ximea

xiC

[ksi-see: or sai-see:]

• USB 3.1 camera series

Technical Manual

Version 1.18, September, 2019

1. Introduction

1.1. 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 questions or if you wish to claim a service or warranty case, please contact your local dealer or refer to the XIMEA Support on our website:
www.ximea.com/support

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

This document is subject to change without notice.

1.2. About XIMEA

XIMEA is one of the worldwide leaders for innovative camera solutions with a 25-year history of research, development and production of digital image acquisition systems. Based in Slovakia, Germany and the US and 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.

XIMEA cameras find use in many industrial applications, such as motion control, robotics, or quality control in manufacturing. The broad spectrum of cameras also includes thermally stabilized X-ray cameras, and specialty cameras for medical applications, research, surveillance and defense.

1.2.1. Contact XIMEA

XIMEA is a worldwide operating company

Headquarters
Sales worldwide

XIMEA GmbH
Am Mittelhafen 16
48155 Münster
Germany

Tel: +49 (251) 202 408-0
Fax: +49 (251) 202 408-99

Sales America

XIMEA Corp.
12600 W Colfax Ave., Suite A-130
Lakewood, CO 80215
USA

Tel: +1 (303) 389-9838
Fax: +1 (303) 202-6350

R&D, Production

XIMEA s.r.o.
Lesna 52
900 33 Marianka
Slovakia

Internet	www.ximea.com
General inquiries	info@ximea.com
Sales	sales@ximea.com
Support	https://www.ximea.com/support/wiki/allprod/Contact_Support

Standard Conformity

The xiC cameras have been tested using the following equipment:

Model option –UB (microB USB 3.1 conector)

- A shielded USB 3.0 cable ref. CBL-U3-3M0 (3m)
- A shielded I/O Sync cable ref. CBL-702-8P-SYNC-5M0 (5m)

Model option – TC (Type C connector in USB 3.1 Gen 1 mode)

- A shielded USB 3.1 Type-C to A cable (1m)
- A shielded I/O Sync cable ref. CBL-702-8P-SYNC-5M0 (5m)

Model option –FV and – FL

- Camera is connected to Tegra TX1 processor board via TX1CB-PHOXI-BRD and CBL-MQ-FL-0M1. Whole setup is housed in AW16918ESS enclosure, with modified end panels to hold camera and provide access to power connector and Ethernet connector. System is Linux operating system controlled over Ethernet from remote computer. For more information please contact our support: https://www.ximea.com/support/wiki/allprod/Contact_Support

Warning: Changes or modifications to the product or the environment may render it ineligible for operation under CE, FCC or other jurisdictions. XIMEA recommends using the above configuration to ensure compliance with the following standards. Please refer also to chapter 1.2.9.

1.2.2. CE Conformity

CE

The xiC cameras described in this manual comply with the requirements of the

- EC EMC Directive 2014/30/EU electromagnetic compatibility of equipment

1.2.3. For customers in the US: FCC Conformity

FC

The xiC cameras described in this manual 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:

- This device may not cause harmful interference, and
- 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 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 above jurisdictions. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.
Please refer also to chapter 1.2.9

1.2.4. For customers in Canada

The xiC cameras comply with the Class A limits for radio noise emissions set out in Radio Interference Regulations.
Please refer also to chapter 1.2.9

1.2.5. RoHS Conformity

The xiC cameras comply with the requirements of the RoHS (Restriction of Hazardous Substances) Directive 2011/65/EU.

1.2.6. WEEE Conformity

The xiC cameras comply with the requirements of the WEEE (waste electrical and electronic equipment) Directive 2012/19/EU.

1.2.7. AIA standard USB3 Vision

The xiC cameras are compliant with the USB 3.0 SuperSpeed specification and are designed to be compliant with the AIA USB3 Vision standard.

1.2.8. GenICam GenTL API

GenICam standard transport layer interface, grabbing images. GenICam/GenTL provides an agnostic transport layer interface to acquire images or other data and to communicate with a device. Each XIMEA camera can be GenTL Producer.

1.2.9. Camera Sub-Assemblies

The FL and FV camera models are "semi" housed with flex ribbon cable interfaces. As such, these devices do not comply with CE/FCC/Class A limits (Canada) regulations. The system integrator (customer) is liable for compliance with CE/FCC/ Class A limits (Canada) regulations.

1.3. Helpful Links

- XIMEA Homepage http://www.ximea.com/
- xiC USB3 Vision Camera Zone http://www.ximea.com/usb3zone
- USB3 Hardware Compatibility http://www.ximea.com/support/wiki/usb3/Compatible_hardware
- USB3.1 Updates https://www.ximea.com/support/wiki/usb3/USB_31_updates
- xiAPI stable versions download https://www.ximea.com/support/documents/4
- xiAPI beta versions download https://www.ximea.com/support/documents/14
- Frequently Asked Questions http://www.ximea.com/support/wiki/allprod/Frequently_Asked_Questions
- Knowledge Base http://www.ximea.com/support/wiki/allprod/Knowledge_Base
- Vision Libraries http://www.ximea.com/support/projects/vision-libraries/wiki
- XIMEA Registration http://www.ximea.com/en/products/register
- XIMEA Live Support http://www.ximea.com/support/wiki/allprod/XIMEA_Live_Support
- XIMEA General Terms & Conditions http://www.ximea.com/en/corporate/generaltc

1.4. Table of Contents

2. xiC Camera Series

2.1. What is xiC

xiC [ksi-see: or sai-see:] is an ultra-compact USB 3.1 (gen 1) Industrial camera family with outstanding features:

- Extremely small footprint, very light
- Low power consumption
- USB3 Vision Standard compatible
- sensors: 2.3 MP, 3.1 MP, 5.0 MP, 8.9 MP and 12.4 MP, b/w, color Sony sensors
- frame rates: 2.3 MP @ 165 fps to 12.4 MP @ 31 fps

The XiC camera line comes with several options for interface to the host computer; standard USB (type-C and micro-B) and custom flex line connections. At the time of writing, the USB cameras utilize USB 3.1 gen1 definitions and yield a bandwidth of about 450 Mbyte/s. The cameras are backward compatible with USB 3.0 and 2.0 (with concomitant reduction in pixel throughput).

2.2. Advantages

Industry standard interface	USB 3.1 Gen1
AIA standard compatibility	USB3 Vision standard
Small	Fits into places where no other camera can fit
Low power consumption	2.2-3.5 W
Powerful	5Gb/s interface up to 450Mbyte/s data throughput for USB3.1 gen1
Fast	High speed, high frame rate: >650fps at VGA and 30fps at 12Mpix resolutions
Robust	Full metal housing, no sheet metal covers
Lightweight	Facilitates increased performance of robotic arms and gimbals
Connectivity	Programmable opto-isolated I/O, and non-isolated digital input and output. 4 status LEDs
Compatibility	Support for Windows, Linux and MacOS, ARM, various Image Processing Libraries
Software interfaces	GenICam / GenTL and highly optimized xiAPI SDK
Economical	Excellent value and price, low TCO and fast ROI

table 2-1, advantages

2.3. USB3 Vision Camera Applications

- Automation
- Ultra-fast 3D scanning
- Miniature and fast robotic arms
- Mobile devices
- In-situ optical inspection camera
- Material and life science microscopy
- Ophthalmology and retinal imaging
- Broadcasting
- Fast process capture, e.g. golf club swings
- Intelligent Transportations Systems (ITS) and traffic monitoring

2.4. Common features

Sensor Technology	CMOS, Global shutter
Acquisition Modes	Continuous, software and hardware trigger, fps limiting, triggered exposure and burst
Partial Image Readout	ROI, Skipping and Binning modes supported (model specific)
Image data formats	8, 10 or 12 bit RAW pixel data
Color image processing	Host based de-bayering, sharpening, Gamma, color matrix, true color CMS
Hot/blemish pixels correction	On camera storage of up to 5000 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 3.1 standard Micro B and standard Type-C with screw lock threads and flat ribbon for embedded implementation compliant to USB3 Vision standard
General Purpose I/O	1x opto-isolated input, 1x opto-isolated output, and 2 non-isolated bidirectional I/O, 4X user configurable LEDs
Signal conditioning	Programmable debouncing time (planned)
Synchronization	Hardware trigger input, software trigger, exposure strobe output, busy output
Housing and lens mount	Standard C-mount convertible to CS mount, and “semi-housed”
Power requirements	2.2-3.5W, supplied via USB 3.1 interface
Environment	Operating 0°C to 50°C on housing, RH 80% non-condensing, -30°C to 70°C storage Ingress Protection: IP40
Operating systems	Windows 10 (x86 and x64), Windows 7 SP1 (x86 and x64), Linux Ubuntu, MacOS 10.8 and newer
Software support	xiAPI SDK, adapters and drivers for various image processing packages
Firmware updates	Field firmware updatable

table 2-2, common features

2.5. Model Nomenclature

Part number convention for the different models:

MCxxxyG-zz[-OPT]$_n$

MC xiC family name

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

y: y=C: color model
y=M: black & white model

G: Global shutter (all XiC cameras are global shutter)

zz: Vendor of the sensor
zz = SY: Sony

[-OPT]: Options

OPT = TC: connector Type-C

OPT = UB: connector micro B

OPT = FL: flexline variant, connector parallel to board, semi-housed

OPT = FV: flexline variant, connector perpendicular to board, semi-housed

2.6. Models Overview, sensor and models

Model[1]		Resolution	Pixel size	ADC [bit]	DR	Optical size	Sensor diagonal	FPS[2]
MC023MG-SY	b/w	1936 x 1216	5.86 µm	10/12	71.7 dB	1/1.2"	13.4 mm	165
MC023CG-SY	Color							
MC031MG-SY	b/w	2064 x 1544	3.45 µm	8/10/12	70.8 dB	1/1.8"	8.9 mm	122
MC031CG-SY	Color							
MC050MG-SY	b/w	2464 x 2056	3.45 µm	8/10/12	70.8 dB	2/3"	11.1 mm	76
MC050CG-SY	Color							
MC089MG-SY	b/w	4112 x 2176	3.45 µm	8/10/12	70.5 dB	1"	16.1 mm	43
MC089CG-SY	Color							
MC124MG-SY	b/w	4112 x 3008	3.45 µm	8/10/12	70.5 dB	1.1"	17.6 mm	31
MC124CG-SY	Color							

table 2-3, models overview

Note: 1) In the model name please add

-TC for USB 3.1 Gen1 Type C

-UB for USB 3.1 Gen1 Micro B

-FL for flat-flex cable connecting from the bottom of the camera

-FV for flat-flex cable connecting perpendicular to the sensor

2) Full resolution, 8-bit RAW

2.7. Accessories

The following accessories are available (short list):

Item P/N	Description
CBL-U3-1M0	1.0m USB 3.0 cable, micro B connector on camera side
CBL-U3-3M0	3.0m USB 3.0 cable, micro B connector on camera side
CBL-U3-3M0-ANG	3.0m USB 3.0 cable, angled micro B USB3 connector
CBL-U3-5M0	5.0m USB 3.0 cable, micro B connector on camera side
MECH-MC-BRACKET-KIT	xiC series tripod mounting bracket with Screws Kit
CBL-MQ-FL-0M1	Cable FPC MQ/MC Flex-Line, 0.1m (gold color)
CBL-MQ-FL-0M25	Cable FPC MQ/MC Flex-Line, 0.25m (gold color)
CBL-USB3FLEX-0M10	Cable FPC MQ/MC Flex-Line, 0.1m (white color)
CBL-USB3FLEX-0M25	Cable FPC MQ/MC Flex-Line, 0.25m (white color)
CBL-USB3FLEX-0M50	Cable FPC MQ/MC Flex-Line, 0.5m (white color)
BOB-MQ-FL	Break Out Board, Flex-Line, Simple Board Level Micro-B USB3.0
U31PE1G3-V1-X2[1]	PCI express adapter, 2x USB 3.1 ports asmedia ASM1142, xHCI
U3PE-FL1100-X4[1]	PCI express adapter, 4x USB 3.0 ports, PCIe x4 slot
CBL-702-8P-SYNC-5M0	5.0m Trigger/Sync I/O cable

table 2-4, accessories

Note: 1)For more information please visit:
https://www.ximea.com/support/projects/usb3/wiki/USB_3_Host_Adapters

3. Hardware Specification

3.1. Power Supply

The xiC cameras are powered via the USB Micro-B, type C or flexline connector. The input voltage is 5 V DC. The power consumption is 2.2 -3.5W depending on the xiC model.

Power supply, via USB system connector:

- 5 V (nominal)
- 4.45 V to 5.5 V (at the camera connector)

Additionally, the models with Micro-B (-UB) and type-C (-TC) connector can use external power supply, with same requirements as power supply defined above. For information about connection please see chapter: *3.10 xiC Digital Input / Output (GPIO) Interface* and *3.11 External power supply input (AUX)*.

Power supply, via Digital Input / Output (GPIO) Interface connector:

- 5 V (nominal)
- 4.45 V to 5.5 V (at the camera connector)

3.2. General Specification

3.2.1. 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	$T_{storage}$	-30 to +70 °C
Relative Humidity, non-condensing	RH	80 %

table 3-1, environment

Housing temperature must not exceed +65°C. It is recommended to mount the camera on heat conductive structure to improve heat dissipation. The following parameters are not guaranteed if the camera is operated outside the optimum range:

- Dark current
- Dynamic Range
- Linearity
- Acquisition and readout noise
- S/N ratio, durability

Please refer to chapter *3.12 Heat Dissipation*.

3.2.2. Firmware / Host driver / API features

Description	Value
Interpolation methods	Proprietary
White balance coefficients ranges	0.0 to 3.9
Sharpness filter	-400 to 400 %
Gamma	0.3 to 1.0
Full color correction matrix (3+1)x3 coefficients ranges	-3.9 to 3.9

table 3-2, firmware / API features

More details on API/SDK features are available at XIMEA support pages: https://www.ximea.com/support/wiki/apis/APIs

3.3. Lens Mount

The xiC cameras are compatible with C-mount and CS-mount lenses.

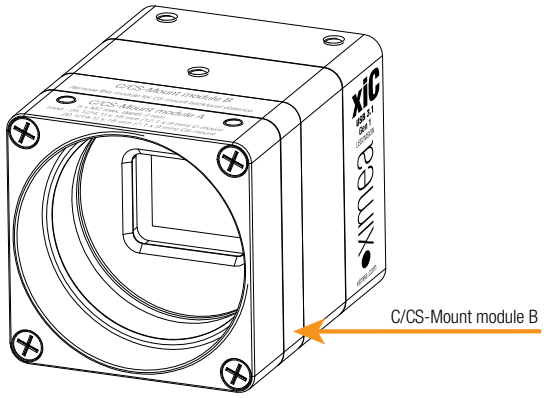


figure 3-1, position C/CS-Mount module B

The cameras are delivered with C-mount back focal length. By removing the "C/CS-Mount module B" (see the figure above) the camera can be rebuilt to CS-mount compatibility. Effectively reducing the back focal distance and overall length of camera by 5mm. The required M2x8mm special screws are part of the camera delivery. The length of the lens thread is 6.5 mm. Please read the chapter *3.4 Optical path* carefully. Conversion between those two options is described: https://www.ximea.com/support/projects/usb3/wiki/Convert_C_to_CS_Mount

Note: The distance between the threaded flange and the surface of the filter glass is 11.9 mm in case of C-Mount and 6.9 mm in case of CS-Mount. To avoid damaging of the filter glass, nothing may extend deeper into the housing.

Lens mount adapter configuration:

- C-Mount (with C/CS Mount module B)
- CS-Mount (without C/CS Mount module B)

3.3.1. Screws

All mounting screws are customized M2 screws with different lengths.

Technical details:

Material	Steel
Surface	Black zinc
Thread	M2
Driver	PH 00
Avail. Lengths	3mm – 24 mm

table 3-3, custom screws, technical details

Drawings, e.g. with 10mm length:

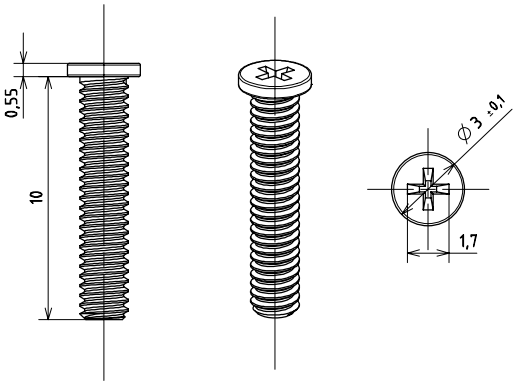


figure 3-2, xiC mounting screws

Note: Never exceed a maximum torque of 0.3Nm when fastening the M2 mounting screws.

3.4. Optical path

3.4.1. Filter glasses

A filter glass is part of the optical path of the camera. This glass is placed on a layer of silicone, to keep dust out of the camera, but not glued. The conversion of C-mount to CS-mount (see section *3.3 Lens Mount*) must be carried out carefully. Operating the camera without a lens mount is not intended and can lead to dropping out of the filter glass and the entry of dust. Do not use compressed air to clean the camera as this could push dust into the camera. Distance from the flange to sensor is designed so the optical distance is 17.526mm - 0.2mm.

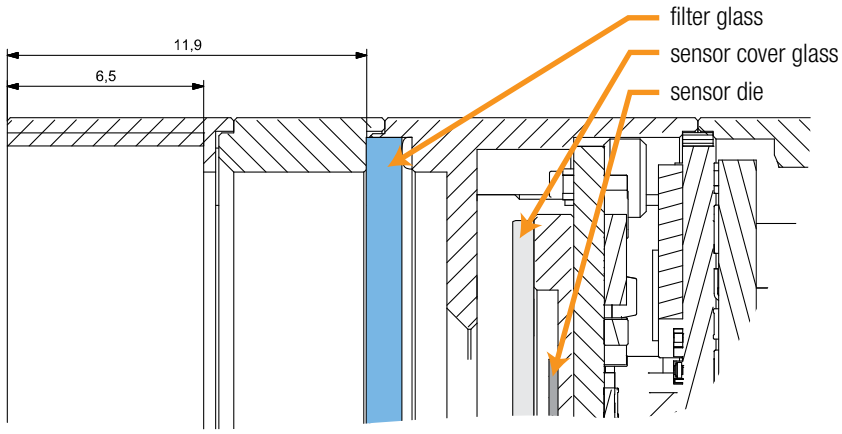


figure 3-3, Optical path section

3.4.2. Monochrome and near infrared extended camera models

Used filter brand	BK7 AR2x
Thickness	1.0±0.1 mm
Coating	Anti-reflex both sides

table 3-4, monochrome camera - filter glass parameter

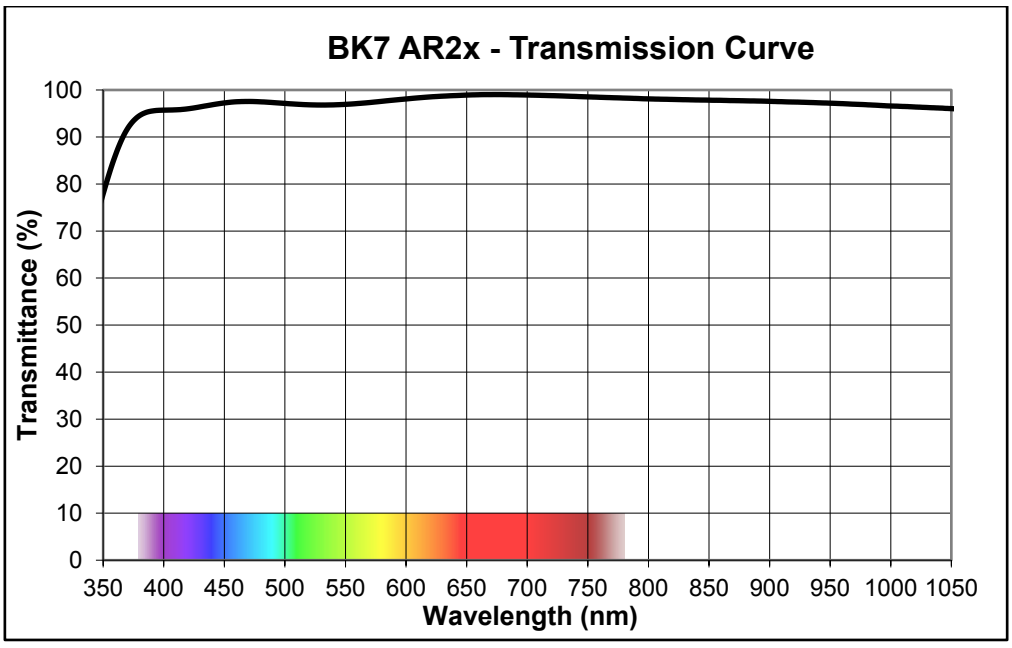


figure 3-4, monochrome camera - filter glass transmission curve

3.4.3. Color camera models

Used filter brand	ICR650
Thickness	1.0±0.1 mm
Coating	NA

table 3-5, color camera - filter glass parameter

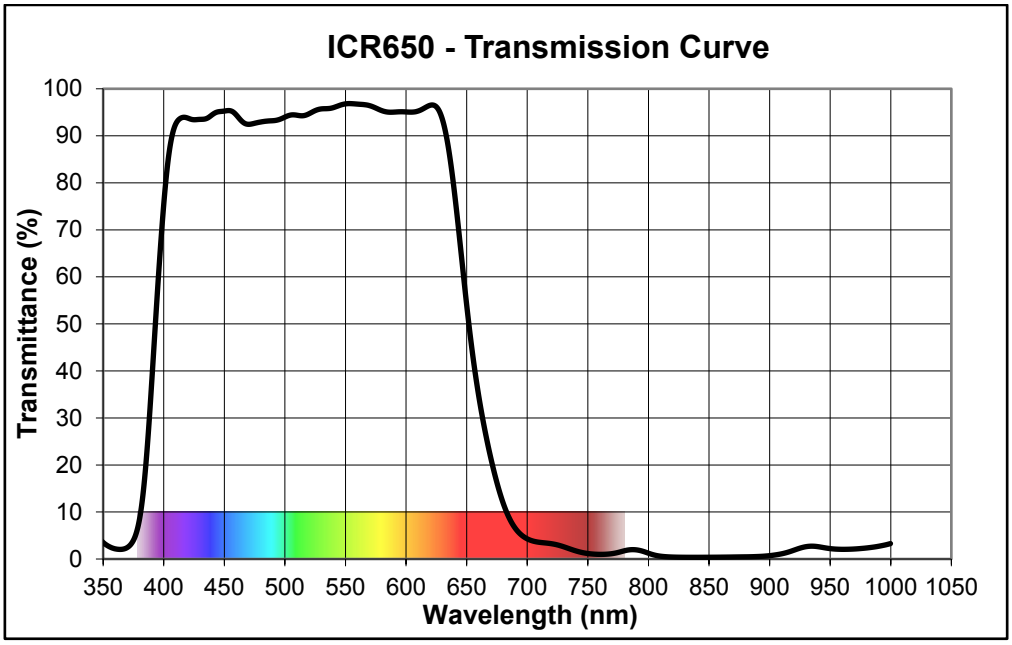


figure 3-5, color camera - filter glass transmission curve

3.5. Model Specific Characteristics

3.5.1. MC023xG-SY

3.5.1.1. Sensor and camera parameters

xiC model		MC023CG-SY	MC023MG-SY
Sensor parameter			
Model name		IMX174LQJ-C	IMX174LLJ-C
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	1936 x 1216	
Active area size (H × V)	[mm]	11.314 x 7.12	
Sensor diagonal	[mm]	13.39	
Optical format	[inch]	1/1.2	
Pixel Size (H × V)	[µm]	5.86 x 5.86	
ADC resolution	[bit]	10, 12	
FWC	[ke-]	30.5	
Dynamic range	[dB]	71.7	
SNR Max	[dB]	45	
Conversion gain	[e-/LSB_{12}]	8.1	
Dark noise	[e-]	7.36	
Dark current	[e-/s]	3	
DSNU	[e-]	1.1	
PRNU	%	0.4	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		19µs to 30sec, in steps of 4.96µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	165	
Power consumption			
typical	[W]	2.2	
Maximum	[W]	2.5	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-TC/-UB/-FL/-FV)	[mm]	42.3/42.0/28.9/29.4(with C/CS Mount module B) 37.3/37.0/23.9/24.4 (without C/CS Mount module B)	
mass (-TC/-UB/-FL/-FV)	[g]	38.3/37.5/28.3/28.3 (with C/CS Mount module B) 34.1/33.3/24.1/24.1 (without C/CS Mount module B)	

table 3-6, MC023xG-SY, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) could be calculated in: Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm

Supported standard readout modes	Binning/skipping	pixels	fps	Bit/px
0	1x1	1936 x 1216	165	8
1	1x1	1936 x 1216	129	10
2	1x1	1936 x 1216	108	12

