xiQ

[ksi-kju: or sai-kju:]

• USB 3.0 camera series

Technical Manual

Version 1.37, January, 2024

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

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

1.3. Standard Conformity

The xiQ cameras have been tested using the following equipment:

- A shielded USB 3.0 cable ref. CBL-U3-3M0 (3m)
- A shielded I/O Sync cable ref. CBL-MQSYNC-3M0 (3m)

Warning: Changes or modifications to the product 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:

1.3.1. CE Conformity

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

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

1.3.2. For customers in the US: FCC Conformity

The xiQ 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.

1.3.3. For customers in Canada

The xiQ cameras comply with the Class A limit s for radio noise emissions set out in Radio Interference Regulations.

1.3.4. RoHS Conformity

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

1.3.5. WEEE Conformity

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

1.3.6. AIA standard USB3 Vision

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

1.3.7. GenICam GenTL API

GENiCAM

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.

1.4. Helpful Links

- XIMEAHomepage http://www.ximea.com/
- xiQ USB3 Vision Camera Zone http://www.ximea.com/usb3zone
- USB3 Hardware Compatibility http://www.ximea.com/support/wiki/usb3/Compatible_hardware
- 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

1.4.1. Table of Contents

2. xiQ Camera Series

2.1. What is xiQ

xiQ [ksi-kju: or sai-kju:] is an ultra-compact USB 3.0 Industrial camera family with outstanding features:

- Extremely small footprint
- Low thermal dissipation
- Single PC board electronics
- USB3 Vision Standard compatible
- sensors: VGA, 1.3 MP, 2 MP, 2.2 MP and 4.2 MP, b/w, color and NIR extended
- frame rates: VGA @ >500 fps to 4.2 MP @ 90 fps

2.2. Advantages

Industry standard interface	Compliant with USB 3.0 SuperSpeed specification
AIA standard compatibility	USB3 Vision standard
small	fits into places where no other camera can fit
Low power consumption	1.0 to 1.8 W
Powerful	5Gb/s interface up to 450Mpix/s data throughput
Fast	high speed, high frame rate: >500fps at VGA and 90fps at 4Mpix resolutions
Robust	full metal housing, no sheet metal covers
Lightweight	facilitates increased performance of robotic arms and gimbals
Connectivity	Programmable opto-isolated input and output, 3 status LEDs
Compatibility	support for Windows, Linux and MacOS, 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
- UAV

2.4. Common features

Sensor Technology	CMOS, Global shutter
Acquisition Modes	Continuous, software and hardware trigger, defined fps, exposure defined by trigger pulse [1] and burst
Partial Image Readout	ROI, Skipping and Binning modes supported (model specific)
Image data formats	8, 10 or 12 bit RAW pixel data [2]
Color image processing	Host based de-Bayering, sharpening, Gamma, color matrix, true color CMS
Hot/blemish pixel 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 3.0 standard Micro B with screw lock threads compliant to USB3 Vision standard
Buffer memory	256kB of memory for stable USB transfer located in CYUSB3035 SuperSpeed USB Controller, additional small buffers inside FPGA
General Purpose I/O	1x opto-isolated input, 1x opto-isolated output, power LED, 3x LED software programmable
Signal conditioning	Programmable debouncing time
Synchronization	Hardware trigger input, software trigger, exposure strobe output, busy output
Housing and lens mount	Standard C-mount. Available options are CS mount, and board level
Power requirements	1 to 1.8W, supplied via USB 3.0 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 (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

Notes:

1): exposure defined by trigger pulse not available for models MQ013xG-E2

2): Maximal image data precision depends on sensor ADC precision.

2.5. Model Nomenclature

Order numbers name conventions for the different models:

MQxxxyG-zz[-OPT]$_n$

MQ: xiQ family name

xxx: Resolution in 0.1 MPixel. E.g. 1.3 MPixel Resolution: xxx = 013

y: y=C: color model
y=M: black & white model
y=R: black & white, Infrared-extended model

zz: Vendor of the sensor

zz = E2: E2V
zz = CM: CMOSIS
zz = ON: Onsemi

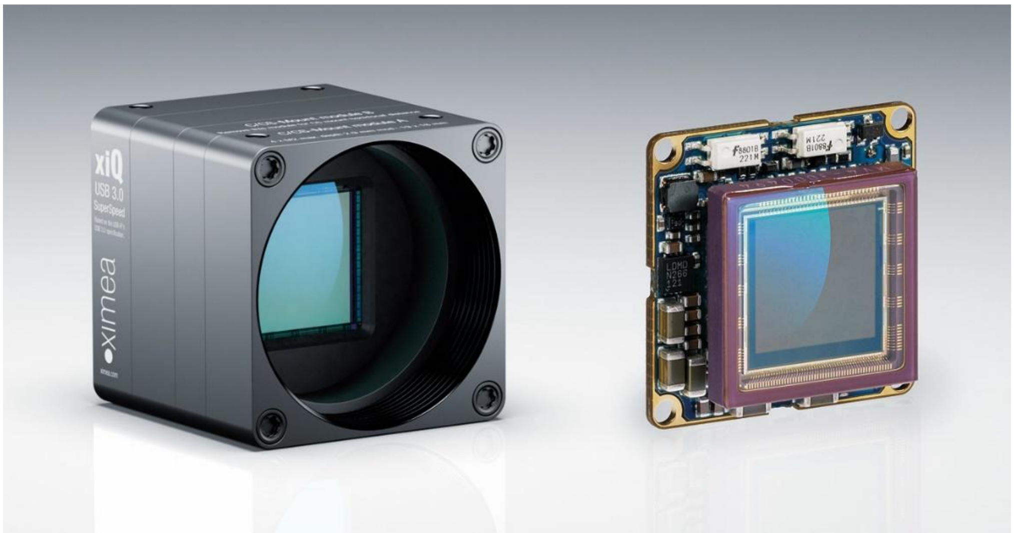
[-OPT]: Options

OPT = TP: sensor with taped sensor glass
OPT = BRD: board level camera

OPT = FL: camera featuring flex cable connector (only specific models) Please contact sales for more information.

OPT = SL: camera features right angle micro USB3 connector (only specific models). Please contact sales for more information.

2.6. Models Overview, sensor and models



Model		Resolution	Pixel size	ADC [bit]	DR	Optical size	Sensor diagonal	FPS
MQ003MG-CM	b/w	648x488	7.4 µm	10/12	66 dB	1/3”	5.9 mm	>500
MQ003CG-CM	Color							
MQ013MG-E2	b/w	1280x1024	5.3 µm	10	66 dB	1/1.8”	8.7 mm	60
MQ013CG-E2	Color							
MQ013RG-E2	b/w NIR							
MQ013MG-ON	b/w	1280x1024	4.8 µm	10	>56 dB	1/2”	7.9 mm	210/172
MQ013CG-ON	Color							
MQ013RG-ON	b/w NIR							
MQ022MG-CM	b/w	2048*1088	5.5 µm	10	60 dB	2/3”	12.8 mm	170
MQ022CG-CM	Color							
MQ022RG-CM	b/w NIR							
MQ042MG-CM	b/w	2048x2048	5.5 µm	10	60 dB	1”	15.9 mm	90
MQ042CG-CM	Color							
MQ042RG-CM	b/w NIR							

table 2-3, models overview

Note: Maximum frame rate measured at 8 bits per pixel

2.7. Options

All models are available in board level version

The models MQ042MG-CM and MQ042CG-CM can be ordered with taped sensor glass.

2.8. Accessories

The following accessories are available:

Item P/N	Description
CBL-U3-1M0	1.0m USB 1.0 cable
CBL-U3-3M0	3.0m USB 3.0 cable
CBL-U3-3M0-ANG	3.0m USB 3.0 cable, angled micro USB3 connector
CBL-U3-5M0	5.0m USB 3.0 cable
CBL-MQSYNC-3M0	3.0m xiQ series I/O sync cable, pig tail
CBL-MQSYNC-5M0	5.0m xiQ series I/O sync cable, pig tail
BOB-MQ-FL	Break Out Board, Flex-Line, Simple Board Level Micro-B USB3.0
CBL-MQ-FL-0M1	Cable FPC MQ/MC Flex-Line, 0.1m
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)
MQ-BRACKET-T	xiQ series tripod mounting bracket, 5.5 mm thick
MQ-BRACKET-T-THICK	xiQ series tripod mounting bracket, 9.5 mm thick
U3PE-FL1100-X4 [1]	PCI express adapter, 4x USB 3.0 ports, PCIe x4 slot
U31PE1G3-V1-X2 [1]	PCI express adapter, 2x USB 3.1 ports asmedia ASM1142, xHCI

table 2-4, accessories

Notes: 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 xiQ cameras are powered via the USB 3.0 Micro-B connector. The input voltage is 5 V DC. The power consumption is 1.0 - 1.8W depending on the xiQ model.

Power supply, via USB 3.0 system connector:

- 5 V (nominal)
- 4.45 V to 5.25 V (at the connector of hub or root port)

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 - +50°C
Ambient temperature for storage and transportation	$T_{storage}$	-30 - +70°C
Relative Humidity, non-condensing	RH	80 %

table 3-1, environment

Housing temperature must not exceed +65°C. The following parameters are not guaranteed if the camera is operated outside the optimum range:

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

3.2.2. Firmware / Host driver / API features

Description	Value
Interpolation methods	9331, SHT_advanced
White balance coefficients ranges	0.0 to 3.9
Sharpness filter	0 to 100 %
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: http://www.ximea.com/support

3.3. Lens Mount

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

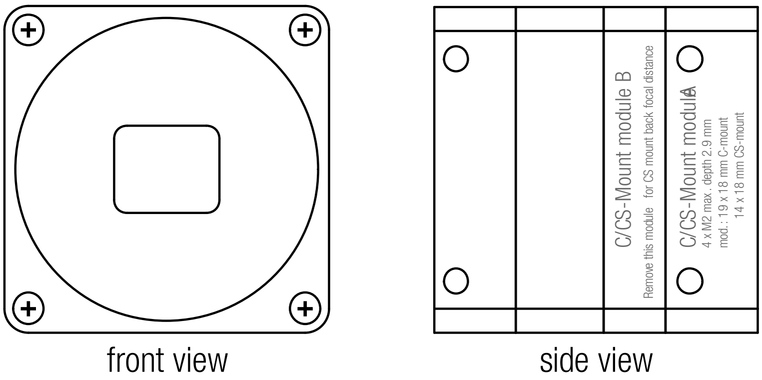


figure 3-1, position C/CS-Mount module B

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:

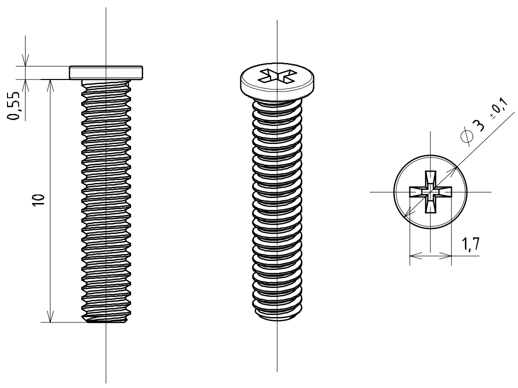


figure 3-2, xiQ mounting screws

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.

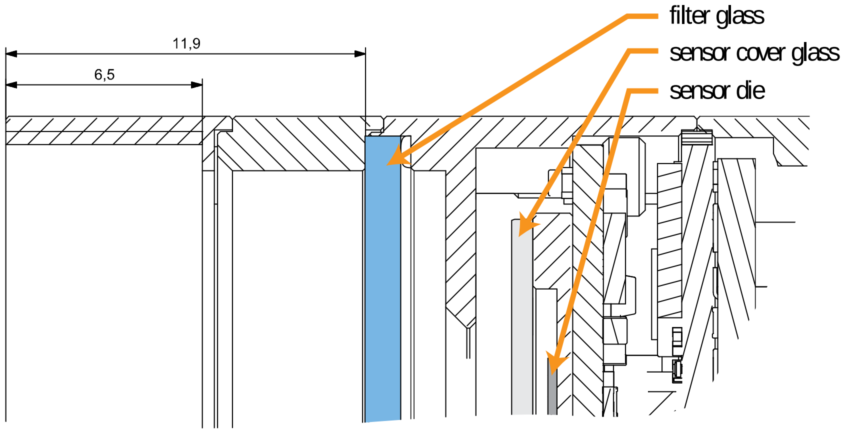


figure 3-3, monochrome camera - filter glass transmission curve

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

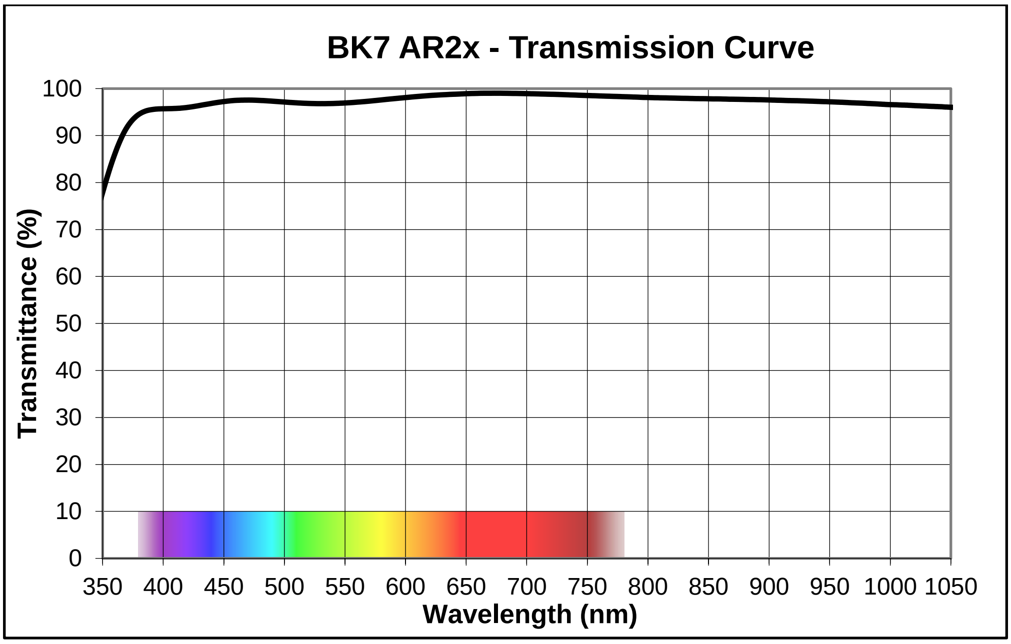


figure 3-4, monochrome camera - filter glass transmission curve

3.4.3. Color camera models

Used filter brand	ICR650
Thickness	1.0±0.1 mm
Coating	Anti-reflex both sides

table 3-5, color camera - filter glass parameter

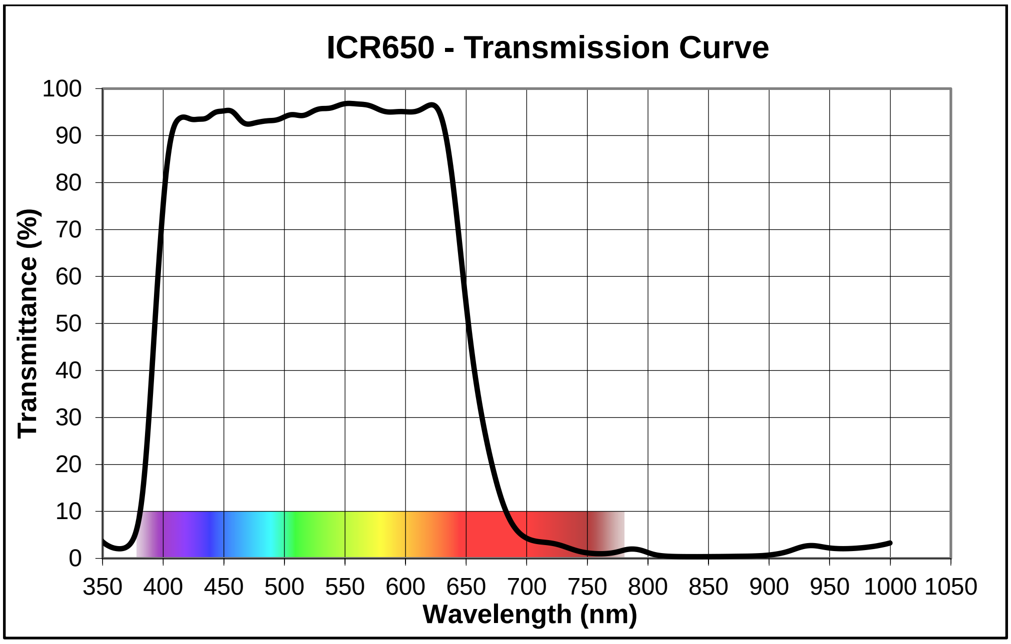


figure 3-5, color camera - filter glass transmission curve

3.5. Model Specific Characteristics

3.5.1. MQ003xG-CM

3.5.1.1. Sensor and camera parameters

xiQ model		MQ003CG-CM	MQ003MG-CM
Sensor parameter			
Brand		CMV300ES-3E7C1WP	CMV300ES-3E7M1WP
Color filter		RGB Bayer mosaic	None
Type		Global shutter, overlap mode	
Pixel Resolution (H × V)	[pixel]	648 × 488, usable: 644 x 484 (b/w) [3] / 640 x 480 (color)	
Active area size (H × V)	[mm]	4.8 × 3.6	
Sensor diagonal	[mm]	5.9	
Optical format	[inch]	1/3	
Pixel Size (H × V)	[µm]	7.4 × 7.4	
ADC resolution	[bit]	12	
FWC	[ke-]	20	
Dynamic range	[dB]	60	
SNR Max	[dB]	>40 (TBD)	
Dark noise	[e-]	20 (RMS)	
Dark current	[e-/s]	120 (25°C)	
DSNU	[LSB_{10}/s]	3	
Sensitivity	[V/(Lux s)]	6	
Camera parameters			
Digitization	[bit]	12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		54µs to 1sec, in steps of 7.56µs [1]	
Variable Gain Range (VGA)	[dB]	6	
Refresh rate (MRR)	[fps]	>500	
Power consumption			
typical	[W]	1.5	
Peak [2]	[W] / [µs]	2.2 / 20	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth	[mm]	25.3 (with C/CS Mount module B) 20.3 (without C/CS Mount module B)	
mass	[g]	26.4 (with C/CS Mount module B) 22.4 (without C/CS Mount module B) 3.4 (board level camera)	

table 3-6, MQ003xG-CM, sensor and camera parameters

Notes:

1) Defined for max. bandwidth. By decreasing the bandwidth the minimum exposure time and exposure step will increase. Maximal achievable FPS will decrease.
2) Short peaks in drained power needed by sensor during pixel area reset
3) There are 4 dark reference rows available on the sensor (rows 0, 1, 486 and 487) and 2 dark reference columns (column 0 and 1). Columns 646 and 647 are test columns and do not contain useful image data. This means that the useable image data area is 644 x 484.

Supported standard readout modes	Binning/skipping	pixels	fps 2	Bit/px
0	1x1	648 × 488	>500	8
1	1x1	648 × 488	>500	10

table 3-7, MQ003xG-CM, supported standard readout modes

3.5.1.2. Quantum efficiency curves [%]

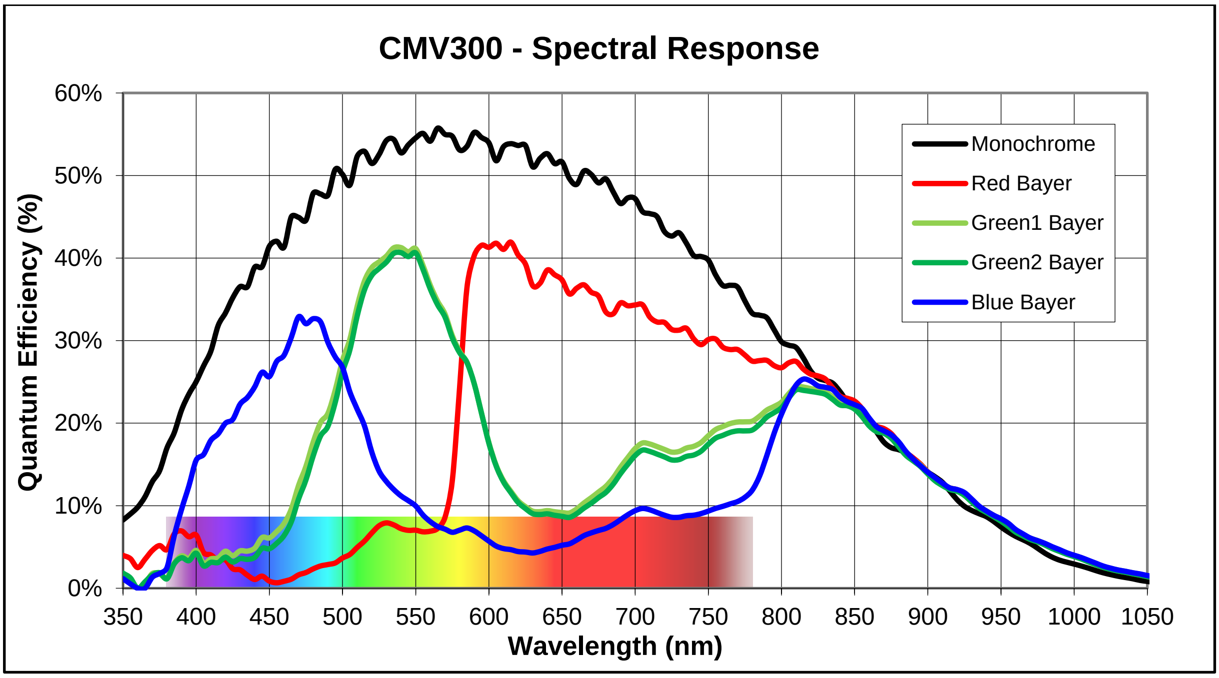


figure 3-6, CMV300-mono and color, quantum efficiency curve, ©CMOSIS (v2.4)

