xiMU

[ksi-mjuː] or [sai-mjuː]

Subminiature USB camera series

XIMEA Cameras
Technical Manual
Version v250923

Introduction

About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

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

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

This document is subject to change without notice.

About XIMEA

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

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

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

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

Contact XIMEA

XIMEA is a worldwide operating company

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Standard conformity

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.

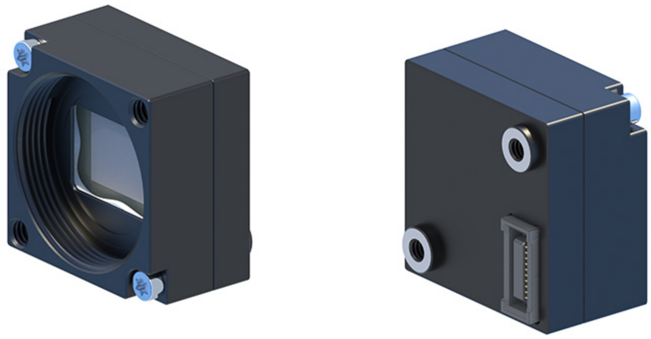
Helpful links

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

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 PregiusTM 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 integrationn
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

MUxxxyT-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 × 1960	2.0
MU050MR-SY	Sony IMX675	Monochrome	None	2592 × 1960	2.0
MU051CG-SY	Sony IMX568	Color	BayerBG	2472 × 2064	2.74
MU051MG-SY	Sony IMX568	Monochrome	None	2472 × 2064	2.74
MU196CR-ON	OnSemi AR2020	Color	BayerGB	5120 × 3840	1.4
MU196MR-ON	OnSemi AR2020	Monochrome	None	5120 × 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

[1] Io cables - CBL-S-M5-3P-PT-5M0, CBL-S-M5-3P-PT-5M0-S
[2] mating cables CBL-MQ-FL-0M1, CBL-MQ-FL-0M25, CBL-USB3FLEX-0M10, CBL-USB3FLEX-0M25, CBL-USB3FLEX-0M50
[3] mating 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

[1]Supported 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

[1]Supported 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

[1]Supported 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 5.5 V. 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.

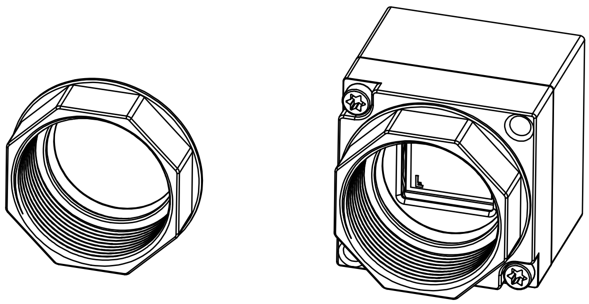


Figure 6: Lens mount adapter S-mount (M12-M) (left), camera with adapter (right)

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.

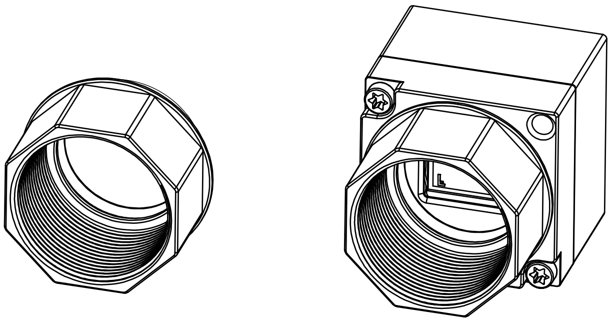


Figure 7: Lens mount adapter S-mount (M12-L) (left) , camera with adapter (right)

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

2.4 Mounting points

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

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

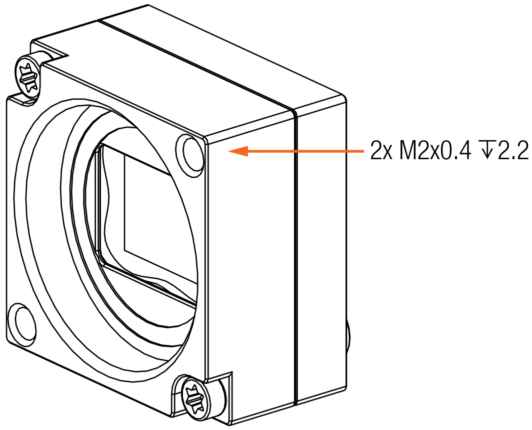


Figure 8: xiMU camera mounting points

2.4.1 Screws

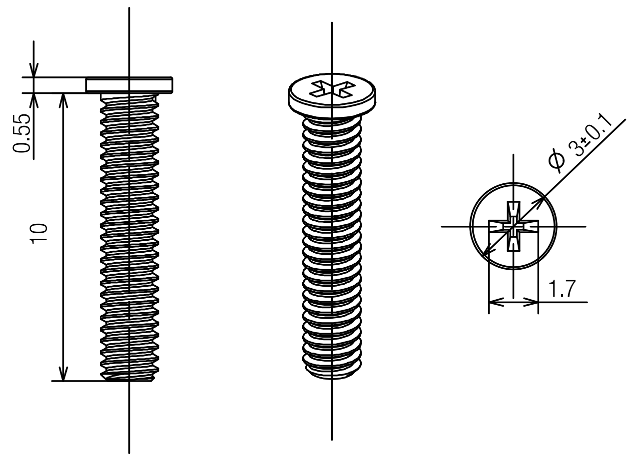


Figure 9: M2 mounting screws

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

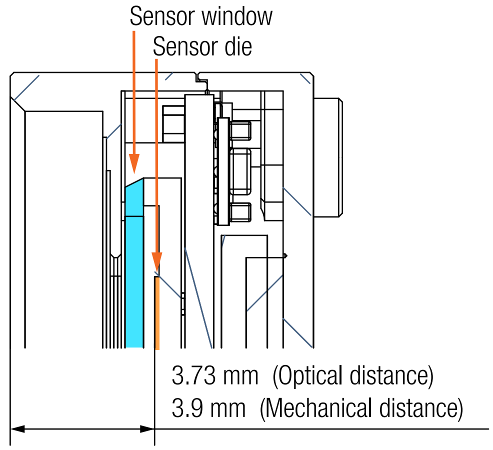


Figure 10: Cross section of MU050xR-SY camera models

Cross-section corresponding to:

MU051CG-SY MU051MG-SY

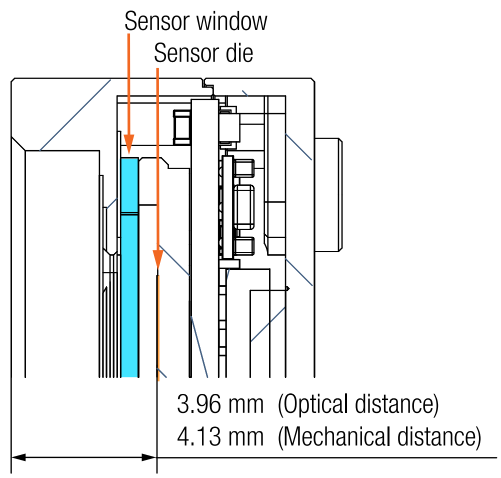


Figure 11: Cross section of MU051xG-SY camera models

Cross-section corresponding to:

MU196CR-ON MU196MR-ON

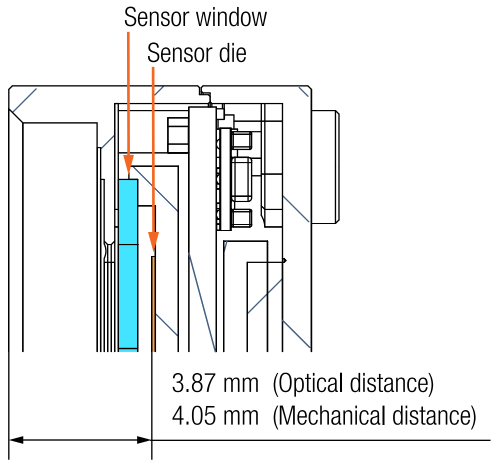


Figure 12: Cross section of MU196xR-ON camera models

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	[µm]

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	[µm]

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	[µm]

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

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_-]	5.11	4.07	0.75
Absolute sensitivity threshold	[e_-]	5.61	4.57	1.25
Saturation capacity	[ke_-]	10.21	9.94	10.85
Dynamic range	[dB]	65.16	66.74	78.81
MAX Signal-to-noise ratio	[dB]	40.4	40.29	40.46
Overall system gain	[e_-/DN]	11.69	2.85	0.17
Dark current	[e_-/s]	5.8	3.67	1.78
Dark current meas. temp.	[°C]	52.8	53.0	52.4
DSNU	[e_-]	0.57	0.49	0.58
PRNU	[%]	0.52	0.51	0.6
Linearity error	[%]	2.84	2.4	2.5

Table 11: Image quality parameters of the specific models

Image quality parameters of:
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_-]	5.11	4.2	0.75
Absolute sensitivity threshold	[e_-]	5.61	4.7	1.25
Saturation capacity	[ke_-]	10.25	10.28	10.85
Dynamic range	[dB]	65.2	66.81	78.81
MAX Signal-to-noise ratio	[dB]	40.38	40.39	40.46
Overall system gain	[e_-/DN]	11.4	2.87	0.17
Dark current	[e_-/s]	5.38	3.55	1.78
Dark current meas. temp.	[°C]	52.5	53.1	52.4
DSNU	[e_-]	0.56	0.51	0.58
PRNU	[%]	0.52	0.52	0.6
Linearity error	[%]	4.36	4.64	2.5

Table 12: 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 13: 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 (Hor.x Ver.)	-	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 14: 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 15: Image quality parameters of the specific models

2.6.3 Sensor read-out modes

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

Sensor Read-out modes of:

MU050CR-SY MU050MR-SY

Downsampling (Hor.x Ver.)	Dual ADC	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	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

[1] Frame rate was measured using the transport format at bandwidth limit 290.0 MB/s

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

Sensor Read-out modes of:

MU051CG-SY

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	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

[1] Frame rate was measured using the transport format at bandwidth limit 290.0 MB/s

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

Sensor Read-out modes of:
MU051MG-SY

Downsampling (Hor.x Ver.)	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	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

[1]Frame rate was measured using the transport format at bandwidth limit 290.0 MB/s

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

Sensor Read-out modes of:
MU196CR-ON

Downsampling (Hor.x Ver.)	Dual ADC	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	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

[1]Frame rate was measured using the transport format at bandwidth limit 290.0 MB/s

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

Sensor Read-out modes of:
MU196MR-ON

Downsampling (Hor.x Ver.)	Dual ADC	Sensor bit/px	Resolution (Wid x Hei)	Transport bit/px	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

[1]Frame rate was measured using the transport format at bandwidth limit 290.0 MB/s

Table 20: 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

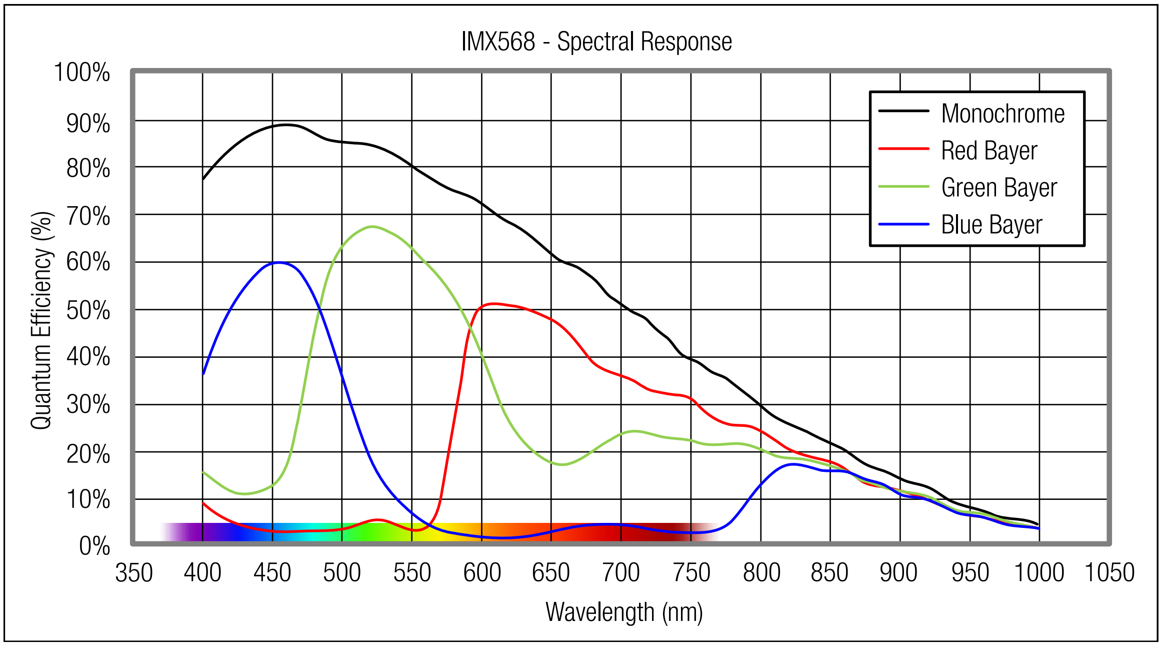


Figure 14: Graph quantum efficiency of Sony IMX568

Quantum efficiency curves for:

MU196CR-ON MU196MR-ON

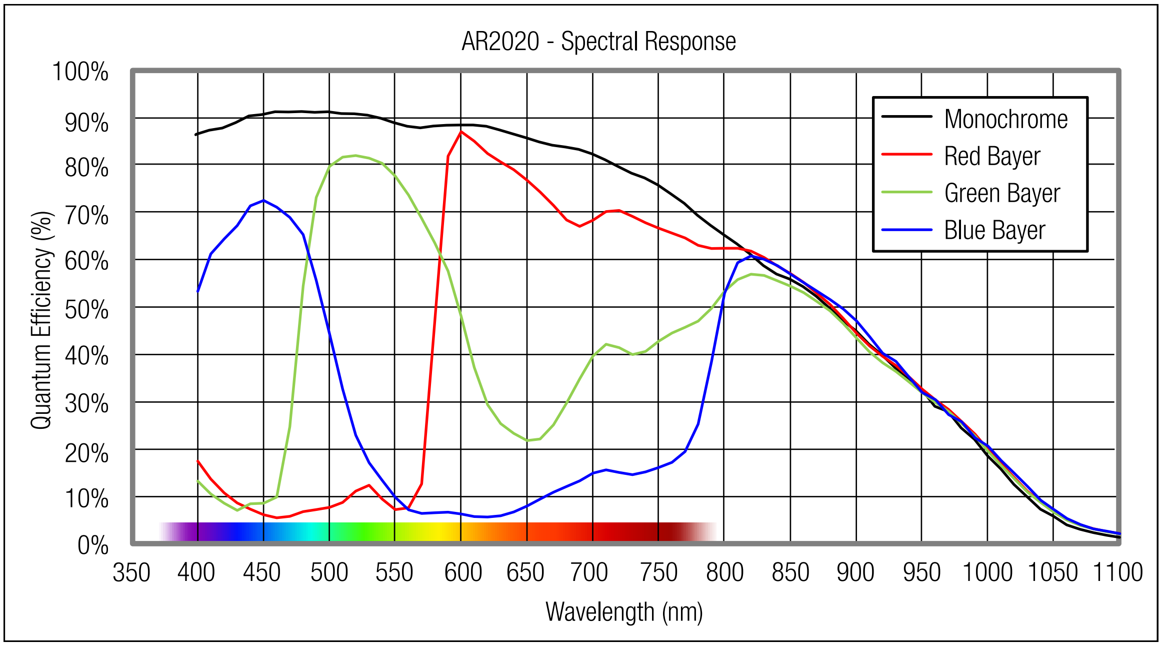


Figure 15: Graph quantum efficiency of OnSemi AR2020

2.7 Mechanical characteristics

2.7.1 Dimensions and mass

Dimensions and mass of:
MU050CR-SY MU050MR-SY

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

[1] without adapters

Table 21: Camera parameters of the specific models

Dimensions and mass of:
MU051CG-SY MU051MG-SY

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

[1] without adapters

Table 22: Camera parameters of the specific models

Dimensions and mass of:
MU196CR-ON MU196MR-ON

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

[1] without adapters

Table 23: Camera parameters of the specific models

2.7.2 Dimensional drawings

Dimensional drawings of:

MU051CG-SY MU051MG-SY

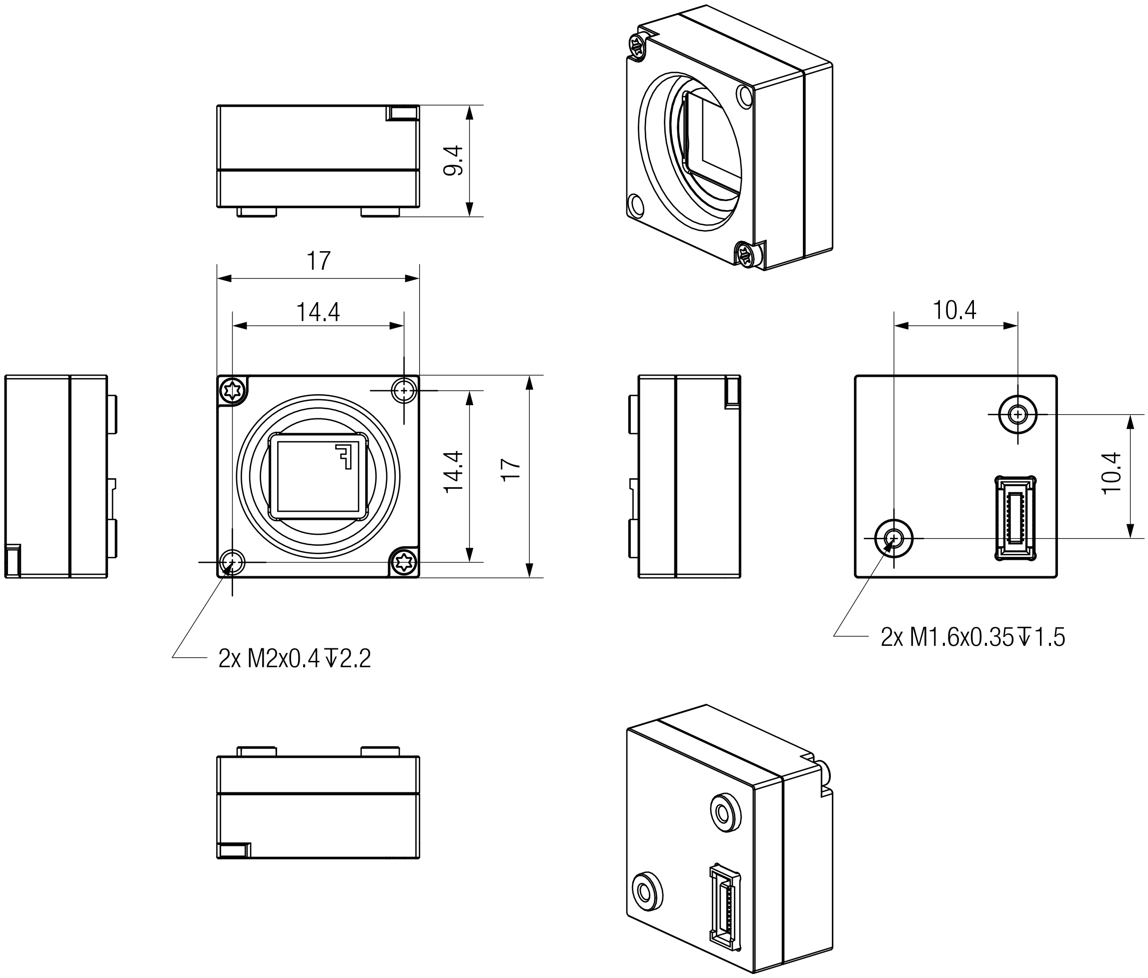


Figure 16: Dimensional drawings of MU051xG-SY

Dimensional drawings of:

MU050CR-SY MU050MR-SY MU196CR-ON MU196MR-ON

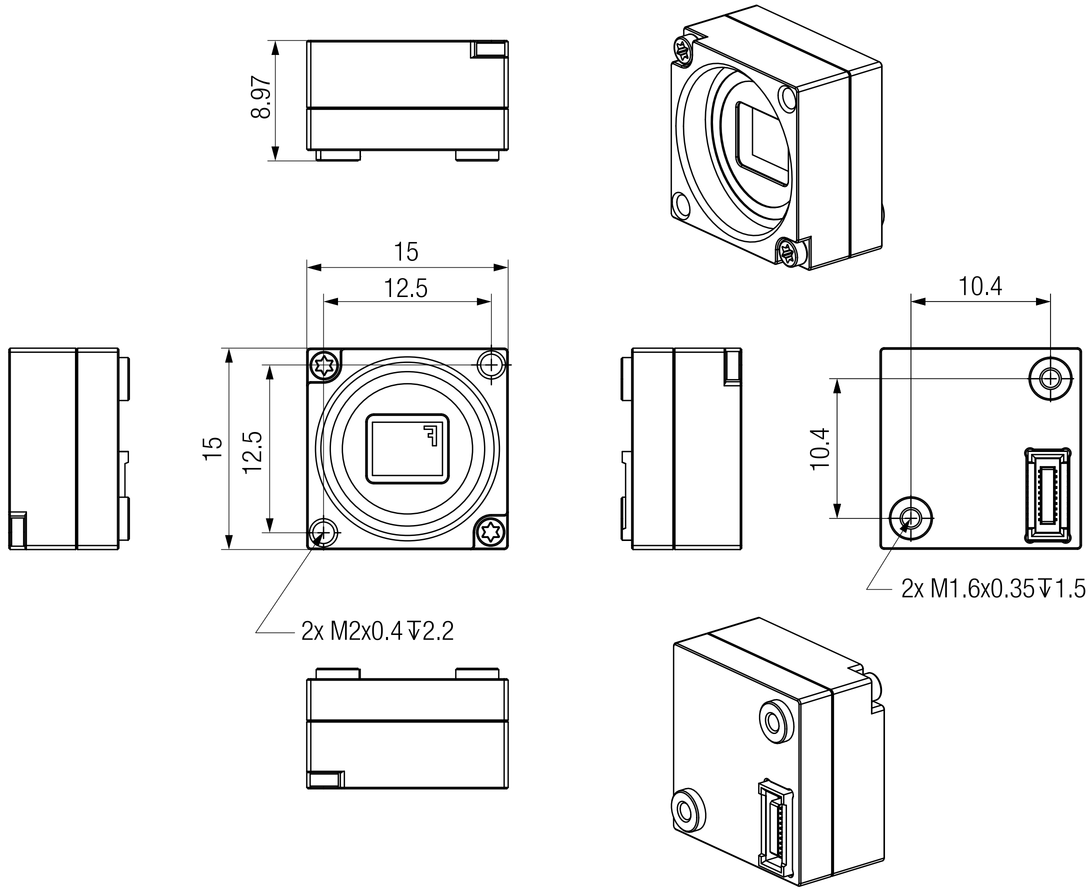


Figure 17: Dimensional drawings of MU196xR-ON and MU050xR-SY

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 Camera 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 24: Data mating connector description

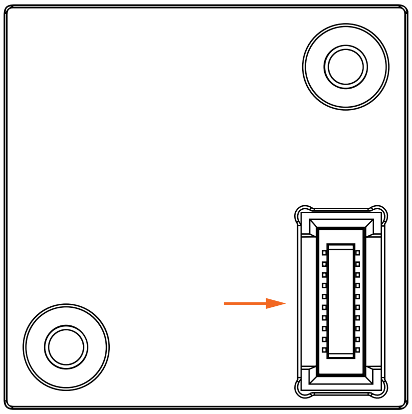


Figure 18: Data connector location

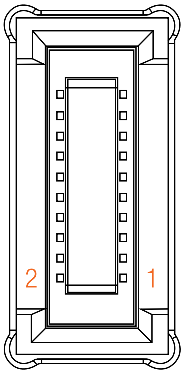


Figure 19: Data connector pinning

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 25: GPIO mating connector description

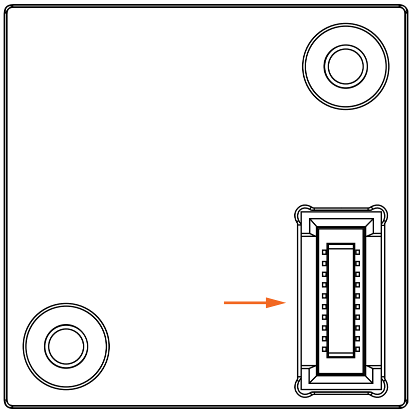


Figure 20: IO connector location

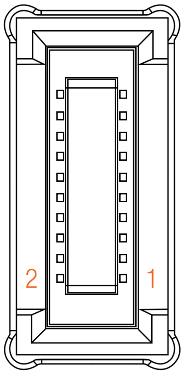


Figure 21: IO connector pinning

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 26: 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 MU050MR-SY MU196CR-ON MU196MR-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 27: GPIO mating connector description

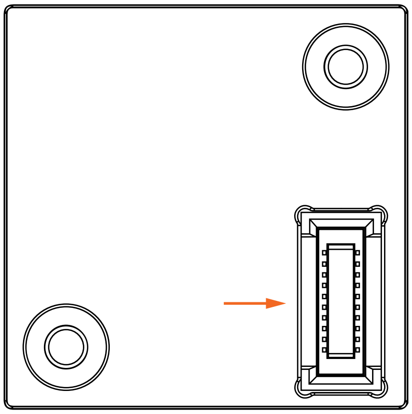


Figure 22: IO connector location

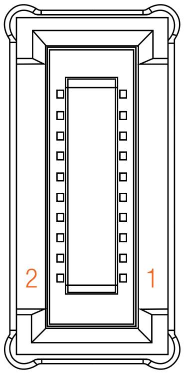


Figure 23: IO connector pinning

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 28: 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

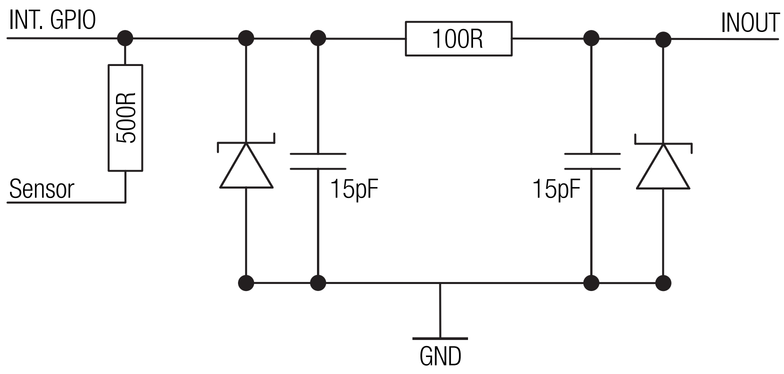


Figure 24: Non-isolated input/output, interface schematic with sensor

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 protecion	ESD IEC 61000-4-2 (Level 4), EMI PI-filter (R = 100 Ohm, CTOTAL = 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 29: 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	MU050MR-SY	MU196CR-ON	MU196MR-ON

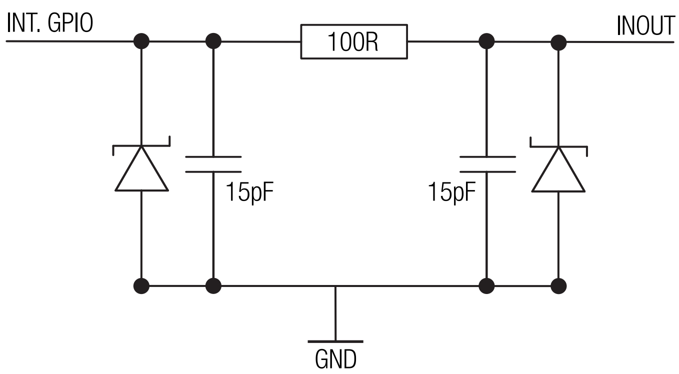


Figure 25: Non-isolated input/output, interface schematic

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 protecion	ESD IEC 61000-4-2 (Level 4), EMI PI-filter (R = 100 Ohm, CTOTAL = 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 30: 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-KIT

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

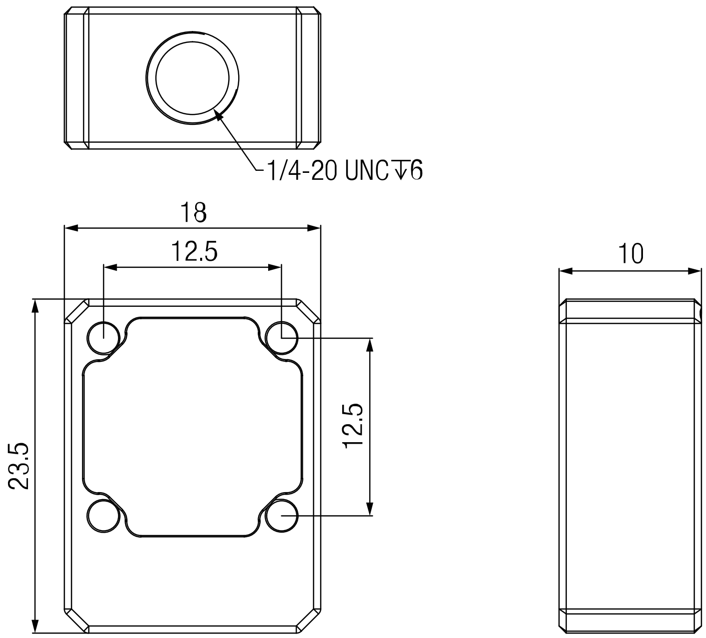


Figure 27: Dimensional drawing of ME-ADPT-MU-T-KIT

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

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

2.10.2 ME-ADPT-MU-17x17-T-KIT

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.