table 3-7, MC023xG-SY, supported standard readout modes

3.5.1.2. Quantum efficiency curves [%]

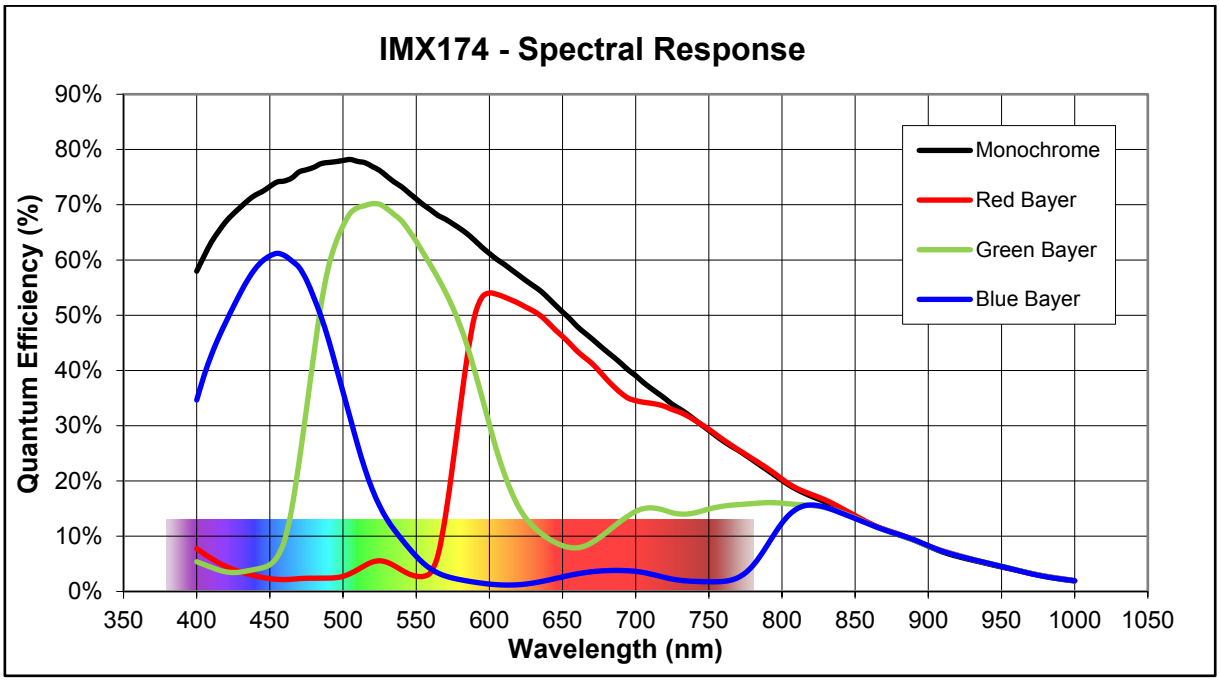


figure 3-6, IMX174-mono, quantum efficiency curve, ©SONY

3.5.1.3. Dimensional drawings MC023xG-SY-TC (C-mount [with C/CS mount module B])

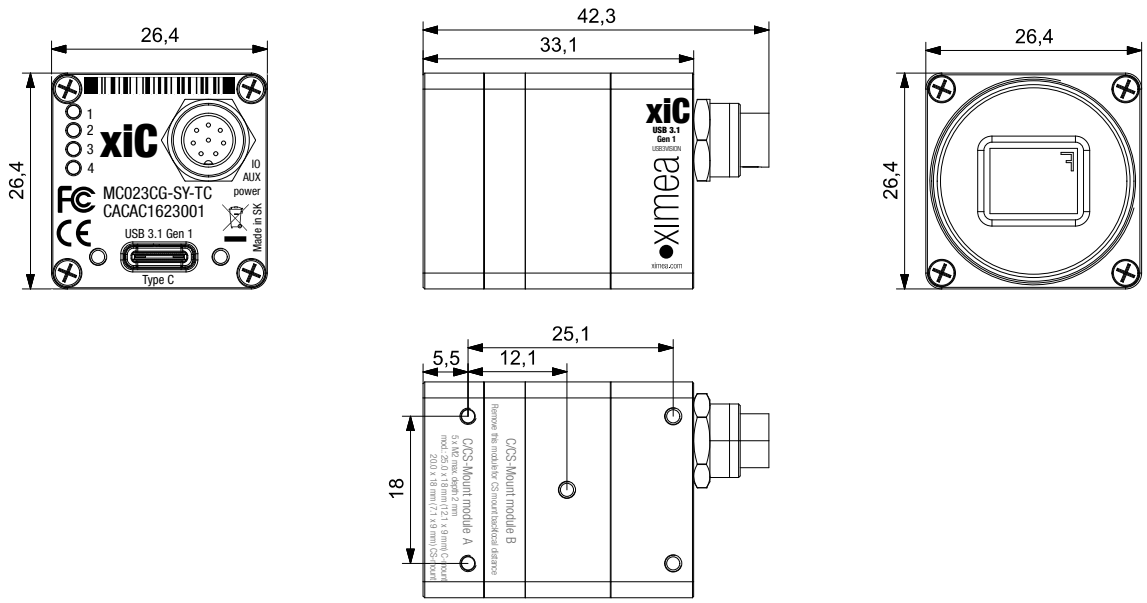


figure 3-7, dimensional drawing MC023xG-SY-TC, C-Mount housing

3.5.1.4. Dimensional drawings MC023xG-SY-UB (C-mount [with C/CS mount module B])

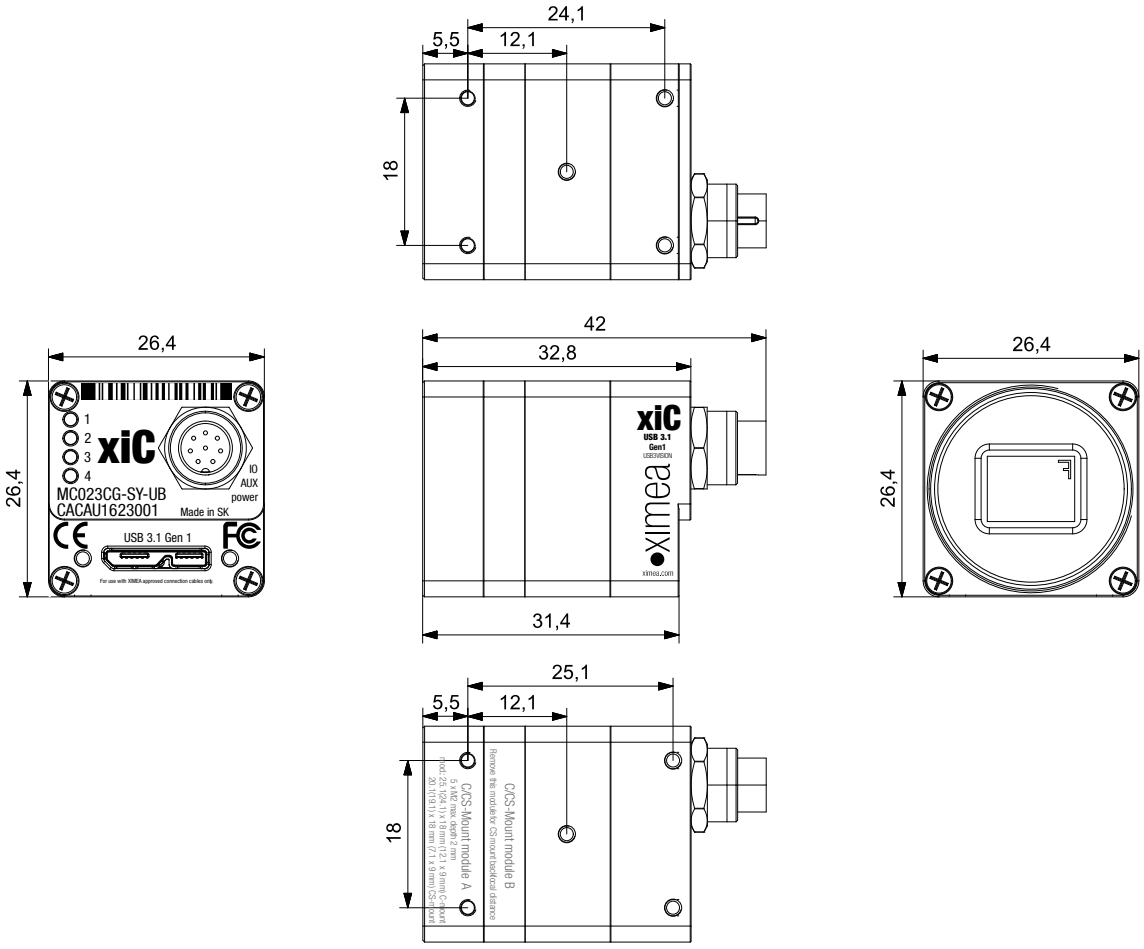


figure 3-8, dimensional drawing MC023xG-SY-UB, C-Mount housing

3.5.1.5. Dimensional drawings MC023xG-SY-FL (C-mount [with C/CS mount module B])

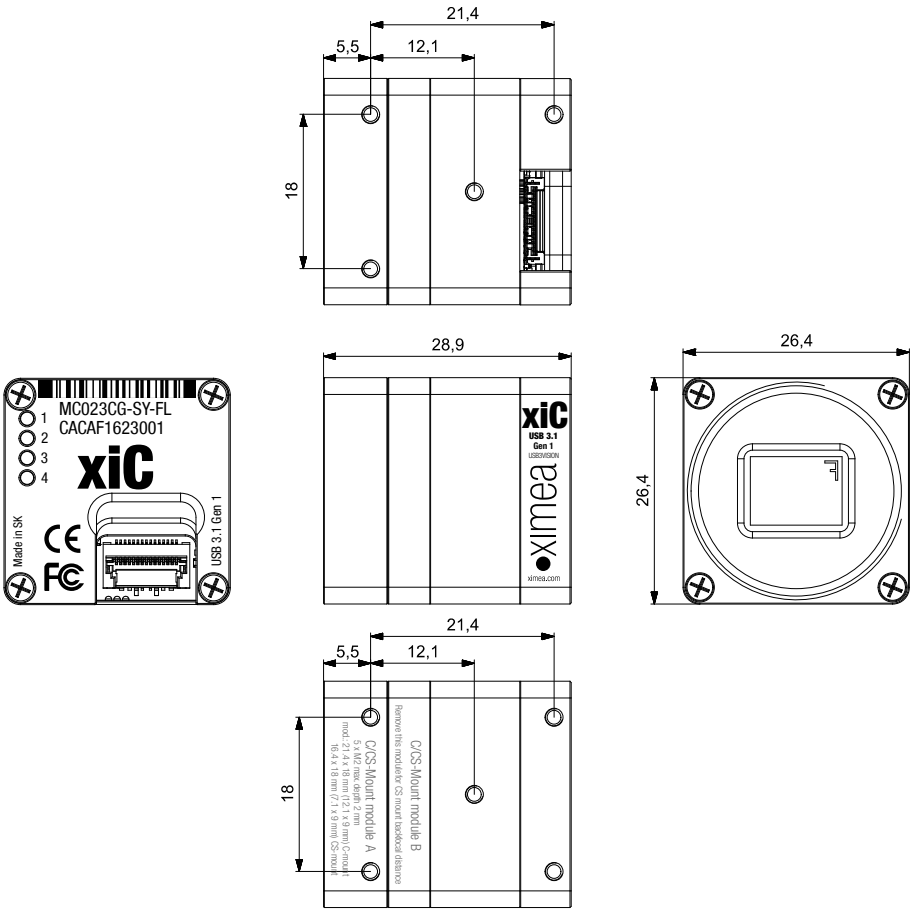


figure 3-9 dimensional drawing MC023xG-SY-FL, C-Mount housing

3.5.1.6. Dimensional drawings MC023xG-SY-FV (C-mount [with C/CS mount module B])

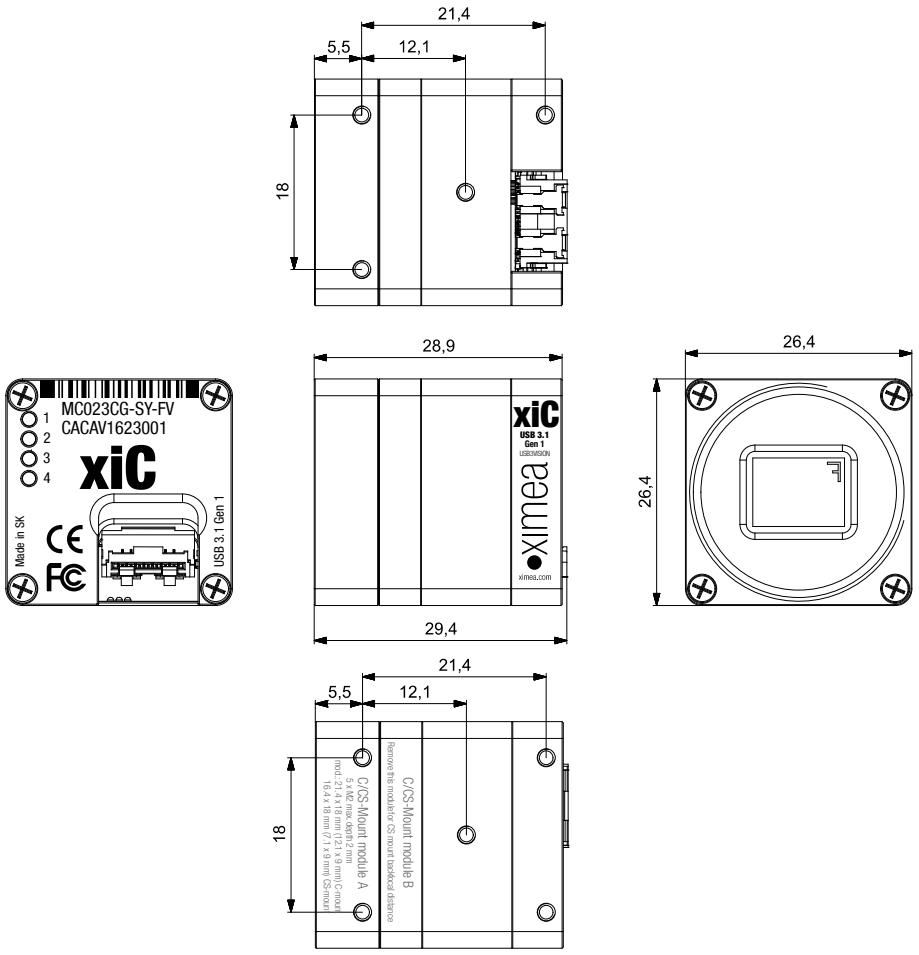


figure 3-10 dimensional drawing MC023xG-SY-FV, C-Mount housing

3.5.1.7. Referenced documents

Sony Datasheet IMX174LQJ-C_E_TechnicalDatasheet_REv0.3 (01/06/14)

Sony Datasheet IMX174LLJ-C_E_data_sheet_E14315 (01/06/14)

3.5.1.8. Sensor features

feature	Note
Binning	No
Skipping	Not supported
ROI	Vertical cropping results in increased read speed, horizontal reduces data transfer
HW Trigger	Trigger with overlap (see *4.3.2.1 Triggered acquisition -*)
HDR	Not available

table 3-8, sensor features available

3.5.2. MC031xG-SY

3.5.2.1. Sensor and camera parameters

xiC model		MC031CG-SY	MC031MG-SY
Sensor parameter			
Model name		IMX252LQR-C	IMX252LLR-C
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	2064 x 1544	
Active area size (H × V)	[mm]	7.12 x 5.33	
Sensor diagonal	[mm]	8.89	
Optical format	[inch]	1/1.8	
Pixel Size (H × V)	[µm]	3.45 × 3.45	
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.9	
Dynamic range	[dB]	70.9	
SNR Max	[dB]	40.3	
Conversion gain	[e-/LSB_{12}]	2.67	
Dark noise	[e-]	2.32	
Dark current	[e-/s]	2.1	
DSNU	[e-]	0.7	
PRNU	%	0.65	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[3], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 5.29µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	122	
Power consumption			
typical	[W]	2.75	
Maximum	[W]	2.85	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-TC/-UB/-FL/-FV)	[mm]	42.2/41.9/28.8/29.3(with C/CS Mount module B) 37.3/36.9/23.8/24.3 (without C/CS Mount module B)	
mass (-TC/-UB/-FL/-FV)	[g]	38.3/37.5/28.3/28.3 (with C/CS Mount module B) 34.1/33.3/24.1/24.1 (without C/CS Mount module B)	

table 3-9, MC031xG-SY, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) could be calculated in: Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm

2) From 1 µs to 14 µs the step is 1µs and the sensor is operating in special mode. This exposure times are not achievable for exposure controlled by trigger pulse length.

3) Saturation level in 8bit digitization is only ¼ of 10bit and 12bit mode (see *4.2.5 Digitization bit depth*)

Color model	Mono model	Binning/skipping (H X V)	pixels	fps	Bit/px
Yes	Yes	1x1 / 1x1	2064 x 1544	122	8
Yes	Yes	1x1 / 1x1	2064 x 1544	96	10
Yes	Yes	1x1 / 1x1	2064 x 1544	80	12
Yes	Yes	1x1 / 1x2	2064 x 772	241	8
Yes	Yes	1x1 / 2x1	1032 x 1544	218	8
Yes	Yes	1x1 / 2x2	1032 x 772	426	8
No	Yes	1x2 / 1x1	2064 x 772	241	8
No	Yes	1x2 / 2x1	1032 x 772	426	8
Yes	Yes	1x1 / 2x2	1032 x 772	377	10
Yes	Yes	1x1 / 2x2	1032 x 772	233	12

table 3-10, MC031xG-SY, supported standard readout modes

3.5.2.2. Quantum efficiency curves [%]

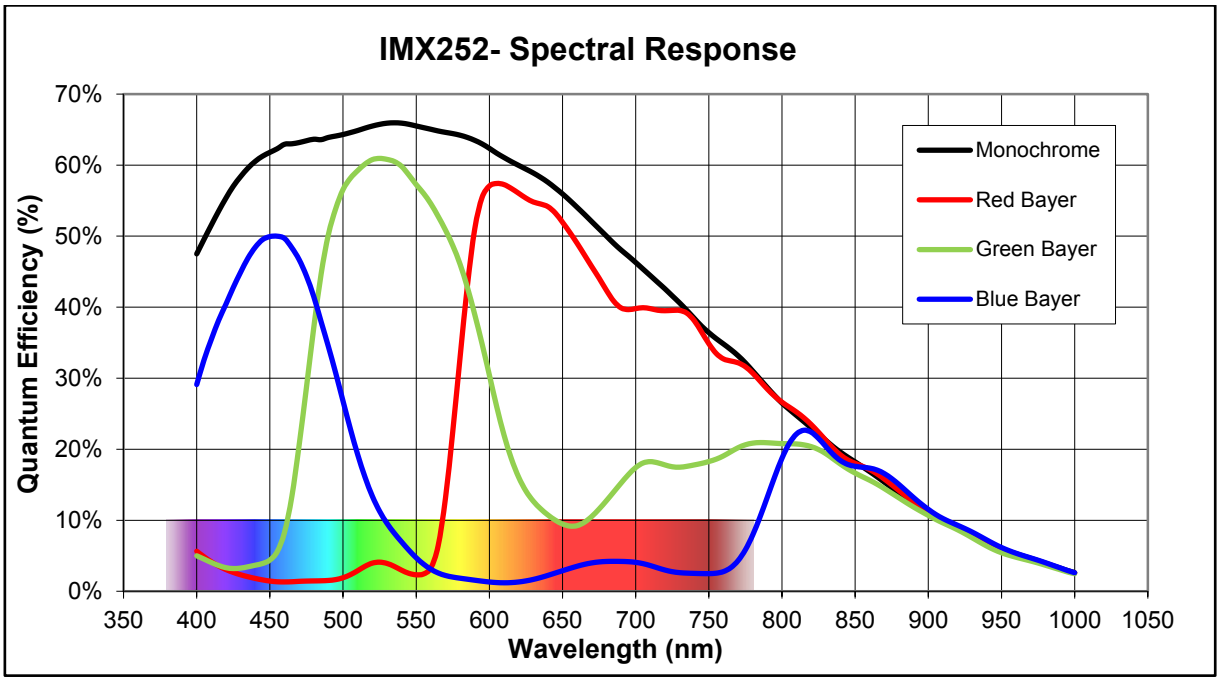


figure 3-11, IMX252-mono and color, quantum efficiency curves, ©SONY

3.5.2.3. Dimensional drawings MC031xG-SY-TC (C-mount [with C/CS mount module B])

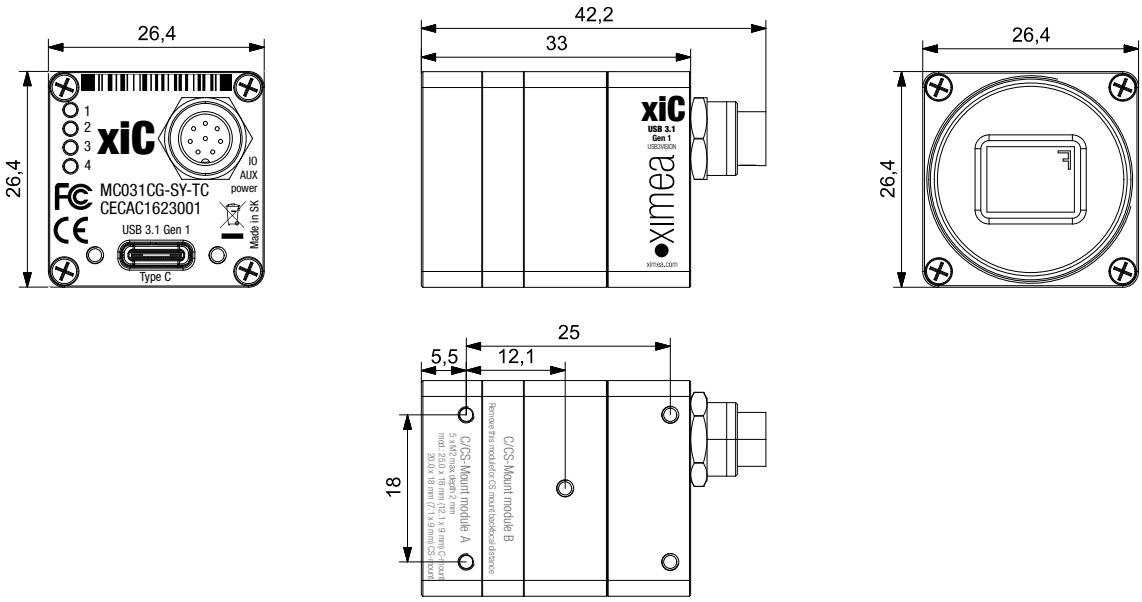


figure 3-12, dimensional drawing MC031xG-SY-TC, C-Mount housing

3.5.2.4. Dimensional drawings MC031xG-SY-UB (C-mount [with C/CS mount module B])

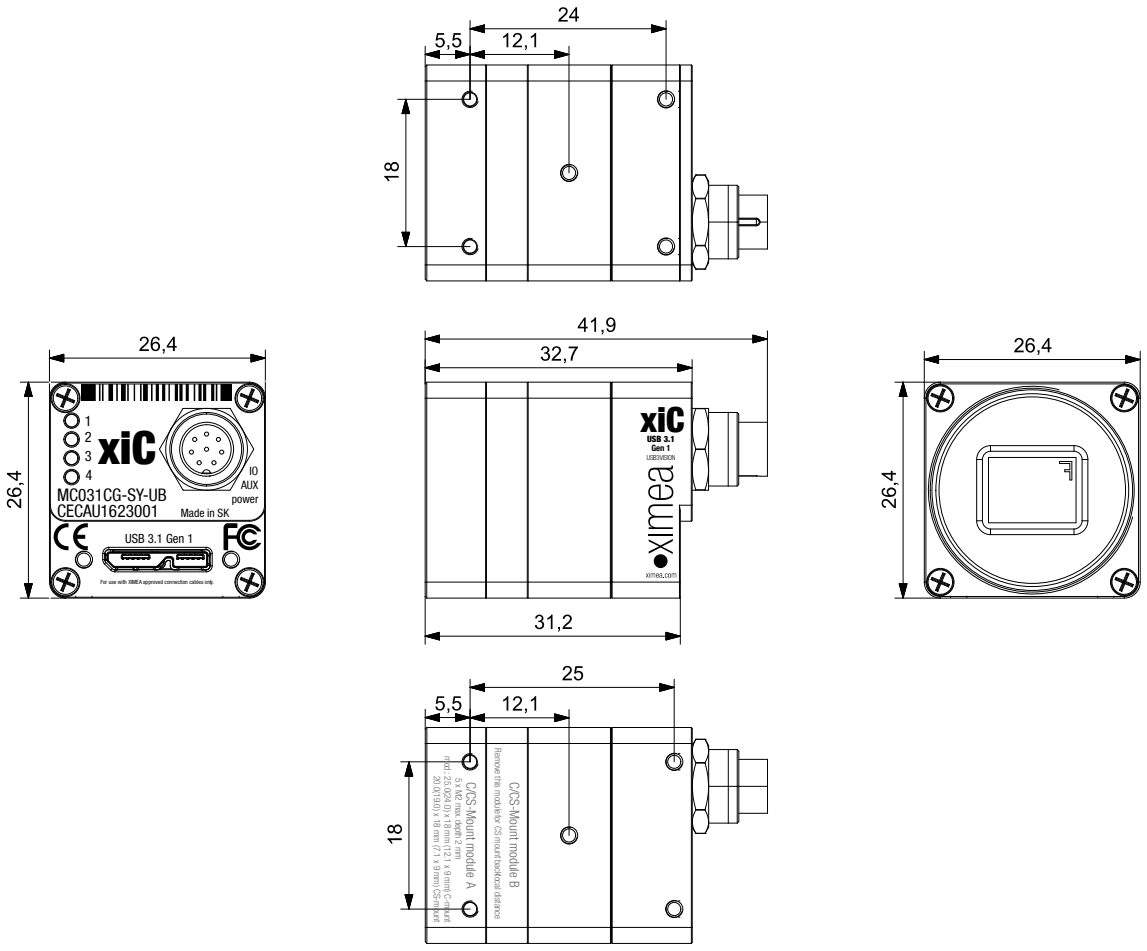


figure 3-13, dimensional drawing MC031xG-SY-UB, C-mount housing

3.5.2.5. Dimensional drawings MC031xG-SY-FL (C-mount [with C/CS mount module B])

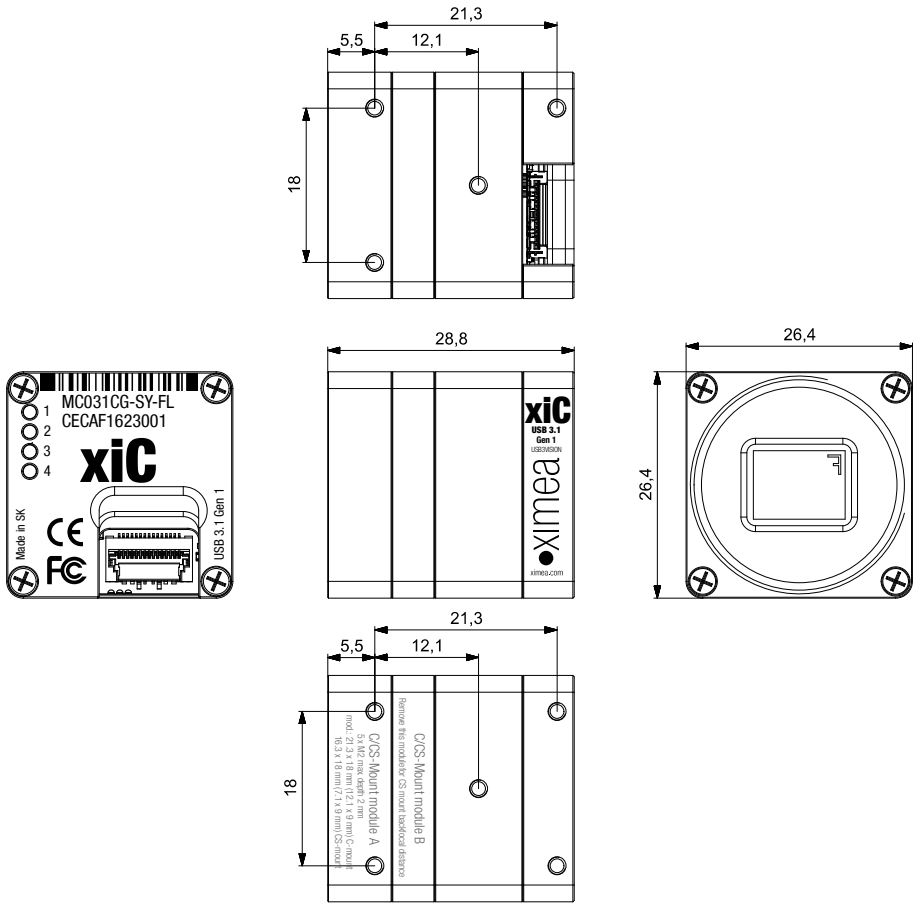


figure 3-14, dimensional drawing MC031xG-SY-FL, C-mount housing

3.5.2.6. Dimensional drawings MC031xG-SY-FV (C-mount [with C/CS mount module B])

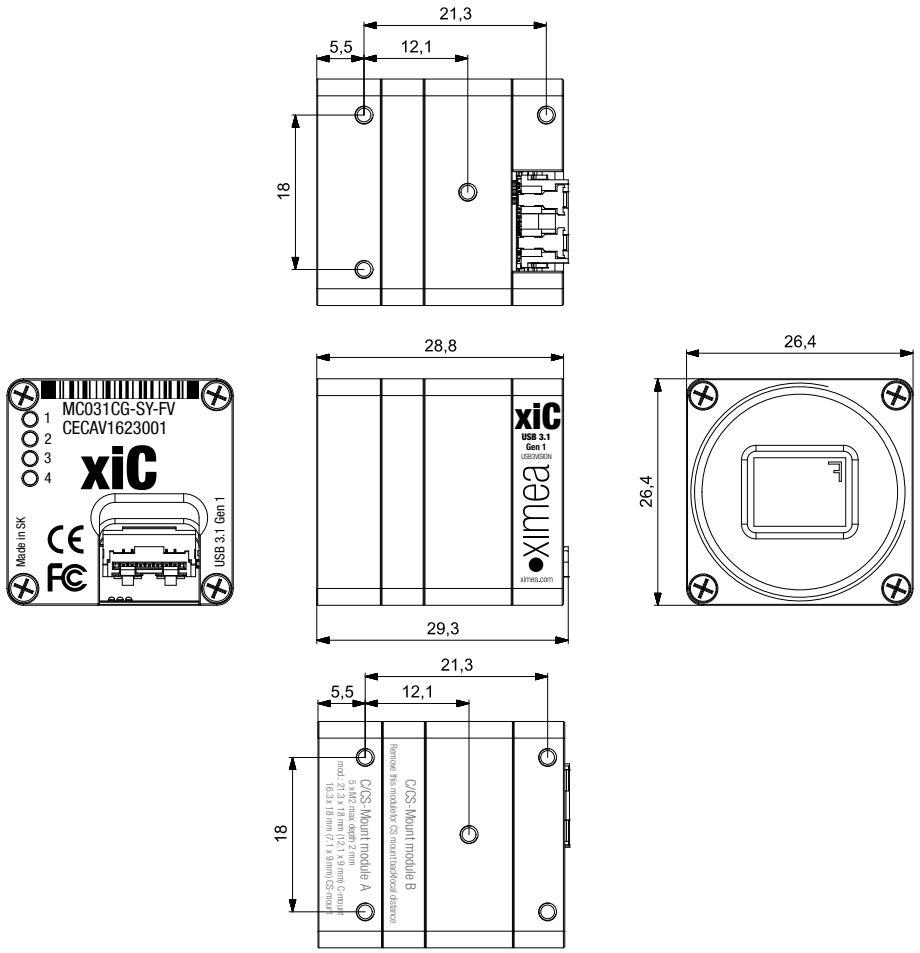


figure 3-15, dimensional drawing MC031xG-SY-FV, C-mount housing

3.5.2.7. Referenced documents

Sony Datasheet IMX252LLR-C_Data_Sheet(E)_E15903 (03/09/15)

Sony Datasheet IMX252LQR-C_Data_Sheet(E)_E15911 (11/09/15)

3.5.2.8. Sensor features

feature	Note
Binning	Yes, 1x2 (H x V) binning supported on monochrome only.
Skipping	Yes, 2x2
ROI	Vertical cropping results in increased read speed, horizontal reduces data transfer
HW Trigger	Trigger with overlap usable (see *4.3.2.1 Triggered acquisition -*)
HDR	Currently not supported

table 3-11, sensor features available

3.5.3. MC050xG-SY

3.5.3.1. Sensor and camera parameters

xiC model		MC050CG-SY	MC050MG-SY
Sensor parameter			
Model name		IMX250LQR-C	IMX250LLR-C
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	2464 x 2056	
Active area size (H × V)	[mm]	8.5 x 7.09	
Sensor diagonal	[mm]	11.1	
Optical format	[inch]	2/3	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.8	
Dynamic range	[dB]	70.8	
SNR Max	[dB]	40.3	
Conversion gain	[e-/LSB_{12}]	2.66	
Dark noise	[e-]	2.32	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	%	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[3], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 6.32µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	76	
Power consumption			
typical	[W]	2.85	
Maximum	[W]	3.0	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-TC/-UB/-FL/-FV)	[mm]	42.2/41.9/28.8/29.3(with C/CS Mount module B) 37.3/36.9/23.8/24.3 (without C/CS Mount module B)	
mass (-TC/-UB/-FL/-FV)	[g]	38.3/37.5/28.3/28.3 (with C/CS Mount module B) 34.1/33.3/24.1/24.1 (without C/CS Mount module B)	

table 3-12, MC050xG-SY, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) could be calculated in: Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm

2) From 1 µs to 14 µs the step is 1µs and the sensor is operating in special mode. This exposure times are not achievable for exposure controlled by trigger pulse length.

