
# xiX-XS

[ksi-eks'es] or [sai-eks'es]

## • PCI Express cameras for integration

XIMEA Cameras •
Technical Manual •
Version v251001 •

# Introduction

## About this manual

Dear customer,

Thank you for purchasing a product from XIMEA.

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

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

This document is subject to change without notice.

## About XIMEA

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

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

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

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

## Contact XIMEA

XIMEA is a worldwide operating company


| Headquarters, Sales worldwide | Sales America | R&D, Production |
|---|---|---|
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| | |
|---|---|
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| Sales | sales@ximea.com |
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## Standard conformity

### Camera Sub-Assemblies

The "semi" housed camera models do not comply with CE/FCC/Class A limits (Canada) regulations. The system integrator (customer) is liable for compliance with CE/FCC/ Class A limits (Canada) regulations.

This text applies to
all models in this manual (refer to the table Models and sensors overview)

### RoHS conformity

Figure 1: Standard conformity RoHS logo

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

### WEEE conformity

Figure 2: Standard conformity WEEE logo

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

### GenICam GenTL API

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

## Disclaimer

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

## Helpful links

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

## Contents

# 1 xiX camera series

## 1.1 What is xiX


xiX 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 Mpx to 24.5 Mpx 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-XS camera series is equipped with compact sensors, a PCIe x2 Gen2 interface (10 Gbit/s), and a C/CS lens mount.

## 1.2 Advantages

| | |
|---|---|
| Industry standard interface | PCI Express |
| Small | perfect size and customization options for Embedded vision system applications |
| Precise | global shutter Pregius™ sensors deliver outstanding imaging quality |
| Fast | high speed, high frame rate |
| Robust | full metal “semi-housed” |
| Connectivity | programmable opto-isolated I/O, and non-isolated digital input and output, 4 status LEDs |
| Compatibility | support for Windows, Linux, MacOS, and various machine vision libraries |
| Software interfaces | GenICam / GenTL and highly optimized xiAPI SDK |
| Economical | excellent value and price, low TCO and fast ROI |
| Low latency | minimum latency and CPU load |

## 1.3 Camera applications

- Automation
- High speed inspection
- Ultra-fast 3D scanning
- Material and Life science microscopy
- Ophthalmology and Retinal imaging
- Broadcasting
- Fast process capture, e.g. golf club swings
- Aerial Imaging
- Miniature and fast robotic arms
- Mobile devices
- In-situ optical inspection camera
- Ophthalmology and retinal imaging
- Intelligent Transportations Systems (ITS) and traffic monitoring
- VR and AR
- Cinematography
- Sports
- Unmanned and autonomous vehicles
- UAV / Droness

## 1.4 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) |
| Color image processing | host based de-bayering, sharpening, gamma, color matrix, true color CMS |
| Hot/blemish pixels correction | on camera storage of up to 5000 px 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 | 1x opto-isolated input, 1x opto-isolated output, and 2 nonisolated bidirectional I/O, 4X user configurable LEDs |
| Signal conditioning | programmable debouncing time |
| Synchronization | hardware trigger input, software trigger, exposure strobe output, busy output |
| Housing and lens mount | standard C-mount convertible to CS mount |
| Power requirements | typically, external power supply required of 12 to 24 V DC |
| Environment | operating 0 to 50 °C on housing, RH 80 % non-condensing, –25 to 60 °C storage |
| Operating systems | Windows, Linux Ubuntu, MacOS |
| Software support | xiAPI SDK, adapters and drivers for various image processing packages |
| Firmware updates | Firmware can be updated in the field, and is free of charge |

## 1.5 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. Flat-flex cables between the cameras and the xSWITCH allow the most compact integration in tight spaces.

