapter S-mount (M12-L) (left) , camera with adapter (right)	16
8	xiMU camera mounting points	17
9	M2 mounting screws	17
10	Cross section of MU050xR-SY camera models	18
11	Cross section of MU051xG-SY camera models	18
12	Cross section of MU196xR-ON camera models	19
13	Graph quantum efficiency of Sony IMX675	27
14	Graph quantum efficiency of Sony IMX568	27
15	Graph quantum efficiency of OnSemi AR2020	28
16	Dimensional drawings of MU051xG-SY	30
17	Dimensional drawings of MU196xR-ON and MU050xR-SY	31
18	Data connector location	32
19	Data connector pinning	32
20	IO connector location	33
21	IO connector pinning	33
22	IO connector location	35
23	IO connector pinning	35
24	Non-isolated input/output, interface schematic with sensor	37
25	Non-isolated input/output, interface schematic	38
26	Images of camera with ME-ADPT-MU-T	39
27	Dimensional drawing of ME-ADPT-MU-T	39
28	Image of ME-ADPT-MU-17x17-T	40
29	Dimensional drawing of ME-ADPT-MU-17x17-T	40
30	Flex connectors location ADPT-MU-CX3-FL / ADPT-MU-CX3-FV	41
31	ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors pinout	41
32	Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-FL adapter	43
33	Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-FL adapter	44
34	Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-FL adapter	45
35	Connecting steps, camera with ADPT-MU-CX3-TC-FV / ADPT-MU-CX3-TC-FL adapter	46
36	Isometric view of ADPT-MU-TC-V	47
37	ADPT-MU-CX3-TC-V connectors location	47
38	ADPT-MU-CX3-TC-V USB3 Type-C connector pinout	48
39	ADPT-MU-CX3-TC-V IO connector pinout	49
40	Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-TC-V adapter	51
41	Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-TC-V adapter	52
42	Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-TC-V adapter	53
43	Location of connector	54
44	ADPT-MU-CX3-UC connector pinout	54
45	Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-UC adapter	56
46	Dimensional drawing of MU051xR-SY with ADPT-MU-17x17-CX3-UC adapter	57
47	Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-UC adapter	58
48	BOB-MQ-FL	59
49	BOB-MQ-FL dimensions	59
50	Acquisition mode - free run	64
51	Triggered burst of frames – frame burst start	65
52	Triggered burst of frames – frame burst active	65
53	Multiple exposures - defined exposure time number - of exposures set to 5	66
54	Multiple exposures - exposure time defined by trigger pulse length - number of exposures set to 5	66
55	Dual ADC non-combined without merging	68
56	Dual ADC non-combined with merging	69

57	Dual ADC combined mode	70
58	Global reset release mode - schematic	71
59	Global reset release mode - image horizontally moved object	71
60	Global reset release mode with flash - schematic	71
61	Rolling shutter mode - schematic	72
62	Rolling shutter mode image of a horizontally moved object	72
63	Rolling shutter mode image of a horizontally moved object, long exposure time	72
64	Rolling shutter mode with flash - schematic	72
65	Camtool	84
66	xiCOP example.....	85
67	GPIO schematic	89

List of Tables

1	List of camera models and their respective sensor models and filters	12
2	xiMU accessories	13
3	Power consumption of: MU050CR-SY and MU050MR-SY	14
4	Power consumption of: MU051CG-SY and MU051MG-SY	14
5	Power consumption of: MU196CR-ON and MU196MR-ON	14
6	Environment	15
7	M2 screw description	17
8	Sensor parameters of: MU050CR-SY and MU050MR-SY	21
9	Sensor parameters of: MU051CG-SY and MU051MG-SY	21
10	Sensor parameters of: MU196CR-ON and MU196MR-ON	21
11	Image quality parameters of: MU050CR-SY and MU050MR-SY	22
12	Image quality parameters of: MU051CG-SY	22
13	Image quality parameters of: MU051MG-SY	23
14	Image quality parameters of: MU196CR-ON and MU196MR-ON	23
15	Sensor read-out modes of: MU050CR-SY and MU050MR-SY	24
16	Sensor read-out modes of: MU051CG-SY	24
17	Sensor read-out modes of: MU051MG-SY	24
18	Sensor read-out modes of: MU196CR-ON	25
19	Sensor read-out modes of: MU196MR-ON	26
20	Camera parameters of: MU050CR-SY and MU050MR-SY	29
21	Camera parameters of: MU051CG-SY and MU051MG-SY	29
22	Camera parameters of: MU196CR-ON and MU196MR-ON	29
23	Data mating connector description	32
24	GPIO mating connector description	33
25	I/O connector pin assignment	34
26	GPIO mating connector description	35
27	I/O connector pin assignment	36
28	General info for non-isolated digital in/out trigger lines which are connected directly to sensor	37
29	General info for non-isolated digital in/out trigger lines	38
30	Mechanical parameters of ME-ADPT-MU-T	39
31	Mechanical parameters of ME-ADPT-MU-17x17-T	40
32	ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors description	41
33	ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors pin assignment	41
34	General info for digital input, ADPT-MU-CX3-FL / ADPT-MU-CX3-FV adapters	42
35	General info for digital output, ADPT-MU-CX3-FL / ADPT-MU-CX3-FV adapters	42
36	ADPT-MU-CX3-TC-V connectors	47
37	ADPT-MU-CX3-TC-V USB3 Type-C connector description	48
38	ADPT-MU-CX3-TC-V USB3 type-C connector pin assignment	48
39	ADPT-MU-CX3-TC-V GPIO connector description	49
40	GPIO connector pin assignment	49
41	General info for digital input / output, ADPT-MU-CX3-TC-V adapter	50
42	General info for digital output, ADPT-MU-CX3-TC-V adapter	50
43	ADPT-MU-CX3-UC connector description	54
44	ADPT-MU-CX3-UC connector pin assignment	54
45	General info for digital input / output, ADPT-MU-CX3-UC adapter	55
46	General info for digital output, ADPT-MU-CX3-UC adapter	55
47	IO connector (WAGO 218-104), pin assignment	59
48	Image data output formats	61
49	Image data output formats	62
50	Image data output formats	62
51	Image data output formats	63
52	service operations overview	92