3.5.1.3. Drawings (C-mount [with C/CS mount module B])

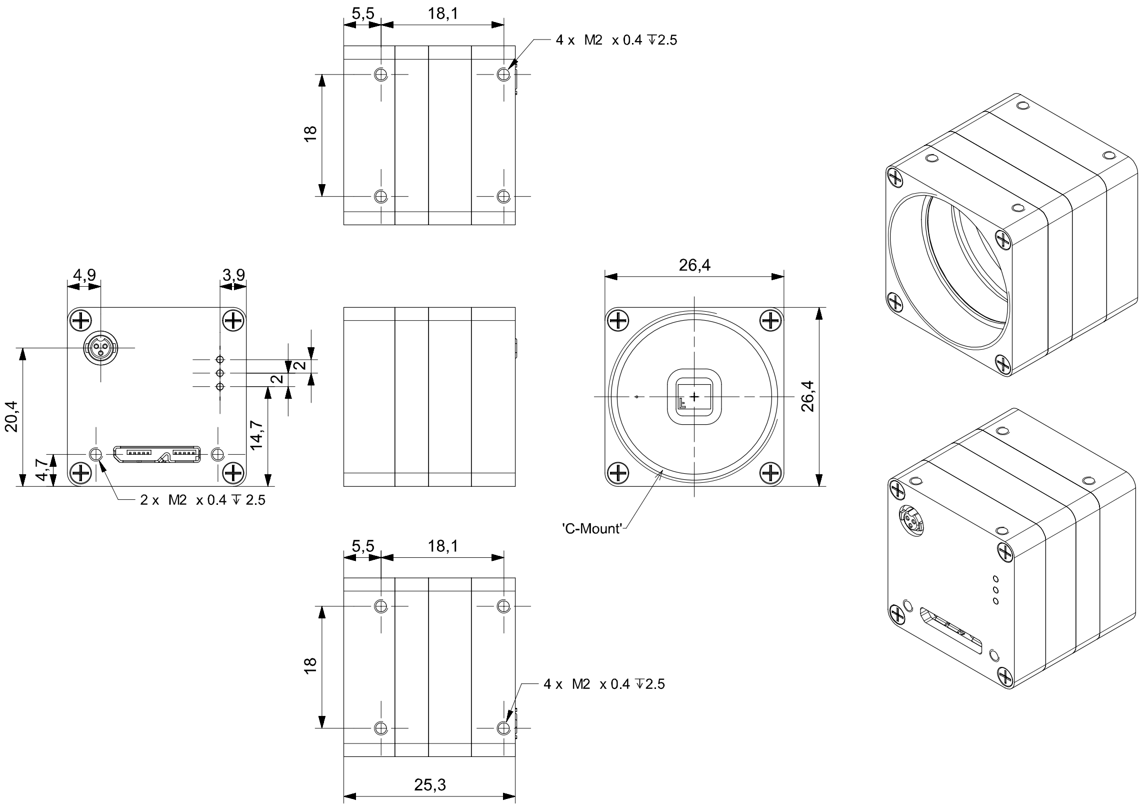


figure 3-7, dimensional drawing MQ003xG-CM, C-Mount housing

3.5.1.4. Drawings board level

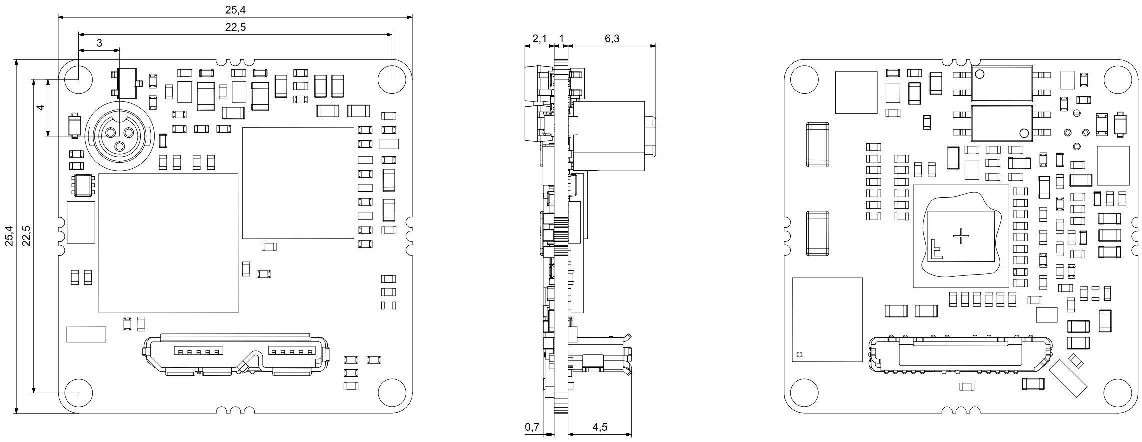


figure 3-8, dimensional drawing MQ003xG-CM-BRD

3.5.1.5. Referenced documents

CMOSIS Datasheet CMV300-datasheet-v2.0 (05/06/13)

3.5.1.6. Sensor features

feature	Note
Binning	No
Skipping	Not supported, yet
ROI	Single window in y direction supported, cropping in X supported by xiAPI (x coordinates multiple of 16, y coordinates multiple of 2
HW Trigger	Trigger with overlap (see *4.3.2.2 Triggered mode with overlap*)
HDR	Knee point based HDR (beta stage), see *4.5.7 HDR*

table 3-8, sensor features available

3.5.2. MQ013xG-E2

3.5.2.1. Sensor and camera parameters

xiQ model		MQ013CG-E2	MQ013MG-E2	MQ013RG-E2
Sensor parameter				
Brand		EV76C560ACT-EQV	EV76C560ABT-EQV	EV76C661ABT-EQTR
Color filter		RGB Bayer mosaic	None	None
Type		Global shutter, overlap mode		
Pixel Resolution (H × V)	[pixel]	1280 × 1024		
Active area size (H × V)	[mm]	6.9 × 5.5		
Sensor diagonal	[mm]	8.7		
Optical format	[inch]	1/1.8		
Pixel Size (H × V)	[µm]	5.3 × 5.3		
ADC resolution	[bit]	10		
FWC	[ke-]	12		
Dynamic range	[dB]	>60		>63 (25°C) / >60 (65°C)
SNR Max	[dB]	40		39
Dark signal [1]	[LSB_{10}/s]	24 (25°C) / 420 (65°C)		38 (25°C) / 830 (65°C)
DSNU [1]	[LSB_{10}/s]	6 (25°C) / 116 (65°C)		21 (25°C) / 220 (65°C)
Sensitivity [2]	[LSB_{10}/(Lux s)]	6600		13000
Camera parameters				
Digitization	[bit]	10		
Supported bit resolutions	[bit/pixel]	8, 10		
Exposure time (EXP)		15.625µs to 1sec, in steps of 15.625µs		
Variable Gain Range (VGA)	[dB]	24		
Refresh rate (MRR)	[fps]	61		
Power consumption				
typical	[W]	0.75		
Peak	[W] / [µs]	0.9 / 60		
Dimensions/Mass				
height	[mm]	26.4		
width	[mm]	26.4		
depth	[mm]	26.2 (with C/CS Mount module B) 21.2 (without C/CS Mount module B)		
mass	[g]	26.6 (with C/CS Mount module B) 22.6 (without C/CS Mount module B) 4 (board level camera)		

table 3-9, MQ013xG-E2, sensor and camera parameters

Note: 1) Min gain, 10 bits.

2) Measurement conditions: 3200K, window without AR coating, IR cut off filter BG38 2 mm

Supported standard readout modes	Binning/skipping	pixels	fps	Bit/px
0	1x1	1280 x 1024	61	8/10/12 [1]
1	2x2 bin	640 x 512	61	8/10/12 [1]

table 3-10, MQ013xG-E2, supported standard readout modes

Note: 1) the sensor has 10 bit output, 12 bit are shifted

3.5.2.2. Quantum efficiency curves [%]

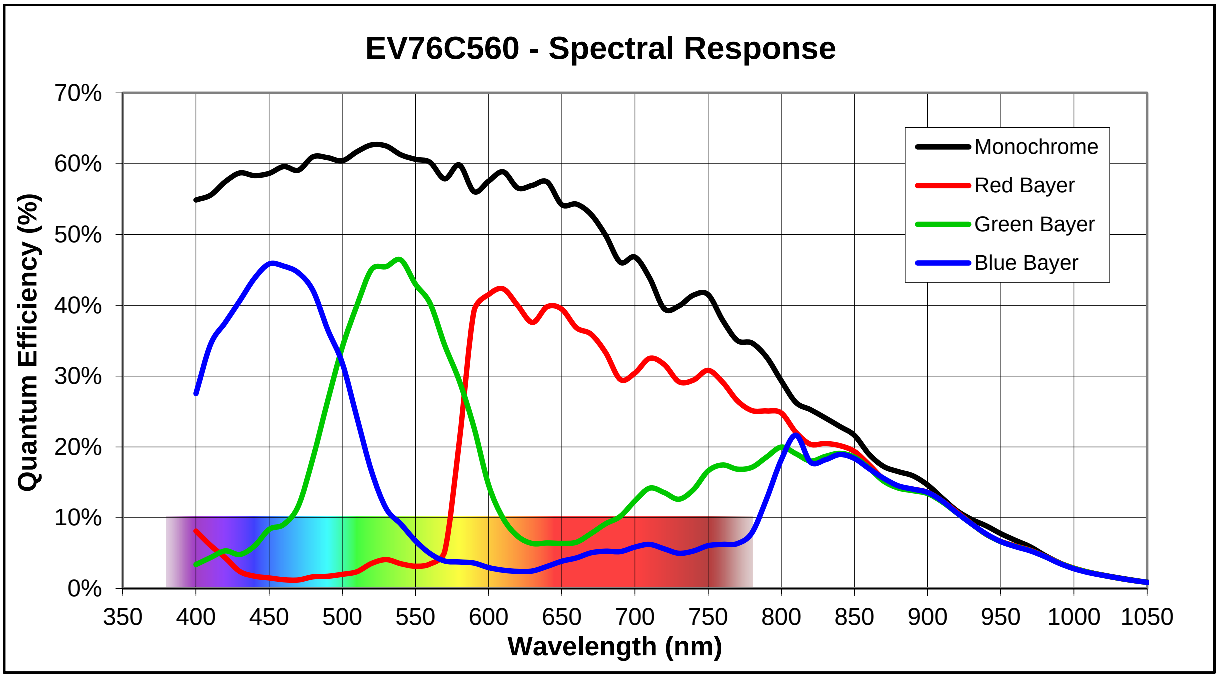


figure 3-9, EV76C560-mono and color, quantum efficiency curves, ©E2V

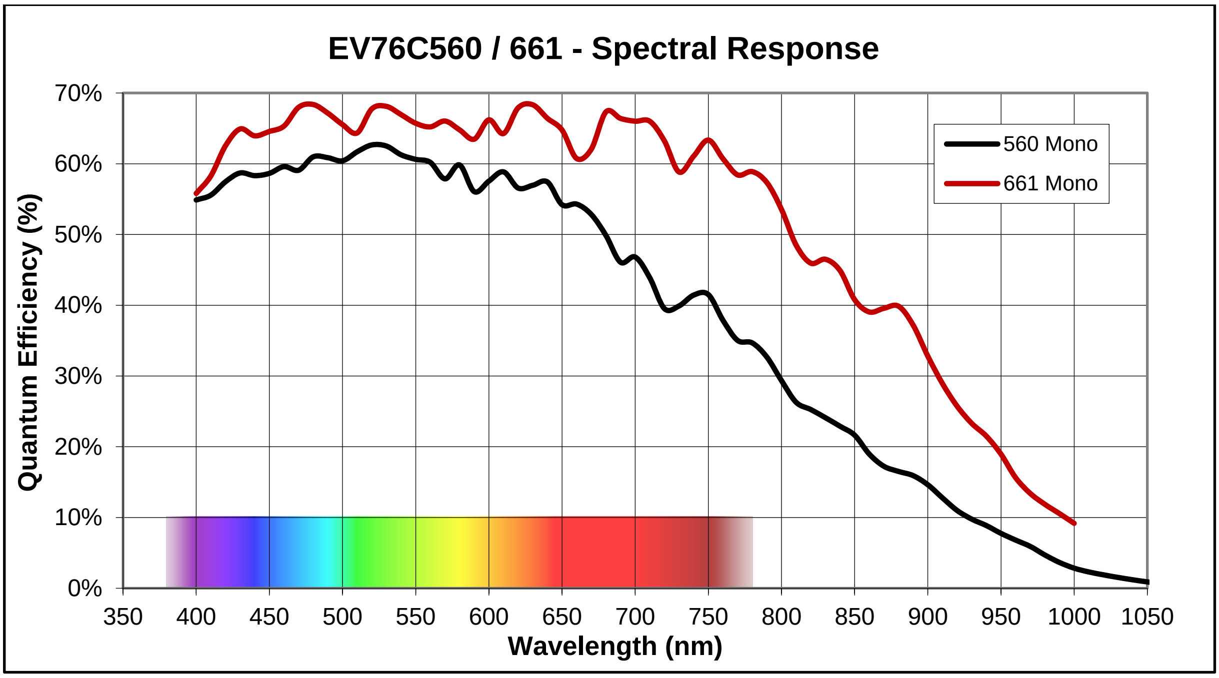


figure 3-10, EV76C560-mono and EV76C661-NIR, quantum efficiency curves, ©E2V

3.5.2.3. Drawings (C-mount [with C/CS mount module B])

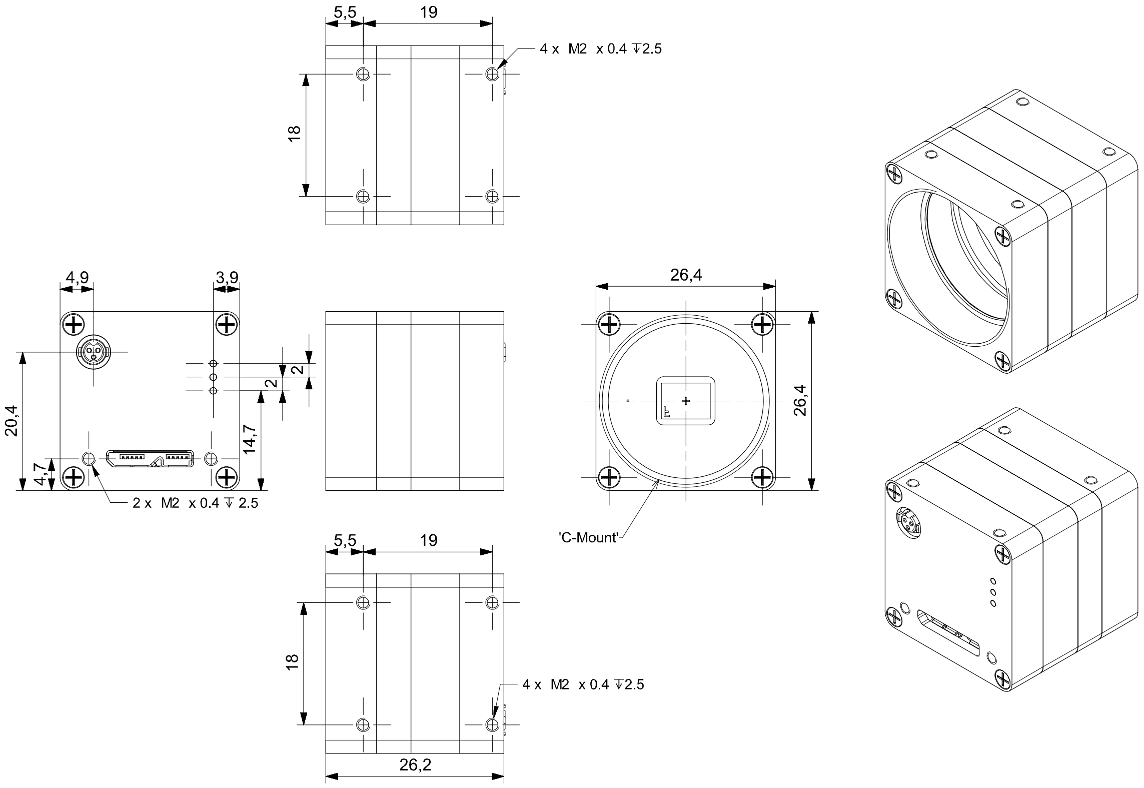


figure 3-11, dimensional drawing MQ013xG-E2, C-Mount housing

3.5.2.4. Drawings board level

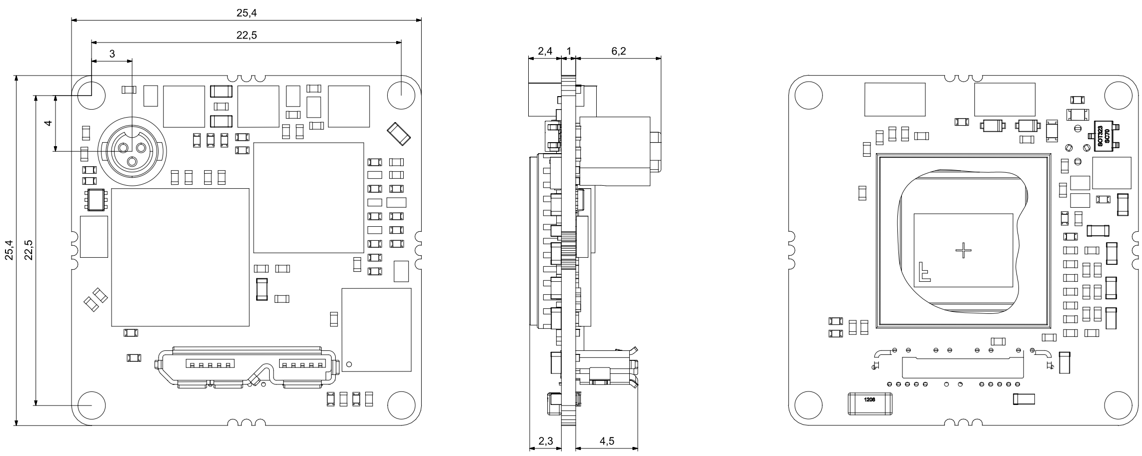


figure 3-12, dimensional drawing MQ013xG-E2-BRD

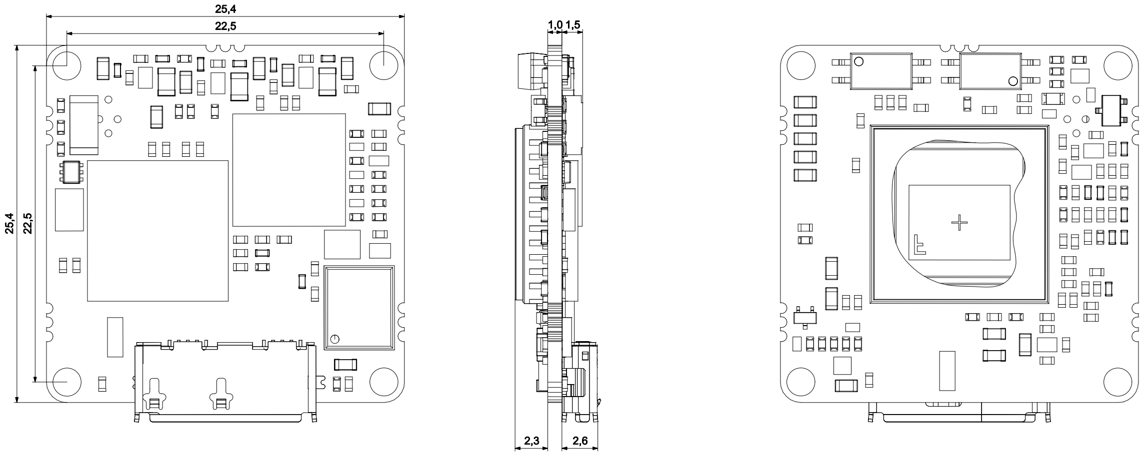


figure 3-13, dimensional drawing MQ013xG-E2-SL-BRD

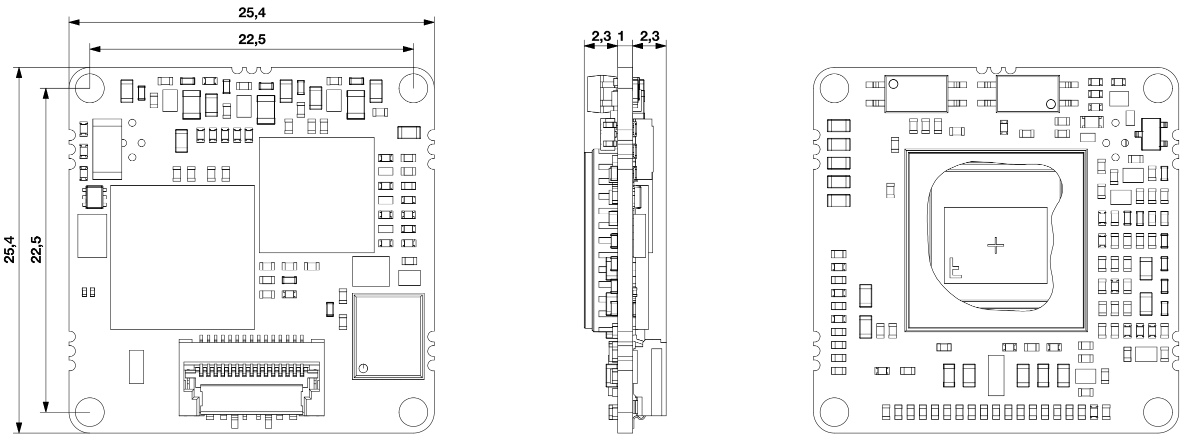


figure 3-14, dimensional drawing MQ013xG-E2-FL-BRD

3.5.2.5. Referenced documents

E2V Datasheet EV76C56 1005A–IMAGE–29/06/09

3.5.2.6. Sensor features

feature	Note
Binning	Yes, 2x2 binning supported
Skipping	Not supported yet
ROI	1 ROI with free parameters supported
HW Trigger	Trigger without overlap usable (see *4.3.2.1 Triggered mode without overlap*)
HDR	Currently not supported

table 3-11, sensor features available

3.5.2.7. Note: horizontal image lines (MQ013CG-E2, MQ013MG-E2)

Running the cameras in overlap mode (live mode) with exposure times between 300µs and 16ms may cause a horizontal line in the image. This is a known issue of the used sensors and is caused by pixel readout or sensor reset during acquisition.

3.5.2.8. Note: triggered exposure

The feature triggered exposure is not supported by the sensors.

3.5.3. MQ013xG-ON (VITA1300)

3.5.3.1. Sensor and camera parameters

<table>
<tr><th>xiQ model</th><th></th><th colspan="2">MQ013CG-ON</th><th colspan="2">MQ013MG-ON</th></tr>
<tr><td>Sensor parameter</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Brand</td><td></td><td colspan="2">NOIV1SE1300A-QDC</td><td colspan="2">NOIV1SN1300A-QDC</td></tr>
<tr><td>Color filter</td><td></td><td colspan="2">RGB Bayer mosaic</td><td colspan="2">None</td></tr>
<tr><td>Type</td><td></td><td colspan="4">Global shutter, overlap mode</td></tr>
<tr><td>Pixel Resolution (H × V)</td><td>[pixel]</td><td colspan="4">1280 × 1024, usable in color mode: 1264 x 1016</td></tr>
<tr><td>Active area size (H × V)</td><td>[mm]</td><td colspan="4">6.18 × 4.95</td></tr>
<tr><td>Sensor diagonal</td><td>[mm]</td><td colspan="4">7.9</td></tr>
<tr><td>Optical format</td><td>[inch]</td><td colspan="4">1/2</td></tr>
<tr><td>Pixel Size (H × V)</td><td>[µm]</td><td colspan="4">4.8 × 4.8</td></tr>
<tr><td>ADC resolution</td><td>[bit]</td><td colspan="4">10, 8</td></tr>
<tr><td>FWC</td><td>[ke-]</td><td colspan="4">13.7</td></tr>
<tr><td>Dynamic range</td><td>[dB]</td><td colspan="4">>53</td></tr>
<tr><td>SNR Max</td><td>[dB]</td><td colspan="4">41</td></tr>
<tr><td>Dark noise</td><td>[e-]</td><td colspan="4">30: 2.2 LSB_{10}</td></tr>
<tr><td>Dark current</td><td>[e-/s]</td><td colspan="4">4.5 (25°C)</td></tr>
<tr><td>DSNU</td><td>[LSB_{10}/s]</td><td colspan="4">0.33</td></tr>
<tr><td>Sensitivity</td><td>[V/(Lux s)]</td><td colspan="4">4.6</td></tr>
<tr><td>Camera parameters</td><td></td><td colspan="4"></td></tr>
<tr><td>Digitization</td><td>[bit]</td><td colspan="4">10</td></tr>
<tr><td>Supported bit resolutions</td><td>[bit/pixel]</td><td colspan="4">8, 10</td></tr>
<tr><td>Exposure time (EXP)</td><td></td><td colspan="4">74µs to 1sec
in steps of 1µs if exp < 65.54ms;
4µs if exp<262.1ms; 16µs otherwise</td></tr>
<tr><td>Variable Gain Range (VGA)</td><td>[dB]</td><td colspan="4">12</td></tr>
<tr><td>Refresh rate (MRR)</td><td>[fps]</td><td colspan="4">150</td></tr>
<tr><td>Supported standard readout modes</td><td></td><td>Skipping</td><td>pixels</td><td>fps</td><td>Bit/px</td></tr>
<tr><td></td><td>0</td><td>1x1</td><td>1280 × 1024</td><td>150</td><td>8</td></tr>
<tr><td></td><td>1</td><td>1x1</td><td>1280 × 1024</td><td>145</td><td>10</td></tr>
<tr><td></td><td>2</td><td>2x2</td><td>640 x 512</td><td>500</td><td>8</td></tr>
<tr><td></td><td>3</td><td>2x2</td><td>640 x 512</td><td>288</td><td>10</td></tr>
<tr><td>Power consumption</td><td></td><td colspan="4"></td></tr>
<tr><td>typical</td><td>[W]</td><td colspan="4">1.3</td></tr>
<tr><td>Peak [1]</td><td>[W] / [µs]</td><td colspan="4">1.4 / 80</td></tr>
<tr><td>Dimensions/Mass</td><td></td><td colspan="4"></td></tr>
<tr><td>height</td><td>[mm]</td><td colspan="4">26.4</td></tr>
<tr><td>width</td><td>[mm]</td><td colspan="4">26.4</td></tr>
<tr><td>depth</td><td>[mm]</td><td colspan="4">26.2 (with C/CS Mount module B)
21.2 (without C/CS Mount module B)</td></tr>
<tr><td>mass</td><td>[g]</td><td colspan="4">26.9 (with C/CS Mount module B)
22.9 (without C/CS Mount module B)
4.3 (board level camera)</td></tr>
</table>

