ximea

xiX

[ksi-x: or sai-ex:]

- PCI Express cameras for integration

Technical Manual

Version 2.0, February 2023

1. Introduction

1.1. About This Manual

Dear customer,

Thank you for purchasing a product from XIMEA.

The purpose of this document is to provide a description of the XIMEA xiX-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.

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 section of our website: www.ximea.com/support

This document is subject to change without notice.

1.2. About XIMEA

We develop, manufacture and market innovative camera solutions and imaging systems for integrators, OEMs, and the global markets in general. Our history in research, development, and production dates back to 1992. From our locations in Slovakia, Germany, and the US, and with a global distributor network, we offer our solutions to all types of companies and institutions across every imaginable application field.

Industrial cameras, scientific cameras, custom engineering, imaging ecosystems as well as software and tools form the portfolio.

A 50/50 mix of custom projects and series production guarantees innovative, technology-driven developments, as well as reliable supply and support.

We utilize the latest CMOS and sCMOS sensors combined with the fastest and highly efficient interfaces such as USB3, Thunderbolt, and PCIe.

The robust camera packages are the smallest and lightest in class. The mechanical and electrical design aims for a high degree of flexibility that facilitates all sorts of integrations.

Innovative cooling concepts and deep knowledge in sensor tuning, elevate the imaging performance.

The extensive software support spans across various platforms, operating systems, and programming environments. In addition, we support generic camera interfaces and a multitude of vision libraries.

Technology-driven and always seeking innovative solutions, our creations are already solving future problems today.

We don‘t just make imaging systems - we invent them.

1.2.1. Contact XIMEA

XIMEA is a worldwide operating company

Headquarters
Sales worldwide

XIMEA GmbH
Am Mittelhafen 16
48155 Münster
Germany
Tel: +49 (251) 202 408-0
Fax: +49 (251) 202 408-99

Sales America

XIMEA Corp.
12600 W Colfax Ave., Suite A-130
Lakewood, CO 80215
USA
Tel: +1 (303) 389-9838
Fax: +1 (303) 202-6350

R&D, Production

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

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

1.3. Standard Conformity

The xiX cameras have been tested using the following equipment:

- List equipment: To be added

1.3.1. CE Conformity

To be added

1.3.2. For customers in the US: FCC Conformity

To be added

1.3.3. For customers in Canada

The xiX cameras comply with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

1.3.4. RoHS Conformity

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

1.3.5. WEEE Conformity

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

1.3.6. GenICam GenTL API

GenICam standard transport layer interface for 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

- XIMEA Homepage http://www.ximea.com/
- XIMEA Software Package https://www.ximea.com/support/wiki/apis/APIs#Software-packages
- 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 Support https://www.ximea.com/support/wiki/allprod/Contact_Support
- XIMEA General Terms & Conditions http://www.ximea.com/en/corporate/generaltc

1.5. Table of Contents

2. xiX Camera Series

2.1. What is xiX

xiX [ksi-x: or sai-ex:]] is an ultra-compact PCI express industrial camera family with outstanding features:

- extremely small footprint
- sensors: Nearly every sensor installed into any XIMEA camera is also available in the xiX line, which provides a higher bandwidth connection to support the full speed potential for every sensor. Resolutions from 2.3 MP to 100+ MP are utilized from every sensor manufacturer we do business with

The impetus behind the xiX family is having the option to utilize multiple cabling systems to transmit data, power and trigger signals. This is ideal for embedded and high-density applications. Most standard connectors - like iPass, USB and Type-C - are much bigger than the high-density connectors utilized in the xiX lines.

The xiX camera line comes in two form factors. Small (1inch square) with smaller sensors and interface PCIe x2 Gen2 (10Gbits/s) and C/CS lens mount, and large (60x60mm) with interface PCIe x4 Gen2 (20Gbit/s) and active Canon EF-mount.

2.2. Advantages

Industry standard interface	PCI Express
Small	Perfect size and customization options for Embedded vision system applications
Powerful	20Gb/s interface using standard PCI Express hardware (X4G2 models)
Fast	High speed, high frame rate: for example, >218fps at 3.1Mpix and 133fps at 12Mpix resolutions
Robust	Full metal 'semi-housed'
Lightweight	Facilitates increased performance of robotic arms and gimbals
Connectivity	Programmable opto-isolated I/O, and non-isolated digital input and output. 4 status LEDs
Compatibility	Support for Windows, Linux and MacOS, various Image Processing Libraries and programming languages
Software interfaces	GenICam / GenTL and highly optimized xiAPI SDK
Economical	Excellent value and price, low TCO and fast ROI
Low latency	Computer CPU not involved in data transfer, latency from camera to memory is low
Optimized transfer	GPU-direct (Linux only) ideal for setups using GPU for image processing

table 2-1, advantages

2.3. PCI Express 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
- VR and AR
- Cinematography
- Sports
- Unmanned and autonomous vehicles
- UAV / Drones etc.

2.4. Common features

Sensor Technology	CMOS, Global shutter
Acquisition Modes	Continuous, software and hardware trigger, fps limiting, triggered exposure and burst
Partial Image Readout	ROI, Skipping and Binning modes supported (model specific)
Image data formats	8-, 10- or 12-bit RAW pixel data
Color image processing	Host based debayering, 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	Ribbon cable and breakout board options for various cabling options such as fiber optic or iPass
General Purpose I/O	X2G2 models - 1x opto-isolated input, 1x opto-isolated output, and 2 non-isolated bidirectional I/O, 4X user configurable LEDs X4G2 models - 2x opto-isolated input, 2x opto-isolated output, and 4 non-isolated bidirectional I/O, 4X user configurable LEDs
Synchronization	Hardware trigger input, software trigger, exposure strobe output, busy output
Housing and lens mount	Standard C-mount convertible to CS mount, and Canon EF mount, customizations available
Power requirements	Typically, external power supply required of 12-24V DC
Environment	Operating 0°C to 50°C ambient temperature, RH 80% non-condensing, -30°C to 70°C storage
Operating systems	Windows 11, Windows 10 (x86 and x64), Windows 7 SP1 (x86 and x64), Linux Ubuntu, MacOS 10.8
Software support	xiAPI SDK, adapters and drivers for various image processing packages
Firmware updates	Firmware can be updated in the field, and is free of charge

table 2-2, common features

2.5. What is xSWITCH

Utilizing PCIe as a camera interface offers unique camera aggregation options, at extremely high bandwidths: multiple cameras can be efficiently connected and their respective data streams bundled into a single copper or fiber optic cable connection to a host computer, writing directly to memory (DMA) at 64 Gbit/s. Ribbon cables between the cameras and the xSWITCH allow the most compact integration in tight spaces.

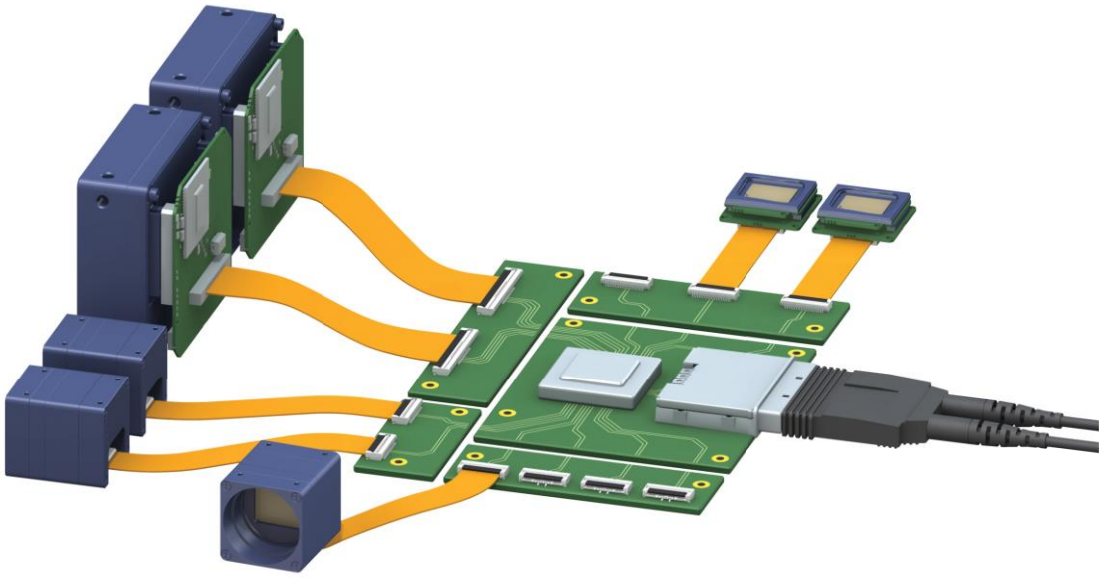


figure 2-1, example of aggregating many cameras into a single connection

PCIe allows multi camera systems aggregate data into one cable while the other end is connected to an expansion slot in the host computer. Moreover, it is possible to link several PCIe switches to create an optimal infrastructure. Together with the cameras it is also possible to populate the PCIe switch downstream ports with other controllers, such as USB 3, UART, etc.

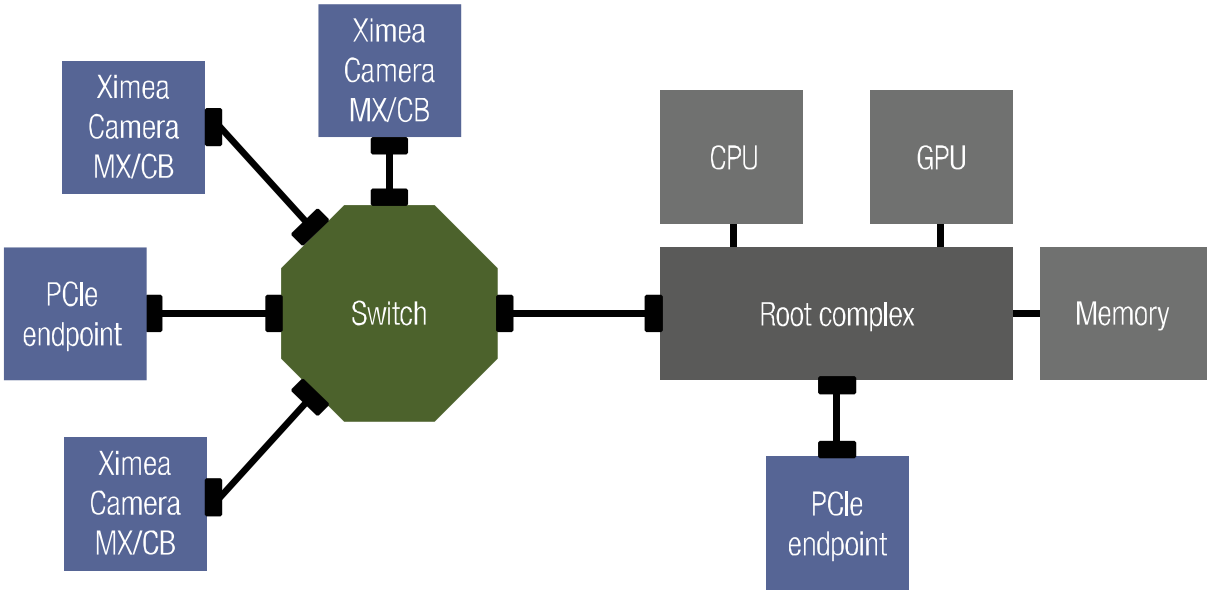


figure 2-2, PCI Express topology

HIGHLIGHTS

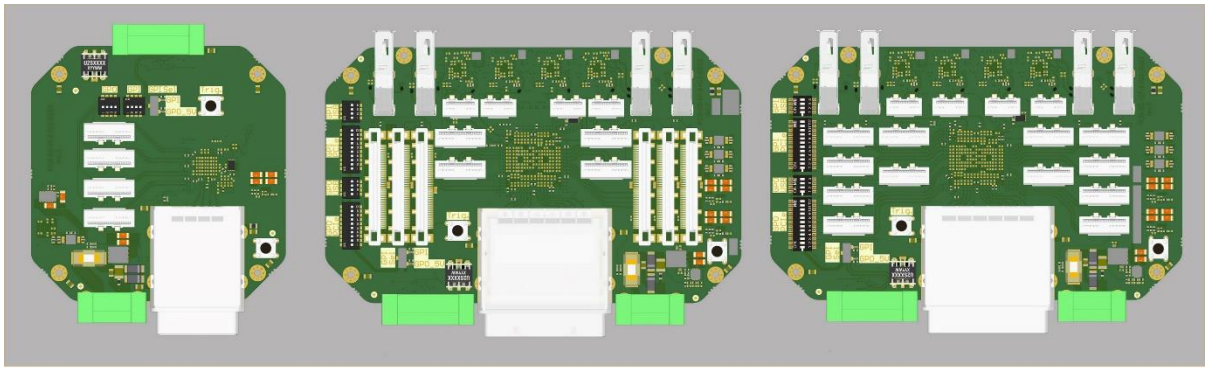
- Maximum compactness: smallest form factor cameras and mini connectors allow closest sensor-to-sensor proximity
- Aggregation into one high bandwidth upstream (currently up to 16Gbit/s with higher speeds on the way)
- Full utilization of PCIe architecture with point-to-point connection and direct memory access
- Use of standard components allows simple assembly for the creation of custom platforms
- No need for external or additional expansion backplanes
- Multiple types of xSWITCH boards available
- Board shape can be customized precisely to application requirements
- Benefits from XIMEA´s unique experience and expertise in the field of PCIe

MIX AND MATCH

- Connect various camera models and types of cameras to a single computer
- Select from a wide range of sensor resolutions and frame rates
- Combine housed and board level as well as monochrome, color, NIR, hyperspectral and other camera types into one system
- Choice of different number of PCIe lanes and PCIe standards (2, 4, 8 lanes / Gen2 or higher)
- Choice of various connectors: ribbon option, board to board, FireFly or iPass
- Choice of flat-flex connectors with vertical or horizontal orientation
- Bridge small or large distances of >100 m by adapting to optical fiber cable

2.5.1. xSWITCH examples

Several standard switches are available for embedded design.



Downstream 4x PCIe x2 Gen2 10Gb/s
Upstream 1x PCIe x4 Gen3 32Gb/s

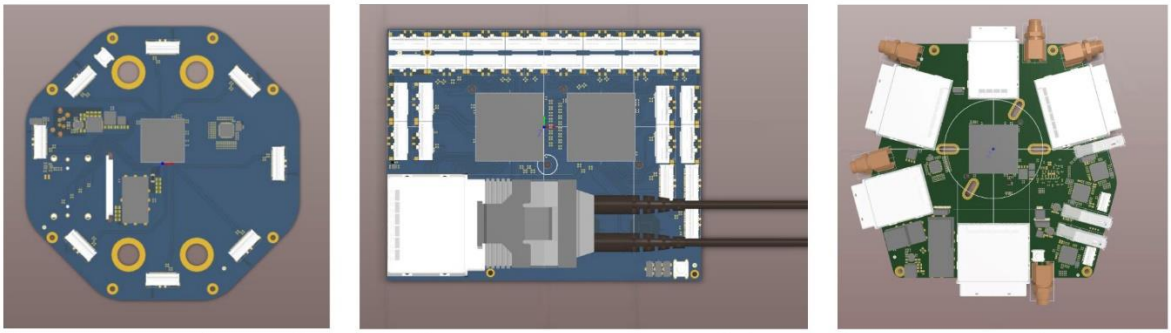
Downstream 6x PCIe x4 Gen2 20Gb/s
4x PCIe x2 Gen2 10Gb/s
4x USB 3.1 Gen1 5Gb/s (USB A)
4x USB 3.1 Gen1 5Gb/s (FLEX)
Upstream 1x PCIe x8 Gen3 64Gb/s

Downstream 12x PCIe x2 Gen2 10Gb/s
4x USB 3.1 Gen1 5Gb/s (USB A)
4x USB 3.1 Gen1 5Gb/s (FLEX)
Upstream 1x PCIe x8 Gen3 64Gb/s

figure 2-3, variations of standard switches for embedded vision systems

XIMEA also offers PCB design capabilities where the quantity, type, location and orientation of PCIe connectors can be varied to optimize the installation of multi-camera systems. Multiple variations of these PCB designs already exist based on the concept of empowering rapid customization of the final assembly and thus enabling most daring customer applications.

For more information, please contact our sales team: info@ximea.com



Downstream 8x x2 Gen2 10Gb/s
Upstream 1x x8 Gen3 64Gb/s

Downstream 27x x2 Gen2 10Gb/s
Upstream 1x x8 Gen3 64Gb/s

Downstream 2x x8 Gen3 64Gb/s
2x x4 Gen3 32Gb/s
5x USB3.0 5Gb/s
Upstream 1x x8 Gen3 64Gb/s

figure 2-4, Variations of customized switches tailored to customer-specific needs

2.6. Model Nomenclature

Part number convention for the different models:

MXxxxyZ-zz-XaGb [-OPT][-DR]

MX xiX family name

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

y: y=C: color model

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

Z: Z=G: Global shutter
Z=R: Rolling shutter

zz: Acronym for the sensor manufacturer

zz = SY: Sony,

zz = CM: AMS/CMOSIS

[-OPT]: Options

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

OPT = FV: flex line variant, connector vertical to board, semi-housed

OPT = FF: Firefly variant, compact Firefly connectors, semi-housed

(orientation of the connector is in reference to the board they are mounted on, which is installed parallel to the back face of the camera. -FV is mounted at 90 degrees to the board, -FL is mounted parallel to the board)

XaGb:

a = Number of PCIe lanes used, currently 2 to 8 lanes (a=2,4 or 8 for xiX cameras)

b = PCIe generation, currently at Gen 2 or 3 for xiX cameras

[-DR]: Dynamic range

DR = '': camera without HDR functionality

DR = HDR: camera with HDR functionality

Example: MX245MG-SY-X2G2-FF-HDR: MX camera with 24.5 Mpix, monochrome, global shutter, SONY sensor, 2-lane PCIe Gen 2 connectivity, with Firefly connectors and HDR capability.

2.7. Models Overview, sensor and models

Model[1]		Resolution	Pixel size	ADC [bit]	DR	Optical size	Sensor diagonal	FPS[2]
MX023MG-SY-X2G2	b/w	1936 x 1216	5.86 µm	10/12	71.7 dB	1/1.2"	13.4 mm	166
MX023CG-SY-X2G2	Color							
MX031MG-SY-X2G2	b/w	2064 x 1544	3.45 µm	8/10/12	70.8 dB	1/1.8"	8.98 mm	218
MX031CG-SY-X2G2	Color							
MX050MG-SY-X2G2	b/w	2464 x 2056	3.45 µm	8/10/12	70.8 dB	2/3"	11.07 mm	165
MX050CG-SY-X2G2	Color							
MX089MG-SY-X2G2	b/w	4112 x 2176	3.45 µm	8/10/12	70.5 dB	1"	16.05 mm	95
MX089CG-SY-X2G2	Color							
MX124MG-SY-X2G2	b/w	4112 x 3008	3.45 µm	8/10/12	70.5 dB	1.1"	17.58 mm	69
MX124CG-SY-X2G2	Color							
MX161MG-SY-X2G2	b/w	5328 x 3040	2.74 µm	8/10/12	70.2 dB	1.1"	16.78 mm	45.7
MX161CG-SY-X2G2	Color							
MX161MG-SY-X2G2-HDR	b/w				72.1 dB			45.6
MX161CG-SY-X2G2-HDR	Color							
MX203MG-SY-X2G2	b/w	4512 x 4512	2.74 µm	8/10/12	TBD dB	1.1"	17.45 mm	35.8
MX203CG-SY-X2G2	Color							
MX203MG-SY-X2G2-HDR	b/w				72.1 dB			35.7
MX203CG-SY-X2G2-HDR	Color							
MX245MG-SY-X2G2	b/w	5328 x 4608	2.74 µm	8/10/12	TBD dB	1.2"	19.27 mm	30.5
MX245CG-SY-X2G2	Color							
MX245MG-SY-X2G2-HDR	b/w				TBD dB			
MX245CG-SY-X2G2-HDR	Color							

table 2-3, X2G2 models overview

Model[1]		Resolution	Pixel size	ADC [bit]	DR	Optical size	Sensor diagonal	FPS[2]
MX120MG-CM-X4G2	b/w	4096 x 3072	5.5 µm	8/10/12	60 dB	22.53 x16.9	28 mm	133
MX120CG-CM-X4G2	Color							
MX200MG-CM-X4G2	b/w	5120 x 3840	6.4 µm	12	66 dB	32.76 x24.58	41 mm	32
MX200CG-CM-X4G2	Color							
MX500MG-CM-X4G2	b/w	7902 x 6004	4.6 µm	12	64 dB	36.35 x27.62	45.6 mm	30
MX500CG-CM-X4G2	Color							

table 2-4, X4G2 models overview

Note: 1) In the model's name please add

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

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

-FF for FIREFLY™ cable connection

2) At full resolution, 8-bit RAW

2.8. Accessories

The following accessories are available:

Item P/N	Description
CBL-MX-X2G2-0M07	0.07m flat ribbon cable for PCIe Gen 2 x2 (gold color)
CBL-MX-X2G2-0M10	0.1m flat ribbon cable for PCIe Gen 2 x2 (gold color)
CBL-MX-X2G2-0M25	0.25m flat ribbon cable for PCIe Gen 2 x2 (gold color)
CBL-MX-X2G2-0M50	0.5m flat ribbon cable for PCIe Gen 2 x2 (gold color)
CBL-PCIEFLEX-X2G2-0M10	0.1m flat ribbon cable for PCIe Gen 2 x2 (white color)
CBL-PCIEFLEX-X2G2-0M25	0.25m flat ribbon cable for PCIe Gen 2 x2 (white color)
CBL-PCIEFLEX-X2G2-0M50	0.5m flat ribbon cable for PCIe Gen 2 x2 cable (white color)
CBL-MX-X4G2-0M20	0.2m flat ribbon cable for PCIe Gen 2 x4
CBL-MX-X4G2-0M30	0.3m flat ribbon cable for PCIe Gen 2 x4
CBL-MX-X4G2-0M40	0.4m flat ribbon cable for PCIe Gen 2 x4
CBL-ECUE-X4G3-1M0	1m FIREFLY™ cable for PCIe (-FF)
CBL-ECUE-X4G3-2M0	2m FIREFLY™ cable for PCIe (-FF)
CBL-ECUE-X4G3-3M0	3m FIREFLY™ cable for PCIe (-FF)
ADPT-MX-X2G2-IPASS-HOST-FL	Breakout board from iPass X2G2 to X2G2 flat ribbon
ADPT-MX-X2G2-IPASS-TARGET-FL	Breakout board from X2G2 flat ribbon cable to iPass X2G2
ADPT-MX-X2G2-M2-FL	Breakout board from M.2 to X2G2 ribbon cable
ADPT-MX-X2G2-M2SSD-FL	Breakout board from X2G2 flat ribbon cable to M.2 SSD socket
ADPT-MX-X2G2-MPCIE-FL	Breakout board from Mini PCIe to X2G2 flat ribbon
ADPT-MX-X2G2-PCIE-FL	Breakout board from PCIe to X2G2 flat ribbon
ADPT-MX-X2G2-X4G2	Breakout board from X2G2 flat ribbon to X4G2 ribbon (both directions)
ADPT-MX-X4G2-IPASS-HOST-Fx[2]	Breakout board from iPass X4G2 to X4G2 flat ribbon
ADPT-MX-X4G2-IPASS-TARGET-Fx[2]	Breakout board from X4G2 flat ribbon cable to iPass X4G2
ADPT-MX-X4G2-M2-Fx[2]	Breakout board from M.2 to X4G2 ribbon cable
ADPT-MX-X4G2-MINI-PCIE-Fx[2]	Breakout board from Mini PCIe to X4G2 flat ribbon
ADPT-MX-X4G2-PCIE-Fx[2]	Breakout board from PCIe to X4G2 flat ribbon
MECH-60MM-BRACKET-T	xiB / xiX X4G2 series tripod mounting bracket
MECH-60MM-EF-ADAPTER-KIT[1]	xiB / xiT Canon EF-Mount Adapter
MECH-MC-BRACKET-KIT	xiX X2G2 / xiC series tripod mounting bracket

table 2-5, accessories

Notes: 1) This kit is sold separately, however it is possible to order assembling during production. These assemblies are sold separately. Additional assemblies purchased along with a camera can be added to the order at time of purchase for assembly with camera head. See table 2-6

2) Adapters are available with a vertical (-FV) or horizontal orientation (-FL) of the flat ribbon connector

Item P/N	Description
A-MECH-60MM-EF-ADAPTER-KIT[1]	Assembly Service for MECH-60MM-EF-ADAPTER-KIT

table 2-6, assembly options

Notes: 1) Available only for 60mm larger sized models

3. Hardware Specification

3.1. Power Supply

The xiX cameras are powered via flex cable from an external power supply 12-24V with power consumption up to 10W max (excluding power needed for lens). Please read the chapter *3.8 xiX X2G2 –FL/-FV Interface connector*, *3.9 xiX X2G2-FF interface* and *3.10 xiX X4G2 Interface connector* regarding camera pinout. A breakout board can be used to power the camera; see *3.17 MX camera adapters.*

3.2. General Specification

3.2.1. Environment

Description	Symbol	Value
Optimal ambient temperature for operation	T_{opt}	+10 to +25°C
Max. ambient temperature for operation	T_{max}	0 to +50°C
Ambient temperature for storage and transportation	$T_{storage}$	-30 to +70°C
Relative humidity, non-condensing	RH	≤ 80 %

table 3-1, environment

Housing temperature must not exceed +65°C. 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

Please refer to chapter: *3.12 Heat Dissipation*.

3.2.2. Firmware / Host driver / API features

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

table 3-2, firmware / API features

More details on API/SDK features are available at XIMEA support pages: http://www.ximea.com/support

3.3. Mounting points

The cameras feature mounting holes for custom mount points i which can also be used to attach our tripod adapter.

MX X2G2

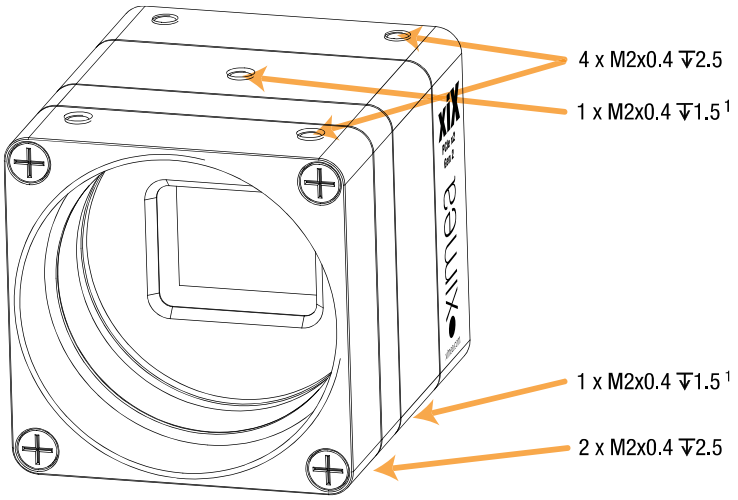


figure 3-1, MX X2G2 mounting points

Note 1) models MX089xG and MX124xG have a different configuration of mounting holes

MX X4G2

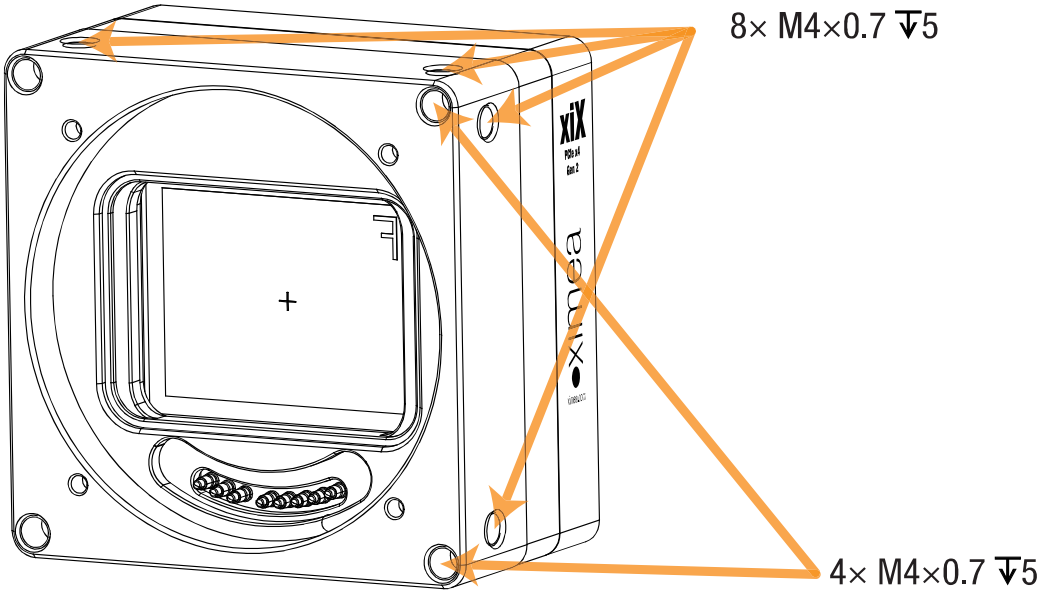


figure 3-2, MX X4G2 mounting points

3.4. Lens Mount

The xiX cameras come standard with 2 different lens mounts. The smaller cameras (X2G2) have a C-mount (convertible to CS-mount), and the larger ones can optionally include a Canon EF mount. Other options may be available (See your local XIMEA sales team for other options.)

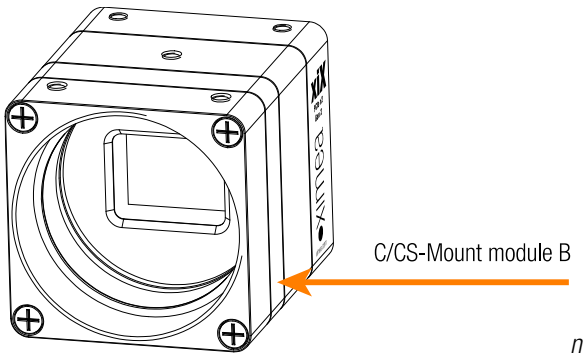


figure 3-3, MX X2G2 position C/CS-Mount module B

The smaller cameras are delivered with C-mount back focal distance. By removing the "C/CS-Mount module B" (see the figure above) the camera can be reconfigured 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. Do not lose these screws, as they are custom made to allow a flush lens mount.

Note: The distance between the front of 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 damage of the filter glass, nothing may extend deeper into the housing.

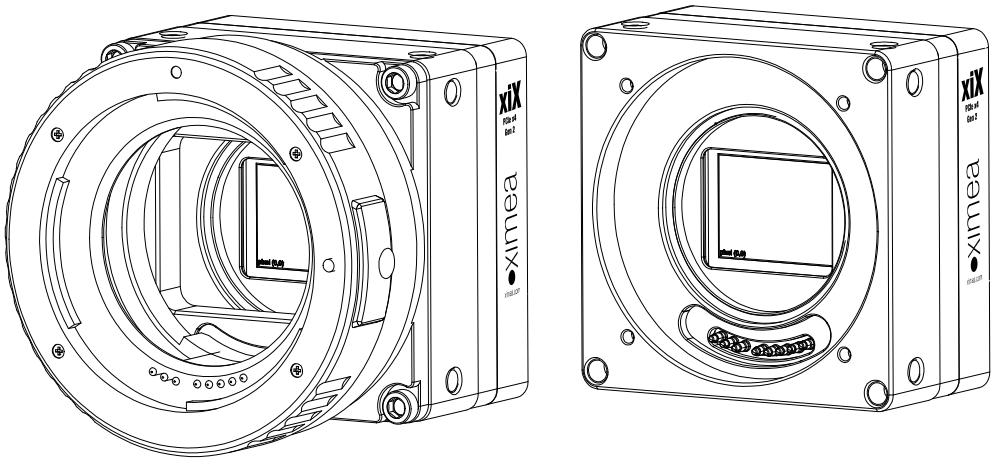


figure 3-4, MX X4G2 camera with/without the optional EF-Mount Adapter

The cameras are optionally delivered with or without the EF-Mount Adapter.

For more information refer to *3.19 xiX X4G2 Lens adapter – MECH-60MM-EF-ADAPTER*

Note: The distance between the outer EF-Mount Adapter and the active sensor surface is 44 mm, and 13.4 mm when no EF-Mount Adapter is included..

3.4.1. Screws

All mounting screws for MX X2G2 are customized M2 screws with different lengths.

Technical details:

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

table 3-3, custom screws, technical details

Drawings, e.g. with 10mm length:

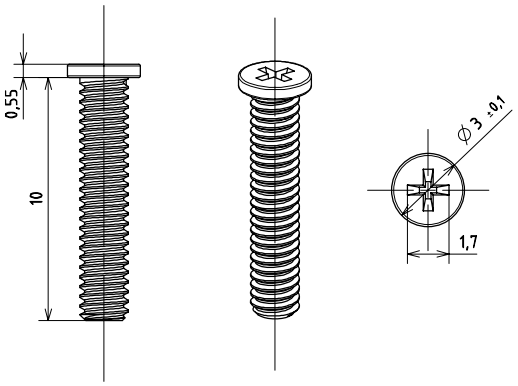


figure 3-5, xiX mounting screws

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

For the MX X4G2 cameras, Standard M4 screws can be used.

3.5. Optical path

3.5.1. Filter glasses (MX X2G2 models only)

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 *3.4 Lens Mount*) must be carried out carefully. Operating the camera without a lens mount is not intended by design as the filter glass is not permanently bound to the camera. Thus, care must be taken that dust does not ingress to the internal sensor chamber of the camera. Do not use compressed air to clean the camera or filter glass as this could push dust into the camera or damage the anti-reflective coating on the glass. Distance from the flange to sensor is designed so the optical distance is 17.526mm – 0.2mm.

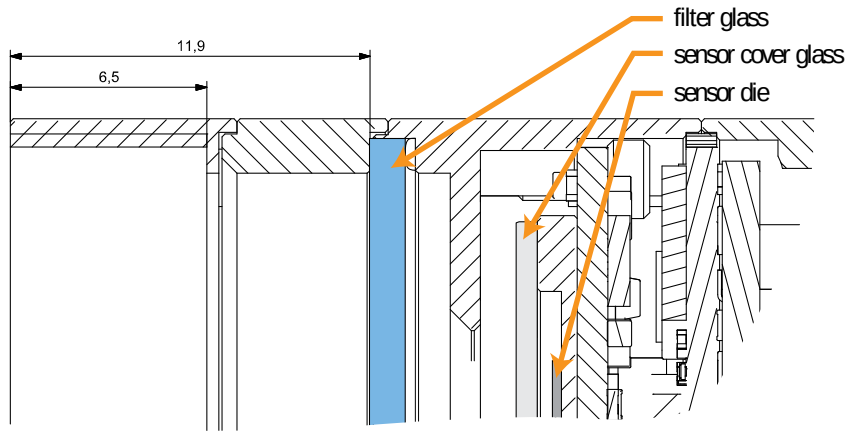


figure 3-6, optical path section MX X2G2

MX X4G2 cameras do not have a filter glass in the optical path.