3) Saturation level in 8bit digitization is only ¼ of 10bit and 12bit mode (see *4.2.5 Digitization bit depth*)

Color model	Mono mode	Binning/skipping (H X V)	pixels	fps	Bit/px
Yes	Yes	1x1 / 1x1	2464 x 2056	76	8
Yes	Yes	1x1 / 1x1	2464 x 2056	60	10
Yes	Yes	1x1 / 1x1	2464 x 2056	50	12
Yes	Yes	1x1 / 1x2	2464 x 1028	152	8
Yes	Yes	1x1 / 2x1	1232 x 2056	152	8
Yes	Yes	1x1 / 2x2	1232 x 1028	304	8
No	Yes	1x2 / 1x1	2464 x 1028	152	8
No	Yes	1x2 / 2x1	1232 x 1028	304	8
Yes	Yes	1x1 / 2x2	1232 x 1028	243	10
Yes	Yes	1x1 / 2x2	1232 x 1028	177	12

table 3-13, MC050xG-SY, supported standard readout modes

3.5.3.2. Quantum efficiency curves [%]

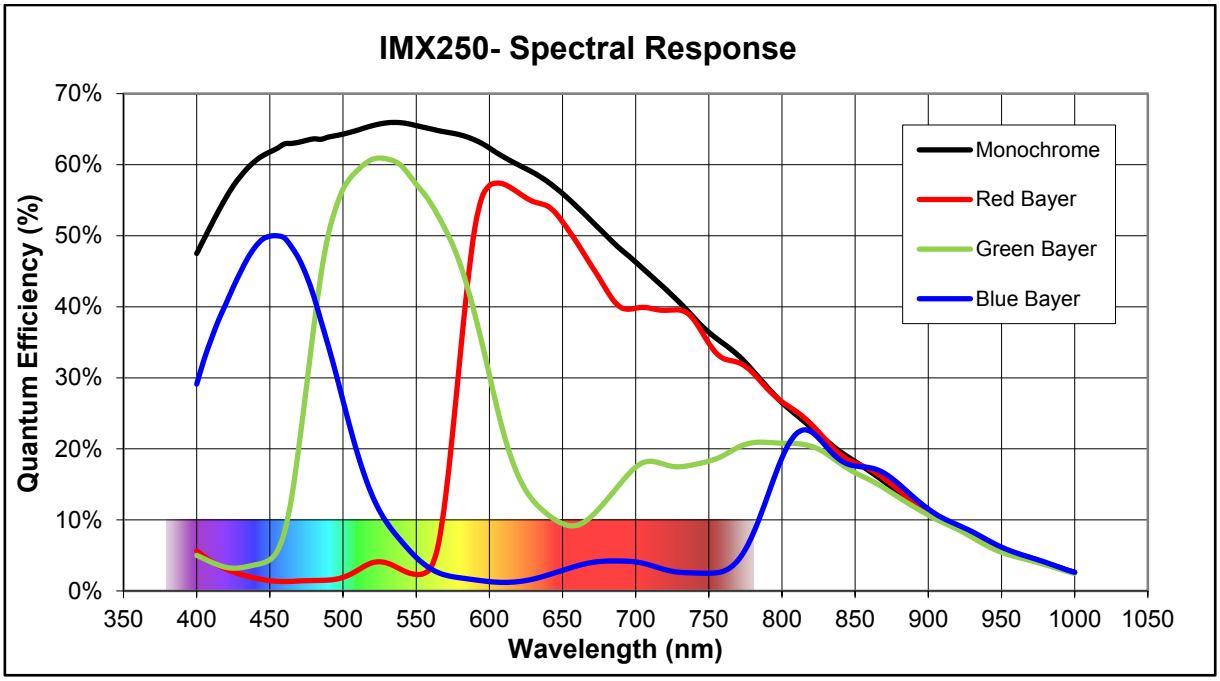


figure 3-16 IMX250 mono and color, quantum efficiency curves, ©SONY

3.5.3.3. Dimensional drawings MC050xG-SY-TC (C-mount [with C/CS mount module B])

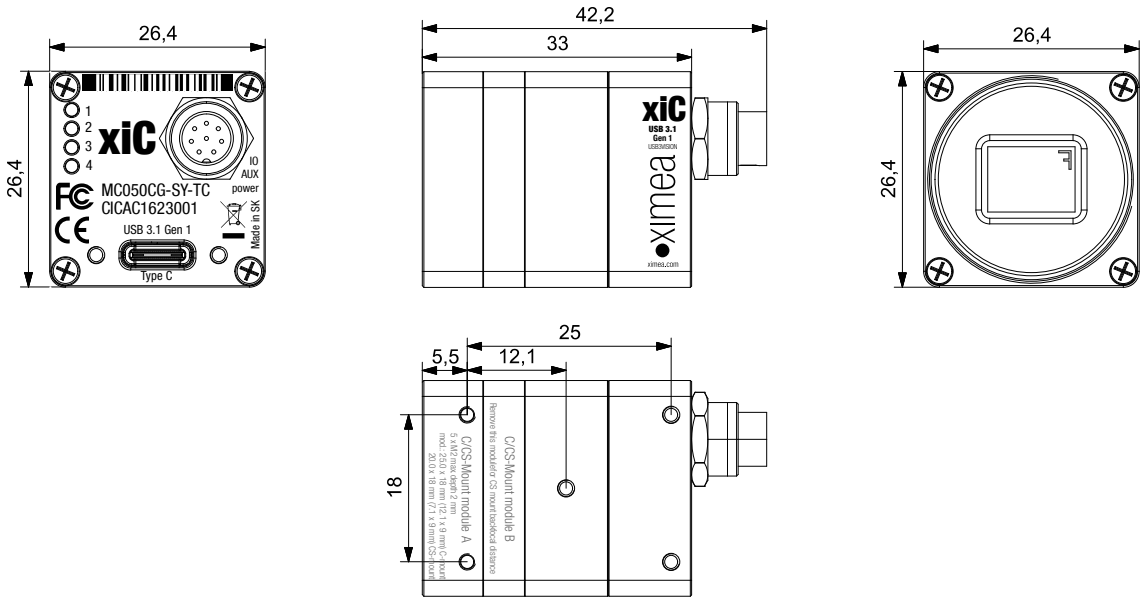


figure 3-17, dimensional drawing MC050xG-SY-TC, C-Mount housing

3.5.3.4. Dimensional drawings MC050xG-SY-UB (C-mount [with C/CS mount module B])

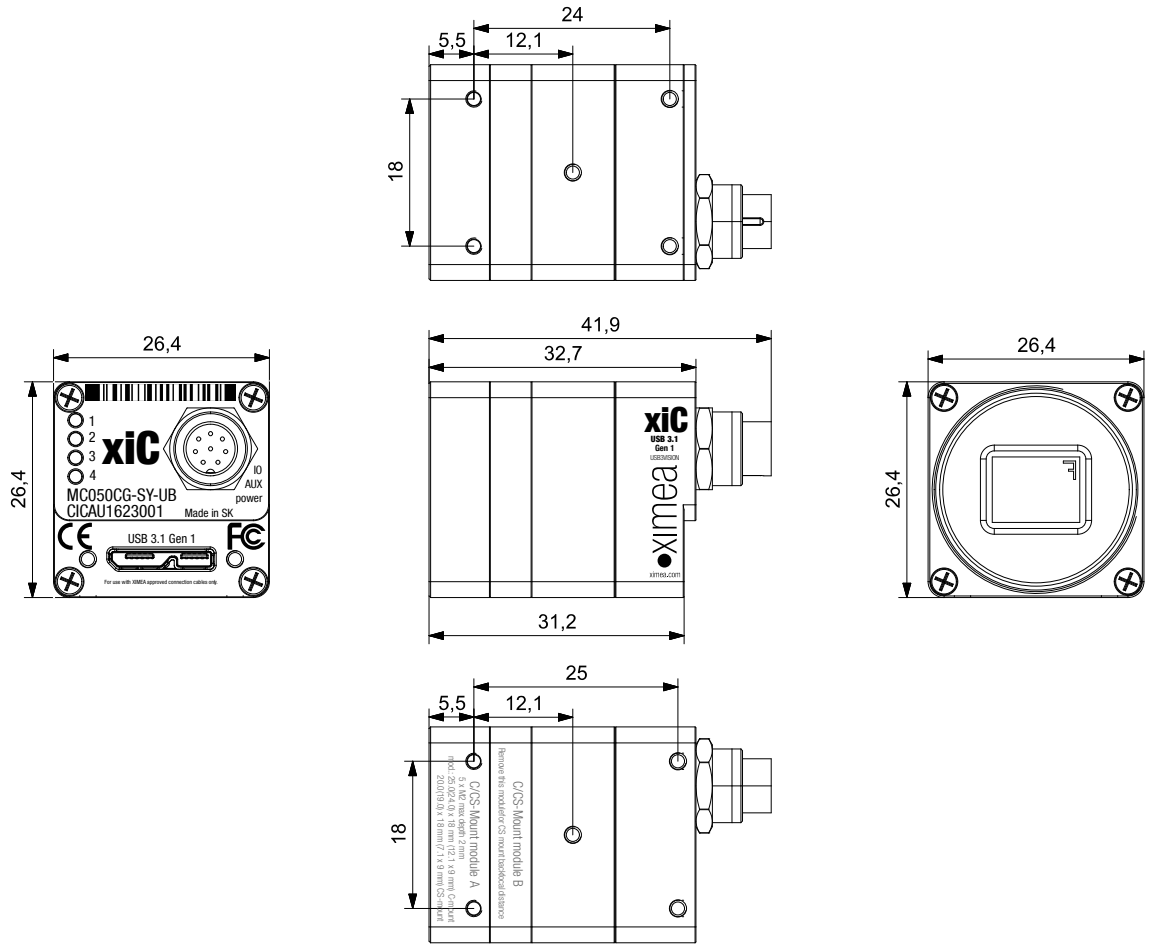


figure 3-18, dimensional drawing MC050xG-SY-UB, C-Mount housing

3.5.3.5. Dimensional drawings MC050xG-SY-FL (C-mount [with C/CS mount module B])

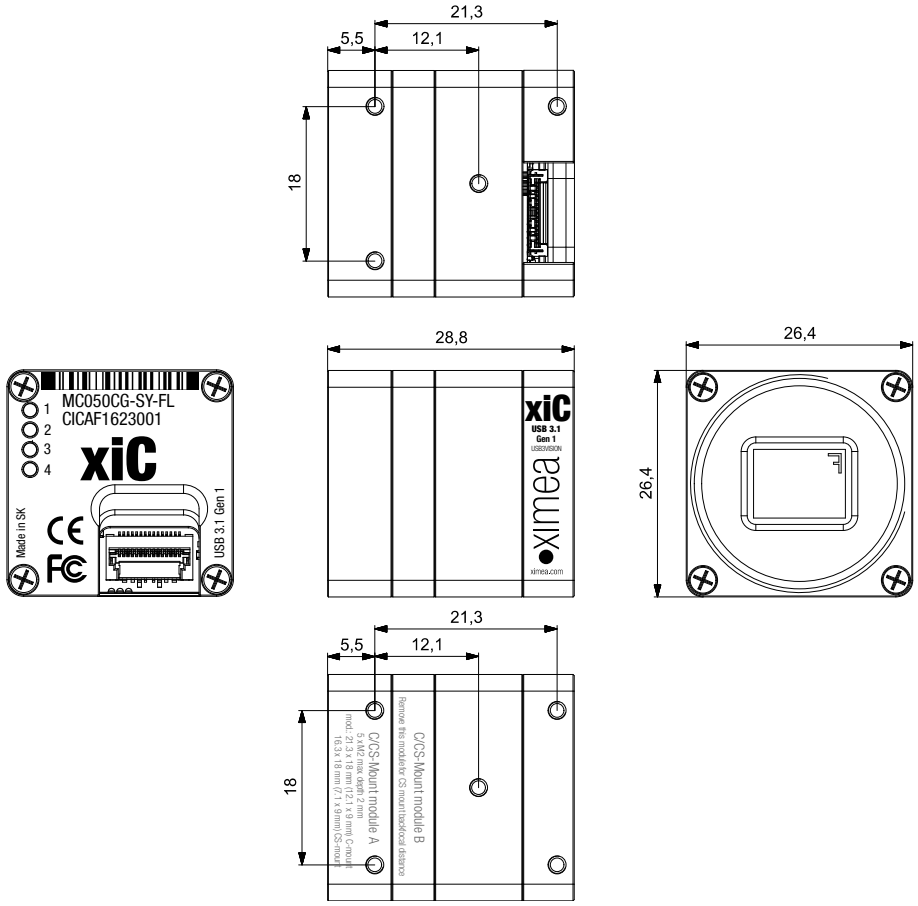


figure 3-19, dimensional drawing MC050xG-SY-FL, C-Mount housing

3.5.3.6. Dimensional drawings MC050xG-SY-FV (C-mount [with C/CS mount module B])

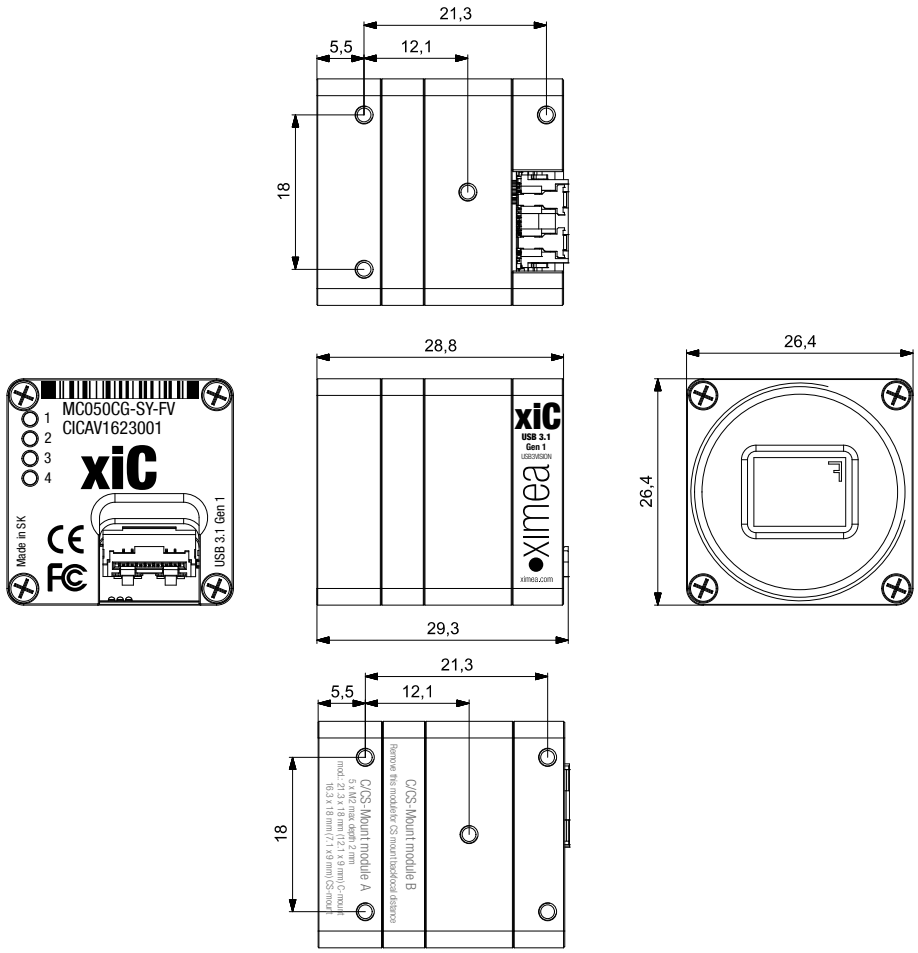


figure 3-20, dimensional drawing MC050xG-SY-FV, C-Mount housing

3.5.3.7. Referenced documents

Sony Datasheet IMX250LLR-C_Data_Sheet(E)_E15902 (02/09/15)

Sony Datasheet IMX250LQR-C_Data_Sheet(E)_E15910 (10/09/15)

3.5.3.8. Sensor features

feature	Note
Binning	Yes, 1x2 (H x V) binning supported on monochrome only.
Skipping	Yes, 2x2
ROI	Vertical cropping results in increased read speed, horizontal reduces data transfer
HW Trigger	Trigger with overlap usable (see *4.3.2.1 Triggered acquisition -*)
HDR	Not available

table 3-14, sensor features available

3.5.4. MC089xG-SY

3.5.4.1. Sensor and camera parameters

xiC model		MC089CG-SY	MC089MG-SY
Sensor parameter			
Model name		IMX255LQR-C	IMX255LLR-C
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	4112 x 2176	
Active area size (H × V)	[mm]	14.2 x 7.5	
Sensor diagonal	[mm]	16	
Optical format	[inch]	1”	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.8	
Dynamic range	[dB]	70.5	
SNR Max	[dB]	40.3	
Conversion gain	[e-/LSB_{12}]	2.67	
Dark noise	[e-]	2.4	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	%	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[3], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 10.54µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	43	
Power consumption			
typical	[W]	3.3	
Maximum	[W]	3.5	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-TC/-UB/-FL/-FV)	[mm]	42.3/42.0/28.9/29.4(with C/CS Mount module B) 37.3/37.0/23.9/24.4 (without C/CS Mount module B)	
mass (-TC/-UB/-FL/-FV)	[g]	38.3/37.5/28.5/28.5 (with C/CS Mount module B) 34.1/33.3/24.3/24.3 (without C/CS Mount module B)	

table 3-15, MC089xG-SY, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) could be calculated in: Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm

2) From 1 µs to 14 µs the step is 1µs and the sensor is operating in special mode. This exposure times are not achievable for exposure controlled by trigger pulse length.

3) Saturation level in 8bit digitization is only ¼ of 10bit and 12bit mode (see *4.2.5 Digitization bit depth*)

Color model	Mono mode	Binning/skipping (H X V)	pixels	fps	Bit/px
Yes	Yes	1x1 / 1x1	4112 x 2176	43	8
Yes	Yes	1x1 / 1x1	4112 x 2176	34	10
Yes	Yes	1x1 / 1x1	4112 x 2176	28	12
Yes	Yes	1x1 / 1x2	4112 x 1088	86	8
Yes	Yes	1x1 / 2x1	2056 x 2176	86	8
Yes	Yes	1x1 / 2x2	2056 x 1088	172	8
No	Yes	1x2 / 1x1	4112 x 1088	86	8
No	Yes	2x2 / 1x1	2056 x 1088	172	8
No	Yes	2x2 / 1x1	2056 x 1088	137	10
No	Yes	2x2 / 1x1	2056 x 1088	114	12
Yes	Yes	1x1 / 2x2	2056 x 1088	137	10
Yes	Yes	1x1 / 2x2	2056 x 1088	114	12