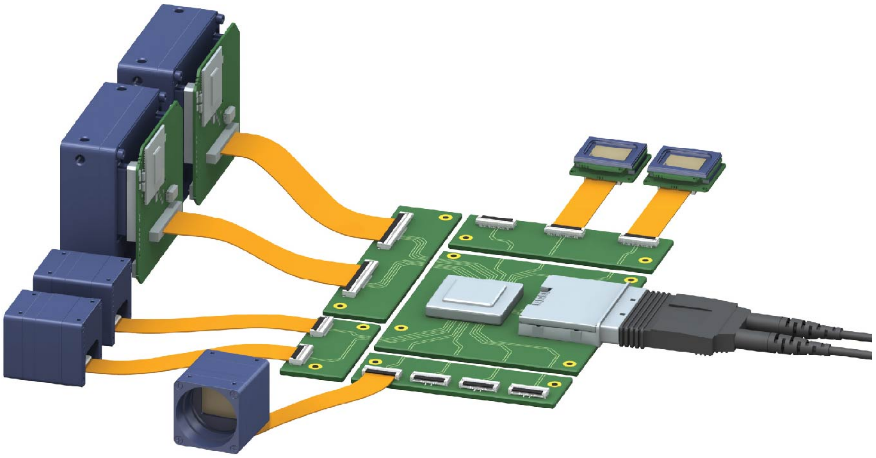


Figure 3: Example of aggregation of many camera in to one cable

PCIe allows multi camera assembly in to one cable stream with other end connected to expansion slot in host computer. It is possible to chain several PCIe switches to create optimal infrastructure. Together with the cameras it is also possible to populate PCIe switch downstream ports with other controllers, like USB 3.0, UART, etc.

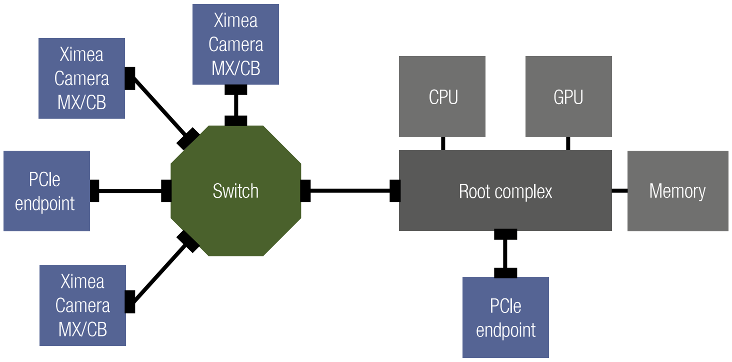



Figure 4: PCI express topology

## Highlights

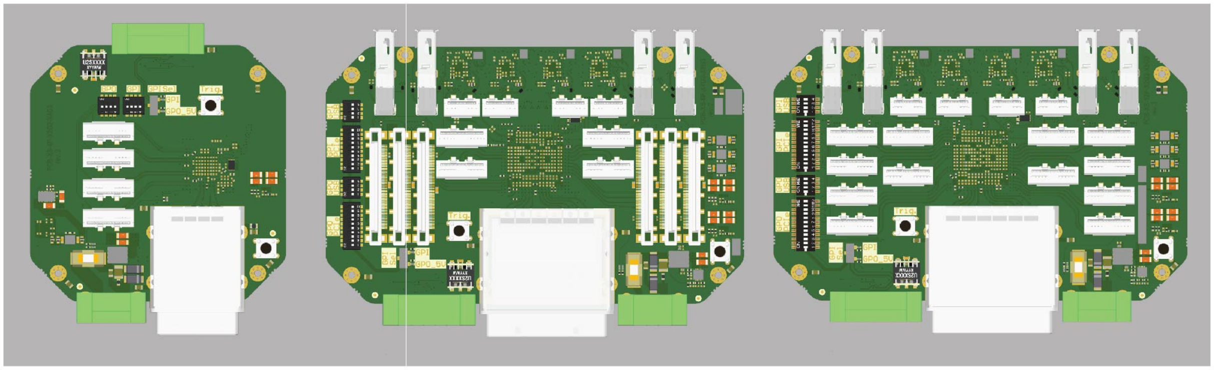
- Maximum compactness: smallest form factor cameras and mini connectors allow closest sensor-to-sensor proximity
- Aggregation into one high bandwidth upstream (up to 64Gbit/s)
- Full utilization of PCIe architecture with point-to-point connection and direct memory access
- Use of standard components allows simple assembly for the creation of a custom platform
- No need for external or additional expansion backplanes
- Multiple example types of xSWITCH board are already designed
- Shape of the board can be tailored precisely to application requirements
- Benefit from XIMEA´s unique experience and expertise in the field of PCIe