3.5.2. Monochrome and near infrared extended camera models (MX X2G2 models only)

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

table 3-4, monochrome camera - filter glass parameter

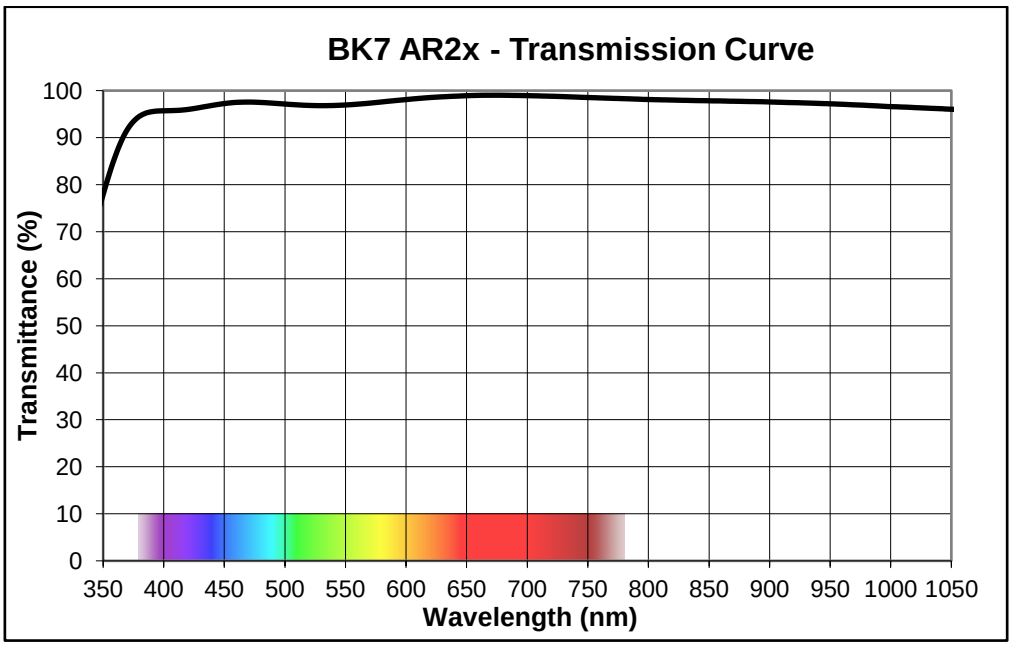


figure 3-7, monochrome camera - filter glass transmission curve

3.5.3. Color camera models (MX X2G2 models only)

Used filter brand	Thickness	Coating
ICR650	1.0±0.1 mm	NA

table 3-5, color camera - filter glass parameter

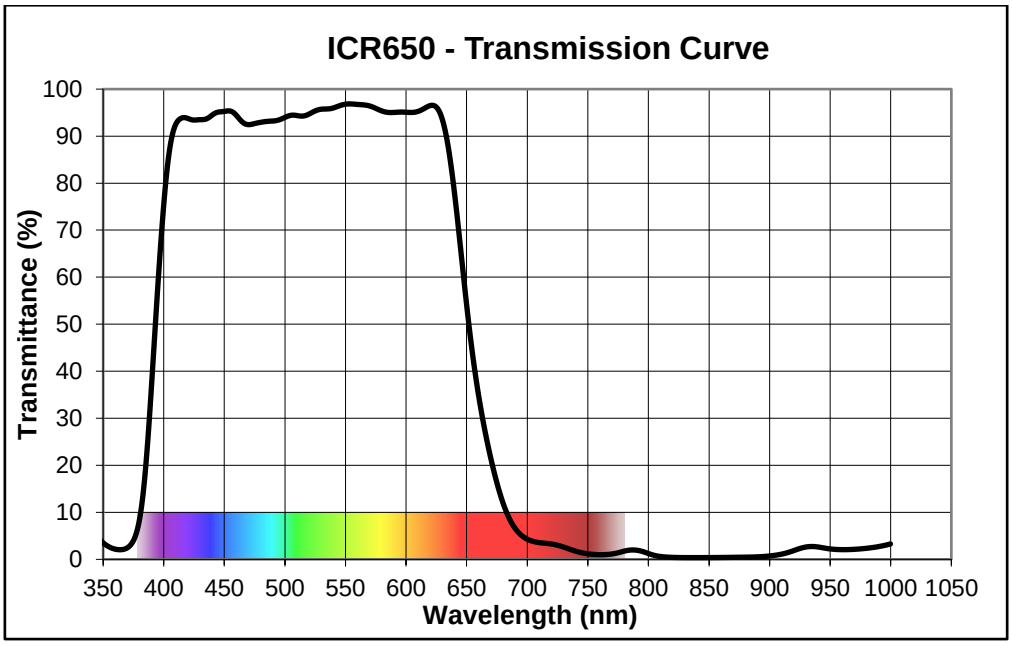


figure 3-8, color camera - filter glass transmission curve

3.6. Model Specific Characteristics

3.6.1. MX023xG-SY-X2G2-Fx

3.6.1.1. Sensor and camera parameters

xiX model		MX023CG-SY-X2G2-Fx	MX023MG-SY-X2G2-Fx
Sensor parameter			
Model name		IMX174LQJ-C	IMX174LLJ-C
Color filter		RGB Bayer mosaic	None
Technology		1st Gen Pregius	
Shutter type		Global	
Pixel Resolution (H × V)	[pixel]	1936 x 1216	
Active area size (H × V)	[mm]	11.314 x 7.12	
Sensor diagonal	[mm]	13.39	
Optical format	[inch]	1/1.2	
Pixel Size (H × V)	[µm]	5.86 x 5.86	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	10, 12	
FWC	[ke-]	30.5	
Dynamic range	[dB]	71.7	
SNR_{max}	[dB]	45	
Conversion gain	[e-/LSB_{12}]	8.1	
Dark noise	[e-]	7.36	
Dark current	[e-/s]	3	
DSNU	[e-]	1.1	
PRNU	[%]	0.4	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		19µs to 30sec, in steps of 4.8µs [1]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	166	
Power consumption			
Typical / Maximum	[W]	2.87 / 2.95	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth (-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/25.9/26.9 (without C/CS Mount module B)	
mass (-FL/-FV/-FF)	[g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)	

table 3-6, MX023xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX023CG-SY-X2G2

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1	1936 x 1216	8	166
Yes	Yes	1x1	1936 x 1216	10	166
Yes	Yes	1x1	1936 x 1216	12	129

table 3-7, MX023xG-SY-X2G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 900MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX023CG-SY-X2G2

3.6.1.2. Spectral Response curve [%]

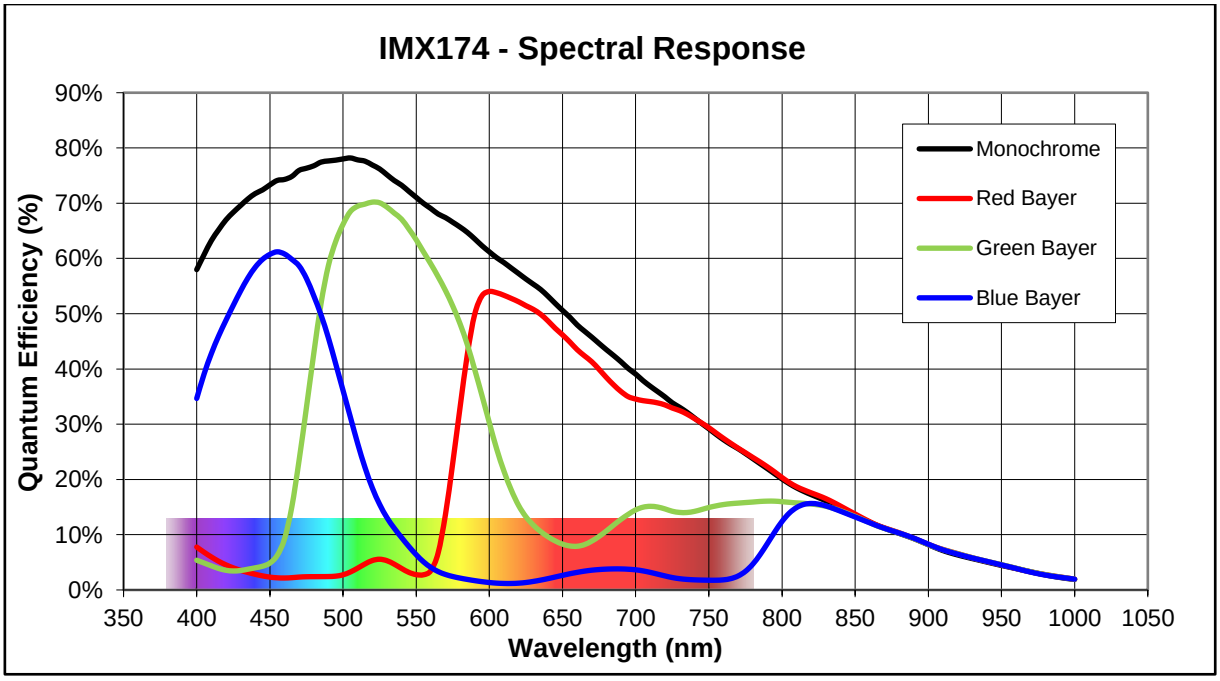


figure 3-9, IMX174-mono, quantum efficiency curve, ©SONY

3.6.1.3. Drawings MX023xG-SY-X2G2-FL (C-mount [with C/CS mount module B])

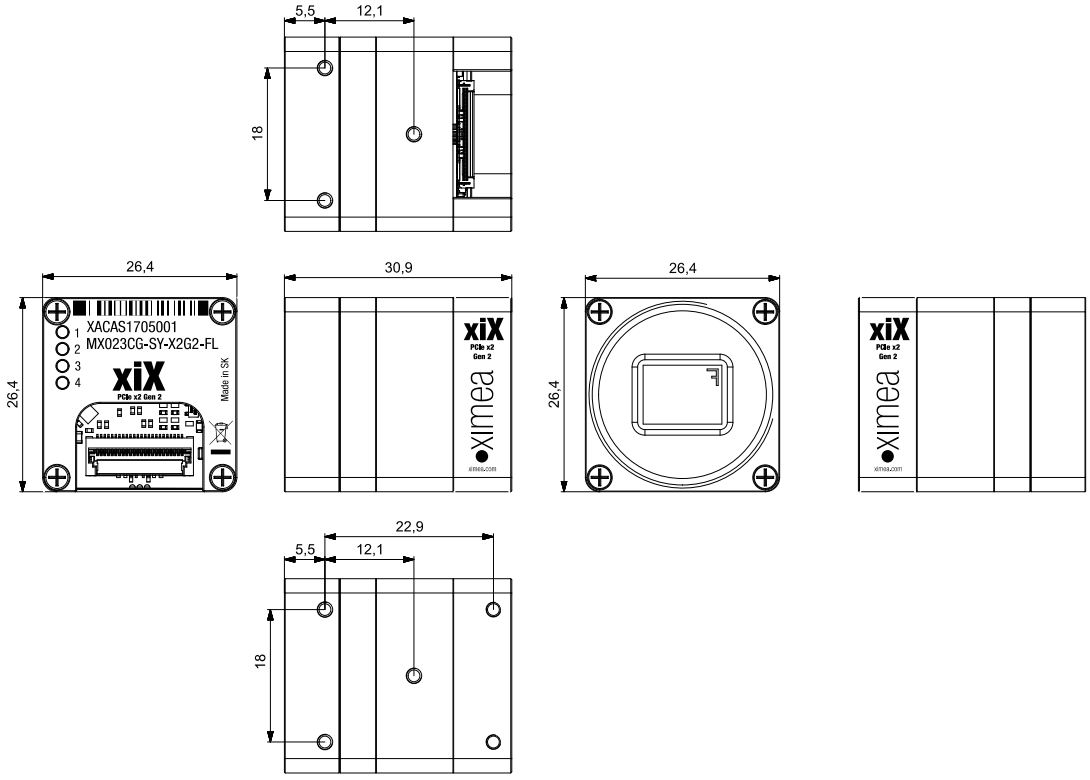


figure 3-10, dimensional drawing MX023xG-SY-X2G2-FL, C-Mount housing

3.6.1.4. Drawings MX023xG-SY-X2G2-FV (C-mount [with C/CS mount module B])

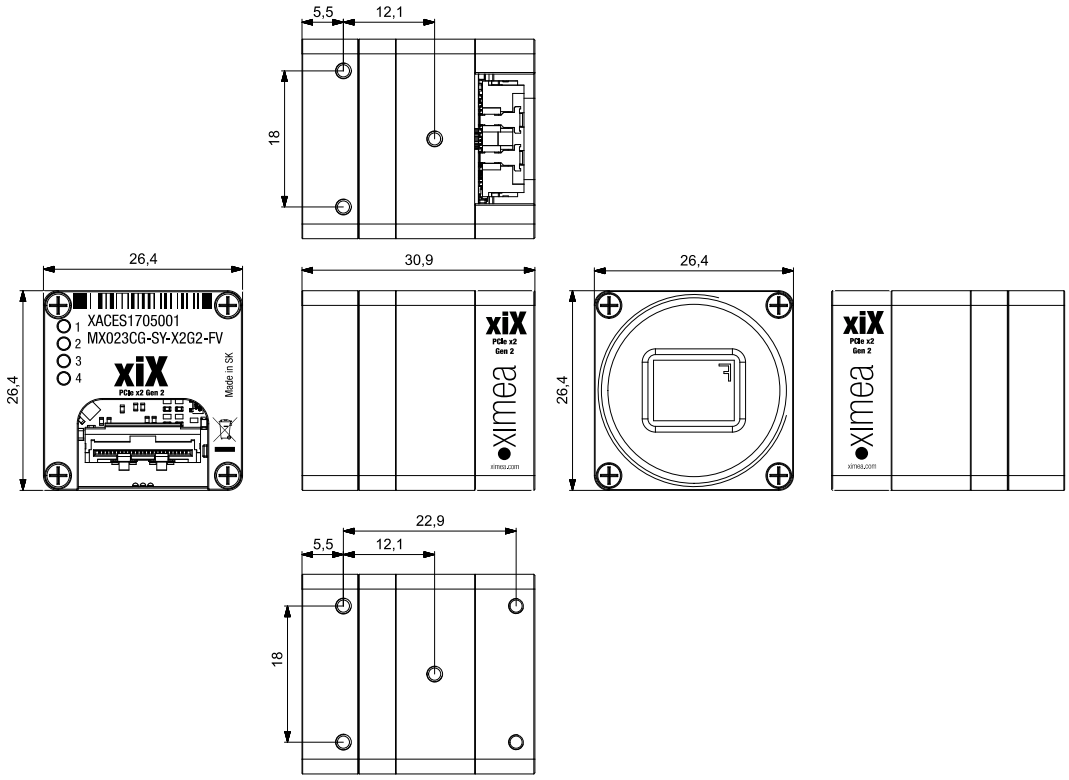


figure 3-11, dimensional drawing MX023xG-SY-X2G2-FV, C-Mount housing

3.6.1.5. Drawings MX023xG-SY-X2G2-FF (C-mount [with C/CS mount module B])

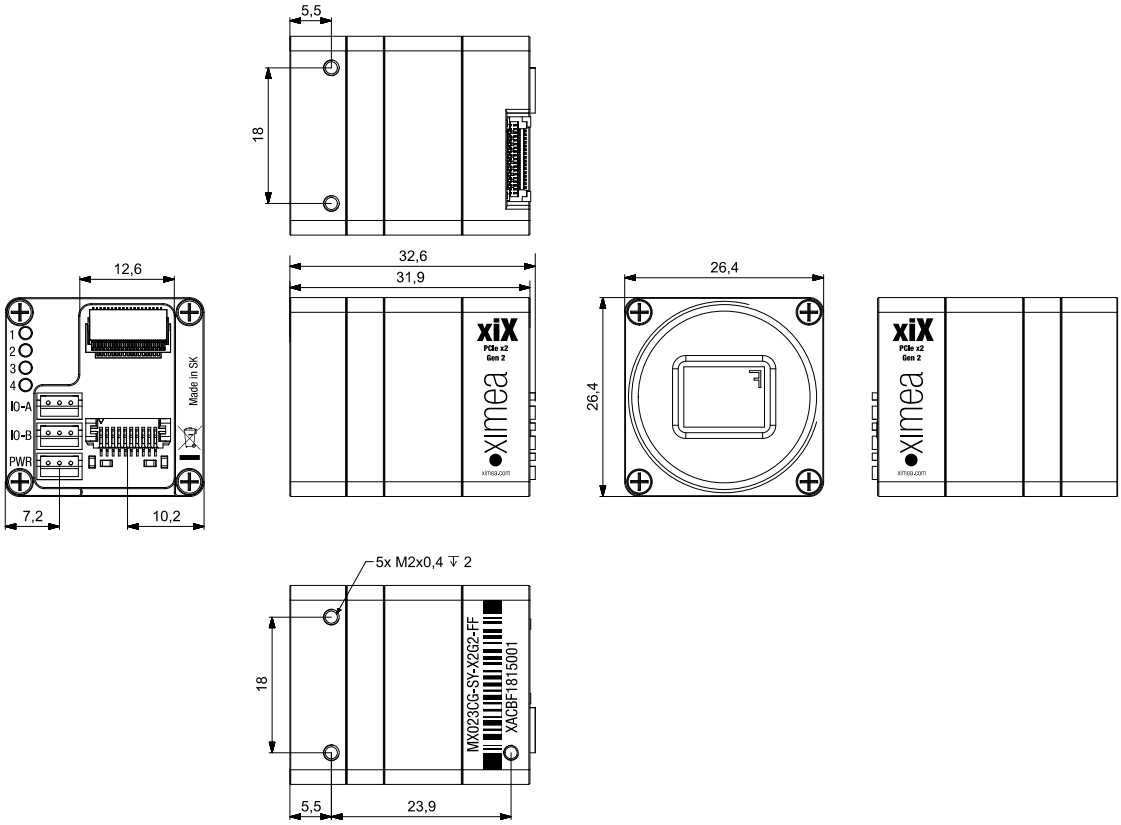


figure 3-12, dimensional drawing MX023xG-SY-X2G2-FF, C-Mount housing

3.6.1.6. Referenced documents

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

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

3.6.1.7. Sensor features

feature	Note
Binning	No
Skipping	Not supported
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-8, sensor features available

3.6.2. MX031xG-SY-X2G2-Fx

3.6.2.1. Sensor and camera parameters

xiX model		MX031CG-SY-X2G2-Fx	MX031MG-SY-X2G2-Fx
Sensor parameter			
Model name		IMX252LQR-C	IMX252LLR-C
Color filter		RGB Bayer mosaic	None
Technology		2nd Gen Pregius	
Shutter type		Global	
Pixel Resolution (H × V)	[pixel]	2064 x 1544	
Active area size (H × V)	[mm]	7.12 x 5.33	
Sensor diagonal	[mm]	8.89	
Optical format	[inch]	1/1.8	
Pixel Size (H × V)	[µm]	3.45 × 3.45	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.9	
Dynamic range	[dB]	70.9	
SNR_{max}	[dB]	40.3	
Conversion gain	[e-/LSB_{12}]	2.67	
Dark noise	[e-]	2.32	
Dark current	[e-/s]	2.1	
DSNU	[e-]	0.7	
PRNU	[%]	0.65	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[1], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 2,89µs [3]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	218	
Power consumption			
Typical / Maximum	[W]	3.64 / 3.72	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth(-FL/-FV/-FF)	[mm]	30.8/30.8/31.8 (with C/CS Mount module B) 25.8/26.8/26.8 (without C/CS Mount module B)	
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)	

table 3-9, MX031xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

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

3) Defined for maximum bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX031CG-SY-X2G2

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1 / 1x1	2064 x 1544	8	218
Yes	Yes	1x1 / 1x1	2064 x 1544	10	193
Yes	Yes	1x1 / 1x1	2064 x 1544	12	119
Yes	Yes	1x1 / 1x2	2064 x 772	8	426
Yes	Yes	1x1 / 2x1	1032 x 1544	8	218
Yes	Yes	1x1 / 2x2	1032 x 772	8	426
No	Yes	1x2 / 1x1	2064 x 772	8	426
No	Yes	1x2 / 2x1	1032 x 772	8	426
Yes	Yes	1x1 / 2x2	1032 x 772	10	378
Yes	Yes	1x1 / 2x2	1032 x 772	12	233

table 3-10, MX031xG-SY-X2G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 900MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX031CG-SY-X2G2

3.6.2.2. Spectral Response curve [%]

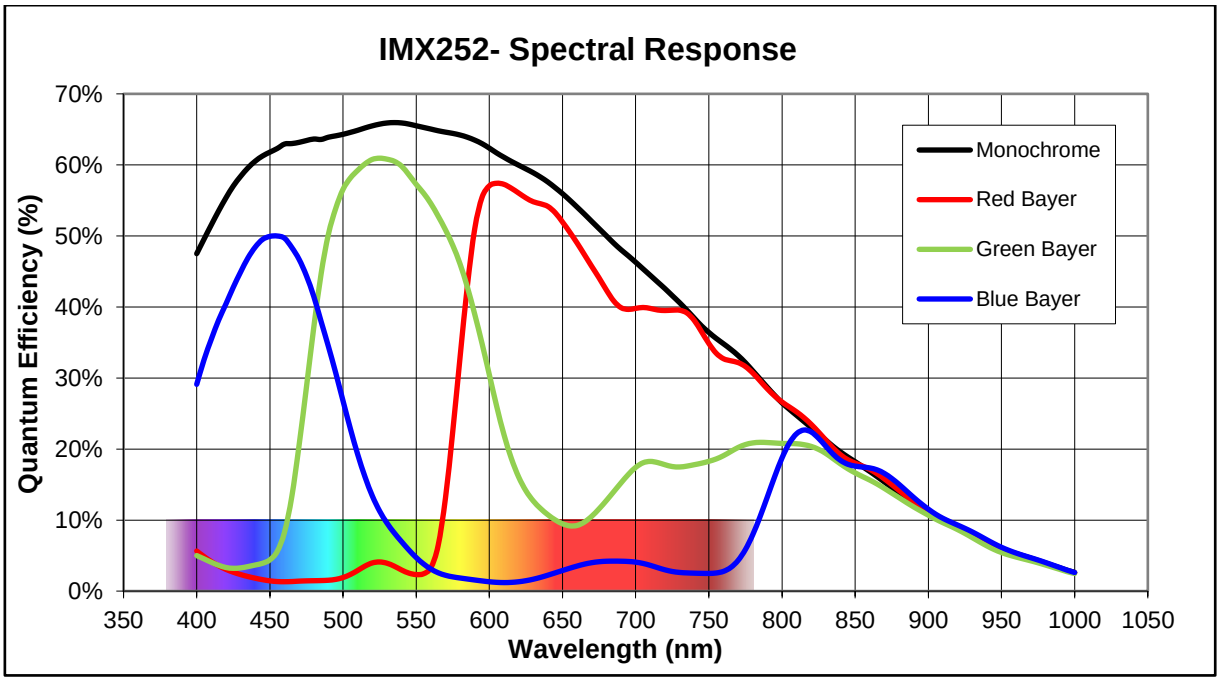


figure 3-13, IMX252-mono and color, quantum efficiency curves, ©SONY

3.6.2.3. Drawings MX031xG-SY-X2G2-FL (C-mount [with C/CS mount module B])

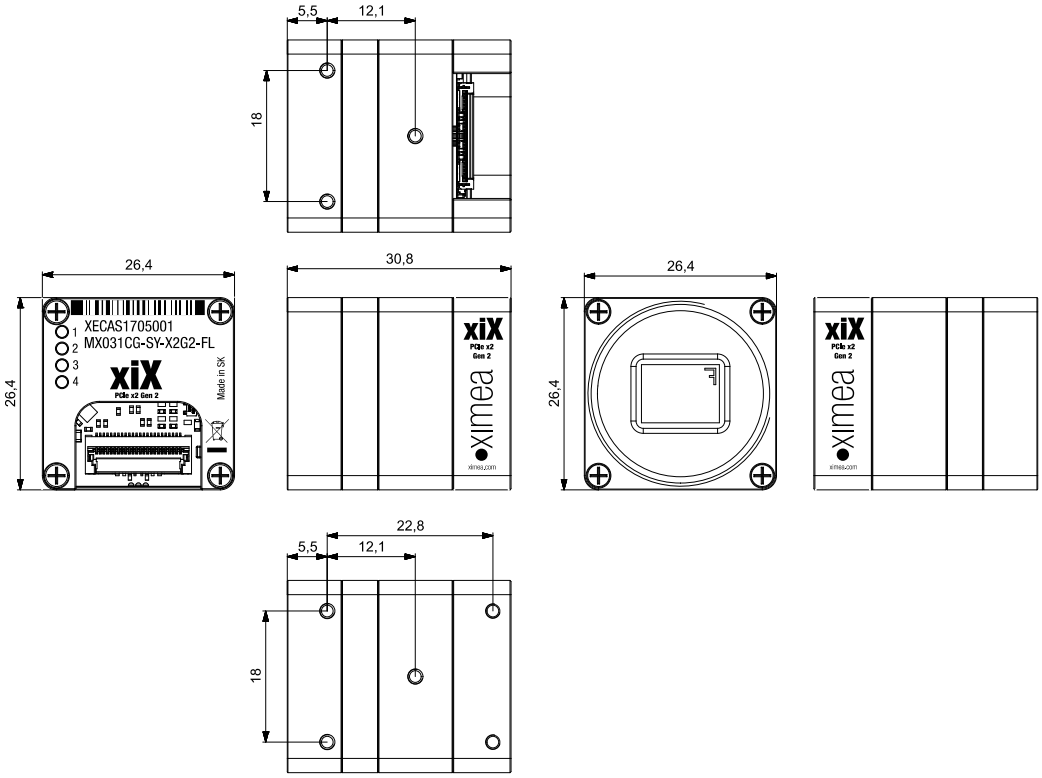


figure 3-14, dimensional drawing MX031xG-SY-X2G2-FL, C-Mount housing

3.6.2.4. Drawings MX031xG-SY-X2G2-FV (C-mount [with C/CS mount module B])

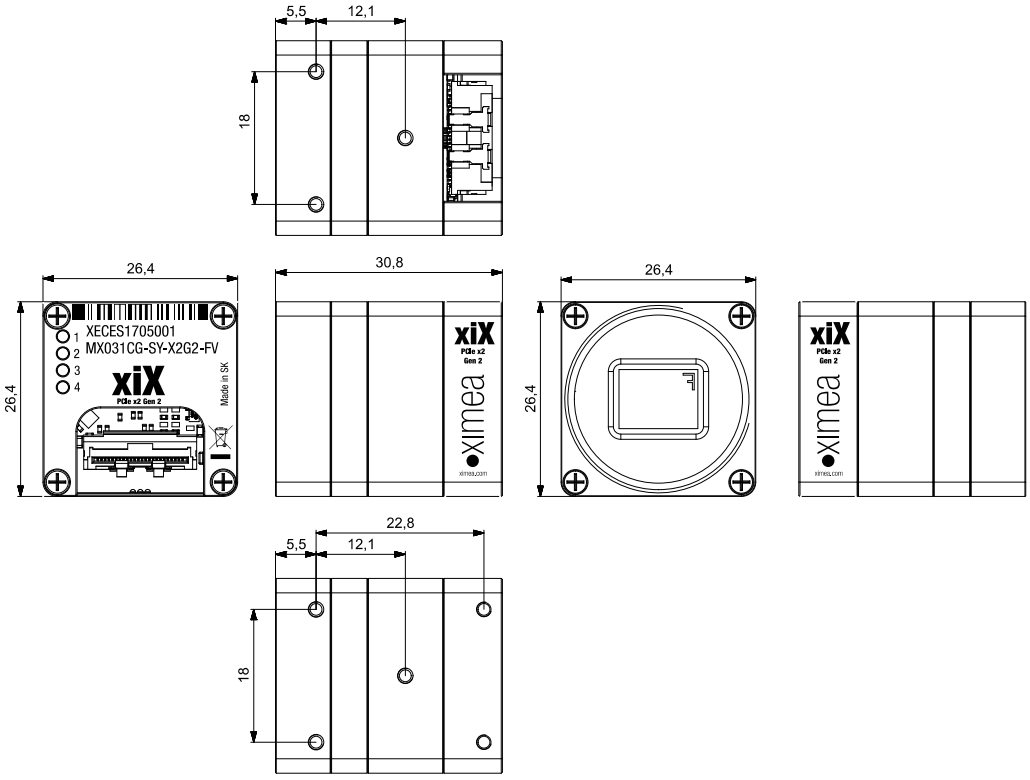


figure 3-15, dimensional drawing MX031xG-SY-X2G2-FV, C-mount housing

3.6.2.5. Drawings MX031xG-SY-X2G2-FF (C-mount [with C/CS mount module B])

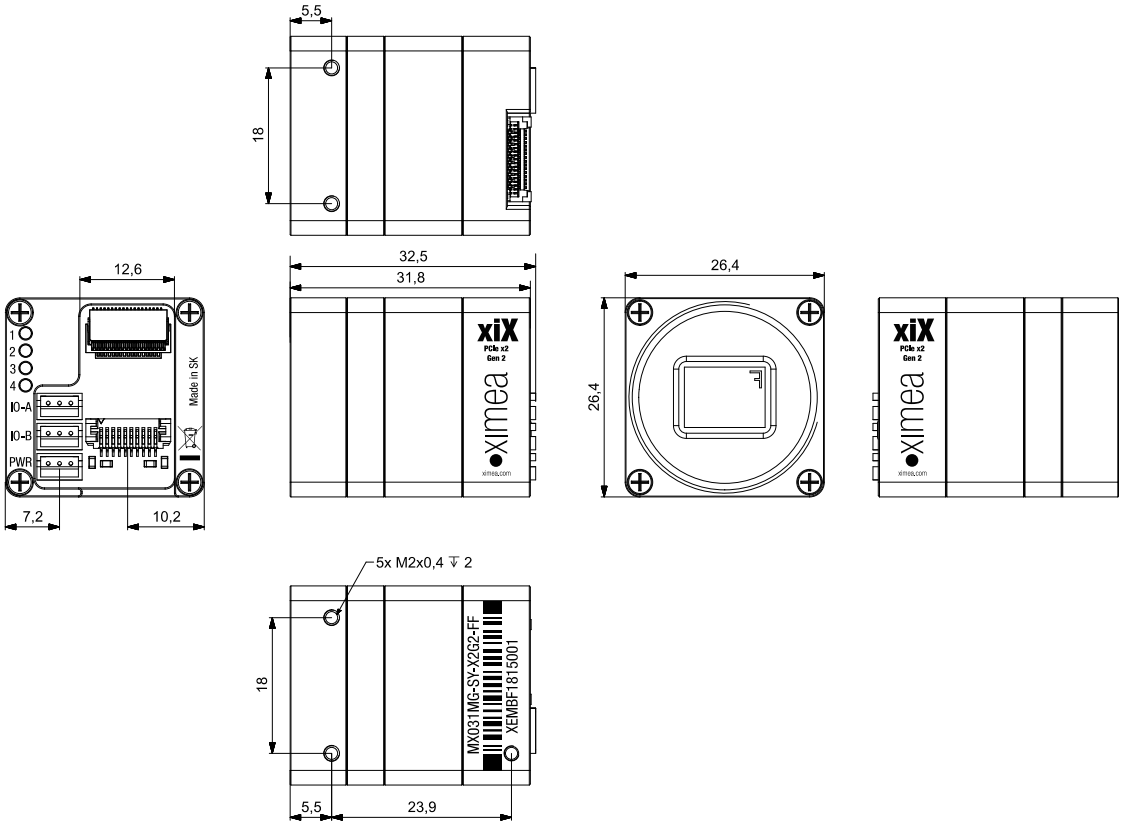


figure 3-16, dimensional drawing MX031xG-SY-X2G2-FF, C-Mount housing

3.6.2.6. Referenced documents

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

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

3.6.2.7. Sensor features

feature	Note
Binning	Yes, 1x2 (H x V) binning supported for monochrome camera only.
Skipping	Yes, 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-11, sensor features available

3.6.3. MX050xG-SY-X2G2-Fx

3.6.3.1. Sensor and camera parameters

xiX model		MX050CG-SY-X2G2-Fx	MX050MG-SY-X2G2-Fx
Sensor parameter			
Model name		IMX250LQR-C	IMX250LLR-C
Color filter		RGB Bayer mosaic	None
Technology		2nd Gen Pregius	
Shutter type		Global	
Pixel Resolution (H × V)	[pixel]	2464 x 2056	
Active area size (H × V)	[mm]	8.5 x 7.09	
Sensor diagonal	[mm]	11.1	
Optical format	[inch]	2/3	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.8	
Dynamic range	[dB]	70.8	
SNR_{max}	[dB]	40.3	
Conversion gain	[e-/LSB_{12}]	2.66	
Dark noise	[e-]	2.32	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	[%]	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[1], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 2.89µs [3]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	165	
Power consumption			
Typical / Maximum	[W]	3.64 / 3.72	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth(-FL/-FV/-FF)	[mm]	30.8/30.8/31.8 (with C/CS Mount module B) 25.8/26.8/26.8 (without C/CS Mount module B)	
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)	

table 3-12, MX050xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

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

3) Defined for maximum bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX050CG-SY-X2G2

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1 / 1x1	2464 x 2056	8	165
Yes	Yes	1x1 / 1x1	2464 x 2056	10	146
Yes	Yes	1x1 / 1x1	2464 x 2056	12	90
Yes	Yes	1x1 / 1x2	2464 x 1028	8	324
Yes	Yes	1x1 / 2x1	1232 x 2056	8	164
Yes	Yes	1x1 / 2x2	1232 x 1028	8	322
No	Yes	1x2 / 1x1	2464 x 1028	8	324
No	Yes	1x2 / 2x1	1232 x 1028	8	322
Yes	Yes	1x1 / 2x2	1232 x 1028	10	270
Yes	Yes	1x1 / 2x2	1232 x 1028	12	177

table 3-13, MX050xG-SY-X2G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 900MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX050CG-SY-X2G2

3.6.3.2. Spectral Response curve [%]

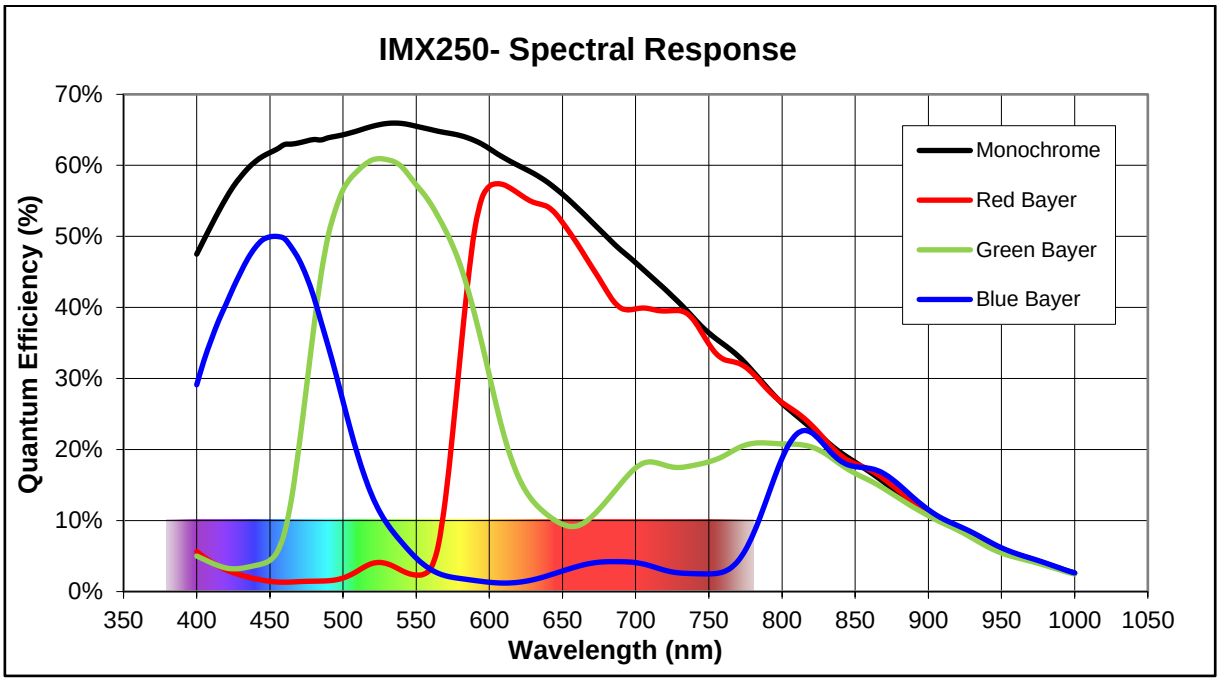


figure 3-17, IMX250 mono and color, quantum efficiency curves, ©SONY

3.6.3.3. Drawings MX050xG-SY-X2G2-FL (C-mount [with C/CS mount module B])

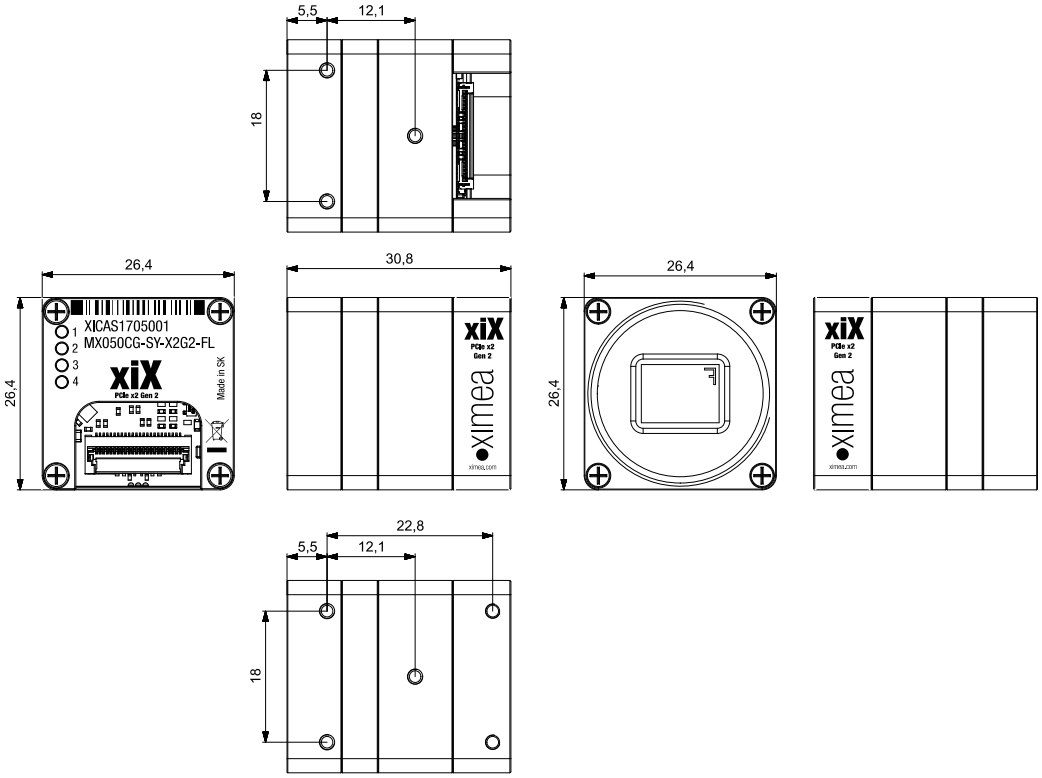


figure 3-18, dimensional drawing MX050xG-SY-X2G2-FL, C-Mount housing

3.6.3.4. Drawings MX050xG-SY-X2G2-FV (C-mount [with C/CS mount module B])

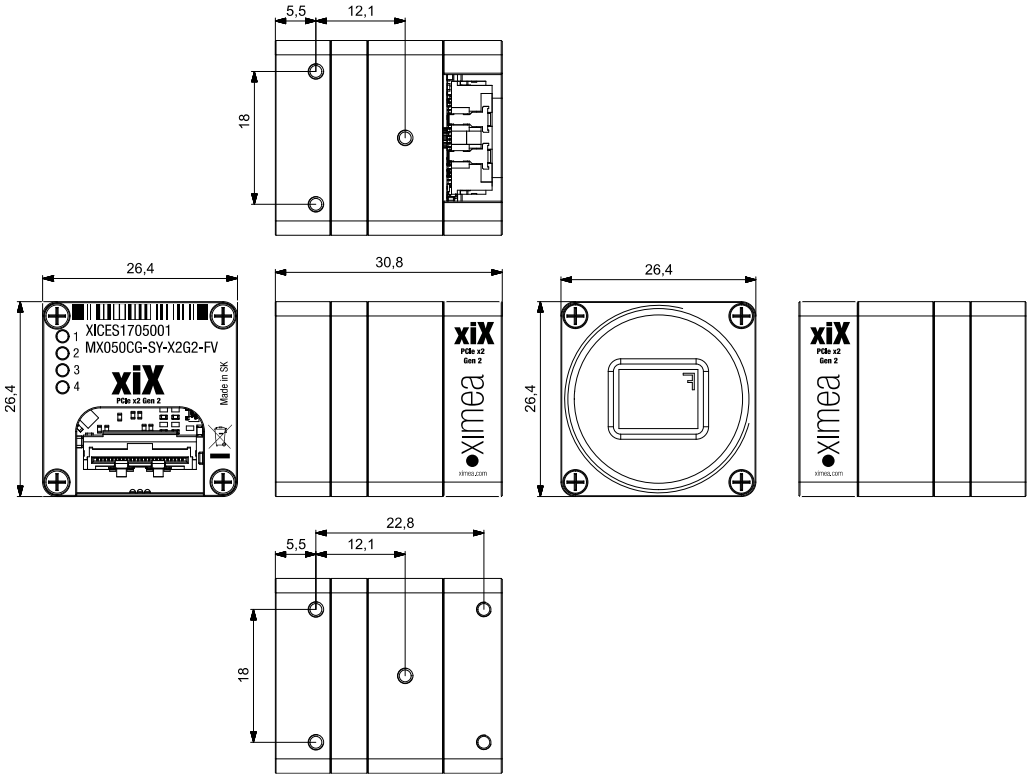


figure 3-19, dimensional drawing MX050xG-SY-X2G2-FV, C-Mount housing

3.6.3.5. Drawings MX050xG-SY-X2G2-FF (C-mount [with C/CS mount module B])

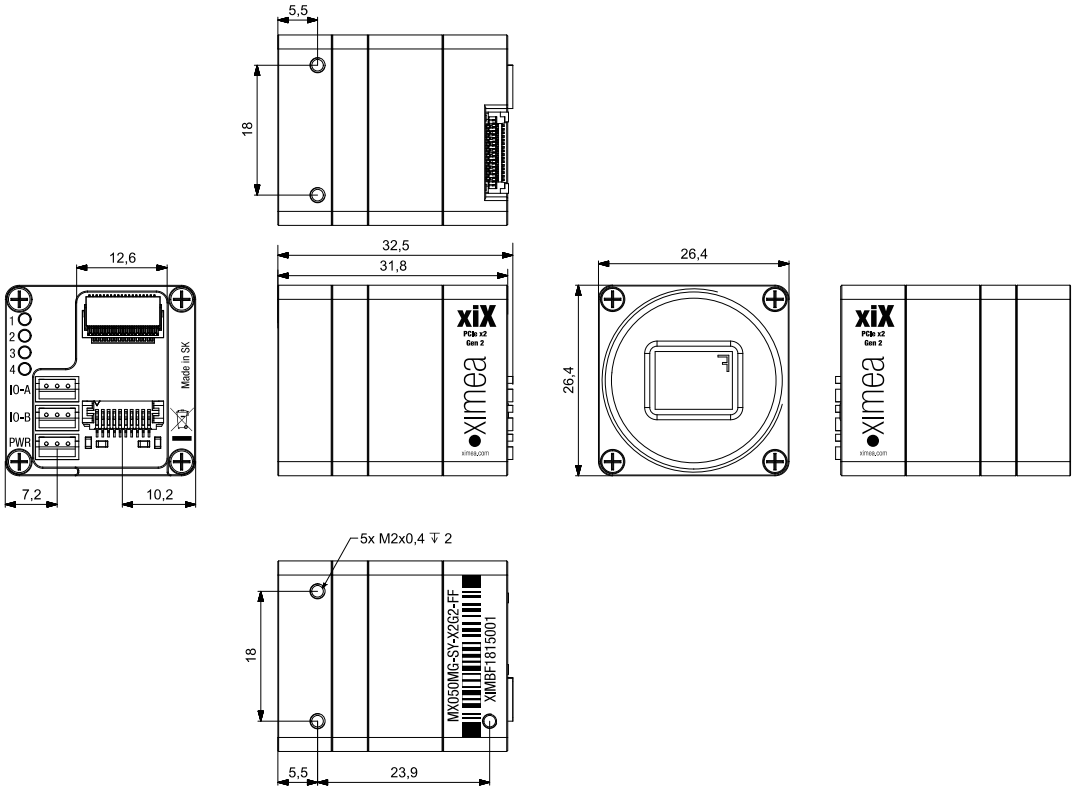


figure 3-20, dimensional drawing MX050xG-SY-X2G2-FF, C-Mount housing

3.6.3.6. Referenced documents

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

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

3.6.3.7. Sensor features

feature	Note
Binning	Yes, 1x2 (H x V) binning supported for monochrome camera only.
Skipping	Yes, 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-14, sensor features available