table 3-16, MC089xG-SY, supported standard readout modes

3.5.4.2. Quantum efficiency curves [%]

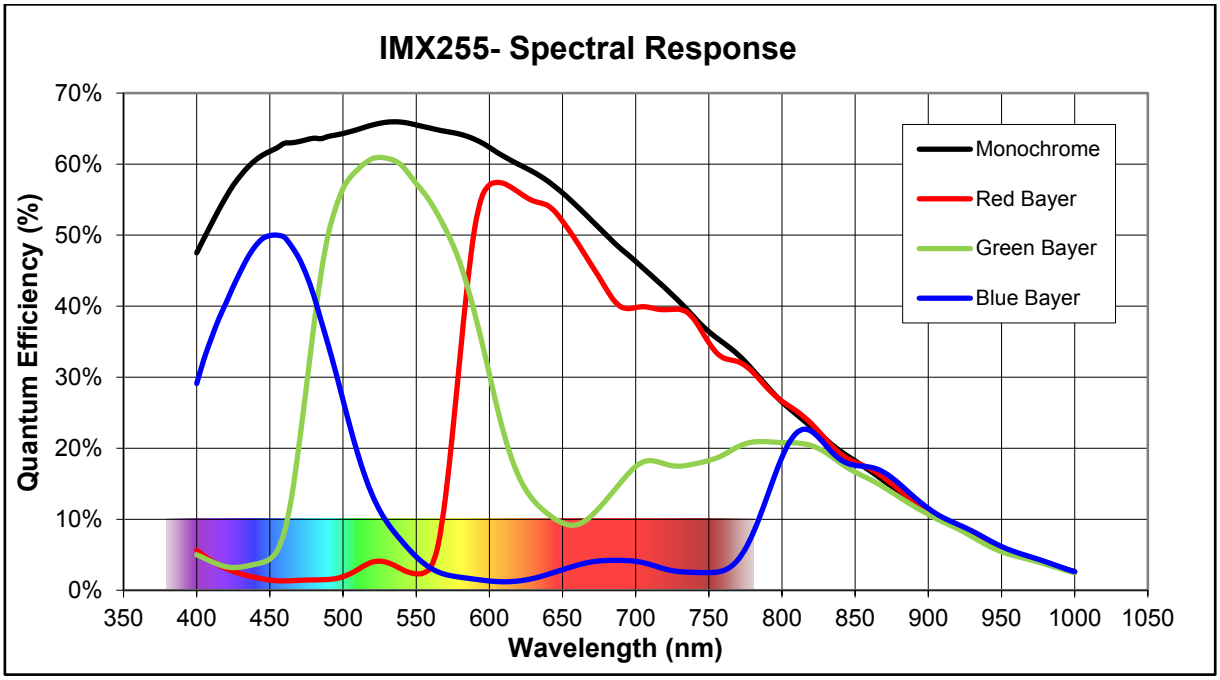


figure 3-21, IMX255 mono and color, quantum efficiency curve, ©SONY

3.5.4.3. Dimensional drawings MC089xG-SY-TC (C-mount [with C/CS mount module B])

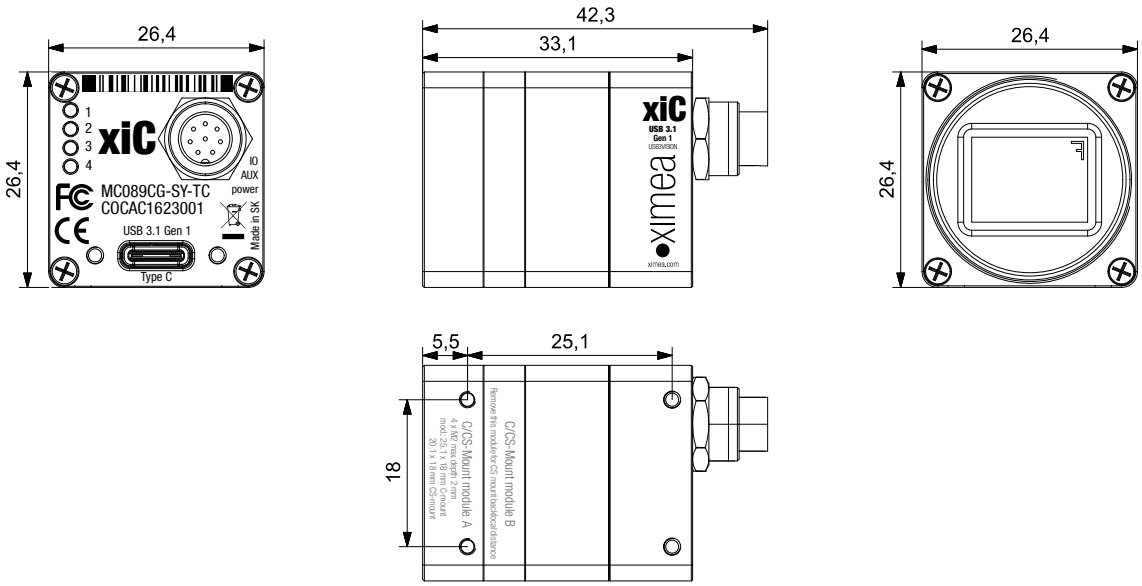


figure 3-22, dimensional drawing MC089xG-SY-TC, C-Mount housing

3.5.4.4. Dimensional drawings MC089xG-SY-UB (C-mount [with C/CS mount module B])

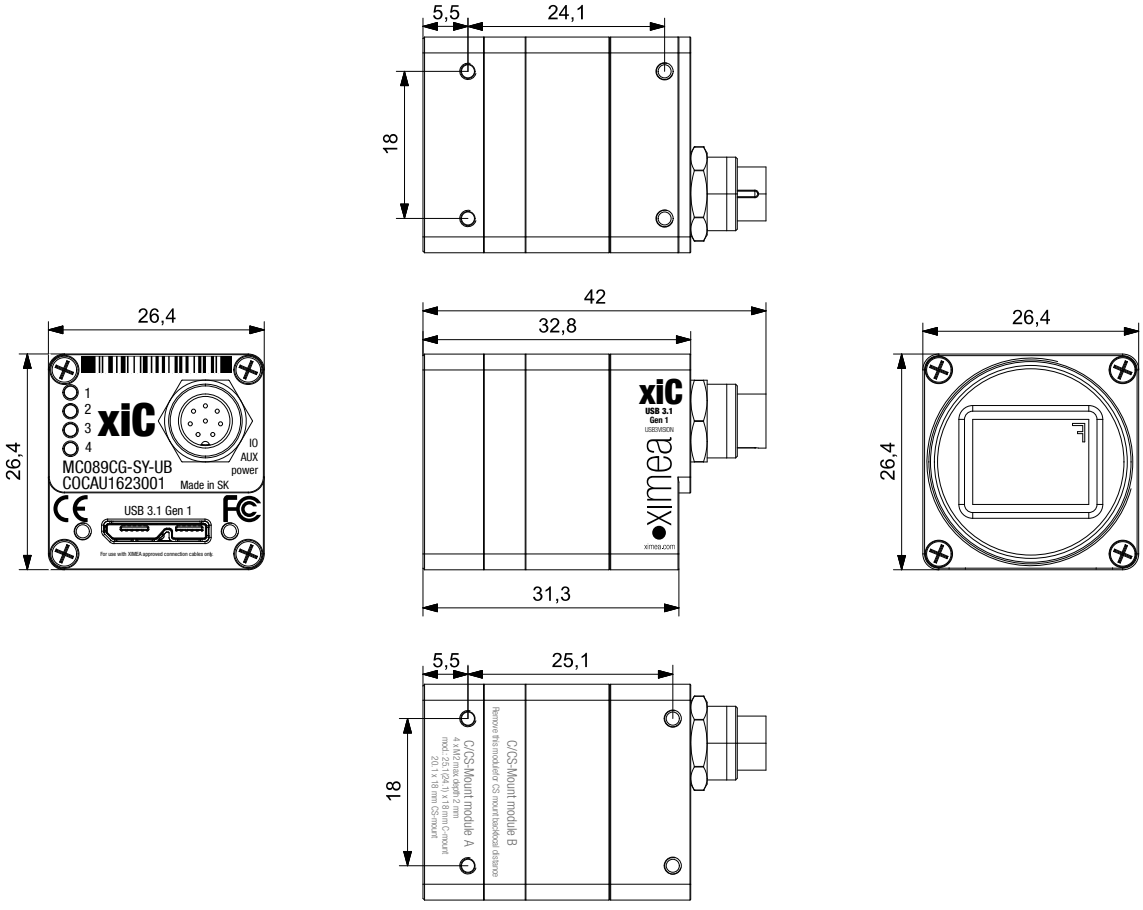


figure 3-23, dimensional drawing MC089xG-SY-UB, C-Mount housing

3.5.4.5. Dimensional drawings MC089xG-SY-FL (C-mount [with C/CS mount module B])

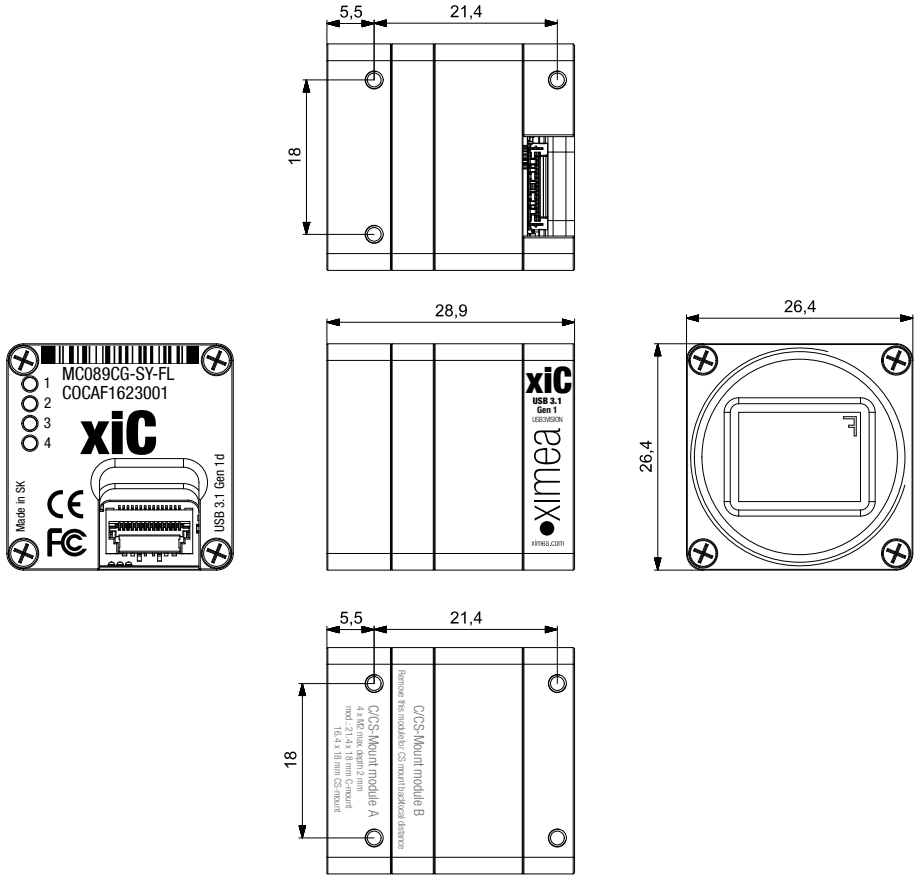


figure 3-24, dimensional drawing MC089xG-SY-FL, C-Mount housing

3.5.4.6. Dimensional drawings MC089xG-SY-FV (C-mount [with C/CS mount module B])

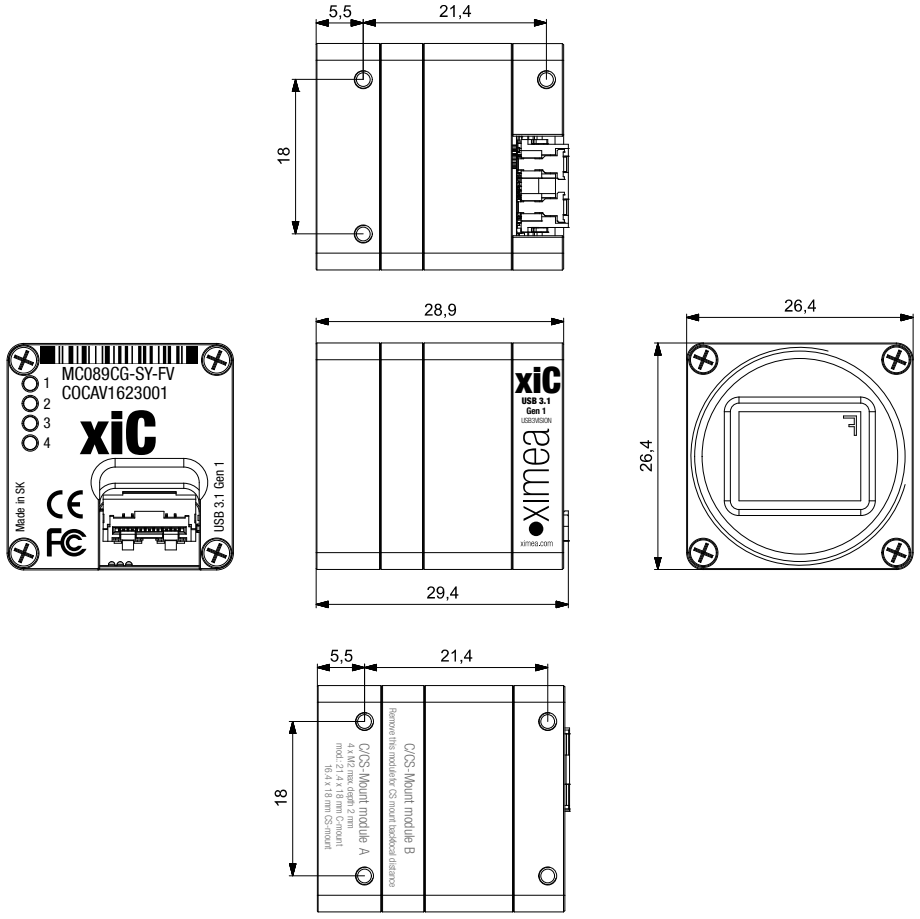


figure 3-25, dimensional drawing MC089xG-SY-FV, C-Mount housing

3.5.4.7. Referenced documents

Sony Datasheet IMX255LLR-C_TechnicalDatasheet_E_Rev0.1 (29/01/16)

Sony Datasheet IMX255LQR-C_TechnicalDatasheet_E_Rev0.1 (29/01/16)

3.5.4.8. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported on monochrome only.
Skipping	Yes, up to 1x2
ROI	Vertical cropping results in increased read speed, horizontal reduces data transfer
HW Trigger	Trigger with overlap usable (see *4.3.2.1 Triggered acquisition -*)
HDR	Not available

table 3-17, sensor features available

3.5.5. MC124xG-SY

3.5.5.1. Sensor and camera parameters

xiC model		MC124CG-SY	MC124MG-SY
Sensor parameter			
Model name		IMX253LQR-C	IMX253LLR-C
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	4112 x 3008	
Active area size (H × V)	[mm]	14.2 x 10.4	
Sensor diagonal	[mm]	17.6	
Optical format	[inch]	1.1”	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.9	
Dynamic range	[dB]	70.4	
SNR Max	[dB]	40.45	
Conversion gain	[e-/LSB_{12}]	2.67	
Dark noise	[e-]	2.4	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	%	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[3], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 10.54µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	31	
Power consumption			
typical	[W]	3.3	
Maximum	[W]	3.5	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-TC/-UB/-FL/-FV)	[mm]	42.3/42.0/28.9/29.4(with C/CS Mount module B) 37.3/37.0/23.9/24.4 (without C/CS Mount module B)	
mass (-TC/-UB/-FL/-FV)	[g]	38.3/37.5/28.5/28.5 (with C/CS Mount module B) 34.1/33.3/24.3/24.3 (without C/CS Mount module B)	

table 3-18, MC124xG-SY, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) could be calculated in: Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm

2) From 1 µs to 14 µs the step is 1µs and the sensor is operating in special mode. This exposure times are not achievable for exposure controlled by trigger pulse length.

3) Saturation level in 8bit digitization is only ¼ of 10bit and 12bit mode (see *4.2.5 Digitization bit depth*)

Color model	Mono mode	Binning/skipping (H X V)	pixels	fps	Bit/px
Yes	Yes	1x1 / 1x1	4112 x 3008	31	8
Yes	Yes	1x1 / 1x1	4112 x 3008	24	10
Yes	Yes	1x1 / 1x1	4112 x 3008	20	12
Yes	Yes	1x1 / 1x2	4112 x 1504	62	8
Yes	Yes	1x1 / 2x1	2056 x 3008	62	8
Yes	Yes	1x1 / 2x2	2056 x 1504	124	8
No	Yes	1x2 / 1x1	4112 x 1504	62	8
No	Yes	2x2 / 1x1	2056 x 1504	124	8
No	Yes	2x2 / 1x1	2056 x 1504	99	10
No	Yes	2x2 / 1x1	2056 x 1504	83	12
Yes	Yes	1x1 / 2x2	2056 x 1504	99	10
Yes	Yes	1x1 / 2x2	2056 x 1504	83	12

table 3-19, MC124xG-SY, supported standard readout modes

3.5.5.2. Quantum efficiency curves [%]

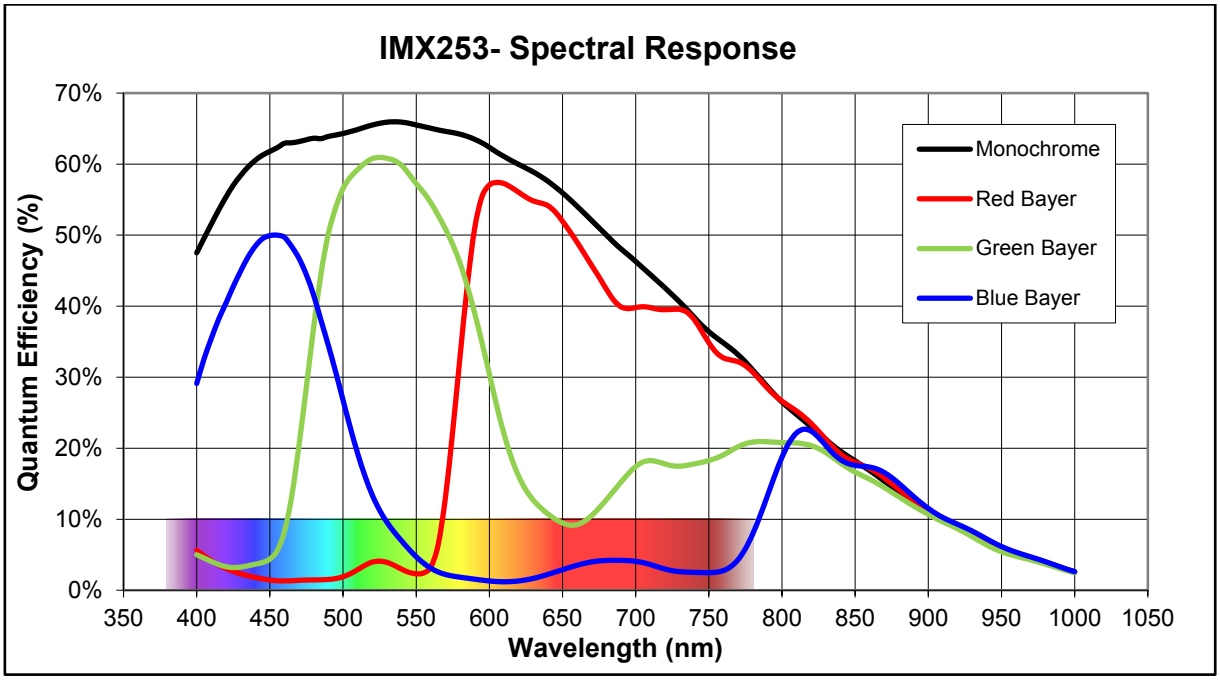


figure 3-26, IMX253 mono and color, quantum efficiency curve, ©SONY

3.5.5.3. Dimensional drawings MC124xG-SY-TC (C-mount [with C mount module B])

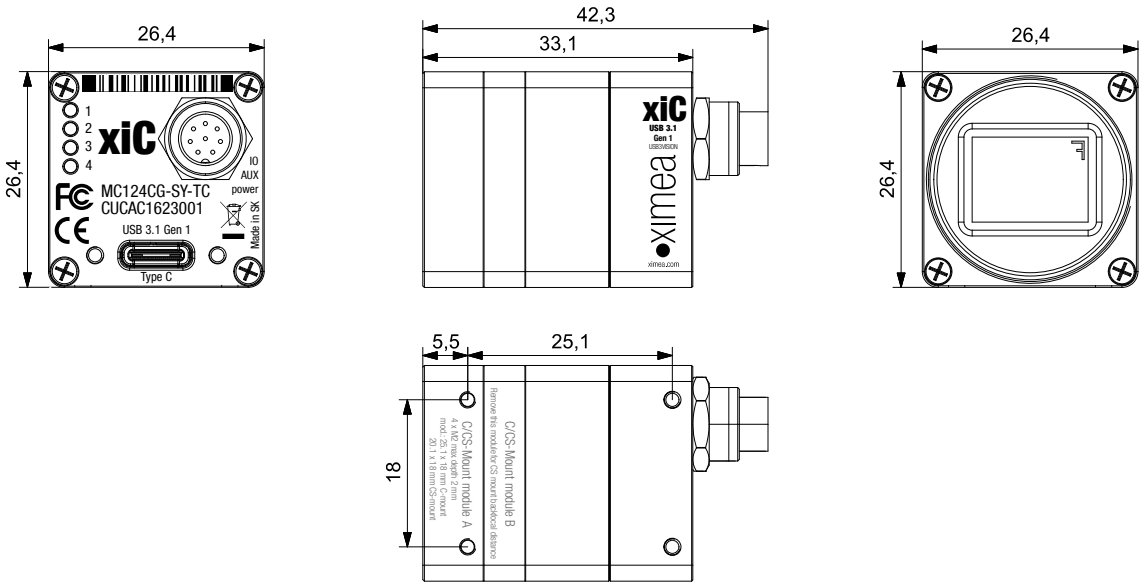


figure 3-27, dimensional drawing MC124xG-SY-TC C-Mount housing

3.5.5.4. Dimensional drawings MC124xG-SY-UB (C-mount [with C mount module B])

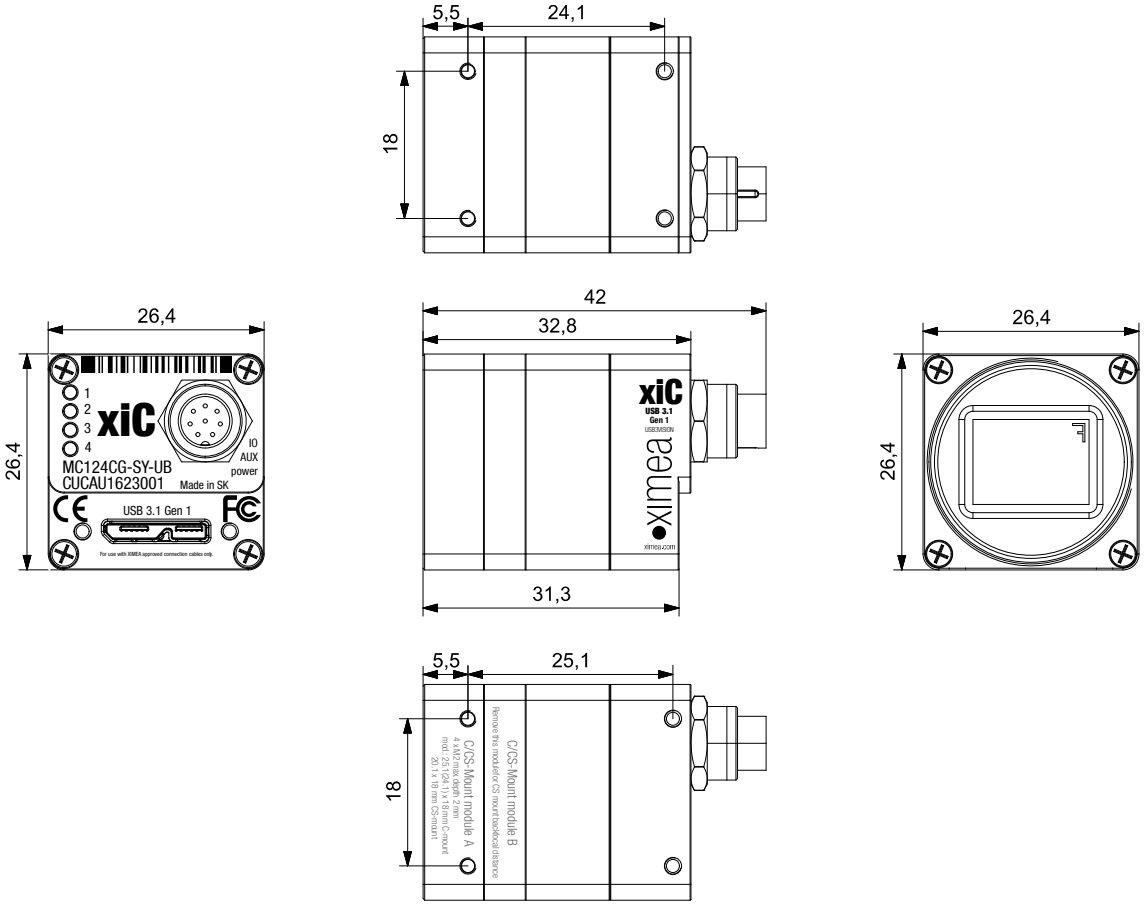


figure 3-28, dimensional drawing MC124xG-SY-UB, C-Mount housing

3.5.5.5. Dimensional drawings MC124xG-SY-FL (C-mount [with C/CS mount module B])

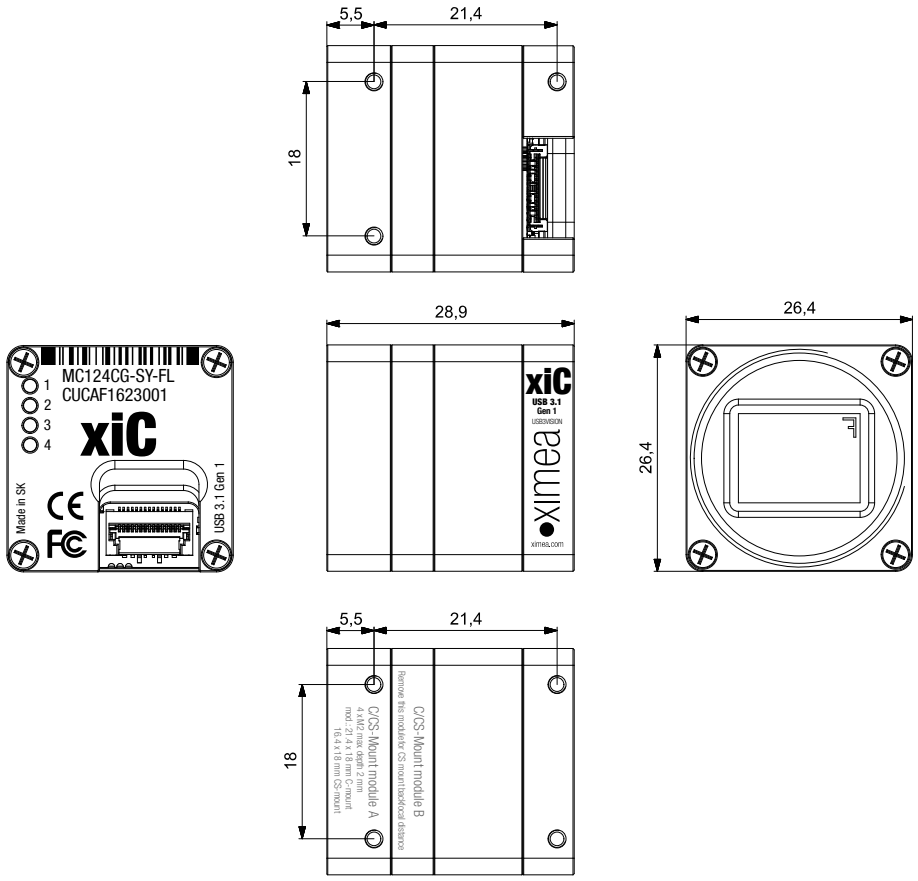


figure 3-29, dimensional drawing MC124xG-SY-FL, C-Mount housing

3.5.5.6. Dimensional drawings MC124xG-SY-FV (C-mount [with C mount module B])

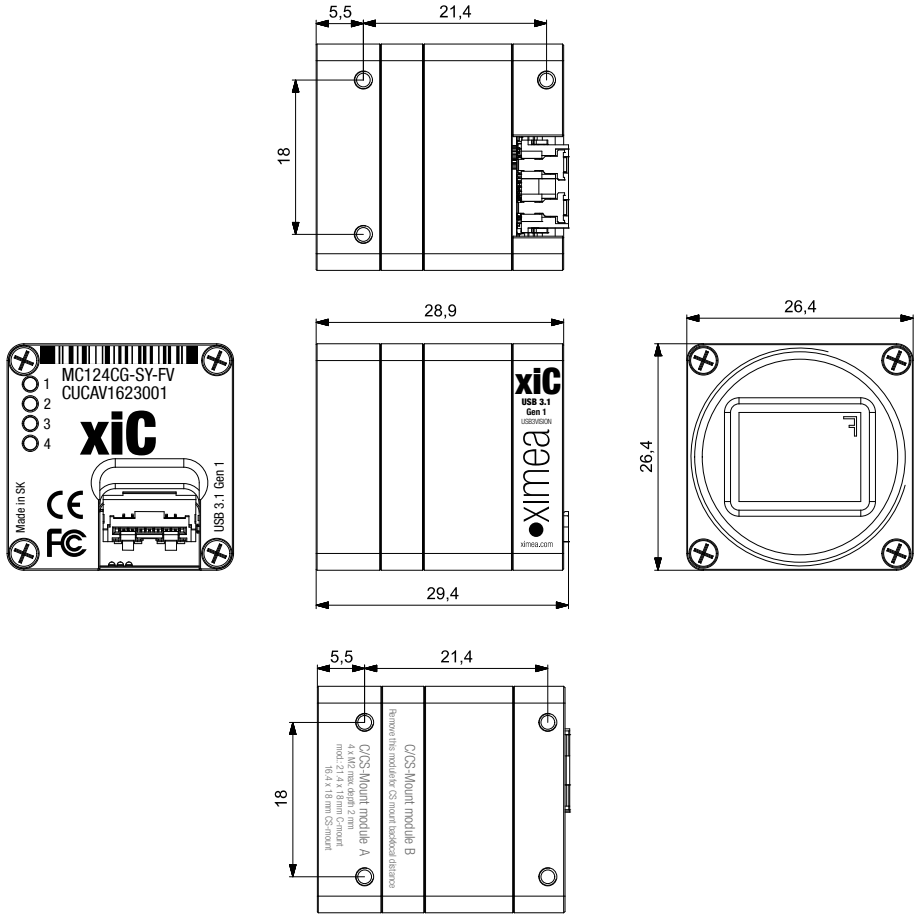


figure 3-30, dimensional drawing MC124xG-SY-FV, C-Mount housing

3.5.5.7. Referenced documents

Sony Datasheet IMX253LLR-C_TechnicalDatasheet_E_Rev0.3 (29/01/16)

Sony Datasheet IMX253LQR-C_TechnicalDatasheet_E_Rev0.1 (29/01/16)

3.5.5.8. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported on monochrome only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed, horizontal reduces data transfer
HW Trigger	Trigger with overlap usable (see *4.3.2.1 Triggered acquisition -*)
HDR	Not available

table 3-20, sensor features available

3.6. User interface – LEDs

Four status LEDs are located on the back of the cameras, please see below.

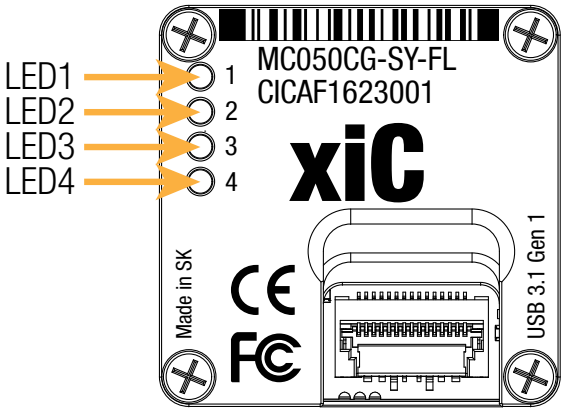


figure 3-31, position status LEDs

All LEDs can be configured similar as standard input and output lines.

Default LED function after power on

LED	Color	Power-on defaults	Note
1	Red	On	User configurable
2	Green	Exposure active	User configurable
3	Blue	Frame active	User configurable
4	Orange	Connection status	User configurable

table 3-21, LED output description

LED statuses during boot sequence

Status	LED1 (Red)	LED2 (Green)	LED3 (Blue)	LED4 (Orange)
Off	Off	Off	Off	Off
Power	On	Off	Off	Off
Booting	Off	flash ~2Hz	flash ~2Hz	Off
Boot up finished	On	Off	Off	On
USB init - wait for enumeration	flash ~1Hz	Off	Off	Off
Enumeration finished USB2	Off	Off	Off	flash ~2Hz
Enumeration finished USB3	Off	Off	Off	On
Device stop	flash ~2Hz	Off	Off	flash ~2Hz
Error	flash ~2Hz	Off	Off	flash async.

table 3-22, LED status during boot

Default LED function after xiOpenDevice

LED	Color	LED function
1	Red	On
2	Green	Exposure active
3	Blue	Frame active
4	Orange	On

table 3-23, LED output description

3.7. xiC USB 3.1 Gen1 Type-C Interface

Connector	Signals	Mating Connectors
USB 3.1	Standard USB 3.1 Gen1 Type-C Connector	Standard USB 3.1 Type C Connector with thumbscrews Screw thread M2, thread distance 15.0mm

table 3-24, USB 3.1 mating connector description

The USB 3.1 Type C connector is used for data transmission, camera control and power.

3.7.1. Type-C connector location

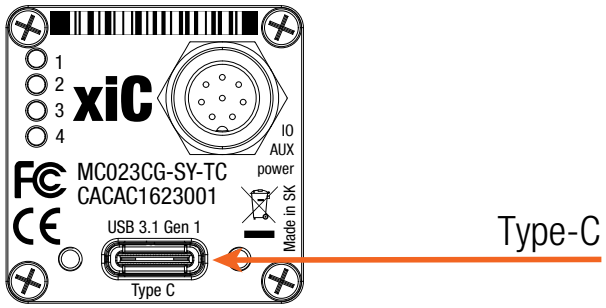


figure 3-32, position of Type-C connector

3.7.2. Pinning

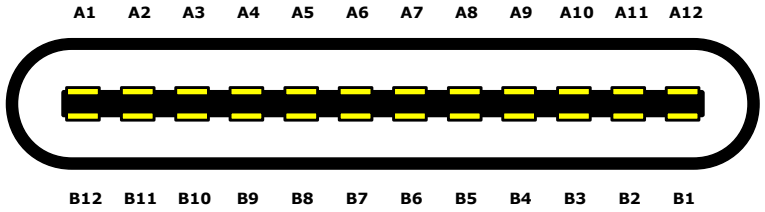


figure 3-33 pinning of Type-C connector

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	VBUS	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 3-25 USB type C connector pin assignment

3.8. xiC USB 3.1 Gen1 micro B Interface

Connector	Signals	Mating Connectors
USB 3.1	Standard USB 3.1 Gen 1 Micro B Female Connector	Standard USB 3.1 Gen1 Micro-B Connector with thumbscrews Screw thread M2, thread distance 18.0mm

table 3-26, USB 3.1micro B mating connector description

The USB 3.1 Micro-B connector is used for data transmission, camera control and power.

3.8.1. USB 3.1 micro B Location

The micro B connector is located on the back side of the camera:

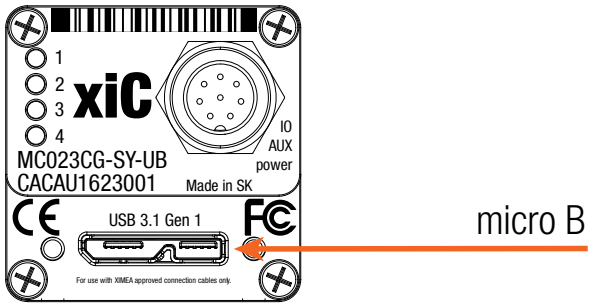


figure 3-34, position USB 3.1 Gen1 interface

3.8.2. Pinning

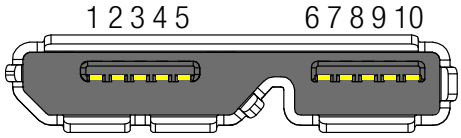


figure 3-35, pinning USB 3.1 / USB 3.0 connector

USB 3.1 Micro B connector (powered) Pin Assignment

Pin	Signal	Description
1	VBUS	Power
2	D-	USB 2.0 signal pair
3	D+	
4	ID	OTG Identification
5	GND	Power Ground
6	SSTX-	USB 3.0 SuperSpeed transmitter signal pair
7	SSTX+	
8	GND_DRAIN	USB 3.0 signal Ground
9	SSRX-	USB 3.0 SuperSpeed receiver signal pair
10	SSRX+	

table 3-27, USB 3.0 connector, pin assignment

The USB 3.1 / USB 3.0 standard is backward compatible with the USB 2.0 interface.

3.9. xiC Flex cable interface

The flex cable interface is located on the back of the camera and comes with two different options based on the orientation the cable plugs into the camera. The (FL) version of the camera allows the cable to approach from the bottom of the camera and the (FV) version has the cable connecting to the camera perpendicular to the sensor surface.