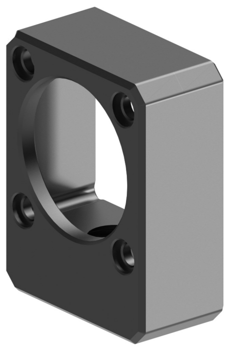


Figure 28: Image of ME-ADPT-MU-17x17-T-KIT

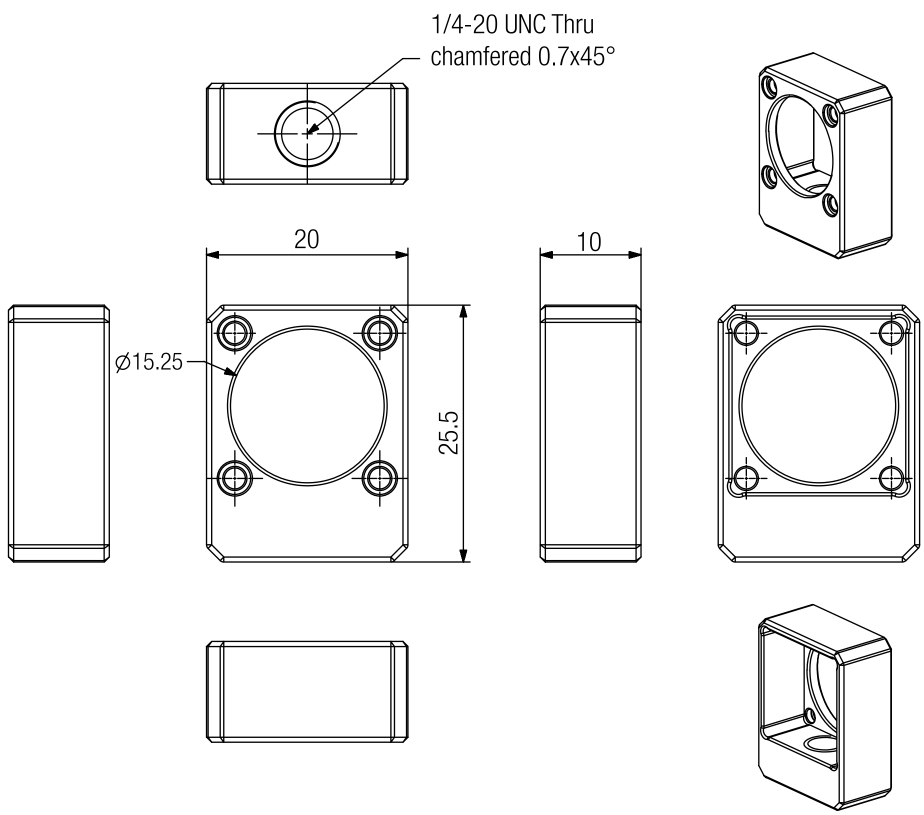


Figure 29: Dimensional drawing of ME-ADPT-MU-17x17-T-KIT

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

Table 32: 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 33: ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors description

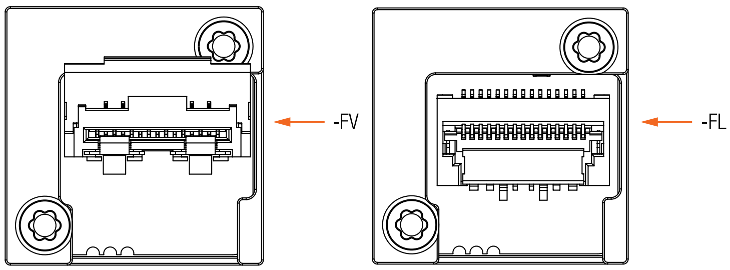


Figure 30: Flex connectors location ADPT-MU-CX3-FL / ADPT-MU-CX3-FV

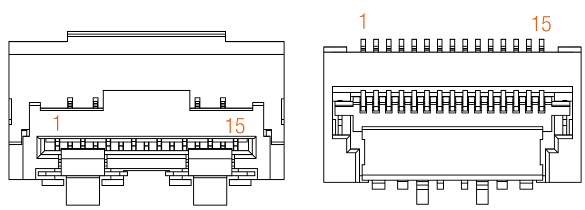


Figure 31: ADPT-MU-CX3-FL / ADPT-MU-CX3-FV connectors pinout

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/Ouput (<0.3 Low; > 1.3 High)
Ground pins	SGND	None	Shield of FPC cable connected to shield of host controller

Table 34: 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 kΩ
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 kΩ
Output Level for logical 0	< 0.3 V, Rload = 100 kΩ
Output Level for logical 1	> 1.6 V, Rload = 100 kΩ
Output delay - rising edge	<100 µs, Rload = 100 kΩ, TAMBIENT=25 °C
Output delay - falling edge	<100 µs, Rload = 100 kΩ, TAMBIENT=25 °C

Table 35: 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 m A
Inductive loads	NO
Output Level logical 0	< 0.8 V, Load 100 kΩ
Output Level logical 1	> 4.5 V, Load 100 kΩ
Output delay - rising edge	<20 ns, Load 100 kΩ threshold 1.5 V
Output delay - falling edge	<20 ns, Load 100 kΩ threshold 0.5 V

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

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

Table 36: General info for digital ouput, ADPT-MU-CX3-FL / ADPT-MU-CX3-FV adapters

Dimensional drawings

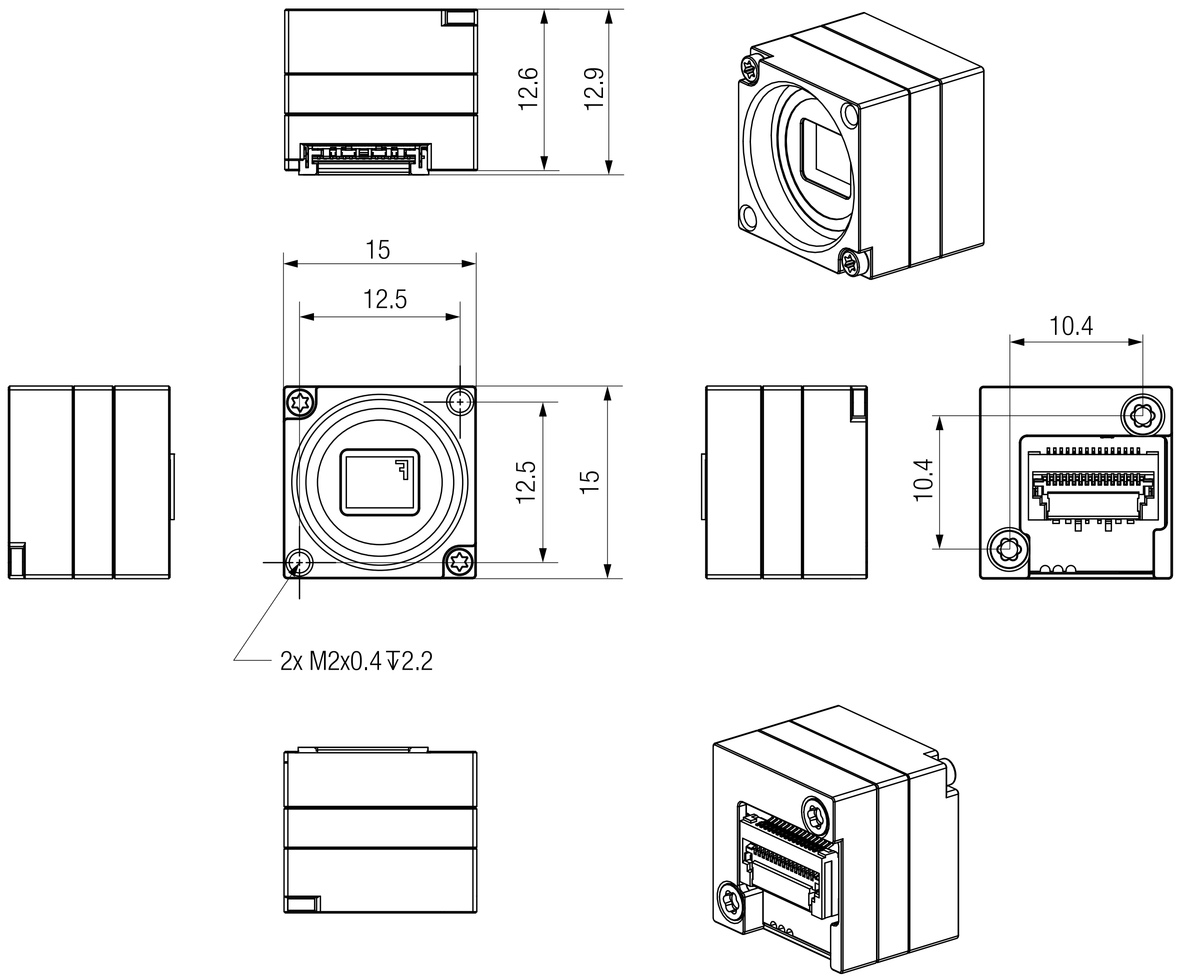


Figure 32: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-FL adapter

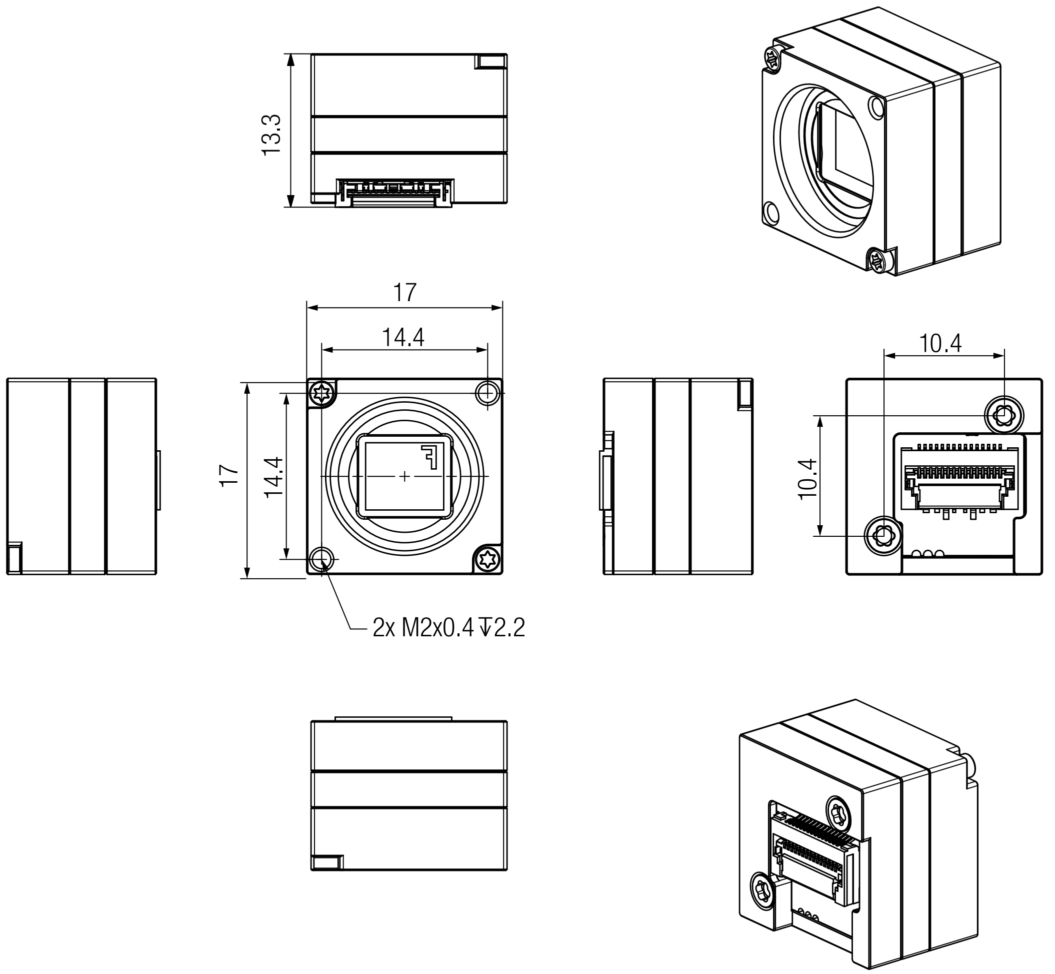


Figure 33: Dimensional drawing of MU051xG-SY with ADPT-MU-17x17-CX3-FL adapter

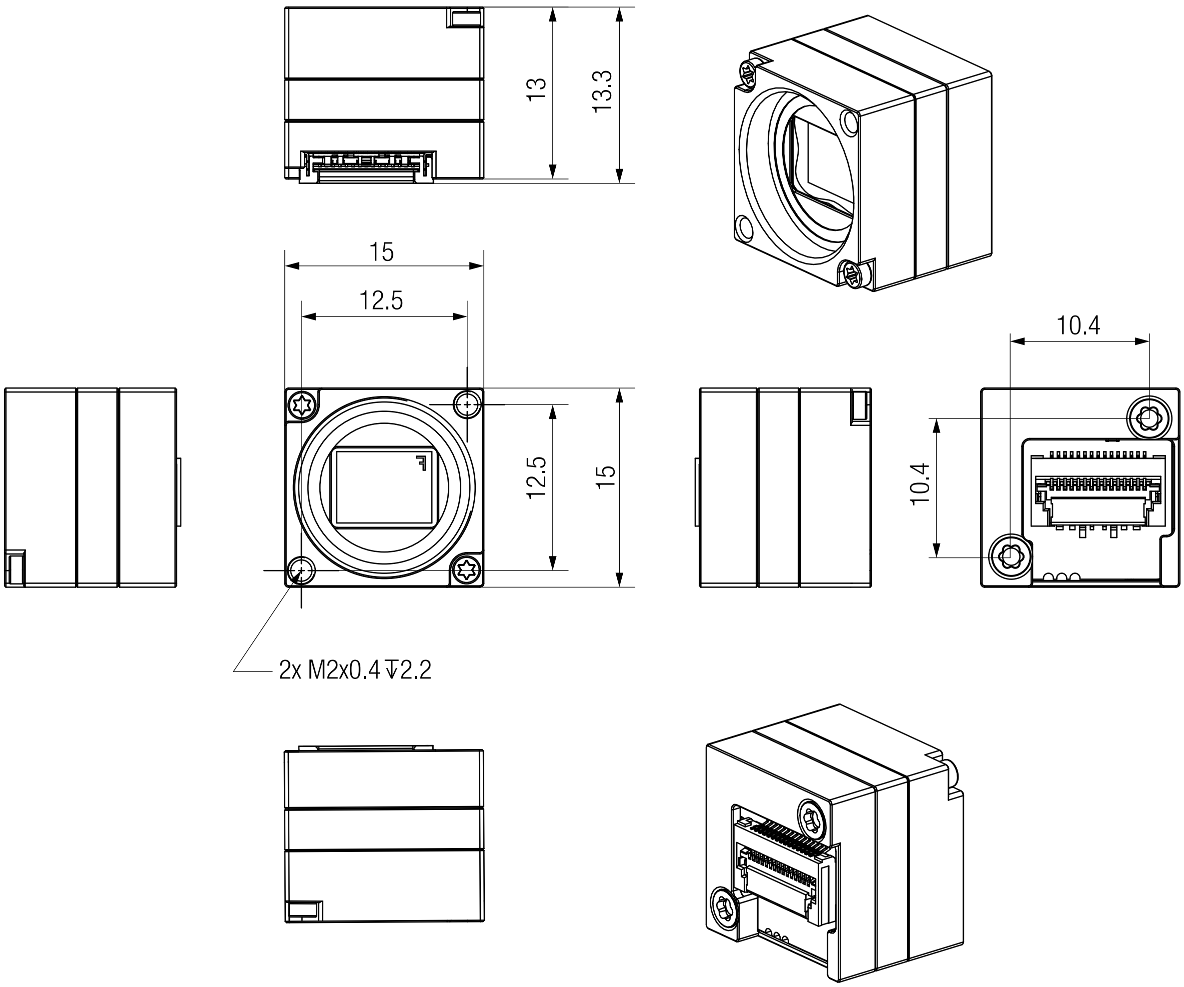


Figure 34: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-FL adapter

Connecting the components

- camera with adapter ADPT-MU-CX3-TC-FV / Adapter ADPT-MU-CX3-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.