3.6.4. MX089xG-SY-X2G2-Fx

3.6.4.1. Sensor and camera parameters

xiX model		MX089CG-SY-X2G2-Fx	MX089MG-SY-X2G2-Fx
Sensor parameter			
Model name		IMX255LQR-C	IMX255LLR-C
Color filter		RGB Bayer mosaic	None
Technology		2nd Gen Pregius	
Shutter type		Global	
Pixel Resolution (H × V)	[pixel]	4112 x 2176	
Active area size (H × V)	[mm]	14.2 x 7.5	
Sensor diagonal	[mm]	16	
Optical format	[inch]	1”	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.8	
Dynamic range	[dB]	70.5	
SNR Max	[dB]	40.3	
Conversion gain	[e-/LSB12]	2.67	
Dark noise	[e-]	2.4	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	[%]	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[1], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 4.73µs [3]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	95	
Power consumption			
Typical / Maximum	[W]	3.82 / 3.88	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth(-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)	
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)	

table 3-15, MX089xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

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

3) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX089CG-SY-X2G2

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1 / 1x1	4112 x 2176	8	95.4
Yes	Yes	1x1 / 1x1	4112 x 2176	10	79.1
Yes	Yes	1x1 / 1x1	4112 x 2176	12	64.9
Yes	Yes	1x1 / 1x2	4112 x 1088	8	187.6
Yes	Yes	1x1 / 2x1	2056 x 2176	8	95.2
Yes	Yes	1x1 / 2x2	2056 x 1088	8	187
No	Yes	1x2 / 1x1	4112 x 1088	8	172.8
No	Yes	2x2 / 1x1	2056 x 1088	8	187
No	Yes	2x2 / 1x1	2056 x 1088	10	177
No	Yes	2x2 / 1x1	2056 x 1088	12	127.6
Yes	Yes	1x1 / 2x2	2056 x 1088	10	177
Yes	Yes	1x1 / 2x2	2056 x 1088	12	127.6

table 3-16, MX089xG-SY-X2G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 900MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX089CG-SY-X2G2

3.6.4.2. Spectral Response curve [%]

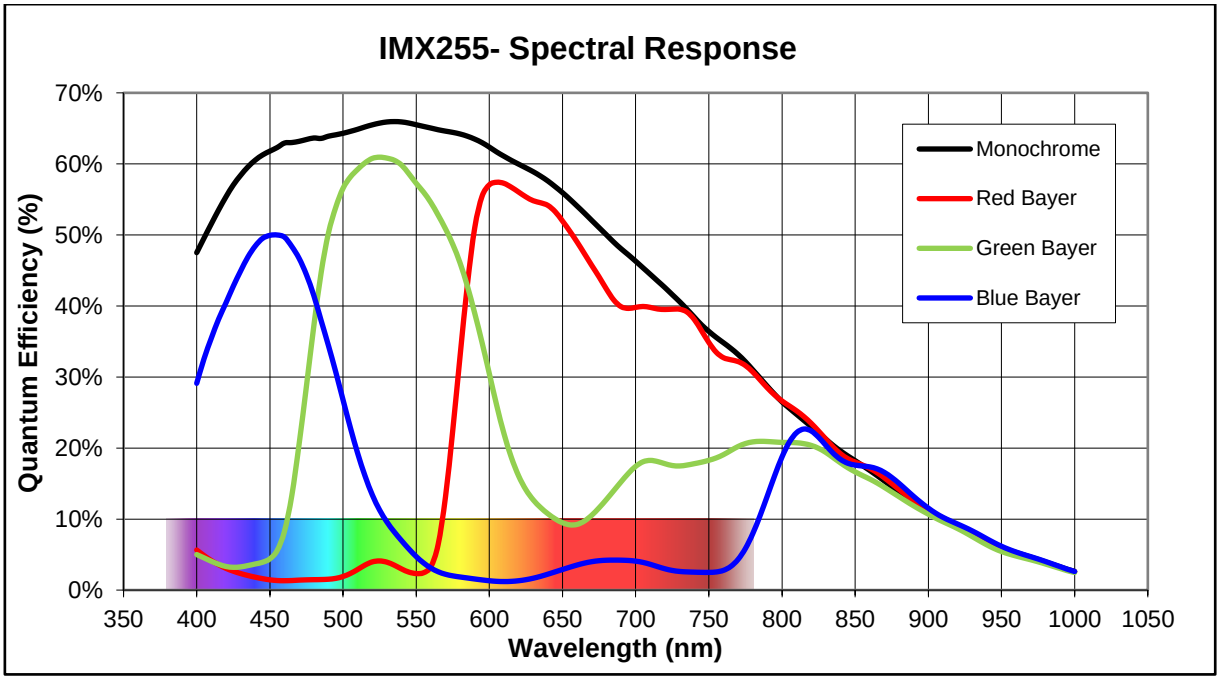


figure 3-21, IMX255 mono and color, quantum efficiency curve, ©SONY

3.6.4.3. Drawings MX089xG-SY-X2G2-FL (C-mount [with C/CS mount module B])

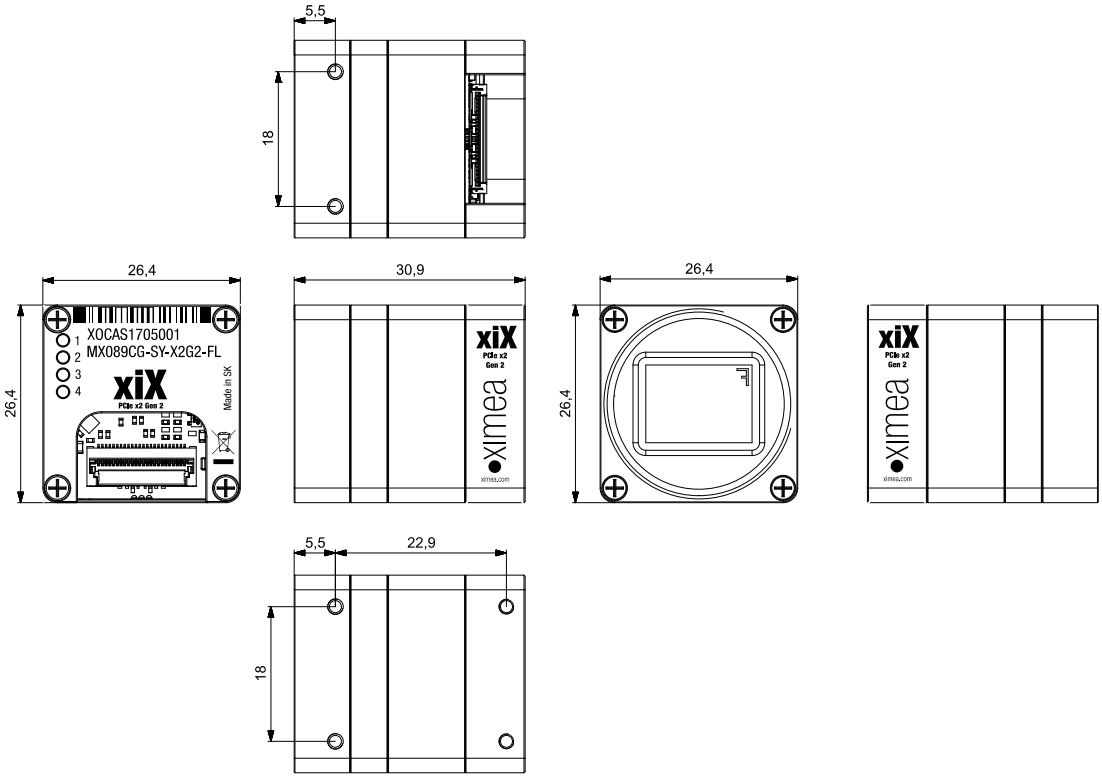


figure 3-22, dimensional drawing MX089xG-SY-X2G2-FL, C-Mount housing

3.6.4.4. Drawings MX089xG-SY-X2G2-FV (C-mount [with C/CS mount module B])

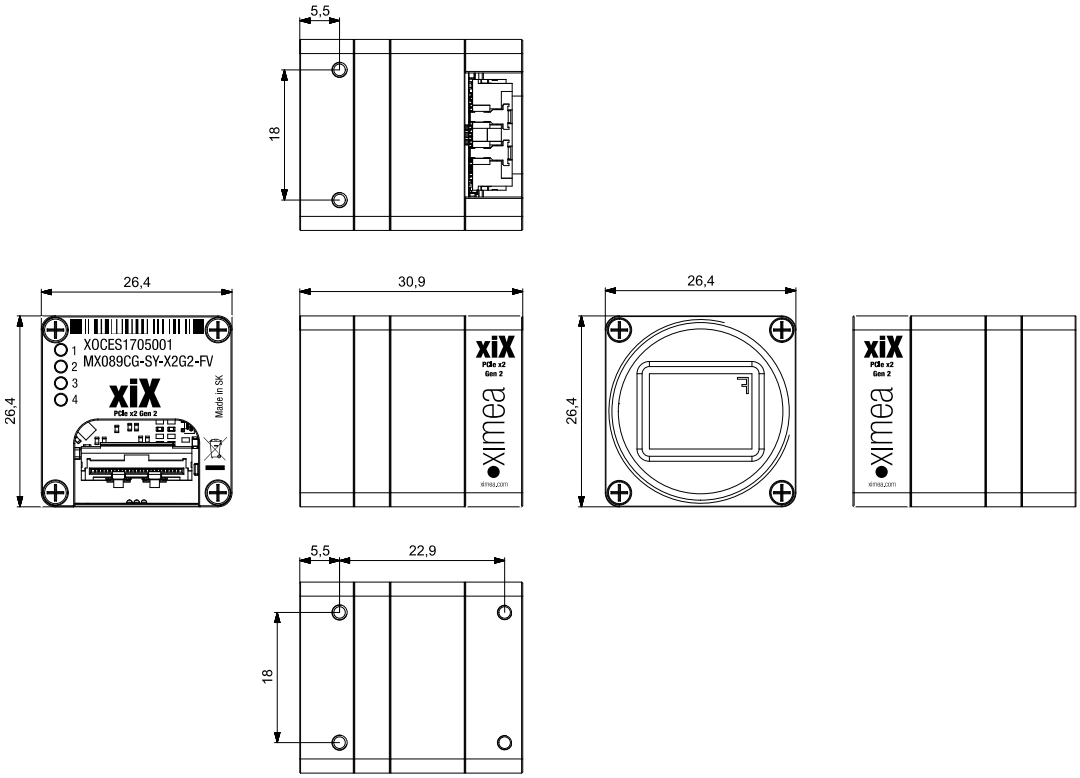


figure 3-23, dimensional drawing MX089xG-SY-X2G2-FV, C-Mount housing

3.6.4.5. Drawings MX089xG-SY-X2G2-FF (C-mount [with C/CS mount module B])

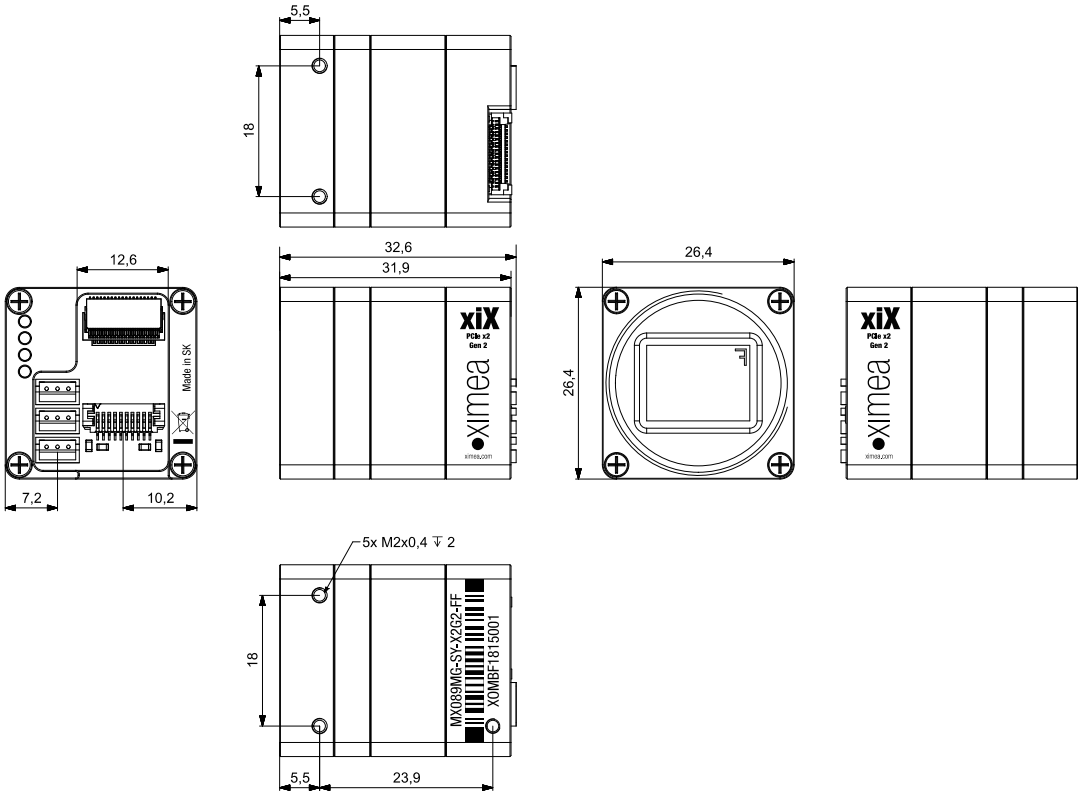


figure 3-24, dimensional drawing MX089xG-SY-X2G2-FF, C-Mount housing

3.6.4.6. Referenced documents

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

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

3.6.4.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 1x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-17, sensor features available

3.6.5. MX124xG-SY-X2G2-Fx

3.6.5.1. Sensor and camera parameters

xiX model		MX124CG-SY-X2G2-Fx	MX124MG-SY-X2G2-Fx
Sensor parameter			
Model name		IMX253LQR-C	IMX253LLR-C
Color filter		RGB Bayer mosaic	None
Technology		2nd Gen Pregius	
Shutter type		Global	
Pixel Resolution (H × V)	[pixel]	4112 x 3008	
Active area size (H × V)	[mm]	14.2 x 10.4	
Sensor diagonal	[mm]	17.6	
Optical format	[inch]	1.1”	
Pixel Size (H × V)	[µm]	3.45 x 3.45	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	8, 10, 12	
FWC	[ke-]	9.9	
Dynamic range	[dB]	70.4	
SNR_{max}	[dB]	40.45	
Conversion gain	[e-/LSB_{12}]	2.67	
Dark noise	[e-]	2.4	
Dark current	[e-/s]	3.9	
DSNU	[e-]	0.75	
PRNU	[%]	0.61	
Linearity	[%]	0.5	
Camera parameters			
Digitization	[bit]	8[1], 10, 12	
Supported bit resolutions	[bit/pixel]	8, 10, 12	
Exposure time (EXP)		1µs[2] to 30sec, in steps of 4.73µs [3]	
Variable Gain Range (VGA)	[dB]	0-24	
Refresh rate (MRR)	[fps]	69	
Power consumption			
Typical / Maximum	[W]	3.82 / 3.88	
Dimensions/Mass			
height	[mm]	26.4	
width	[mm]	26.4	
depth(-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)	
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)	

table 3-18, MX124xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

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

3) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX124CG-SY-X2G2

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1 / 1x1	4112 x 3008	8	69.4
Yes	Yes	1x1 / 1x1	4112 x 3008	10	57.5
Yes	Yes	1x1 / 1x1	4112 x 3008	12	47.2
Yes	Yes	1x1 / 1x2	4112 x 1504	8	126.2
Yes	Yes	1x1 / 2x1	2056 x 3008	8	69.4
Yes	Yes	1x1 / 2x2	2056 x 1504	8	137
No	Yes	1x2 / 1x1	4112 x 1504	8	137
No	Yes	2x2 / 1x1	2056 x 1504	8	137
No	Yes	2x2 / 1x1	2056 x 1504	10	129.7
No	Yes	2x2 / 1x1	2056 x 1504	12	93.2
Yes	Yes	1x1 / 2x2	2056 x 1504	10	129.7
Yes	Yes	1x1 / 2x2	2056 x 1504	12	93.2

table 3-19, MX124xG-SY-X2G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 900MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX124CG-SY-X2G2

3.6.5.2. Spectral Response curve [%]

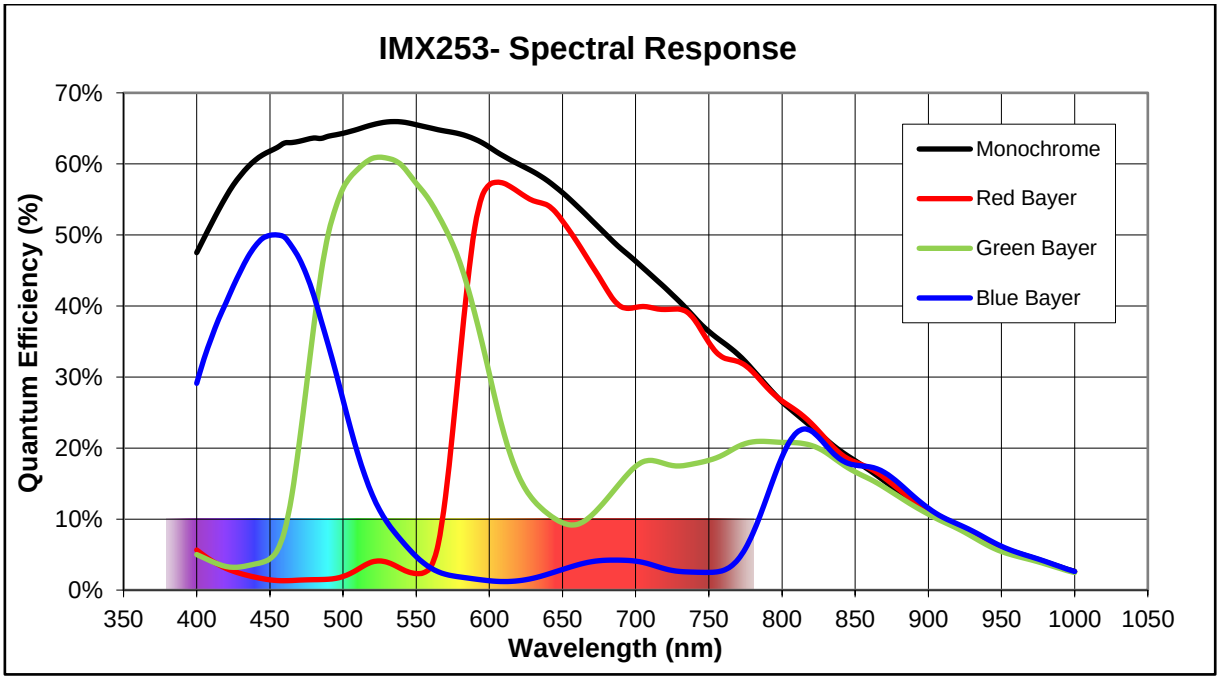


figure 3-25, IMX253 mono and color, quantum efficiency curve, ©SONY

3.6.5.3. Drawings MX124xG-SY-X2G2-FL (C-mount [with C mount module B])

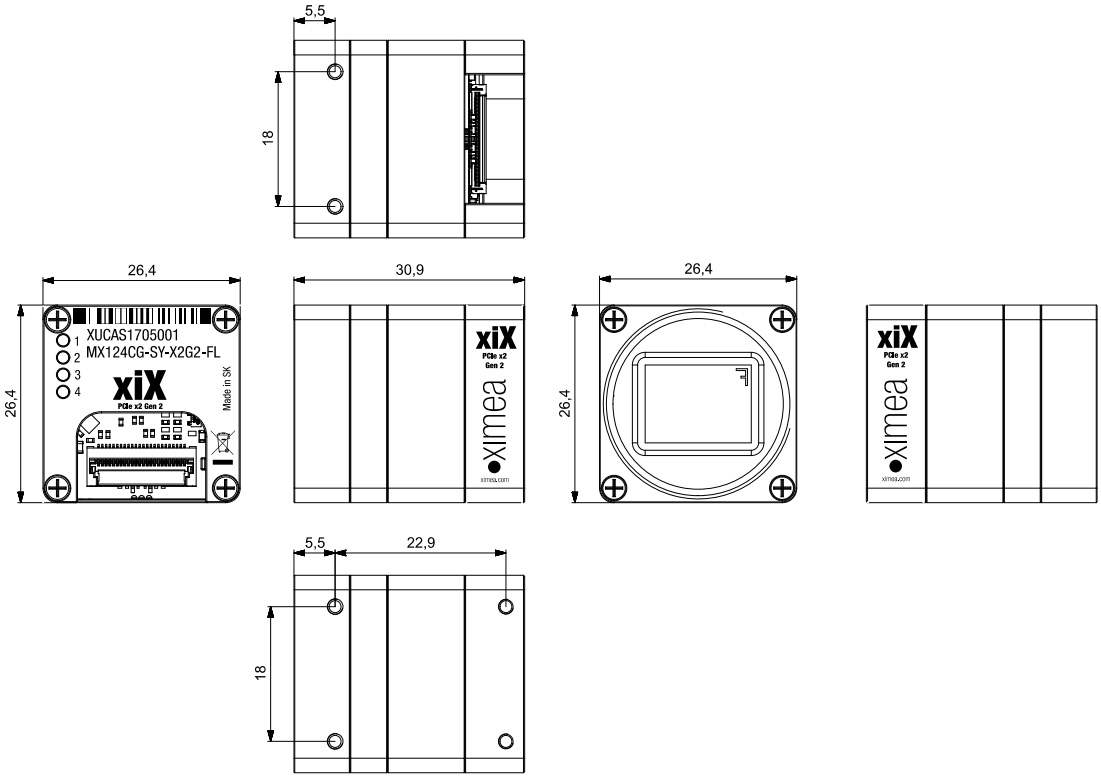


figure 3-26, dimensional drawing MX124xG-SY-X2G2-FL C-Mount housing

3.6.5.4. Drawings MX124xG-SY-X2G2-FV (C-mount [with C mount module B])

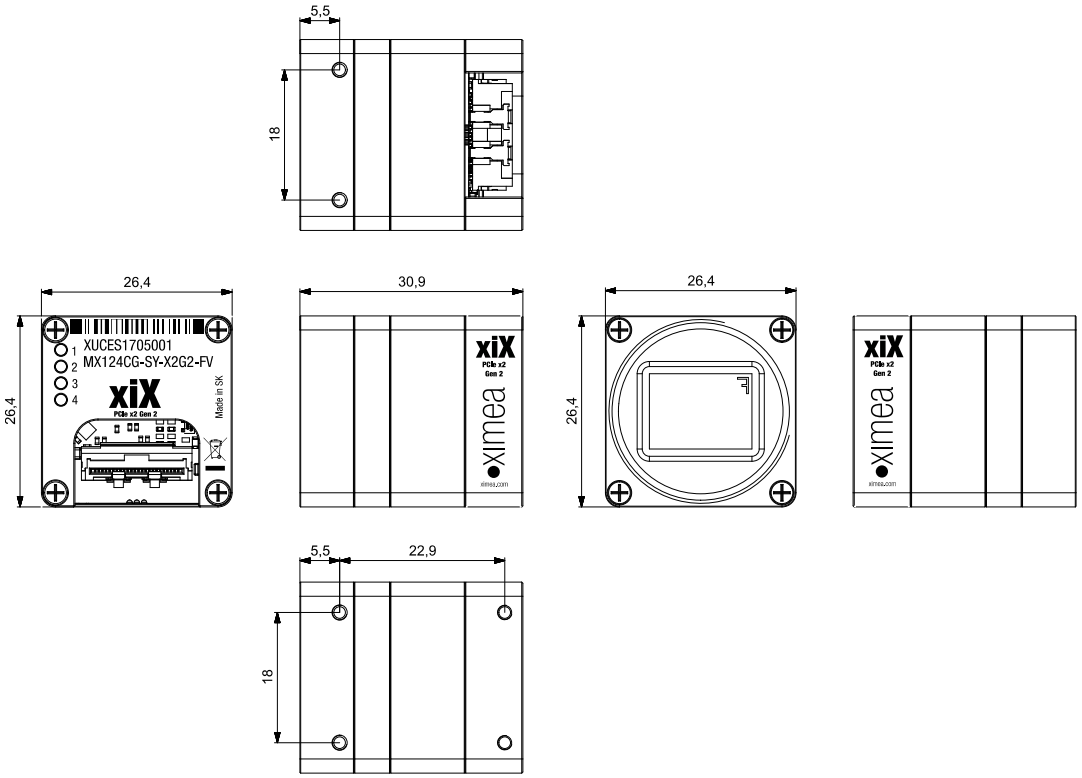


figure 3-27, dimensional drawing MX124xG-SY-X2G2-FV, C-Mount housing

3.6.5.5. Drawings MX124xG-SY-X2G2-FF (C-mount [with C mount module B])

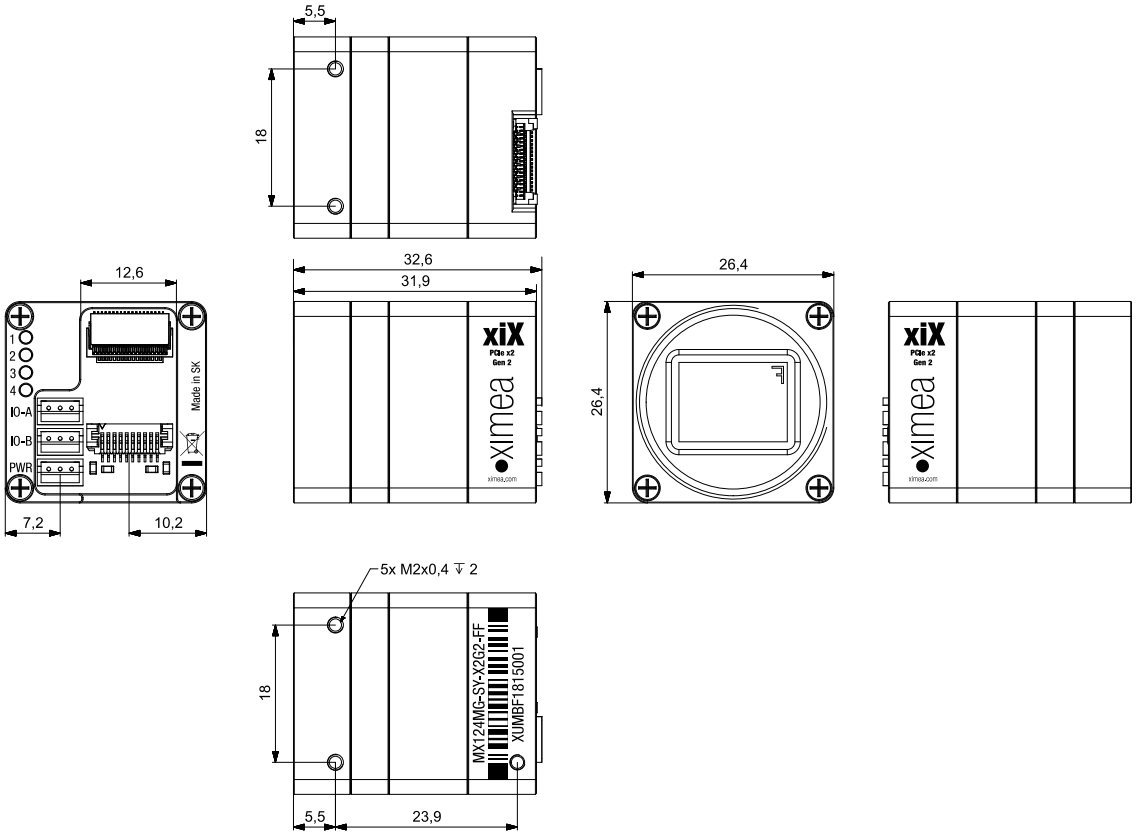


figure 3-28, dimensional drawing MX124xG-SY-X2G2-FF, C-Mount housing

3.6.5.6. Referenced documents

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

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

3.6.5.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-20, sensor features available

3.6.6. MX161xG-SY-X2G2-Fx

3.6.6.1. Sensor and camera parameters

xiX model		MX161CG-SY-X2G2-Fx		MX161MG-SY-X2G2-Fx
Sensor parameters				
Model name		IMX542AAQJ-C		IMX542AAMJ-C
Color filter		RGB Bayer mosaic		None
Technology		4th Gen Pregius S		
Shutter type		Global		
Pixel Resolution (H × V)	[pixel]	5328 x 3040		
Active area size (H × V)	[mm]	14.58 x 8.314		
Sensor diagonal	[mm]	16.78		
Optical format	[inch]	1.1"		
Pixel Size (H × V)	[µm]	2.74 x 2.74		
Image quality parameters (EMVA 1288)				
ADC resolution	[bit]	8 [1]	10	12
FWC	[ke-]	2.44	10.05	9.28
Dynamic range	[dB]	52.49	64.61	69.82
SNR_{max}	[dB]	33.83	40.26	40.06
System gain 1/K	[e-/DN][2]	10.29	10.43	2.37
Dark noise	[e-]	5.3	5.41	2.5
Dark current @ 60°C	[e-/s]	22.68	28.41	17.6
Absolute sensitivity threshold	[e-]	5.8	5.91	3
DSNU	[e-]	1.34	1.83	1.63
PRNU	[%]	1.22	1.21	1.16
Linearity error	[%]	0.87	0.23	0.39
Camera parameters				
Exposure time (EXP)		16 µs to 30 s, in steps of 6.9 µs [3]		
Variable Gain Range (VGA)	[dB]	0-24		
ADC resolution	[bit/pixel]	8 [1]	10	12
Maximal framerate (MRR)	[fps]	45.7	36.8	33.3
Power consumption				
Typical / Maximum	[W]	3.2 / 3.4		
Dimensions/Mass				
height	[mm]	26.4		
width	[mm]	26.4		
depth(-FL/-FV/-FF)	[mm]	31/31/32 (with C/CS Mount module B) 26/26/27 (without C/CS Mount module B)		
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.3 (with C/CS Mount module B) 25.8/25.8/27.1 (without C/CS Mount module B)		

table 3-21, MX161xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

2) DN is LSB_N where N is the ADC resolution bit depth

3) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here:
Camera model frame rate calculator:
https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX161CG-SY-X2G2