Camera model	Connector	Camera model	Connector
-FL	Molex 502244-1530	-FV	Molex 502231-1500

table 3-28 Connector part numbers

3.9.1. Flex Connection Location

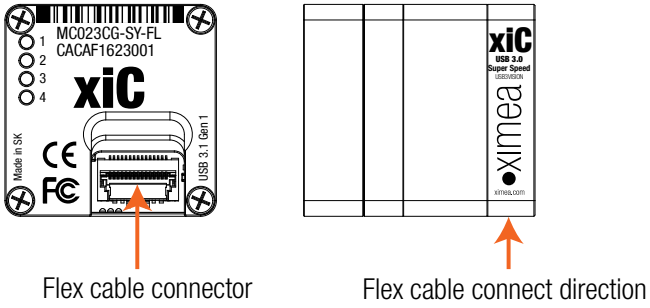


figure 3-36 Flex connector location FL version

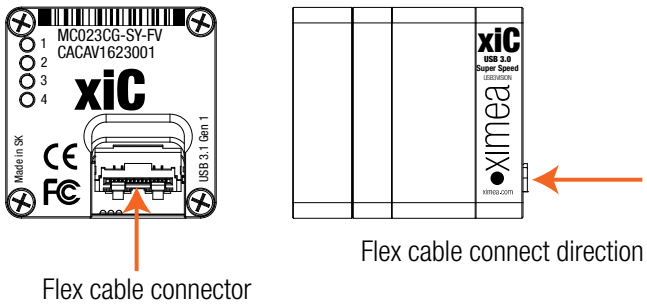


figure 3-37 Flex connector location FV version

3.9.2. Pinning

Pin	Signal	Technical description
1	GND	Ground for power return and for SuperSpeed signal return
2	SSRX-	SuperSpeed receiver dif. pair (accepts reverse polarity)
3	SSRX+	SuperSpeed receiver dif. pair (accepts reverse polarity)
4	GND	Ground for power return and for SuperSpeed signal return
5	SSTX+	SuperSpeed transmitter dif. pair (accepts reverse polarity)
6	SSTX-	SuperSpeed transmitter dif. pair (accepts reverse polarity)
7	GND	Ground for power return and for SuperSpeed signal return
8	D+	USB 2.0 differential pair
9	D-	USB 2.0 differential pair
10	GND	Ground for power return and for SuperSpeed signal return
11	VBUS	+5V Power input
12	VBUS	+5V Power input
13	OUT1	Trigger/sync digital Output (GPO) - Open collector NPN
14	IN/OUT GND	Common pole (IO Ground
15	IN1	Trigger/sync digital Input (GPI) Current limited input
Ground pins	SGND	Shield of FPC cable connected to shield of host controller

table 3-29 Pin list for flex cable

3.9.3. Inserting / detaching FPC cable

When inserting or detaching cables increased caution need to be taken, to prevent connector or cable damage. MC cameras interface connectors are equipped with locking mechanism. When locked pulling the cable may lead to damage of connector or camera. When manipulating with cable the power supply for the camera must be turned off.

Cables PN: CBL-MQ-FL-xxx (gold) have marked ends. It is important to connect the end marked “CAM” to the camera and end marked “BOB” to host or adapter. Swapped orientation can cause damage to camera. It is important that the power is turned off when inserting/detaching the cable.

figure 3-38, MC FPC cable CBL-MQ-FL-xxx laser marking

Cables PN: CBL-USB3FLEX-xxx (white) are not polarized therefore the orientation of the cable between camera and host is not important.

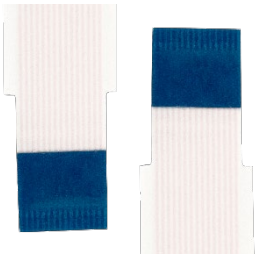


figure 3-39, MC FPC cable CBL-USB3FLEX-xxx ends

Inserting FPC cable MC option -FL

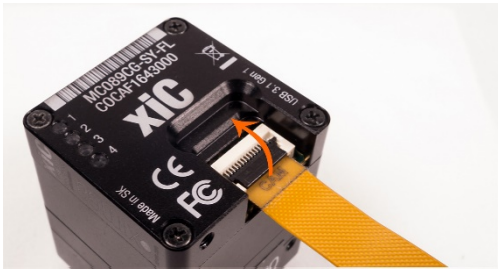
Open connector lock

Insert cable (contact on cable fasing down)

Close connector lock

figure 3-40, MC FPC insert procedure option -FL

Detaching FPC cable MX X2G2 option –FL



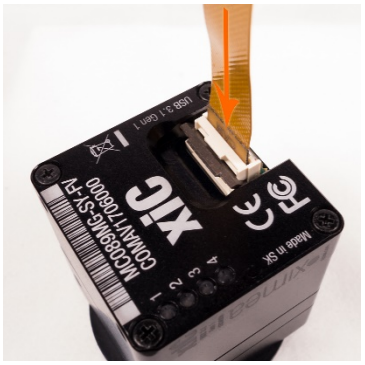
Open connector lock

Pull cable gently in marked direction.

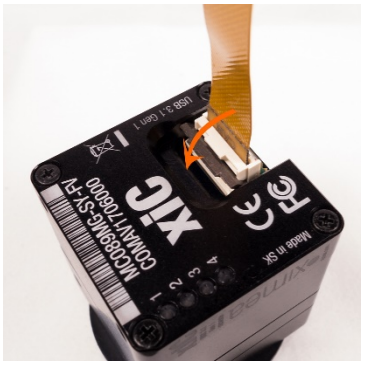
figure 3-41, MC FPC detach procedure option -FL

Inserting FPC cables MC option -FV

Open connector lock



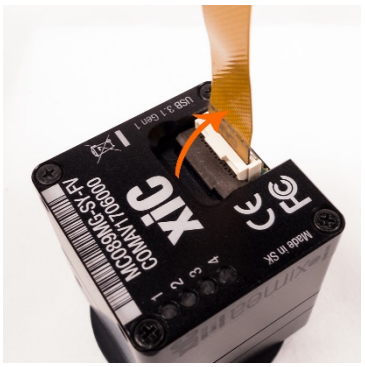
Insert cable



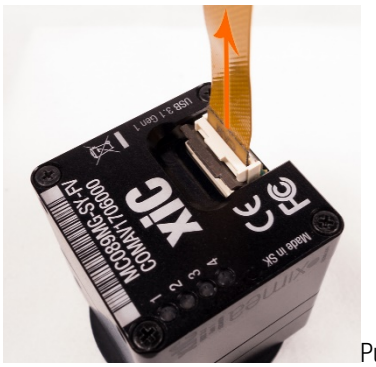
Close connector lock.

figure 3-42 MC FPC insert procedure option -FV

Detaching FPC cable MX X2G2 option –FV



Open connector lock



Pull gently the cable out as marked.

figure 3-43, MC FPC detach procedure option -FV

3.10. xiC Digital Input / Output (GPIO) Interface

USB XiC cameras use the 8-pin connector for the GPIO interface and external power supply (AUX) connection and have multiple options for inputs and outputs. The flex line cameras have one input and one output available through the flex line (see pin-out above).

Connector	Signals	Mating Connectors
I/O & Sync 8-pin	Opto-isolated trigger input and non-isolated I/O	Binder 8-pin PN: 79 1426 15 08
Flex cable	One input and one output non-isolated	

table 3-30, GPIO mating connector description

3.10.1. Location

IO interface receptacle (for USB cameras only) is located on the back of the camera:

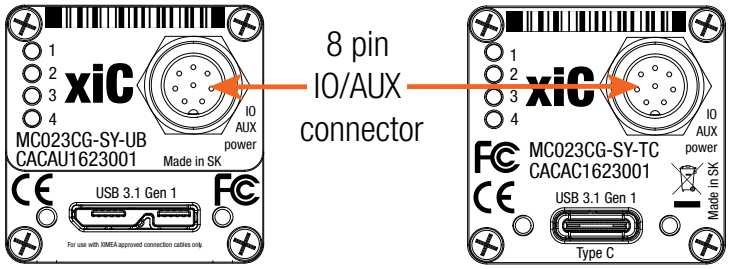


figure 3-44, position GPIO connector

3.10.2. IO Connector Pinning

Pinning of the IO connector (camera):

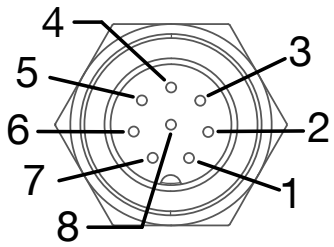


figure 3-45, pinning GPIO connector

I/O connector Pin Assignment:

Pin	Name	Signal	Technical description	GPI/GPO index API
1	AUX PWR	Power supply input	5V	
2	INOUT2	Non-isolated I/O	LVTTL (3V, 50µA)	3/3
3	OUT1	Opto- isolated Output 1	Open collector	-/1
4	OUT GND	Ground for Opto-Isolated Out (OUT1)		
5	IN1	Opto-isolated Input 1	(<0.8V low; 4-24V high)	1/-
6	IN GND	Ground for Opto-Isolated Input (IN1)		
7	GND	Ground for power and non-isolated I/O		
8	INOUT1	Non-isolated I/O	LVTTL (3V, 50µA)	2/2

table 3-31, I/O connector Pin Assignment

3.10.3. Optically isolated Digital Input

3.10.3.1. Optically isolated Digital Input - General info

Item	Parameter / note
Maximal input voltage	24V
Common pole	No
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	No damage, no lost data
Maximum recommended cable length	5m
Input level for logical 0	Voltage < 2.0V/Current 0mA to 0.3mA
Input level for logical 1	Voltage > 4.0V/Current 4mA to 6mA
Input debounce filter	No
Input delay – rising edge	1.7 +/-0.2µs (V_{INPUT}=10V, $T_{AMBIENT}$=25°C)
Input delay – falling edge[1]	10.7 +/-0.2µs (V_{INPUT}=10V, $T_{AMBIENT}$=25°C)
Number of inputs	1
External trigger mapping	Yes
Input functions	Trigger, get current level (rising or falling edge are supported)

table 3-32, Optically isolated digital input, general info

Note: – 1) Propagation delay depends on voltage level, propagation jitter is significantly lower.

3.10.3.2. Digital Input – signal levels

Input levels are not IEC 61131-2, Type 1 as the ON state has been extended to support 5V TTL

V-in-min [V]	V-in-max [V]	State	I-max [mA]
-24.0	2.0	Off (0)	0.0 – 0.3 mA (0mA nominal)
2.0	4.0	Transient	4
4.0	24.0	On (1)	4 – 6 mA (5mA nominal)

table 3-33, digital info, signal levels

Note:

- Input level **Vin** represents amplitude of the input signal.
- Voltage levels referenced to common ground GND

3.10.3.3. Digital Input – Internal Schematic

The internal scheme of Digital Input signal flow inside the camera is below.

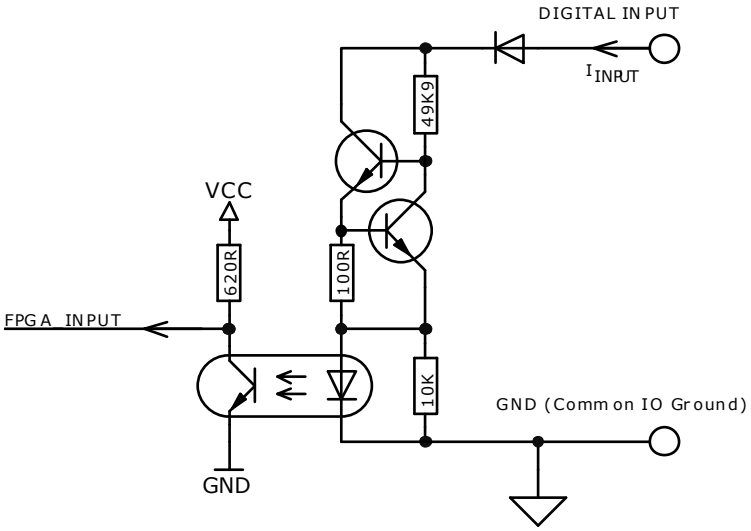


figure 3-46, digital input, interface schematic

3.10.3.4. Digital Input – Wiring

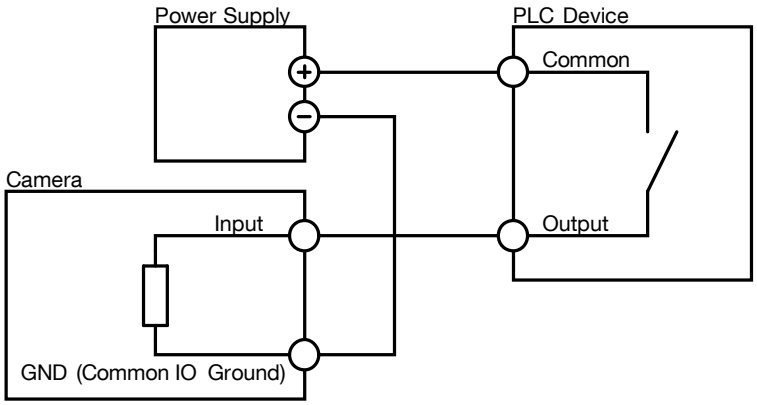


figure 3-47, digital input, interface wiring

3.10.3.5. Digital Input – Timing

Typical measured input delay between Digital Input to FPGA Input

Measurements of input delays:

Edge Type	Input Voltage [V]	Typ. delay [µs]
Rising	5	1.6
Rising	10	1.7
Falling	5	7.8
Falling	10	10.7
Falling	24	12.7

table 3-34, digital input, timing

Note:

- Measured at: Ambient Temperature 25°C

3.10.4. Optically isolated Digital Output

3.10.4.1. Optically isolated Digital Output - General info

Item	Parameter / note
Maximal open circuit voltage	24V
Output port type	Open collector NPN
Protection	short-circuit / over-current / Reverse voltage
Protection circuit	PTC Resettable Fuse
Maximal sink current	25mA
Trip current	50mA – self restarting when failure mode current disconnected
Inductive loads	No
Effect of incorrect output terminal connection	Protected against reverse voltage connection
Maximal output dropout	1.7V, sink current 25mA
Number of outputs	1
Strobe output mapping	Yes

table 3-35, Optically isolated digital output, general info

3.10.4.2. Optically isolated Digital Output Delay

Output current	OFF -> ON	ON -> OFF	Note
2mA	0.55 µs	41 µs	V_{OUTPUT}=5V, $T_{AMBIENT}$=25°C
5mA	0.6 µs	43 µs	V_{OUTPUT}=5V, $T_{AMBIENT}$=25°C
10mA	0.88 µs	51 µs	V_{OUTPUT}=11V, $T_{AMBIENT}$=25°C
25mA	1.4 µs	51 µs	V_{OUTPUT}=13V, $T_{AMBIENT}$=25°C

3.10.4.3. Optically isolated Digital Output – Internal schematic

Following scheme is the internal scheme of the Digital Output signal flow inside the camera.

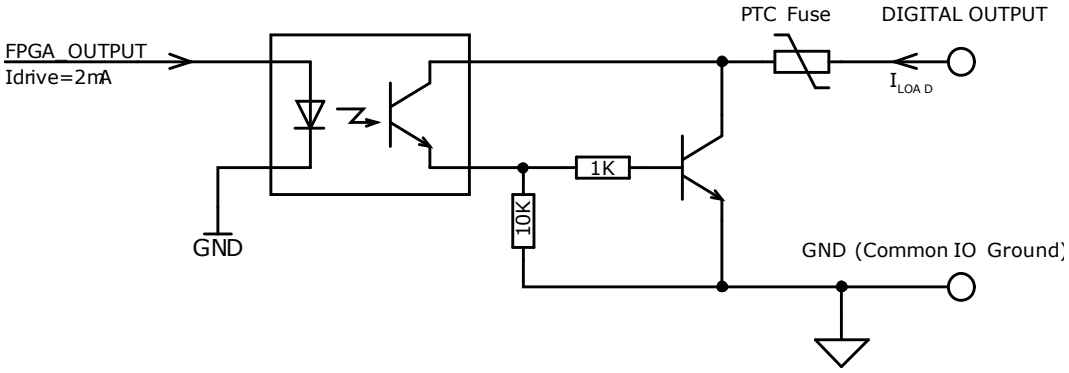


figure 3-48, digital output, interface schematic

Output Transfer Characteristic

When Output is in **On** state - typical transfer characteristic of output is as on following figure:

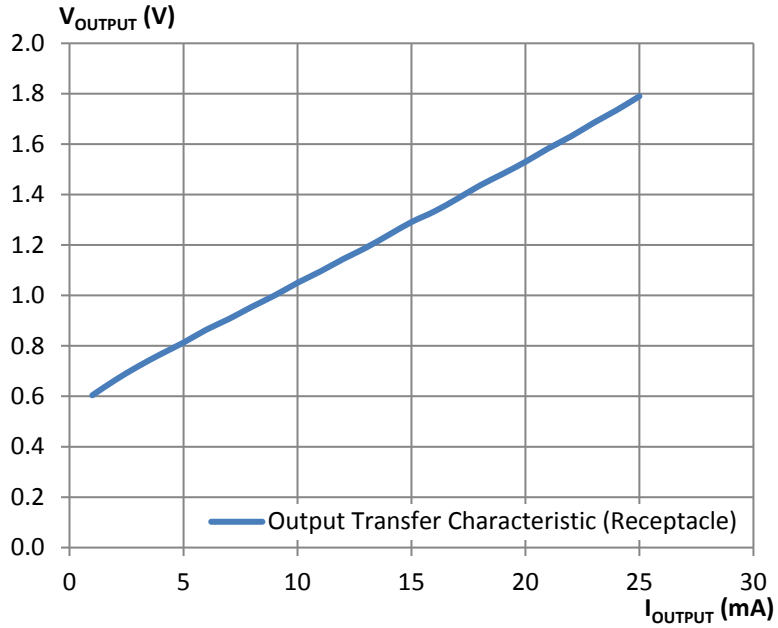


figure 3-49, digital output transfer characteristics

3.10.4.4. Digital Output – Wiring

Digital output has an open collector switching transistor with common IO Ground. In most cases a power source for external device must be provided.

3.10.4.4.1. Connecting Digital OUTPUT to a NPN-compatible PLC device input (biased)

Output state	Output switch state	Input state
ON	Sourcing current	Pull up (energized)
OFF	Relaxing	Not energized

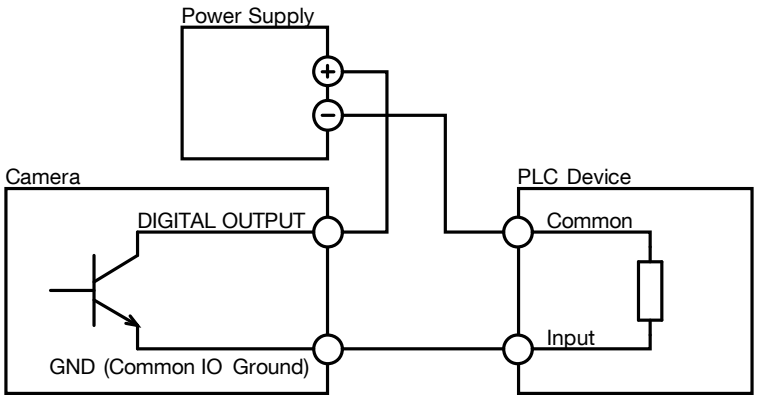


figure 3-50, Connecting Digital OUTPUT to a NPN-compatible PLC device input (biased)

Important note:

- If using this configuration, take into account that Common Ground connection may be biased by power supply for Digital Input!

3.10.4.4.2. Connecting Digital OUTPUT to a NPN-compatible PLC device input

This type of connection is possible only when opto-isolated input is used (bidirectional in some cases) or when only one general opto-isolated input is used.

Output state	Output switch state	Input state
ON	Sourcing current	Pull down (energized)
OFF	Relaxing	Not energized

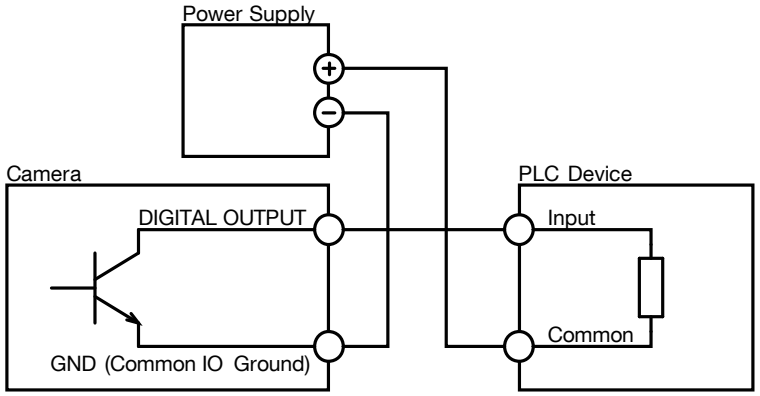


figure 3-51, Connecting Digital OUTPUT to a NPN-compatible PLC device input - more bidirectional inputs used

Note:

- In this case a bidirectional opto-isolated input must be used

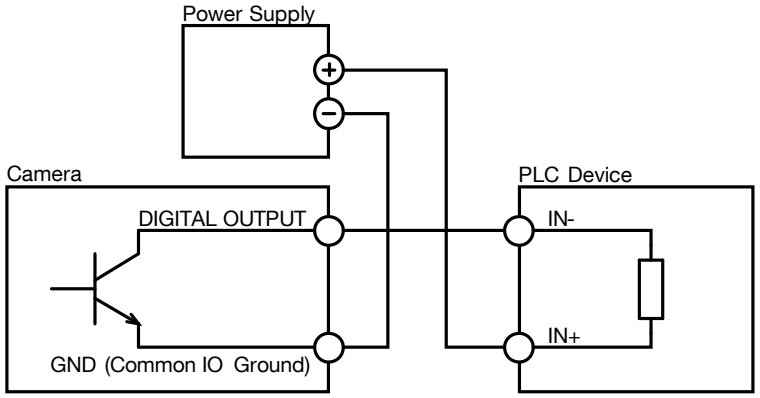


figure 3-52, Connecting Digital OUTPUT to a NPN-compatible PLC device - single input

3.10.4.4.3. Connecting Digital OUTPUT to a PNP-compatible device

Output state	Output switch state	Input state
ON	Sinking current	Not energized
OFF	Relaxing	Pull up (energized)

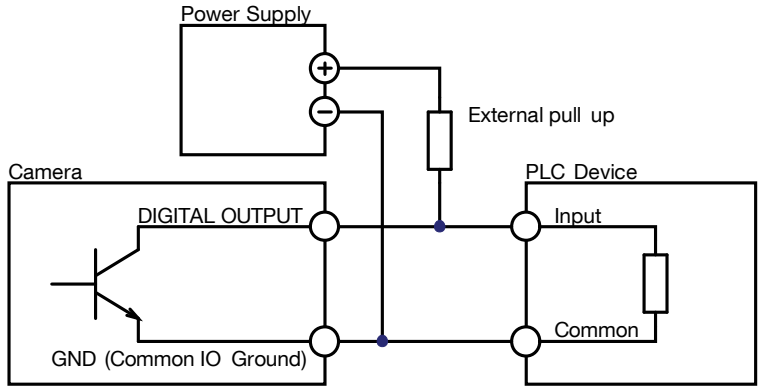


figure 3-53, Connecting Digital OUTPUT to a PNP-compatible device

Pull up resistor can be calculated as follows: $R = \frac{V_{psu} - V_{input}}{I_{input}}$

Where:

V_{psu} power supply voltage. Must be higher than required input amplitude

V_{input} required input amplitude

I_{input} input driving current (corresponding to input amplitude)

Remember to use the appropriate resistor power rating $P(R) > (V_{psu} - V_{input}) * I_{input}$

3.10.4.4.4. Output Wiring Example: LED Driving

LED can be driven directly by camera digital output. A series resistor must be used to limit LED current.

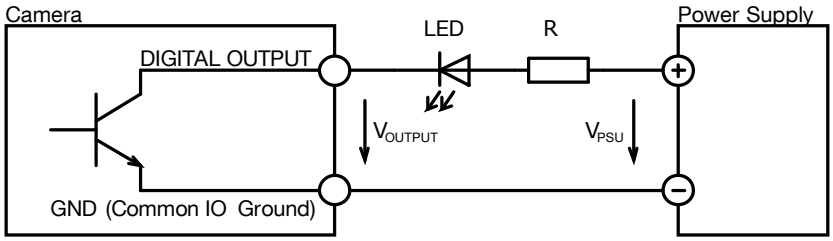


figure 3-54, LED Driving

LED series resistor can be calculated by the following equation: $R = \frac{V_{psu} - V_{output} - V_{led}}{I_{led}}$

Where:

V_{psu} power supply voltage (5V to 24V)

V_{output} voltage across digital output pins (see. *3.10.4.1 Optically isolated Digital Output - General info*)

V_{led} LED forward voltage (see table below)

I_{led} LED current

Note:

- Remember to use the appropriate resistor power rating $P(RES) = {I_{led}}^2 \times R = (V_{psu} - V_{led}) \times I_{led}$

Typical LED forward voltage

LED Colour	V_{led} (typ.)	V_{led} (max.)	Note
Standard Red	1.7V	2.1V	
Super Bright Red	1.85V	2.5V	
Low power Red	1.7V	2.0V	
Orange	2.0V	2.1V	
Yellow	2.1V	2.2V	
Green	1.9V	2.5V	
Emerald Green	2.1V	2.7V	
Blue	2.5V	3.7V	
White	2.8V	3.8V	
Infra-Red	1.3V	1.8V	Opto coupler

table 3-36, digital output, LED driving

3.10.4.4.5. Output Wiring Example: Inductive load (Relay) Driving

Do not connect inductive load RL directly to Camera Digital Output. A transistor must be used to prevent damage of the output. See image below for possible inductive load driving. Resistor R can be connected to Digital Outputs and power supply to provide the necessary bias current for transistor. You should also use an external diode to protect the transistor from over voltage while disconnecting an inductive load. Keep in mind that this connection has an inverted logic. Current will flow through the load at the start of the camera.

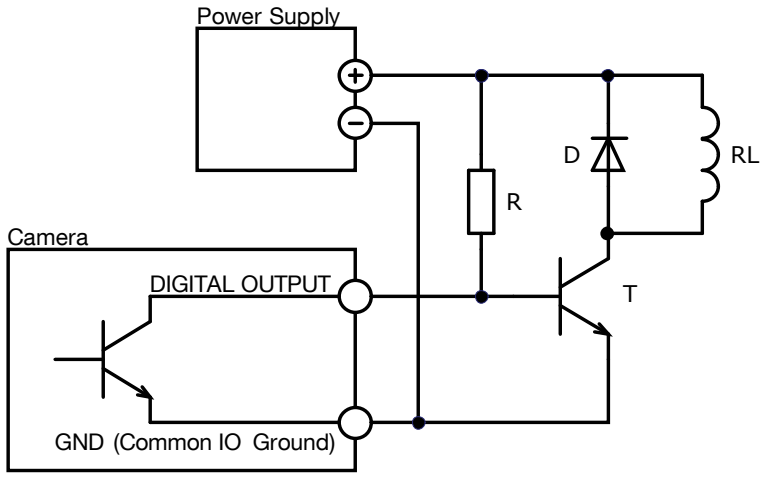


figure 3-55, Inductive load (Relay) Driving (inverted logic)

For positive logic you can use a second bipolar transistor.

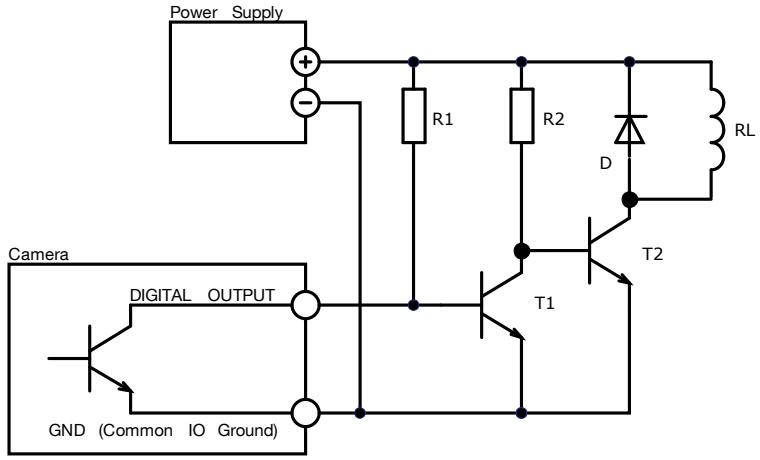


figure 3-56, Inductive load (Relay) Driving (non-inverted logic)

3.10.4.4.6. Output Wiring Example: Driving the trigger input of a strobe controller

The digital output can be used to drive a strobe controller according to the table below.