## Mix and match

- Connect multiple various camera models and types of cameras to a single computer
- Select from wide range of sensor resolutions and frame rates
- Combine housed and board level camera types
- Choice of different number of PCIe lanes and PCIe standards (2, 4, 8 lanes / Gen2 or Gen3)
- Choice of various connectors: flat-flex option, board to board or iPass
- Choose between flat-flex connectors with vertical or horizontal orientation
- Bridge small or large distances of >100 m by selecting copper cable or optical fiber cable

### 1.5.1 xSWITCH examples

Several standard switches are available for embedded design.



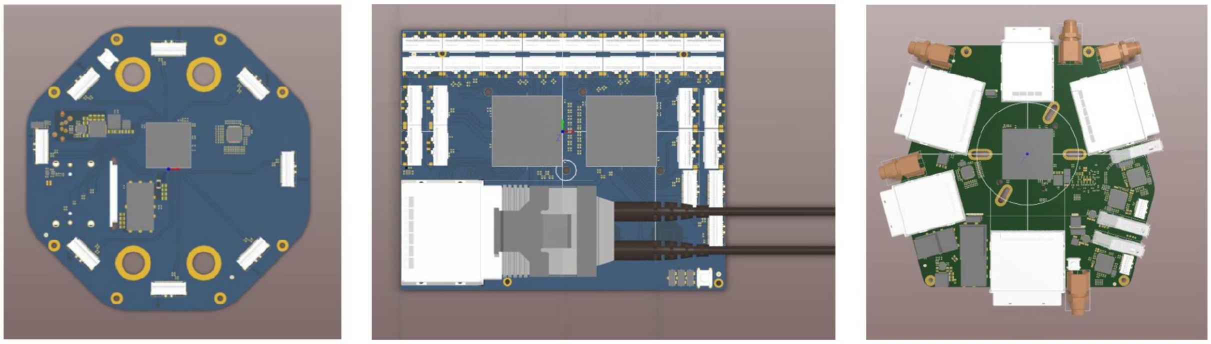
Downstream 4x PCIe x2 Gen2 10Gb/s
Upstream 1x PCIe x4 Gen3 32Gb/s

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 5: Variations of standard switches for embedded vision systems

XIMEA also provides a PCB design where quantity, type, location and orientation of PCIe connectors can be varied to optimize the building 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 of customer applications.
For more information please contact our sales: 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 6: Variations of switches for embedded vision systems

## 1.6 Model nomenclature

| | |
|---|---|
| xiX family | MXxxxyG-zz-XaGb[-OPT][-DR] |
| MX: | xiX family name |
| xxx: | resolution in 0.1 Mpx. e.g. 1.3 Mpx Resolution: xxx = 013 |
| y: | Color sensing |
| y = C: | color model |
| y = M: | black & white model |
| y = R: | IR extended |
| y = U: | ultraviolet (UV) |
| G: | global shutter |
| zz: | Vendor of the sensor |
| zz = SY: | SONY |
| zz = CM: | CMOSIS |
| XaGb: | |
| a = 2 | Number of PCIe lanes used |
| b = 2 | PCIe generation |
| [-OPT]: | Connector options |
| OPT = FF: | FireFly variant, compact FireFly connectors, semi-housed |
| OPT = FL: | flex line variant, connector parallel to board, semi-housed |
| OPT = FV: | flex line variant, connector perpendicular to board, semi-housed |
| [-DR]: | Dynamic range |
| OPT = '': | camera without HDR functionality |
| OPT = HDR: | camera with HDR functionality |