table 3-12, MQ013xG-ON, sensor and camera parameters

1) short peaks in drained power needed by sensor during pixel area reset

3.5.3.2. Quantum efficiency curves [%]

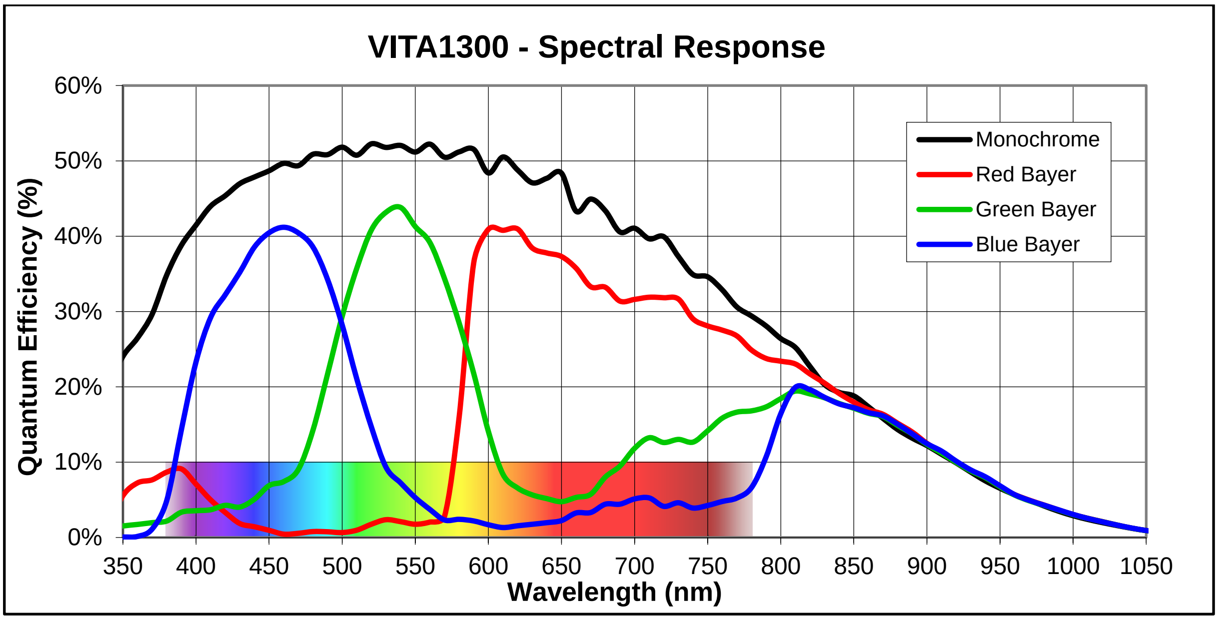


figure 3-15 VITA1300 mono and color, quantum efficiency curves, ©Onsemi

3.5.3.3. Drawings (C-mount [with C/CS mount module B])

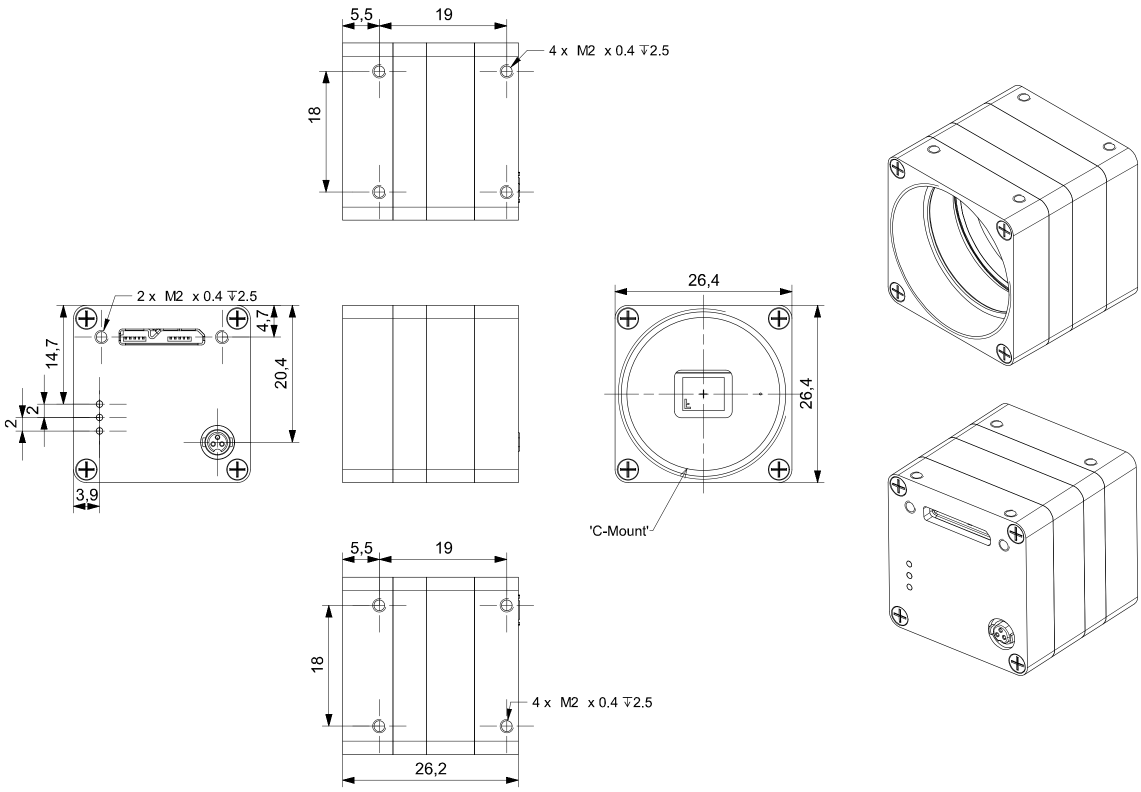


figure 3-16, dimensional drawing MQ013xG-ON, C-Mount housing

3.5.3.4. Camera orientation

Please note that the camera orientation of the MQ013xG-ON models are different. The USB 3.0 connector is at the upper side of the camera. Please see the next figure:

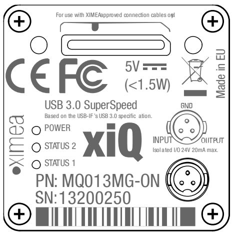


figure 3-17, MQ013xG-ON, camera orientation

3.5.3.5. Referenced documents

Onsemi Datasheet VITA1300-datasheet-Rev. 8 (July 2012)

3.5.3.6. Sensor features

feature	Note
Binning	Not implemented
Skipping	Yes, 2x2 skipping supported
ROI	1 ROI with free parameters supported (x coordinates multiple of 16, y coordinates multiple of 2)
HW Trigger	Trigger with overlap usable (see *4.3.2.2 Triggered mode with overlap*)
HDR	Knee point based HDR (beta stage), see *4.5.7 HDR – Not implemented, yet*

table 3-13, sensor features available

3.5.4. MQ013xG-ON (PYTHON1300)

3.5.4.1. Sensor and camera parameters

xiQ model		MQ013CG-ON	MQ013MG-ON	MQ013RG-ON
Sensor parameter				
Brand		NOIP1SE1300A-QDI	NOIP1SN1300A-QDI	NOIP1FN1300A-QDI
Color filter		RGB Bayer mosaic	None	None
Type		Global shutter, overlap mode		
Pixel Resolution (H × V)	[pixel]	1280 × 1024, usable in color mode: 1264 x 1016		
Active area size (H × V)	[mm]	6.18 × 4.95		
Sensor diagonal	[mm]	7.9		
Optical format	[inch]	1/2		
Pixel Size (H × V)	[µm]	4.8 × 4.8		
ADC resolution	[bit]	10		
FWC	[ke-]	10		
Dynamic range	[dB]	>56		
SNR Max	[dB]	40		
Dark noise	[e-]	9: 1 LSB_{10}		
Dark current	[e-/s]	5 (20°C)		
DSNU	[LSB_{10}/s]	0.33		
Sensitivity	[V/(Lux s)]	7.7		
Camera parameters				
Digitization	[bit]	10		
Supported bit resolutions	[bit/pixel]	8, 10, 12		
Exposure time (EXP) [1]		29µs to 1sec in steps of 1µs if exp < 65.54ms; 4µs if exp<262.1ms; 16µs otherwise		
Variable Gain Range (VGA)	[dB]	20		
Refresh rate (MRR)*	[fps]	172(210)		

Supported standard readout modes	Binning/skipping	pixels	Fps [1]	Bit/px
0	1x1	1280 × 1024	172(210)	8
1	1x1	1280 × 1024	148(148)	10
2	2x2 skip	640 x 512	555(797)	8
3	2x2 skip	640 x 512	540(569)	10

Power consumption		
typical	[W]	1.3
Peak [2]	[W] / [µs]	1.4 / 80
Dimensions/Mass		
height	[mm]	26.4
width	[mm]	26.4
depth	[mm]	26.2 (with C/CS Mount module B) 21.2 (without C/CS Mount module B)
mass	[g]	26.9 (with C/CS Mount module B) 22.9 (without C/CS Mount module B) 4.3 (board level camera)

table 3-14, MQ013xG-ON, sensor and camera parameters

1) values in brackets represents frame rates when sensor is operating in Zero ROT mode
2) short peaks in drained power needed by sensor during pixel area reset

3.5.4.2. Quantum efficiency curves [%]

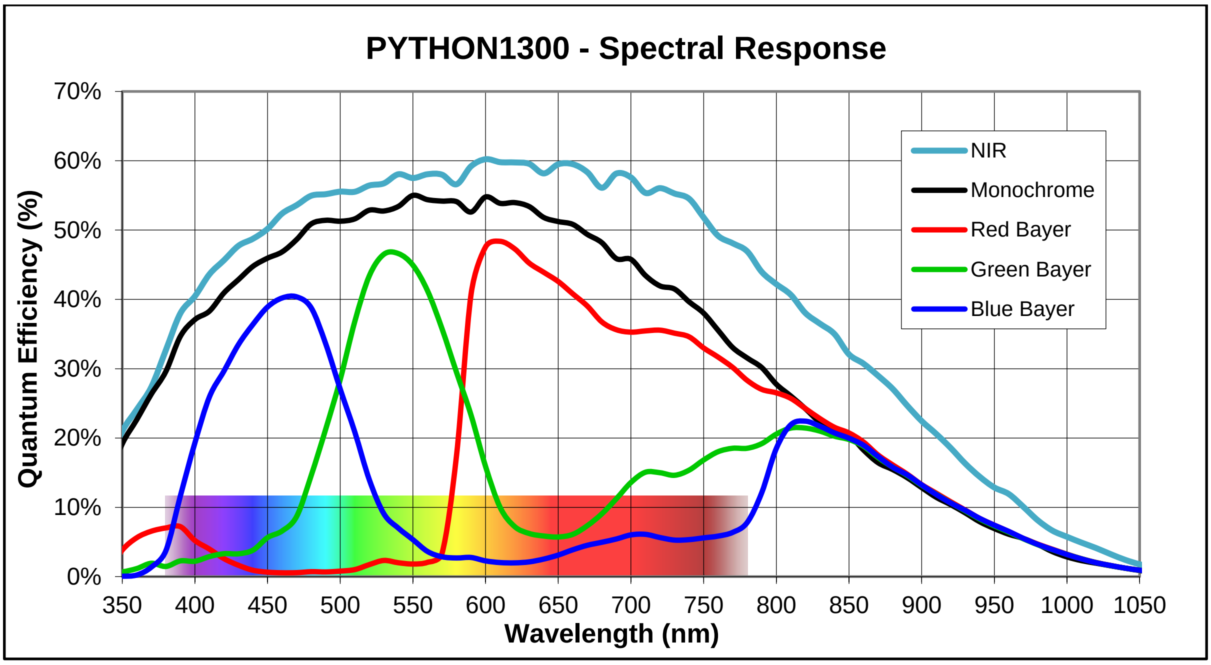


figure 3-18, PYTHON1300 NIR, mono and color, quantum efficiency curves, ©Onsemi

3.5.4.3. Drawings (C-mount [with C/CS mount module B])

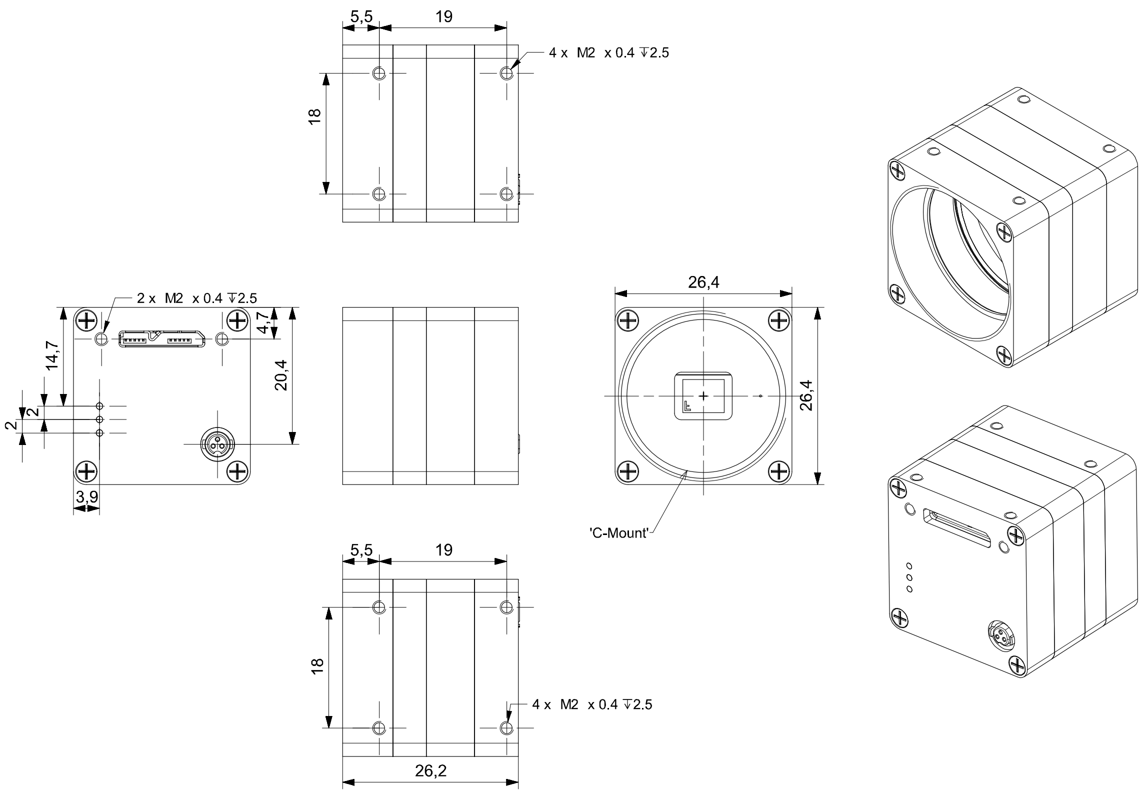


figure 3-19, dimensional drawing MQ013xG-ON, C-Mount housing

3.5.4.4. Drawings board level

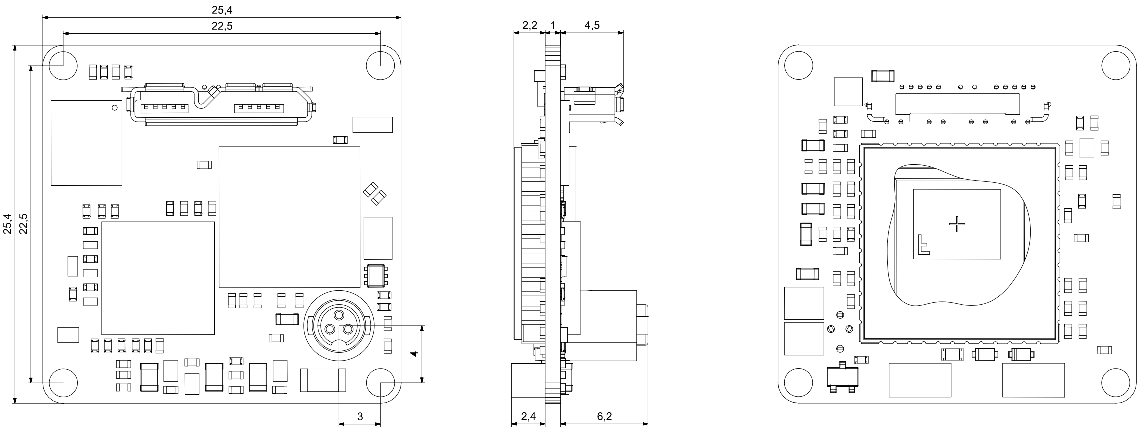


figure 3-20, dimensional drawing MQ013xG-ON-BRD

3.5.4.5. Camera orientation

Please note that the camera orientation of the MQ013xG-ON models are different. The USB 3.0 connector is at the upper side of the camera. Please see the next figure:

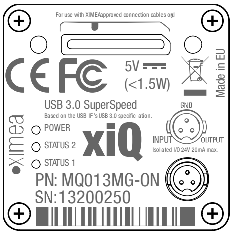


Figure 3-21, MQ013xG-ON, camera orientation

3.5.4.6. Referenced documents

Onsemi Datasheet PYTHON1300-datasheet-Rev. 2 (June 2016)

3.5.4.7. Sensor features

feature	Note
Binning	Not implemented
Skipping	Yes, 2x2 skipping supported
ROI	1 ROI with free parameters supported (x coordinates multiple of 16, y coordinates multiple of 2)
3.5.4.7.1. HW Trigger	Trigger with overlap usable (see *4.3.2.2 Triggered mode with overlap*)
HDR	Knee point based HDR (beta stage), see *4.5.7 HDR – Not implemented, yet*

table 3-15, sensor features available

NOTE

The saturation behavior of the PYTHON image sensors can be impacted during integration times longer than approximately 10ms. A fully exposed pixel may not result in a fully-saturated digital signal, and a fixed row-to-row pattern may be observed in the captured image.

These effects can typically be mitigated by increasing the analog gain (API function XI_PRM_GAIN) of the image sensor 2.3 dB at exposure time of 100ms, which re-maps the linear portion of the pixel's analog signal to the full range of the ADC input to recover the full digital output range of the device. For some sensors this procedure might not be needed or the required gain is lower than 2.3dB.

It is emphasized that this behavior is within spec of the sensor manufacturer and all published specs.

3.5.5. MQ022xG-CM

3.5.5.1. Sensor and camera parameters

xiQ model	MQ022CG-CM	MQ022MG-CM	MQ022RG-CM
Sensor parameter			
Brand	CMV2000-XE5C1PP	CMV2000-XE5M1PP	CMV2000-XE12M1PP
Color filter	RGB Bayer mosaic	None	None
Type	Global shutter, overlap mode		
Pixel Resolution (H × V) [pixel]	2048 × 1088, usable in color mode: 2040 x 1080		
Active area size (H × V) [mm]	11.27 × 6		
Sensor diagonal [mm]	12.8		
Optical format [inch]	2/3		
Pixel Size (H × V) [µm]	5.5 × 5.5		
ADC resolution [bit]	10		
FWC [ke-]	13.5		
Dynamic range [dB]	60		
SNR Max [dB]	41.3		
Dark noise [e-]	13 (RMS)		
Dark current [e-/s]	125 (25°C)		
DSNU [LSB_{10}/s]	3		
Sensitivity [V/(Lux s)]	4.64		
Camera parameters			
Digitization [bit]	10		
Supported bit resolutions [bit/pixel]	8, 10		
Exposure time (EXP)	16.2µs to 1s [1]		
Variable Gain Range (VGA) [dB]	-1.5dN to 6dB		
Refresh rate (MRR) [fps]	170		

Supported standard readout modes	Binning/skipping	pixels	fps	Bit/px
0	1x1	2048 × 1088	170	8
1	1x1	2048 × 1088	85[2]	10

Power consumption			
typical [W]	1.5		
Peak[3] [W]/[us]	4.4 / 20		
Dimensions/Mass			
height [mm]	26.4		
width [mm]	26.4		
depth [mm]	30.2 (with C/CS Mount module B) 25.2 (without C/CS Mount module B)		
mass [g]	31.8 (with C/CS Mount module B) 27.8 (without C/CS Mount module B) 7.2 (board level camera)		

table 3-16, MQ022xG-CM, sensor and camera parameters

Notes:

1) Defined for max. bandwidth and 8bit per pixel. Higher dynamic range (i.e. 10 bit/pixel) will reduce the available frame rate. By decreasing bandwidth the minimal exposure time and exposure step will increase.
2) Applies for 16bit per pixel on transport layer. When packing is enabled in camera the achievable FPS would be higher.
3) Short peaks in drained power needed by sensor during pixel area reset