Driving the trigger input of a strobe controller

Trigger polarity	Opto-isolated controller input	Output delay	Wiring	Description
Positive edge	Yes	0.5µs	figure 3-49	
Negative edge	Yes	0.5µs	figure 3-51	
Positive edge	No	155µs	figure 3-52	Not recommended in cases when short delay time is required. Output delay is much longer than in other wiring examples. Use external pull up in case that no pull up at controller input is used.
Negative edge	No	0.5µs	figure 3-52	Note that external pull up is not used in this case. Assume that internal pull up at the controller input is used.

table 3-37, digital output, wiring examples

3.10.4.5. Digital Output – Timing

Typical input delay between FPGA Output to Digital Output

Edge Type	Typ. delay [µs]
Off -> On	0.5
On -> Off	155

table 3-38, digital output, typical timing

Note: Measured at conditions: V_{OUTPUT}=18V, $T_{AMBIENT}$=27°C

Output delay depending on output current:

Output current	OFF->ON	ON->OFF
2mA	0.55µs	184µs
5mA	0.55µs	182µs
10mA	0.55µs	133µs
25mA	0.55µs	113µs

table 3-39, digital output, current depending timing

Note: Measured at conditions: V_{OUTPUT}=11V, $T_{AMBIENT}$=25°C

3.10.5. Non-isolated Digital Lines (-UB and -TC only)

Non isolated Digital lines can be used as inputs or outputs compatible with TTL logic. These are high impedance pins so when used as output high impedance slave input has to be used.

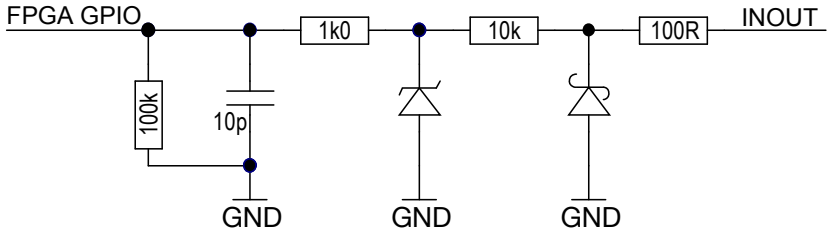


figure 3-57, non isolated input/output, interface schematic

3.10.5.1. Non-isolated Digital Input/Output (INOUT) General info

Item	Parameter/note
Number of digital lines	2, each line can be configured by application separately as input or output
Maximum input voltage	24V DC
Common pole	Yes, AUX power GND
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	No damage, no lost data
Protection	Short-circuit/over-current/reverse voltage
Maximal output sink current	30µA, maximum advised load = 60kΩ
Inductive loads	No
Output level logical 0	<0.4V, Load 100kΩ
Output level logical 1	>2.5V, Load100kΩ
Output delay – rising edge	400ns, Load 100kΩ, threshold 2V
Output delay - falling edge	450ns, Load 100kΩ, threshold 0.5V
Input impedance – minimum	15kΩ
Input level for logical 0	<0.7V
Input level for logical 1	>3.3V
Input debounce filter	No
Input delay – rising edge	750ns, V_{INPUT}=5V,$T_{AMBIENT}$=25°C
Input delay – falling edge[1]	1200ns, V_{INPUT}=5V,$T_{AMBIENT}$=25°C
Input functions	Trigger, get current level; Rising or falling edge are supported for trigger
Output functions	Off, On, Exposure active, Frame active; Signal inversion supported

table 3-40, General info for non-isolated digital in/out trigger lines.

NOTE 1) Because of low input impedance of non-isolated input it is not possible to connect master slave of two cameras directly. Signal conditioning (buffer, opamp…) is required

3.11. External power supply input (AUX)

Item	Parameter/note
Supported voltage range	4.5-5.5V
Typical input current*	0.65A, @5V while acquiring
Maximum input current*	0.67A, @5V
Protection	Over/under voltage protection

* Is model depended. Used values are for MC124MG-SY-TC

3.12. Heat Dissipation

XIMEA strives to offer the smallest cameras with the highest performance. Although the cameras are first in terms of power efficiency, the high packing density of components can lead to elevated temperatures, and an adequate dissipation of this heat must be ensured. The cameras rely on adequate surface contact with a thermal mass (tripod, lens, heat sink) of sufficient size for heat dissipation and this must be provided ensured by the user.

3.13. CBL-U3-1M0 / CBL-U3-3M0 / CBL-U3-5M0

1.0m / 3.0m / 5.0m USB 3.0 cables

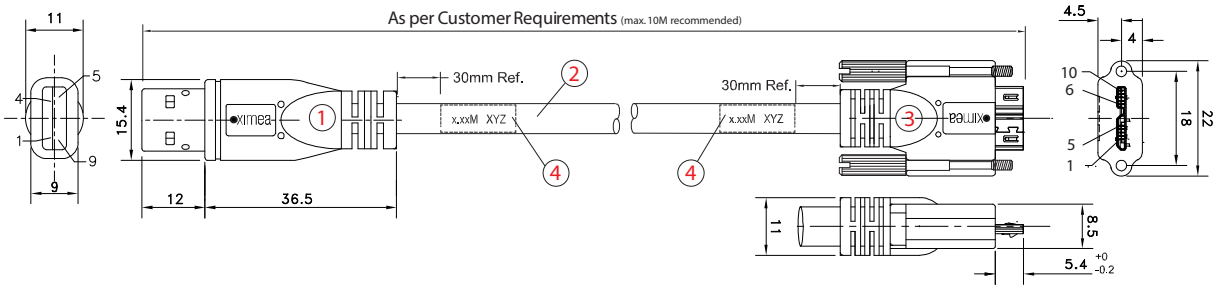


figure 3-58, drawing USB3 cable

Item	Description
1	USB A 3.0 9 pin Molded Plug <BLK>
2	MCD-USB-211 [OD= 7.3mm] <BLK>
3	3 USB MicB 3.0 sl 10 pin Molded Plug with Screw Locking <BLK>
4	Cable Label

table 3-41, USB3 cable, components

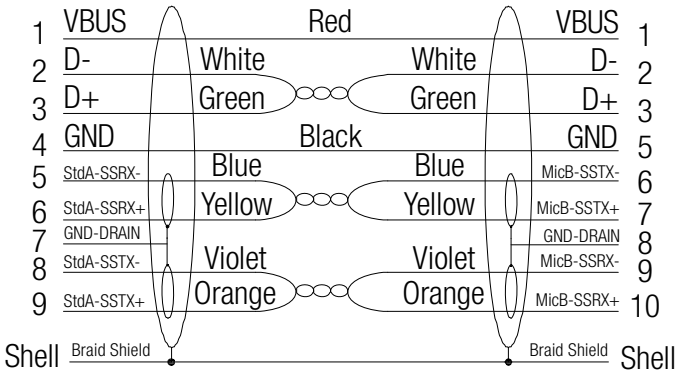


figure 3-59, wiring USB3 cable

Pin	Signal	Description
1	VBUS	Power
2	D-	USB 2.0 signal pair
3	D+	
4	ID	OTG Identification
5	GND	Power Ground
6	MicB_SSTX-	USB 3.0 SuperSpeed transmitter signal pair
7	MicB_SSTX+	
8	GND_DRAIN	USB 3.0 signal Ground
9	MicB_SSRX-	USB 3.0 SuperSpeed receiver signal pair
10	MicB_SSRX+	

table 3-42, USB3 connector, pin assignment

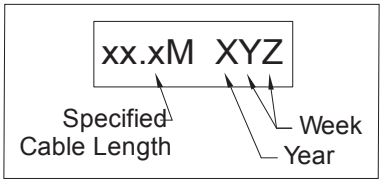


figure 3-60, label details USB3 cable

3.14. CBL-U3-3M0-ANG

3.0m USB 3.0 cable, angled micro USB3 connector

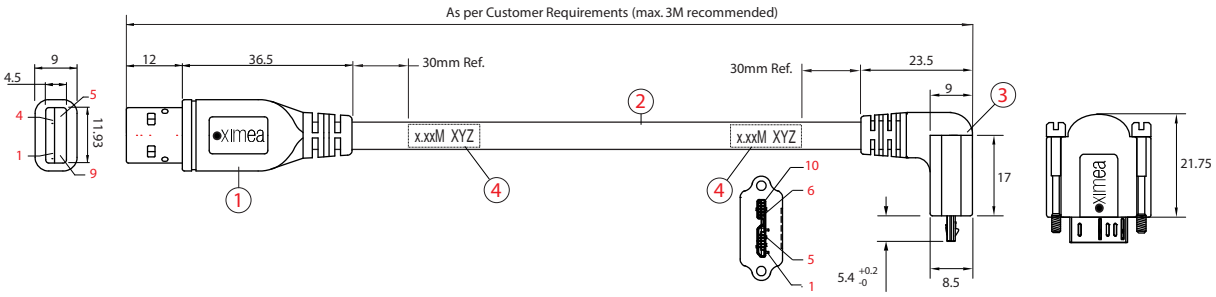


figure 3-61, drawing USB3 cable angled

Item	Description
1	USB A 3.0 9 pin Molded Plug <BLK>
2	A12-7143 [OD=5.9mm] <BLK> UL20726 2STP#30 + 1UTP#28 + 2C#26
3	USB MicB 3.0 sl 90D A1(10 pin Molded Plug) <BLK>
4	Cable Label

table 3-43, USB3 cable angled, components

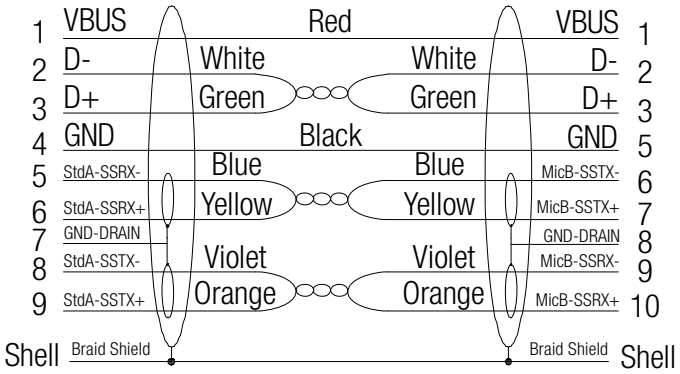


figure 3-62, wiring USB3 cable angled

Pin	Signal	Description
1	VBUS	Power
2	D-	USB 2.0 signal pair
3	D+	
4	ID	OTG Identification
5	GND	Power Ground
6	MicB_SSTX-	USB 3.0 SuperSpeed transmitter signal pair
7	MicB_SSTX+	
8	GND_DRAIN	USB 3.0 signal Ground
9	MicB_SSRX-	USB 3.0 SuperSpeed receiver signal pair
10	MicB_SSRX+	

table 3-44, USB3 connector, pin assignment

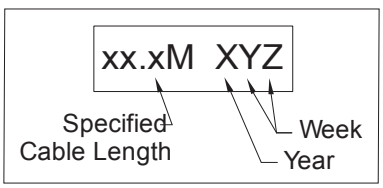


figure 3-63, label details USB3 cable angled

3.15. CBL-MQ-FL-0M1/CBL-MQ-FL-0M25

Cable FPC MQ Flex-Line, 0.1m/0.25m can be used for connecting xiC flex line models to carrier board or trough adapter and standard USB 3.0 cable to the host computer. Minimal advised bending radius is 2mm. Cable thickness 0.16mm.

figure 3-64, flex cable gold color

Cable have marked ends. It is important to connect the end marked “CAM” to the camera and end marked “BOB” to host or adapter. Swapped orientation leads to nonoperational state. Connecting camera to powered host can cause destruction of camera. For detaching cable the connector need to be unlocked, otherwise connector soldering may be damaged.

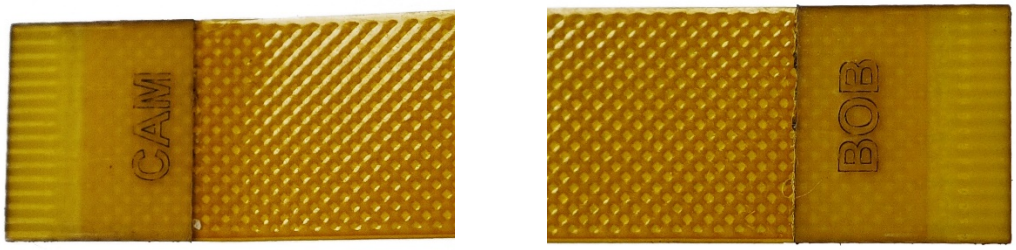


figure 3-65, flex cable ends

3.16. CBL-USB3FLEX-0M10 / CBL-USB3FLEX-0M25 / CBL-USB3FLEX-0M50

The newer generation of FFC cable with available lengths 0.1m, 0.25m and 0.5m can be used for connecting camera to carrier board or trough adapter to the host computer. Minimal advised bending radius is 5mm. Cable thickness 0.38mm. This cable is NOT polarized and either end can be used for the camera or the host.

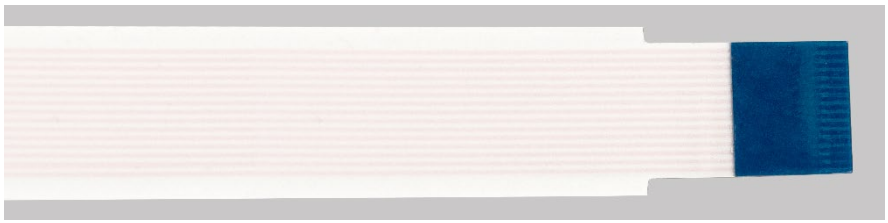


figure 3-66, flex cable white color

3.17. 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. Please refer to *3.9.2 Pinning*

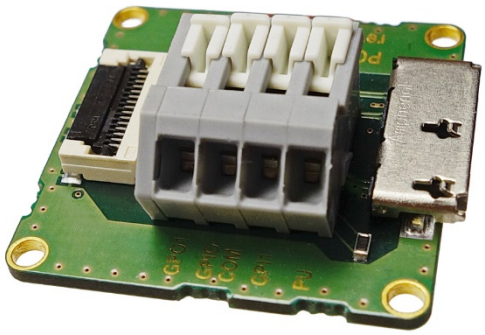


figure 3-67, drawing USB3 cable

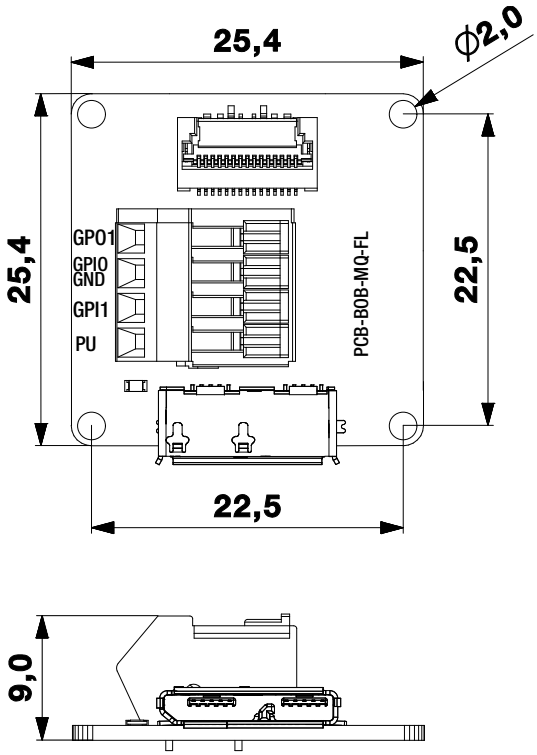


figure 3-68, BOB-MQ-FL dimensions

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 1kOhm to GPO1 – Connect power supply up to 25V if needed

table 3-45, IO connector (WAGO 218-104), pin assignment

3.18. CBL-702-8P-SYNC-5M0

5.0m xiC / xiT series I/O Sync cable 8 poles

Sync cable wiring

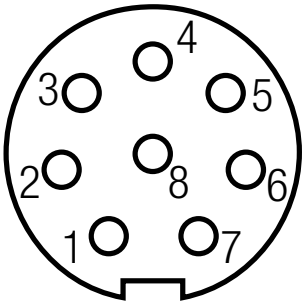


figure 3-69, IO/AUX cable pin numbering

Pin	color	Signal
1	White	AUX power supply input
2	Brown	INOUT2 - non-isolated Input/Output
3	Green	OUT1 - Opto-isolated Output
4	Yellow	OUT_GND Opto-Isolated output ground pole
5	Grey	IN1 - Opto-isolated Input
6	Pink	IN_GND Opto-Isolated input ground pole
7	Blue	External grounds for power supply and non-isolated I/O
8	Red	INOUT1 - non-isolated Input/Output

table 3-46, IO/AUX cable, pin assignment

3rd party cables compatible with xiC

Part number	Manufacturer	Link
79 1426 12 08	binder	https://www.binder-usa.com/products/partsdetail/88888
79 1426 15 08	binder	https://www.binder-usa.com/products/partsdetail/88890
79 1426 72 08	binder	https://www.binder-usa.com/products/partsdetail/88889
79 1426 75 08	binder	https://www.binder-usa.com/products/partsdetail/88892
79 1462 212 08	binder	https://www.binder-usa.com/products/partsdetail/88901
79 1462 215 08	binder	https://www.binder-usa.com/products/partsdetail/88904
79 1462 275 08	binder	https://www.binder-usa.com/products/partsdetail/88905
79 1462 272 08	binder	https://www.binder-usa.com/products/partsdetail/88906

table 3-47, alternative cables,

3.19. Tripod Adapter – MECH-MC-BRACKET-KIT

xiC series tripod mounting bracket

figure 3-70, mounting tripod adapter

xiC series tripod mounting bracket with 1/4-20 thread.

Use 4x SROB-M2x4-CUST screws (included) for mounting. Bracket can be mounted on the bottom or top side of the camera.

3.19.1. Dimensional drawings

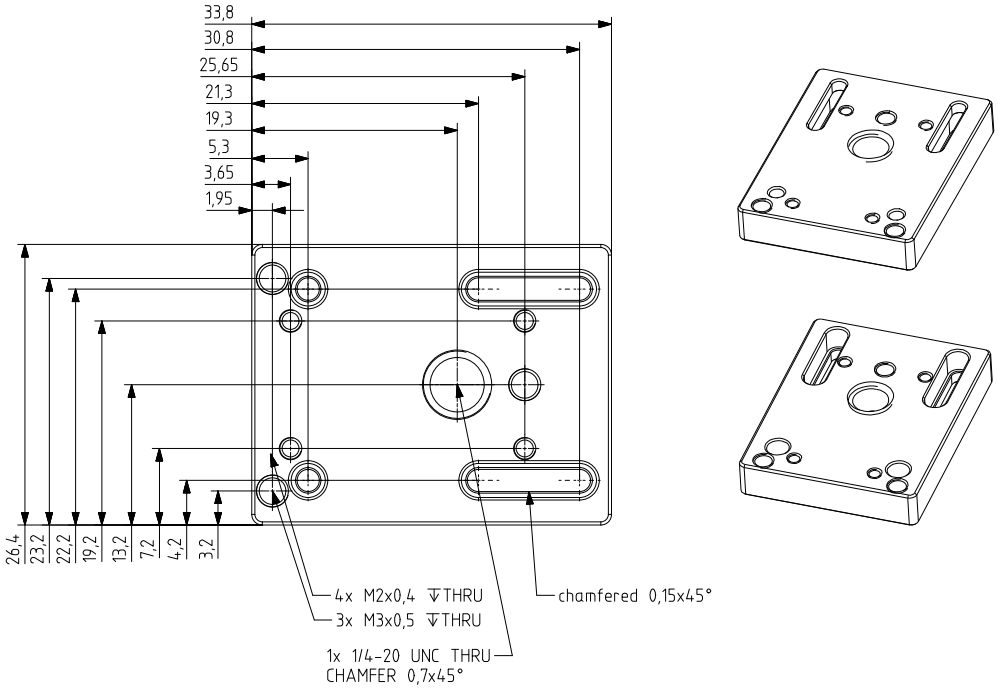


figure 3-71, dimensional drawing tripod adapter

Mass without screws: 11.4 g.

3.20. USB 3 host adapters

USB 3.0 to PCI Express x1 Gen2 Host Card

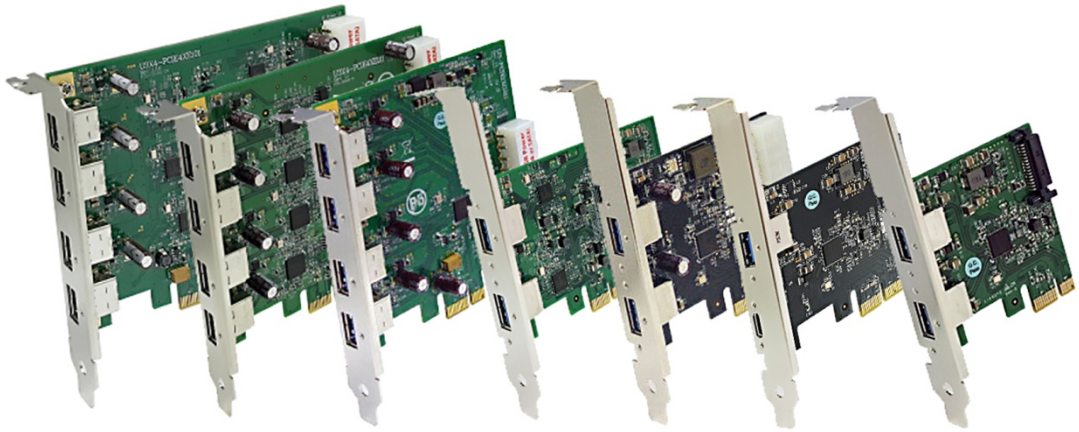


figure 3-72, USB3 host adapters

Please refer to following page https://www.ximea.com/support/projects/usb3/wiki/USB_3_Host_Adapters for more information.

System requirements

All requirements depend on selected host adapter. Please refer to host adapter specification

4. Operation

For a proper operation of your xiC 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 xiC camera in the following sections.

4.1. System Requirements

4.1.1. Software Requirements

The xiC cameras are compatible with the following operating systems:

- Windows 10
- Windows 7 SP1
- Linux Ubuntu
- MacOS 10.8 or newer

All XIMEA cameras are compatible with the most advanced Vision and Image Processing Libraries.

See chapter *5 Software* for more information about the options to access a xiC cameras, as well as a list of currently supported libraries and frameworks supported in Windows.

For more information visit page: https://www.ximea.com/support/wiki/apis/APIs

4.1.2. Hardware Requirements

The XIMEA xiC 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 at:

Recommended hardware http://www.ximea.com/support/wiki/usb3/Compatible_hardware

4.1.2.1. System Configuration

Minimum system configuration:

For a basic operation of your xiC camera with a PC the following minimum system configuration is required. Please note that bandwidth and processing performance are tied to the hardware configuration and the minimum hardware configuration could lead to a reduced bandwidth and limited frame rate.

CPU:	Intel i3 or better
RAM:	2GB RAM or more
Disc Space:	200 MB of free disc space
Video:	NVIDIA or Radeon graphics card 128MB or integrated on CPU
Ports:	Motherboard with USB 2.0 or USB 3.0 port or PCIe x1-16 Gen 2 slot for compatible USB 3.0 host adapter

Recommended system configuration:

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

CPU:	Intel i7
RAM:	4GB RAM or more
Disc Space:	200 MB of free disc space
Video:	NVIDIA or Radeon graphics card 128MB or integrated on CPU
Ports:	Motherboard with a USB 3.1 Gen1 port connected to a high performance chipset (e.g. Intel QM77, Z77 or successors) and/or PCIe x1-16 Gen 2 slot for compatible USB 3.1 Gen1 host adapter. Some host adapters may require PCIe Gen3 ports (see next chapter for more details).

4.1.2.2. USB 3.1 Host Adapter

For a stable operation of your xiC camera and achieving the maximum possible system performance with the highest frame rate it is important to choose an appropriate USB 3.1 host adapter chipset.

Please have a look at the following link to our webpage: http://www.ximea.com/support/wiki/usb3/Compatible_hardware

XIMEA maintains a regularly updated overview of compatible USB 3.0 and USB 3.1 host adapters together with the available bandwidth https://www.ximea.com/support/projects/usb3/wiki/USB_3_Host_Adapters

The maximum data transfer rate depends on different conditions (motherboard, chipset, driver version, operating system,...).

PCI Express (PCIe) bus speed requirement: To achieve maximum performance of USB3 cameras - USB 3.1 host adapter must be connected to the PCIe slot/port/hub and running at 5GT/s in case of PCIe Gen2 host adapters. For cards requiring Gen3 the speed needs to be 8GT/s.

4.1.2.3. Cables

The USB 3.1 Gen1 cable that you use with the xiC camera is responsible for the power supply and the data transfer to the PC. It is required to use an industrial USB 3.1 Gen1 cable with a proper wiring and shielding. We recommend using XIMEA industrial USB 3.1 Gen1 cables in order to achieve the maximum possible performance of the camera.

XIMEA offers several passive USB 3.1 Gen1 cables and a sync cables, please see *3.13 CBL-U3-1M0 / CBL-U3-3M0 / CBL-U3-5M0*, *3.14 CBL-U3-3M0-ANG* and *3.15 CBL-MQ-FL-0M*

4.2. Video Formats

4.2.1. Full Resolution

By default, each camera outputs a full resolution image based on its sensor specification.

4.2.2. 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.

Depending on the sensor xiC cameras support the definition of one single ROI by specifying the size (width and height) as well as the position (based on upper left corner) of the of the sub-area.

Please note *3.5 Model Specific Characteristics*

4.2.3. Downsampling Modes

Downsampling describes the possibility of reducing the image resolution without affecting the sensors physical size, ie. 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 skipping.

4.2.3.1. 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.

4.2.3.2. Skipping

When skipping 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 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.

4.2.4. Image Data Output Formats

All modes are provided by the xiAPI or standard interfaces using the xiAPI (please note *5.1 Accessing the Camera*).

Each xiC cameras supports several Image Data Output Formats.

Mode	Description
RAW8	Raw sensor data, 8 Bit per pixel, single channel
RAW16	Raw sensor data, 16 Bit per pixel, single channel 10 or 12 Bit sensor output (LSB) with bit-shift up to 16 Bit
MONO8	Intensity output, 8 Bit per pixel, single channel
MONO16	Intensity output, 16 Bit per pixel, single channel
RGB24	RGB filtered output, 24 Bit per pixel, 3 channels Sequence: [Blue][Green][Red]
RGB32	RGBA filtered output, 32 Bit per pixel, 4 channels, Alpha channel equals 0. Sequence: [Blue][Green][Red][0]
RGB_PLANAR	RGB filtered output with planar-oriented channels. Format: [R][R]...[G][G]...[B][B]...
FRM_TRANSPORT_DATA	Data from transport layer (e.g. packed). This format is optimal when an efficient storage and later (offline) processing is required. Format is defined by XI_PRM_TRANSPORT_PIXEL_FORMAT

table 4-1, image formats,

Note1: For color modes **RGB32** and **RGB24** the image from sensor needs to be pre-processed (de-bayering). CPU load is higher in these modes. Setting this parameter will reset current region of interest. **RGB24** is being processed from the **RGB32** by removing the unused Alpha channel creating a slightly higher CPU load than the **RGB32** format.

Note2: The color filtering (de-bayering) relies on the interpolation of adjacent pixels in order to create pixel in the target image. Pixels on the edges of the image are missing adjacent pixels and therefore cannot be used for the interpolation process. The result is a target image that is smaller than the source image (4 pixels on all sides).

Note3: For most formats the transport data can be packed. 12-bit pixel bit depth transfers only 12bit per pixel compared to 16bit per pixel when the data are not packed. In case of packed format the CPU load is higher due to unpacking of the image data. Available bandwidth is however used optimally.

4.2.5. Digitization bit depth

In case of most cameras changing the sensor digitization bit depth may increases the maximum possible frame rate, but does not affect the saturation level.

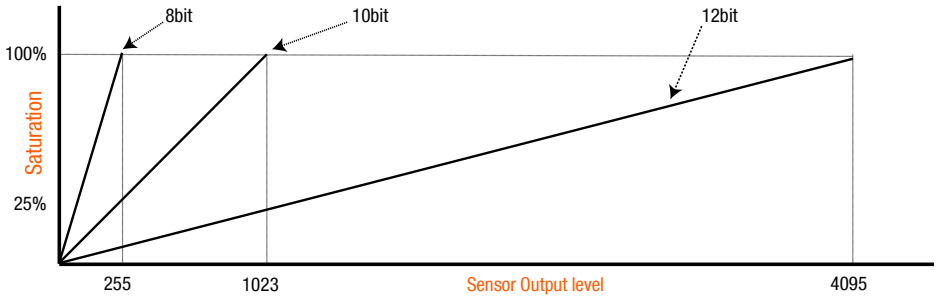


figure 4-1, Saturation vs Sensor output for different digitization bit depths

Cameras featuring 2nd generation of Sony IMX sensors (MC031, MC050, MC089, MC124) have special 8bit digitization mode, which features same conversion gain as 10bit mode using only ¼ of the saturation. This lead to four times brighter images compared to 10bit and 12bit modes.