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1	5328 x 3040	8	45.7
Yes	Yes	1x1 / 1x1	5328 x 3040	10	36.8
Yes	Yes	1x1 / 1x1	5328 x 3040	12	33.3
Yes	Yes	1x1 / 2x2	2664 x 1520	8	151.6
Yes	Yes	1x1 / 2x2	2664 x 1520	10	122.4
Yes	Yes	1x1 / 2x2	2664 x 1520	12	120.5
No	Yes	2x2 / 1x1	2664 x 1520	8	151.6
No	Yes	2x2 / 1x1	2664 x 1520	10	122.4
No	Yes	2x2 / 1x1	2664 x 1520	12	120.5

table 3-22, MX161xG-SY-X2G2-Fx, supported standard readout modes

3.6.6.2. Spectral Response curve [%]

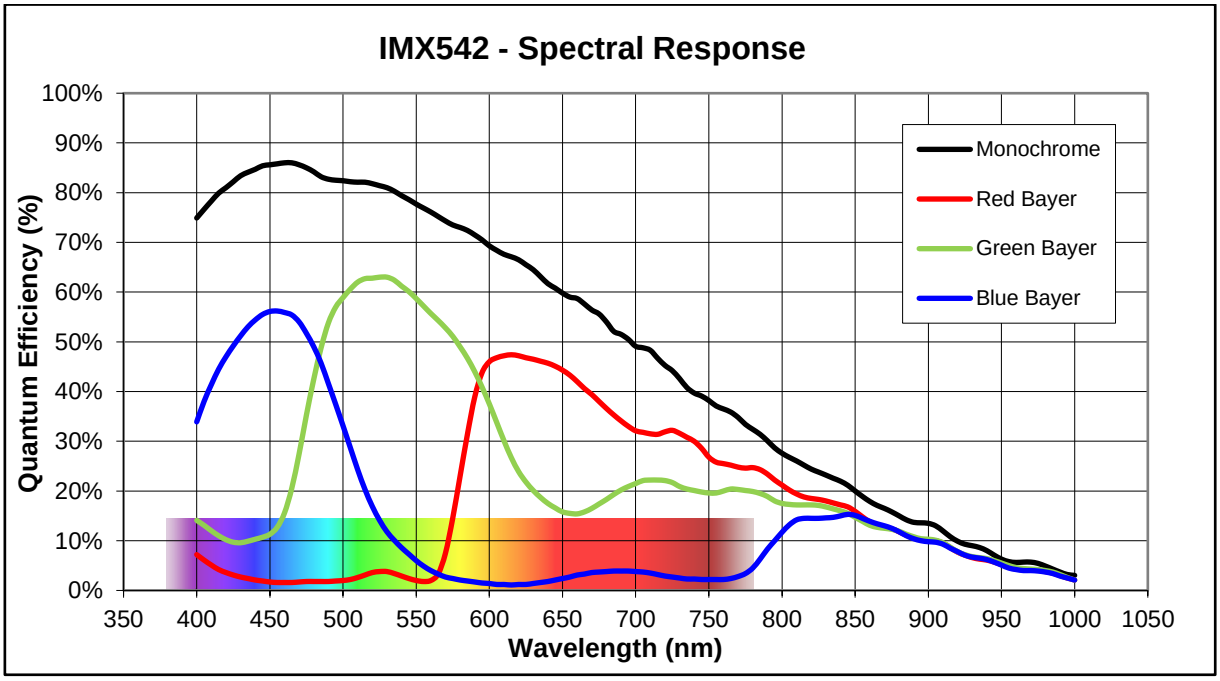


figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY

3.6.6.3. Drawings MX161xG-SY-X2G2-FL (C-mount [with C mount module B])

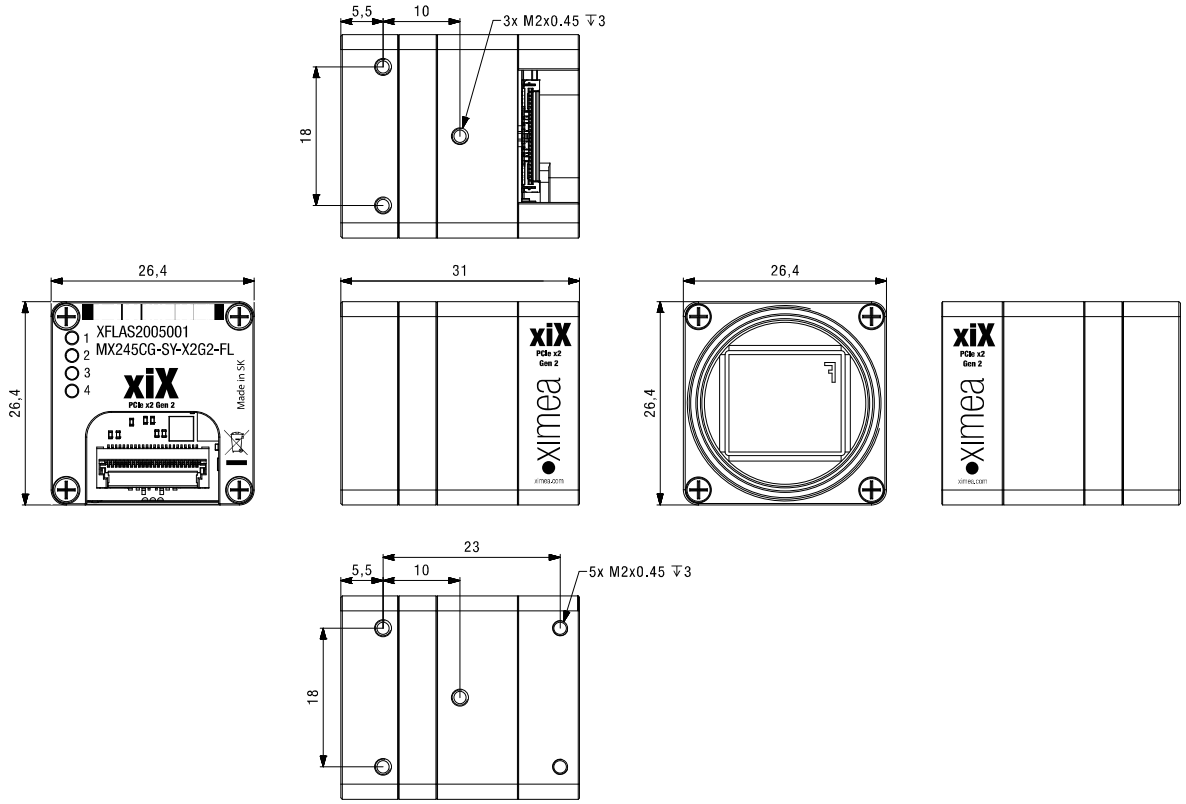


figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing

3.6.6.4. Drawings MX161xG-SY-X2G2-FV (C-mount [with C mount module B])

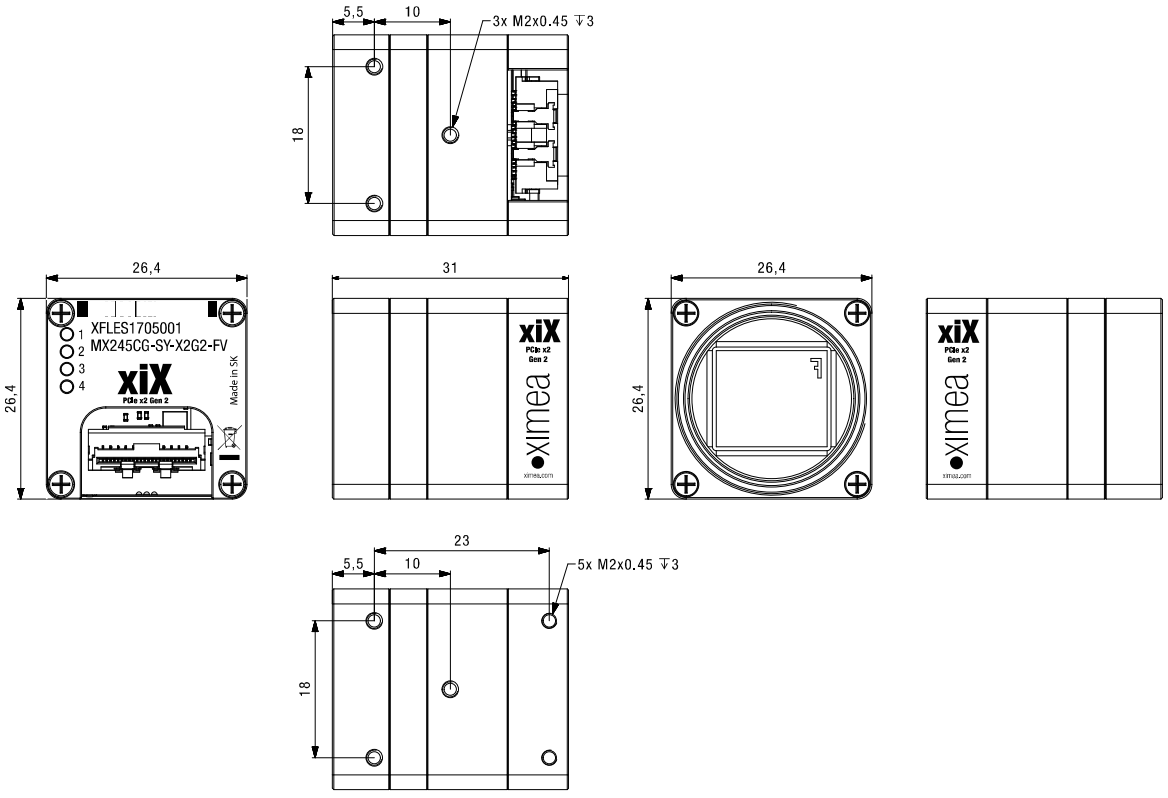


figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing

3.6.6.5. Drawings MX161xG-SY-X2G2-FF (C-mount [with C mount module B])

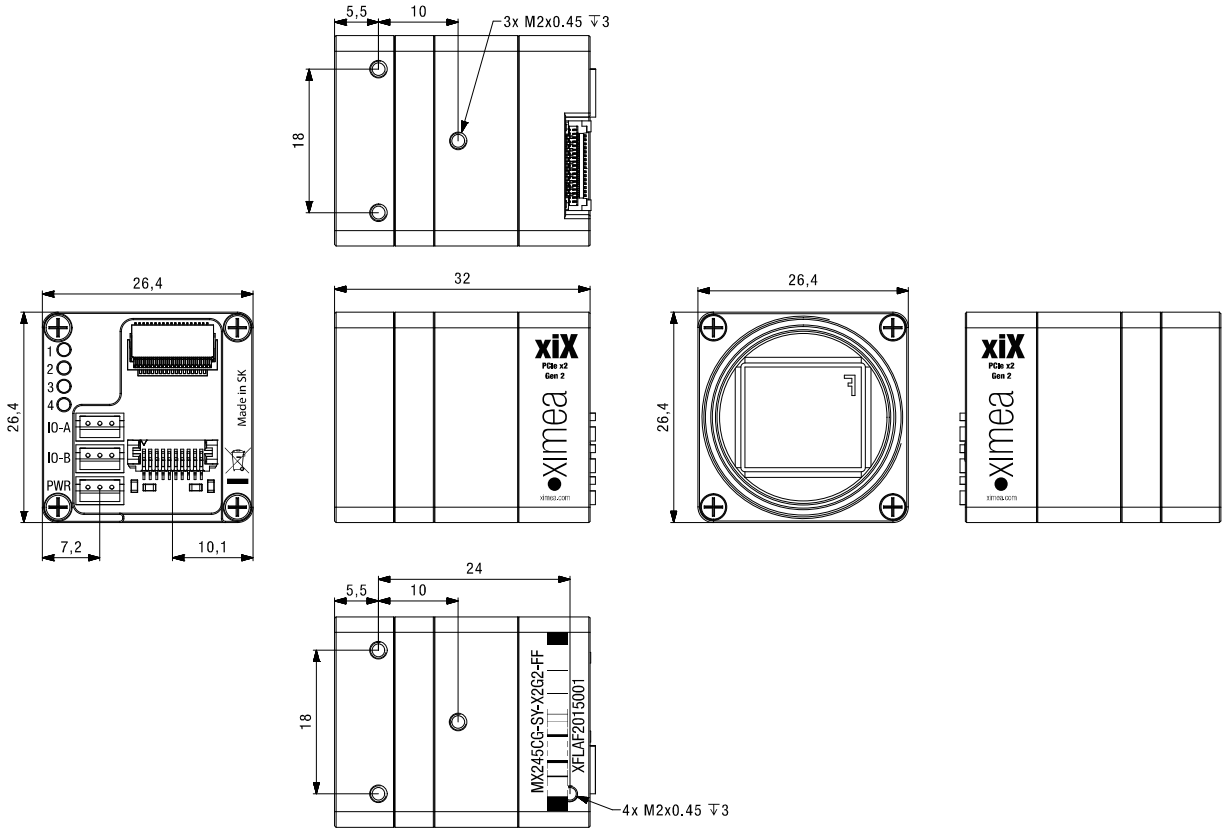


figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing

3.6.6.6. Referenced documents

Sony Datasheet IMX542-AAMJ-C_Data_Sheet(E)_E20516B09 (23/10/20)

Sony Datasheet IMX542-AAQJ-C_Data_Sheet(E)_E20602A09 (23/09/20)

3.6.6.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
Overlap mode	Sensor can expose next image during the readout phase

table 3-23, sensor features available

3.6.7. MX161xG-SY-X2G2-Fx-HDR

3.6.7.1. Sensor and camera parameters

xiX model		MX161CG-SY-X2G2-Fx-HDR			MX161MG-SY-X2G2-Fx-HDR		
Sensor parameters							
Model name		IMX532AAQJ-C			IMX532AAMJ-C		
Color filter		RGB Bayer mosaic			None		
Technology		4th Gen Pregius S					
Shutter type		Global					
Pixel Resolution (H×V)	[pixel]	5328 x 3040					
Active area size (H×V)	[mm]	14.58 x 8.314					
Sensor diagonal	[mm]	16.78					
Optical format	[inch]	1.1"					
Pixel Size (H×V)	[µm]	2.74 x 2.74					
Image quality parameters (EMVA 1288)							
Mode		Standard			Dual ADC[1]		
Gain ratio	[dB]	Not applicable			24		
ADC resolution	[bit]	8 [2]	10	12	8 [2]	10	12
Saturation capacity	[ke-]	2.41	9.85	9.1	2.34	9.92	9.39
Dynamic range	[dB]	53.25	64.68	70.05	61.54	71.71	72.34
SNR_{max}	[dB]	33.8	40.44	40.01	33.65	40.46	40.24
System gain 1/K	[e-/DN][3]	10.04	10.16	2.41	0.04	0.16	0.15
Dark noise	[e-]	4.74	5.24	2.36	1.46	2.08	1.77
Dark current @ 60 °C	[e-/s]	20.76	20.43	23.67	17.47	21.82	19.64
Abs. sensitivity thresh.	[e-]	5.24	5.74	2.86	1.96	2.58	2.27
DSNU	[e-]	1	1.9	1.81	1.57	3.34	3.22
PRNU	[%]	0.69	0.6	0.61	0.65	0.6	0.6
Linearity error	[%]	0.71	0.3	0.18	0.62	0.24	0.52
Camera parameters							
Exposure time		16 µs to 30 s, in steps of 6.9µs [4]					
Variable Gain Range	[dB]	0-24					
ADC resolution		8 [2]		10		12	
Maximal framerate – standard	[fps]	23.1		18.5		15.4	
Maximal framerate – Dual ADC							
Non-combined [5]	[fps]	11.7		9.3		7.8	
Combined	[fps]	23.1 [6]		N/A		15.4 [7]	
Power consumption							
Typical / Maximum	[W]	3.4 / 3.6					
Dimensions/Mass							
height	[mm]	26.4					
width	[mm]	26.4					
depth(-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)					
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.3 (with C/CS Mount module B) 25.8/25.8/27.1 (without C/CS Mount module B)					

table 3-24, MX161xG-SY-X2G2-Fx-HDR, sensor and camera parameters

Notes:

1) Dual ADC non-combined modes were measured with gain ratio set to the maximum value of 24 dB
2) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)
3) For standard modes DN is LSB_N where N is the ADC resolution bit depth and for dual ADC modes DN is LSB_{16}
4) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera model frame rate calculator:

   https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX161CG-SY-X2G2-HDR
5) Possibility to combine in host computer (API)
6) With Dual ADC combining on-sensor - 2x12 bit with 8-bit output data
7) With Dual ADC combining on-sensor - 2x12 bit with 12-bit output data

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1 [1]	5328 x 3040	8	45.6
Yes	Yes	1x1 / 1x1 [1]	5328 x 3040	10	36.7
Yes	Yes	1x1 / 1x1 [1]	5328 x 3040	12	33.1
Yes	Yes	1x1 / 2x2 [1]	2664 x 1520	8	149.5
Yes	Yes	1x1 / 2x2 [1]	2664 x 1520	10	120.7
Yes	Yes	1x1 / 2x2 [1]	2664 x 1520	12	118.8
No	Yes	2x2 [1] / 1x1	2664 x 1520	8	150.2
No	Yes	2x2 [1] / 1x1	2664 x 1520	10	121.3
No	Yes	2x2 [1] / 1x1	2664 x 1520	12	118.8
Yes	Yes	1x1 / 1x1 [2]	5328 x 3040	8	23
Yes	Yes	1x1 / 1x1 [2]	5328 x 3040	10	18.5
Yes	Yes	1x1 / 1x1 [2]	5328 x 3040	12	16.7
Yes	Yes	1x1 / 1x1	5328 x 3040	8 [3]	45.6
Yes	Yes	1x1 / 1x1	5328 x 3040	12 [4]	33.2

table 3-25, MX161xG-SY-X2G2-Fx-HDR, supported standard readout modes

1) Standard mode
2) Dual ADC mode without in sensor combination - possibility to combine in computer (API)
3) Dual ADC mode with combining on-sensor - 2x12 bit with 8-bit output data
4) Dual ADC mode with combining on-sensor - 2x12 bit with 12-bit output data

3.6.7.2. Quantum efficiency curves [%]

Spectral response for IMX532 sensor is the same as for sensor IMX542. See the page 49 figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY.

3.6.7.3. Drawings MX161xG-SY-X2G2-FL-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing on page 50).

3.6.7.4. Drawings MX161xG-SY-X2G2-FV-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FV (see figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing on page 50).

3.6.7.5. Drawings MX161xG-SY-X2G2-FF-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FF (see figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing on page 51).

3.6.7.6. Referenced documents

Sony Datasheet IMX532-AAMJ-C_Data_Sheet(E)_E20515A0X (30/10/20)

Sony Datasheet IMX532-AAQJ-C_Data_Sheet(E)_E20601A0X (30/10/20)

3.6.7.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
Overlap mode	Sensor can expose next image during the readout phase

table 3-26, sensor features available

3.6.8. MX203xG-SY-X2G2-Fx

3.6.8.1. Sensor and camera parameters

xiX model		MX203CG-SY-X2G2-Fx		MX203MG-SY-X2G2-Fx
Sensor parameters				
Model name		IMX541AAQJ		IMX541AAMJ
Color filter		RGB Bayer mosaic		None
Technology		4th Gen Pregius S		
Shutter type		Global		
Pixel Resolution (H × V)	[pixel]	4512 x 4512		
Active area size (H × V)	[mm]	12.34 x 12.34		
Sensor diagonal	[mm]	17.45		
Optical format	[inch]	1.1”		
Pixel Size (H × V)	[µm]	2.74 x 2.74		
Image quality parameters (EMVA 1288)				
ADC resolution	[bit]	8 [1]	10	12
FWC	[ke-]	2.38	9.91	9.24
Dynamic range	[dB]	52.69	65	70.43
SNR_{max}	[dB]	33.73	40.2	39.92
System gain 1/K	[e-/DN][2]	10	10.16	2.37
Dark noise	[e-]	5.03	5.07	2.28
Dark current @ 60°C	[e-/s]	8.09	13.19	8.54
Absolute sensitivity threshold	[e-]	5.53	5.57	2.78
DSNU	[e-]	1.29	1.79	1.73
PRNU	[%]	0.64	0.56	0.56
Linearity error	[%]	0.78	0.41	0.52
Camera parameters				
Exposure time (EXP)		14 µs to 30 s, in steps of 6 µs [3]		
Variable Gain Range (VGA)	[dB]	0-24		
ADC resolution	[bit/pixel]	8 [1]	10	12
Maximal framerate (MRR)	[fps]	18.7	15	12.5
Power consumption				
Typical / Maximum	[W]	3.2 / 3.4		
Dimensions/Mass				
height	[mm]	26.4		
width	[mm]	26.4		
depth(-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)		
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.3 (with C/CS Mount module B) 25.8/25.8/27.1 (without C/CS Mount module B)		

table 3-27, MX203xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

2) DN is LSB_N where N is the ADC resolution bit depth

3) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera model frame rate calculator:

https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX203CG-SY-X2G2

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1	4512 x 4512	8	35.8
Yes	Yes	1x1 / 1x1	4512 x 4512	10	28.9
Yes	Yes	1x1 / 1x1	4512 x 4512	12	26.4
Yes	Yes	1x1 / 2x2	2256 x 2256	8	120.3
Yes	Yes	1x1 / 2x2	2256 x 2256	10	97.6
Yes	Yes	1x1 / 2x2	2256 x 2256	12	96
No	Yes	2x2 / 1x1	2256 x 2256	8	120.3
No	Yes	2x2 / 1x1	2256 x 2256	10	97.6
No	Yes	2x2 / 1x1	2256 x 2256	12	96

table 3-28, MX203xG-SY-X2G2-Fx, supported standard readout modes

3.6.8.2. Quantum efficiency curves [%]

Spectral response for IMX541 sensor is the same as for sensor IMX542. See the page 49 figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY.

3.6.8.3. Drawings MX203xG-SY-X2G2-FL (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing on page 50).

3.6.8.4. Drawings MX203xG-SY-X2G2-FV (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing on page 50).

3.6.8.5. Drawings MX203xG-SY-X2G2-FF (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing on page 51).

3.6.8.6. Referenced documents

Sony Datasheet IMX541-AAMJ-C_Data_Sheet(E)_E20522A09 (10/05/10)

Sony Datasheet IMX541-AAQJ-C_Data_Sheet(E)_E20603A09 (10/05/10)

3.6.8.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
Overlap mode	Sensor can expose next image during the readout phase

table 3-29, sensor features available

3.6.9. MX203xG-SY-X2G2-Fx-HDR

3.6.9.1. Sensor and camera parameters

xiX model	MX203CG-SY-X2G2-Fx-HDR			MX203MG-SY-X2G2-Fx-HDR		
Sensor parameters						
Model name	IMX531AAQJ			IMX531AAMJ		
Color filter	RGB Bayer mosaic			None		
Technology	4th Gen Pregius S					
Shutter type	Global					
Pixel Resolution (H × V) [pixel]	4512 x 4512					
Active area size (H × V) [mm]	12.34 x 12.34					
Sensor diagonal [mm]	17.45					
Optical format [inch]	1.1”					
Pixel Size (H × V) [µm]	2.74 x 2.74					
Image quality parameters						
Mode	Standard			Dual ADC[1]		
ADC resolution [bit]	8 [2]	10	12	8 [2]	10	12
FWC [ke-]	2.45	9.82	9.45	2.37	9.99	9.5
Dynamic range [dB]	52.97	64.8	71.61	62.22	71.83	72.74
SNR_{max} [dB]	33.81	40.4	40.28	33.75	40.55	40.33
System gain 1/K [e-/DN][3]	10.04	10.16	2.41	0.04	0.16	0.15
Dark noise [e-]	5	5.15	1.98	1.33	2.06	1.69
Dark current @ 60 °C [e-/s]	16.97	16.98	11.53	6.14	15.89	10.25
Absolute sensitivity threshold [e-]	5.5	5.65	2.48	1.83	2.56	2.19
DSNU [e-]	1.53	2.03	1.65	1.63	3.79	3.05
PRNU [%]	0.57	0.51	0.51	0.56	0.51	0.51
Linearity error [%]	3.1	0.39	0.24	0.85	1.38	0.27
Camera parameters						
Exposure time (EXP)	14 µs to 30 s, in steps of 6 µs [4]					
Variable Gain Range (VGA) [dB]	0-24					
ADC resolution	8 [2]	10	12			
Maximal framerate – standard [fps]	18.6	14.9	12.4			
Maximal framerate – Dual ADC						
Non-combined [5] [fps]	9.4	7.5	6.3			
Combined [fps]	18.6 [6]	N/A	12.4 [7]			
Power consumption						
Typical / Maximum [W]	3.4 / 3.6					
Dimensions/Mass						
height [mm]	26.4					
width [mm]	26.4					
depth(-FL/-FV/-FF) [mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)					
mass(-FL/-FV/-FF) [g]	30.0/30.0/31.3 (with C/CS Mount module B) 25.8/25.8/27.1 (without C/CS Mount module B)					

table 3-30, MX203xG-SY-X2G2-Fx-HDR, sensor and camera parameters

Notes:

1) Dual ADC non-combined modes were measured with gain ratio set to the maximum value of 24 dB
2) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)
3) For standard modes DN is LSB_N where N is the ADC resolution bit depth and for dual ADC modes DN is LSB_{16}
4) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera model frame rate calculator:
   https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX203CG-SY-X2G2-HDR
5) Possibility to combine in host computer (API)
6) With Dual ADC combining on-sensor - 2x12 bit with 8-bit output data
7) With Dual ADC combining on-sensor - 2x12 bit with 12-bit output data

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1 [1]	4512 x 4512	8	35.7
Yes	Yes	1x1 / 1x1 [1]	4512 x 4512	10	28.9
Yes	Yes	1x1 / 1x1 [1]	4512 x 4512	12	26.4
Yes	Yes	1x1 / 2x2 [1]	2256 x 2256	8	119
Yes	Yes	1x1 / 2x2 [1]	2256 x 2256	10	96.8
Yes	Yes	1x1 / 2x2 [1]	2256 x 2256	12	95.1
No	Yes	2x2 [1] / 1x1	2256 x 2256	8	119
No	Yes	2x2 [1] / 1x1	2256 x 2256	10	96.8
No	Yes	2x2 [1] / 1x1	2256 x 2256	12	95.1
Yes	Yes	1x1 / 1x1 [2]	4512 x 4512	8	18
Yes	Yes	1x1 / 1x1 [2]	4512 x 4512	10	14.5
Yes	Yes	1x1 / 1x1 [2]	4512 x 4512	12	13.3
Yes	Yes	1x1 / 1x1	4512 x 4512	8 [3]	35.8
Yes	Yes	1x1 / 1x1	4512 x 4512	12 [4]	26.4

table 3-31, MX203xG-SY-X2G2-Fx-HDR, supported standard readout modes

1) Standard mode
2) Dual ADC mode without on-sensor combination - possibility to combine in host computer (API)
3) Dual ADC mode with combining on-sensor - 2x12 bit with 8-bit output data
4) Dual ADC mode with combining on-sensor - 2x12 bit with 12-bit output data

3.6.9.2. Quantum efficiency curves [%]

Spectral response for IMX531 sensor is the same as for sensor IMX542. See the page 49 figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY.

3.6.9.3. Drawings MX203xG-SY-X2G2-FL-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing on page 50).

3.6.9.4. Drawings MX203xG-SY-X2G2-FV-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FV (see figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing on page 50).

3.6.9.5. Drawings MX203xG-SY-X2G2-FF-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FF (see figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing on page 51).

3.6.9.6. Referenced documents

Sony Datasheet IMX531-AAMJ-C_Data_Sheet(E)_E20521A0X (23/10/20)

Sony Datasheet IMX531-AAQJ-C_Data_Sheet(E)_E20604A0X (23/10/20)

3.6.9.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
HDR	Yes, allowed via special mode
Overlap mode	Sensor can expose next image during the readout phase

table 3-32, sensor features available

3.6.10. MX245xG-SY-X2G2-Fx

3.6.10.1. Sensor and camera parameters

xiX model		MX245CG-SY-X2G2-Fx		MX245MG-SY-X2G2-Fx
Sensor parameters				
Model name		IMX540AAQJ		IMX540AAMJ
Color filter		RGB Bayer mosaic		None
Technology		4th Gen Pregius S		
Shutter type		Global		
Pixel Resolution (H × V)	[pixel]	5328 x 4608		
Active area size (H × V)	[mm]	14.58 x 12.6		
Sensor diagonal	[mm]	19.27		
Optical format	[inch]	1.2”		
Pixel Size (H × V)	[µm]	2.74 x 2.74		
Image quality parameters (EMVA 1288)				
ADC resolution	[bit]	8 [1]	10	12
FWC	[ke-]	2.38	9.91	9.24
Dynamic range	[dB]	52.69	65	70.43
SNR_{max}	[dB]	33.73	40.2	39.92
System gain 1/K	[e-/DN][2]	10	10.16	2.37
Dark noise	[e-]	5.03	5.07	2.28
Dark current @ 60°C	[e-/s]	8.09	13.19	8.54
Absolute sensitivity threshold	[e-]	5.53	5.57	2.78
DSNU	[e-]	1.29	1.79	1.73
PRNU	[%]	0.64	0.56	0.56
Linearity error	[%]	0.78	0.41	0.52
Camera parameters				
Exposure time (EXP)		16 µs to 30 s, in steps of 6.9 µs [3]		
Variable Gain Range (VGA)	[dB]	0-24		
ADC resolution	[bit/pixel]	8 [1]	10	12
Maximal framerate (MRR)	[fps]	15.5	12.4	10.4
Power consumption				
Typical / Maximum	[W]	3.2 / 3.4		
Dimensions/Mass				
height	[mm]	26.4		
width	[mm]	26.4		
depth(-FL/-FV/-FF)	[mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)		
mass(-FL/-FV/-FF)	[g]	30.0/30.0/31.3 (with C/CS Mount module B) 25.8/25.8/27.1 (without C/CS Mount module B)		

table 3-33, MX245xG-SY-X2G2-Fx, sensor and camera parameters

Notes:

1) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)

2) DN is LSB_N where N is the ADC resolution bit depth

3) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here: Camera model frame rate calculator:

https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX245CG-SY-X2G2

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1	5328 x 4608	8	30.5
Yes	Yes	1x1 / 1x1	5328 x 4608	10	24.6
Yes	Yes	1x1 / 1x1	5328 x 4608	12	22.2
Yes	Yes	1x1 / 2x2	2664 x 2304	8	102
Yes	Yes	1x1 / 2x2	2664 x 2304	10	82.4
Yes	Yes	1x1 / 2x2	2664 x 2304	12	81
No	Yes	2x2 / 1x1	2664 x 2304	8	102
No	Yes	2x2 / 1x1	2664 x 2304	10	82.4
No	Yes	2x2 / 1x1	2664 x 2304	12	81

table 3-34, MX245xG-SY-X2G2-Fx, supported standard readout modes

3.6.10.2. Quantum efficiency curves [%]

Spectral response for IMX540 sensor is the same as for sensor IMX542. See the page 49 figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY.

3.6.10.3. Drawings MX245xG-SY-X2G2-FL (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing on page 50).

3.6.10.4. Drawings MX245xG-SY-X2G2-FV (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FV (see figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing on page 50).

3.6.10.5. Drawings MX245xG-SY-X2G2-FF (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FF (see figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing on page 51).

3.6.10.6. Referenced documents

Sony Datasheet IMX540-AAMJ-C_Data_Sheet(E)_E20505B09 (10/05/20)

Sony Datasheet IMX540-AAQJ-C_Data_Sheet(E)_E20503B09 (10/05/20)

3.6.10.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
Overlap mode	Sensor can expose next image during the readout phase

table 3-35, sensor features available

3.6.11. MX245xG-SY-X2G2-Fx-HDR

3.6.11.1. Sensor and camera parameters

xiX model	MX245CG-SY-X2G2-Fx-HDR			MX245MG-SY-X2G2-Fx-HDR		
Sensor parameters						
Model name	IMX530AAQJ			IMX530AAMJ		
Color filter	RGB Bayer mosaic			None		
Technology	4th Gen Pregius S					
Shutter type	Global					
Pixel Resolution (H × V) [pixel]	5328 x 4608					
Active area size (H × V) [mm]	14.58 x 12.6					
Sensor diagonal [mm]	19.27					
Optical format [inch]	1.2”					
Pixel Size (H × V) [µm]	2.74 x 2.74					
Image quality parameters						
Mode	Standard			Dual ADC[1]		
ADC resolution [bit]	8 [2]	10	12	8 [2]	10	12
FWC [ke-]	2.45	9.82	9.45	2.37	9.99	9.5
Dynamic range [dB]	52.97	64.8	71.61	62.22	71.83	72.74
SNR_{max} [dB]	33.81	40.4	40.28	33.75	40.55	40.33
System gain 1/K [e-/DN][3]	10.04	10.16	2.41	0.04	0.16	0.15
Dark noise [e-]	5	5.15	1.98	1.33	2.06	1.69
Dark current @ 60 °C [e-/s]	16.97	16.98	11.53	6.14	15.89	10.25
Absolute sensitivity threshold [e-]	5.5	5.65	2.48	1.83	2.56	2.19
DSNU [e-]	1.53	2.03	1.65	1.63	3.79	3.05
PRNU [%]	0.57	0.51	0.51	0.56	0.51	0.51
Linearity error [%]	3.1	0.39	0.24	0.85	1.38	0.27
Camera parameters						
Exposure time (EXP)	16 µs to 30 s, in steps of 6.9 µs [4]					
Variable Gain Range (VGA) [dB]	0-24					
ADC resolution	8 [2]		10		12	
Maximal framerate – standard [fps]	15.5		12.4		10.3	
Maximal framerate – Dual ADC						
Non-combined [5] [fps]	7.8		6.2		5.2	
Combined [fps]	15.5 [6]		N/A		10.3 [7]	
Power consumption						
Typical / Maximum [W]	3.4 / 3.6					
Dimensions/Mass						
height [mm]	26.4					
width [mm]	26.4					
depth(-FL/-FV/-FF) [mm]	30.9/30.9/31.9 (with C/CS Mount module B) 25.9/26.9/26.9 (without C/CS Mount module B)					
mass(-FL/-FV/-FF) [g]	30.0/30.0/31.2 (with C/CS Mount module B) 25.8/25.8/27.0 (without C/CS Mount module B)					

table 3-36, MX245xG-SY-X2G2-Fx-HDR, sensor and camera parameters

Notes:

1) Dual ADC non-combined modes were measured with gain ratio set to the maximum value of 24 dB
2) Saturation level in 8-bit digitization is only ¼ of 10-bit and 12-bit mode (see *4.3.5 Digitization bit depth*)
3) For standard modes DN is LSB_N where N is the ADC resolution bit depth and for dual ADC modes DN is LSB_{16}
4) Defined for maximal bandwidth. Minimal Exposure and exposure step (Line Period) can be calculated here:
   Camera model frame rate calculator:
   https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX245CG-SY-X2G2-HDR
5) Possibility to combine in computer (API)
6) With Dual ADC combining on-sensor - 2x12 bit with 8-bit output data
7) With Dual ADC combining on-sensor - 2x12 bit with 12-bit output data

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS
Yes	Yes	1x1 / 1x1 [1]	5328 x 4608	8	30.5
Yes	Yes	1x1 / 1x1 [1]	5328 x 4608	10	24.5
Yes	Yes	1x1 / 1x1 [1]	5328 x 4608	12	22.1
Yes	Yes	1x1 / 2x2 [1]	2664 x 2304	8	101
Yes	Yes	1x1 / 2x2 [1]	2664 x 2304	10	81.6
Yes	Yes	1x1 / 2x2 [1]	2664 x 2304	12	80.2
No	Yes	2x2 [1] / 1x1	2664 x 2304	8	101
No	Yes	2x2 [1] / 1x1	2664 x 2304	10	81.6
No	Yes	2x2 [1] / 1x1	2664 x 2304	12	80.2
Yes	Yes	1x1 / 1x1 [2]	5328 x 4608	8	15.3
Yes	Yes	1x1 / 1x1 [2]	5328 x 4608	10	12.4
Yes	Yes	1x1 / 1x1 [2]	5328 x 4608	12	11.1
Yes	Yes	1x1 / 1x1	5328 x 4608	8 [3]	30.5
Yes	Yes	1x1 / 1x1	5328 x 4608	12 [4]	22.2

table 3-37, MX245xG-SY-X2G2-Fx-HDR, supported standard readout modes

1) Standard mode
2) Dual ADC mode without on-sensor combination - possibility to combine in computer (API)
3) Dual ADC mode with combining on-sensor - 2x12 bit with 8-bit output data
4) Dual ADC mode with combining on-sensor - 2x12 bit with 12-bit output data

3.6.11.2. Quantum efficiency curves [%]

Spectral response for IMX530 sensor is the same as for sensor IMX542. See the page 49 figure 3-29, IMX542 mono and color, quantum efficiency curve, ©SONY.

3.6.11.3. Drawings MX245xG-SY-X2G2-FL-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FL (see figure 3-30, dimensional drawing MX161xG-SY-X2G2-FL C-Mount housing on page 50).

3.6.11.4. Drawings MX245xG-SY-X2G2-FV-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FV (see figure 3-31, dimensional drawing MX161xG-SY-X2G2-FV, C-Mount housing on page 50).

3.6.11.5. Drawings MX245xG-SY-X2G2-FF-HDR (C-mount [with C mount module B])

Dimensions and drawings are the same as for the camera MX161xG-SY-X2G2-FF (see figure 3-32, dimensional drawing MX161xG-SY-X2G2-FF, C-Mount housing on page 51).

3.6.11.6. Referenced documents

Sony Datasheet IMX530-AAMJ-C_Data_Sheet(E)_E20506A0X (23/10/20)

Sony Datasheet IMX530-AAQJ-C_Data_Sheet(E)_E20504A0X (23/10/20)

3.6.11.7. Sensor features

feature	Note
Binning	Yes, up to 2x2 binning supported for monochrome camera only.
Skipping	Yes, up to 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
HDR	Yes, allowed via special mode
Overlap mode	Sensor can expose next image during the readout phase

table 3-38, sensor features available

3.6.12. MX120xG-CM-X4G2-Fx

3.6.12.1. Sensor and camera parameters

xiX model		MX120CG-CM-X4G2-Fx	MX120MG-CM-X4G2-Fx	MX120RG-CM-X4G2-Fx
Sensor parameter				
Part number		CMV12000-2E5C1PA	CMV12000-2E5M1PA	CMV12000-2E12M1PA
Color filter		RGB Bayer mosaic	None	None
Shutter type		Global		
Pixel Resolution (W x H)	[pixel]	4096 x 3072		
Active area size (W x H)	[mm]	22.5 x 16.9		
Sensor diagonal	[mm]	28.16		
Optical format	[inch]	1.75" (APS-C)		
Pixel Size	[µm]	5.5µm		
Image quality parameters (EMVA 1288)				
ADC resolution	[bit]	8, 10, 12		
FWC	[ke-]	13.5		
Dynamic range	[dB]	60		
SNR_{max}	[dB]	TBD		
Dark noise	[e-]	TBD		
Dark current	[e-/s]	22 @ RT 10-bit mode		
DSNU	[e-]	2 in 10-bit mode		
PRNU	[%]	<1.27%		
Linearity	[%]	TBD		
Shutter efficiency		1/50,000		
Micro lenses		Yes		
Camera parameters				
Digitization	[bit]	8, 10, 12		
Supported bit resolutions	[bit/pixel]	8, 9, 10, 11, 12, 16		
Exposure time (EXP)		19µs-3.5s, in steps of 2.3 µs [2]		
Variable Gain Range (VGA)	[dB]	0-12dB[1]		
Refresh rate (MRR)	[fps]	138/110/92 at 8/10/12 bit		
Power consumption[3]				
Standby / Maximum	[W]	7.4 / 10		
Dimensions/Mass				
height	[mm]	60		
width	[mm]	60		
depth	[mm]	31.6 (w/o EF-Mount Adapter)		
mass	[g]	151 (w/o EF-Mount Adapter)		

table 3-39, MX120xG-CM-X4G2-Fx, sensor and camera parameters

Notes:

1) Analog gain has only discrete steps.
2) Defined for bandwidth 1750 MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX120CG-CM-X4G2
3) Measured at 24V, connected with 10m fiber optical PCIe cable CBL-PCI-FIB-10M0. Optical cable power consumption is about 1.25W.