3.5.5.2. Quantum efficiency curves [%]

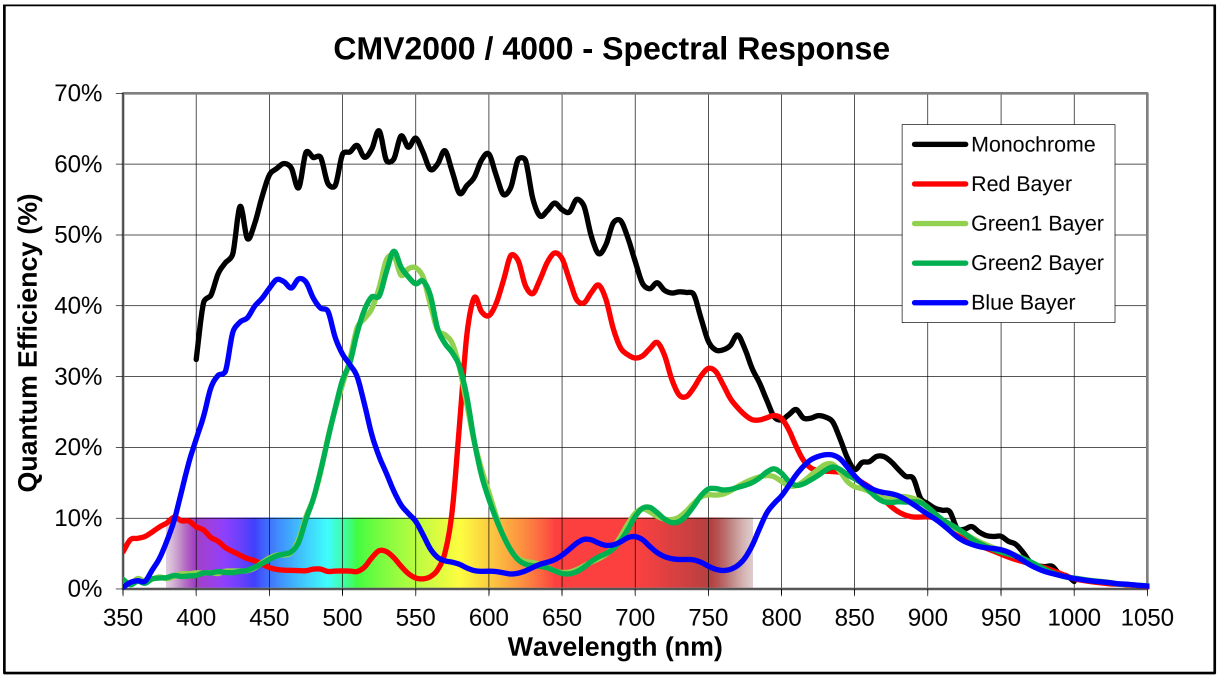


figure 3-22, CMV2000 mono and color, quantum efficiency curve, ©CMOSIS

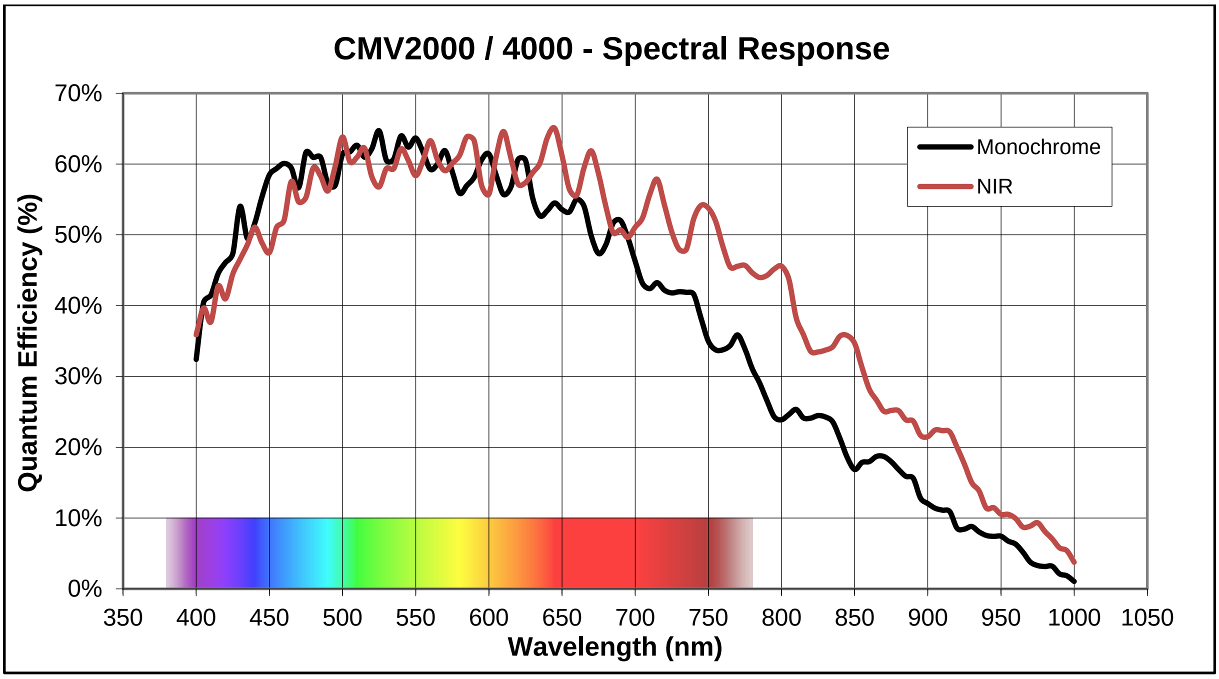


figure 3-23, CMV2000-mono and NIR (E12), quantum efficiency curves, ©CMOSIS

3.5.5.3. Drawings (C-mount [with C/CS mount module B])

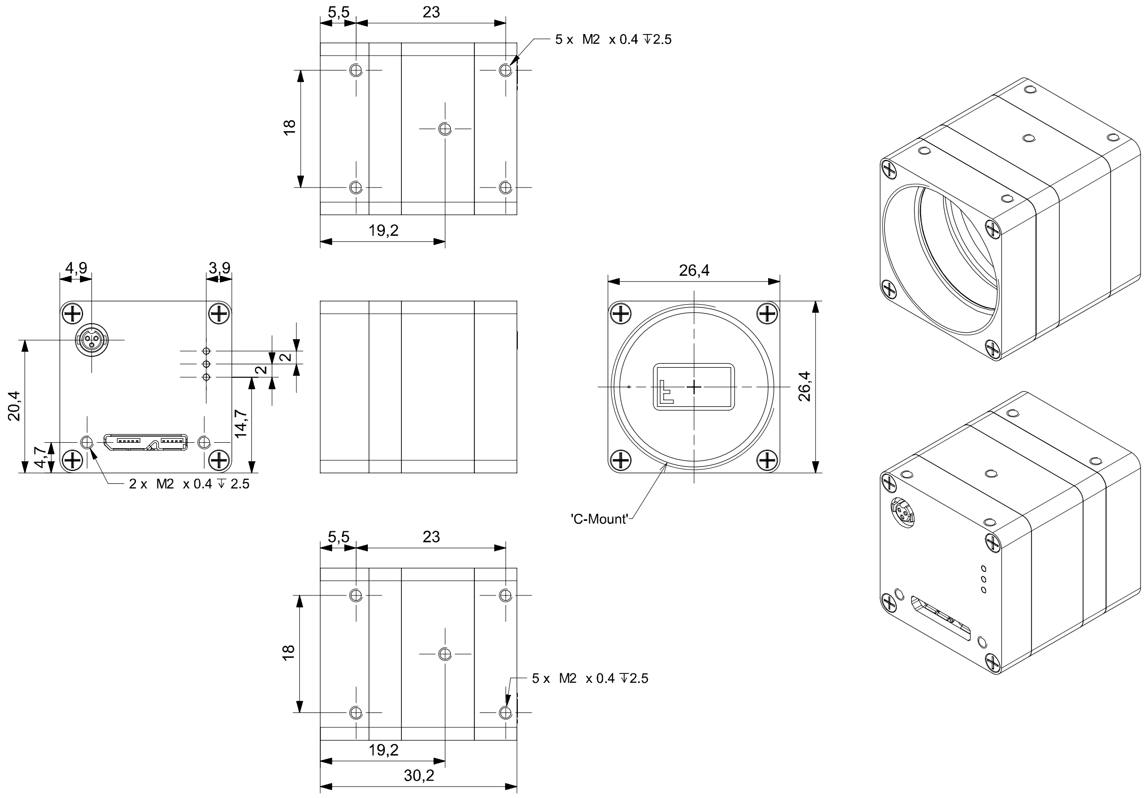


figure 3-24, dimensional drawing MQ022xG-CM, C-Mount housing

3.5.5.4. Drawings board level

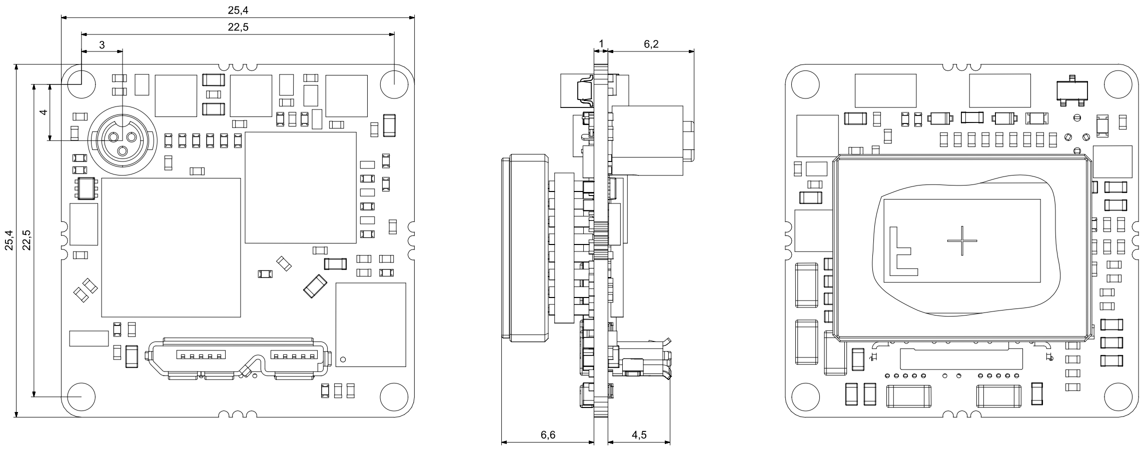


figure 3-25, dimensional drawing MQ022xG-CM-BRD

3.5.5.5. Referenced documents

CMOSIS Datasheet CM2000-datasheet-v3.2 (30/07/12)

3.5.5.6. Sensor features

feature	Note
Binning	No
Skipping	Not supported, yet
ROI	Single window in y direction supported, cropping in X supported by xiAPI (x coordinates multiple of 16, y coordinates multiple of 2
HW Trigger	Trigger with overlap usable (see *4.3.2.2 Triggered mode with overlap*)
HDR	Knee point based HDR (beta stage), see *4.5.7 HDR*

table 3-17, sensor features available

3.5.6. MQ042xG-CM

3.5.6.1. Sensor and camera parameters

xiQ model		MQ042CG-CM	MQ042MG-CM	MQ042RG-CM
Sensor parameter				
Brand		CMV4000-XE5C1PP	CMV4000-XE5M1PP	CMV4000-XE12M1PP
Color filter		RGB Bayer mosaic	None	None
Type		Global shutter, overlap mode		
Pixel Resolution (H × V)	[pixel]	2048 × 2048, usable in color mode: 2040 x 2040		
Active area size (H × V)	[mm]	11.27 × 11.27		
Sensor diagonal	[mm]	15.9		
Optical format	[inch]	1		
Pixel Size (H × V)	[µm]	5.5 × 5.5		
ADC resolution	[bit]	10		
FWC	[ke-]	13.5		
Dynamic range	[dB]	60		
SNR Max	[dB]	41		
Dark noise	[e-]	13 (RMS)		
Dark current	[e-/s]	125 (25°C)		
DSNU	[LSB_{10}/s]	3		
Sensitivity	[V/(Lux s)]	4.64		
Camera parameters				
Digitization	[bit]	10		
Supported bit resolutions	[bit/pixel]	8, 10		
Exposure time (EXP)		26µs to 1s [1]		
Variable Gain Range (VGA)	[dB]	-1.5dN to 6dB		
Refresh rate (MRR)	[fps]	90		

Supported standard readout modes	Binning/skipping	pixels	fps	Bit/px
0	1x1	2048 × 2048	90	8
1	1x1	2048 × 2048	45 [2]	10

Power consumption		
typical	[W]	1.5
Peak	[W]/[us]	6 / 20
Dimensions/Mass		
height	[mm]	26.4
width	[mm]	26.4
depth	[mm]	30.2 (with C/CS Mount module B) 25.2 (without C/CS Mount module B)
mass	[g]	32.1 (with C/CS Mount module B) 28.1 (without C/CS Mount module B) 8 (board level camera)

table 3-18, MQ042xG-CM, sensor and camera parameters

Notes:

1) Defined for max. bandwidth and 8bit per pixel. Higher dynamic range (i.e. 10 bit/pixel) will reduce the available frame rate. By decreasing bandwidth the minimal exposure time and exposure step will increase.
2) Applies for 16bit per pixel on transport layer. When packing is enabled in camera the achievable FPS would be higher.
3) Short peaks in drained power needed by sensor during pixel area reset

3.5.6.2. Quantum efficiency curves [%]

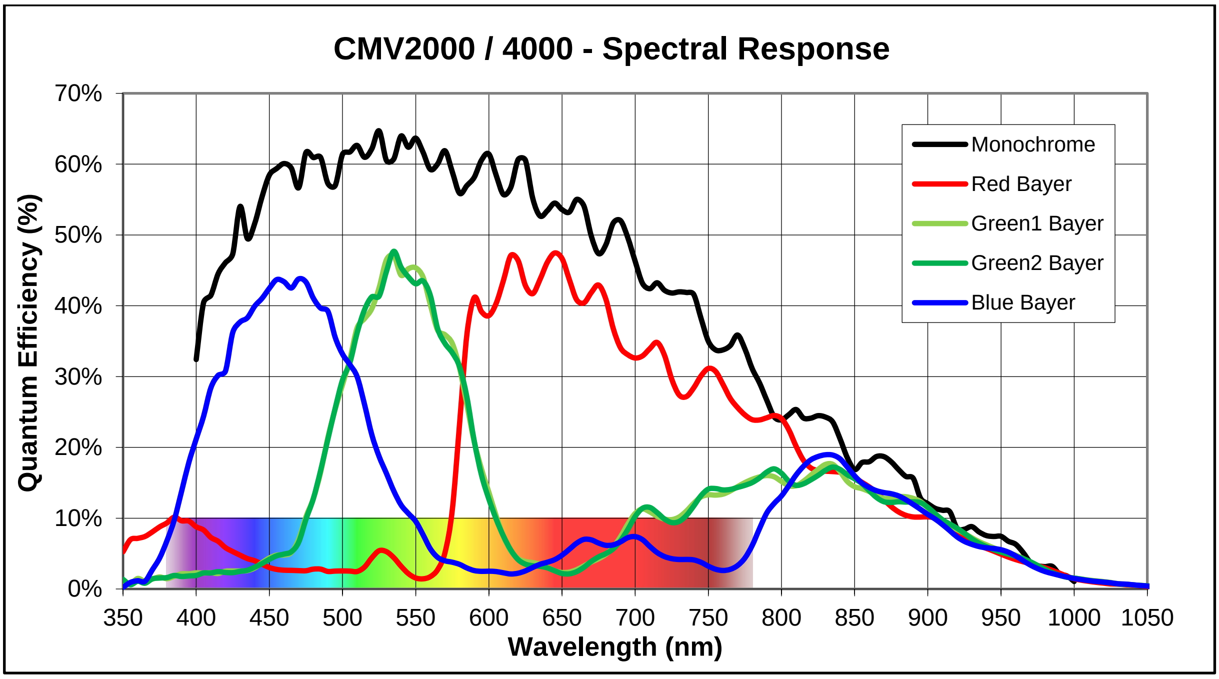


figure 3-26, CMV4000 mono and color, quantum efficiency curve, ©CMOSIS

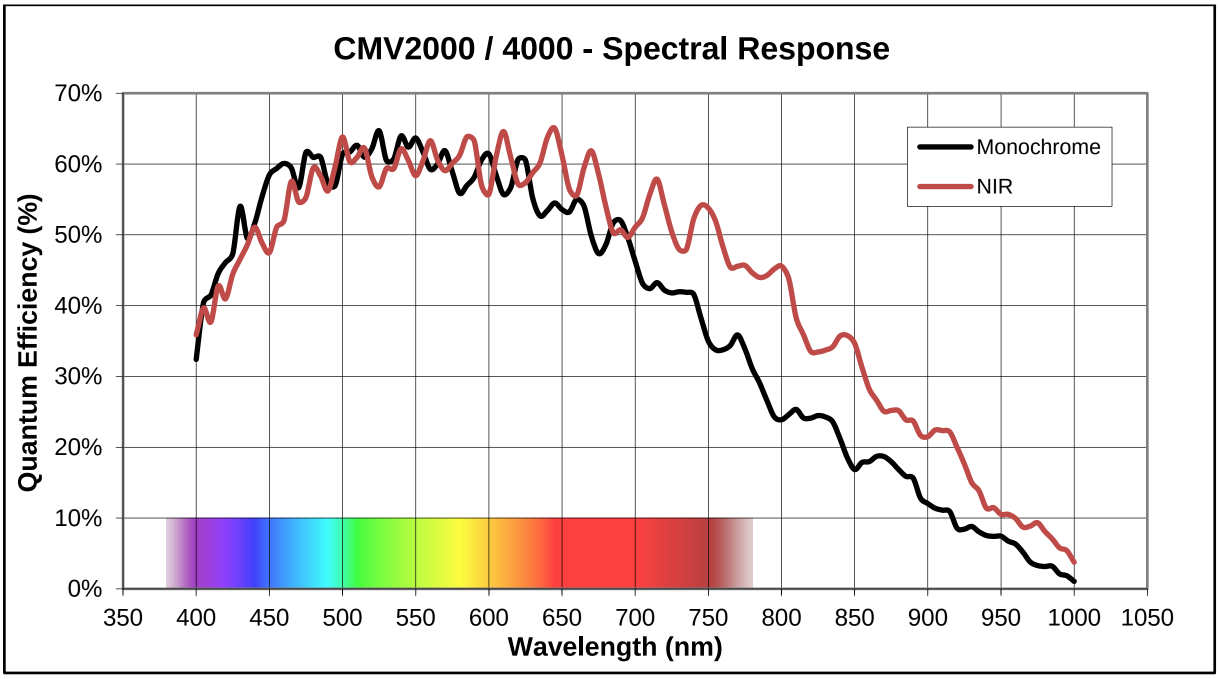


figure 3-27, CMV4000-mono and NIR (E12), quantum efficiency curves, ©CMOSIS

3.5.6.3. Drawings (C-mount [with C/CS mount module B])

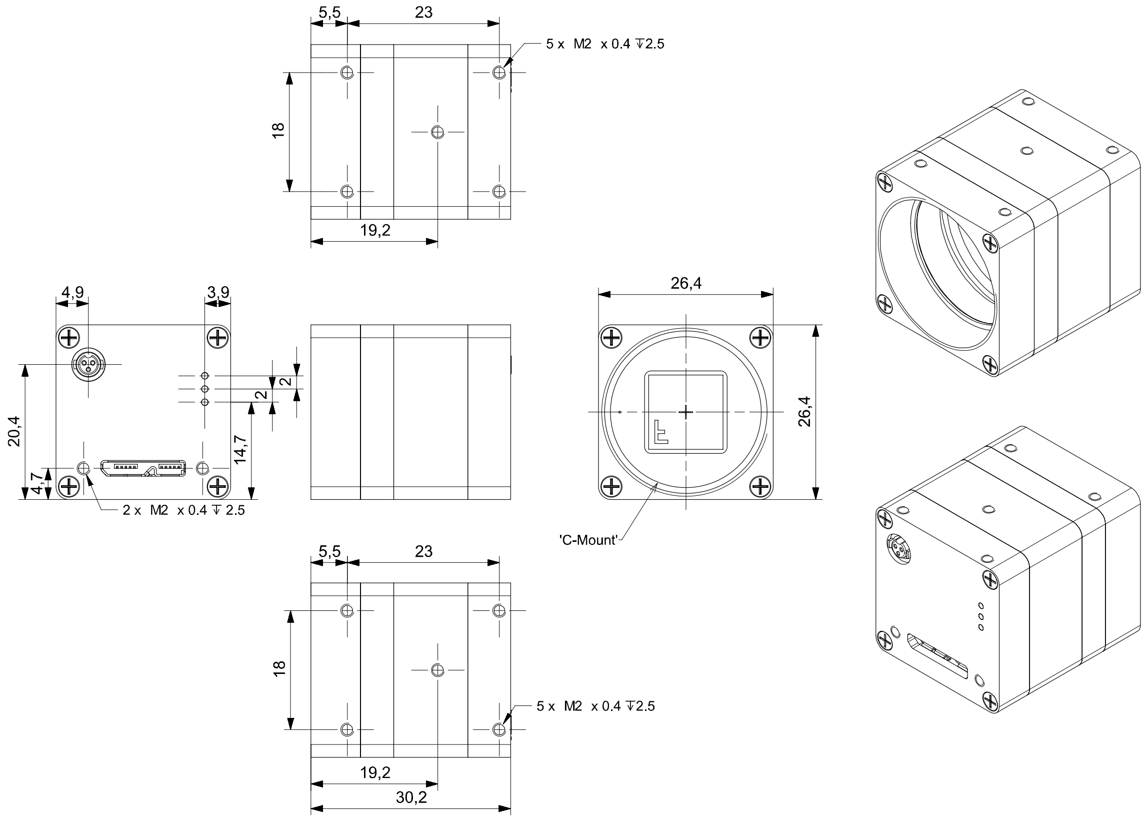


figure 3-28, dimensional drawing MQ042xG-CM, C-Mount housing

3.5.6.4. Drawings board level

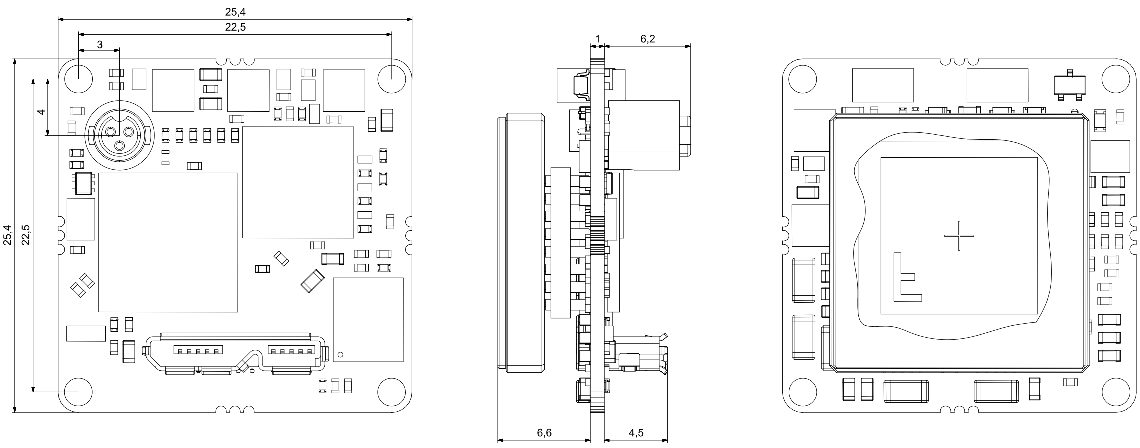


figure 3-29, dimensional drawing MQ042xG-CM-BRD

3.5.6.5. Referenced documents

CMOSIS Datasheet CMV4000-datasheet-v3.2 (30/07/12)

3.5.6.6. Sensor features

feature	Note
Binning	No
Skipping	Not supported, yet
ROI	Single window in y direction supported, cropping in X supported by xiAPI (x coordinates multiple of 16, y coordinates multiple of 2)
HW Trigger	Trigger with overlap usable (see *4.3.2.2 Triggered mode with overlap*)
HDR	Knee point based HDR (beta stage), see *4.5.7 HDR*

table 3-19, sensor features available

3.6. User interface – LEDs

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

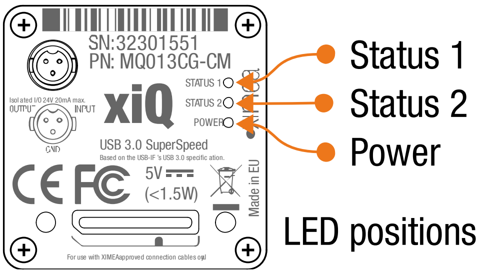


figure 3-30, position status LEDs

The LEDs Status1 and Status2 are programmable. Please note the following description:

LED	Color	Description
Power	Orange	Power indication: LED is on if the power is on (USB 3.0 cable connected)
Status 2	Green	USB 3.0 Enumeration USB 2.0 Enumeration (default), User configurable: register (set value) strobe busy streaming trigger level edge digital input slow blink fast blink
Status 1	Red	Streaming (default), User configurable: register (set value) strobe busy streaming trigger level edge digital output slow blink fast blink

table 3-20, LED output description

3.7. xiQ USB 3.0 Interface

Connector	Signals	Mating Connectors
USB 3.0	Standard USB 3.0 Micro-B Female Connector	Standard USB 3.0 Micro-B Connector with thumbscrews Screw thread M2, thread distance 18.0mm

table 3-21, USB 3.0 mating connector description

The USB 3.0 Micro-B connector is used for data transmission, camera control and power.