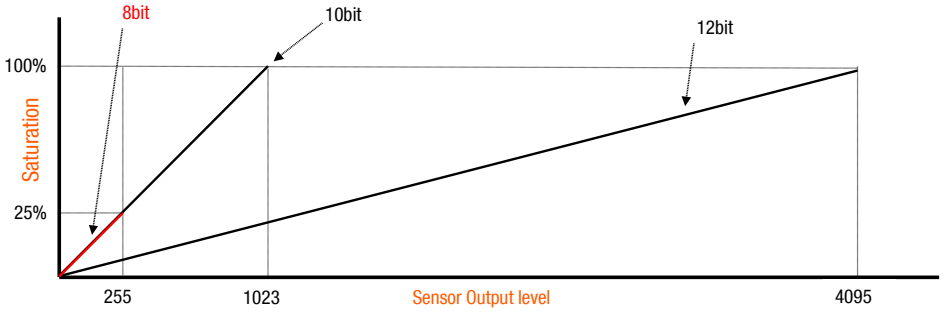


figure 4-2, Saturation vs Sensor output for different digitization bit depths 2nd generation IMX sensors

4.3. Acquisition modes

4.3.1. 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 Overlapped mode gives the highest number of frames per second (FPS).

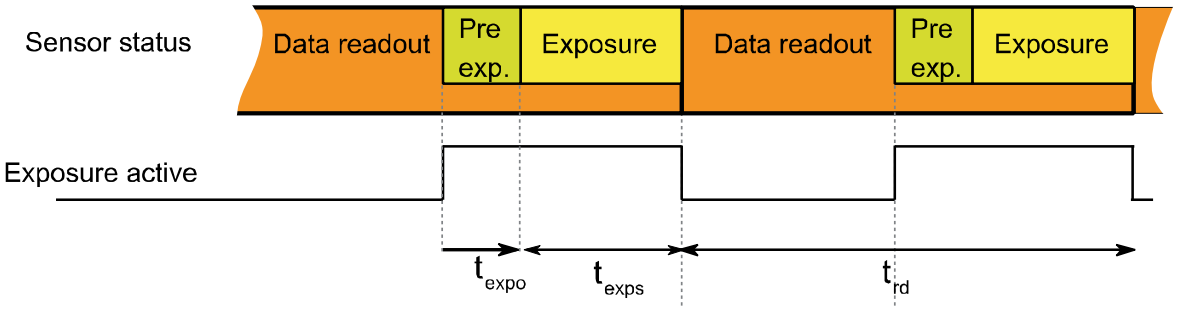


figure 4-3, acquisition mode - free run

In this mode the timing depends on the Exposure Time and Data Readout Time.

All xiC cameras 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: https://www.ximea.com/support/wiki/allprod/Frame_Rate_Control

This is also applicable in case of triggered acquisition.

4.3.2. 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 case of level sensitive it can used to control length of exposure or acquisition itself.

Generally trigger sources can be divided in to two groups:

Software Trigger

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

Hardware Trigger

A hardware trigger can be sent to the sensor using the digital input described in *3.10.3 Optically isolated* Digital Input, or non-isolated ports configured as input described in *3.10.5 Non-isolated Digital Lines (-UB and -TC only)* Triggering by hardware is usually used to reduce latencies and jitter in applications that require the most accurate timing.

4.3.2.1. Triggered acquisition - single frame

Sensors support exposure overlapped with readout. When the trigger period (t_{tper}) is longer than the exposure plus readout time, exposure is not overlapped with readout. However when the trigger period is decreased, the sensor will expose the images in overlap mode. In this case, the frame active signal will be constantly active. The trigger period has to be long enough so the exposure of next frame does not end sooner than readout of previous frame.

Sensor timing in Exposure Overlapped with Data Readout Mode

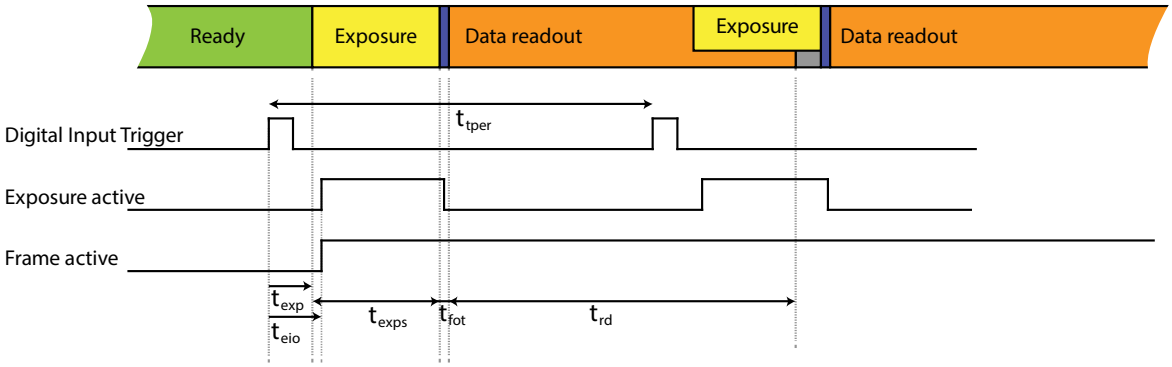


figure 4-4, acquisition mode – triggered with overlap

Description:

t_{eio} – Trigger (Digital Input) to Exposure Active (Digital Output)

t_{exp} – Trigger (Digital Input) to start of exposure

t_{exps} – Current Exposure Time set (XI_PRM_EXPOSURE)

t_{fot} – Frame overhead time (FOT)

t_{rd} – readout time (Readout Time)

t_{row} – readout time of one row (Line period) depends on sensor settings

Conditions: Debounce on trigger input line and trigger delay are disabled.

The timing strongly depends on camera settings. Most of the times can be calculated using Camera performance calculator.

The delay between trigger input and start of exposure:

$$t_{exp} = 3 \times t_{row} + t_{idelay}$$

Where:

t_{idelay} – Delay inside camera caused by internal electronics. This depends on input type.

Please refer to: *3.10.3 Optically isolated Digital Input* or *3.10.5 Non-isolated Digital Lines (-UB and -TC only)*

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

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

Where:

t_{odelay} – Delay inside camera caused by internal electronics. This depends on output type.

Please refer to: *3.10.4 Optically isolated Digital Output* or *3.10.5 Non-isolated Digital Lines (-UB and -TC only)*

For minimum trigger period (t_{tper}) the following applies. The next trigger after one is processed needs to be applied so the end of the triggered exposure does not overlap with the readout of the previous frame.

$$t_{tper} > \max(t_{rd}, t_{exp}) + t_{fot}$$

4.3.2.2. Triggered acquisition - burst of frames

Frame Burst Start

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

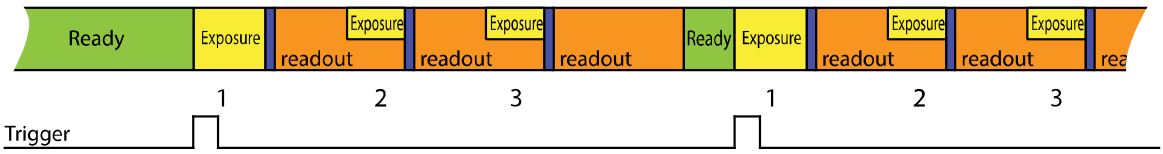


figure 4-5, triggered burst of frames – frame burst start, number of frames in burst set to 3

Frame Burst Active

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

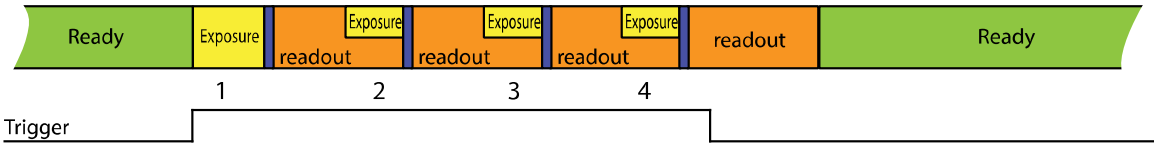


figure 4-6, triggered burst of frames – frame burst active

Please see: Frame Burst Modes: https://www.ximea.com/support/wiki/allprod/Frame_Burst_Modes

4.3.2.3. Exposure defined by trigger pulse length

In this mode the exposure is defined by trigger pulse length. This can be used to achieve longer exposure than allowed by API. Also it can be used to trigger several images in sequence with different exposure time. Exposure time is measured and reported in image metadata.

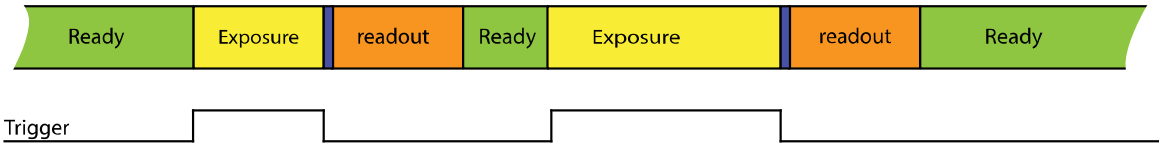


figure 4-7, Exposure defined by trigger pulse length

Please see: Exposure Defined by Trigger Pulse Length:
https://www.ximea.com/support/wiki/allprod/Exposure_Defined_by_Trigger_Pulse_Length

4.3.2.4. Multiple exposures in one frame

All Sony IMX based xiC models except MC023xG-SY support defined number of exposures exposed into a single frame.
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:

1. 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);
```

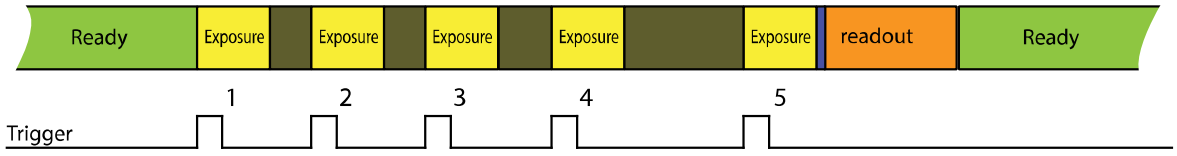


figure 4-8, Multiple exposures - defined exposure time, number of exposures set to 5

2. 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);
```

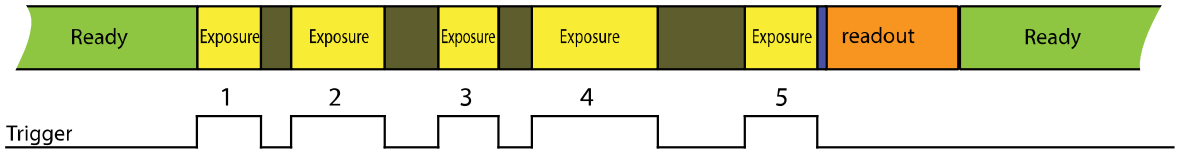


figure 4-9, Multiple exposures - exposure time defined by trigger pulse length, number of exposures set to 5

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 (the line period depends on various other parameters, see Line Period in the using Camera performance calculator).

4.4. Camera Parameters and Features

4.4.1. 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.

4.4.2. 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.

4.5. Host-Assisted Image Processing Parameters Available in xiAPI.

4.5.1. Auto 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).

4.5.2. 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.

4.5.2.1. 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.

4.5.2.2. 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.

4.5.3. 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.

4.5.4. Sharpness

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

4.5.5. 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.

4.5.6. 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.

5. Software

5.1. Accessing the Camera

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.

5.1.1. Proprietary API

All XIMEA cameras are supported by the same unified APIs (application programming interface). The API is a software interface between the camera system driver and the application. Different APIs are available for different programming environments, e.g. *xiAPI* (see *5.7.1 XIMEA APIs*) for C/C++ developments and *xiAPI.Net* for C#/.Net based developments

5.1.2. 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.

5.1.2.1. GenICam

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.

5.1.2.2. USB3 Vision

The USB3 Vision standard not only defines hardware specifications and communication protocols, but also enables a library vendor or application developer to set up a software stack including their own drivers and the GenICam programming interface. This allows the usage of any USB3 Vision compliant device while relying on mechanisms for device discovery and identification, control, and image streaming which are defined by the standard.

5.1.3. Vision Library Integration

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).

5.2. XIMEA CamTool

The CamTool is a cross-platform application showcasing the features of all XIMEA camera families.

Short description

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

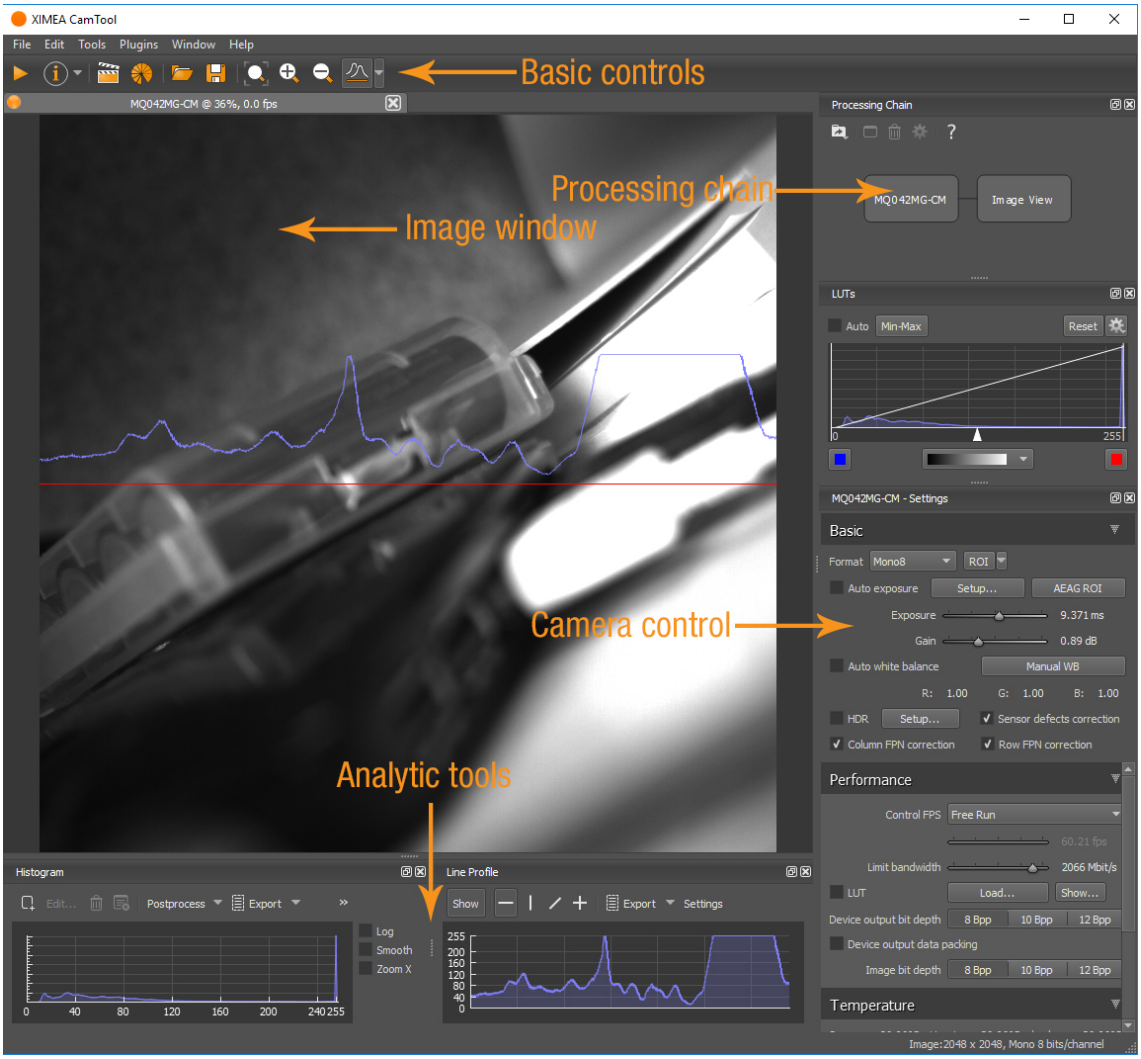


figure 5-1, CamTool Layout

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

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

For more information please refer to: https://www.ximea.com/support/wiki/allprod/XIMEA_CamTool

5.3. Supported Vision Libraries

For an up-to-date listing of the supported vision libraries and software packages, visit our web site http://www.ximea.com/support/projects/vision-libraries/wiki.

5.3.1. Libraries maintained by XIMEA

All cameras listed in the section Products are supported with these libraries.

XIMEA commits to update the API within twelve months after a new major release.

XIMEA warranties backwards compatibility of these software packages for two major releases.

5.3.1.1. MathWorks MATLAB

MathWorks® is the leading developer and supplier of software for technical computing and Model-Based Design.

More: http://www.mathworks.de/ or https://www.ximea.com/support/wiki/vision-libraries/MathWorks_Matlab

5.3.1.2. MVTec HALCON

HALCON is the comprehensive standard software for machine vision with an integrated development environment (IDE) that is used worldwide.

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

5.3.1.3. National Instruments LabVIEW Vision Library

LabVIEW is a graphical programming environment.

More: http://www.ni.com/labview/

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

5.3.1.4. OpenCV

OpenCV is an open source library of programming functions mainly aimed at real time computer vision, developed by Intel and now supported by Willow Garage.

More: https://opencv.org/

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

5.4. XIMEA Windows Software Package

XIMEA API Software Package can be installed on: Microsoft Windows 10, Microsoft Windows 8, Microsoft Windows 7 (and Microsoft Windows 7 Embedded), Microsoft Windows Server 2008 R2.

5.4.1. Contents

The package contains:

- OS Drivers of all XIMEA camera types for OS Microsoft Windows 7 SP1 32/64 bit, Windows 8 32/64 bit, 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

5.4.2. 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):

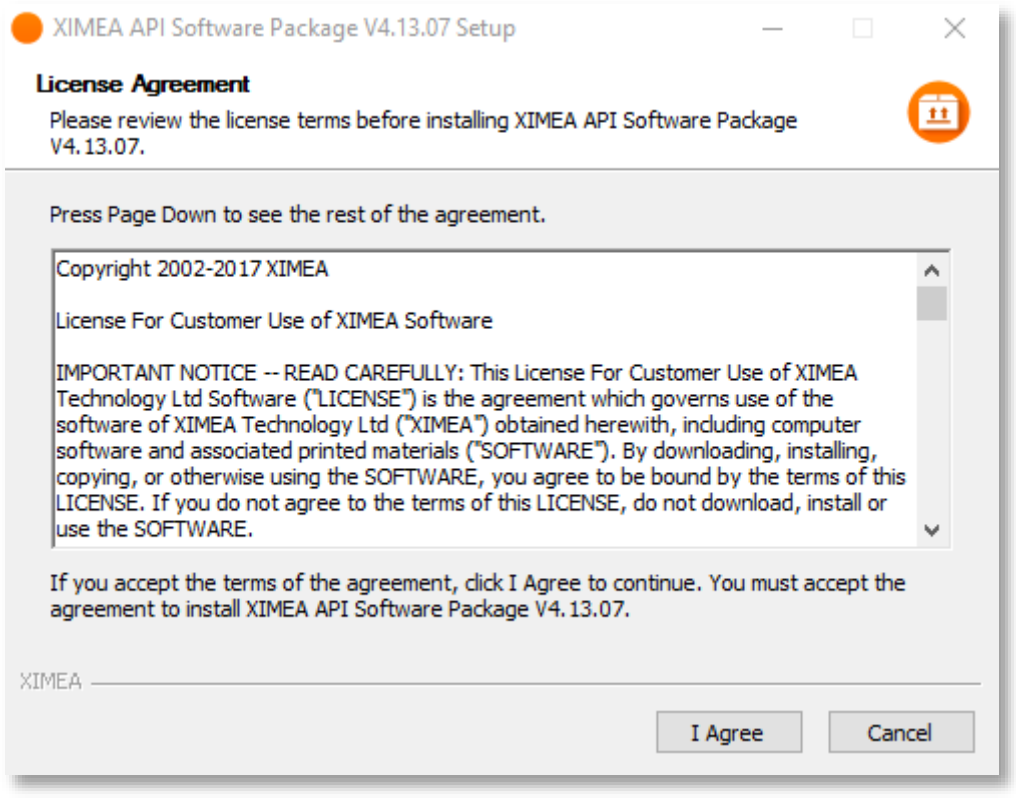


figure 5-2, XIMEA Windows Software Package installation - 1

- 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.

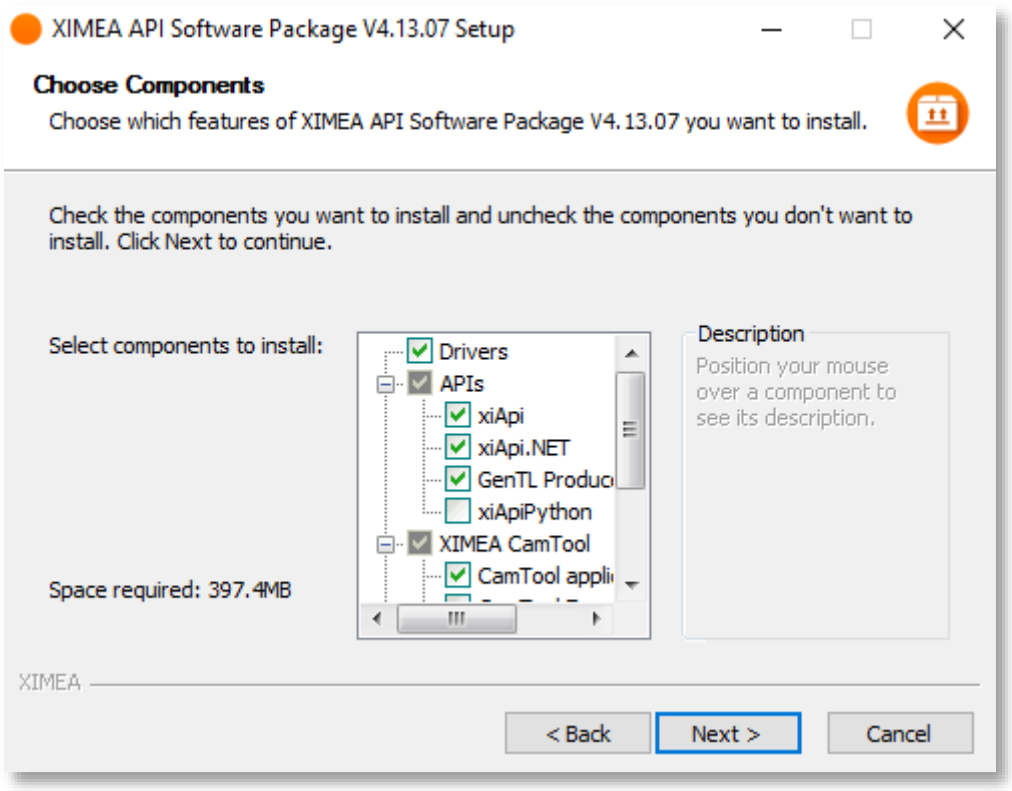


figure 5-3, XIMEA Windows Software Package installation - 2

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

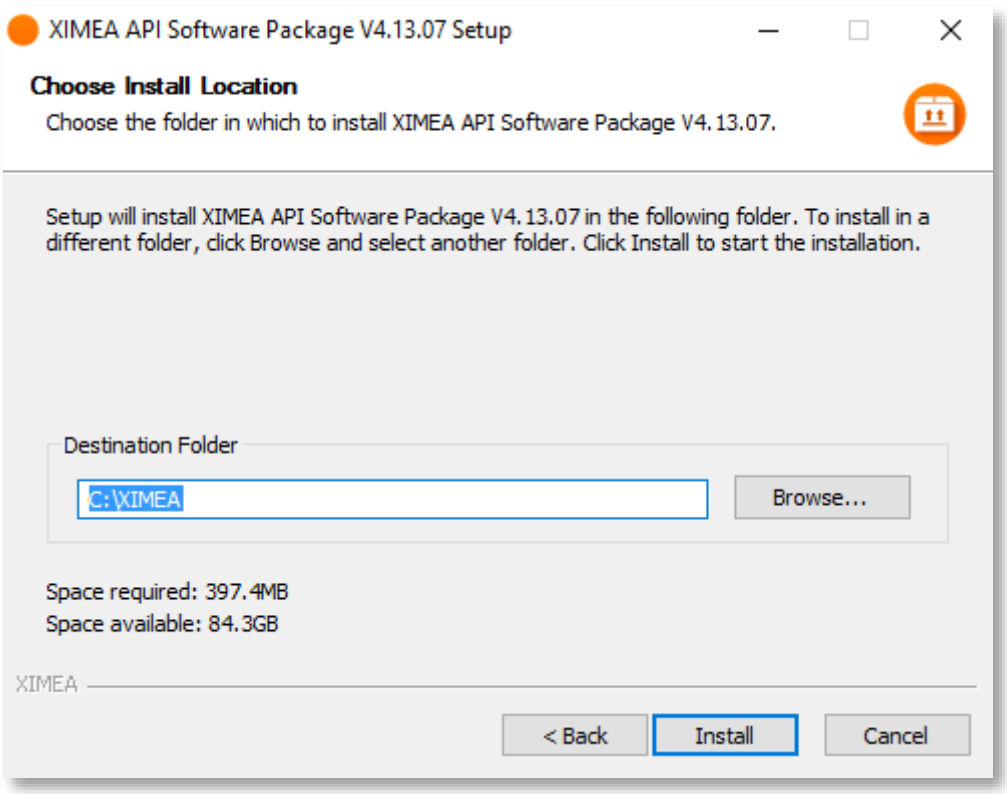


figure 5-4, XIMEA Windows Software Package installation - 3

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

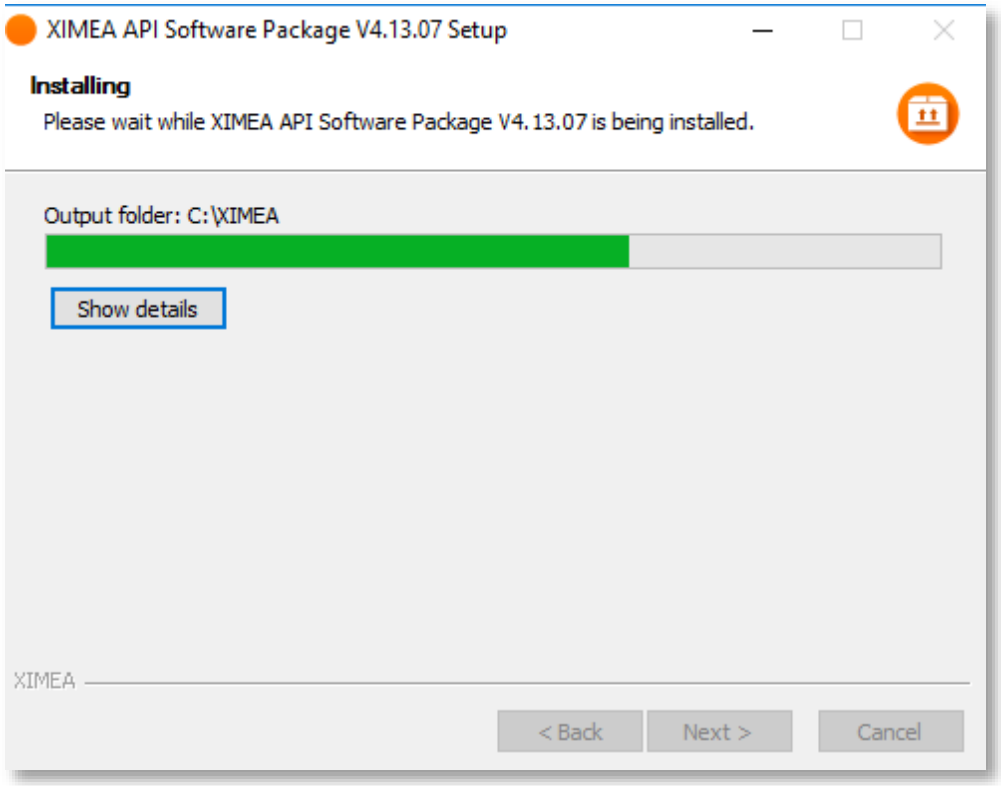


figure 5-5, xiAPI installation, Windows - 4

- Installation is completed.