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1/1x1	4096 x 3072	8	138
Yes	Yes	1x1/1x1	4096 x 3072	10	110
Yes	Yes	1x1/1x1	4096 x 3072	12	92
Yes	Yes	1x1/2x2	2048 x 1536	8	542
Yes	Yes	1x1/2x2	2048 x 1536	10	436
Yes	Yes	1x1/2x2	2048 x 1536	12	357
Yes	Yes	2x2/1x1	2048 x 1536	8	200
Yes	Yes	2x2/1x1	2048 x 1536	10	267
Yes	Yes	2x2/1x1	2048 x 1536	12	267

table 3-40, MX120xG-SY-X4G2-Fx, supported standard readout modes

Notes:

1) Defined for bandwidth 1750MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX120CG-CM-X4G2

3.6.12.2. Spectral Response curves [%]

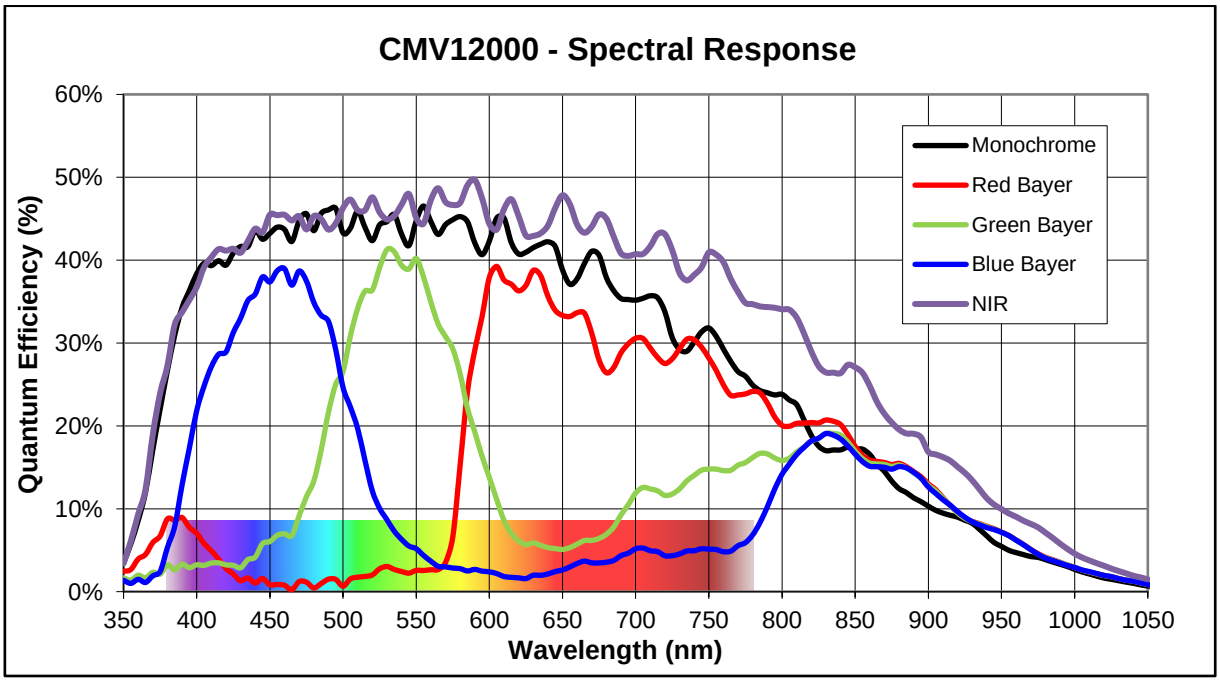


figure 3-33, CMV12000-mono, color and NIR, quantum efficiency curve, ©CMOSIS

3.6.12.3. Drawings MX120xG-CM-X4G2-FL

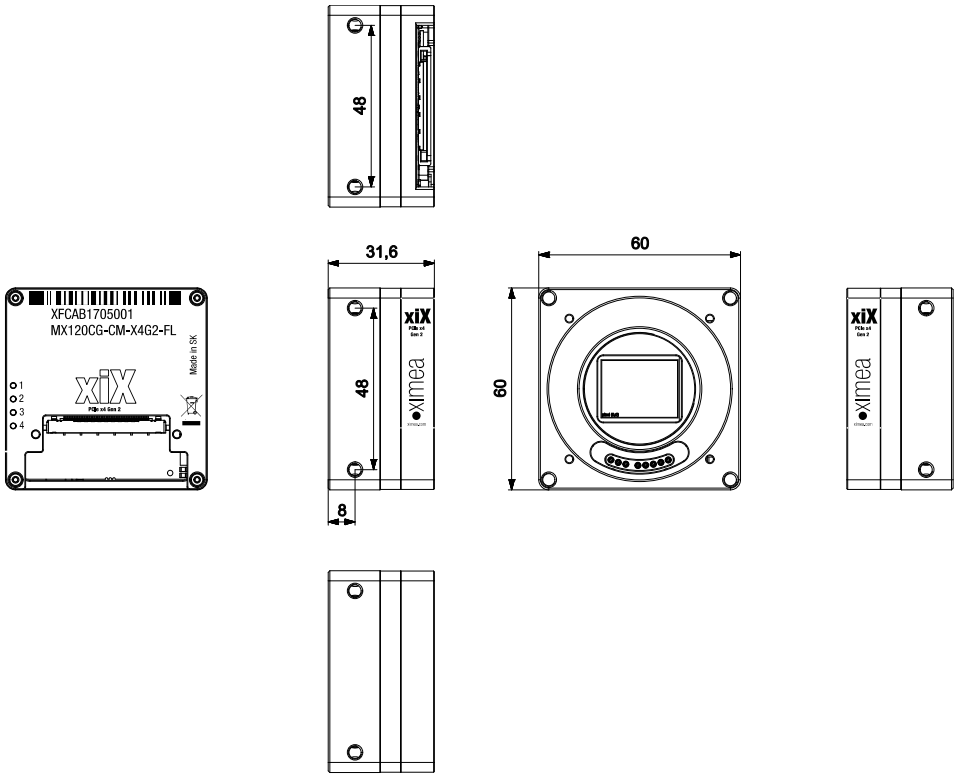


figure 3-34, dimensional drawing MX120xG-CM-X4G2-FL

3.6.12.4. Drawings MX120xG-CM-X4G2-FV

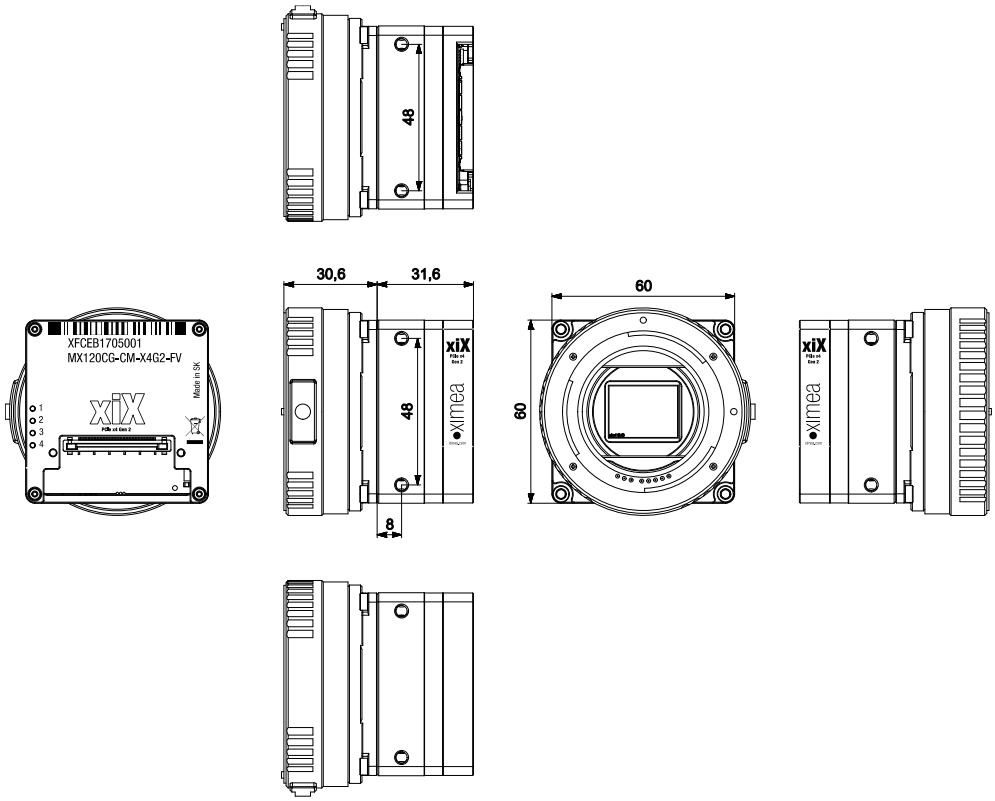


figure 3-35, dimensional drawing MX120xG-CM-X4G2-FV, with EF-mount adapter

3.6.12.5. Referenced documents

CMOSIS datasheet CMV12000 datasheet v2.11

3.6.12.6. Sensor features

feature	Note
Binning	Yes 2x2
Skipping	Yes 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-41, sensor features available

3.6.13. MX200xG-CM-X4G2-Fx

3.6.13.1. Sensor and camera parameters

xiX model		MX200CG-CM-X4G2-Fx	MX200MG-CM-X4G2-Fx
Sensor parameter			
Part number		CMV20000-1E5C1PA	CMV20000-1E5M1PA
Color filter		RGB Bayer mosaic	None
Shutter type		Global	
Pixel Resolution (W x H)	[pixel]	5120 x 3840	
Active area size (W x H)	[mm]	32.8 x 24.6	
Sensor diagonal	[mm]	40.96	
Optical format		2.56" (Full frame)	
Pixel Size	[µm]	6.4µm	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	12	
FWC	[ke-]	15	
Dynamic range	[dB]	66	
SNR_{max}	[dB]	TBD	
Dark noise	[e-]	TBD	
Dark current	[e-/s]	125e-/s @ RT	
DSNU	[e-/s]	10	
PRNU	%	1%	
Shutter efficiency		1/50,000	
Micro lenses		Yes	
Camera parameters			
Digitization	[bit]	12	
Supported bit resolutions	[bit/pixel]	8, 9, 10, 11, 12, 16	
Exposure time (EXP)		94µs – 1.05s, in steps of 8 µs [2]	
Variable Gain Range (VGA)	[dB]	0- 2.55[1]	
Refresh rate (MRR)	[fps]	32.5 at 8/10/12 bit	
Power consumption[3]			
Standby / Maximum	[W]	6.6 / 9.0	
Dimensions/Mass			
height	[mm]	60	
width	[mm]	60	
depth	[mm]	33.6 (w/o EF mount)	
mass	[g]	156 (w/o EF mount)	

table 3-42, MX200xG-CM-X4G2-Fx, sensor and camera parameters

Notes:

1) Analog gain has only several discrete steps.
2) Defined for bandwidth 1750MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX200CG-CM-X4G2
3) Measured at 24V, connected with 10m fiber optical PCIe cable CBL-PCI-FIB-10M0. Optical cable consumption is about 1.25W.

Color model	Mono model	Binning/skipping (H X V)	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1/1x1	5120 x 3840	8, 10, 12	32.5

table 3-43, MX200xG-CM-X4G2-Fx

Notes:

1) Defined for bandwidth 1750MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX200CG-CM-X4G2

3.6.13.2. Spectral Response curves [%]

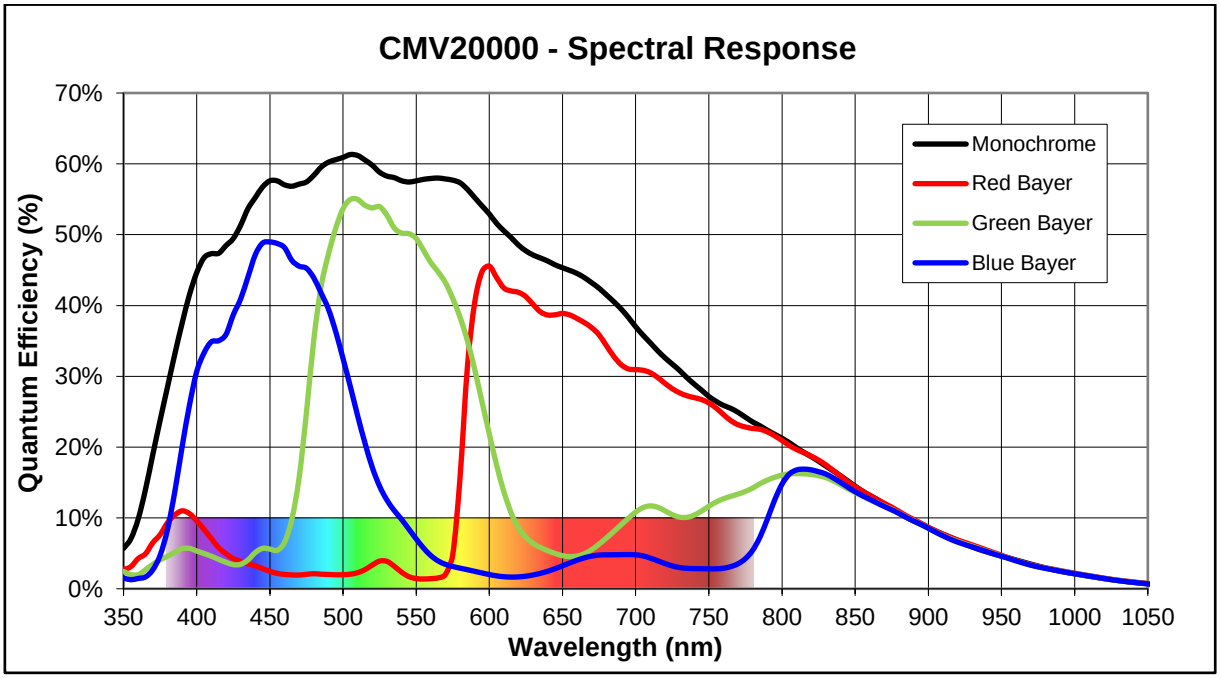


figure 3-36, CMV20000 mono and color, quantum efficiency curve, ©CMOSIS

3.6.13.3. Drawings MX200xG-CM-X4G2-FL

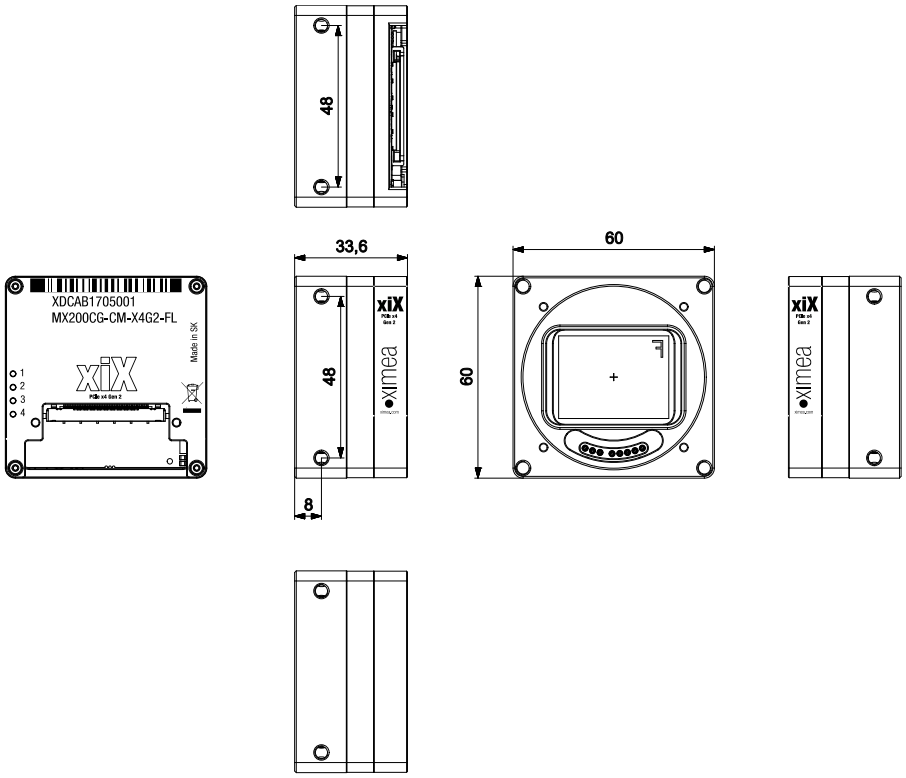


figure 3-37, dimensional drawing MX200xG-CM-X4G2-FL

3.6.13.4. Drawings MX200xG-CM-X4G2-FV

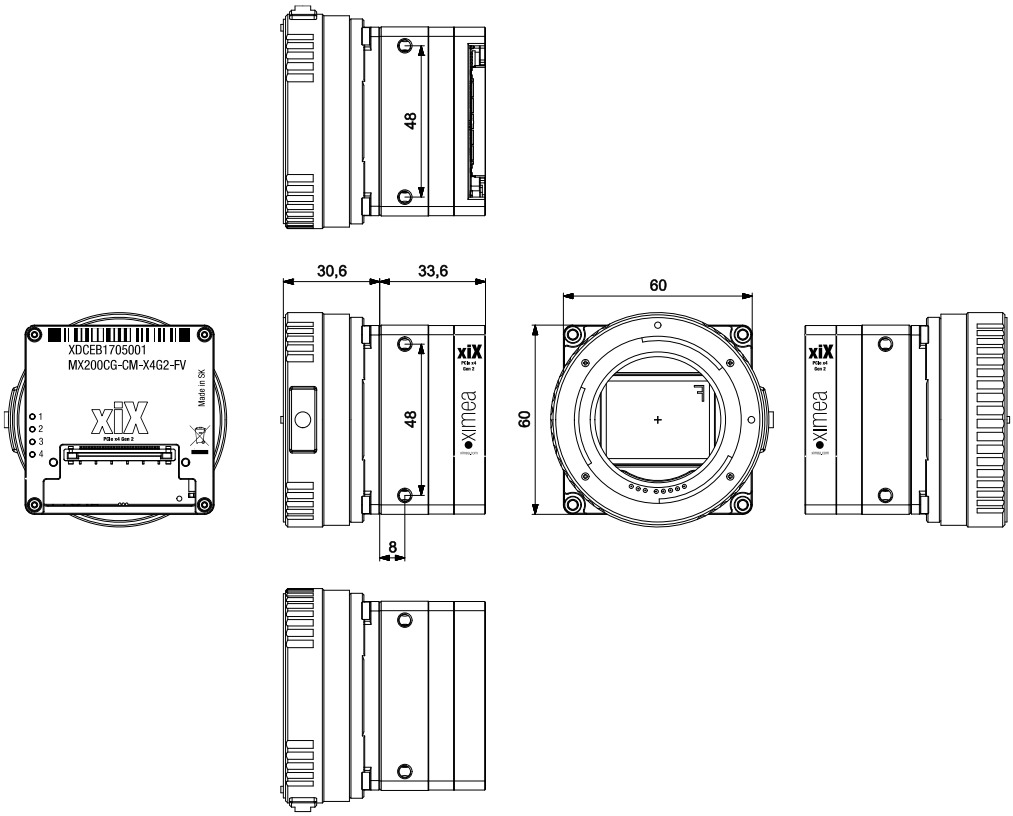


figure 3-38, dimensional drawing MX200xG-CM-X4G2-FV, with EF-mount adapter

3.6.13.5. Referenced documents

CMOSIS datasheet CMV20000 v2.3_2

3.6.13.6. Sensor features

feature	Note
Binning	No
Skipping	No
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)
HDR	Supported

table 3-44, sensor features available

3.6.14. MX500xG-CM-X4G2-Fx

3.6.14.1. Sensor and camera parameters

xiX model		MX500CG-CM-X4G2-Fx	MX500MG-CM-X4G2-Fx
Sensor parameter			
Part number		CMV50000-1E35C1PA	CMV50000-1E3M1PA
Color filter		RGB Bayer mosaic	None
Shutter type		Global	
Pixel Resolution (W x H)	[pixel]	7920 x 6004	
Active area size (W x H)	[mm]	36.4 x 27.6	
Sensor diagonal	[mm]	45.68	
Optical format		2.86" (Full frame)	
Pixel Size	[µm]	4.6µm	
Image quality parameters (EMVA 1288)			
ADC resolution	[bit]	12	
FWC	[ke-]	14.5	
Dynamic range	[dB]	64	
SNR_{max}	[dB]	41.6	
Dark noise	[e-]	8.8	
Dark current	[e-/s]	0.24e-/s @ RT	
DSNU	[e-/s]	24.5	
PRNU	%	1%	
Shutter efficiency		1/18,000	
Micro lenses		Yes	
Camera parameters			
Digitization	[bit]	12	
Supported bit resolutions	[bit/pixel]	8, 9, 10, 11, 12, 16	
Exposure time (EXP)		0.1 – 1050 ms	
Variable Gain Range (VGA)	[dB]	0 – 12dB [1]	
Refresh rate (MRR)	[fps]	24.4 @ 12 bit, in steps of 2.3 µs [2]	
Power consumption[3]			
Standby / Maximum	[W]	9.0 / 9.5	
Dimensions/Mass			
height	[mm]	60	
width	[mm]	60	
depth	[mm]	38.8 (w/o EF mount)	
mass	[g]	179 (w/o EF mount)	

table 3-45, MX500xG-CM-X4G2-Fx, sensor and camera parameters

Notes:

1) Analog gain has only several discrete steps.

2) Defined for bandwidth 1750MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX500CG-CM-X4G2

3) Measured at 24V, connected with 10m fiber optical PCIe cable CBL-PCI-FIB-10M0. Optical cable consumption is about 1.25W.

Color model	Mono model	Binning/skipping	Pixels	Bit/px	FPS [1]
Yes	Yes	1x1/1x1	7920 × 6004	8	30.9
Yes	Yes	1x1/1x1	7920 × 6004	10	28.9
Yes	Yes	1x1/1x1	7920 × 6004	12	24.1
Yes	Yes	1x1/1x2	7920 × 3002	8	60.5
Yes	Yes	1x1/1x2	7920 × 3002	10	57.1
Yes	Yes	1x1/1x2	7920 × 3002	12	47.9
Yes	Yes	1x1/2x2	3960 × 3000	8	61.4
Yes	Yes	1x1/2x2	3960 × 3000	10	61.4
Yes	Yes	1x1/2x2	3960 × 3000	12	61.4
Yes	Yes	2x2/1x1	3960 × 3000	8	30.8
Yes	Yes	2x2/1x1	3960 × 3000	10	30.8
Yes	Yes	2x2/1x1	3960 × 3000	12	30.8

table 3-46, MX500xG-CM-X4G2-Fx, standard readout modes

Notes:

1) Defined for bandwidth 1750MB/s. Camera performance calculator: https://www.ximea.com/support/wiki/allprod/Industrial-scientific-camera-sensor-fps-frames-speed-calculator#/camera/MX500CG-CM-X4G2

3.6.14.2. Spectral Response curves [%]

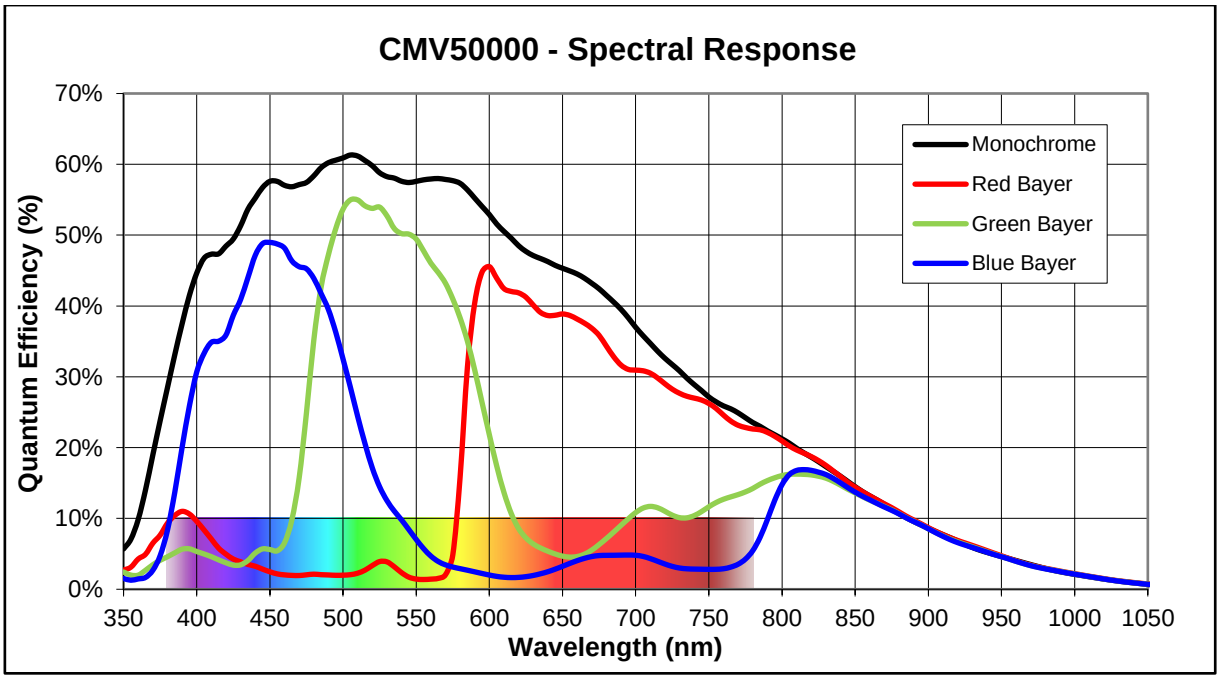


figure 3-39, CMV50000 mono and color, quantum efficiency curve, ©CMOSIS

3.6.14.3. Drawings MX500xG-CM-X4G2-FL

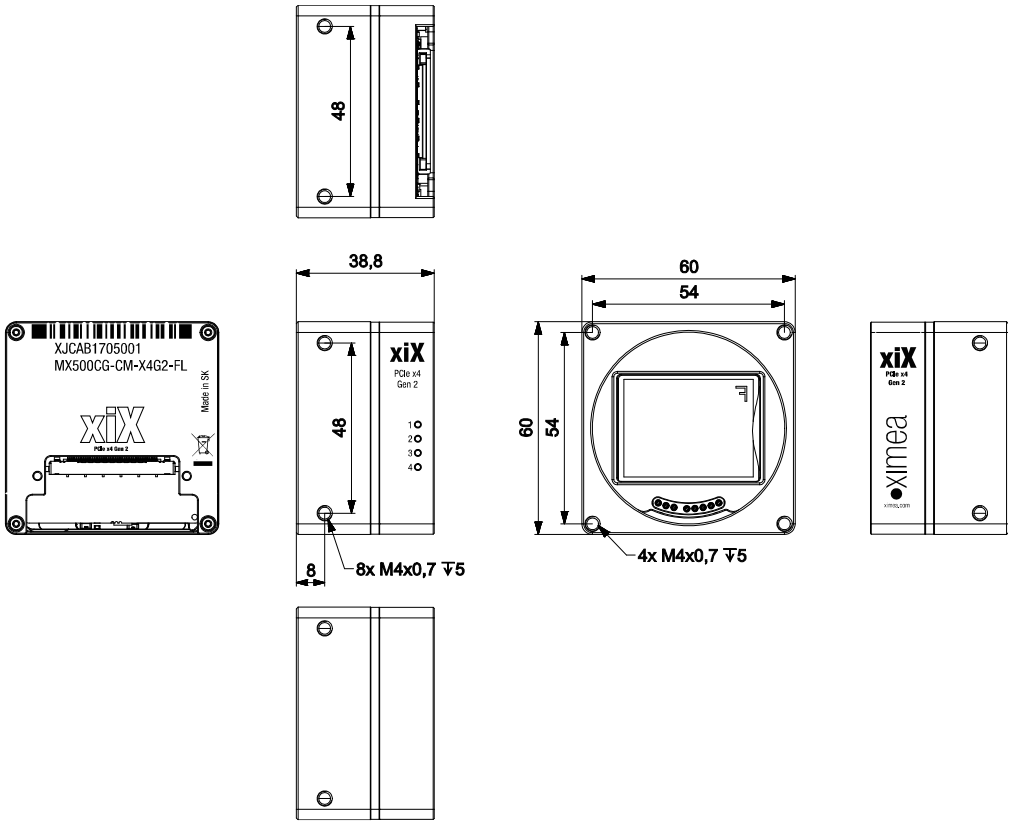


figure 3-40, dimensional drawing MX500xG-CM-X4G2-FL

3.6.14.4. Drawings MX500xG-CM-X4G2-FV

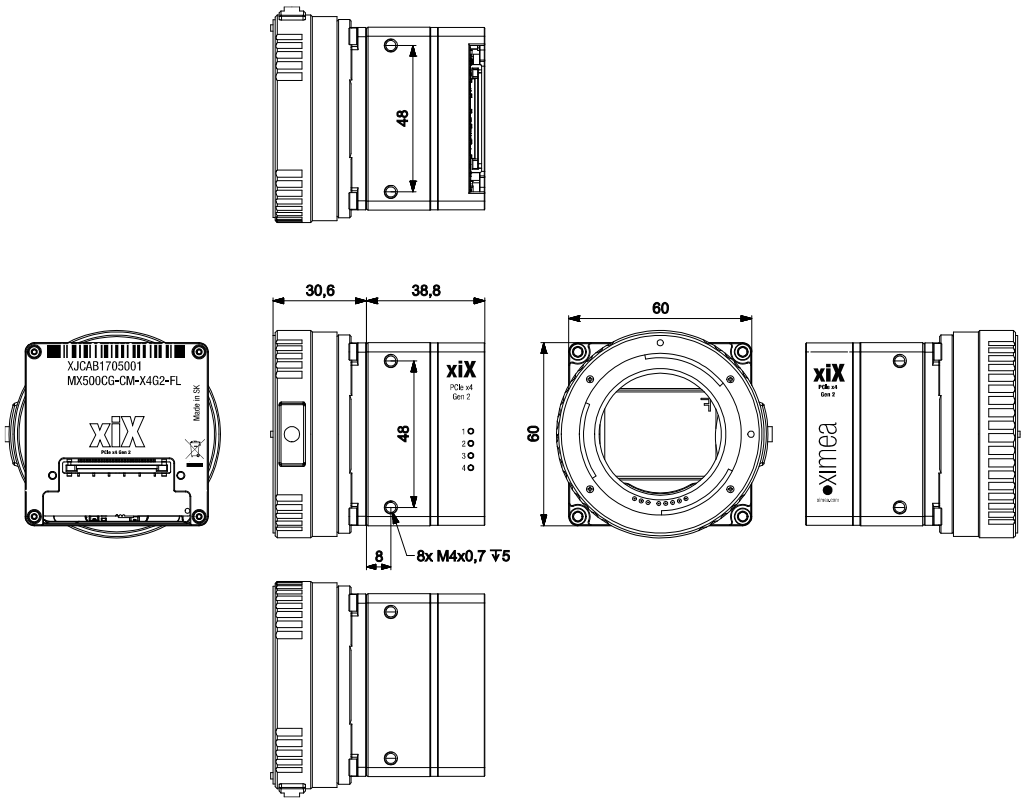


figure 3-41, dimensional drawing MX500xG-CM-X4G2-FV, with EF-mount adapter

3.6.14.5. Referenced documents

CMV50000_DS000522_0-01

3.6.14.6. Sensor features

feature	Note
Binning	Yes 2x2
Skipping	Yes 2x2
ROI	Vertical cropping results in increased read speed and reduced data transfer, horizontal reduces data transfer
HW Trigger	Trigger without overlap usable (see *4.4.2 Triggered Acquisition*)

table 3-47, sensor features available

3.7. User interface – LEDs

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

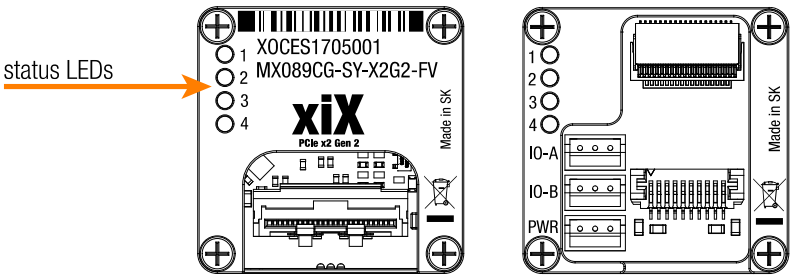


figure 3-42, position status LEDs MX X2G2

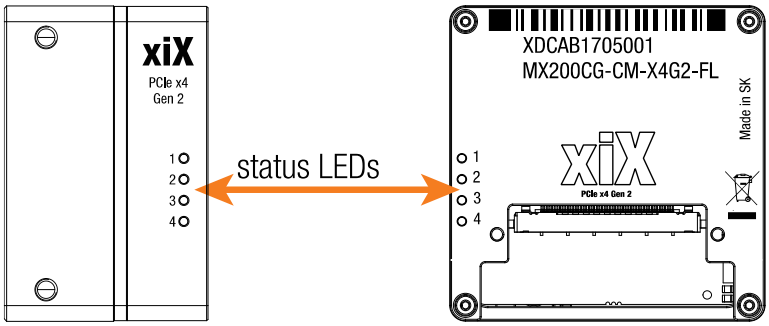


figure 3-43, position status LEDs MX X4G2(location of status LEDs depends on camera model)

The LEDs are programmable. Please note the following description:

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

table 3-48, LED output description after camera is opened in API

After camera has been powered up, LEDs show the camera status. The meaning differs slightly between X2G2 and X4G2 models.

Status	LED1 (Red)	LED2 (Green)	LED3 (Blue)	LED4 (Orange)
Off	Off	Off	Off	Off
Power	On	Off	Off	Off
Camera booted no PCIe	Off	Off	On	On
Factory firmware loaded[1)]	flash	flash	flash	flash
PCIe connected x4 Gen2	On	flash	flash	On
PCIe connected x4 Gen1	On	flash	flash	flash
PCIe connected x2(x1) Gen2	flash	flash	flash	On
PCIe connected x2(x1) Gen1[1)]	flash	flash	flash	flash

table 3-49, LED output description during camera power up xiX X4G2.

Notes:

1) Factory firmware is loaded when the functional firmware is corrupted. It has limited capability and is used to restore the functional firmware.

After camera has been powered up, LEDs show the camera status. The meaning differs slightly between X2G2 and X4G2 models.

Status	LED1 (Red)	LED2 (Green)	LED3 (Blue)	LED4 (Orange)
Off	Off	Off	Off	Off
Power	On	Off	Off	Off
Camera booted no PCIe	Off	Off	On	On
Factory firmware loaded[1)]	flash	flash	flash	flash
PCIe connected x2 Gen2	On	flash	flash	On
PCIe connected x2 Gen1	On	flash	flash	flash
PCIe connected x1 Gen2	flash	flash	flash	On
PCIe connected x1 Gen1[1)]	flash	flash	flash	flash

table 3-50, LED output description during camera power up xiX X4G2.

Notes:

1) Factory firmware is loaded when the functional firmware is corrupted. It has limited capability and is used to restore the functional firmware. To identify if the golden firmware is loaded pleas start xiCOP. See: *5.8 XIMEA Control Panel.*

3.8. xiX X2G2 –FL/-FV Interface connector

Connector	Signals	Mating cables
Molex 502244-2430 (-FL) Molex 502231-2400 (-FV)	PCIe x2 Gen2, power, IO	Ximea cables: CBL-MX-X2G2-0M07 CBL-MX-X2G2-0M10 CBL-MX-X2G2-0M25 CBL-MX-X2G2-0M50 CBL-PCIEFLEX-X2G2-0M10 CBL-PCIEFLEX-X2G2-0M25 CBL-PCIEFLEX-X2G2-0M50

table 3-51, MX X2G2 interface connector description

The interface connector is used for data transmission, camera control, power and IO.

3.8.1. Interface connector location

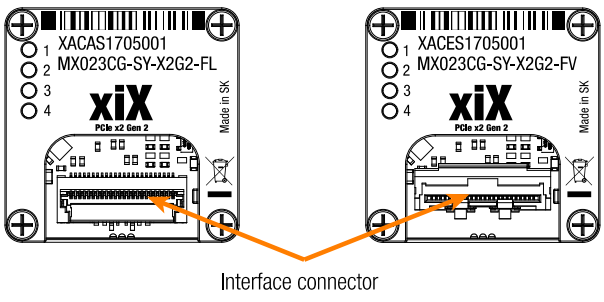


figure 3-44, position of MX X2G2 –FL/-FV interface connector

Cables CBL-MX-X2G2-xxxx have marked ends. It is important to connect the end marked “CAM” to the camera and end marked “BOB” to host or adapter. Swapped orientation can cause damage to camera.

It is important that the power is turned off when inserting/detaching the cable. 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.

3.8.2. Pinning

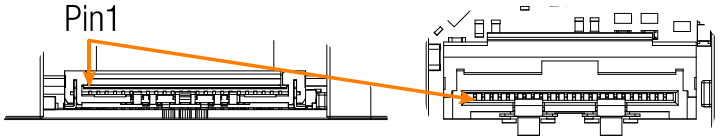


figure 3-45, pinning of MX X2G2 interface connector

Pin	Signal	Description	GPI/GPO index API
1	GND	Ground return	
2	PCIe_REFCLK_P	PCIe reference clock diff. pair, pos.	
3	PCIe_REFCLK_N	PCIe reference clock diff. pair, neg.	
4	GND	Ground return	
5	PCIe_PERP_1	PCIe RX differential pair 1, pos.	
6	PCIe_PERN_1	PCIe RX differential pair 1, neg.	
7	GND	Ground return	
8	PCIe_PERP_0	PCIe RX differential pair 0, pos.	
9	PCIe_PERN_0	PCIe RX differential pair 0, neg.	
10	GND	Ground return	
11	PCIe_PETP_1	PCIe TX differential pair 1, pos.	
12	PCIe_PETN_1	PCIe TX differential pair 1, neg.	
Pin	Signal	Description	
13	GND	Ground return	
14	PCIe_PETP_0	PCIe TX differential pair 0, pos.	
15	PCIe_PETN_0	PCIe TX differential pair 0, neg.	
16	GND	Ground return	
17	PCIe_RST0_N_IN	PCIe reset	
18	PWR	Power (12-24V)	
19	PWR	Power (12-24V)	
20	INOUT1	Non-isolated I/O	2/2
21	INOUT2	Non-isolated I/O	3/3
22	IN1	Opto-isolated Input 1	1/-
23	IN_OUT_GND	Common ground for opto-isolated IO	
24	OUT1	Opto-isolated Output 1	-/1

table 3-52, MX X2G2 connector pin assignment

3.8.3. Inserting / detaching FPC cable

When inserting or detaching cables increased caution need to be taken to prevent connector or cable damage. MX X2G2 interface connectors are equipped with a locking mechanism. When locked, pulling the cable may lead to damage of the connector or camera. When connecting or disconnecting the cable the power supply for the camera must be turned off.

Cables PN: CBL-MX-X2G2-xxxx have marked ends. It is important to connect the end marked “CAM” to the camera and end marked “BOB” to host or adapter. Swapped orientation can cause damage to camera. It is important that the power is turned off when inserting/detaching the cable.

figure 3-46, MX X2G2 FPC cable laser marking

Cables PN: CBL-PCIEFLEX-X2G2-xxx (white) are not polarized therefore the orientation of the cable between camera and host is not important.

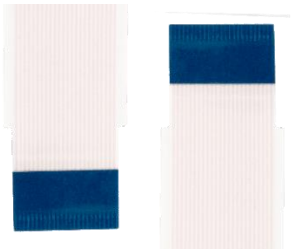
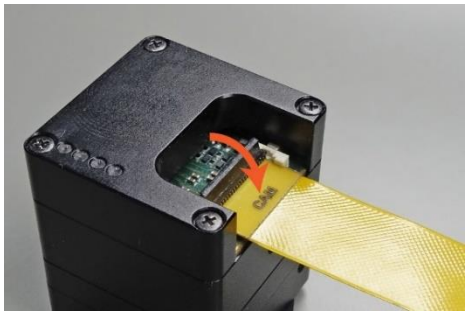


figure 3-47, MX FPC cable CBL-PCIEFLEX-X2G2-xxx ends

Inserting FPC cable MX X2G2 option -FL


Open connector lock

Insert cable (contacts facing down)

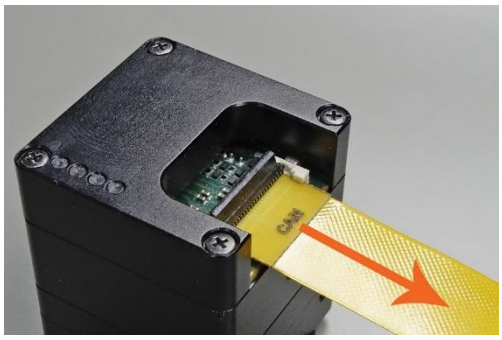


Close connector lock

figure 3-48, MX X2G2 FPC insert procedure option -FL

Detaching FPC cable MX X2G2 option –FL

Open connector lock



Pull cable gently in marked direction.