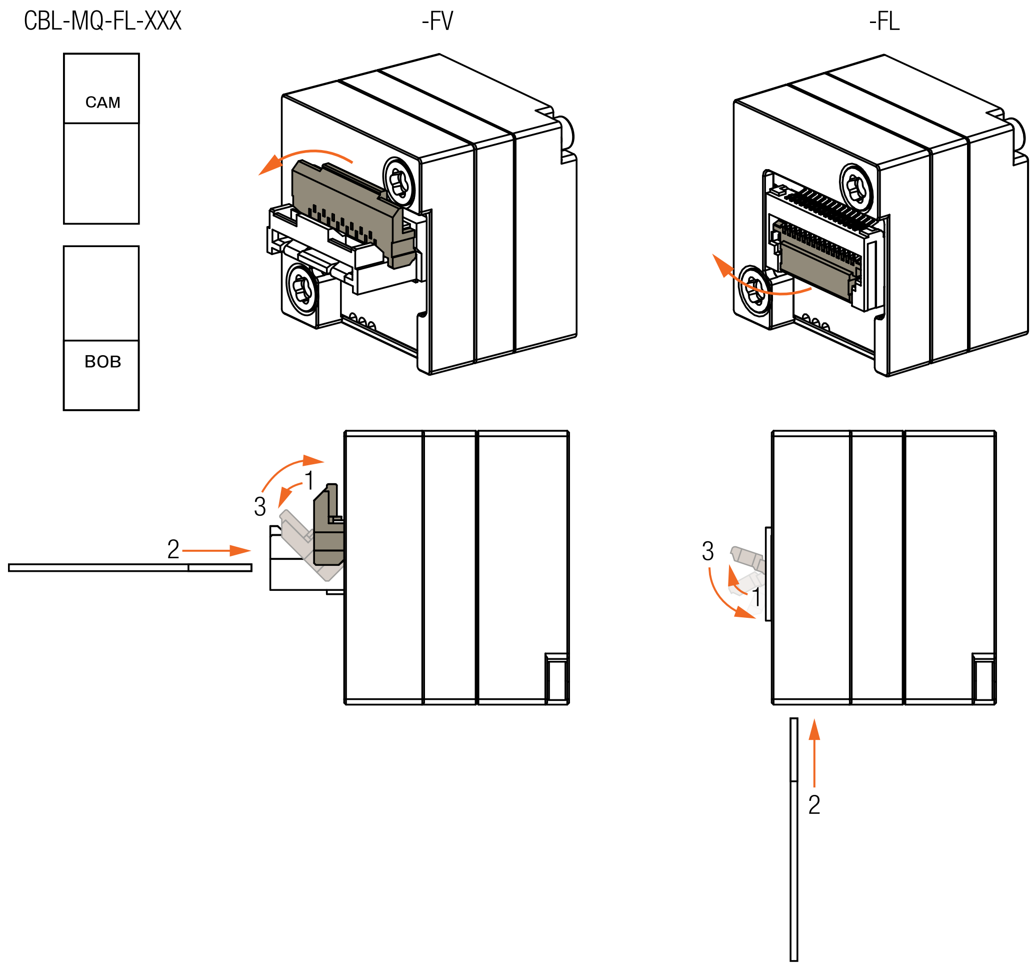


Figure 35: Connecting steps, camera with ADPT-MU-CX3-TC-FV / ADPT-MU-CX3-TC-FL adapter

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

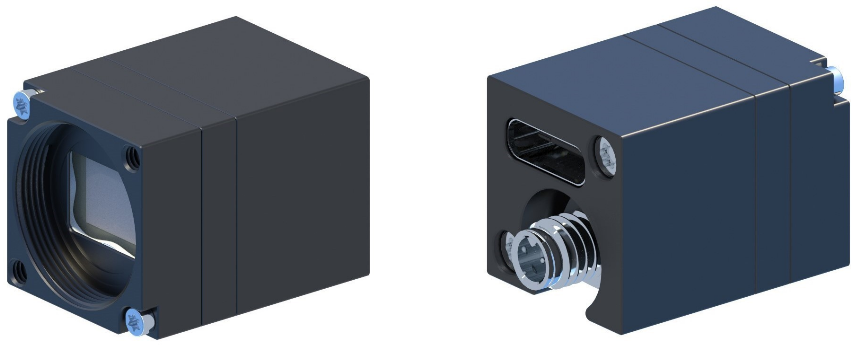


Figure 36: Isometric view of ADPT-MU-TC-V

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

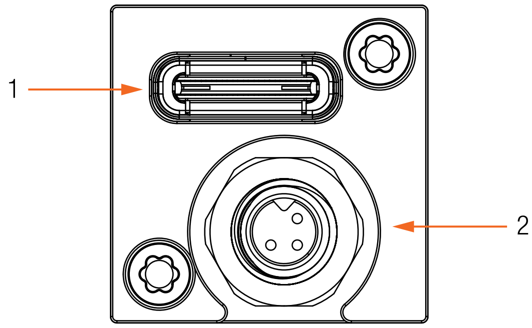


Figure 37: ADPT-MU-CX3-TC-V connectors location

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

Table 38: ADPT-MU-CX3-TC-V USB3 Type-C connector description

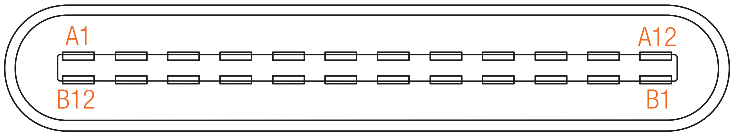


Figure 38: ADPT-MU-CX3-TC-V USB3 Type-C connector pinout

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

GPIO

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 40: ADPT-MU-CX3-TC-V GPIO connector description

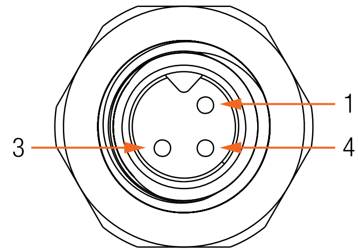


Figure 39: ADPT-MU-CX3-TC-V IO connector pinout

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

Table 41: 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 kΩ
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 kΩ
Output Level for logical 0	< 0.3 V, Rload = 100 kΩ
Output Level for logical 1	> 1.6 V, Rload = 100 kΩ
Output delay - rising edge	<100 µs, Rload = 100 kΩ, TAMBIENT=25 °C
Output delay - falling edge	<100 µs, Rload = 100 kΩ, TAMBIENT=25 °C

Table 42: 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 m A
Inductive loads	NO
Output Level logical 0	< 0.8 V, Load 100 kΩ
Output Level logical 1	> 4.5 V, Load 100 kΩ
Output delay - rising edge	<20 ns, Load 100 kΩ threshold 1.5 V
Output delay - falling edge	<20 ns, Load 100 kΩ threshold 0.5 V