## 1.7 Models and sensors overview

| Camera model | Sensor model | Sensor type | Filter | Resolution [px] | Pixel size [µm] |
|---|---|---|---|---|---|
| MX023CG-SY-X2G2-FF | Sony IMX174 | Color | BayerBG | 1936 × 1216 | 5.86 |
| MX023CG-SY-X2G2-FL | Sony IMX174 | Color | BayerBG | 1936 × 1216 | 5.86 |
| MX023CG-SY-X2G2-FV | Sony IMX174 | Color | BayerBG | 1936 × 1216 | 5.86 |
| MX023MG-SY-X2G2-FF | Sony IMX174 | Monochrome | None | 1936 × 1216 | 5.86 |
| MX023MG-SY-X2G2-FL | Sony IMX174 | Monochrome | None | 1936 × 1216 | 5.86 |
| MX023MG-SY-X2G2-FV | Sony IMX174 | Monochrome | None | 1936 × 1216 | 5.86 |
| MX031CG-SY-X2G2-FF | Sony IMX252 | Color | BayerBG | 2064 × 1544 | 3.45 |
| MX031CG-SY-X2G2-FL | Sony IMX252 | Color | BayerBG | 2064 × 1544 | 3.45 |
| MX031CG-SY-X2G2-FV | Sony IMX252 | Color | BayerBG | 2064 × 1544 | 3.45 |
| MX031MG-SY-X2G2-FF | Sony IMX252 | Monochrome | None | 2064 × 1544 | 3.45 |
| MX031MG-SY-X2G2-FL | Sony IMX252 | Monochrome | None | 2064 × 1544 | 3.45 |
| MX031MG-SY-X2G2-FV | Sony IMX252 | Monochrome | None | 2064 × 1544 | 3.45 |
| MX042CG-CM-X2G2-FF | CMOSIS CMV4000 | Color | BayerGR | 2048 × 2048 | 5.5 |
| MX042CG-CM-X2G2-FL | CMOSIS CMV4000 | Color | BayerGR | 2048 × 2048 | 5.5 |
| MX042CG-CM-X2G2-FV | CMOSIS CMV4000 | Color | BayerGR | 2048 × 2048 | 5.5 |
| MX042MG-CM-X2G2-FF | CMOSIS CMV4000 | Monochrome | None | 2048 × 2048 | 5.5 |
| MX042MG-CM-X2G2-FL | CMOSIS CMV4000 | Monochrome | None | 2048 × 2048 | 5.5 |
| MX042MG-CM-X2G2-FV | CMOSIS CMV4000 | Monochrome | None | 2048 × 2048 | 5.5 |
| MX042RG-CM-X2G2-FF | CMOSIS CMV4000 | Monochrome-NIR | None | 2048 × 2048 | 5.5 |
| MX042RG-CM-X2G2-FL | CMOSIS CMV4000 | Monochrome-NIR | None | 2048 × 2048 | 5.5 |
| MX042RG-CM-X2G2-FV | CMOSIS CMV4000 | Monochrome-NIR | None | 2048 × 2048 | 5.5 |
| MX050CG-SY-X2G2-FF | Sony IMX250 | Color | BayerBG | 2464 × 2056 | 3.45 |
| MX050CG-SY-X2G2-FL | Sony IMX250 | Color | BayerBG | 2464 × 2056 | 3.45 |
| MX050CG-SY-X2G2-FV | Sony IMX250 | Color | BayerBG | 2464 × 2056 | 3.45 |
| MX050MG-SY-X2G2-FF | Sony IMX250 | Monochrome | None | 2464 × 2056 | 3.45 |
| MX050MG-SY-X2G2-FL | Sony IMX250 | Monochrome | None | 2464 × 2056 | 3.45 |
| MX050MG-SY-X2G2-FV | Sony IMX250 | Monochrome | None | 2464 × 2056 | 3.45 |
| MX051CG-SY-PG4-X2G2-FF | Sony IMX547 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051CG-SY-PG4-X2G2-FF-HDR | Sony IMX537 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051CG-SY-PG4-X2G2-FL-HDR | Sony IMX537 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051CG-SY-PG4-X2G2-FL | Sony IMX547 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051CG-SY-PG4-X2G2-FV-HDR | Sony IMX537 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051CG-SY-PG4-X2G2-FV | Sony IMX547 | Color | BayerBG | 2472 × 2064 | 2.74 |
| MX051MG-SY-PG4-X2G2-FF-HDR | Sony IMX537 | Monochrome | None | 2472 × 2064 | 2.74 |
| MX051MG-SY-PG4-X2G2-FF | Sony IMX547 | Monochrome | None | 2472 × 2064 | 2.74 |
| MX051MG-SY-PG4-X2G2-FL | Sony IMX547 | Monochrome | None | 2472 × 2064 | 2.74 |
| MX051MG-SY-PG4-X2G2-FL-HDR | Sony IMX537 | Monochrome | None | 2472 × 2064 | 2.74 |