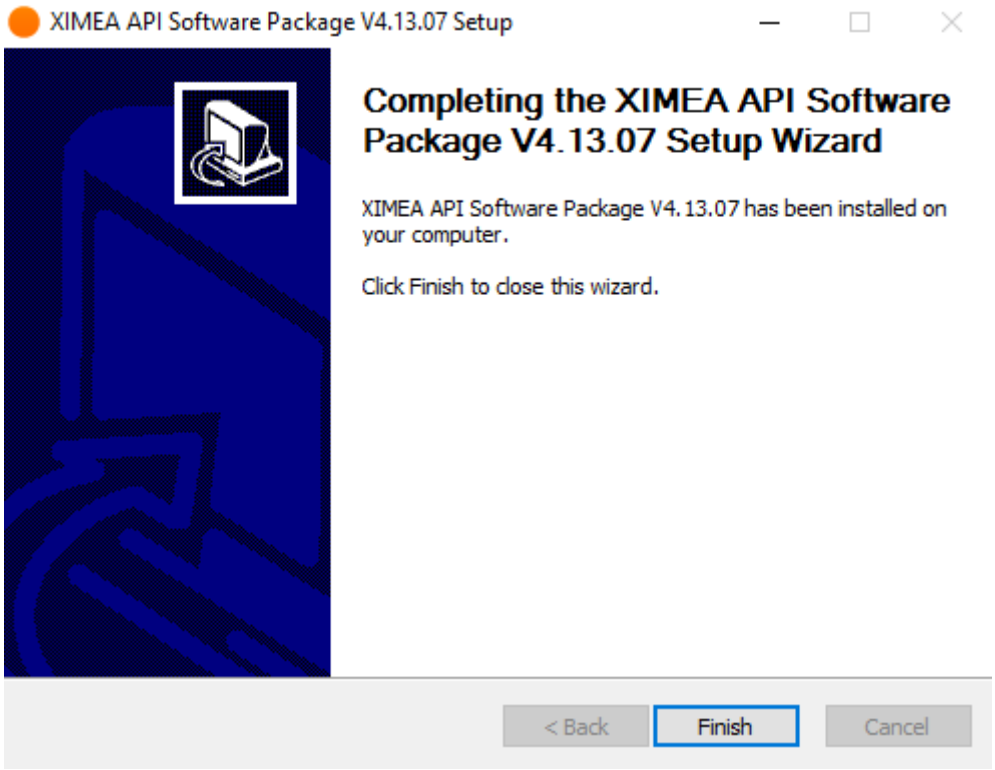


figure 5-6, xiAPI installation, Windows - 5

- Finish.

5.5. 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.

5.5.1. 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

5.5.2. Installation

- Download XIMEA Linux Software Package
  `wget http://www.ximea.com/downloads/recent/XIMEA_Linux_SP.tgz`

figure 5-7, XIMEA Linux Software Package installation - 1

- Untar
  `tar xzf XIMEA_Linux_SP.tgz`
  `cd package`
- Start installation script
  `./install`

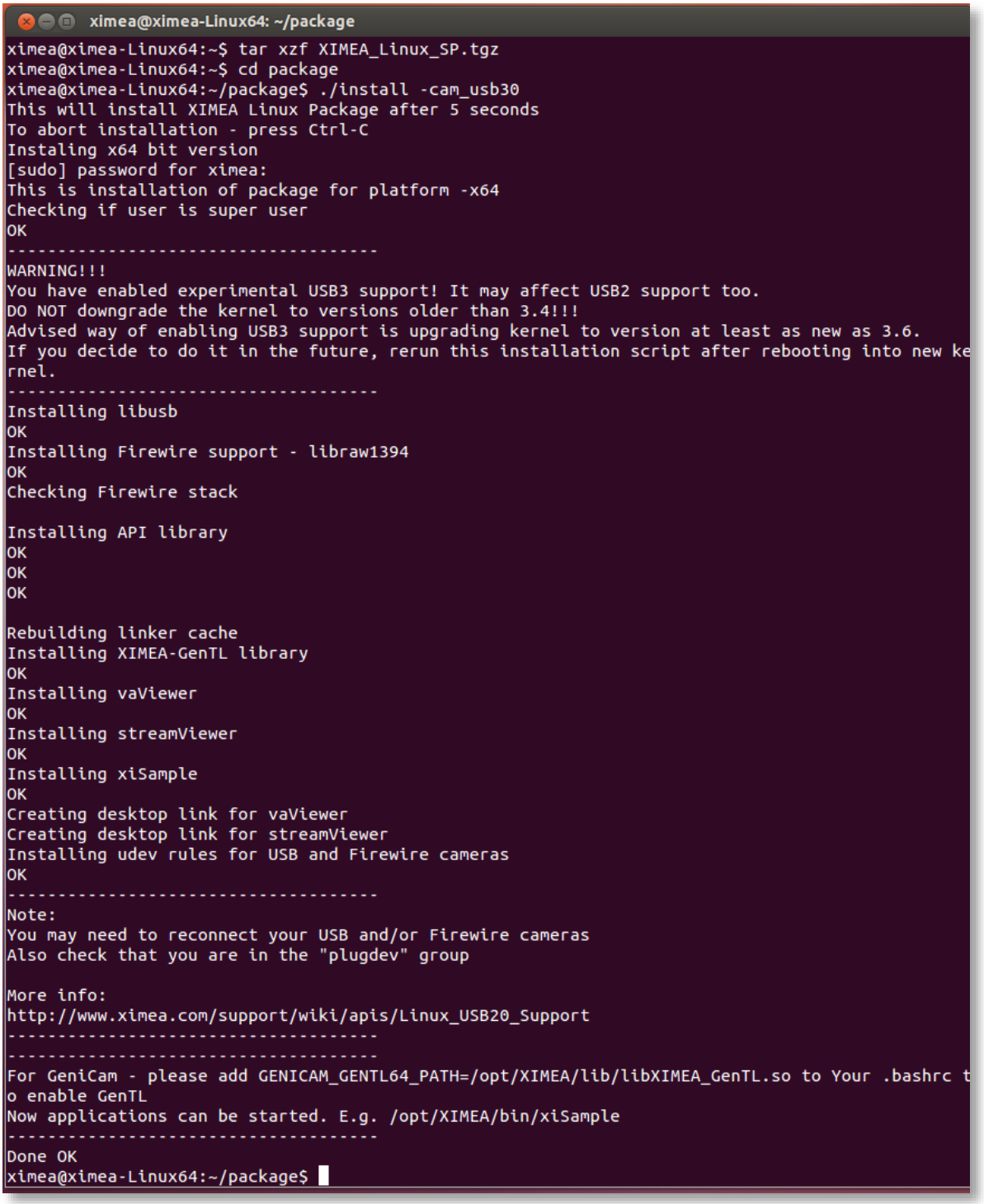


figure 5-8, XIMEA Linux Software Package installation - 2

1) **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*.

5.6. XIMEA macOS Software Package

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

5.6.1. 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

5.6.2. 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.

figure 5-9, XIMEA macOS Software Package installation - 1

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

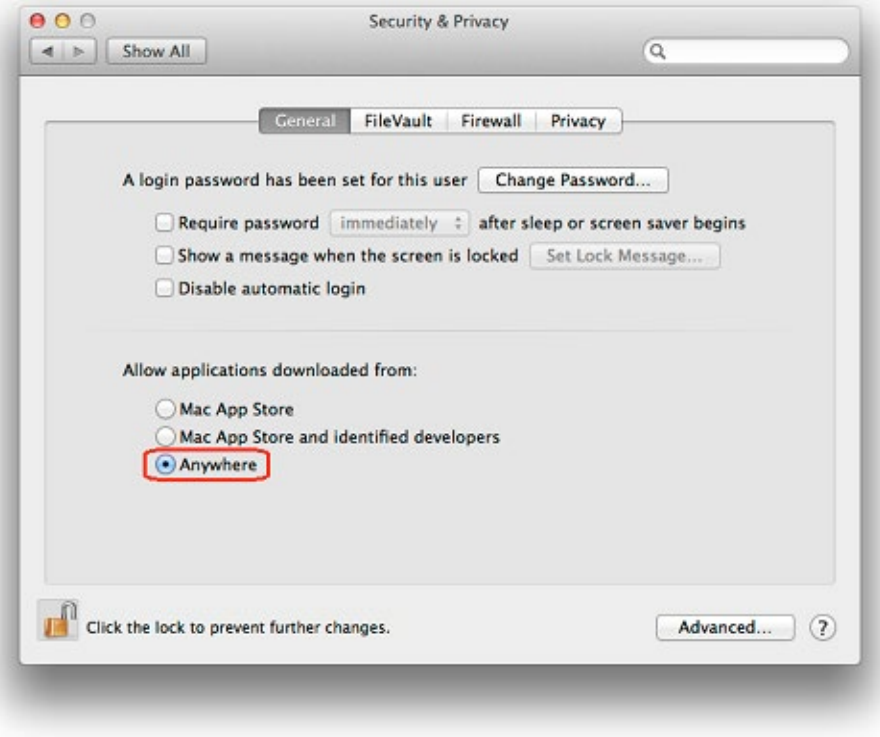


figure 5-10, xiAPI installation, MacOS - 2

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

5.6.3. Start XIMEA CamTool

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

5.7. Programming

5.7.1. XIMEA APIs

- xiAPI - Streamlined API. The standard API for C/C++ based projects, see *5.7.2 xiAPI Overview*.
- xiAPI.NET - Managed .NET Common Language Runtime (CLR) API.
  xiAPI.NET is designed as a wrapper around xiAPI and therefore shares most of its functionality.
- xiApiPython – Integrated API into PYTHON.

5.7.2. xiAPI Overview

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 5 Software

5.7.3. 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);
```

5.7.4. xiAPI Parameters Description

For a complete list of available parameter, please visit the xiAPI online manual at
http://www.ximea.com/support/wiki/apis/XiAPI_Manual

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.

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).*

5.7.5. xiAPI Examples

5.7.5.1. 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);
}
```

5.7.5.2. 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);
```

5.7.5.3. 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);
```

5.7.5.4. Control Digital Input / Output (GPIO)

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. This time should be less than 10µs.

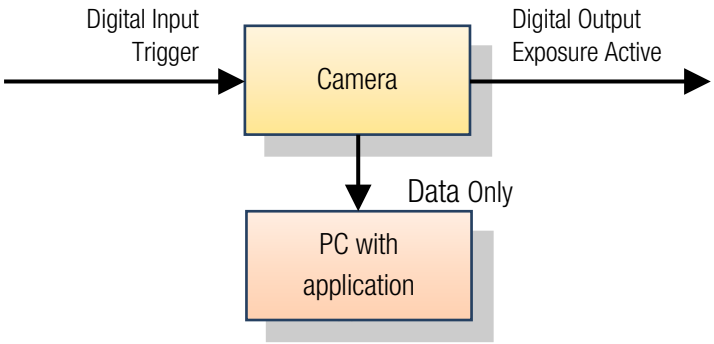


figure 5-11, GPIO - schematic

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

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

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

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

xiStartAcquisition(handle1);

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

5.7.6. 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.

5.7.7. USB3 Vision

For more information on programing according the USB3 VISION standard, please visit the standard's website at http://www.visiononline.org/vision-standards-details.cfm?type=11

5.7.8. GenICam

For more information on programing according the GenICam standard, please visit the standard's website at http://www.emva.org/standards-technology/genicam/

5.8. XIMEA Control Panel

The XIMEA Control Panel (xiCOP), is a diagnostics and management tool for all XIMEA cameras.

xiCOP is currently only available for Windows operating system.

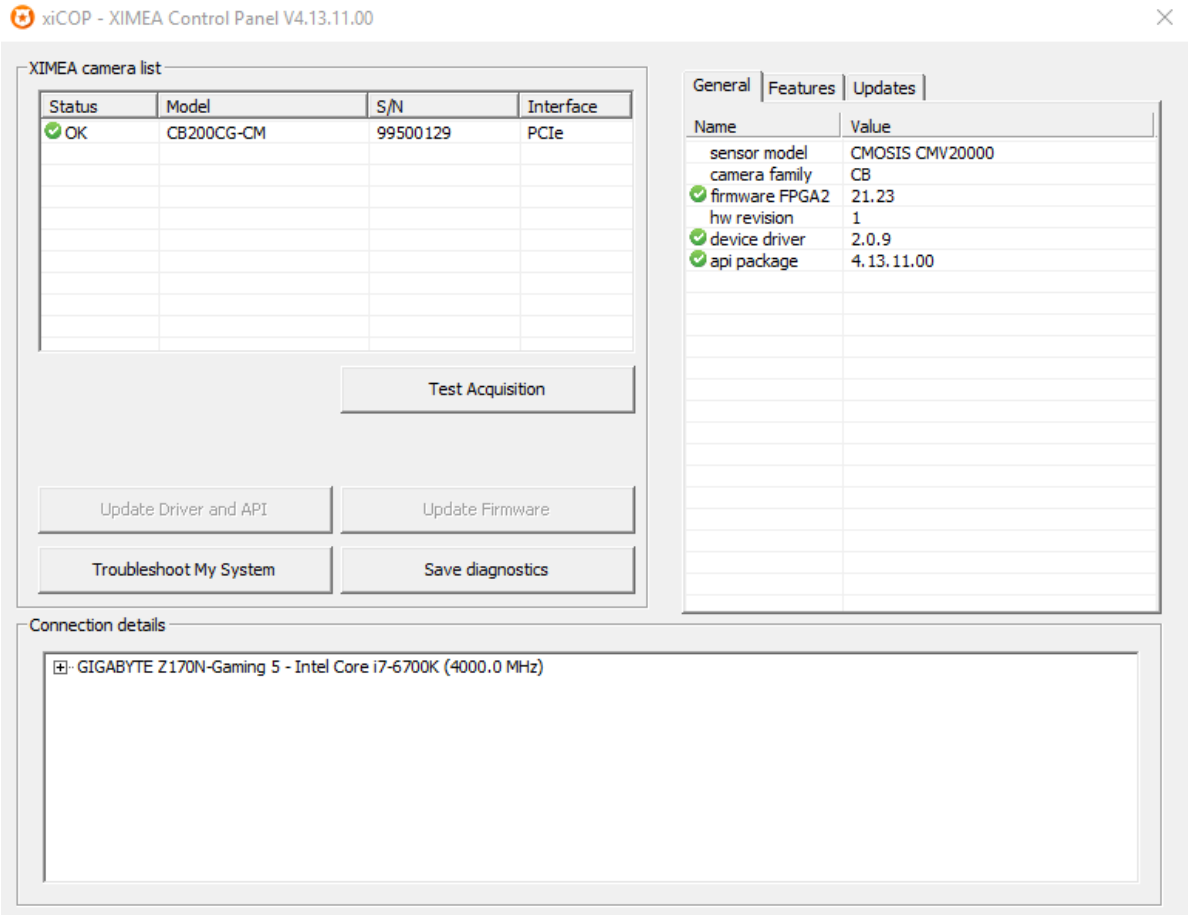


figure 5-12, xiCOP

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.
- List all currently attached XIMEA devices and their features.
- Suggests solution for diagnosed issues.
- One click update to the latest XIMEA API Software Package.
- One click update of firmware in selected cameras.

6. Appendix

6.1. Troubleshooting and Support

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

At first, please make sure, that you have installed the latest version of the following XIMEA software:

- XIMEA Windows Software Package http://www.ximea.com/downloads/recent/XIMEA_Installer.exe

Please make sure, that you have connected your xiC camera with the XIMEA USB 3.0 cable to an appropriate USB 2.0 or USB 3.0 port. Ensure that the connections are carefully locked. Follow the instructions described in chapter *5.2 XIMEA CamTool* (run the xiC camera with the Ximea CamTool). In case that you still have issues, please read the following chapters. If this does not at first work, please check all your connections to the camera and then try the latest 'beta' version of API with the most recent fixes: https://www.ximea.com/downloads/recent_beta/XIMEA_Installer.exe

In case that you still have issues, please read the following chapters.

6.1.1. 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 xiC camera.

6.1.2. Before Contacting Technical Support

There are a few steps to take before contacting your local dealer for technical support. In case you cannot display images from your xiC camera, please open the XIMEA xiCOP software (please see *5.8 XIMEA Control Panel)*. 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 *4.1 System Requirements*. If the camera does not appear, please proceed with the following steps:

Step no:	Description
1	Click on the button “Troubleshoot My System” and follow the instructions that are suggested.
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.
3	Contact your local dealer where you bought the camera either by phone or by email for first level support. He will decide if he can help you immediately or if more information is necessary for initiating the next steps.

table 6-1, use xiCOP before contacting technical support

6.1.3. Frequently Asked Questions

In this manual, we can list only a few FAQ. For more and updated information, please also note:

- Frequently Asked Questions
  http://www.ximea.com/support/wiki/allprod/Frequently_Asked_Questions
- Knowledge Base http://www.ximea.com/support/wiki/allprod/Knowledge_Base

6.1.3.1. What is USB 3.1 Gen 1 SuperSpeed?

USB 3.1 Gen 1 revision of Universal Serial Bus (USB) standard boosts transfer speed of 5Gb/s and enables delivery of up to 4.5W of power to the target device. It uses communication technology similar to that of PCI Express Gen2.

6.1.3.2. What is the real transfer speed?

xiC camera can deliver up to 450Mbyte/sec. This requires that certain conditions are met, see *4.1 System Requirements.*

Maximum transfer speeds of different interfaces:

Interface	Transfer speed	Usable bandwidth	System costs
IEEE1394A	400 Mbit/s	45 MByte/sec	Medium
CameraLink base	2.04 Gbit/s	255 MByte/sec	High
GigE	1024 Mbit/s	100 MByte/sec	Medium
USB 2.0	480 Mbit/s	49 MByte/sec	Low
USB 3.0	5 Gbit/s	450 MByte/sec	Low
USB 3.1 (gen1)	5 Gbit/s	450 MByte/sec	Low

table 6-2, interface depending transfer rates

6.1.3.3. Why can I not achieve maximum transfer speed?

In order to reliably achieve maximum transfer speed it is necessary to verify that you are using recommended hardware (please see *4.1 System Requirements)*, and that all software requirements are met.

xiCOP (please see *5.8 XIMEA Control Panel*) - XIMEA Control Panel free software tool, facilitates the task of verification of XIMEA USB3 Vision camera installations.

6.1.3.4. What voltage should be applied to Digital Input of xiC to turn it on/off?

xiC camera features two type of inputs (-UB, -TC only). First is optoisolated input only. Second is INOUT set to input function.

Following table shows different levels of Voltage on Digital Input (VDI) on xiC and their logical interpretation.

VDI (Opto-isolated)	Logical level
<2Vdc	Off (zero)
2-4Vdc	Undefined
>4Vdc	On (one)

table 6-3, voltage levels for optoisolated digital input

VDI (non-isolated)	Logical level
<0.7Vdc	Off (zero)
0.7-3.3Vdc	Undefined
>3.3Vdc	On (one)

table 6-4, voltage levels for non-isolated digital input

Maximal input voltage 24Vdc

6.1.3.5. What is the implementation of Digital Output (VDO) of xiC?

xiC cameras features two kind of digital output:

1. Opticaly isolated digital output - opto-isolated NPN open collector type, max. load current 25mA, max. open voltage 24Vdc.

For more details see also: 3.10.4 Optically isolated Digital Output

2. Non isolated high impedance input/output

For more details see also: 3.10.5 Non-isolated Digital Lines (-UB and -TC only)

6.2. Product service request (PSR)

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

6.2.1. Step 1 - Contact Support

If your xiC camera is not working as expected, please contact your local dealer for troubleshooting the product and determine the eligibility of a Product Service Request (PSR).

In case you were asked to create a PSR by your local contact, please continue to STEP 2

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

6.2.2. Step 2 - Create Product Service Request (PSR)

- Read the XIMEA General Terms & Conditions http://www.ximea.com/en/corporate/generaltc
- Open the XIMEA Product Service Request form http://www.ximea.com/support/projects/service/issues/new
- Fill in all fields
- Confirm with the button „Create“

6.2.3. Step 3 - Wait for PSR Approval

Our support personnel will verify the PSR for validity.

If your PSR is valid, it will be approved for sending the camera to us. This is done usually within 24 business hours. After that you will get a PSR Approval email (sent to the email address that you have entered in the field “Contact person – email”).

The email contains:

- shipping instructions
- attached document containing the Product Service Request Number (PSRN)

When you received the PSR Approval email - please continue to Step 4.

In case your PSR was rejected – please do not send your camera to XIMEA.

6.2.4. Step 4 - Sending the camera to XIMEA

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

6.2.5. Step 5 - Waiting for Service Conclusion

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

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

table 6-5, service operations overview

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

6.2.6. 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”.

6.3. Safety instructions and precautions

This chapter describes safety instructions and precautions valid for xiC cameras and special considerations regarding XIMEA board level cameras. In order to avoid harm or damage your xiC camera, please handle it like described in this manual, paying special attention to the cautions shown in the following table:

6.3.1. Disassembling

Do not disassemble the camera except for conversion to CS-Mount, see *3.3 Lens* Mount.

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

6.3.2. Mounting / Screwing

Use only the designated threaded holes for mounting the camera. Please note the camera / bracket drawings in chapter *3.5 Model Specific Characteristics* and *3.19 Tripod Adapter – MECH-MC-BRACKET-KIT*.

Use only the specified screws and torques when fastening, see *3.3.1 Screws*.

6.3.3. Connections

Use only recommended connectors and cables. Please check the system requirements described in *4.1 System Requirements*.

6.3.4. Power supply

xiC camera can be bus powered or powered from external power supply (-UB and –TC models only). The flex line models (-FL, -FV) could be powered only via the flex cable. For more information see *3.1 Power Supply*

6.3.5. Environment / protect against water

Use camera in acceptable environment only, please note the descriptions in *3.2.1 Environment*.

Protect the camera against contact with water. Do not let camera get wet.

Damages may be caused by:

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

6.3.6. Recommended light conditions.

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

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

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

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

6.3.7. Protect the optical components

Do not touch the optical components with hard or abrasive objects.

When handling the camera, avoid touching the lenses and filter glasses. Fingerprints or other impurities may affect the image quality and may damage the surfaces.

Mount / dismount lenses and additional filters only in a dust free environment.

Do not use compressed air as this could push dust into the camera (and lenses).

6.3.8. Mechanical loads

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

6.3.9. Camera / lens cleaning

Please follow instructions described below.

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

6.3.10. Protect against static discharge (ESD)

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

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

6.4. Warranty

In addition to the provisions of Article VIII of the Standard Terms & Conditions of XIMEA GmbH (see *6.7 Standard Terms & Conditions of XIMEA GmbH*) the following additions and specifications apply:

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

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

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

6.5. Disclaimer of Warranty

In addition to the provisions of Article XII of the Standard Terms & Conditions of XIMEA GmbH (see *6.7 Standard Terms & Conditions of XIMEA GmbH*) the following apply:

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

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

6.6. List Of Trademarks

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

Microsoft, Windows, Windows 10, Windows 8, Windows 7, Windows Vista, and Windows XP are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. Apple, the Apple logo, Macintosh, MacOS, OS X, Bonjour, the Bonjour logo and the Bonjour symbol are trademarks of Apple Computer, Inc. Linux is a trademark of Linus Torvalds. The USB3 Vision is trademark owned by the AIA.

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

6.7. Standard Terms & Conditions of XIMEA GmbH

General Conditions for the Supply of Products and Services of the Electrical and Electronics Industry ("Grüne Lieferbedingungen" – GL)* for commercial transactions between businesses recommended by ZVEI-Zentralverband Elektrotechnik- und Elektronikindustrie e. V. as of June 2011

Article I: General Provisions

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

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

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

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

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

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

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

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

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

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

Article III: Retention of Title

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

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

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

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

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

(c) The provisions on the assignment of claims according to No. 3 above shall also apply to the new item. The assignment, however, shall only apply to the amount corresponding to the value invoiced by Supplier for the Retained Goods that have been processed, combined or amalgamated.

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

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

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

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

Article IV: Time for Supplies; Delay

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

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

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

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

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

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

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

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

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

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

Article V: Passing of Risk

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

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

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

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

Article VI: Assembly and Erection

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

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

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

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

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

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

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

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

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

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

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

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

Article VII: Receiving Supplies

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

Article VIII: Defects as to Quality

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

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

2. Claims for repair or replacement are subject to a statute of limitations of 12 months calculated from the start of the statutory statute of limitations; the same shall apply mutatis mutandis in the case of rescission and reduction. This shall not apply where longer periods are prescribed by law according to Sec. 438 para. 1 No. 2 (buildings and things used for a building), Sec. 479 para. 1 (right of recourse), and Sec. 634a para. 1 No. 2 (defects of a building) German Civil Code ("Bürgerliches Gesetzbuch"), in the case of intent, fraudulent concealment of the Defect or non-compliance with guaranteed characteristics (“Beschaffenheitsgarantie”). The legal provisions regarding suspension of the statute of limitations ("Ablaufhemmung", "Hemmung") and recommencement of limitation periods shall be unaffected.

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

4. In the case of notification of a Defect, the Purchaser may withhold payments to an amount that is in a reasonable proportion to the Defect. The Purchaser, however, may withhold payments only if the subject-matter of the notification of the Defect involved is justified and incontestable. The Purchaser has no right to withhold payments to the extent that its claim of a Defect is time-barred. Unjustified notifications of Defect shall entitle the Supplier to demand reimbursement of its expenses by the Purchaser.

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

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

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

8. The Purchaser shall have no claim with respect to expenses incurred in the course of supplementary performance, including costs of travel, transport, labor, and material, to the extent that expenses are increased because the subjectmatter of the Supplies has subsequently been brought to another location than the Purchaser's branch office, unless doing so complies with the normal use of the Supplies.

9. The Purchaser's right of recourse against the Supplier pursuant to Sec. 478 BGB is limited to cases where the Purchaser has not concluded an agreement with its customers exceeding the scope of the statutory provisions governing claims based on

Defects. Moreover, No. 8 above shall apply mutatis mutandis to the scope of the right of recourse the Purchaser has against the Supplier pursuant to Sec. 478 para. 2 BGB.

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

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

1. Unless otherwise agreed, the Supplier shall provide the Supplies free from third parties' industrial property rights and copyrights (hereinafter referred to as "IPR") with respect to the country of the place of delivery only. If a third party asserts a justified claim against the Purchaser based on an infringement of an IPR by the Supplies made by the Supplier and used in conformity with the contract, the Supplier shall be liable to the Purchaser within the time period stipulated in Article VIII No. 2 as follows:

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

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

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

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

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

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

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

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

Article X: Conditional Performance

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

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

Article XI: Impossibility of Performance; Adaptation of Contract

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

2. Where events within the meaning of Article IV No. 2 (a) to (c) substantially change the economic importance or the contents of the Supplies or considerably affect the Supplier's business, the contract shall be adapted taking into account the principles of reasonableness and good faith. To the extent this is not justifiable for economic reasons, the Supplier shall have the right to rescind the contract. The same applies if required export permits are not granted or cannot be used. If the Supplier intends to

exercise its right to rescind the contract, it shall notify the Purchaser thereof without undue delay after having realized the repercussions of the event; this shall also apply even where an extension of the delivery period has previously been agreed with the Purchaser.

Article XII: Other Claims for Damages

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

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

(a) the German Product Liability Act ("Produkthaftungsgesetz");

(b) intent;

(c) gross negligence on the part of the owners, legal

representatives or executives;

(d) fraud;

(e) failure to comply with a guarantee granted;

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

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

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

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

Artikel XIII: Venue and Applicable law

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

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

Article XIV: Severability Clause

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

6.8. 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.

6.9. Revision History

Version	Date	Notes
0.00	10/24/2016	Initial version
1.00	04/06/2017	First release
1.10	04/12/2017	Acquisition modes, Updated accessories description, updated conformity description.
1.11	04/13/2017	Corrected typos and reference links
1.12	07/14/2017	Updated performance tables
1.13	08/16/2017	Added chapter 3.12 Heat dissipation, added LED status after xiOpenDevice
1.14	10/19/2017	Added connector description for –FL and –FV variants
1.15	01/17/2018	Corrected exposure time ranges, updated optical path paragraph
1.16	08/24/2018	Added 8bit digitization mode description, FPC insertion guide line
1.17	26/06/2019	Added GPI/GPO index in API
1.18	09/09/2019	Added new generation of Flex cables, corrected flex connector pin description

7. Glossary

Term /Abbreviation	Definition
ADC	Analog to Digital Converter
API	Application Programming Interface
AR (coating)	Anti-Reflex
B/W or B&W	Black and White
CCD	Charge-Coupled Device
CDS	Correlated double sampling
CMOS	Complementary Metal Oxide Semiconductor
DNC	Do not connect
DSNU	Dark Signal non-Uniformity
DR	Dynamic Range
EMC	Electro Magnetic Compatibility
ERS	Electronic rolling shutter
FPN	Fixed pattern noise
FPS	Frame per second
FWC	Full Well Capacity
GR	Global reset
GS	Global shutter
IR	Infra-Red
JTAG	Joint Test Action Group
LSB	Least Significant Bit
MIMR	Multiple integration multiple ROI
MSB	Most significant bit
MSL	Moisture sensitivity level
NA	Not Available
PCB	Printed Circuit Board (same as PWB)
PGA	Programmable gain amplifier
PRNU	Photo response non-uniformity
PWB	Printed Wiring Board (same as PCB)
RGB	Red Green Blue
ROI	Region of interest
Sat	Saturation value
SDK	Software Development Kit
SIMR	Single integration multiple ROI
SNR	Signal To Noise (ratio)
SPI	Serial peripheral interface
SW	Software
TBD	To be determined – some parameters require characterization
T_{int}	Integration time

8. list of figures

9. list of tables

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