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

Table 43: General info for digital output, ADPT-MU-CX3-TC-V adapter

Dimensional drawings

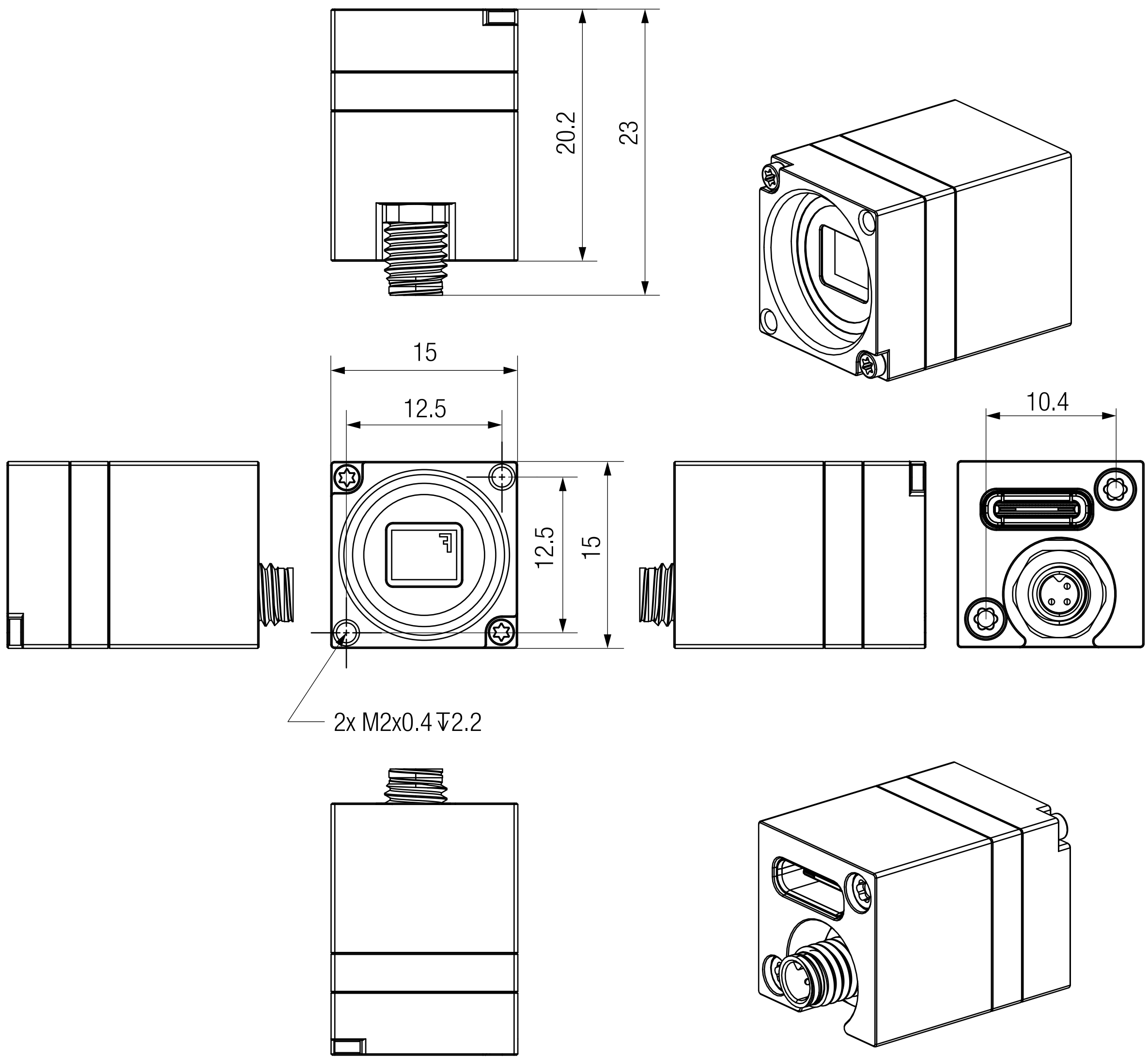


Figure 40: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-TC-V adapter

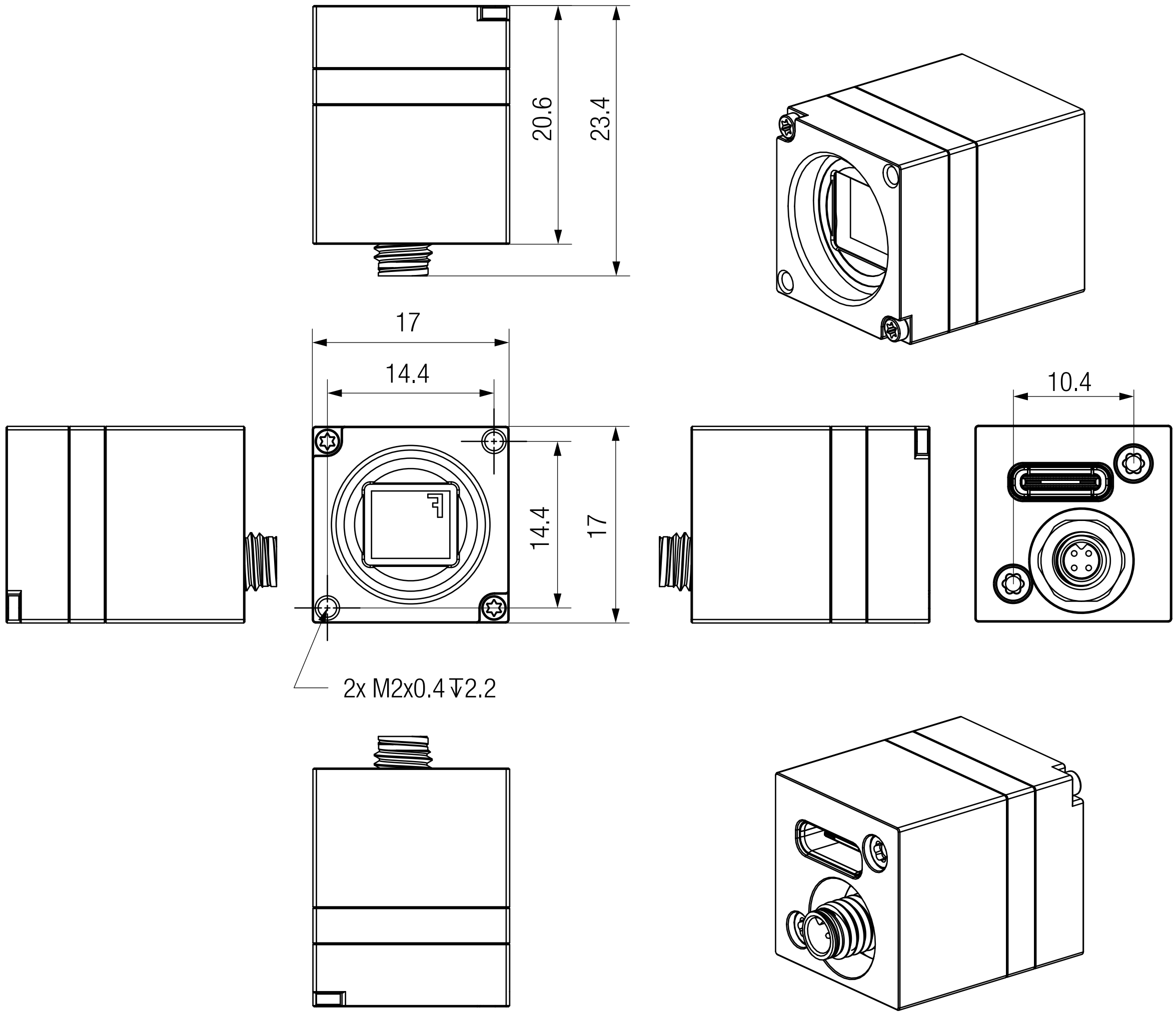


Figure 41: Dimensional drawing of MU051xG-SY with ADPT-MU-17x17-CX3-TC-V adapter

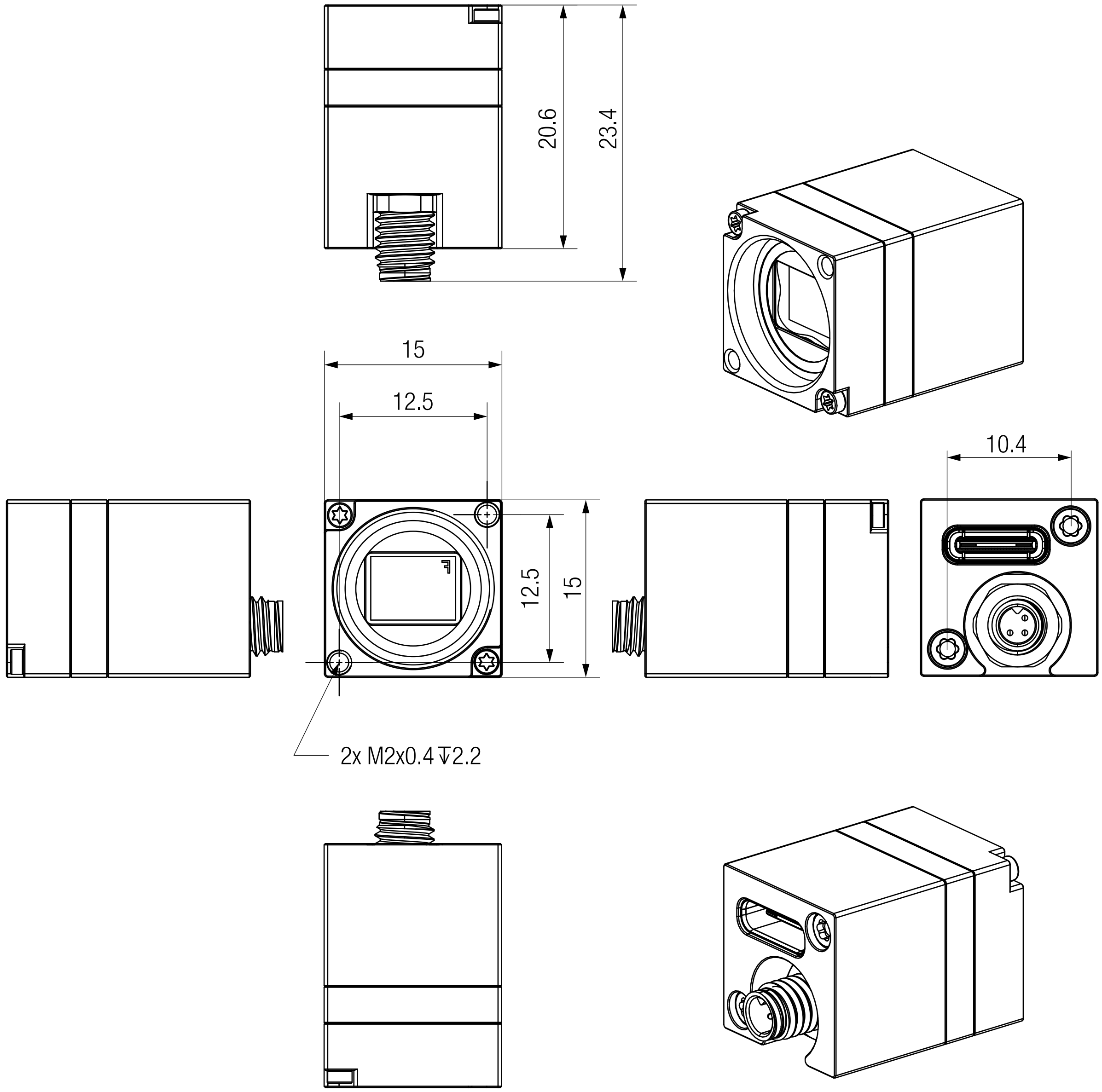


Figure 42: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-TC-V adapter

2.10.5 CBL-S-M5-3P-PT-5M0 / CBL-S-M5-3P-PT-5M0-S

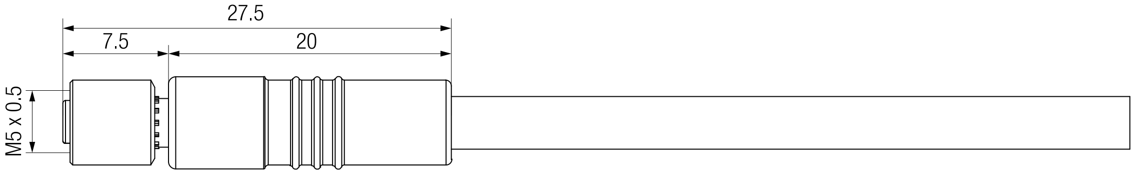


Figure 43: CBL-S-M5-3P-PT-5M0

Connect optically isolated input and output to the xiQ-S7 family of cameras. Also connect non-isolated IO to the xiMU cameras featuring binder connector. 3 pin IO cable for cameras featuring M5 connector, two variants of cable are available:

Part number CBL-S-M5-3P-PT-5M0

Binder part number 77 3450 0000 40003-0500

Description M5 Female cable connector, Contacts: 3, unshielded, moulded on the cable, IP67, UL, M5x0.5, PUR, black, 3×0.14 mm, 5 m

Part number CBL-S-M5-3P-PT-5M0-S

Binder part number 77 3550 0000 40003-0500

Description M5 Female cable connector, Contacts: 3, shielded, moulded on the cable, IP67, M5x0.5, PUR, black, 3×0.14 mm, 5 m

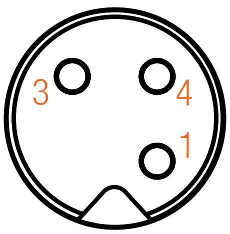


Figure 44: CBL-S-M5-3P-PT-5M0 / CBL-S-M5-3P-PT-5M0-S pinout

Pin	Wire color	Signal MQ-S7	Signal MU
1	brown	GPIO_GND	GND
2	-	-	-
3	blue	IN	INOUT 1
4	black	OUT	OUT 1
Shielding	-	connected to camera housing[1]	connected to camera housing[1]

[1] Only for CBL-S-M5-3P-PT-5M0-S variant

Table 44: CBL-S-M5-3P-PT-5M0 / CBL-S-M5-3P-PT-5M0-S pin assignment

2.10.6 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[1]

[1] Cables up to 1 m in length are supported when cameras are directly connected to the xSwitch (e.g., XS-5P-U3-UC-TC). However, when cameras are connected via the ADPT-U3-UC-U3-UB, the maximum supported length of the micro coaxial cable depends on the VBUS voltage provided by the USB 3.0 controller and the length of the USB 3.0 cable used between the ADPT-U3-UC-U3-UB and the USB 3.0 controller.

Table 45: ADPT-MU-CX3-UC connector description

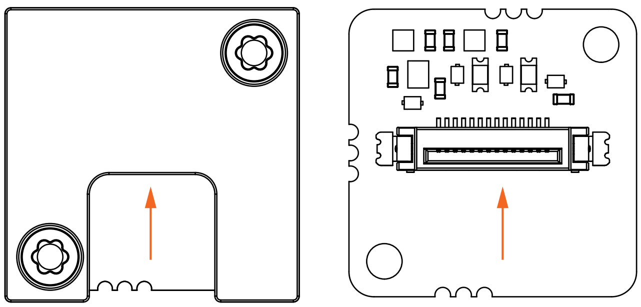


Figure 45: Location of connector

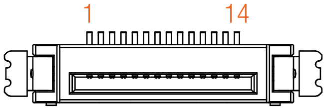


Figure 46: ADPT-MU-CX3-UC connector pinout

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-isoalted 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-isoalted Output 1
13	VBUS	None	+5 V Power input
14	VBUS	None	+5 V Power input

Table 46: 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 kΩ
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 47: 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 kΩ
Output Level logical 1	> 4.5 V, Load 100 kΩ
Output delay - rising edge	< 20 ns, Load 100 kΩ threshold 1.5 V
Output delay - falling edge	< 20 ns, Load 100 kΩ threshold 0.5 V