3.7.1. Location

The USB 3.0 connector is located on the back side of the camera:

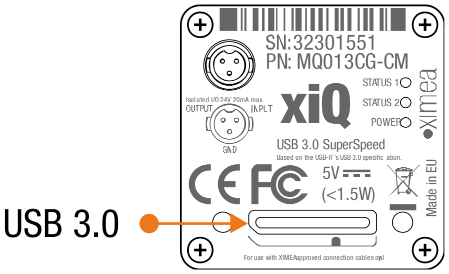


figure 3-31, position USB 3.0 interface

3.7.2. Pinning

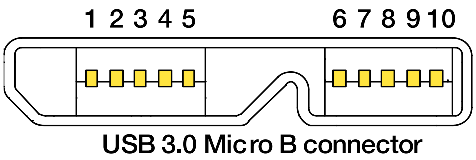


figure 3-32, pinning USB 3.0 connector

USB 3.0 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	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 3-22, USB 3.0 connector, pin assignment

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

3.8. xiQ 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 3-23 Connector part numbers

3.8.1. Flex Connection Location

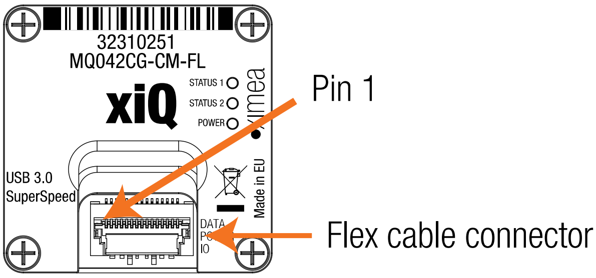


figure 3-33 Flex connector location

3.8.2. 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 3-24 Pin list for flex cable

3.9. xiQ Digital Input / Output (GPIO) Interface

Connector	Signals	Mating Connectors
I/O & Sync	Opto-isolated trigger input and illuminator sync output	HIROSE SR38-4P-3P(71)) with optional locking nut

table 3-25, GPIO mating connector description

3.9.1. Location

IO interface receptacle is located on the back of the camera:

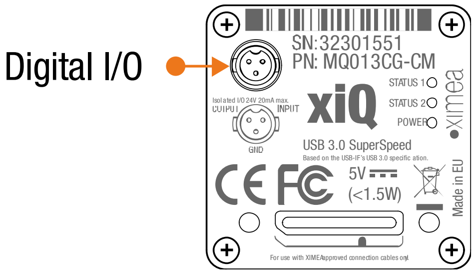


figure 3-34, position GPIO connector

3.9.2. IO Connector Pinning

Pinning of the IO connector (camera):

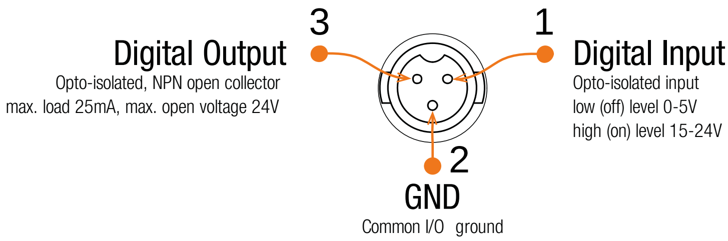


figure 3-35, pinning GPIO connector 24V logic

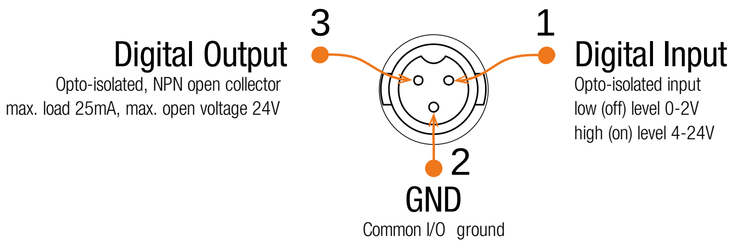


figure 3-36, pinning GPIO connector 5V logic

I/O connector Pin Assignment:

Pin	Signal	Technical description
1	Trigger/sync digital Input (GPI)	IEC 61131-2 specification for 24V logic
2	Common (IO Ground)	
3	Trigger/sync digital Output (GPO)	Open collector NPN
(Shell)	Chassis ground	For revisions with 24V logic it is Common (IO Ground)

table 3-26, I/O connector Pin Assignment

3.9.3. Digital Input

3.9.3.1. Digital Input - General info

Item	Parameter / note
Indicator	Yes, must be configured by user to Status 2 LED
Effect of incorrect input terminal connection	Reverse voltage polarity protected
Effects when withdrawing/inserting input module under power	no damage, no lost data
Maximal recommended cable length	10m
Input debounce filter	yes, (rising and/or falling), 10µs step, max time 81.92ms

table 3-27, digital input, general info

xiQ cameras with older hardware revisions are compatible only with 24V input signals. xiQ cameras with newer hardware revisions support 5V digital input, while staying backward compatible with 24V input signals.

Assignment hardware revision to input signal level:

Camera model	Hardware revision 24V logic	Hardware revision 5V logic
MQ003xG-CM	< 4	≥ 4
MQ013xG-E2	< 6	≥ 6
MQ013M(C)G-ON	< 3	≥ 3
MQ013RG-ON	-	any
MQ022xG-CM	< 6	≥ 6
MQ042xG-CM	< 6	≥ 6

table 3-28, Assignment hardware revision to input signal level

The hardware revision of the camera can be verified using xiCOP, please see 5.8 XIMEA Control Panel.

3.9.3.2. Digital Input – Wiring

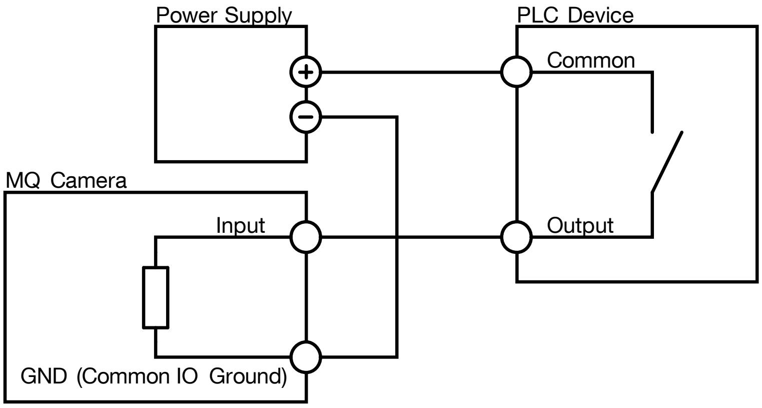


figure 3-37, digital input, interface wiring

3.9.3.3. Digital Input – 24V logic

Digital Input 24V – signal levels

3.9.3.3.1.

Depending on the camera's hardware version two different input signal levels are supported.

Input levels according IEC 61131-2, Type 1

V-in-min [V]	V-in-max [V]	State	I-max [mA]
-3	5	Off (0)	0.004
5	15	Transient	4
15	24	On (1)	12

table 3-29, digital info, signal levels, 24V logic

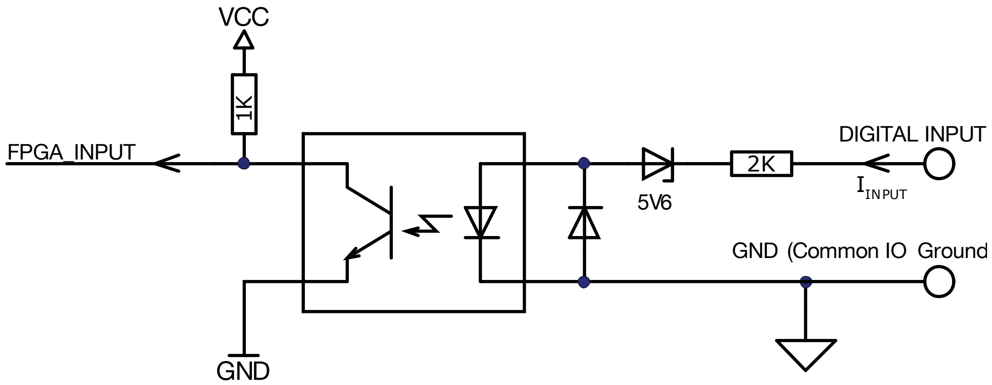
Note:

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

Digital Input 24V – Internal Schematic

3.9.3.3.2.

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



3.9.3.3.3. *figure 3-38, digital input, interface schematic, 24V logic*

Digital Input 24V – Timing

Typical measured input delay between Digital Input to FPGA Input

Measurements of input delays:

Edge Type	Input Voltage [V]	Typ. delay [µs]
Rising	15	1.4
Rising	20	0.6
Falling	15	5.3
Falling	20	7.8

table 3-30, digital input, timing, 24V logic

Note:

- Measured at: Ambient Temperature 25°C

3.9.3.4. Digital Input – 5V logic

Digital Input 5V – signal levels

Depending on the camera's hardware version two different input signal levels are supported.

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

3.9.3.4.1.

V-in-min [V]	V-in-max [V]	State	I [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 3-31, digital info, signal levels, 5V logic

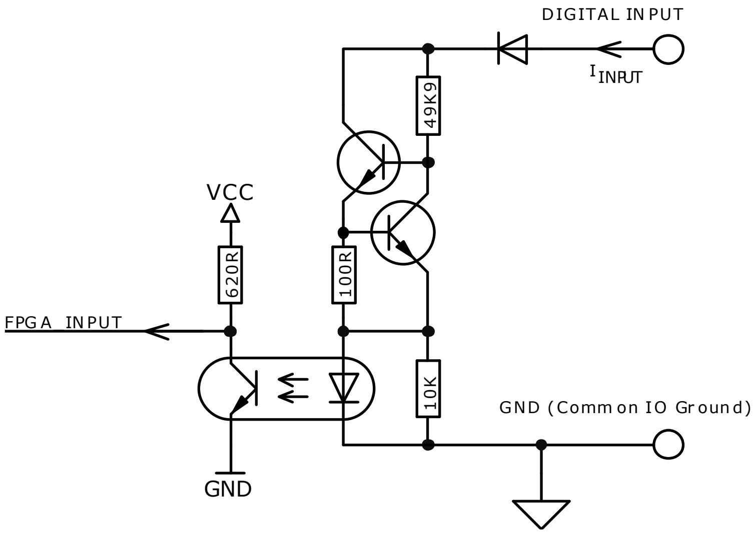
Note:

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

Digital Input 5V – Internal Schematic

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

3.9.3.4.2.



3.9.3.4.3.

figure 3-39, digital input, interface schematic, 5V logic

Digital Input 5V – 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 3-32, digital input, timing, 5V logic

Note:

- Measured at: Ambient Temperature 25°C

3.9.4. Digital Output

3.9.4.1. Digital Output - General info

Item	Parameter / note
Indicator	Yes, must be configured by user to Status 1 LED
Output port type	Open collector NPN
Protection	short-circuit / over-current / Reverse voltage
Protection circuit	PTC Resettable Fuse
Effect of incorrect output terminal connection	Not protected against reverse voltage connection
Inductive loads	no
Maximal output dropout	1.8V, Sink current 25mA

table 3-33, digital output, general info

The digital output can only be used if the camera works in triggered mode.(software or hardware trigger).

3.9.4.2. Digital Output – signal levels

Output levels definition

State	Open Collector Switch State	R [Ohm]	Conditions
On (1)	ON - Transistor is conducting	max. 160	For output > 5mA
Off (0)	OFF - Transistor is not conducting	min 100 k	

table 3-34, digital output, signal levels

Maximum sink current: 25 mA

Maximum open circuit voltage: 24V

3.9.4.3. Digital Output – Internal schematic

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

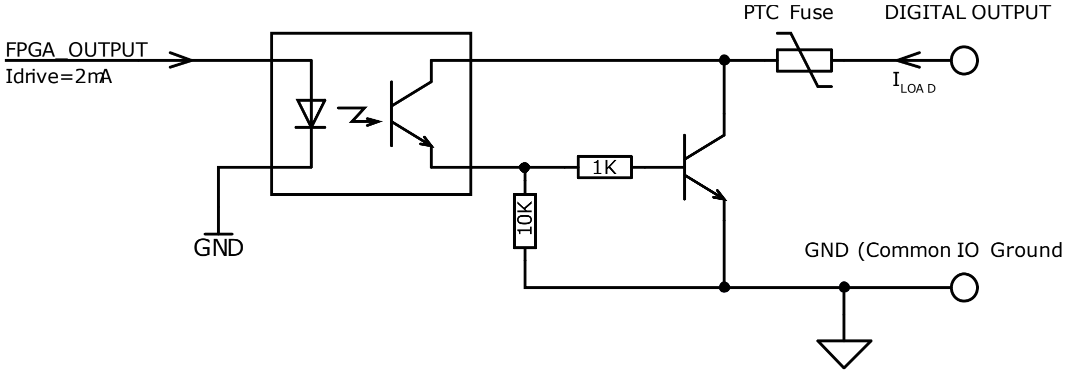


figure 3-40, digital output, interface schematic

Output Transfer Characteristic

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

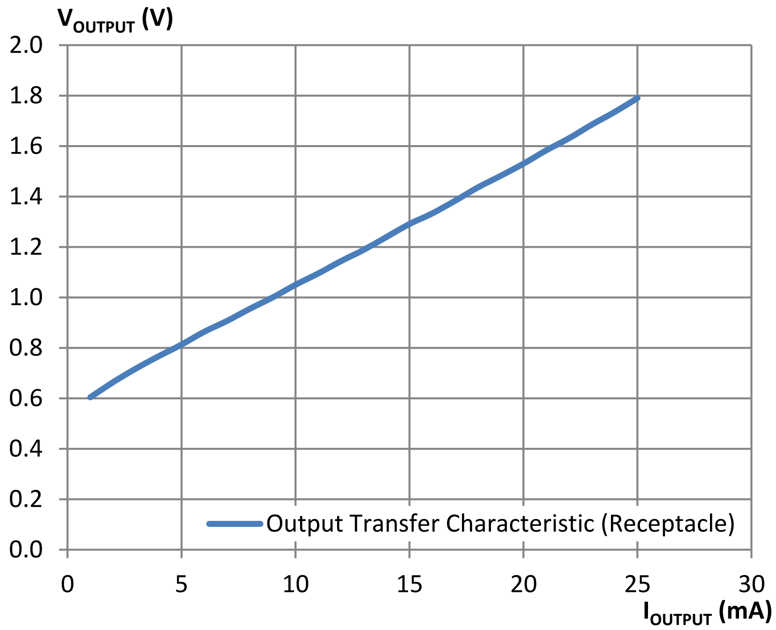


figure 3-41, digital output transfer characteristics

3.9.4.4. 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.

3.9.4.4.1. 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

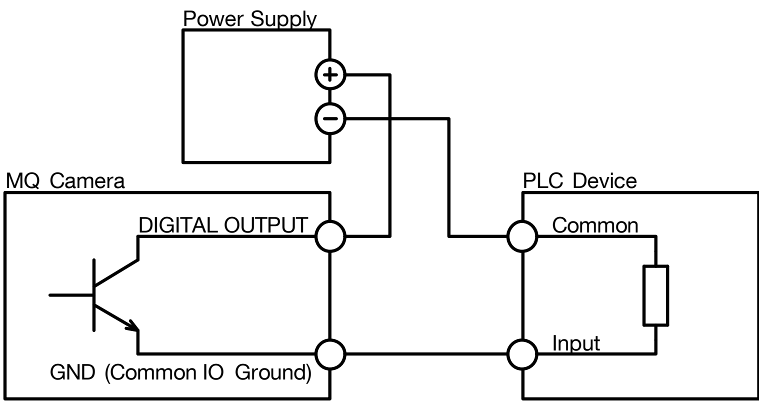


figure 3-42, Connecting Digital OUTPUT to a NPN-compatible PLC device input (biased)

Important note:

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

3.9.4.4.2. 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

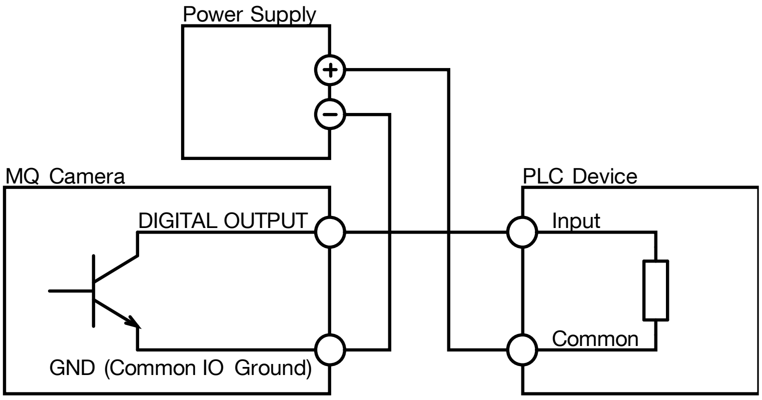


figure 3-43, Connecting Digital OUTPUT to a NPN-compatible PLC device input - more bidirectional inputs used

Note:

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

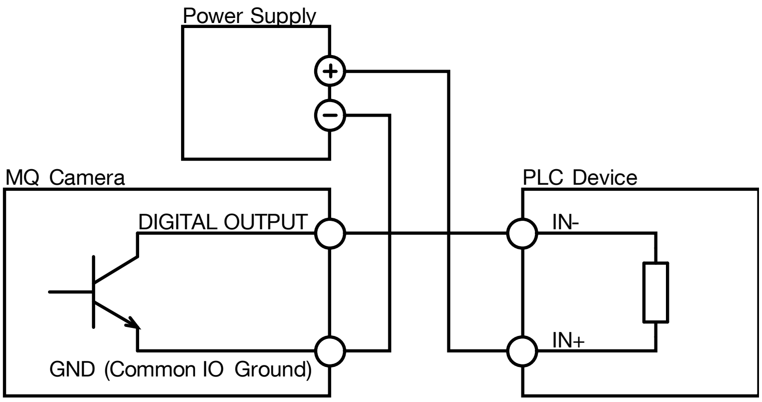


figure 3-44, Connecting Digital OUTPUT to a NPN-compatible PLC device - single input

3.9.4.4.3. 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)

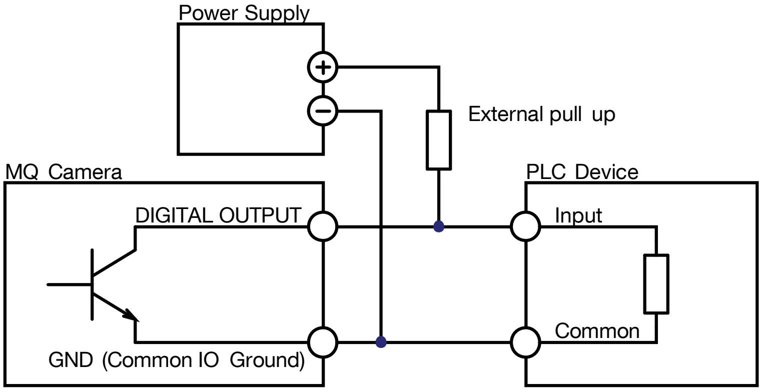


figure 3-45, Connecting Digital OUTPUT to a PNP-compatible device

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 $P(R) > (V_{psu} - V_{input}) * I_{input}$

3.9.4.4.4. Connecting Cameras in Master-Slave setup

Connecting Opto-isolated Digital output to Opto-isolated Digital input (master biased)

Use power supply in range 7-24V DC and current rating more than N * 5mA where N is number of cameras. Current trough master camera output is limited by slave camera inputs. Maximal allowed current is 25mA. This gives practical limit of maximum 5 slave MQ cameras (or other models with opto-isolated input)

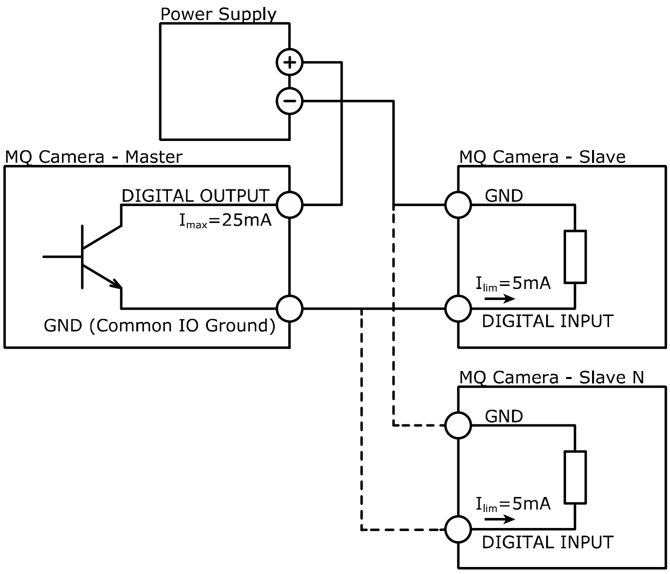


figure 3-46, Connecting Digital OUTPUT to a Opto-isolated Digital input (master biased)

Connecting Opto-isolated Digital output to Opto-isolated Digital input (slave biased)

Use power supply in range 7-24V DC and current rating more than N * 5mA where N is number of cameras. Current trough master camera output is limited by slave camera inputs. Maximal allowed current from master output is 25mA. This gives practical limit of maximum 5 slave MQ cameras (or other models with opto-isolated input)

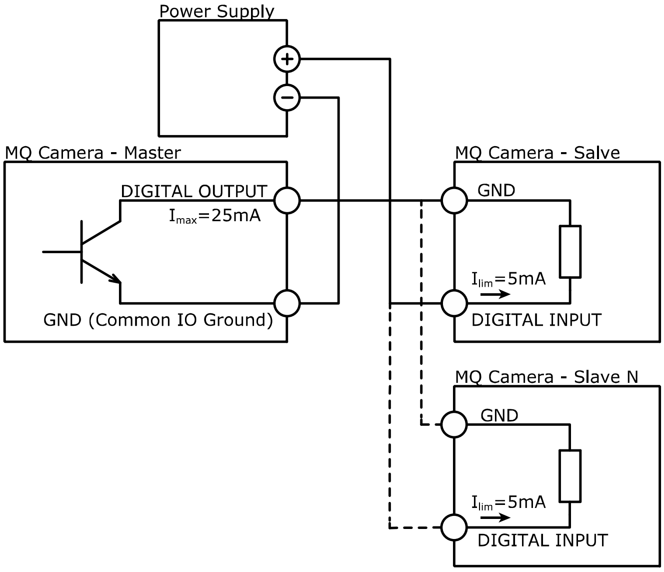


figure 3-47, Connecting Digital OUTPUT to a Opto-isolated Digital input (slave biased)

Connecting Opto-isolated Digital output to Opto-isolated Digital input (PNP-compatible device)

Use power supply in range 7-24V DC and current rating more than N * 5mA where N is number of cameras. Current trough master camera output is limited used pull-up resistor. Maximal allowed current from master output is 25mA. Also the current needed high enough to trigger camera inputs. Nominal current for camera input is 5mA. Resistor need to be selected according to following criteria.

$$R > (V_{PSU} - 0.7V)/25mA$$
$$R < (V_{PSU} - 4V)/(N \times 5mA)$$

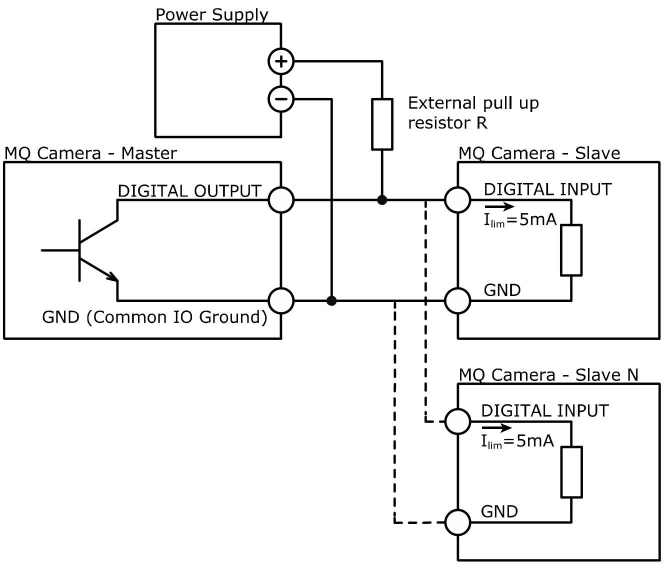


figure 3-48, Connecting Digital OUTPUT to a Opto-isolated Digital input (PNP-compatible device)

3.9.4.4.5. Output Wiring Example: LED Driving

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

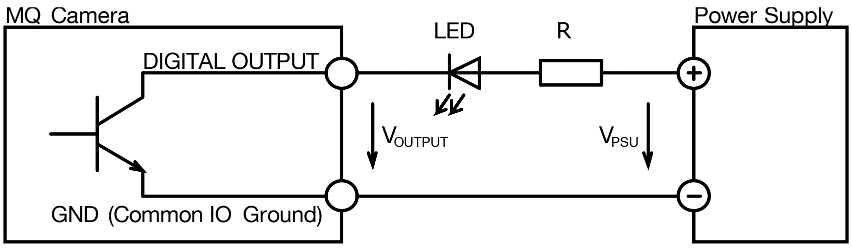


figure 3-49, LED Driving

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.*3.9.4.3 Digital Output – Internal schematic*)

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

I_{led} LED current

Note:

- Remember to use the appropriate resistor power rating $P(RES) = I_{led} * I_{led} * R$

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 3-35, digital output, LED driving

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.

3.9.4.4.6.