Table 1: List of camera models and their respective sensor models and filters

| Camera model | Sensor model | Sensor type | Filter | Resolution [px] | Pixel size [µm] |
|---|---|---|---|---|---|
| MX051MG-SY-PG4-X2G2-FV-HDR | Sony IMX537 | Monochrome | None | 2472 × 2064 | 2.74 |
| MX051MG-SY-PG4-X2G2-FV | Sony IMX547 | Monochrome | None | 2472 × 2064 | 2.74 |
| MX081CG-SY-PG4-X2G2-FF-HDR | Sony IMX536 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081CG-SY-PG4-X2G2-FF | Sony IMX546 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081CG-SY-PG4-X2G2-FL | Sony IMX546 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081CG-SY-PG4-X2G2-FL-HDR | Sony IMX536 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081CG-SY-PG4-X2G2-FV | Sony IMX546 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081CG-SY-PG4-X2G2-FV-HDR | Sony IMX536 | Color | BayerBG | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FF-HDR | Sony IMX536 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FF | Sony IMX546 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FL | Sony IMX546 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FL-HDR | Sony IMX536 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FV-HDR | Sony IMX536 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081MG-SY-PG4-X2G2-FV | Sony IMX546 | Monochrome | None | 2856 × 2848 | 2.74 |
| MX081UG-SY-X2G2-FF-HDR | Sony IMX487 | Monochrome-Ultraviolet | None | 2856 × 2848 | 2.74 |
| MX081UG-SY-X2G2-FL-HDR | Sony IMX487 | Monochrome-Ultraviolet | None | 2856 × 2848 | 2.74 |
| MX081UG-SY-X2G2-FV-HDR | Sony IMX487 | Monochrome-Ultraviolet | None | 2856 × 2848 | 2.74 |
| MX089CG-SY-X2G2-FF | Sony IMX255 | Color | BayerBG | 4112 × 2176 | 3.45 |
| MX089CG-SY-X2G2-FL | Sony IMX255 | Color | BayerBG | 4112 × 2176 | 3.45 |
| MX089CG-SY-X2G2-FV | Sony IMX255 | Color | BayerBG | 4112 × 2176 | 3.45 |
| MX089MG-SY-X2G2-FF | Sony IMX255 | Monochrome | None | 4112 × 2176 | 3.45 |
| MX089MG-SY-X2G2-FL | Sony IMX255 | Monochrome | None | 4112 × 2176 | 3.45 |
| MX089MG-SY-X2G2-FV | Sony IMX255 | Monochrome | None | 4112 × 2176 | 3.45 |
| MX124CG-SY-PG4-X2G2-FF-HDR | Sony IMX535 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-PG4-X2G2-FF | Sony IMX545 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-PG4-X2G2-FL-HDR | Sony IMX535 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-PG4-X2G2-FL | Sony IMX545 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-PG4-X2G2-FV-HDR | Sony IMX535 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-PG4-X2G2-FV | Sony IMX545 | Color | BayerBG | 4128 × 3008 | 2.74 |
| MX124CG-SY-X2G2-FF | Sony IMX253 | Color | BayerBG | 4112 × 3008 | 3.45 |
| MX124CG-SY-X2G2-FL | Sony IMX253 | Color | BayerBG | 4112 × 3008 | 3.45 |
| MX124CG-SY-X2G2-FV | Sony IMX253 | Color | BayerBG | 4112 × 3008 | 3.45 |
| MX124MG-SY-PG4-X2G2-FF | Sony IMX545 | Monochrome | None | 4128 × 3008 | 2.74 |
| MX124MG-SY-PG4-X2G2-FF-HDR | Sony IMX535 | Monochrome | None | 4128 × 3008 | 2.74 |
| MX124MG-SY-PG4-X2G2-FL | Sony IMX545 | Monochrome | None | 4128 × 3008 | 2.74 |
| MX124MG-SY-PG4-X2G2-FL-HDR | Sony IMX535 | Monochrome | None | 4128 × 3008 | 2.74 |
| MX124MG-SY-PG4-X2G2-FV-HDR | Sony IMX535 | Monochrome | None | 4128 × 3008 | 2.74 |