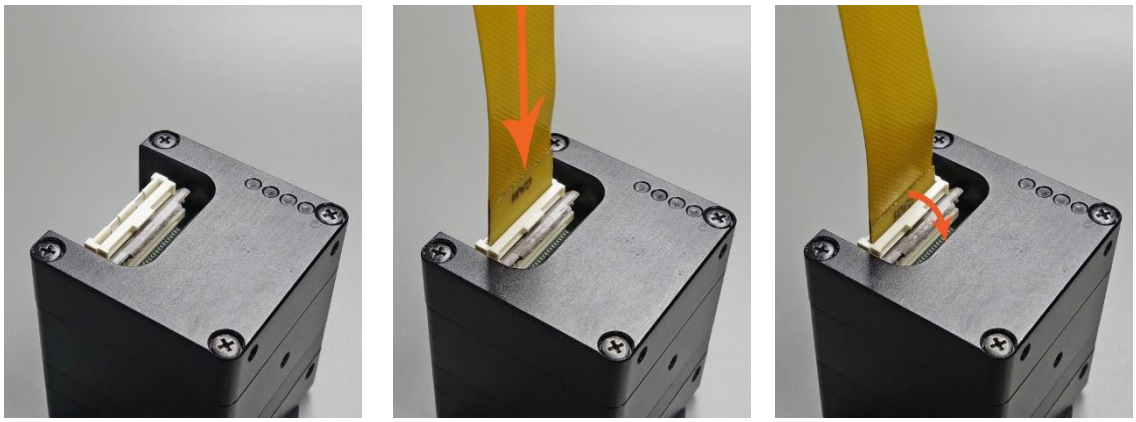
figure 3-49, MX X2G2 FPC detach procedure option -FL

Opening connector lock (option –FV)

In order to avoid damages when unlocking the connector, a thin screwdriver needs to be inserted from the side. Gently tilt and rotate the screwdriver to lift the lock. Lifting the lock needs to be carried out alongside the connector, so that the force is only applied to the lock and not the connector itself.

figure 3-50 MX X2G2 unlocking the connector option –FV

Inserting FPC cables MX X2G2 option -FV



Open connector lock Insert cable (contacts facing to camera edge) Close connector lock.

figure 3-51 MX X2G2 FPC insert procedure option -FV

Detaching FPC cable MX X2G2 option –FV

Open connector lock and pull gently the cable out as marked.

figure 3-52, MX X2G2 FPC detach procedure option -FV

3.9. xiX X2G2-FF interface

The interface connectors are used for data transmission, camera control, power and IO. Minimal operation connectivity requires connection of FIREFLY™.

Connector	Signals	Mating cables
Samtec UEC5-019-1-H-D-RA-1-A and UCC8-010-1-H-S-1-A	PCIe x2 Gen2, IO[1]	Ximea cables: CBL-ECUE-X4G3-1M0 CBL-ECUE-X4G3-2M0

table 3-53, MX X2G2-FF FIREFLY™ interface connector description

Notes:

1) Spare signals in cable are used for isolated IO signaling. These signals are accessible in xSwitch XS-8P-X2G2-FF-X8G3 or in FIREFLY™ to iPass adapter ADPT-MX-X4G2-FF-IPASS.

Connector	Signals	Mating cables
JST B3B-ZR(LF)(SN)	Optically isolated IO	JST ZHR-3, 03ZR-8M-P, 03ZR-3H-P

table 3-54, MX X2G2-FF IO-A connector description

Connector	Signals	Mating cables
JST B3B-ZR(LF)(SN)	Non-isolated IO	JST ZHR-3, 03ZR-8M-P, 03ZR-3H-P

table 3-55, MX X2G2-FF IO-B connector description

Connector	Signals	Mating cables
JST B3B-ZR(LF)(SN)	PWR	JST ZHR-3, 03ZR-8M-P, 03ZR-3H-P

table 3-56, MX X2G2-FF PWR connector description

3.9.1. Interface connector location

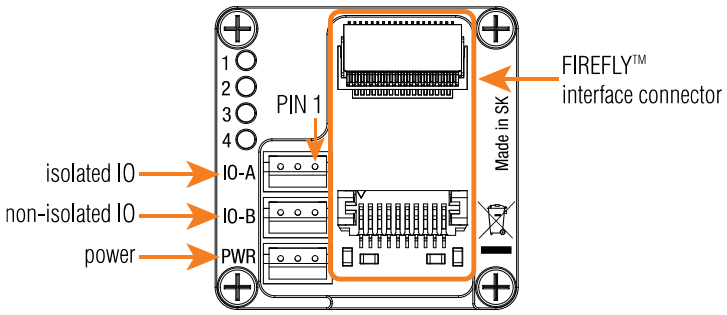


figure 3-53, position of MX X2G2 –FL/-FV interface connector

3.9.2. Pinning

FIREFLY™

FIREFLY™ pinout is proprietary to XIMEA cameras as it is meant to be used with XIMEA provided accessories only. Therefore, pinout of this connector is not part of this manual.

It is important that the power is turned off when inserting/detaching the cable.
Connecting camera to a powered host can cause destruction of the camera.

Opticaly isolated IO (IO-A)

Pin	Signal	Description	GPI/GPO index API
1	IN1	Opto-isolated Input 1	1/-
2	IN_OUT_GND	Common ground for opto-isolated IO	
3	OUT1	Opto-isolated Output 1	-/1

table 3-57, MX X2G2-FF IO-A connector pinout

Non-isolated IO (IO-B)

Pin	Signal	Description	GPI/GPO index API
1	INOUT1	Non-isolated I/O	2/2
2	GND	Ground return	
3	INOUT2	Non-isolated I/O	3/3

table 3-58, MX X2G2-FF IO-B connector pinout

Power connector (PWR)

Pin	Signal	Description	GPI/GPO index API
1	PWR	Power (12-24V)	
2	GND	Ground return	
3	PWR	Power (12-24V)	

table 3-59, MX X2G2-FF PWR connector pinout

3.10. xiX X4G2 Interface connector

Connector	Signals	Mating cables
JAE FI-RE51S-HF-R1500 (-FL) JAE FI-RE51S-VF-R1300 (-FV)	PCIe x4 Gen2, power, IO	Ximea cables: CBL-MX-X4G2-0M10 CBL-MX-X4G2-0M25 CBL-MX-X4G2-0M50

table 3-60, MX X4G2 interface connector description

The interface connector is used for data transmission, camera control, power and IO.

3.10.1. Interface connector location

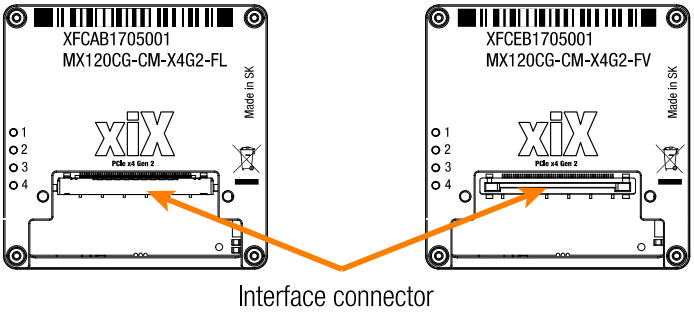


figure 3-54, position of MX X4G2 interface connector

3.10.2. Pinning

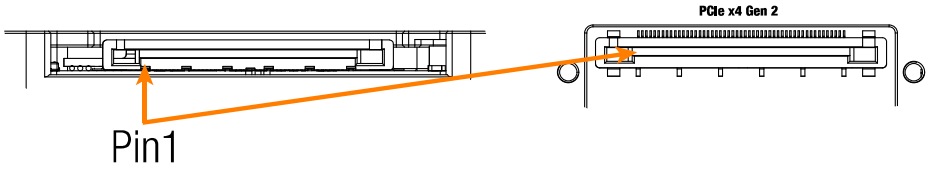


figure 3-55, pinning of MX X4G2 interface connector

It is important that the power is turned off when inserting/detaching the cable.
Connecting camera to a powered host can cause destruction of the camera.

Pin	Signal	Description	Pin	Signal	Description
1	GND	Ground return	27	PWR	Power input
2	IN1	Opto-isolated Input 1	28	GND	Ground return
3	IN_OUT_GND	Ground for opto-isolated Inputs	29	PCIe_PETP_0	PCIe TX differential pair 0, pos.
4	IN2	Opto-isolated Input 2	30	PCIe_PETN_0	PCIe TX differential pair 0, neg.
5	GND	Ground return	31	GND	Ground return
6	INOUT1	Non-isolated I/O	32	PCIe_PETP_1	PCIe TX differential pair 1, pos.
7	INOUT2	Non-isolated I/O	33	PCIe_PETN_1	PCIe TX differential pair 1, neg.
8	NC		34	GND	Ground return
9	GND	Ground return	35	PCIe_PETP_2	PCIe TX differential pair 2, pos.
10	NC		36	PCIe_PETN_2	PCIe TX differential pair 2, neg.
11	NC		37	GND	Ground return
12	GND	Ground return	38	PCIe_PETP_3	PCIe TX differential pair 3, pos.
13	PCIe_PERP_0	PCIe RX differential pair 0, pos.	39	PCIe_PETN_3	PCIe TX differential pair 3, neg.
14	PCIe_PERN_0	PCIe RX differential pair 0, neg.	40	GND	Ground return
15	GND	Ground return	41	PCIe_REFCLK_P	PCIe reference clock diff. pair, pos.
16	PCIe_PERP_1	PCIe RX differential pair 1, pos.	42	PCIe_REFCLK_N	PCIe reference clock diff. pair, neg.
17	PCIe_PERN_1	PCIe RX differential pair 1, neg.	43	GND	Ground return
18	GND	Ground return	44	PCIe_RST0_N_IN	PCIe reset
19	PCIe_PERP_2	PCIe RX differential pair 2, pos.	45	INOUT3	Non-isolated I/O
20	PCIe_PERN_2	PCIe RX differential pair 2, neg.	46	INOUT4	Non-isolated I/O
21	GND	Ground return	47	GND	Ground return
22	PCIe_PERP_3	PCIe RX differential pair 3, pos.	48	OUT2	Opto- isolated Output 2
23	PCIe_PERN_3	PCIe RX differential pair 3, neg.	49	IN_OUT_GND	Ground for opto-isolated Outputs
24	GND	Ground return	50	OUT1	Opto- isolated Output 1
25	PWR	Power input	51	GND	Ground return
26	PWR	Power input			

table 3-61, MX X4G2 connector pin assignment

Signal	Description	GPI/GPO index API
IN1	Opto-isolated Input	1/-
IN2	Opto-isolated Input	2/-
OUT1	Opto- isolated Output	-/1
OUT2	Opto- isolated Output	-/2
INOUT1	Non-isolated I/O	3/3
INOUT2	Non-isolated I/O	4/4
INOUT3	Non-isolated I/O	5/5
INOUT4	Non-isolated I/O	6/6

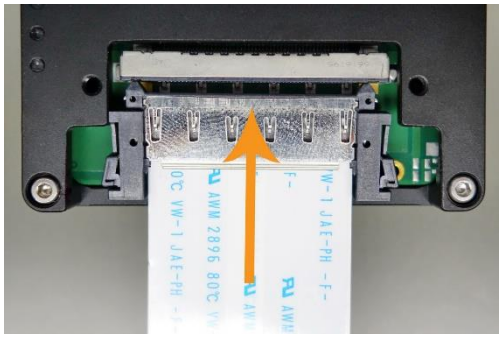
table 3-62, MX X4G2 connector IO pin to API index assignment

3.10.3. Inserting / detaching FFC cable

When inserting or detaching cables increased caution need to be taken to prevent connector or cable damage. MX X4G2 interface cables are equipped with a locking mechanism. When locked, pulling the cable may lead to damage of the connector or camera. When connecting or disconnecting the cable, the power supply for the camera must be turned off.

figure 3-56, MX X4G2 FFC cable connector top and bottom view

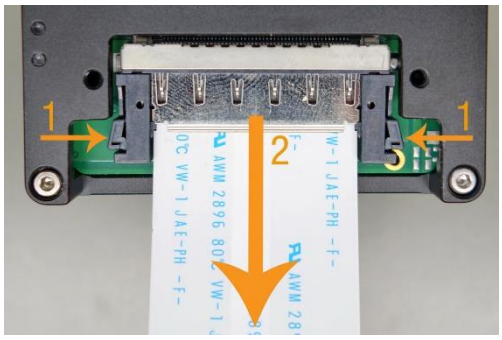
Inserting FFC cable MX X4G2 option -FL



Insert cable

figure 3-57, MX X4G2 FFC insert procedure option -FL

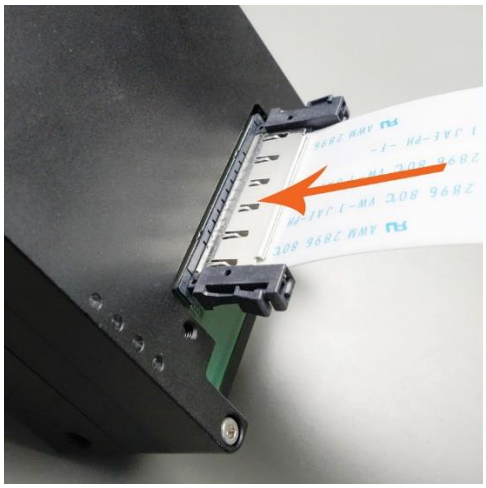
Detaching FFC cable MX X4G2 option -FL



Press locking tabs and gently pull the cable out as depicted

figure 3-58, MX X4G2 FFC detach procedure option -FL

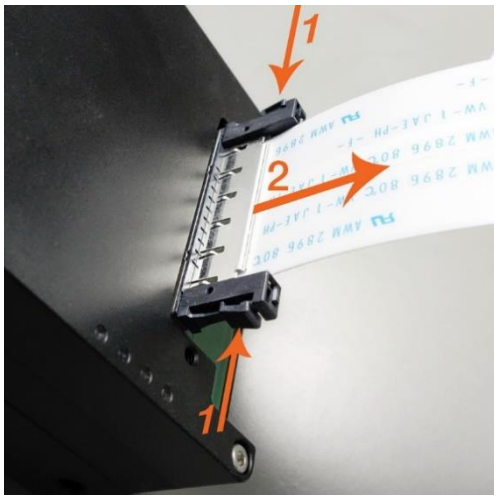
Inserting FFC cable MX X4G2 option -FV



Insert cable

figure 3-59, MX X4G2 FFC insert procedure option -FV

Detaching FFC cable MX X4G2 option -FV



Press locking tabs and gently pull the cable out as depicted

figure 3-60, MX X4G2 FFC detach procedure option -FV

3.11. xiX Digital Input / Output (GPIO) Interface

xiX cameras Digital Input / Output is part of interface Optically isolated Digital Input

3.11.1. Optically isolated Digital Input

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

table 3-63, Optically isolated digital input, general info

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

3.11.1.1. Digital Input – signal levels

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

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

table 3-64, digital input, signal levels

Note:

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

3.11.1.2. Digital Input – Internal Schematic

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

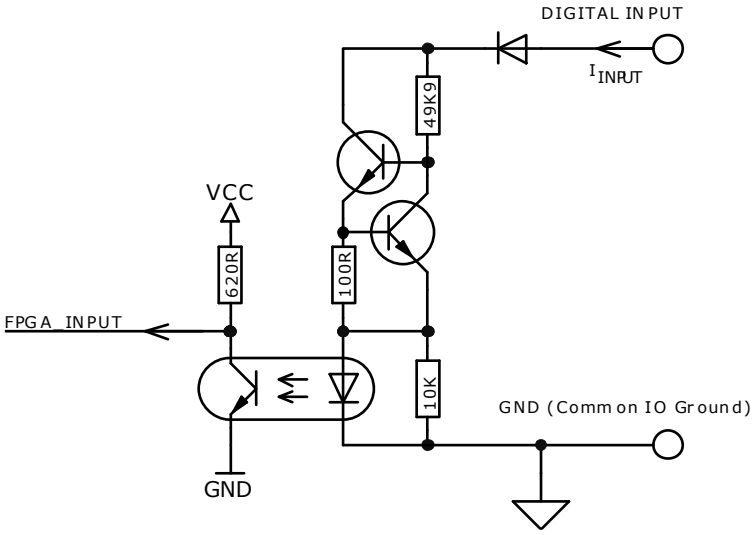


figure 3-61, digital input, interface schematic

3.11.1.3. Digital Input – Wiring

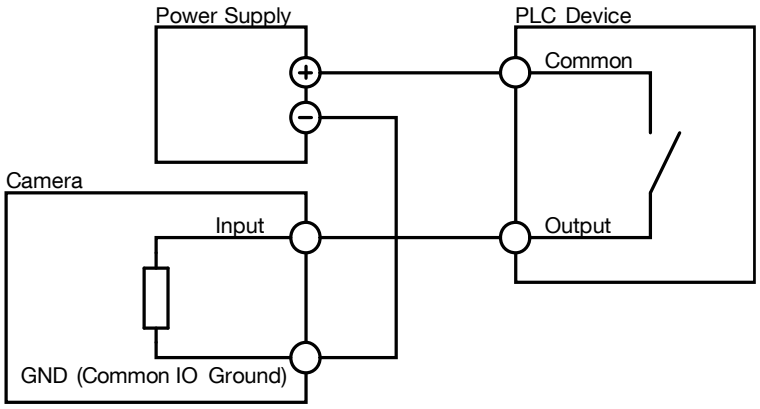


figure 3-62, digital input, interface wiring

3.11.1.4. Digital Input – Timing

Typical measured input delay between Digital Input to FPGA Input

Measurements of input delays:

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

table 3-65, digital input, timing

Note:

- Measured at: Ambient Temperature 25°C

3.11.2. Optically isolated Digital Output

3.11.2.1. Optically isolated Digital Output - General info

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

table 3-66, Optically isolated digital output, general info

3.11.2.2. Optically isolated Digital Output Delay

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

table 3-67, Optically isolated digital output, delay

3.11.2.3. Optically isolated Digital Output – Internal schematic

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

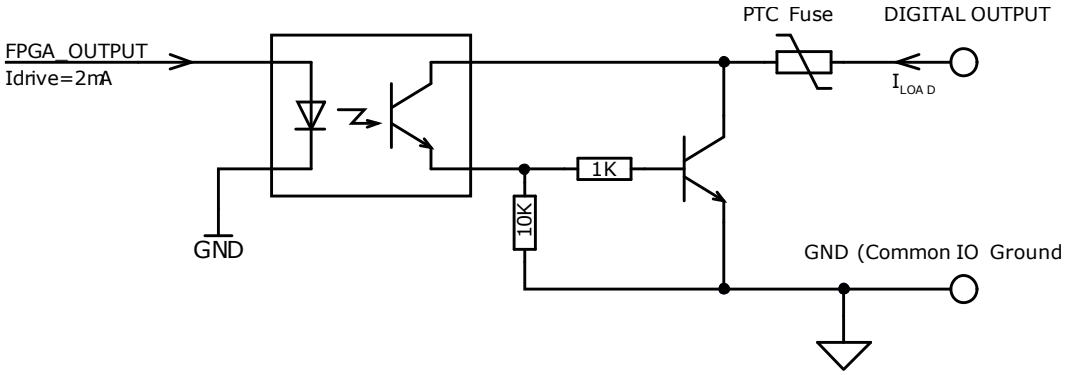


figure 3-63, digital output, interface schematic

Output Transfer Characteristic

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

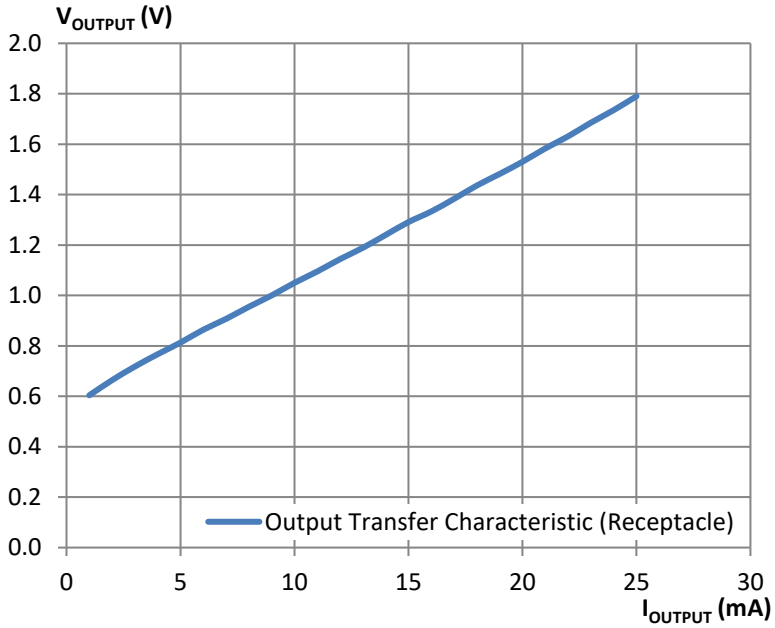


figure 3-64, digital output transfer characteristics

3.11.2.4. 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.

3.11.2.4.1. Connecting Digital OUTPUT to an NPN-compatible PLC device input (biased)

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

table 3-68, Connecting Digital OUTPUT to an NPN-compatible PLC device input (biased)

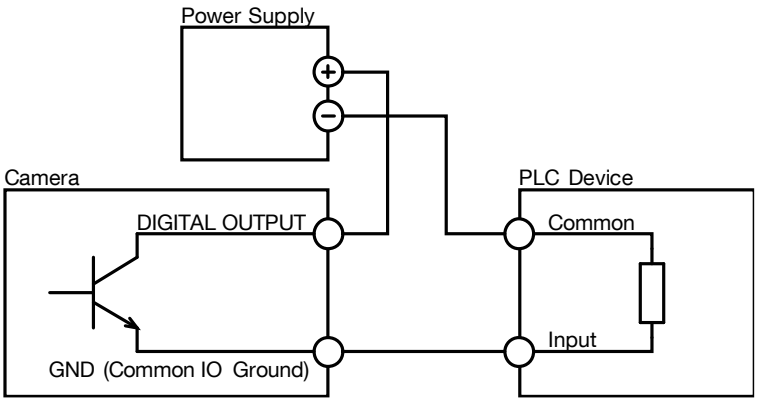


figure 3-65, Connecting Digital OUTPUT to a NPN-compatible PLC device input (biased)

Important note:

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

3.11.2.4.2. Connecting Digital OUTPUT to an 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

table 3-69, Connecting Digital OUTPUT to an NPN-compatible PLC device input

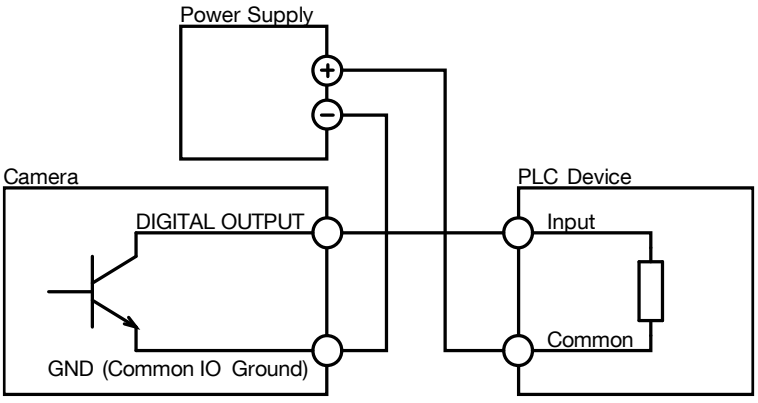


figure 3-66, Connecting Digital OUTPUT to a NPN-compatible PLC device input - more bidirectional inputs used

Note:

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

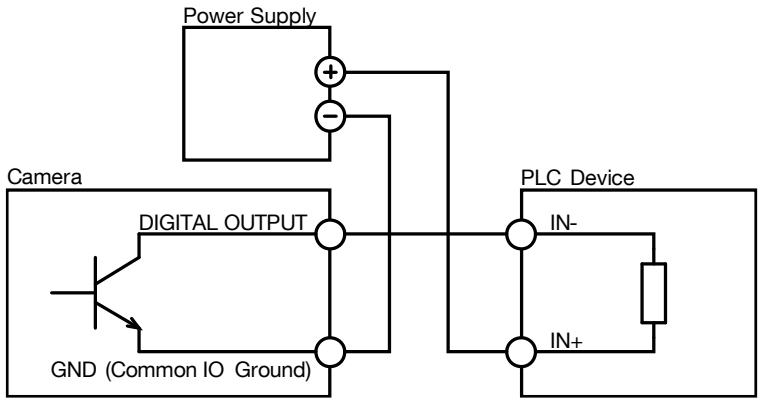


figure 3-67, Connecting Digital OUTPUT to a NPN-compatible PLC device - single input

3.11.2.4.3. 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)

table 3-70, Connecting Digital OUTPUT to a PNP-compatible device

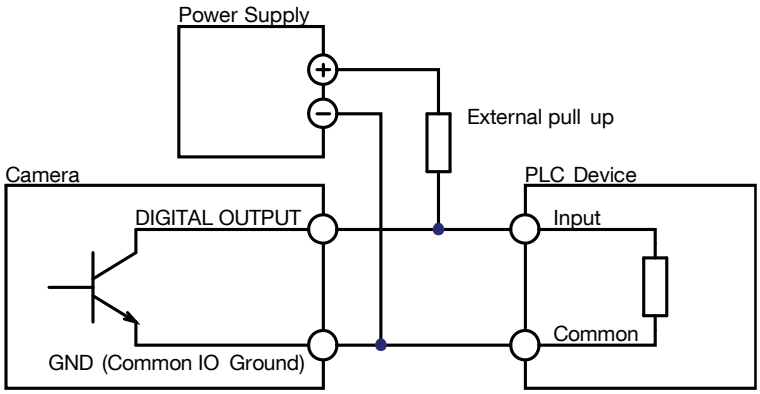


figure 3-68, Connecting Digital OUTPUT to a PNP-compatible device

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

3.11.2.4.4. Output Wiring Example: LED Driving

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

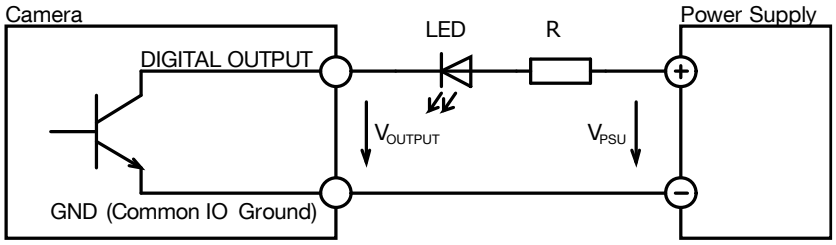


figure 3-69, LED Driving

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.3.11.1 Optically isolated Digital Input)*

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

I_{led} LED current

Note:

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

Typical LED forward voltage

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

table 3-71, digital output, LED driving

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

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

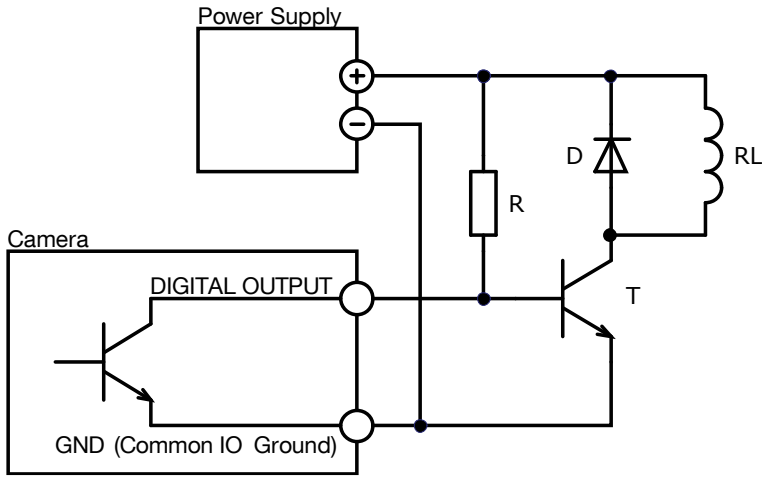


figure 3-70, Inductive load (Relay) Driving (inverted logic)

For positive logic you can use a second bipolar transistor.

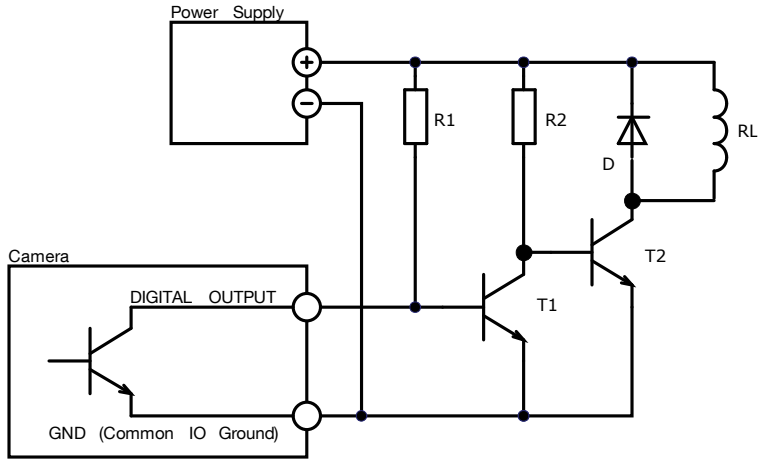


figure 3-71, Inductive load (Relay) Driving (non-inverted logic)

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

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

Driving the trigger input of a strobe controller

Trigger polarity	Opto-isolated controller input	Output delay	Wiring	Description
Positive edge	Yes	0.5µs	figure 3-65	
Negative edge	Yes	0.5µs	figure 3-67	
Positive edge	No	155µs	figure 3-68	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 3-68	Note that external pull up is not used in this case. Assume that internal pull up at the controller input is used.

table 3-72, digital output, wiring examples

3.11.2.5. 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 3-73, 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 3-74, digital output, current depending on timing

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

3.11.3. Non-isolated Digital Lines

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

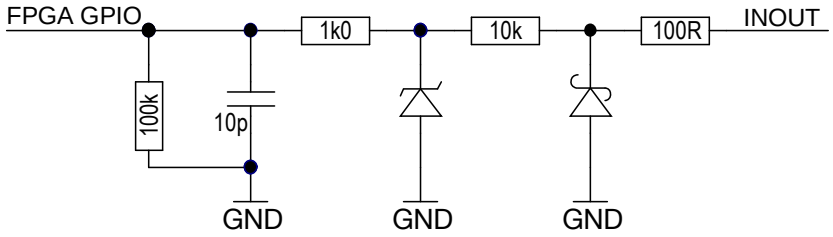


figure 3-72, non-isolated input/output, interface schematic

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

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

table 3-75, General info for non-isolated digital in/out trigger lines.

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

3.12. Heat Dissipation

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

3.13. CBL-MX-X2G2-0M10/ CBL-MX-X2G2-0M25/ CBL-MX-X2G2-0M50

10cm / 25cm / 50cm flex ribbon cable

MX X2G2 cameras can be connected to host via flex cable. For connecting to different host via vast range of adapters. Please refer to chapter *3.17 MX camera adapters*.

figure 3-73, image CBL-MX-X2G2-0Mxx cable ends

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 can cause damage to camera. It is important that the power is turned off when inserting/detaching the cable. Connecting camera to a powered host can cause destruction of the camera. When detaching cables, the connector needs to be unlocked, otherwise the connector soldering may be damaged.

3.14. CBL-PCIEFLEX-X2G2-0M10 / CBL-PCIEFLEX-X2G2-0M25 / CBL-PCIEFLEX-X2G2-0M50

10cm / 25cm / 50cm flex ribbon cable

MX X2G2 cameras can be connected to host via flex cable. For connecting to different host via vast range of adapters. Please refer to chapter *3.17 MX camera adapters*.

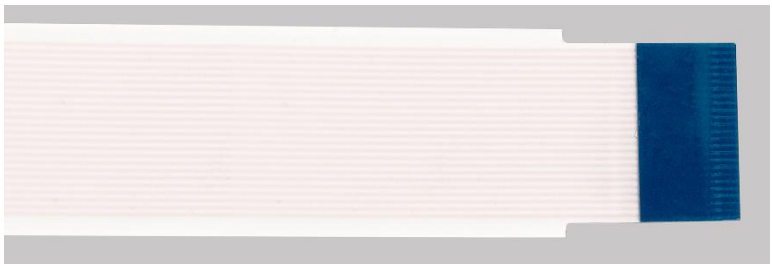


figure 3-74, CBL-PCIEFLEX-X2G2-0MXX cable ends

The newer generation of these cables (PN: CBL-PCIEFLEX-X2G2-XMXX, white color) is NOT polarized and either end can be used for the camera or the host.

3.15. CBL-MX-X4G2-0M20 / CBL-MX-X4G2-0M30 / CBL-MX-X4G2-0M40

20cm / 30cm / 40cm flex ribbon cable

MX X4G2 cameras can be connected to host via 51pin flex cable. For connecting to different host via vast range of adapters. Please refer to chapter *3.17 MX camera adapters*.

figure 3-75, image of CBL-MX-X4G2-0Mxx cable end

It is important that the power is turned off when inserting/detaching the cable. Connecting a camera to a powered host can cause destruction of the camera.

3.16. CBL-ECUE-X4G3-1M0 / CBL-ECUE-X4G3-2M0

1m / 2m FIREFLY™ cable

MX X2G2 cameras can be connected to host via cable with FIREFLY™ connector and can connect to the host via a vast range of adapters. Please refer to chapter *3.17 MX camera adapters*.

figure 3-76, image of CBL-ECUE-X4G3-xxxx connector

3.17. MX camera adapters

Ximea provides vast variety of adapters which allow xiX camera to be connected to your host computer and interface the camera system.

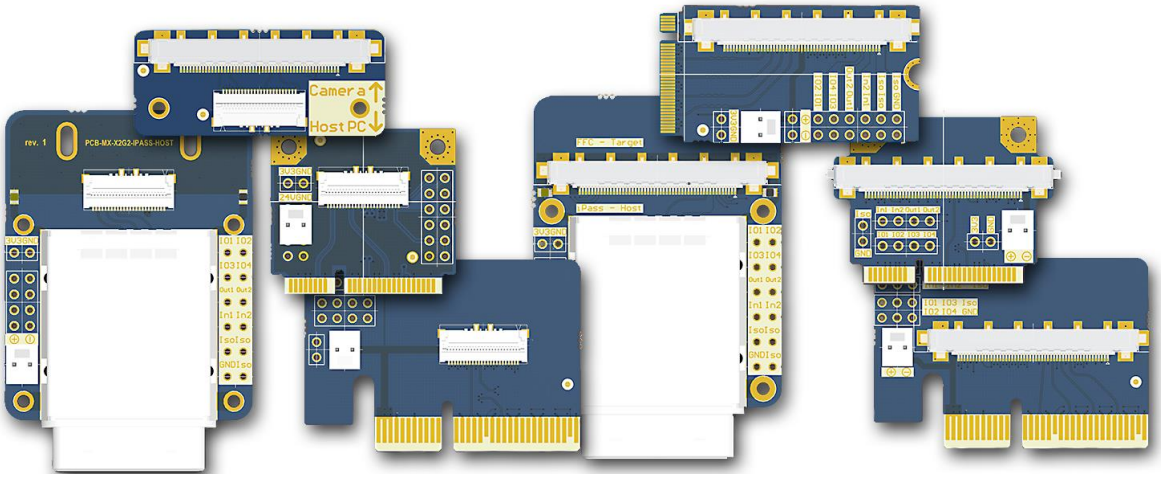


figure 3-77, PCIe adapters

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

3.18. Tripod Adapter

3.18.1. Tripod Adapter MX X2G2 (MECH-MC-BRACKET-KIT)

xiX X2G2 series tripod mounting bracket with 1/4-20 thread.

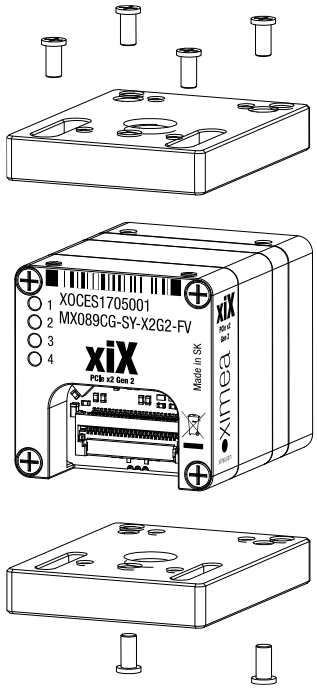


figure 3-78, mounting tripod adapter

Use 4x SROB-M2x4-CUST screws for mounting. Bracket can be mounted on the bottom or top side of the camera. At bottom side of camera there are only two mounting threads.

3.18.2. Drawings

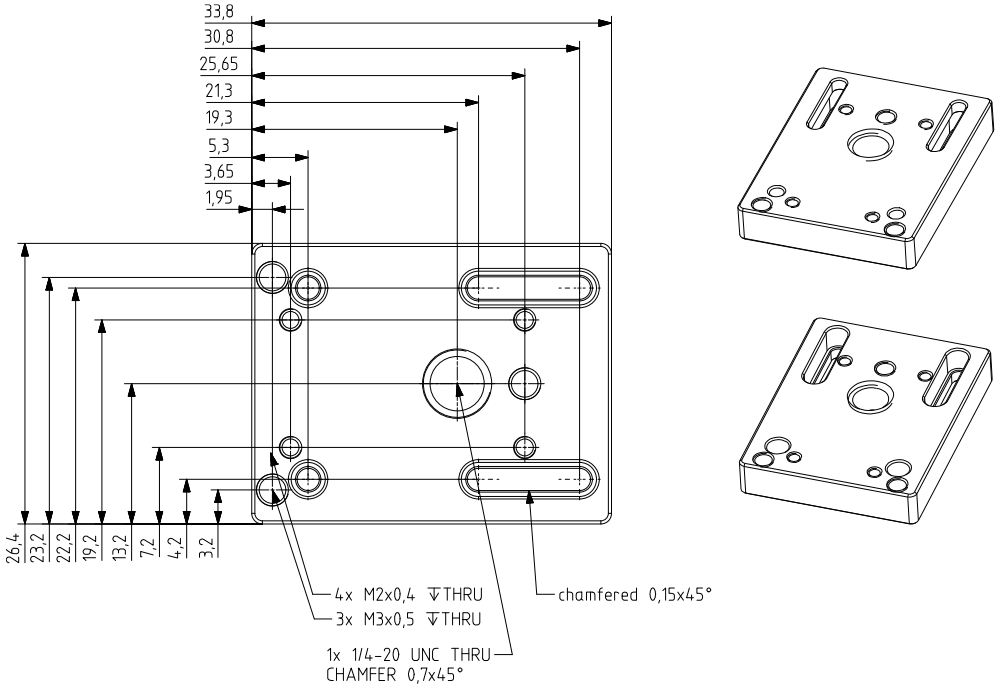


figure 3-79, dimensional drawing tripod adapter MX X2G2

Mass without screws: 11.4 g.