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

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

Table 48: General info for digital output, ADPT-MU-CX3-UC adapter

Dimensional drawings

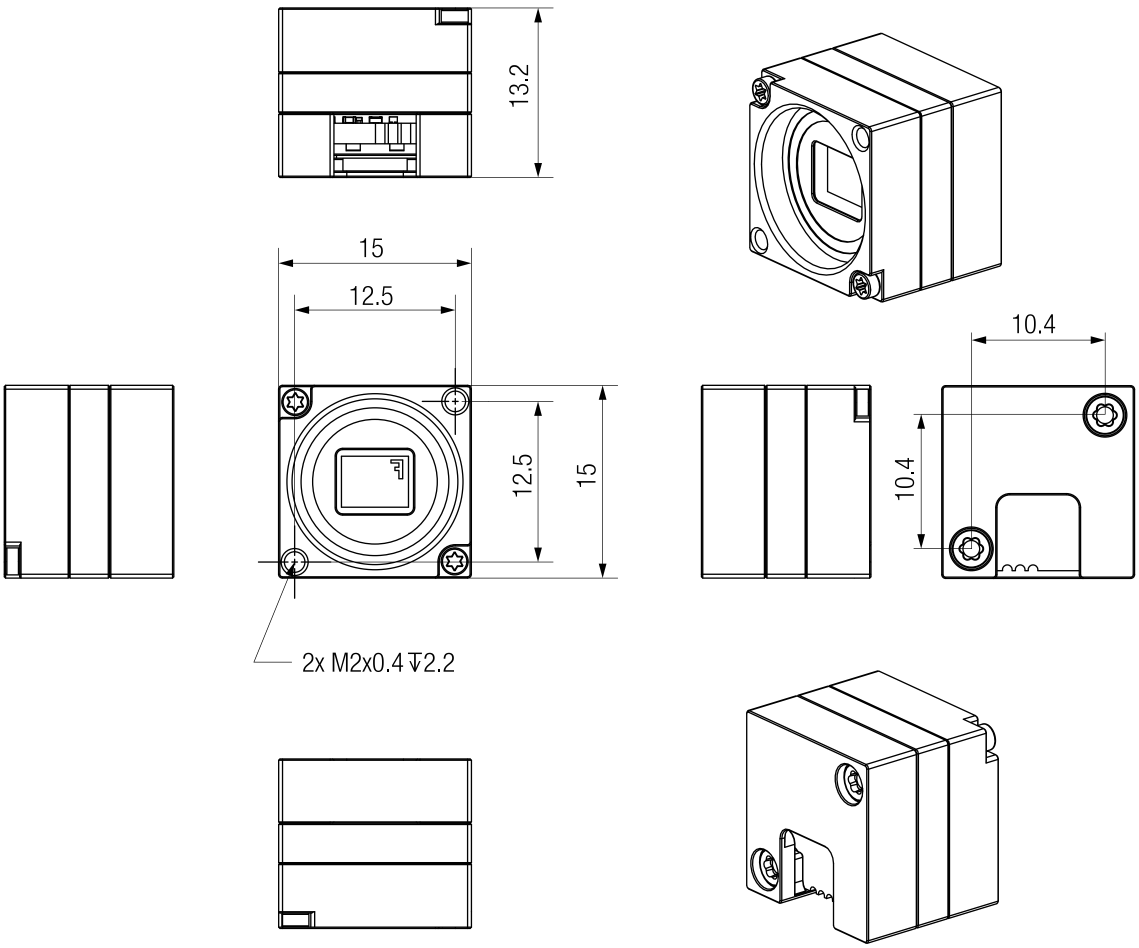


Figure 47: Dimensional drawing of MU050xR-SY with ADPT-MU-CX3-UC adapter

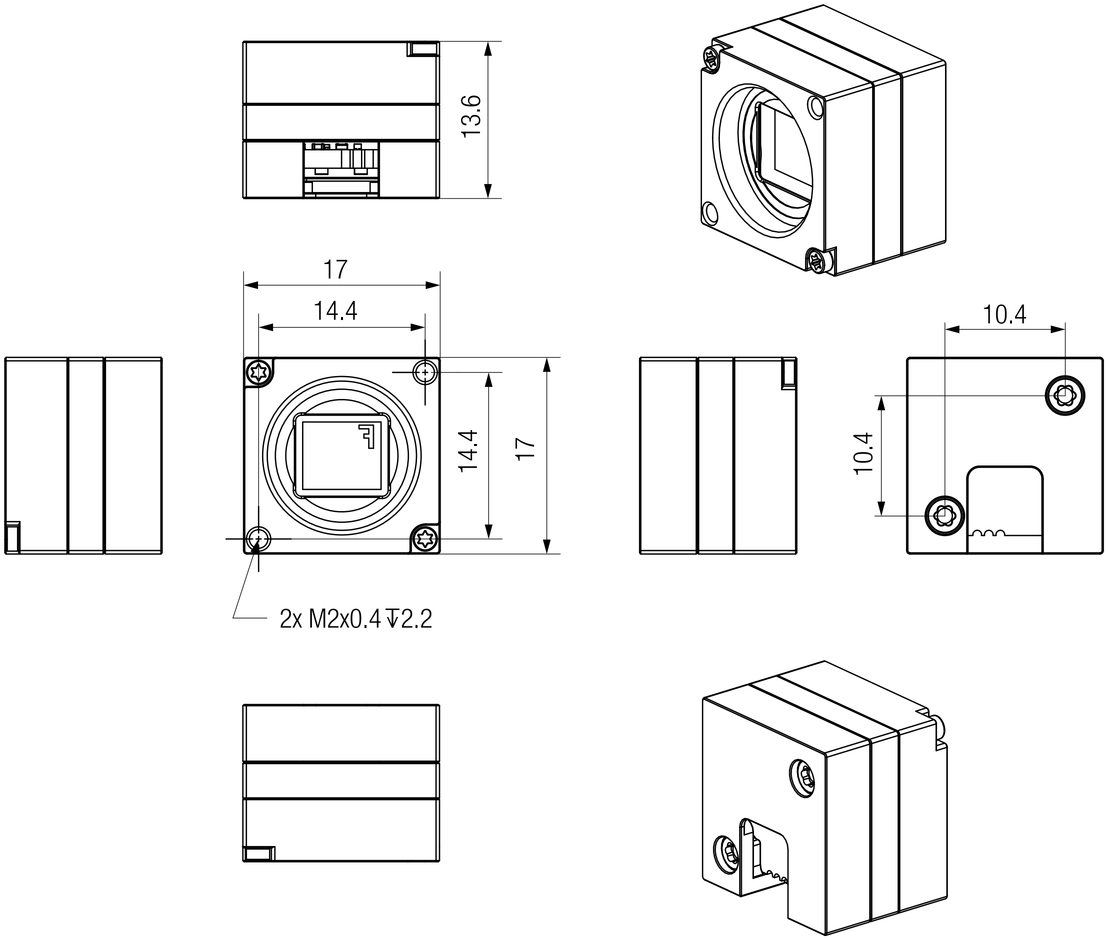


Figure 48: Dimensional drawing of MU051xG-SY with ADPT-MU-17x17-CX3-UC adapter

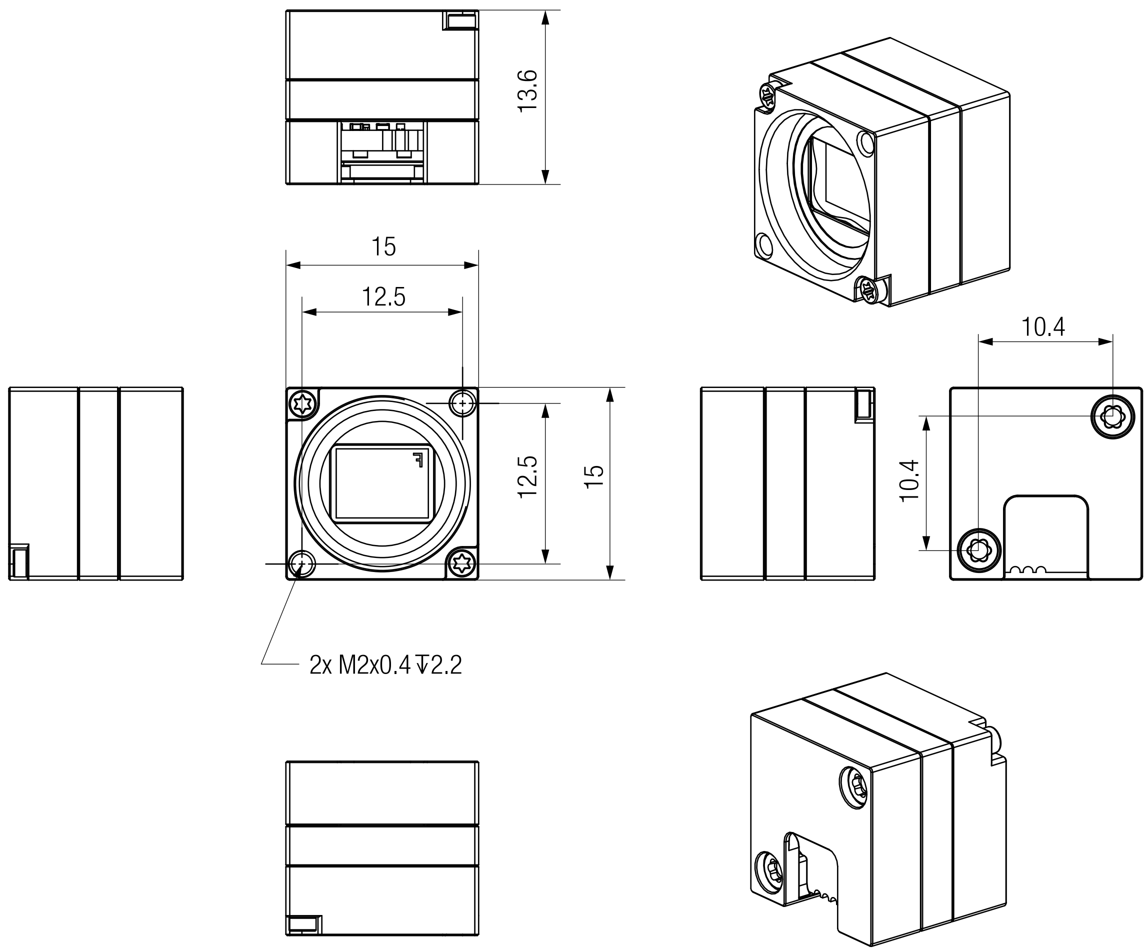


Figure 49: Dimensional drawing of MU196xR-ON with ADPT-MU-CX3-UC adapter

2.10.7 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.

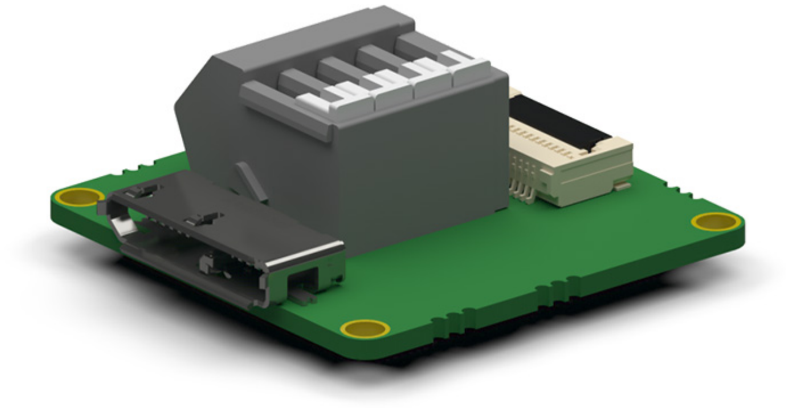


Figure 50: BOB-MQ-FL

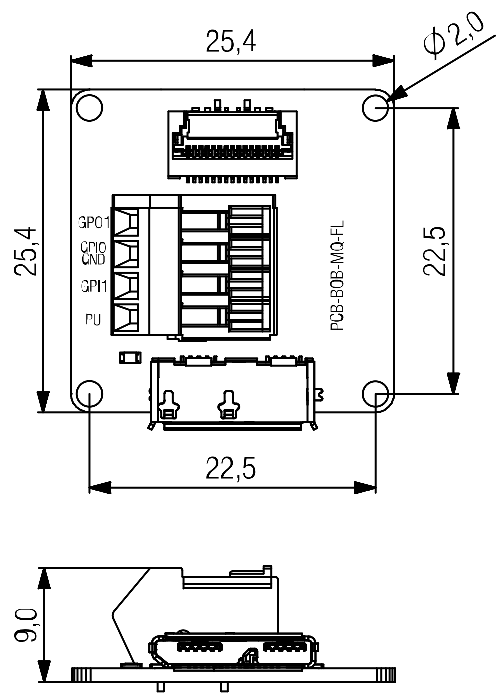


Figure 51: BOB-MQ-FL dimensions

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 kΩ to GPO1 – Connect power supply up to 25 V if needed

Table 49: 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 of the sub-area.

3.1.2 Downsampling modes

Downsampling describes the possibility of reducing the image resolution without affecting the sensors physical size, i.e. without reducing the physical size of the sensing area. This feature is useful when optics are used, that are particularly fitted to a certain sensor size and if it is necessary to maintain the full image circle on the sensor.

Downsampling can be achieved in two ways: binning and decimation.
Binning/decimation selector selects which binning/decimation engine is used (Sensor, FPGA, CPU). After setting of selector, multiple parameters could be get or set for the selected unit.

They can be divided into:

Patterns define the horizontal/vertical pattern how photo-sensitive cells are combined (mono or bayer)

Values reduce the horizontal or vertical resolution of the image by the specified horizontal/vertical downsampling factor

Modes in case of binning set the mode used to combine horizontal/vertical photo-sensitive cells together (sum or average)

Binning

When binning is applied, the image is divided into cluster of k*l pixels, where all pixels in each cluster are interpolated and result in the value of one output pixel. For example, a 2*2 binning produces 2*2-pixel clusters and results in images with ¼ of the original resolution.

Decimation – Skipping

When decimation is chosen, only every n-th pixel is used to create the output image. For example, with a 2x1 vertical skipping, every odd number line is used and every even number line is skipped, resulting in an image with half its original vertical resolution. Skipping is a faster downsampling mode, but also introduces more aliasing effects.

3.1.3 Image data output formats

All modes are provided by the xiAPI or standard interfaces using the xiAPI (please see Programming). Each camera model supports several Image Data Output Formats.

This table is applicable to:
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]

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

Table 50: 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]

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

Table 51: 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]

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

Table 52: 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]

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

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

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

Table 53: 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).

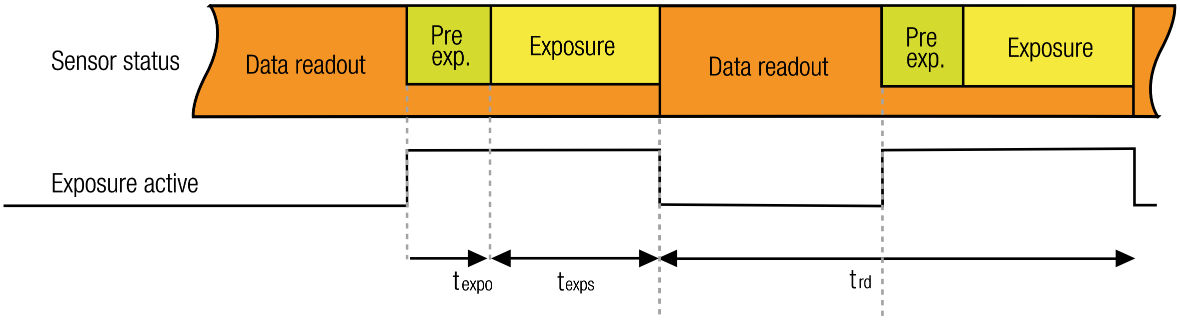


Figure 52: Acquisition mode - free run

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.

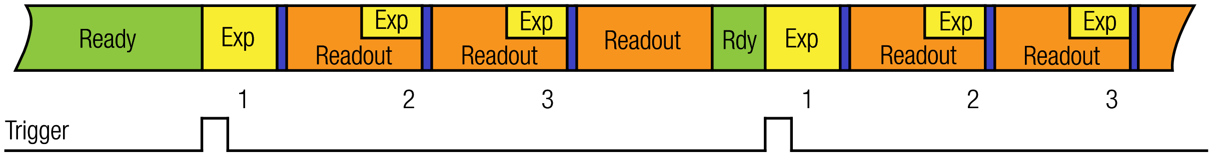


Figure 53: Triggered burst of frames – frame burst start

Frame Burst Active

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

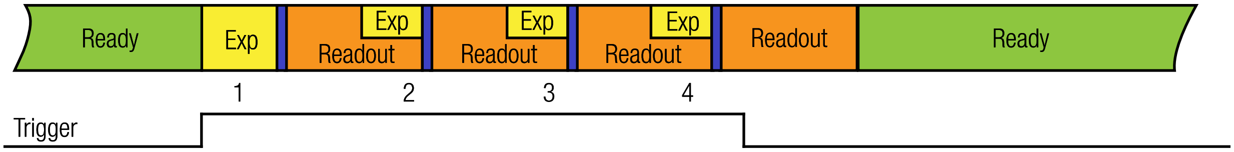


Figure 54: Triggered burst of frames – frame burst active

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);
```

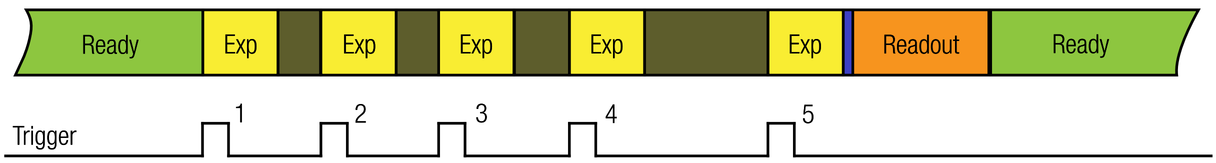


Figure 55: Multiple exposures - defined exposure time number - of exposures set to 5

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);
```

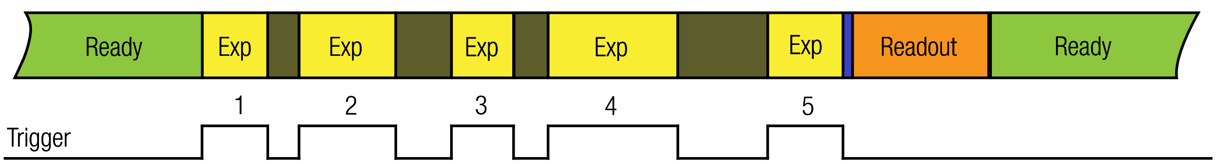


Figure 56: Multiple exposures - exposure time defined by trigger pulse length - number of exposures set to 5

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* 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.

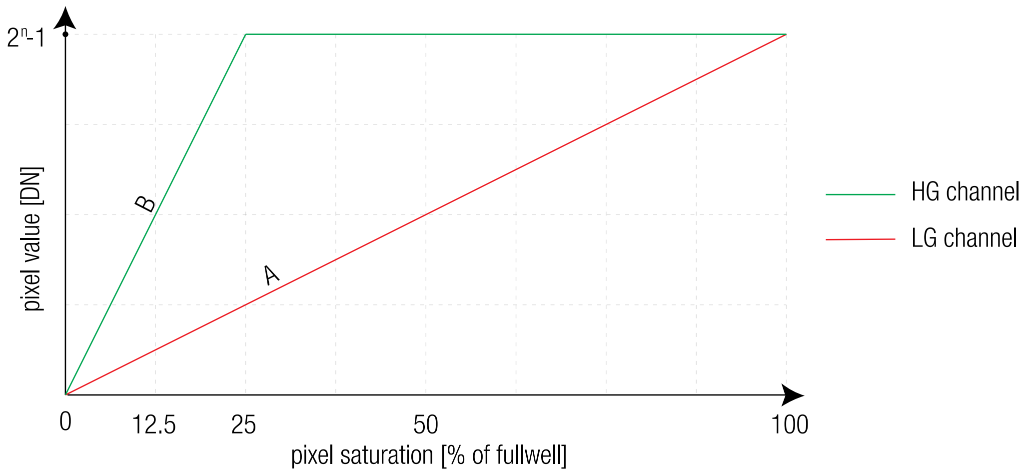


Figure 57: Dual ADC mode non-combined without merging

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

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

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

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

3.5.1 Combined mode

Following camera models support Combined mode:

MU196CR-ON 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.

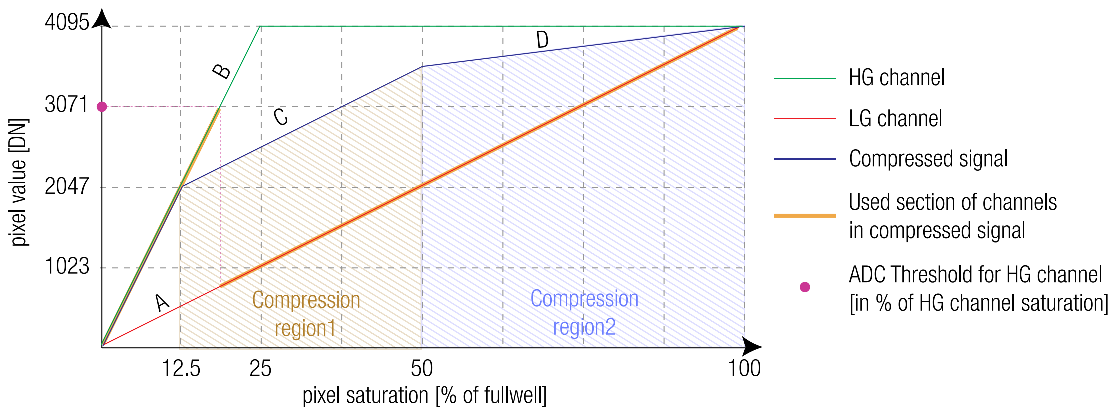


Figure 58: Dual ADC mode combined

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

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

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

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

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

3.5.2 Non-combined mode

Following camera models support Non-combined mode:

MU050CR-SY 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 CPU and is optimized for processors with x86 architecture.