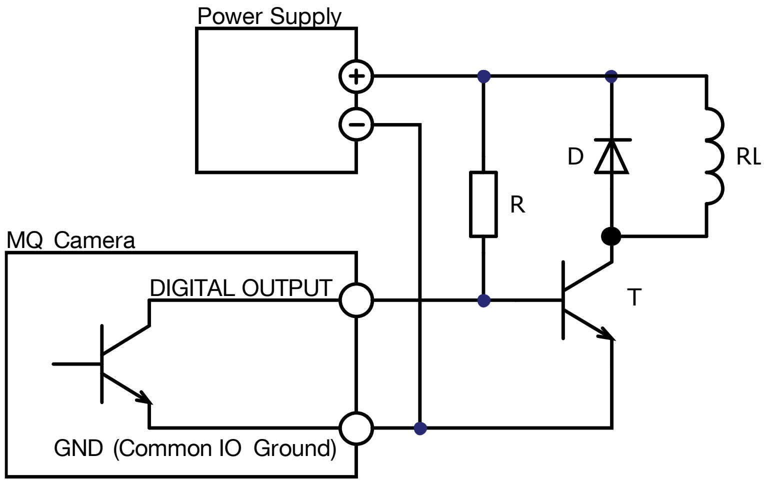


figure 3-50, Inductive load (Relay) Driving (inverted logic)

For positive logic you can use a second bipolar transistor.

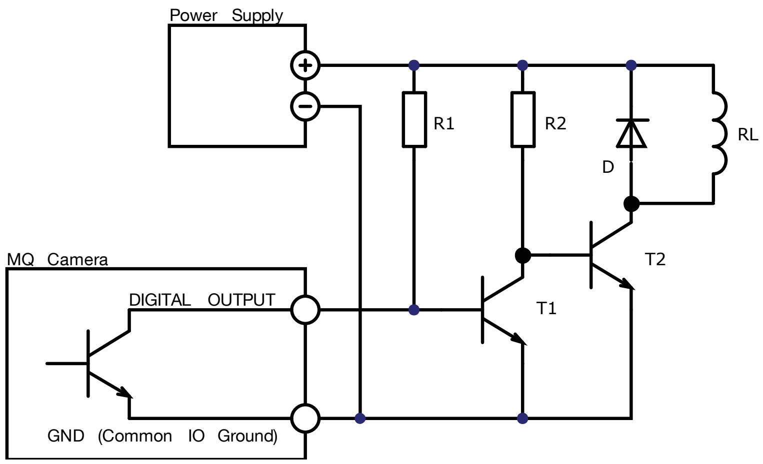


figure 3-51, Inductive load (Relay) Driving (non-inverted logic)

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

3.9.4.4.7.

Trigger polarity	Opto-isolated controller input	Output delay	Wiring	Description
Positive edge	Yes	0.5µs	figure 3-42	
Negative edge	Yes	0.5µs	figure 3-44	
Positive edge	No	155µs	figure 3-45	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 3-45	Note that external pull up is not used in this case. Assume that internal pull up at the controller input is used.

table 3-36, digital output, wiring examples

3.9.4.5. 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 3-37, 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 3-38, digital output, current depending timing

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

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

1.0m / 3.0m / 5.0m USB 3.0 cables

Cable drawing

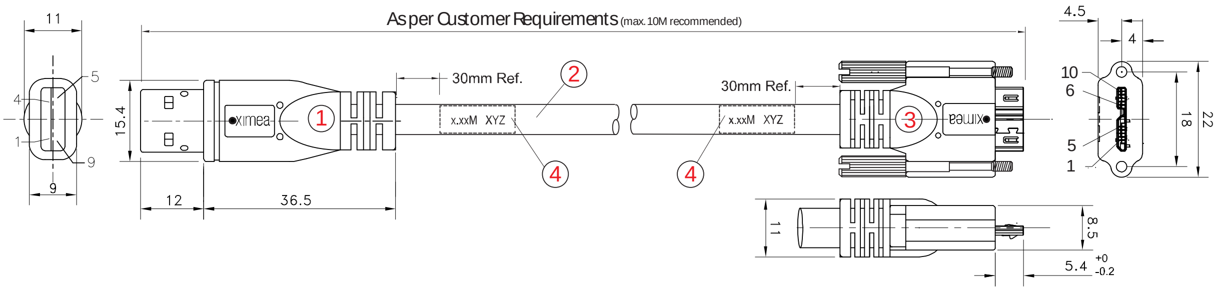


figure 3-52, drawing USB3 cable

Cable components

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 3-39, USB3 cable, components

USB 3.0 cable wiring

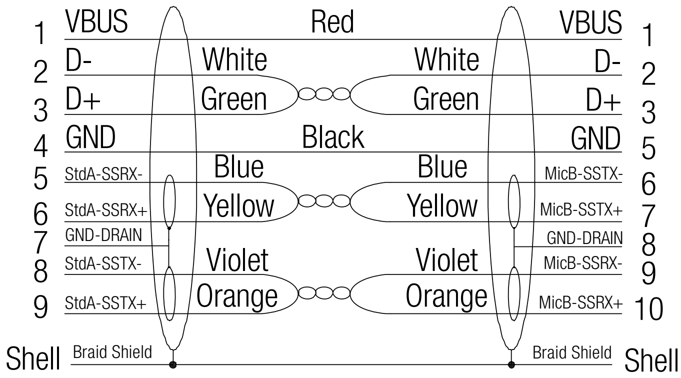


figure 3-53, wiring USB3 cable

Pin Assignment micro USB3 connector:

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 3-40, USB3 connector, pin assignment

Cable label details

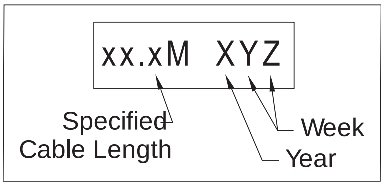


figure 3-54, label details USB3 cable

3.11. CBL-U3-3M0-ANG

3.0m USB 3.0 cable, angled micro USB3 connector

Cable drawing

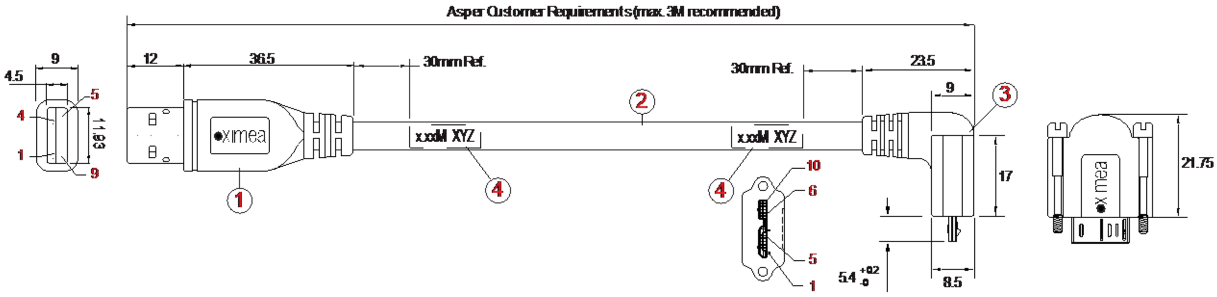


figure 3-55, drawing USB3 cable angled

Cable components

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 3-41, USB3 cable angled, components

USB 3.0 cable wiring

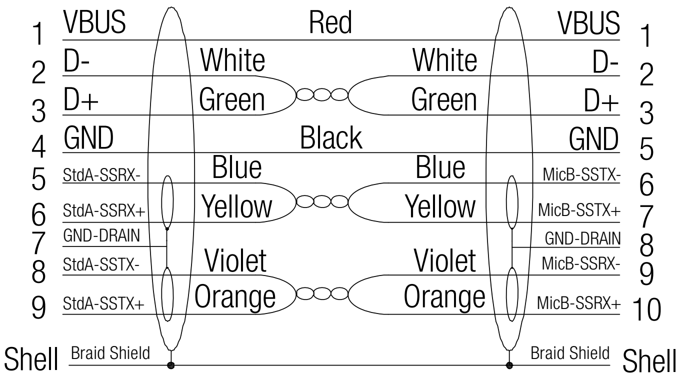


figure 3-56, wiring USB3 cable angled

Pin Assignment micro USB3 connector:

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

Cable label details

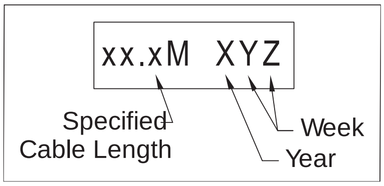


figure 3-57, label details USB3 cable angled

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

Cable FPC MQ Flex-Line, 0.1m/0.25m can be used for connecting xiQ flex line models to carrier board or trough adapter and standard USB 3.0 cable to the host computer.

figure 3-58, 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.

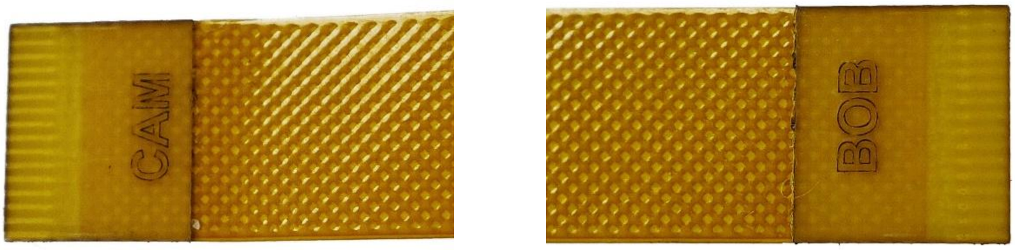


figure 3-59, flex cable ends

3.13. 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 3-60, flex cable (white color)

3.14. BOB-MQ-FL

Break Out Board, Simple Board Level. Enables access to the optoisolated input and output.

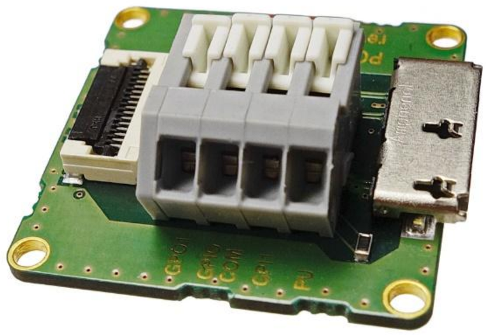


figure 3-61, BOB-MQ-FL

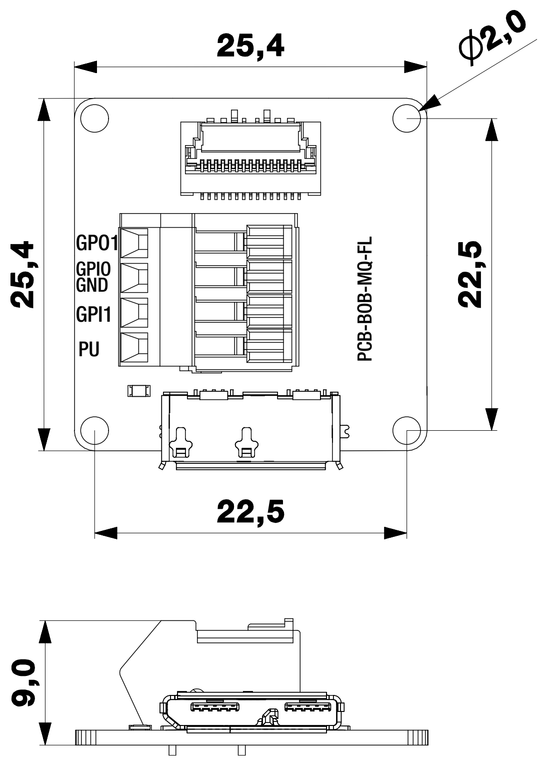


figure 3-62, BOB-MQ-FL dimensions

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 3-43, IO connector (WAGO 218-104), pin assignment

3.15. CBL-MQSYNC-3M0 / CBL-MQSYNC-5M0

3.0m/5.0m xiQ series I/O sync cable, pig tail

Cable drawing

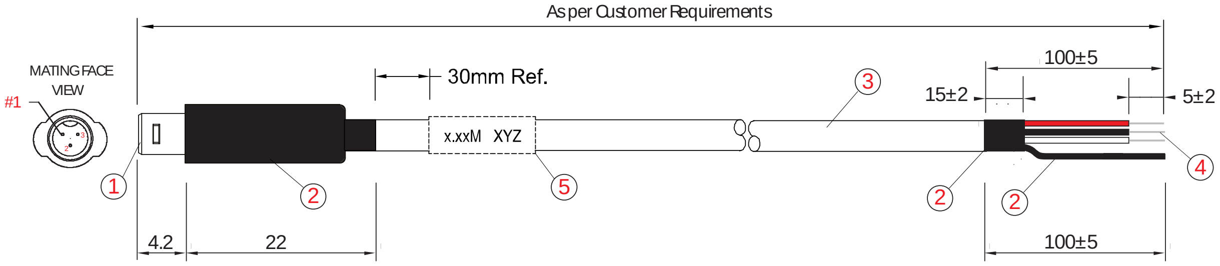


figure 3-63, drawing sync cable

Cable components

Item	Description
1	HRS SR38-4P-3P (71) Hirose SR38 Series Male Connector
2	Heat Shrink Tube
3	A12-1709 [OD=3.30mm] <BLK> (10/0.120x3C) + 32/0.120 27AWG 3Core Line Cord
4	Process end with wire end Striped and tin plated soldering
5	Cable Label

table 3-44, sync cable, components

Sync cable wiring

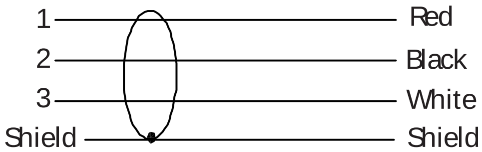


figure 3-64, wiring sync cable

Pin Assignment:

Pin	color	Signal
1	Red	Trigger/sync digital Input (VDI)
2	Black	Common (IO Ground)
3	White	Trigger/sync digital Output (VDO)

table 3-45, sync cable, pin assignment

Cable label details

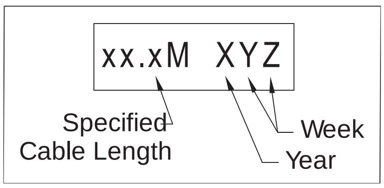


figure 3-65, label details sync cable

3.16. Tripod Adapter – MQ-BRACKET-T

xiQ series tripod mounting bracket

figure 3-66, mounting tripod adapter

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

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

Brackets are delivered as kit with respective screws.

MQ-BRACKET-T-KIT	Standard bracket kit with height of 5.5mm
MQ-BRACKET-T-THICK-KIT	Thick bracket kit for use with lenses with diameter > 37mm

3.16.1. Drawings legacy brackets for MQ013xG-yy and MQ042xG-CM

This bracket is not available anymore.

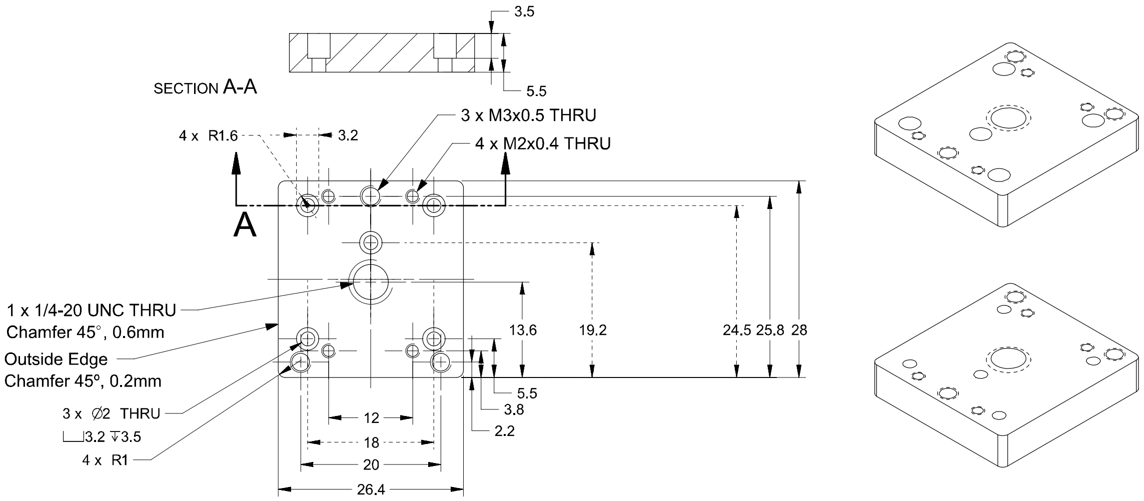


figure 3-67, dimensional drawing tripod adapter (MQ013xG-yy and MQ042xG-CM)

Mass without screws: 9.8 g.

3.16.2. Drawings (universal bracket)

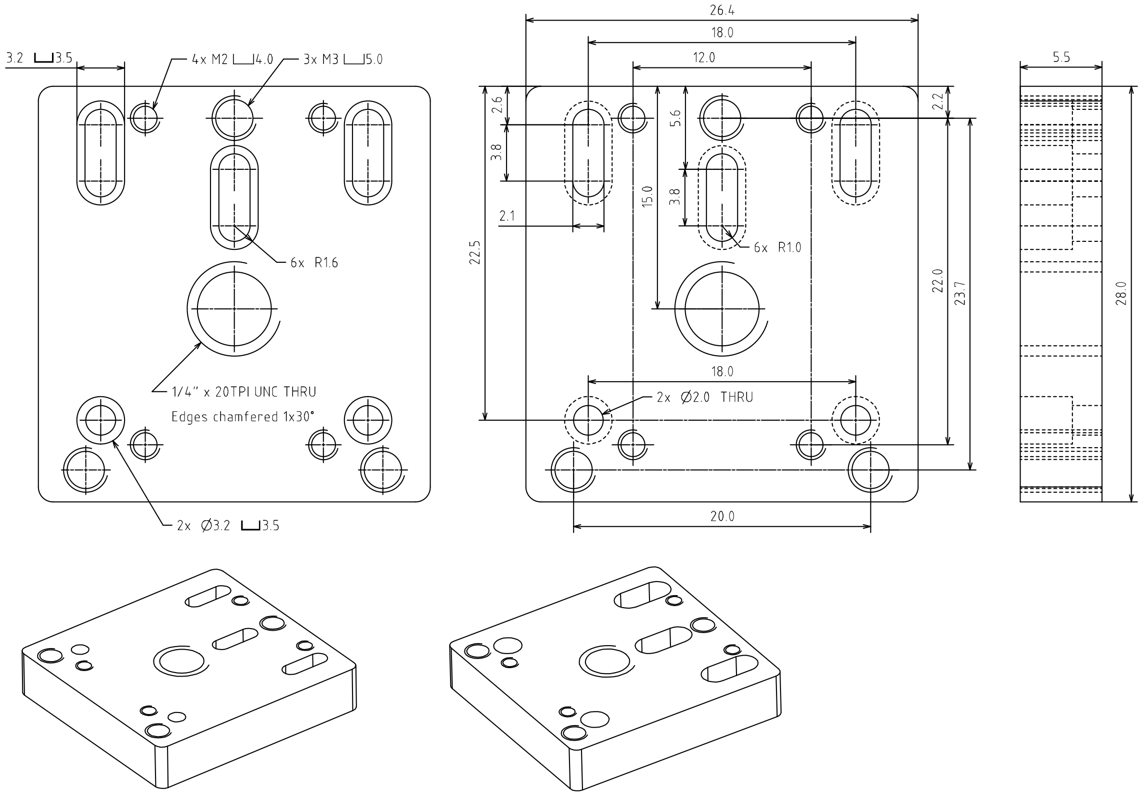


figure 3-68, dimensional drawing tripod adapter MQ-BRACKET-T

MQ-BRACKET-T Mass without screws: 9.3 g.

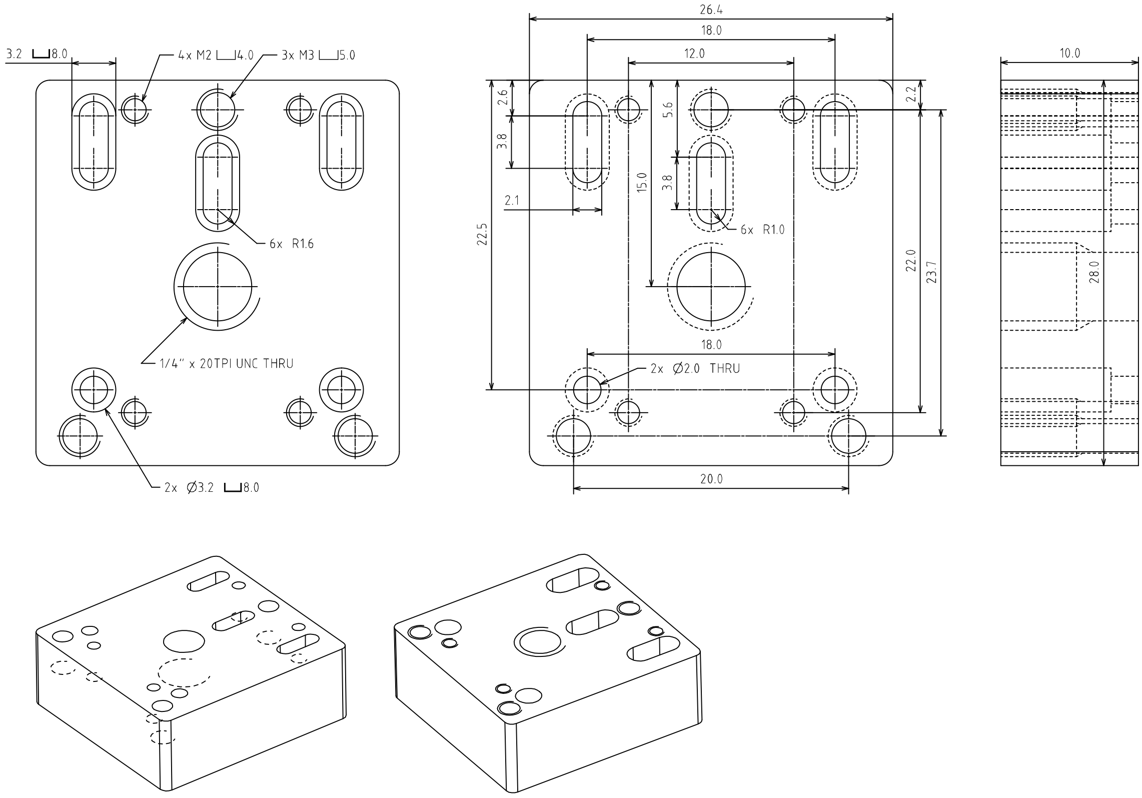


figure 3-69, dimensional drawing tripod adapter MQ-BRACKET-T-THICK

MQ-BRACKET-T-THICK Mass without screws: 16.8 g.

3.17. USB 3 host adapters

USB 3.0 to PCI Express x1 Gen2 Host Card

figure 3-70, 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 depends on selected host adapter. Please refer to host adapter specification

4. Operation

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

4.1. System Requirements

4.1.1. Software Requirements

The xiQ cameras are compatible with the following operating systems:

- Windows 7 SP1
- Windows 10
- 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 xiQ 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 xiQ cameras are compatible with USB 3.0 and USB 2.0 (only camera models MQ013xG-E2). Please note, that the highest performance can only be achieved by using high performance 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 xiQ 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
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:	2GB RAM or more
Disc Space:	200 MB of free disc space
Video:	NVIDIA or Radeon graphics card 128MB
Ports:	Motherboard with a USB 3.0 port connected to a high performance chipset (e.g. Intel QM77 or Z77) and/or PCIe x1-16 Gen 2 slot for compatible USB 3.0 host adapter (see next chapter for more details)

4.1.2.2. USB 3.0 Host Adapter

For a stable operation of your xiQ camera and achieving the maximum possible system performance with the highest frame rate it is important to choose an appropriate USB 3.0 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 host adapter chipsets together with the available bandwidth (e.g. see *4.1.2.2 USB 3.0 Host Adapter*).

The maximum data transfer rate depends on different conditions (motherboard, chipset, driver version, operating system , ...). The Following table lists the maximum data transfer speed achieved using the selected controller on Windows 7 x64 with CPU Intel i7-3770.

USB3-Controller	Driver version	Data [MB/s]
Fresco Logic FL1009	3.5.24.0	395
Fresco Logic FL1100	3.5.24.0	400
Intel QM77	1.0.4.220	450
Intel Z77	1.0.4.220	450
Renesas D720202	3.0.12.0	365

table 4-1, USB3 maximum data transfer rates

PCI Express (PCIe) bus speed requirement: To achieve maximum performance of USB3 cameras - USB 3.0 host adapter must be connected to the PCIe slot/port/hub supporting Gen 2 (or higher) and running at 5Gb/s.