3.18.3. Tripod Adapter MX X4G2

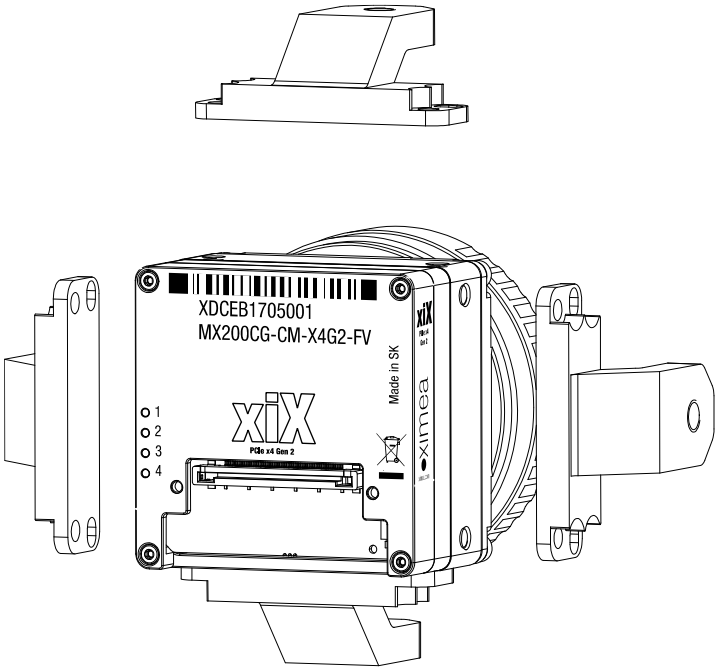


figure 3-80, mounting tripod adapter MX X4G2

Use 2x M4 screws for mounting. Bracket can be mounted on all four sides of the camera.

3.18.4. Drawings

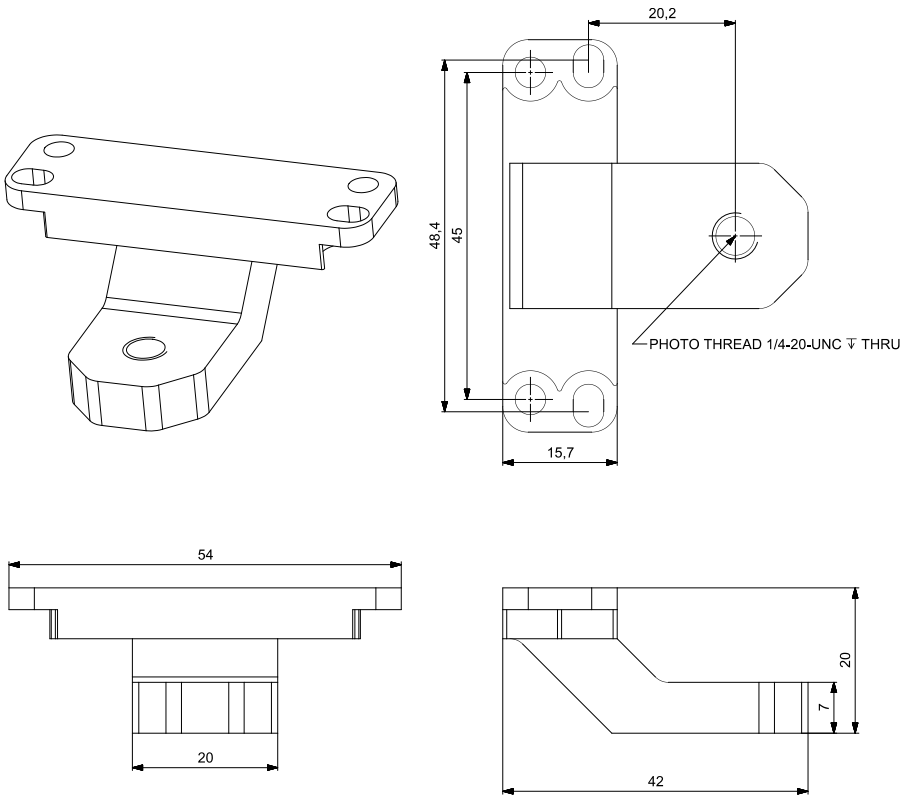


figure 3-81, dimensional drawing tripod adapter MX X4G2

3.19. xiX X4G2 Lens adapter – MECH-60MM-EF-ADAPTER

xiX X4G2 cameras with the MECH-60MM-EF-ADAPTER lens adapter features the ability to have an active control interface for lenses with a CANON EF-mount. The adapter is mounted using 4 front mount holes. Screws are included in MECH-60MM-EF-ADAPTER-KIT which can be purchased from XIMEA. Optionally, the camera can be assembled in production and delivered with the lens adapter already mounted . If compatible, the PN of the camera would end with –EF to designate the adapter is already built onto the camera (i.e., MX500MG-CM-X4G2-FL-EF).

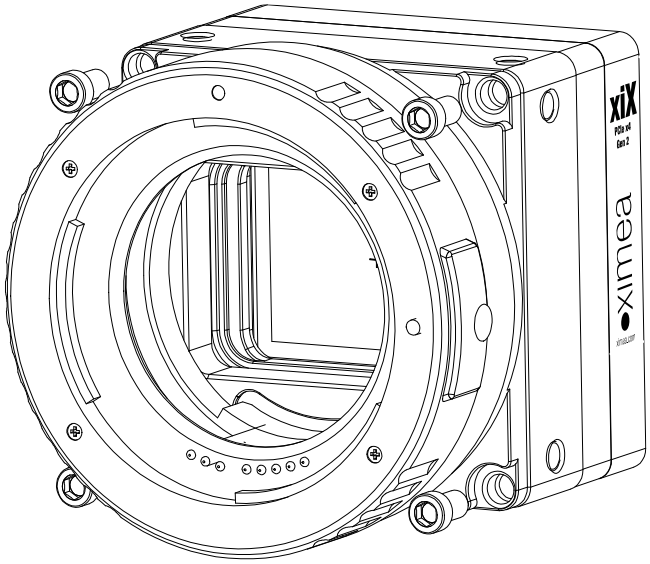


figure 3-82, mounting lens adapter with CANON EF-mount (MECH-60MM-EF-ADAPTER)

4. Operation

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

4.1. System Requirements

4.1.1. Software Requirements

The xiX cameras are compatible with the following operating systems:

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

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

See chapter *5 Software* for more information about the options to access a xiX 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 xiX cameras are compatible with PCI express Generation 2.

4.1.2.1. System Configuration

Minimum system configuration:

For a basic operation of your xiX 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 PCIe x4-16 Gen 2(x8 Gen3 for xiB-64) slot for compatible PCIe host adapter

Recommended system configuration:

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

CPU:	Intel i7
RAM:	4GB RAM or more
Disc Space:	200 MB of free disc space
Video:	NVIDIA or Radeon graphics card 128MB
Ports:	Motherboard with PCIe x4-16 Gen 2(x8 Gen3 for xiB-64) slot for compatible PCIe host adapter

4.2. Correct system connection and power on sequence

For a proper operation of your xiX camera specific order of steps needs to be followed. All cables need to be connected with disconnected power from system. After enabling power to camera or recycling the power the host system needs to be power on, or restarted.

4.3. Video Formats

4.3.1. Full Resolution

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

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

Please note *3.6 Model Specific Characteristics*

4.3.3. Downsampling Modes

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

Downsampling can be achieved in two ways: binning and skipping.

4.3.3.1. Binning

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

4.3.3.2. Skipping

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

4.3.4. 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 of xiX cameras supports several Image Data Output Formats.

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

table 4-1, image formats,

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

Note2: The color filtering (de-bayering) relies on the interpolation of adjacent pixels 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.

4.3.5. Digitization bit depth

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

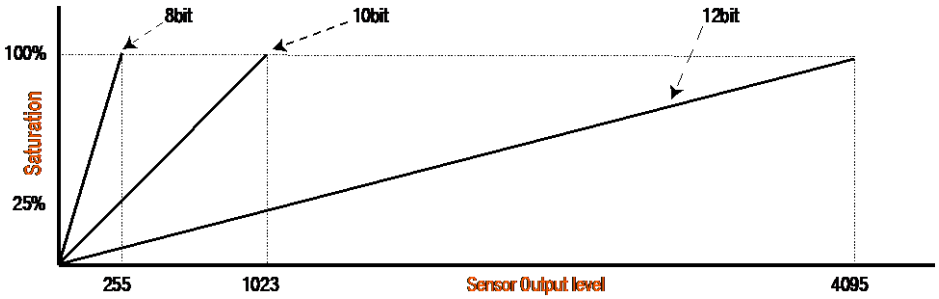


figure 4-1, Saturation vs Sensor output for different digitization bit depths

Cameras featuring 2nd generation of Sony IMX sensors (MX031, MX050, MX089, MX124) have special 8bit digitization mode, which features same conversion gain as 10bit mode using only ¼ of the saturation. This lead to four times brighter images compared to 10bit and 12bit modes.

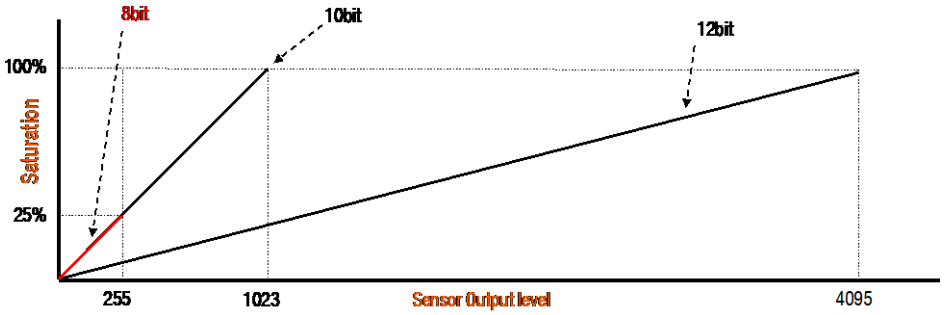


figure 4-2, Saturation vs Sensor output for different digitization bit depths 2nd generation IMX sensors

4.4. Acquisition modes

4.4.1. Free-Run

Also known as continuous acquisition. In this mode the sensor delivers a constant stream of image data at the maximum speed available by the current bandwidth, without any external trigger. Each image exposure is sequentially started automatically when possible.

For all sensors the exposure of the next frame overlaps with the data readout of the previous frame.

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

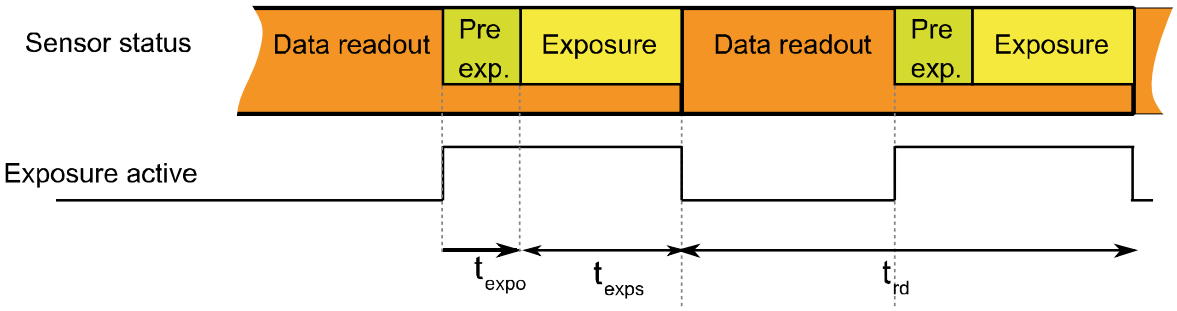


figure 4-3, acquisition mode - free run

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

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 *3.11.2 Optically isolated Digital Output*) Polarity inversion might help to make visible the separated exposure pulses.

4.4.2. Triggered Acquisition

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 is started, which is followed by the data readout. Ximea cameras supports several triggered modes along with single image exposure after one trigger. Please see:

Frame Burst Modes: https://www.ximea.com/support/wiki/allprod/Frame_Burst_Modes
Exposure Defined by Trigger Pulse Length:
https://www.ximea.com/support/wiki/allprod/Exposure_Defined_by_Trigger_Pulse_Length

4.4.2.1. 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.

4.4.2.2. Hardware Trigger

A hardware trigger can be sent to the sensor using the digital input described in *3.11.1 Optically isolated Digital Input*, or non-isolated ports configured as input described in *3.11.3 Non-isolated Digital Lines* Triggering by hardware is usually used to reduce latencies and jitter in applications that require the most accurate timing.

4.4.2.3. Triggered acquisition - single frame

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

Sensor timing in Exposure Overlapped with Data Readout Mode

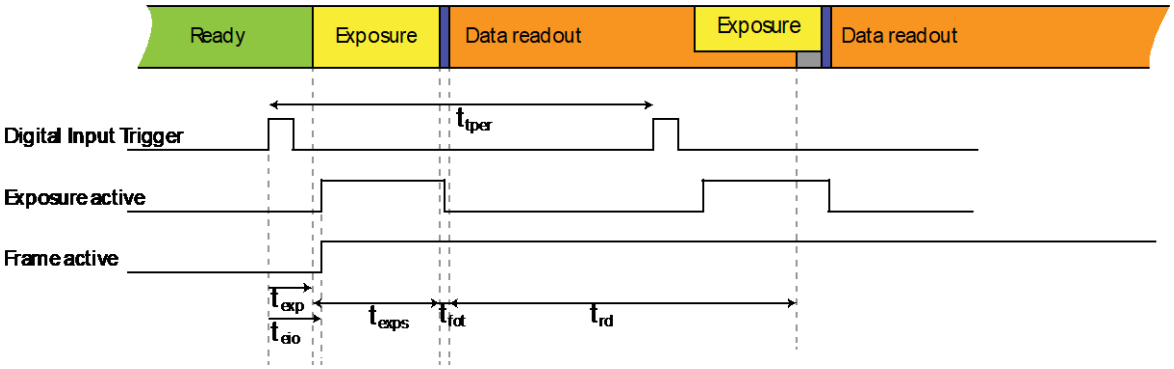


figure 4-4, acquisition mode – triggered with overlap

Description:

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

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

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

t_{fot} – Frame overhead time (FOT)

t_{rd} – readout time (Readout Time)

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

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

The timing strongly depends on camera settings. Most of the times can be calculated using Camera performance calculator: https://www.ximea.com/support/attachments/download/7828/Camera_Performance_Calculator.xlsm.

The delay between trigger input and start of exposure:

$$t_{exp} = t_{sensdelay} + t_{idelay}$$

Where:

$t_{sensdelay}$ – Delay introduced by sensor itself. For most sensors the delay is constant.
Cameras with CMV50000 sensor have this time dependent on setting of the sensor. Namely it is line period and bandwidth limit.
For cameras featuring Sony IMX sensors the $t_{sensdelay} = 3 \times t_{row}$

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

Please refer to: *3.11.1 Optically isolated Digital Input* or *3.11.3 Non-isolated Digital Lines*

The output signaling is then delayed by the delay introduced from the output electronics.

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

Where:

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

Please refer to: *3.11.2 Optically isolated Digital Output* or *3.11.3 Non-isolated Digital Lines*

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

For exposures shorter than readout time: $t_{tper} > \max(t_{rd}, t_{exp}) + t_{fot}$

4.4.2.4. Triggered acquisition - burst of frames

Frame Burst Start

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

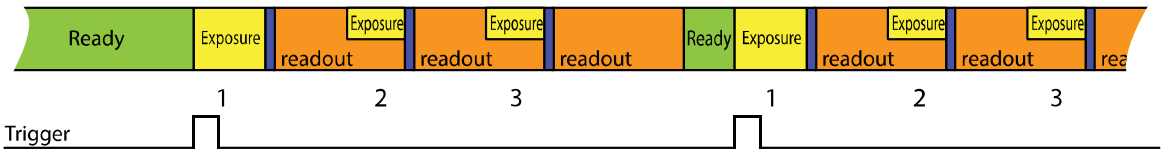


figure 4-5, triggered burst of frames – frame burst start, number of frames in burst set to 3

Frame Burst Active

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

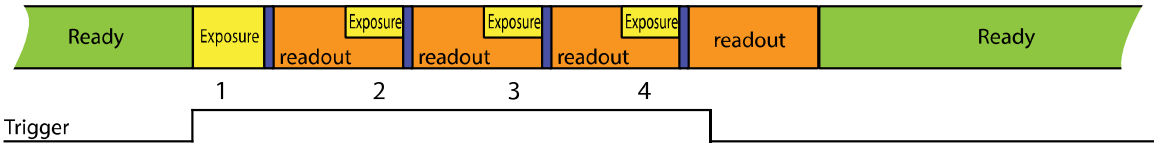


figure 4-6, triggered burst of frames – frame burst active

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

4.4.2.5. Exposure defined by trigger pulse length

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

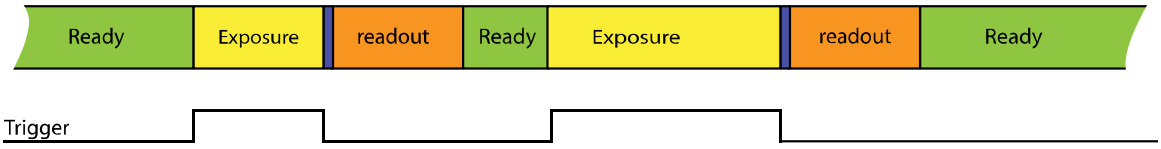


figure 4-7, Exposure defined by trigger pulse length

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

4.4.2.6. Multiple exposures in one frame

All Sony IMX based xiX models except MX023xG-SY support defined number of exposures exposed in a single frame.
In this mode the number of exposures need to be defined. The number of exposures can be defined using the XiApi parameter XI_PRM_EXPOSURE_BURST_COUNT. The readout of the frame starts after the last exposure period has finished.
It can operate in two modes:

1. Exposure defined by XiApi parameter "XI_PRM_EXPOSURE"

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

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

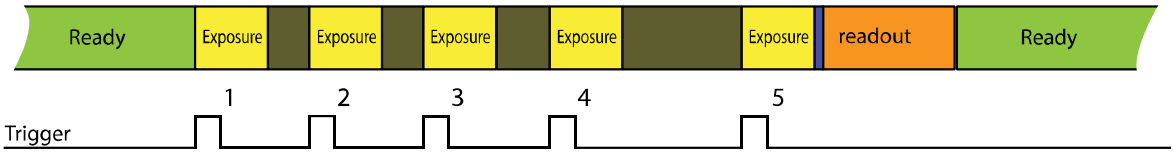


figure 4-8, Multiple exposures - defined exposure time, number of exposures set to 5

2. Exposure is defined by length of trigger pulse.

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

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

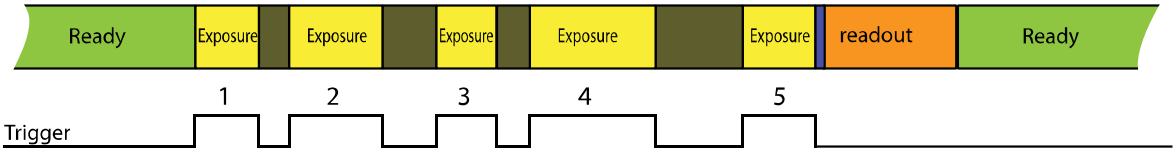


figure 4-9, Multiple exposures - exposure time defined by trigger pulse length, number of exposures set to 5

In both above modes there is a short period (FOT) after each exposure during which the next exposure cannot start. In case of the cameras with IMX sensors this period is 11*line period (the line period depends on various other parameters, see Line Period in the using Camera performance calculator).

4.5. Camera Parameters and Features

4.5.1. Short Interval Shutter Mode

Cameras based on the IMX530, IMX531, IMX532, IMX540, IMX541 and IMX542 sensors support short interval shutter mode. In this mode a pair of consecutive frames can be grabbed with virtually no gap between the end of the exposure of the first frame and start of the exposure of the second frame. This feature is particularly desired in Particle Image Velocimetry (PIV) because it allows positioning two laser pulses with short separation on sequential frames (frame straddling).

This feature is supported in free run as well as in triggered acquisition modes. In triggered mode a single trigger will result in a pair of frames.

The lengths of the exposures of both frames are fixed and their exact values depend on the camera's settings (e.g., sensor data bit depth, bandwidth limit etc.). The first exposure (texp1) is in magnitude of hundreds of microseconds and the second exposure (texp2) equals to the readout time. The time between the end of the first exposure and start of the second exposure is very short. However, the sensor manufacturer recommends a period (Flash Prohibited Period) with a magnitude of 2 - 3 microseconds during which the flash should not be fired to ensure correct operation. This period is indicated in the exposure active signal which can be forwarded to the camera's digital output. Please note that it is recommended to use the non-isolated outputs of the camera with low capacitance IO cables to ensure low distortion of the output signal.

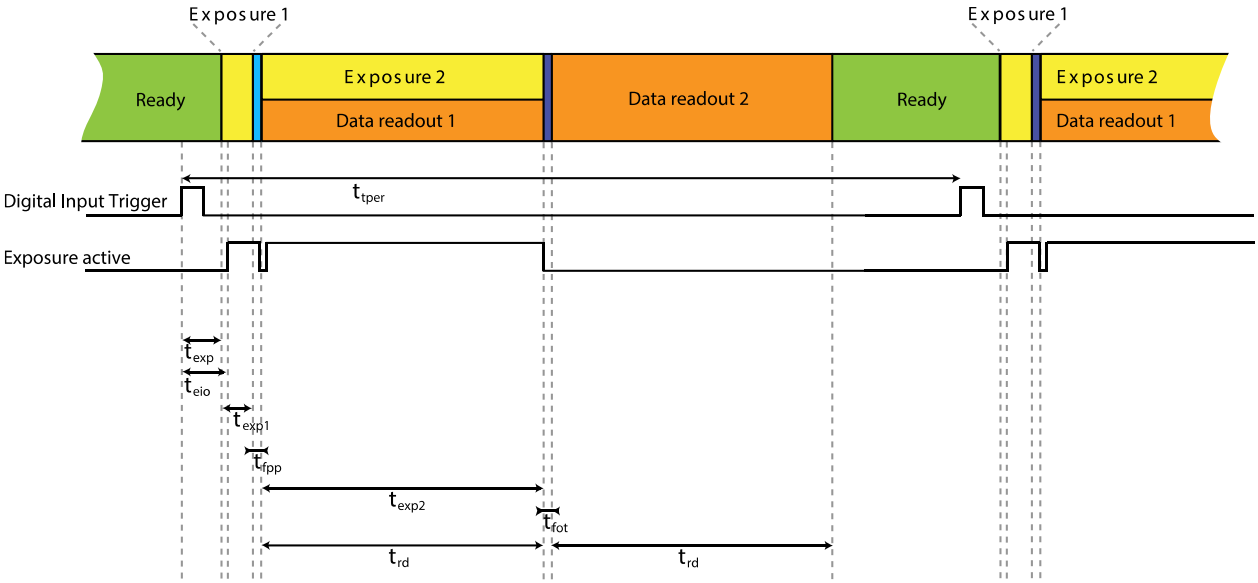


figure 4-10, short interval shutter mode – triggered

Description:

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

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

t_{exp1} – Exposure Time of the first image

t_{fpp} – Flash Prohibited Period

t_{exp2} – Exposure Time of the second image

t_{fot} – Frame overhead time (FOT) – does not necessarily equals interframe time

t_{rd} – readout time (Readout Time)

The timing strongly depends on camera settings.

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

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

Where:

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

Please refer to: *3.11.2 Optically isolated Digital Output* or *3.11.3 Non-isolated Digital Lines*

4.5.2. Dual ADC modes

Cameras based on the IMX530, IMX531, IMX532 sensors support Dual ADC readout modes. In these modes a single exposed frame can be read out twice via different readout channels resulting in two images with different analog gain settings. The high gain (HG) image has a lower readout noise and therefore offers better signal to noise ratio (SNR) in the low light regions of the scene. On the other hand, the low gain (LG) image offers higher SNR in the well illuminated regions of the scene as it utilizes the larger (or the whole) portion of the full well capacity.

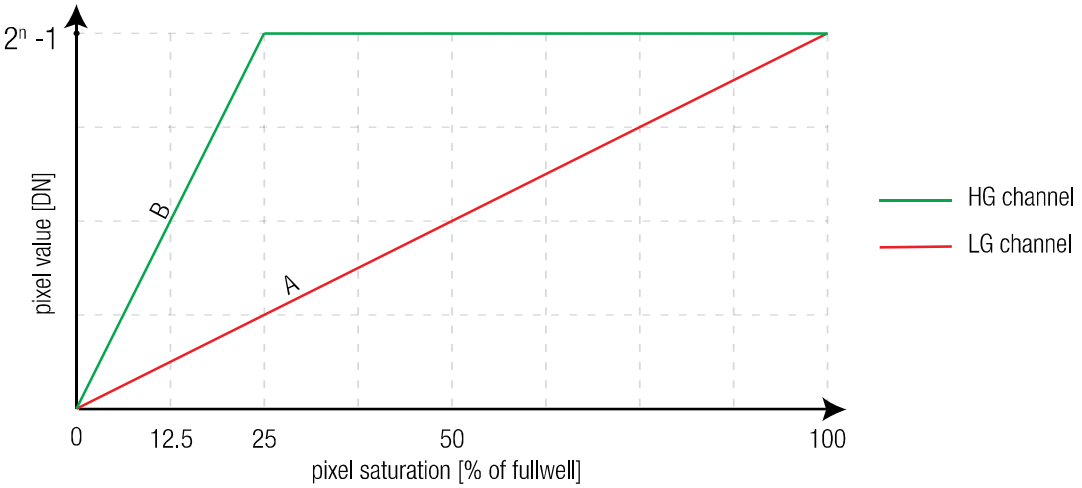


figure 4-11, Dual ADC non-combined without merging

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

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

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

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

4.5.2.1. Non-combined mode

In the non-combined mode both images are read out from the sensor and are transported to the host PC memory. Depending on the used image data format, these images can be either passed directly to the application or can be merged into a single linear output with extended dynamic range. The merging is performed in the xiAPI library running on the host computer's CPU and is optimized for processor's with x86 architecture.

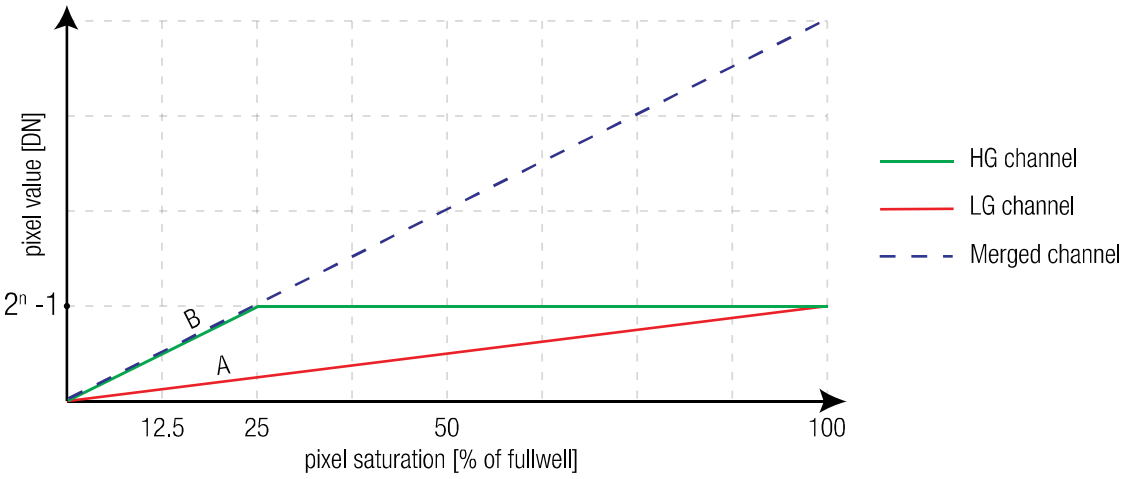


figure 4-12, Dual ADC non-combined with merging

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

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

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

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

4.5.2.2. Combined mode

In the combined mode the HG and LG images are merged directly in the sensor. This mode usually gives a higher frame rate than the non-combined mode since instead of two (8 or 12 bit) values only one (8 or 12 bit) value is read out from the sensor and transported to the PC memory. There is also less processing overhead in the xiAPI library as the data are already merged in the sensor. Since the output data bit depth from the sensor is limited to the set ADC bit depth, the data is compressed in the sensor using a piecewise linear function.

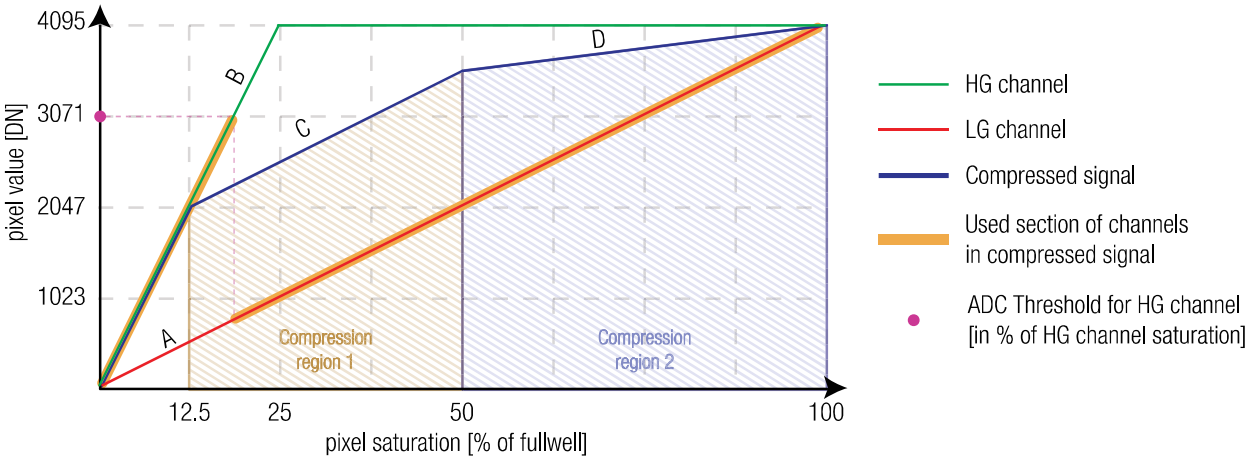


figure 4-13, Dual ADC combined mode

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

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

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

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

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

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

4.6.1. 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).

4.6.2. 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.

4.6.2.1. 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.

4.6.2.2. 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.

4.6.3. 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.

4.6.4. Sharpness

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

4.6.5. 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.

4.6.6. 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.

4.6.7. HDR

Some sensors offer the ability to acquire images with a higher dynamic range than the value presented in the specification. High dynamic range can be achieved by several means as part of the sensor output. The feature supported by MX200xG-CM camera 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.

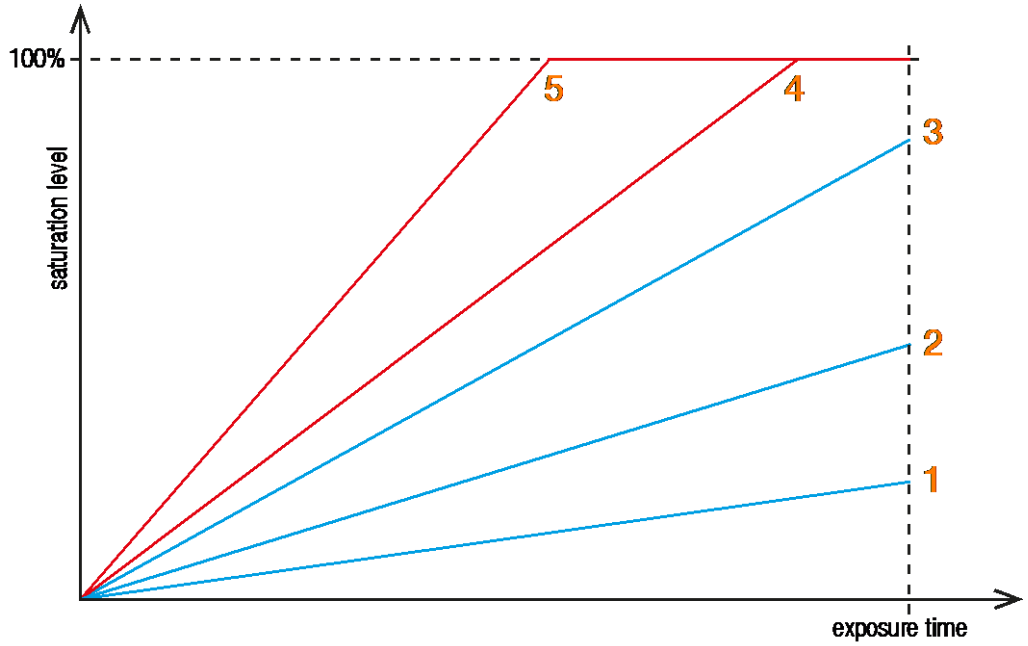


figure 4-14, image saturation example without HDR

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

figure 4-15, 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 CB200xG-CM camera supports 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:

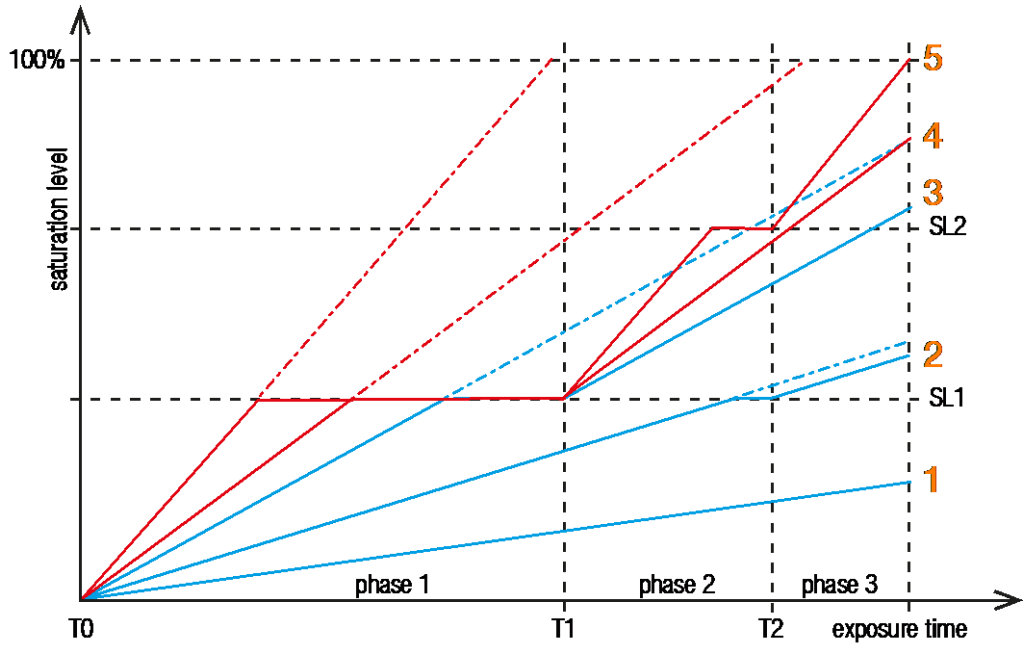


figure 4-16, image saturation example with HDR

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

figure 4-17, 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.

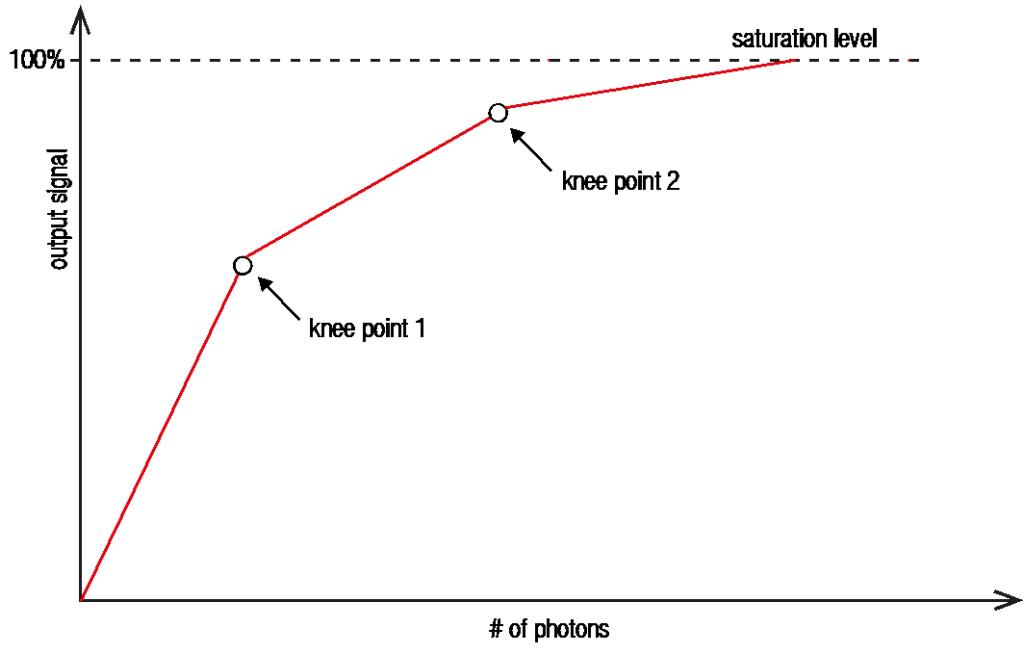


figure 4-18, HDR - approx. logarithmic saturation curve

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.