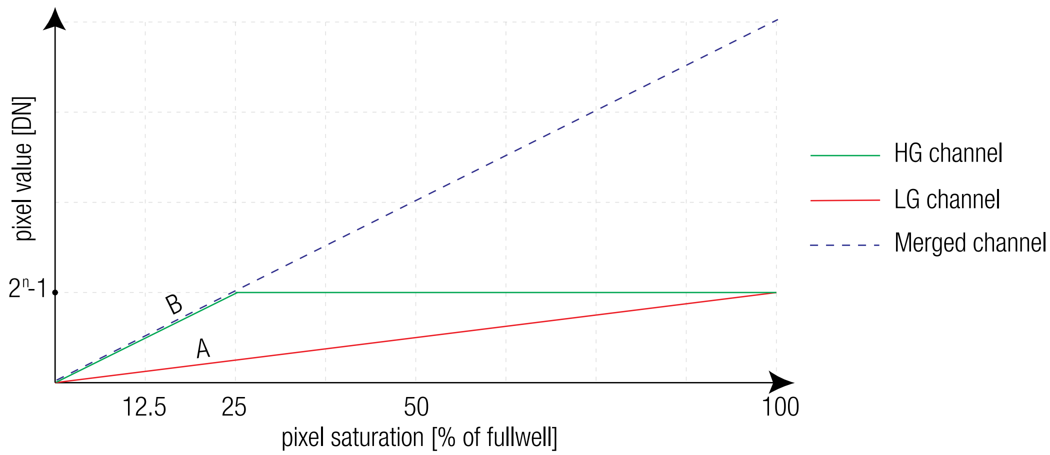


Figure 59: Dual ADC mode non-combined with merging

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

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

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

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

3.6 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.

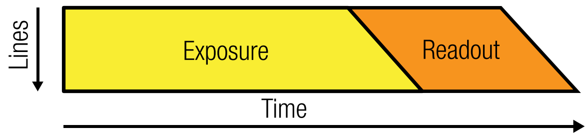


Figure 60: Global reset release mode - schematic

Because of the longer exposure of the lower lines they may be 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 61: Global reset release mode - image horizontally moved object

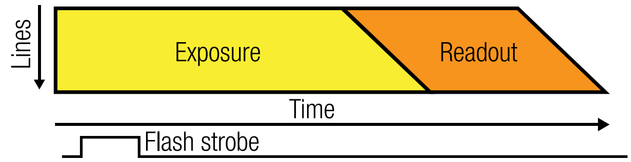


Figure 62: Global reset release mode with flash - schematic

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

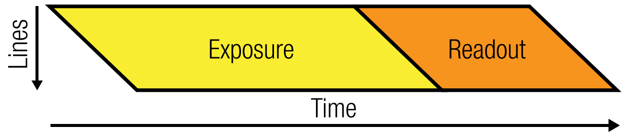


Figure 63: Rolling shutter mode - schematic

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 64: Rolling shutter mode image of a horizontally moved object

Figure 65: 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/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.

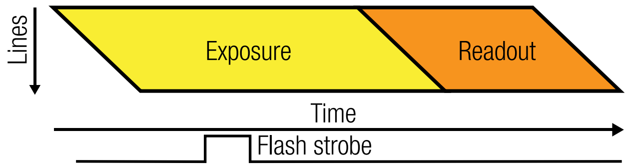


Figure 66: Rolling shutter mode with flash - schematic

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 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.

3.7.7 Flat field correction

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

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

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

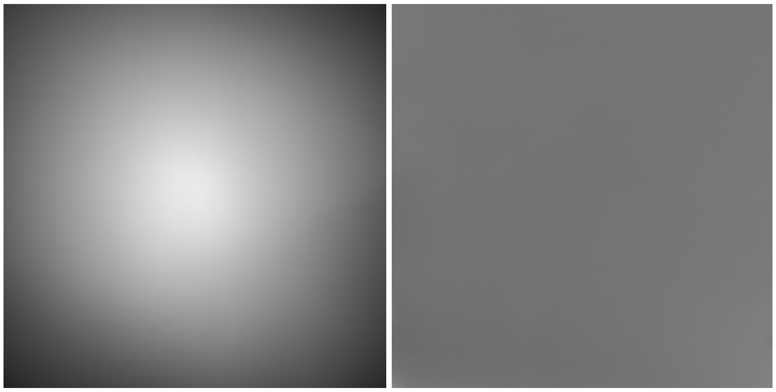


Figure 67: Flat field correction - images comparison

Acquisition of calibration images

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

Figure 68: Flat field correction - new FFC

Dark Image

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

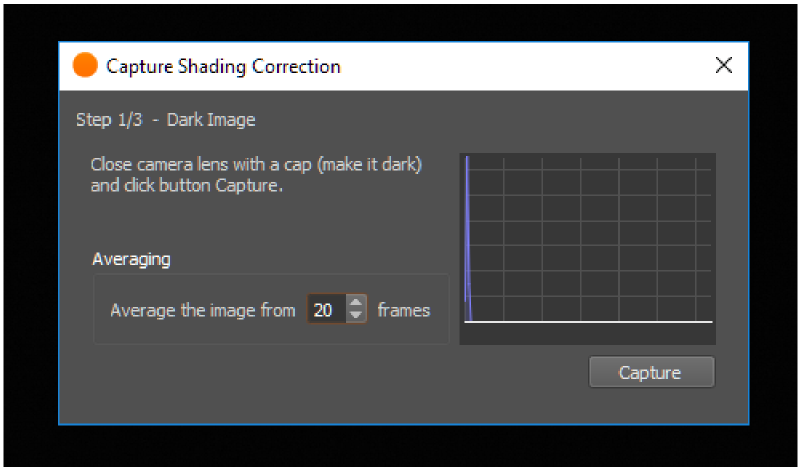


Figure 69: Flat field correction - Dark image

Mid-saturated image

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

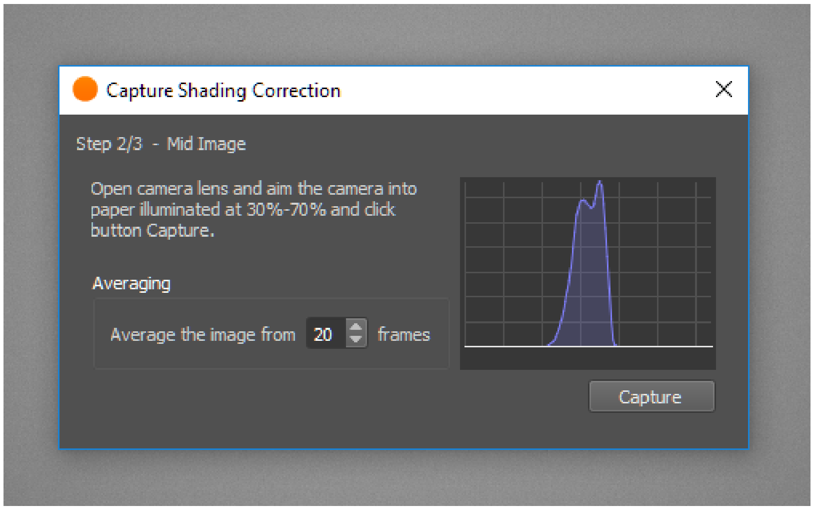


Figure 70: Flat field correction - Mid- saturated image

Save TIFF files

Save the new preset how it be displayed in CamTool.

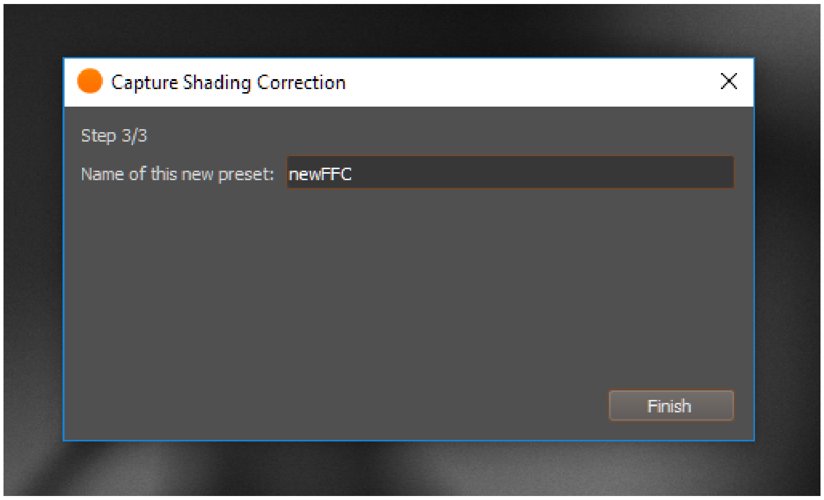


Figure 71: Flat field correction - new preset

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

Figure 72: Flat field correction - Enabling FFC

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

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

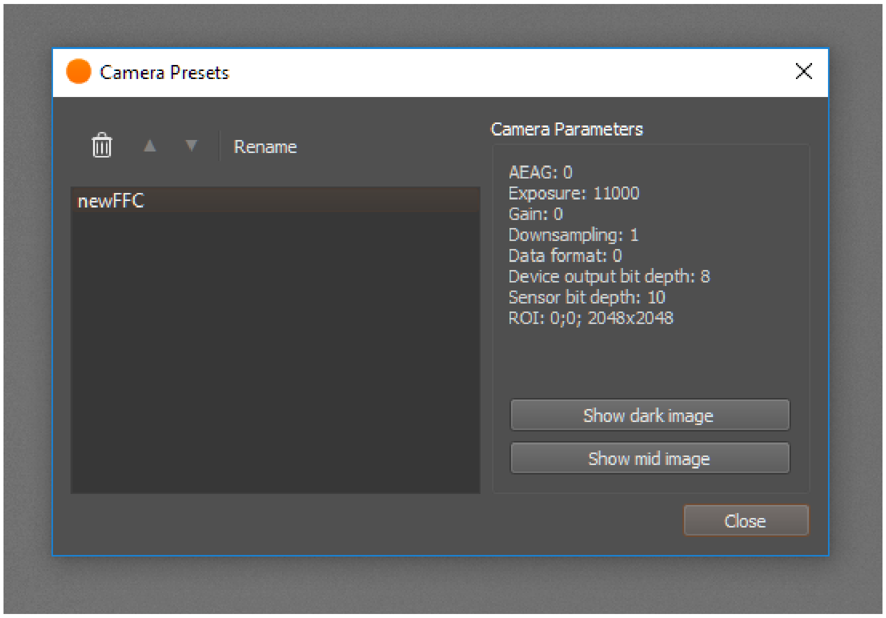


Figure 73: Flat field correction - FFC management

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

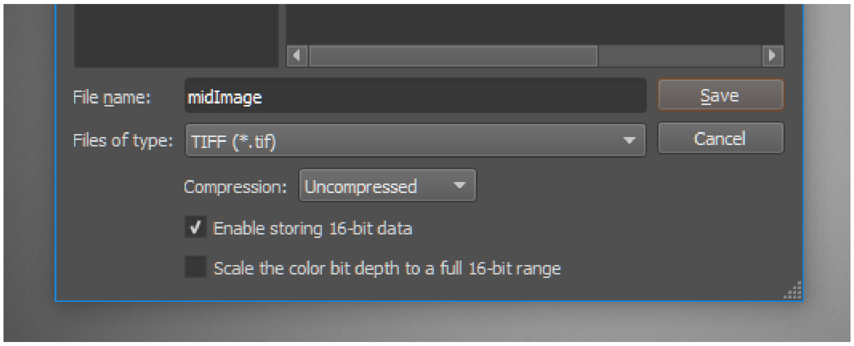


Figure 74: Flat field correction - Safe TIFF

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

`%LOCALAPPDATA%\xiCamTool\shading`

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

Applying FFC in xiAPI

xiAPI command sequence:

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

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

- Enable XI_PRM_FFC.

Sample code:

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

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

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

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

4 Operation

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

4.1 System requirements

4.1.1 Software requirements

Cameras are compatible with the following operating systems:

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

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

4.1.2 Hardware requirements

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

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

4.2 XIMEA software packages

4.2.1 XIMEA Windows software package

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

Contents

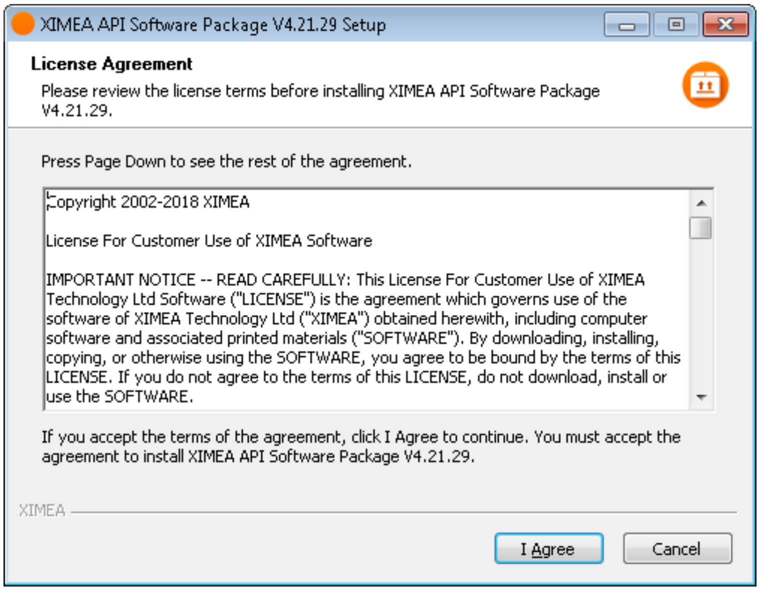
The package contains:

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

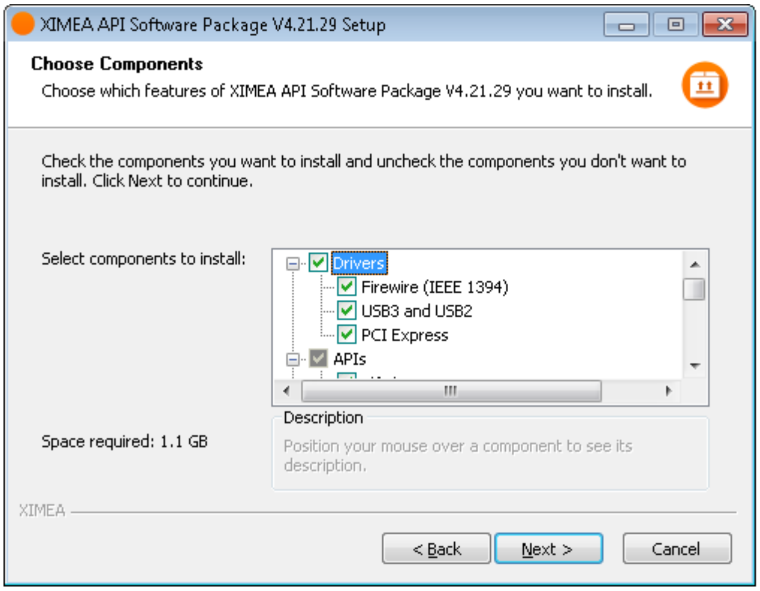
Installation

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

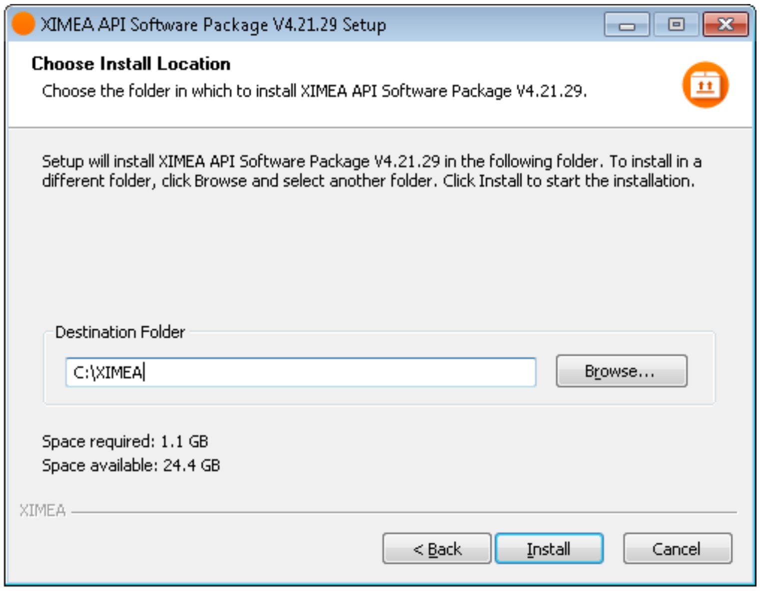
  Be sure that you have administrator privileges or start the Installer with administrator rights
  (right click and select “run as administrator”):