4.1.2.3. Cables

The USB 3.0 cable that you use with the xiQ camera is responsible for the power supply and the data transfer to the PC. It is required to use an industrial USB 3.0 cable with a proper wiring and shielding. We recommend using XIMEA industrial USB 3.0 cables in order to achieve the maximum possible performance of the camera.

XIMEA offers several passive USB 3.0 cables and a sync cables, please see *3.10 CBL-U3-1M0 / CBL-U3-3M0* / CBL-U3-5M0, *3.11 CBL-U3-3M0-ANG* and *3.12 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.

However, on some sensors, the actual output resolution can deviate from the specification if a color mode is used (see. *3.5 Model Specific Characteristics*).

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 xiQ 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. Since the utilized CMOS sensors rely on the output of full lines, only the decrease of lines, i.e. the vertical resolution, results in an increase of frame rate.

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 cropping the image. 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×k 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 2×2 skipping, every odd number line used and every even number line is skipped, every even number pixel in line is skipped as well, resulting in an image with ¼ of the original resolution. Skipping is a faster binning 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 xiQ 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 4-2, 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.

4.3. 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 exposition is 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).

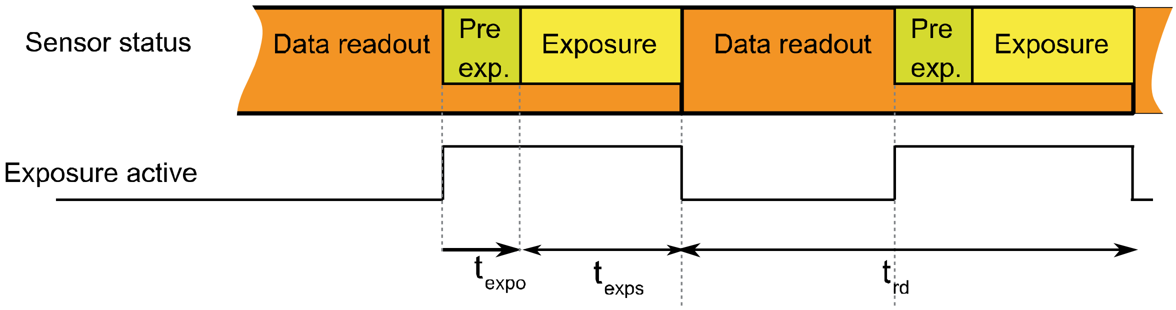


figure 4-1, acquisition mode - free run

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

In situation when the exposure time is comparable or longer than readout time, the exposure active signal might have constant active level during acquisition. This might be caused also by different propagation delay for rising and falling edge of opto isolated outputs. (See *3.9.4 Digital Output*) Polarity inversion might help to make visible the separated exposure pulses.

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 send to the sensor using the digital input described in *3.9.3 Digital Input* section.

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

4.3.2.1. Triggered mode without overlap

This mode gives lower FPS compared to *Free-Run* mode and lower FPS than *Exposure Overlapped with Data Readout* mode.

Sensor timing in Exposure Overlapped with Data Readout Mode

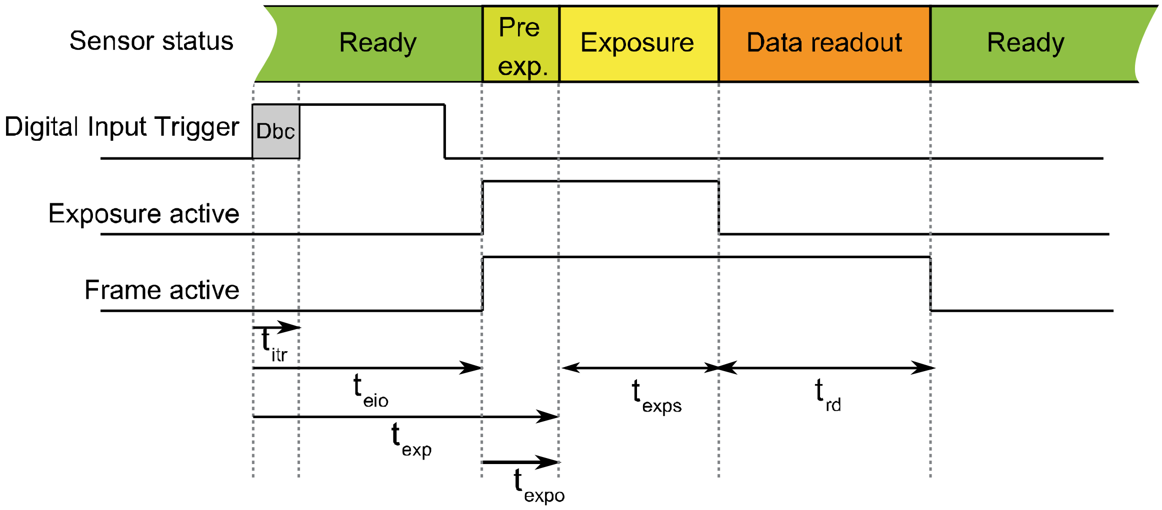


figure 4-2, acquisition mode – triggered without overlap

In this mode the timing depends on sum of:

- Input transition time (t_{itr}), depends on:
  - Digital Input Delay - time for changing internal circuit to active state. It is constant for each camera model.
  - Input Debouncing Time - time for stabilizing uneven input signals (e.g. from mechanical switches). This time can be can be set using xiAPI with parameters XI_PRM_DEBOUNCE_EN and XI_PRM_DEBOUNCE_T0 on some cameras. Default 0.
- Exposure time (see ET above).
- Data Readout time (see t_{rd} above)

Typical times for selected camera models

Camera Model	DownS	t_{itr} [µs]	t_{exp} [µs]	t_{eio} [µs]	t_{expo} [µs]	t_{rd} [µs]	Notes
MQ013xG-E2	any	1.4	29	19/238	-10	400+16.6*BWF*LC	N1, N2

table 4-3, trigger mode w/o overlap, timing

Notes:

- N1: V(Input)=15V
- N2:**x** in model name means all available models (M, C, R)

Description:

DownS = Current camera DownSampling (XI_PRM_DOWNSAMPLING)

t_{eio} = Trigger (Digital Input) to Strobe (Digital Output) (on some models is listed: Off->On change / On->Off change)

t_{exp} = Strobe (Sensor) to Digital Output (on some models is listed: Off->On change / On->Off change)

t_{expo} = Start of exposition to Exposure Active Digital Output

LC = Current Line Count (XI_PRM_ HEIGHT)

BW = Bandwidth Factor for maximum bandwidth this is 1 when the bandwidth will be lower BWF will rise (TBD)

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

Conditions: XI_PRM_DEBOUNCE_EN=0 (off).

Minimum trigger period (T_{trig_min})

Minimum trigger period can be calculated using the following formula:

$t_{trig\_min} = t_{exp} + t_{exps} + t_{rd}$

Example for MQ013MG-E2, Exposure time = 500µs, image = 500 pixels width x 200 pixels height:

t_{trig_min} = 29µs + 500µs + 400µs + 16.6µs * 200lines = 4.249ms

4.3.2.2. Triggered mode with overlap

Several sensors are capable to trigger exposure in overlap mode, so it is capable to reach the same frame rate as in free run mode.

When the trigger period is longer than the exposure and readout time, the signal wave form will look similar to *Triggered mode without overlap*. 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.

Sensor timing in Exposure Overlapped with Data Readout Mode

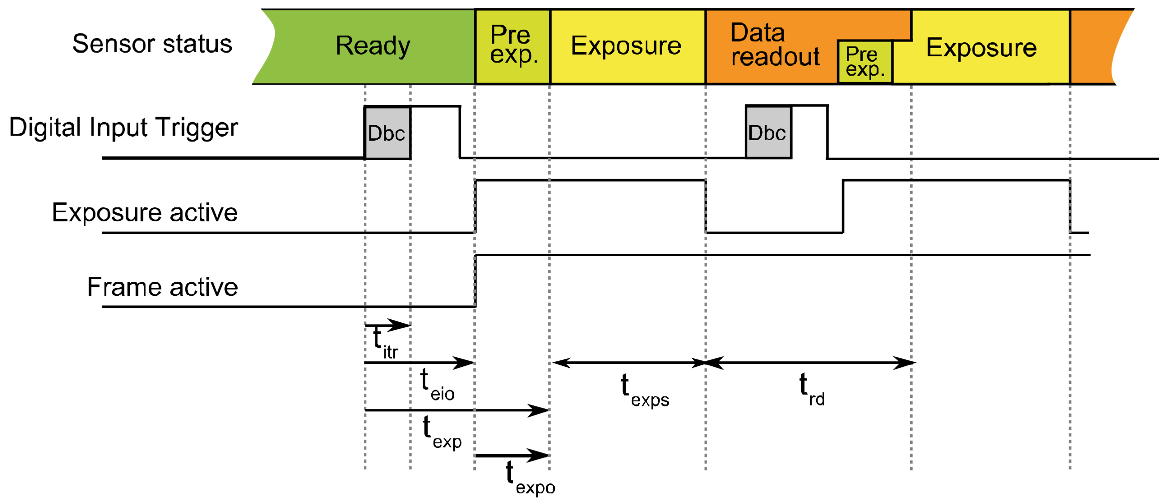


figure 4-3, acquisition mode – triggered with overlap

For timing description please see previous paragraph

Typical times for selected camera models

Camera Model	DownS	t_{itr} [µs]	t_{exp} [µs]	t_{eio} [µs]	t_{expo} [µs]	t_{rd} [µs]	Notes
MQ042xG-CM	any	1.4	10	11/224	0	(64.5+5.375*LC)*BWF	N1,N2
MQ022xG-CM	any	1.4	10	11/224	0	(37.625+5.375*LC)*BWF	N1,N2
MQ003xG-CM	any	1.4	10	11/224	0	(40.625+6.771*LC)*BWF	N1,N2,N3

table 4-4, trigger mode with overlap, timing

Notes:

- N1: V(Input)=15V
- N2: 8bit per pixel maximum bandwidth (TBD)
- N3: $t_{exps} > t_{rd}$ for $t_{exps} < t_{rd}$, t_{eio} and t_{exp} will plus (t_{rd} - t_{exp})

Description:

DownS = Current camera DownSampling (XI_PRM_DOWNSAMPLING)

t_{eio} = Trigger (Digital Input) to Strobe (Digital Output) (on some models is listed: Off->On change / On->Off change)

t_{exp} = Strobe (Sensor) to Digital Output (on some models is listed: Off->On change / On->Off change)

t_{expo} = Start of exposition to Exposure Active Digital Output

LC = Current Line Count (XI_PRM_ HEIGHT)

BWF = Bandwidth Factor see table below

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

Conditions: XI_PRM_DEBOUNCE_EN=0 (off).

Bandwidth factor

Bandwidth factor is a number reflecting the ratio between the maximum sensor frequency and the current sensor frequency, calculated from the Bandwidth Limit.

$BWF = F_{max} / F_{limit}$

Where F_{max} is maximum possible clock for used sensor in MHz and F_{limit} is used clock depending on Bandwidth Limit parameter set in API (XI_PRM_LIMIT_BANDWIDTH). F_{limit} is set in 1MHz steps and cannot go lower than F_{min}.

MQ003xG-CM

F_{max} = 24MHz

F_{min} = 10MHz

$$F_{limit} = \frac{325 * BWL}{10368 * BPP} * \frac{6 + LC}{LC} [MHz]$$

t_{fot} = 40.625*BWF [µs]

BPP number of bytes per pixel

BWL bandwith limit in Mbit/s

MQ042xG-CM and MQ022xG-CM

F_{max} = 48MHz

F_{min} = 5Mhz

$$F_{limit} = \frac{129 * BW}{8192 * BPP} * \frac{12 + LC}{LC} [MHz]$$

t_{fot} = 64.5 * BWF [µs]

BPP number of bytes per pixel

BW bandwidth in Mbit/s

Minimum trigger period (t_{trig_min})

Minimum trigger period can be calculated using the following formula:

$t_{trig\_min} = t_{exp} + t_{exps}$ (When exposure time is longer than readout time)

$t_{trig\_min} = t_{rd}$ (When exposure time is significantly shorter then readout time)

$t_{trig\_min} = t_{exps} + t_{fot}$ (When exposure is smaller than readout time but the difference is less than t_{fot})

Example for MQ022MG-CM, Exposure time = 500µs, image = 2048 pixels width x 1088 pixels height with maximum bandwidth and 1 byte per pixel:

t_{trig_min} = 10µs + (37.625 + 5.375 * 1088 lines) * 1 = 5895µs

4.3.2.3. Triggered acquisition - burst of frames

Frame Burst Start

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

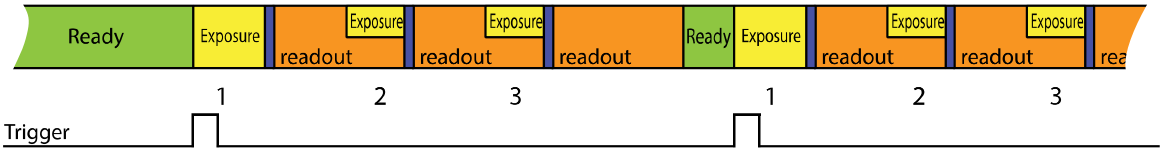


figure 4-4, triggered burst of frames – frame burst start, number of frames in burst set to 3

Frame Burst Active

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

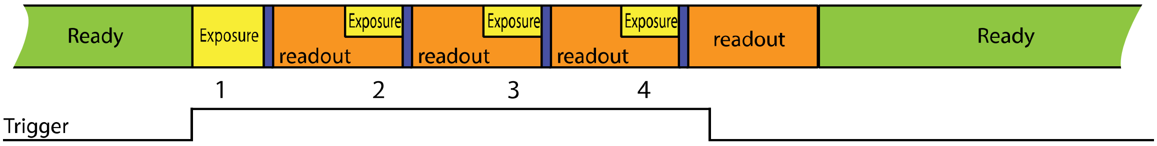


figure 4-5, triggered burst of frames – frame burst active

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

4.3.2.4. 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.

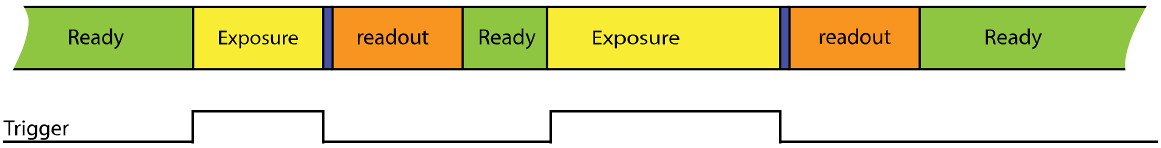


figure 4-6, Exposure defined by trigger pulse length

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

Note: This feature is not supported by MQ013xG-E2.

4.4. Camera Parameters and Features

4.4.1. Exposure

Also known as shutter speed. This parameter defines the length of the integration period for each frame.

Most of 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 are using dividers to generate slower clocks for internal usage.

The exposure time is mostly defined by number row times, where the row time is dependent on various internal settings. Very few sensors support exposure times equal to zero. There is defined minimal exposure time as well as steps between possible exposure times.

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.

4.5.7. HDR

Some sensors offer the ability to acquire images with a higher dynamic range than the value presented in the specification.

The high dynamic range can be achieved by several means as part of the sensor output. The feature that is used on xiQ cameras is a piecewise linear response, a so-called multiple slope integration.

The dynamic range of a linear image sensor is limited by the saturation of the pixel. Different light intensities are shown in the figure below. All blue marked light intensities cause different signal levels and can be separated without saturation. All red marked intensities cause an overexposure and the info about the different light intensity above 100% is lost.

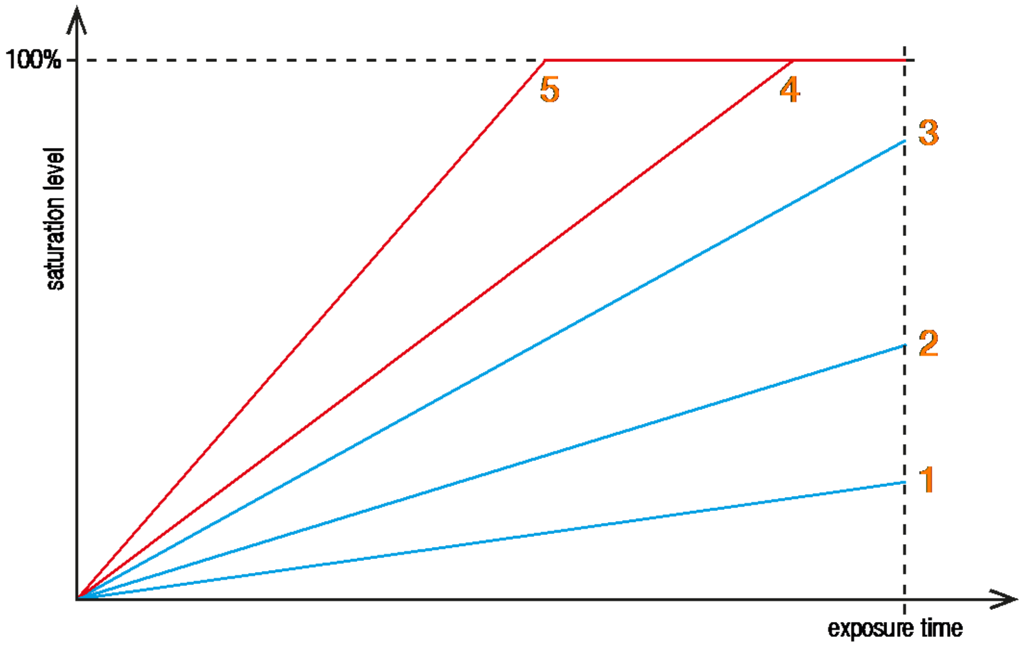


figure 4-7, image saturation example without HDR

Please note the exemplary corresponding positions 1 – 5 in the image with standard dynamic range:

figure 4-8, image example without HDR

The dynamic range can be increased by dividing the integration (exposure time) in two or three phases (slopes), with different maximum saturation levels. The xiQ cameras support the dividing in three slopes.

To use this kind of HDR method the user has to define two pairs of parameters: (T1, SL1) and (T2, SL2).

- T1 and T2 define portions of the total exposure time and the length of the three timing phases.
- SL1 and SL2 define portions of the sensor saturation, so called kneepoint1 and kneepoint2.

Please note the figure below:

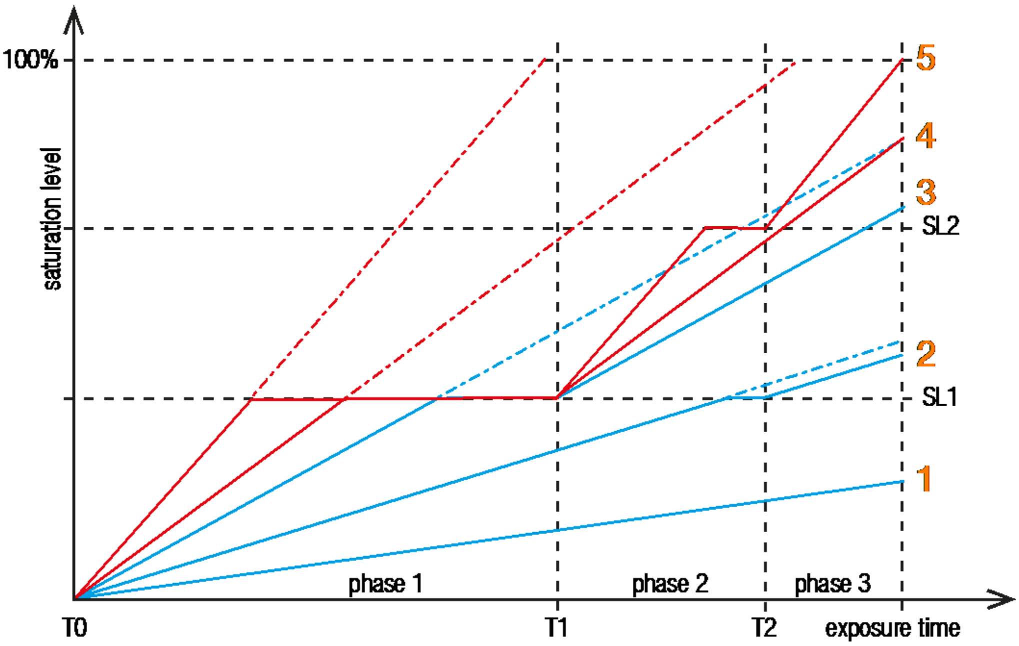


figure 4-9, image saturation example with HDR

Please note the exemplary corresponding positions 1 – 5 in the image with high dynamic range:

figure 4-10, image example with HDR

Description of the multiple slope integration:

Phase 1

- All pixels are integrated until they reach the defined saturation level of kneepoint1 (SL1).
- If the saturation level of kneepoint1 is reached, the integration stops. SL1 is the maximum saturation level for all pixels in this phase.

Phase 2

- All pixels are integrated until they reach the defined saturation level of kneepoint2 (SL2).
- If the saturation level of kneepoint2 is reached, the integration stops. SL2 is the maximum saturation level for all pixels in this phase.

Phase 3

- All pixels are integrated until the exposure time is reached. The pixel saturation may reach the maximum saturation level.

The main idea of this method is to reach an approx. logarithmic saturation curve. In order to achieve this goal phase2 always has a smaller slope than phase1 and phase3 smaller than phase 2. Thus, the signal response during phase1 is higher as during phase2. And the signal increase during phase2 is higher than during phase3.

As a result, darker pixels can be integrated during the complete integration time and the full sensor sensitivity can be exploited. Brighter pixels are limited at the knee points and lose a part of their integration time.