5.1.3. 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

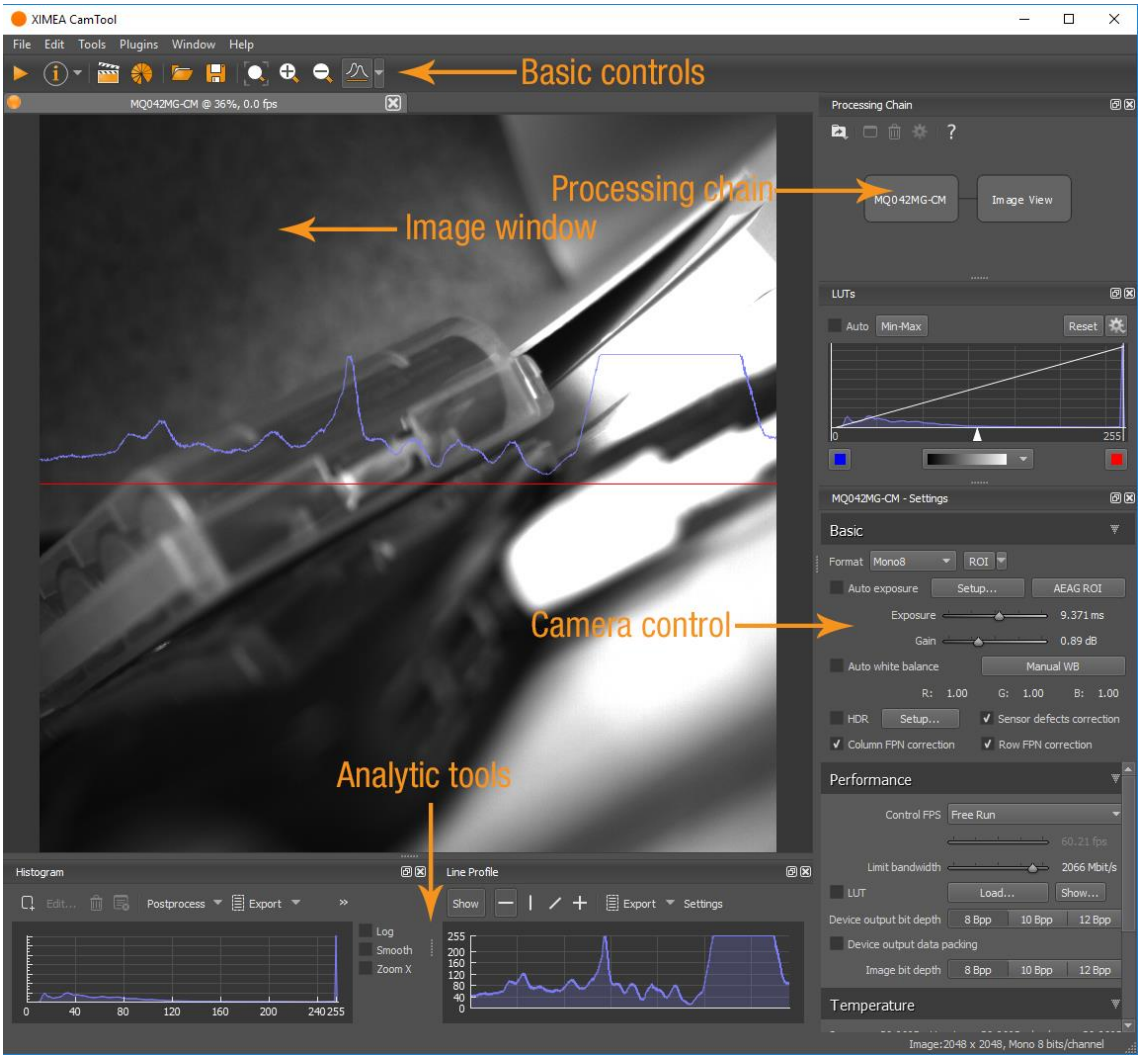


figure 5-1, CamTool Layout

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 is 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, xiApiPtyhon)
- 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):

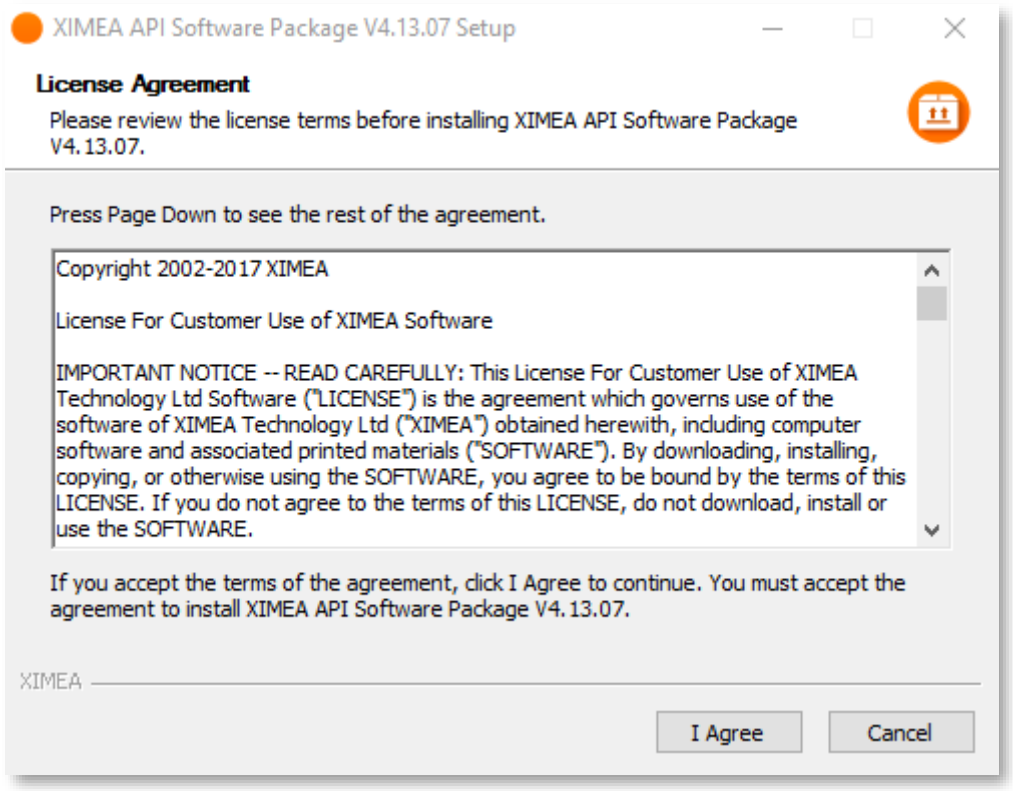


figure 5-2, XIMEA Windows Software Package installation - 1

- 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.

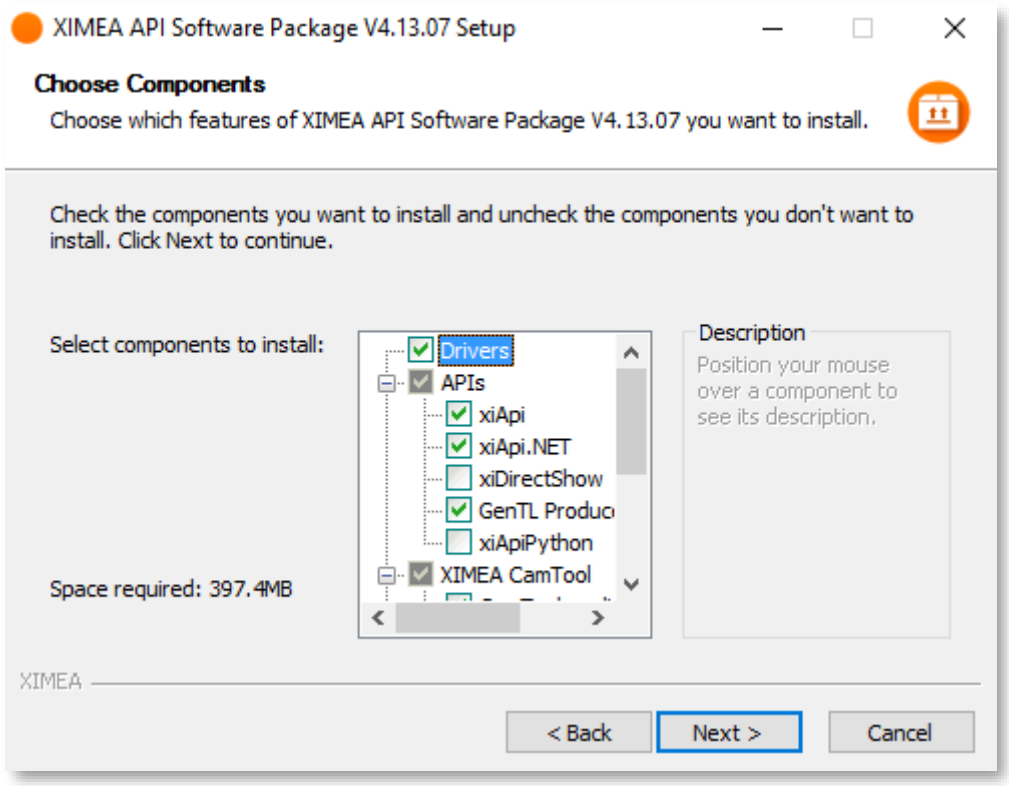


figure 5-3, XIMEA Windows Software Package installation - 2

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

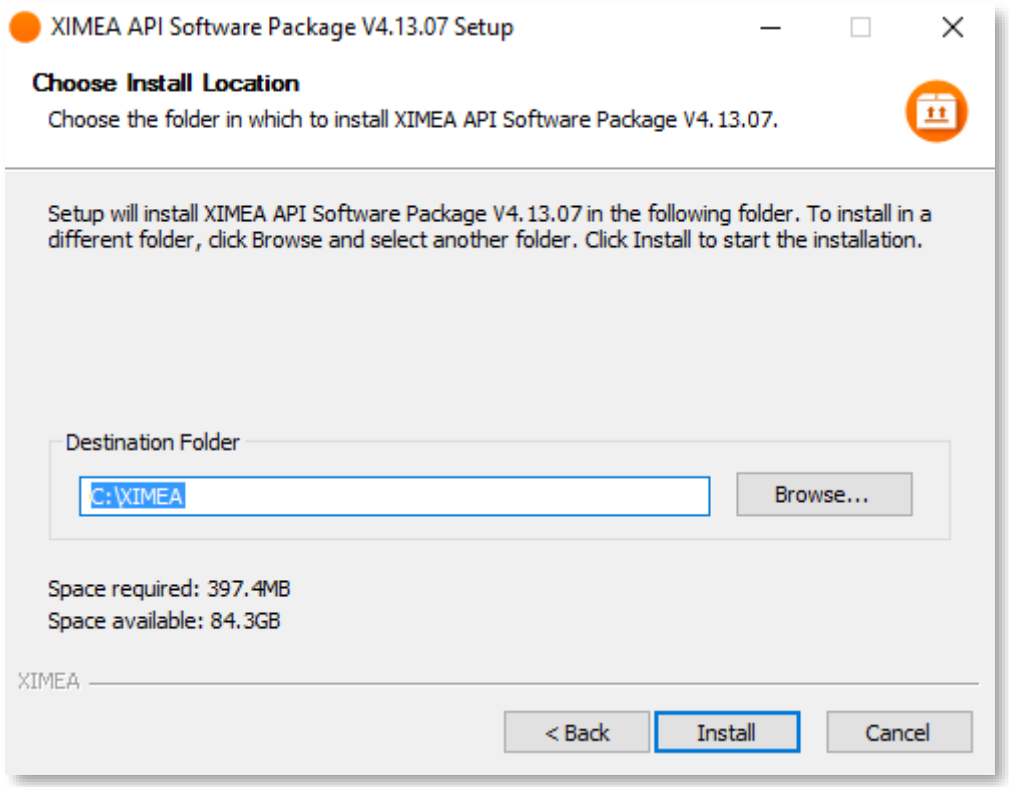


figure 5-4, XIMEA Windows Software Package installation - 3

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

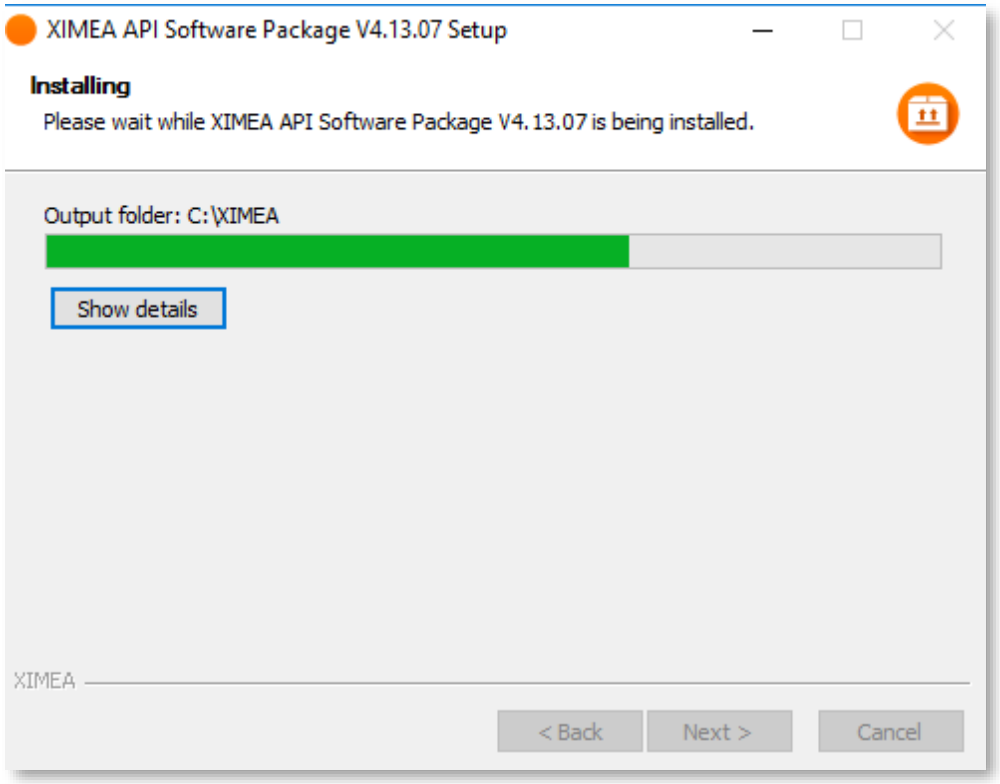


figure 5-5, xiAPI installation, Windows - 4

- Installation is completed.

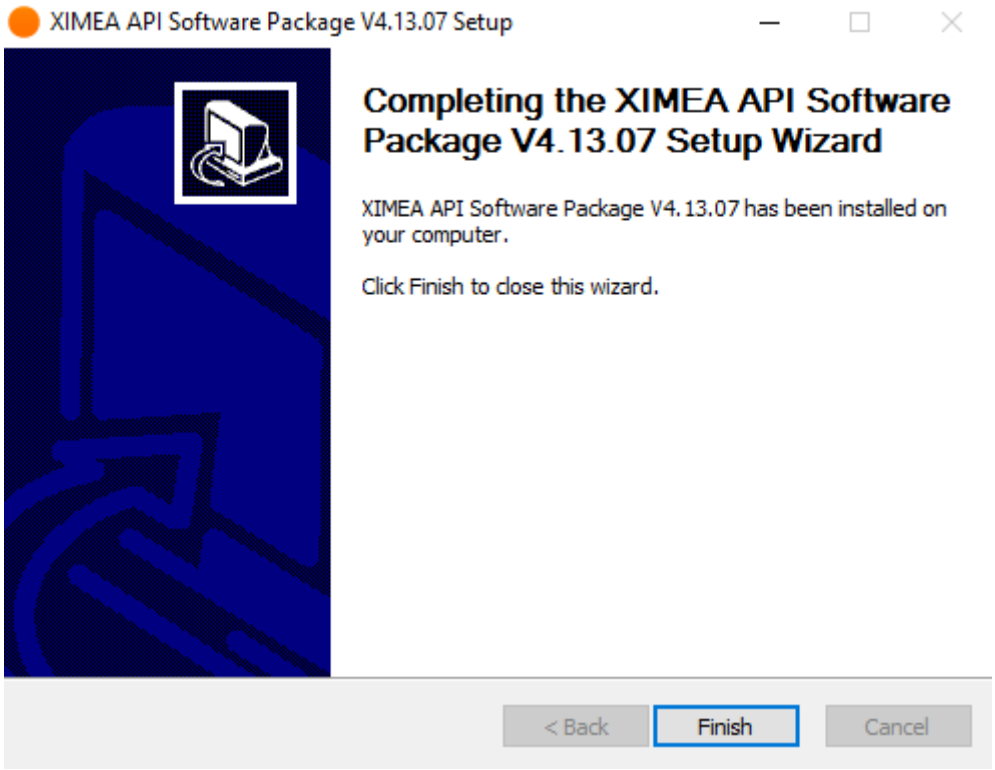


figure 5-6, xiAPI installation, Windows - 5

- 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 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-pcie`

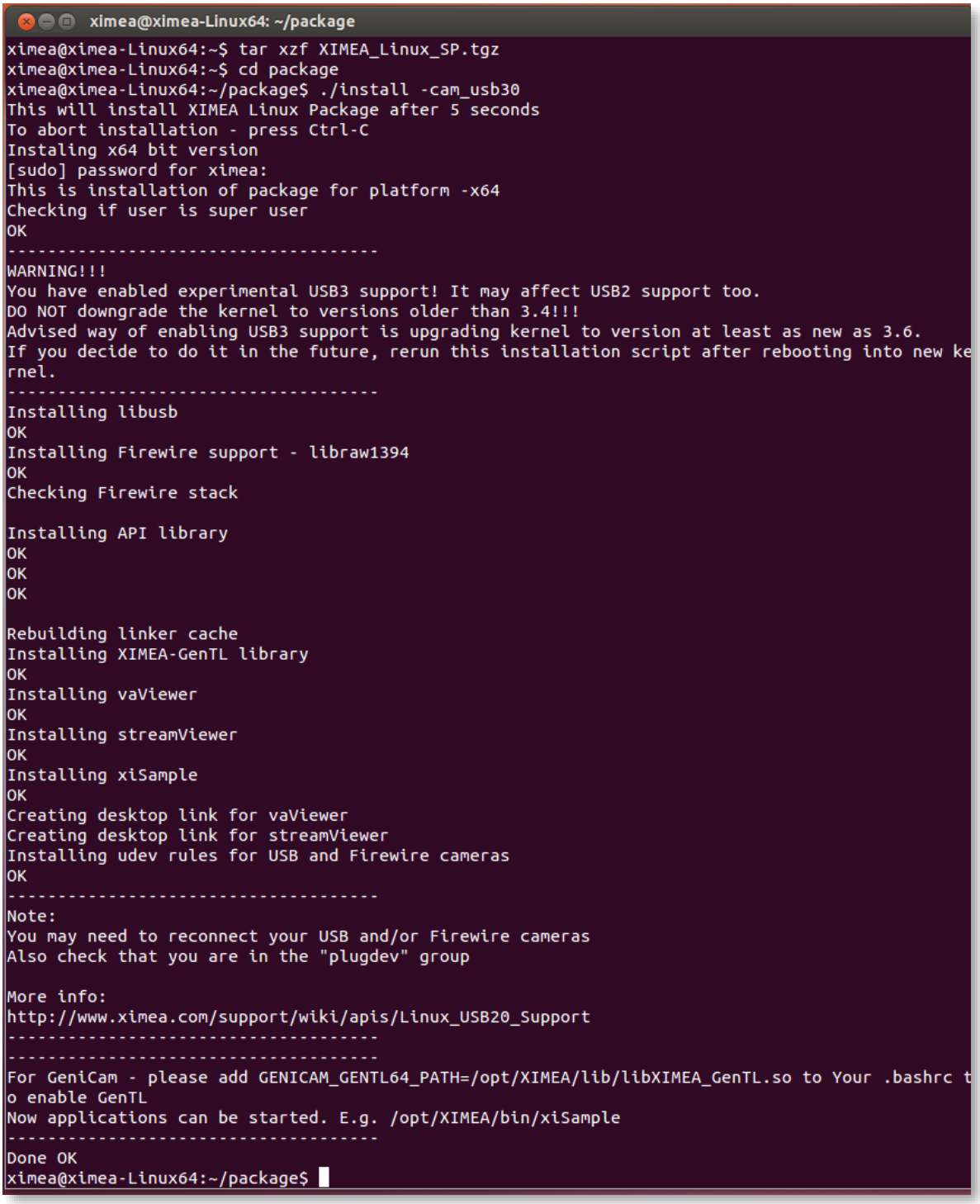


figure 5-8, XIMEA Linux Software Package installation - 2

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 all XIMEA 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 since 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:

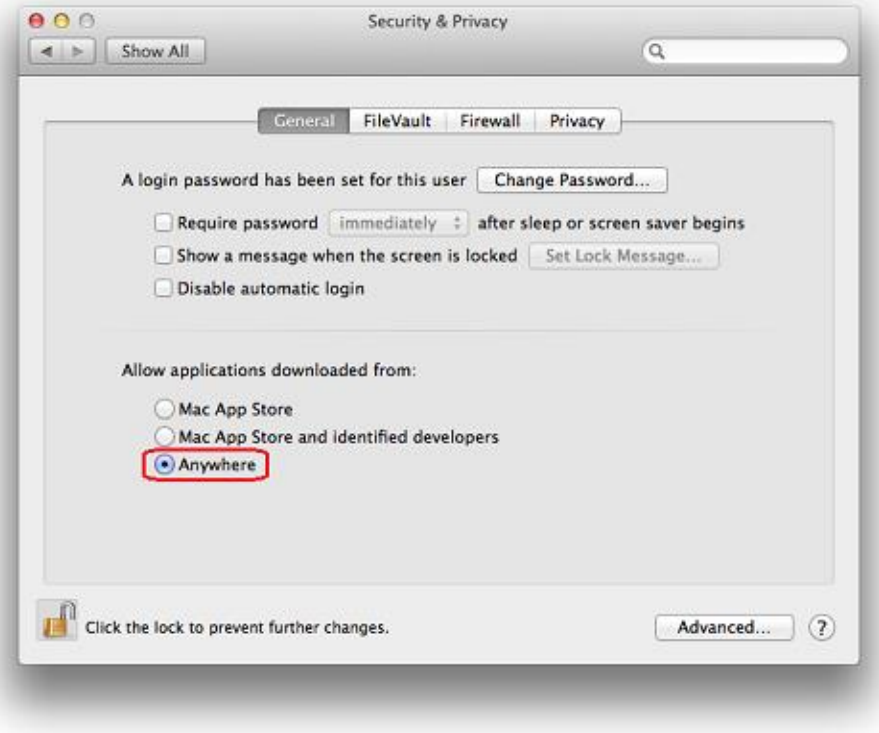


figure 5-10, xiAPI installation, MacOS - 2

- 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.

5.7.2. xiAPI Overview

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

Architecture

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

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

Installation

xiAPI is part of all current XIMEA software packages for Windows, Linux and MacOS.

For information on the software packages, see 5 Software

5.7.3. xiAPI Functions Description

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

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

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

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

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

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

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

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

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

5.7.4. xiAPI Parameters Description

For a complete list of available parameters, 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.

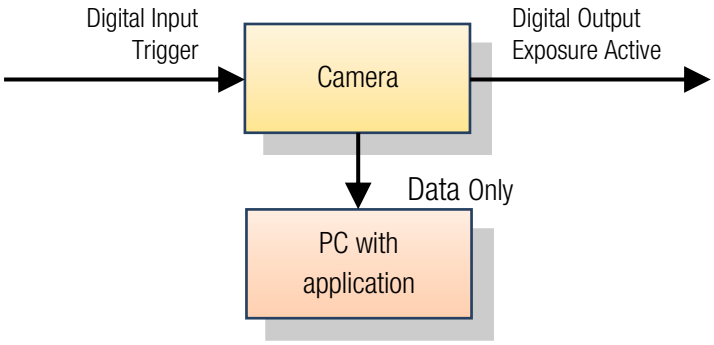


figure 5-11, GPIO - schematic

```
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. GenICam

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

5.8. XIMEA Control Panel

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

xiCOP is currently only available for Windows operating system.

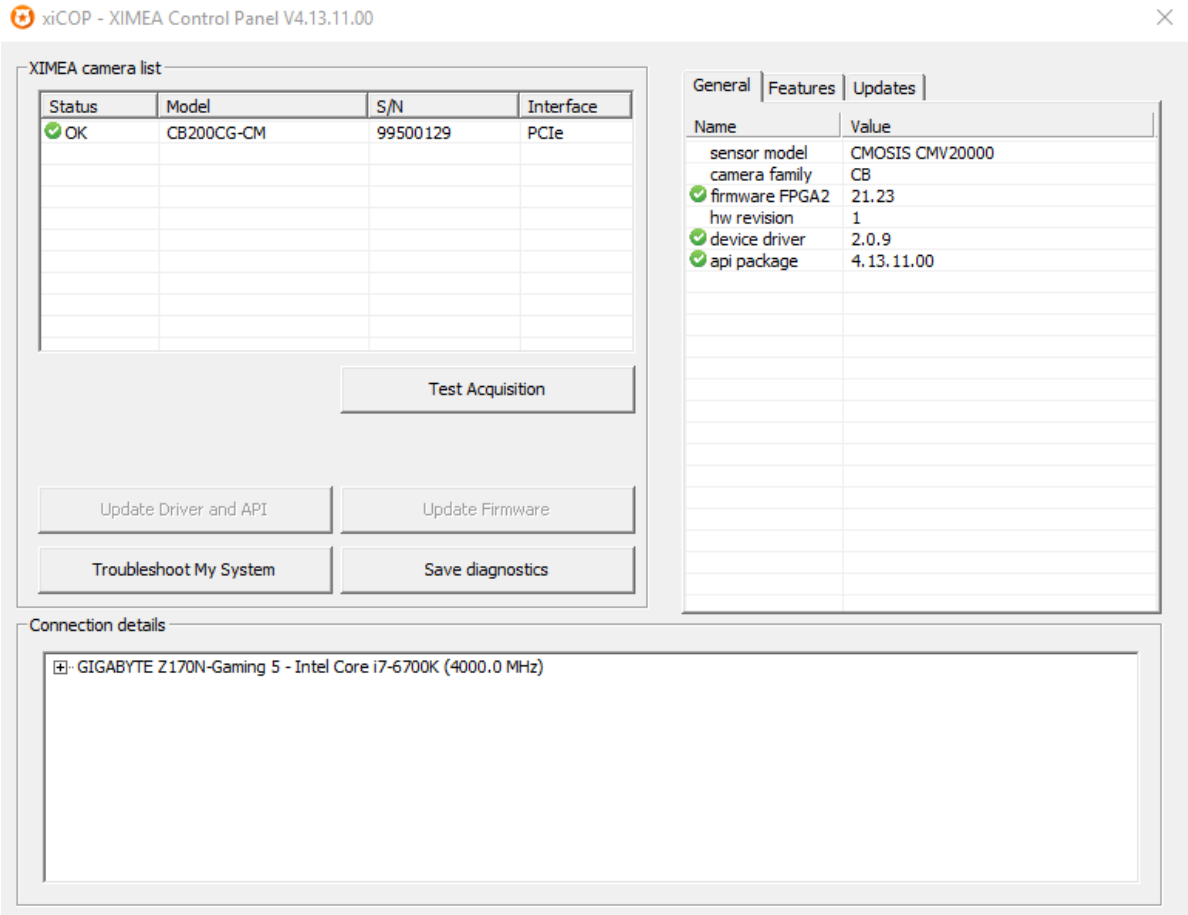


figure 5-12, xiCOP

Features

- Facilitates diagnostics of system performance bottlenecks.
  xiCOP can retrieve the system's hardware tree, thus problematic hardware configurations can be identified.
- Diagnosis of firmware and software compatibility.
  xiCOP checks relevant firmware and software versions and warns if a component is not up to date.
- List all currently attached XIMEA devices and their features.
- Suggests solution for diagnosed issues.
- One click update to the latest XIMEA API Software Package.
- One click update of firmware in selected cameras.

6. Appendix

6.1. Troubleshooting and Support

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

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

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

Please make sure, that you have connected your xiX camera is correctly connected to your system. After power up sequence follow the instructions described in chapter *5.2 XIMEA CamTool* (run the xiX camera with the Ximea CamTool). 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 xiX 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 xiX 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 PCIe interface meets the minimum system requirements described in *4.1 System Requirements*. If the camera does not appear, please proceed with the following steps:

Step no:	Description
1	Click on the button “Troubleshoot My System” and follow the instructions that are suggested.
2	If step 1 does not lead to a positive result, please click the button “Save diagnostics”. Keep the diagnostic file ready for providing it to support.
3	Contact your local dealer where you bought the camera either by phone or by email for first level support. He will decide if he can help you immediately or if more information is necessary for initiating the next steps.

table 6-1, use xiCOP before contacting technical support

6.1.3. Frequently Asked Questions

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

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

6.1.3.1. What is PCIe Gen2?

PCI Express Gen2 is a high-speed serial computer expansion bus standard. PCIe is mostly used as internal bus in computers as well as embedded devices. Extension to XIMEA allows high bandwidth transfers with latency close to zero as well as minimal CPU load leaving processing power for image processing and other tasks.

6.1.3.2. What is the real transfer speed?

xiX camera can deliver up to 800Mbyte/sec. This requires that certain conditions are met, see *4.1 System Requirements.*

Maximum transfer speeds of different interfaces:

Interface	Transfer speed	Usable bandwidth	System costs
IEEE1394A	400 Mbit/s	45 MByte/sec	Medium
CameraLink base	2.04 Gbit/s	255 MByte/sec	High
GigE	1024 Mbit/s	100 MByte/sec	Medium
USB 2.0	480 Mbit/s	49 MByte/sec	Low
USB 3.0	5 Gbit/s	450 MByte/sec	Low
USB 3.1 (gen1)	5 Gbit/s	450 MByte/sec	Low
PCIe gen2 x2	8 Gbit/s		Low
PCIe gen2 x4	16Gbit/s		Low
PCIe gen3 x8	64Gbit/s		Low

table 6-2, interface depending transfer rates

6.1.3.3. Why can I not achieve maximum transfer speed?

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

xiCOP (please see *5.8 XIMEA Control Panel*) - XIMEA Control Panel free software tool, facilitates the task of verification of XIMEA camera connection and installation as well as firmware updates.

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

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

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

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

table 6-3, voltage levels for optoisolated digital input

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

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

Maximal input voltage 24Vdc

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

xiX cameras feature two kind of digital output:

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

For more details see also: *3.11.2 Optically isolated Digital Output*

2. Non isolated high impedance input/output

For more details see also: *3.11.3 Non-isolated Digital Lines*

6.2. Product service request (PSR)

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

6.2.1. Step 1 - Contact Support

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

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

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

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

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

6.2.3. Step 3 - Wait for PSR Approval

Our support personnel will verify the PSR for validity.

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

The email contains:

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

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

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

6.2.4. Step 4 - Sending the camera to XIMEA

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

6.2.5. Step 5 - Waiting for Service Conclusion

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

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

table 6-5, service operations overview

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

6.2.6. STEP 6 - Waiting for return delivery

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

6.3. Safety instructions and precautions

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

6.3.1. Disassembling

Do not disassemble the camera except for conversion to CS-Mount or lens mount, see *3.4 Lens Mount*.

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

6.3.2. Mounting / Screwing

Use only the designated threaded holes for mounting the camera. Please note the camera / bracket drawings in chapter and *3.18 Tripod Adapter*.

Use only the specified screws and torques when fastening, see *3.3 Mounting points.*

6.3.3. Connections

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

6.3.4. Power supply

The xiX cameras are powered via flex cable from an external power supply 12-24V with power consumption up to 10W max. Please read the chapter *3.8 xiX X2G2 –FL/-FV Interface connector* and *3.9 xiX X2G2-FF interface* regarding camera pinout.

6.3.5. Environment / protect against water

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

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

Damages may be caused by:

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

6.3.6. Recommended light conditions.

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

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

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

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

6.3.7. Protect the optical components

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

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

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

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

6.3.8. Mechanical loads

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

6.3.9. Camera / lens cleaning

Please follow instructions described below.

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

6.3.10. Protect against static discharge (ESD)

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

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

6.4. Warranty

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

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

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

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

6.5. Disclaimer of Warranty

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

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

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

6.6. List Of Trademarks

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

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

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

6.7. Standard Terms & Conditions of XIMEA GmbH

General Conditions for the Supply of Products and Services of the Electrical and Electronics Industry ("Grüne Lieferbedingungen" – GL) for commercial transactions between businesses recommended by ZVEI-Zentralverband Elektrotechnik- und Elektronikindustrie e. V.as of May 2021 (with 24 months warranty period)

Article I: General Provisions

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

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

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

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

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

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

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

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

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

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

Article III: Retention of Title

1. The items pertaining to the Supplies (“Retained Goods”) for which the purchase price claim is due immediately or for which a payment period of up to and including 30 days after delivery, delivery with installation/assembly or receipt of invoice has been agreed for the due date of the purchase price claim shall remain the property of the Supplier until payment has been made in total.

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

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

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

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

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

(c) The provisions on the assignment of claims according to No. 4 above shall also apply to the new item. The assignment, however, shall only apply to the amount corresponding to the value invoiced by Supplier for the Retained Goods that have been processed, combined or amalgamated.

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

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

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

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

Article IV: Time for Supplies; Delay

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

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

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

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

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

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

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

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

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

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

Article V: Passing of Risk

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

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

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

after a successful trial run.

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

Article VI: Assembly and Erection

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

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

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

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

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

(d) suitable dry and lockable rooms of sufficient size adjacent to the site for the storage of machine parts, apparatus, materials, tools, etc. and adequate working and recreation rooms for the erection personnel, including sanitary facilities as are appropriate

in the specific circumstances; furthermore, the Purchaser shall take all measures it would take for the protection of its own possessions to protect the possessions of the Supplier and of the erection personnel at the site;

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

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

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

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

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

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

Article VII: Receiving Supplies

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

Article VIII: Defects as to Quality

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

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

2. Claims for repair or replacement are subject to a statute of limitations of 24 months calculated from the start of the statutory statute of limitations; the same shall apply mutatis mutandis in the case of rescission and reduction. This shall not apply:

- where longer periods are prescribed by law according to Sec. 438 para. 1 No. 2 (buildings and things used for a building), and Sec. 634a para. 1 No. 2 (defects of a building) German Civil Code ("Bürgerliches Gesetzbuch"),

- in the case of intent,

- in the case of fraudulent concealment of the Defect or

- non-compliance with guaranteed characteristic (“Beschaffenheitsgarantie”).

Claims for the reimbursement of expenses on the part of the Purchaser in accordance with Sec. 445a BGB (entrepreneur’s right of recourse) shall likewise be subject to a statute of limitations of 24 months from the start of the statutory statute of limitations, provided the last contract in the supply chain is not a sale of consumer goods. The legal provisions regarding suspension of the statute of limitations ("Ablaufhemmung", "Hemmung") and recommencement of limitation periods shall be unaffected.

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

4. In the case of claims for Defects, the Purchaser may withhold payments to an amount that is in a reasonable proportion to the Defect. The Purchaser has no right to withhold payments to the extent that its claim of a Defect is time-barred. Unjustified notifications of Defect shall entitle the Supplier to demand reimbursement of its expenses by the Purchaser.

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

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

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

modifications, installation/ removal, or repair work carried out by the Purchaser or third parties and the consequences thereof are likewise excluded.

8. The Purchaser shall have no claim with respect to expenses incurred in the course of supplementary performance, to the extent that expenses are increased because the subjectmatter of the Supplies has subsequently been brought to another location than the Purchaser's branch office, unless doing so complies with the normal use of the Supplies. This applies accordingly to claims for the reimbursement of expenses on the part of the Purchaser in accordance with Sec. 445a BGB (entrepreneur's right of recourse), provided the last contract in the supply chain is not a sale of consumer goods.

9. The Purchaser's right of recourse against the Supplier pursuant Sec. 445a BGB (entrepreneur's right of recourse) is limited to cases where the Purchaser has not concluded an agreement with its customers exceeding the scope of the statutory provisions governing claims based on Defects.

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

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

1. Unless otherwise agreed, the Supplier shall provide the Supplies in the country of the place of delivery only, without infringing any third-party industrial property rights and copyrights (hereinafter referred to as "IPR"). If a third party asserts a justified claim against the Purchaser based on an infringement of an IPR by the Supplies made by the Supplier and used in conformity with the contract, the Supplier shall be liable to the Purchaser within the time period stipulated in Article VIII No. 2 as follows:

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

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

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

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

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

4. In addition, with respect to claims by the Purchaser pursuant to No. 1 a) above, Article VIII Nos. 4, 5, 8, and 9 shall apply mutatis mutandis in the event of an infringement of an IPR.

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

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

Article X: Conditional Performance

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

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

Article XI: Impossibility of Performance; Adaptation of Contract

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

2. Where events within the meaning of Article IV No. 2 (a) to (c) substantially change the economic importance or the contents of the Supplies or considerably affect the Supplier's business, the contract shall be adapted taking into account the principles of reasonableness and good faith. To the extent this is not justifiable for economic reasons, the Supplier shall have the right to rescind the contract. The same applies if required export permits are not granted or cannot be used. If the Supplier intends to exercise its right to rescind the contract, it shall notify the Purchaser thereof without undue delay after having realized the repercussions of the event; this shall also apply even where an extension of the delivery period has previously been agreed with the Purchaser.

Article XII: Other Claims for Damages

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

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

(a) the German Product Liability Act (“Produkthaftungsgesetz”);

(b) intent;

(c) gross negligence on the part of the owners, legal representatives or executives;

(d) fraud;

(e) failure to comply with a guarantee granted;

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

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

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

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

Artikel XIII: Venue and Applicable law

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

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

Article XIV: Severability Clause

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

6.8. Copyright

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

6.9. Revision History

Version	Date	Notes
1.0	08/31/2017	Initial release
1.1	01/17/2018	Added MX500xG-SY-X4G2 camera model, updated optical path paragraph, updated Triggered acquisition paragraph, corrected FPS for MX X2G2
1.2	08/22/2018	Updated MX500 standard readout modes table, added digitization bit depth paragraph
1.3	08/27/2018	Removed empty page
1.4	08/26/2019	Added –FF models Added new accessories Added LED patterns for diagnostics Added standard xSwitch description Added proper connection sequence
2.0	02/10/2023	Added new camera models based on 4th generation Pregius S sensor

7. Glossary

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

8. List of figures

9. List of tables

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