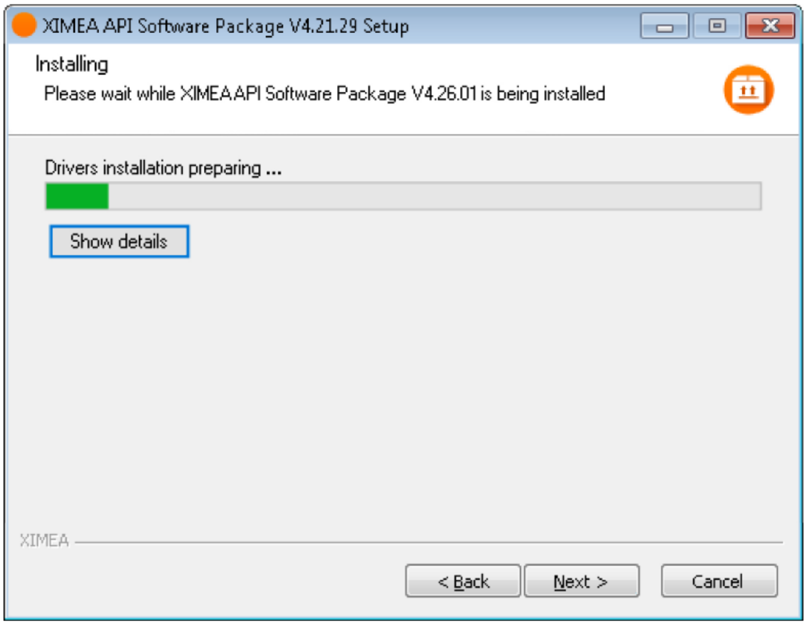
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



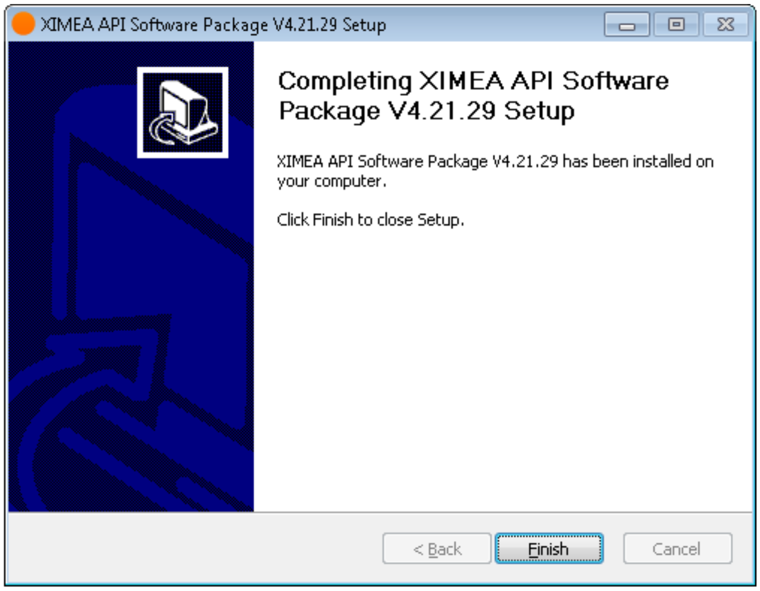
- Specify the install location - you can leave the default location or change it to your desired location



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



- Installation is completed
- Finish



4.2.2 XIMEA Linux software package

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

Contents

The package contains:

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

Instalation

- Download XIMEA Linux Software Package:

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

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

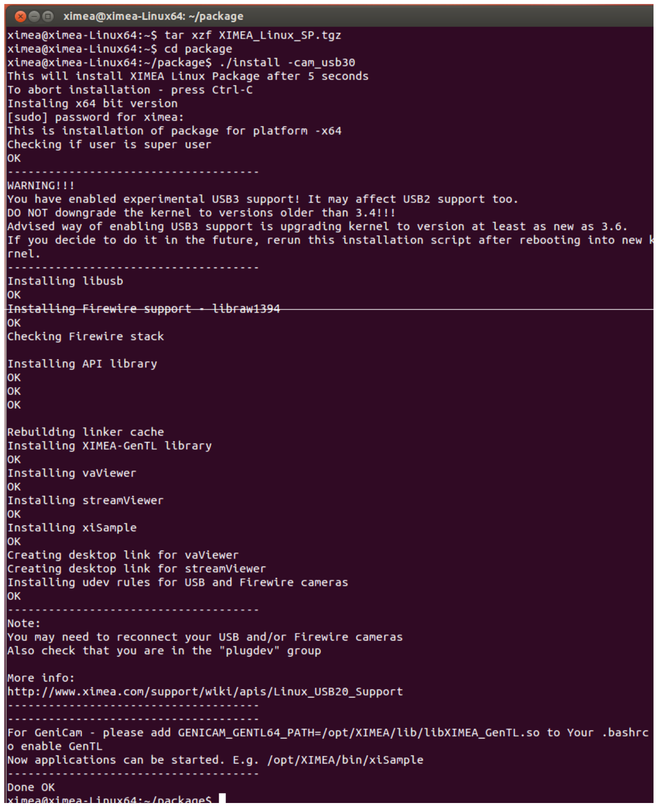
- Untar

  `tar xzf XIMEA_Linux_SP.tgz`

  `cd package`

- Start installation script

```
./install
```



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

4.2.3 XIMEA macOS software package

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

Contents

The package contains:

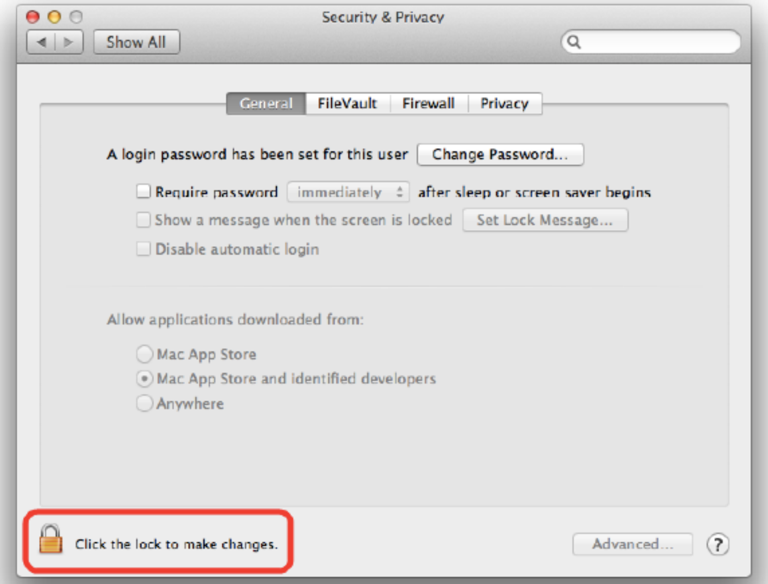
- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
  - xiSample - sample showing basic image acquisition in xiAPI

Installation

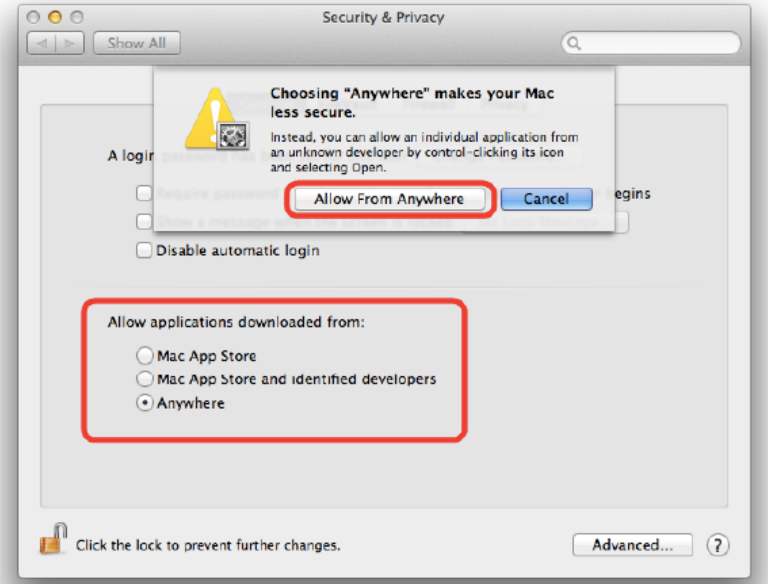
Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- Open System Preferences application and click on Security & Privacy

- Click on the lock to allow changes to be made



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



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

Start XIMEA CamTool

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

Short description

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

4.3 XIMEA CamTool

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

Figure 75: CamTool preview

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

Table 54: CamTool layout

Functions

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

4.4 XIMEA control panel

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

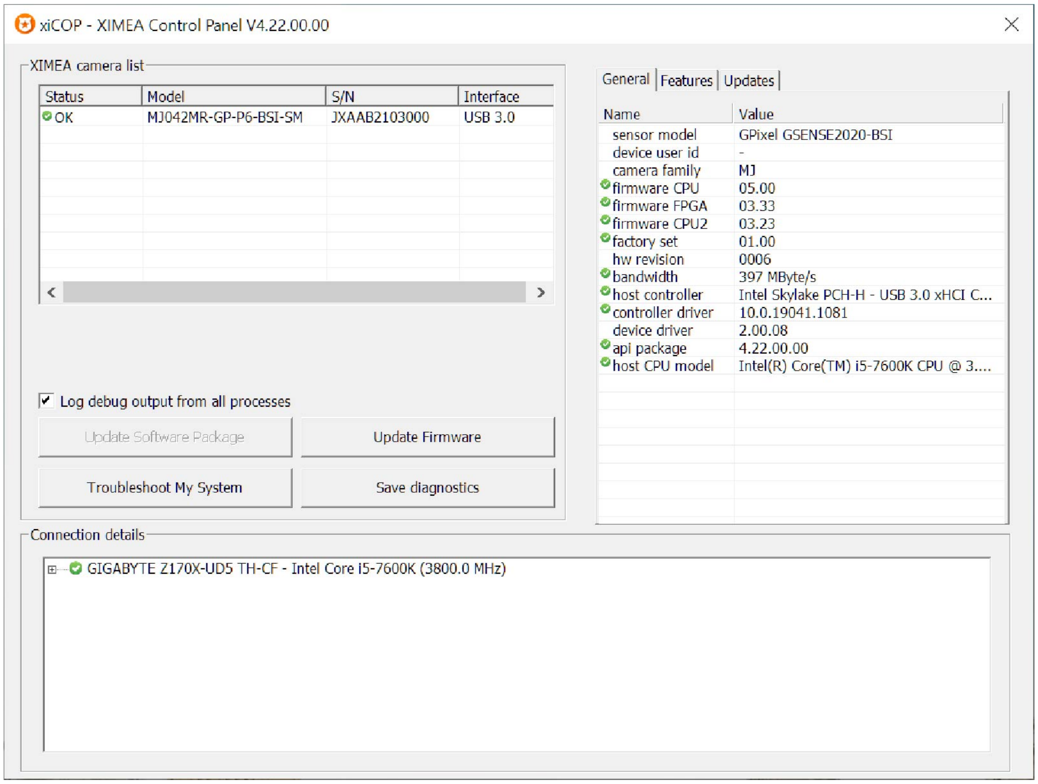


Figure 76: xiCOP example

Features

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

4.5 Supported vision libraries

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

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

4.5.1 MathWorks MATLAB

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

4.5.2 MVTec HALCON

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

4.5.3 National Instruments LabVIEW vision library

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

4.5.4 OpenCV

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

4.6 Programming

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

4.6.1 Standard interface

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

GenICam/GenTL

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

4.6.2 xiAPI

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

Architecture

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

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

Installation

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

xiAPI functions description

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

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

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

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

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

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

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

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

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

xiAPI parameters description

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

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

xiAPI examples

Connect device

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

```
HANDLE xiH = NULL;

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

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

Parameterize device

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

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

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

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

Acquire images

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

```
        xiStartAcquisition(xiH);

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

Hardware trigger and exposure active output

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

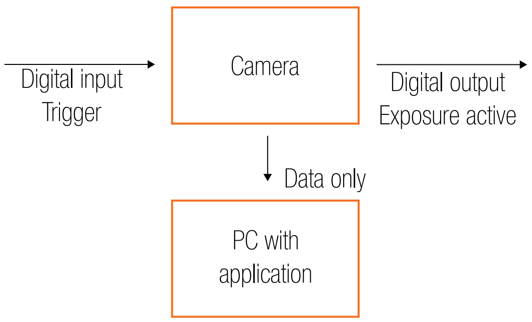


Figure 77: GPIO scheme

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

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

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

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

xiStartAcquisition(handle1);

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

xiAPI Auto Bandwidth Calculation

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

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

xiAPI.NET

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

xiApiPython

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

5 Appendix

5.1 Troubleshooting and support

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

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

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

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

5.1.1 Worldwide support

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

5.1.2 Before contacting technical support

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

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

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

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

5.2 Frequently Asked Questions

- Frequently Asked Questions
- Knowledge Base

5.3 Product service request (PSR)

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

Step 1 – Contact support

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

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

Step 2 – Create product service request (PSR)

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

Step 3 – Wait for PSR approval

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

Step 4 – Sending the camera to XIMEA

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

Step 5 – Waiting for service conclusion

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

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

Table 55: Service operations overview

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

Step 6 – Waiting for return delivery

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

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

5.4 Safety instructions and precautions

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

5.5 Warranty

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

5.6 Standard Terms & Conditions of XIMEA GmbH

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

5.7 List of Trademarks

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

5.8 Copyright

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

Glossary

CMOS Complementary Metal-Oxide-Semiconductor 68

ESD Electrostatic discharge 32

FPGA Field Programmable Gate Array 61

FPS Frame Per Second 65

PSR Product Service Request 96

ROI Region Of Interest 61

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