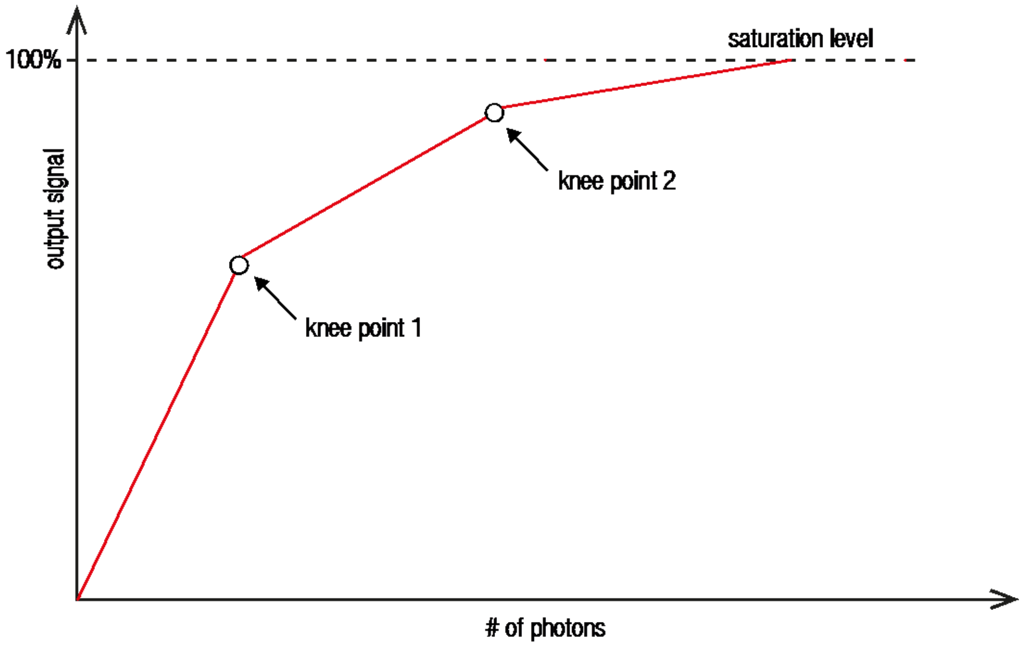


figure 4-11, HDR - approx. logarithmic saturation curve

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

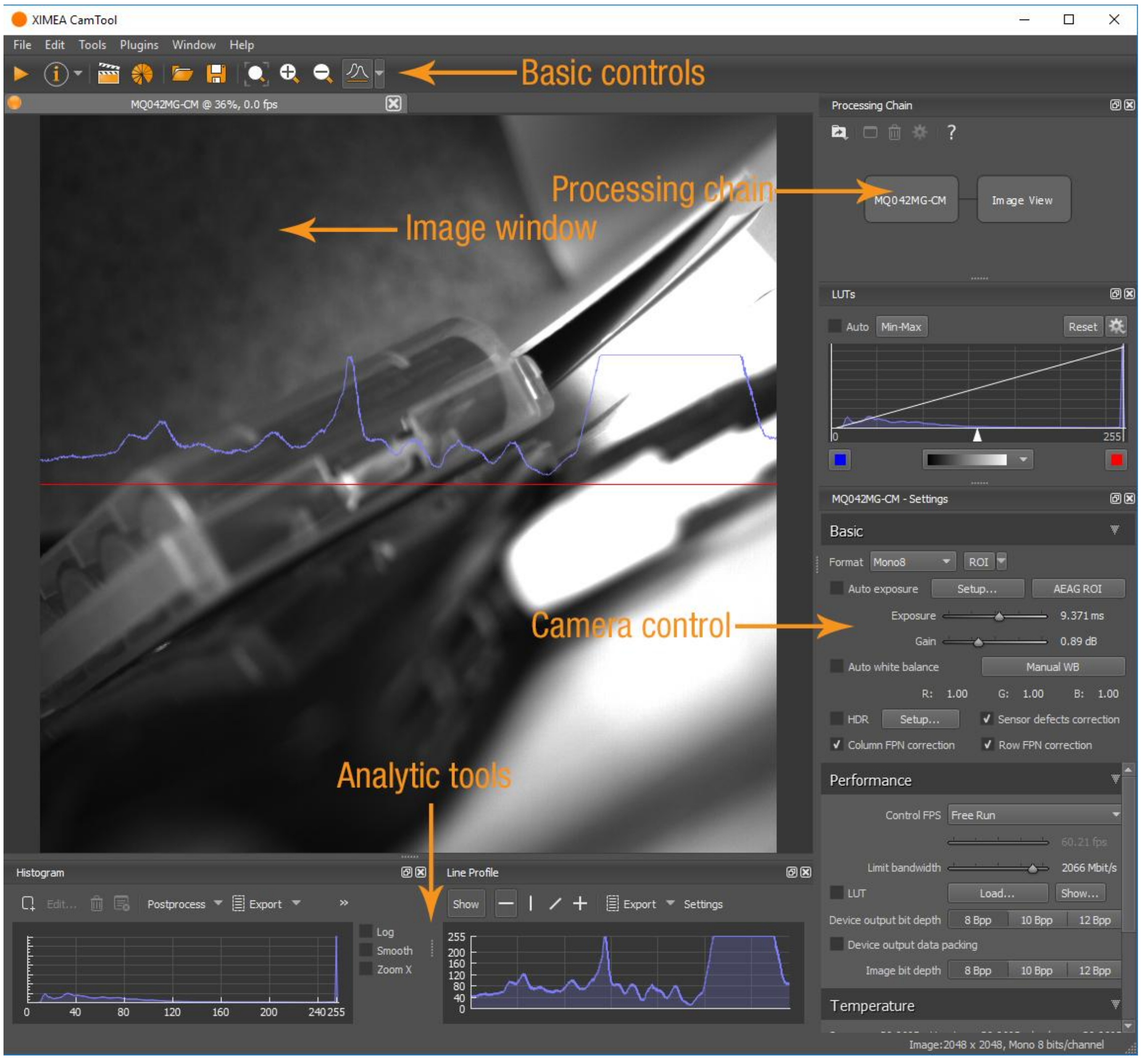


figure 5-1, CamTool Layout

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 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, approx. 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):

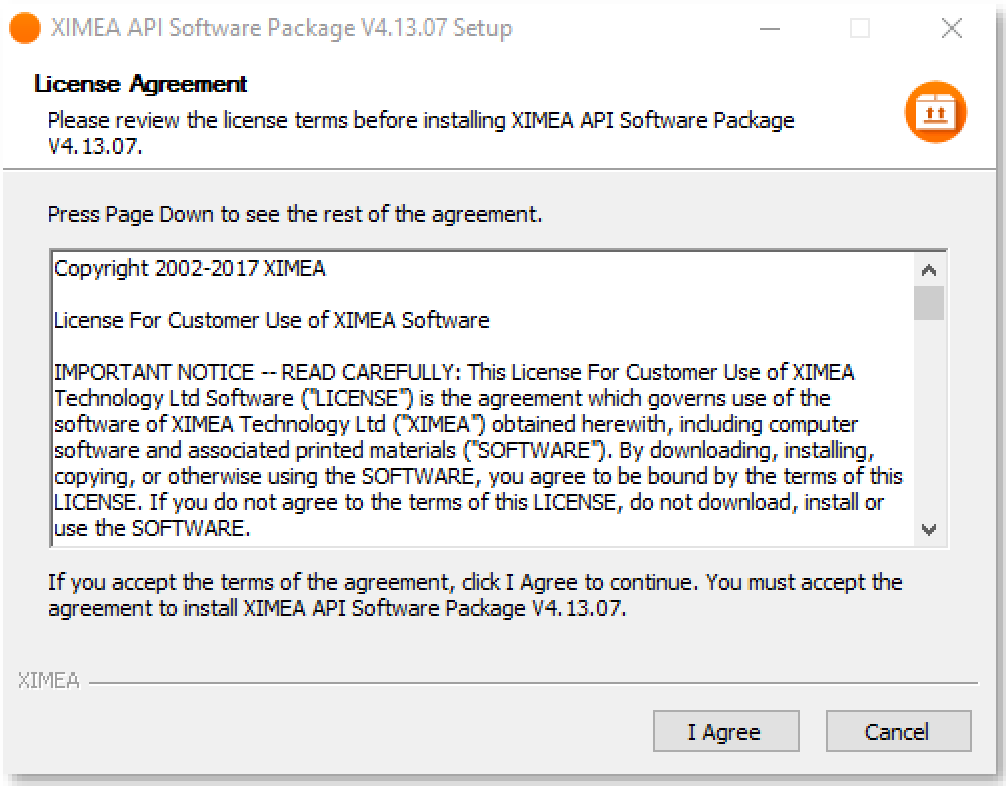


figure 5-2, XIMEA Windows Software Package installation - 1

- 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.

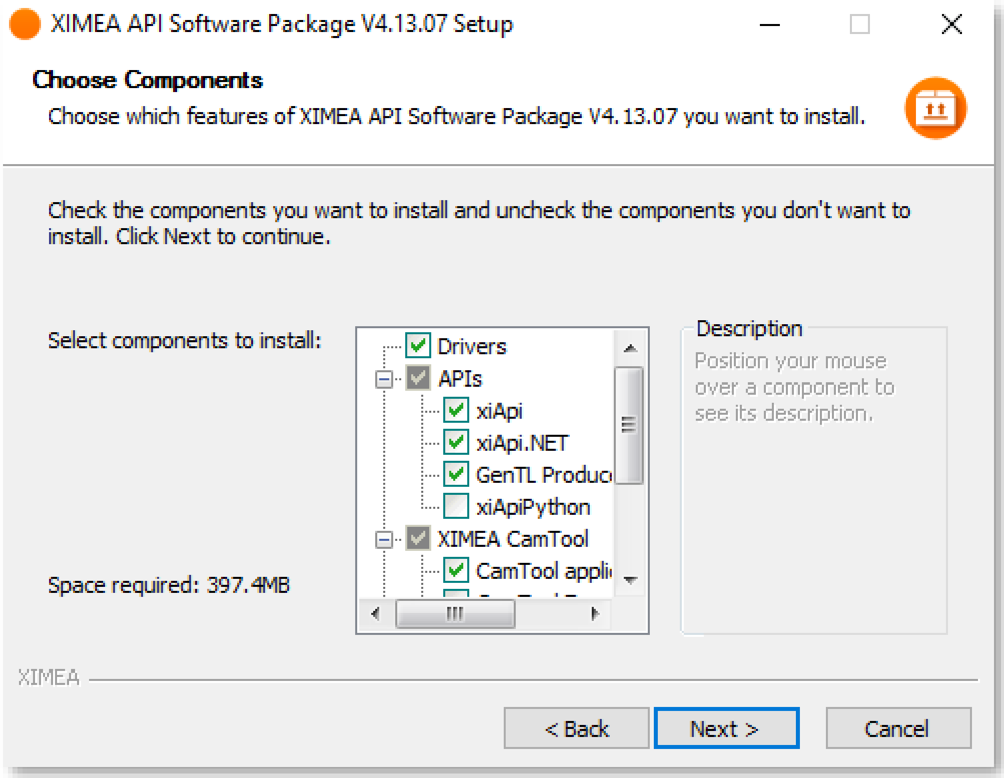


figure 5-3, XIMEA Windows Software Package installation - 2

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

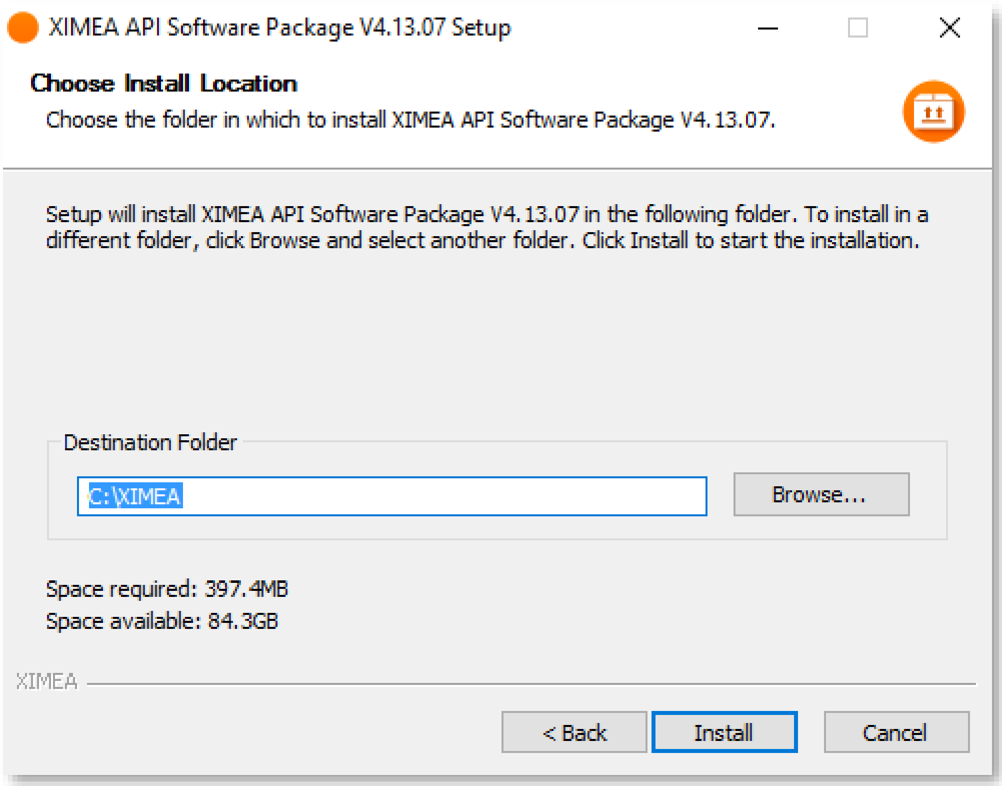


figure 5-4, XIMEA Windows Software Package installation - 3

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

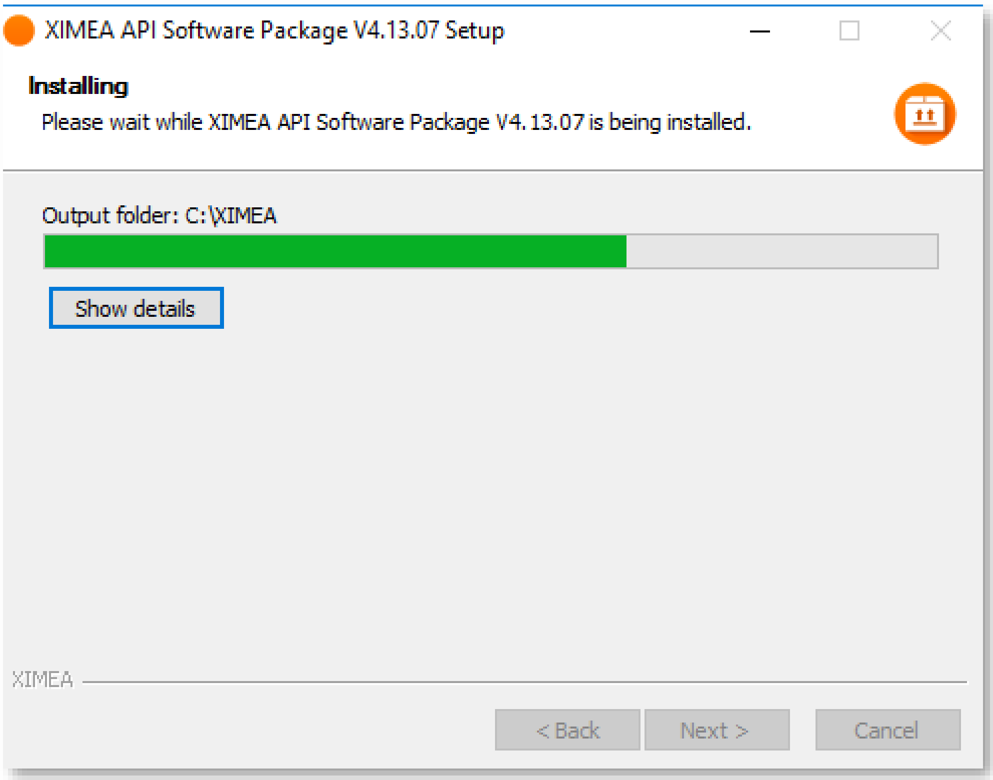


figure 5-5, xiAPI installation, Windows - 4

- Installation is completed.

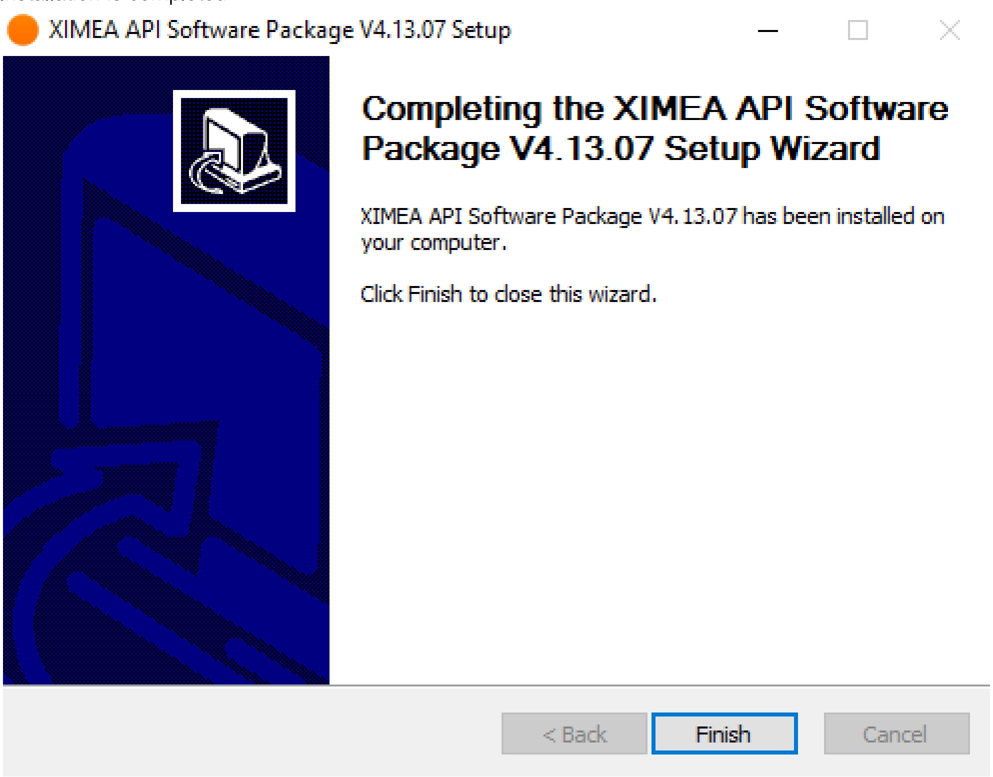


figure 5-6, xiAPI installation, Windows - 5

- 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
  ```

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

Installing API library
OK
OK
OK

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

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

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 *5.4 XIMEA Windows Software Package*

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.

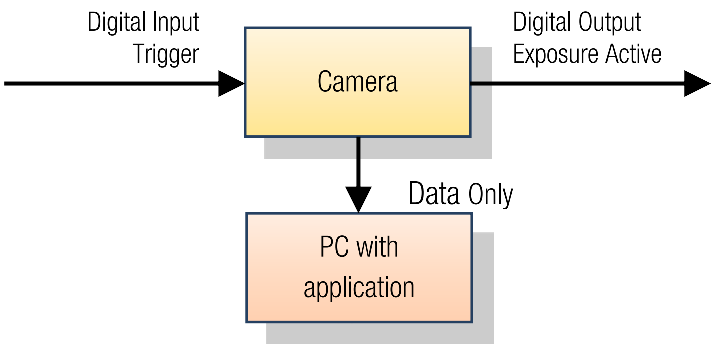


figure 5-11, GPIO - schematic

```
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, or short xiCOP, is a diagnostics and management tool for all XIMEA cameras.

xiCOP is currently only available for Windows operating system.

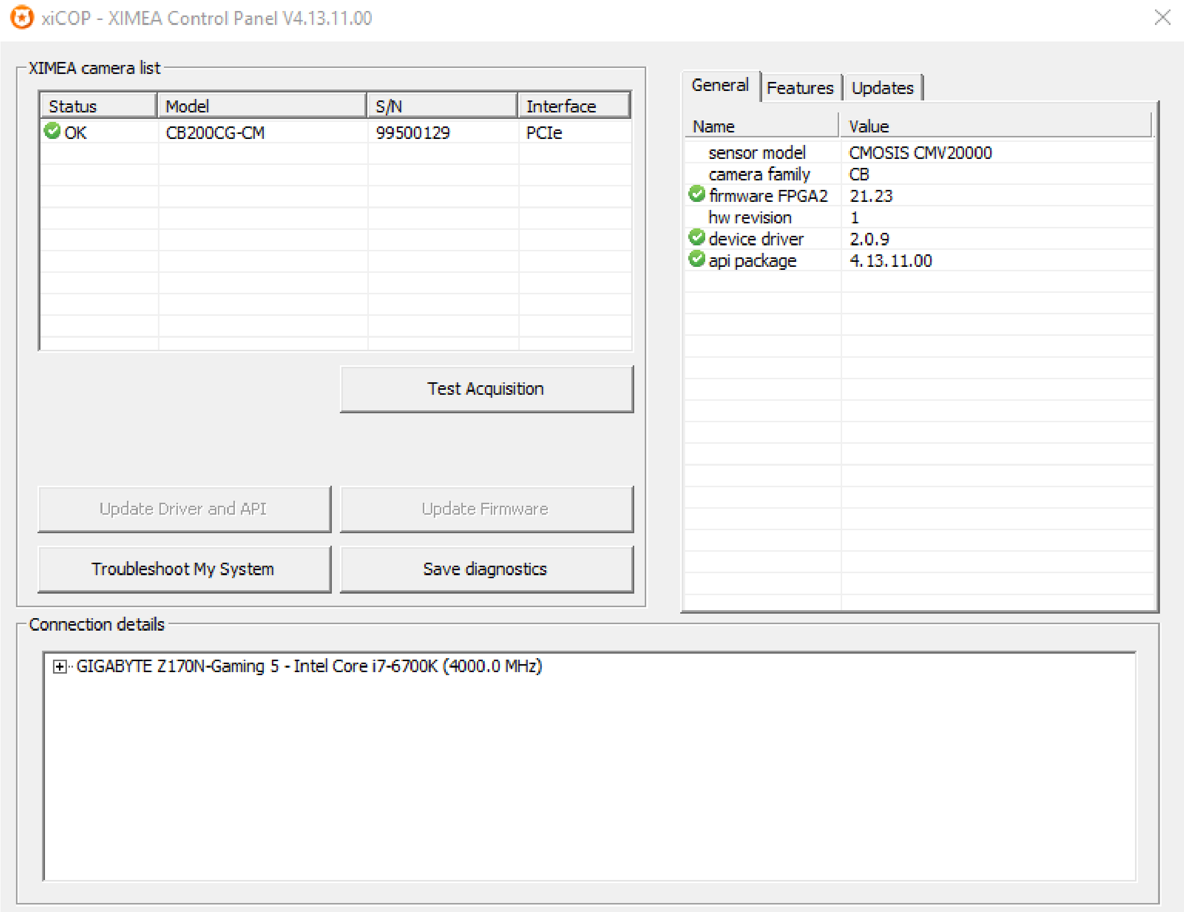


figure 5-12, xiCOP

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 is a component is not up-to-date.
- List all currently attached XIMEA devices and their features.
- Suggests solution for diagnosed issues.
- One click to switch selected XIMEA cameras to USB3 Vision standard.
- One click to switch selected XIMEA cameras to back to XIMEA API.
- 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 xiQ camera to a proper operation.

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

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

Please make sure, that you have connected your xiQ 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 xiQ 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 xiQ 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 xiQ 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 take 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 3.0 SuperSpeed?

USB 3.0 is the latest major revision of Universal Serial Bus (USB) standard which brings transfer speed of 5Gb/s and enables delivery of up to 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?

xiQ camera can deliver up to 450Mbyte/sec. This requires that certain conditions are met, see in *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

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 in *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 xiQ to turn it on/off?

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

VDI (Opto-isolated)	Logical level
0 – 5Vdc	Off (zero)
5 – 15Vdc	Undefined
15 – 24Vdc	On (one)

table 6-3, voltage levels for digital input 24V logic

VDI (Opto-isolated)	Logical level
-24 – 5Vdc	Off (zero)
2 – 4Vdc	Undefined
4 – 24Vdc	On (one)

table 6-4, voltage levels for digital input 5V logic

Maximal input voltage 24Vdc

For more details see also *3.9.3 Digital Input*

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

VDO is opto-isolated NPN open collector type, max. load current 25mA, max. open voltage 24Vdc.

For more details see also *3.9.4 Digital Output*.

6.2. Product service request (PSR)

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

6.2.1. Step 1 - Contact Support

If your xiQ 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 6-4, 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

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

6.4. Warranty

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

6.5. List Of Trademarks

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

6.6. Standard Terms & Conditions of XIMEA GmbH

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

6.7. 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.

6.8. Revision History

Version	Date	Notes
1.0	06/21/2013	Initial version
1.01	06/24/2013	--
1.02	07/01/2013	Minor changes in chapter "optical path"
1.12	05/05/2015	Added 5V input description, small corrections
1.20	24/07/2015	Added MQ013xG-ON (PYTHON1300), added FL1100 host controller card
1.21	04/11/2015	Corrected minimal exposure for MQ013xG-ON
1.22	10/11/2015	Corrected minimal exposure for MQ003xG-CM
1.23	02/12/2015	Buffering info added
1.24	25/07/2016	Added peak power consumption information
1.25	18/10/2016	Corrected image parameters for MQ013xG-ON
1.30	07/18/2017	Added MQ013RG-ON camera model Added flex line accessories Reviewed software paragraphs Added board level mechanical drawing
1.31	08/07/2017	Extended MQ013xG-ON (PYTHON) specification
1.32	08/31/2017	Corrected typing errors
1.33	01/17/2018	Updated optical path paragraph
1.34	08/24/2018	Added description of –FL variant of MQ family
1.35	09/09/2019	Added new generation of Flex cables, corrected flex connector pin description Added description for master slave camera connection Corrected typing errors
		Updated MQ0x2xG available gain range
1.36	19/10/2023	Cumulative updates
1.37	01/08/2024	Corrected information about AR coating of IR650 filters

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
T_{int}	Integration time

8. list of figures

9. list of tables

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