Table 2: List of camera models and their respective sensor models and filters

| Camera model | Sensor model | Sensor type | Filter | Resolution [px] | Pixel size [µm] |
|---|---|---|---|---|---|
| MX124MG-SY-PG4-X2G2-FV | Sony IMX545 | Monochrome | None | 4128 × 3008 | 2.74 |
| MX124MG-SY-X2G2-FF | Sony IMX253 | Monochrome | None | 4112 × 3008 | 3.45 |
| MX124MG-SY-X2G2-FL | Sony IMX253 | Monochrome | None | 4112 × 3008 | 3.45 |
| MX124MG-SY-X2G2-FV | Sony IMX253 | Monochrome | None | 4112 × 3008 | 3.45 |
| MX161CG-SY-X2G2-FF-HDR | Sony IMX532 | Color | BayerBG | 5328 × 3040 | 2.74 |
| MX161CG-SY-X2G2-FL-HDR | Sony IMX532 | Color | BayerBG | 5328 × 3040 | 2.74 |
| MX161CG-SY-X2G2-FL | Sony IMX542 | Color | BayerBG | 5328 × 3040 | 2.74 |
| MX161CG-SY-X2G2-FV | Sony IMX542 | Color | BayerBG | 5328 × 3040 | 2.74 |
| MX161CG-SY-X2G2-FV-HDR | Sony IMX532 | Color | BayerBG | 5328 × 3040 | 2.74 |
| MX161MG-SY-X2G2-FF-HDR | Sony IMX532 | Monochrome | None | 5328 × 3040 | 2.74 |
| MX161MG-SY-X2G2-FL | Sony IMX542 | Monochrome | None | 5328 × 3040 | 2.74 |
| MX161MG-SY-X2G2-FL-HDR | Sony IMX532 | Monochrome | None | 5328 × 3040 | 2.74 |
| MX161MG-SY-X2G2-FV | Sony IMX542 | Monochrome | None | 5328 × 3040 | 2.74 |
| MX161MG-SY-X2G2-FV-HDR | Sony IMX532 | Monochrome | None | 5328 × 3040 | 2.74 |
| MX203CG-SY-X2G2-FF-HDR | Sony IMX531 | Color | BayerBG | 4512 × 4512 | 2.74 |
| MX203CG-SY-X2G2-FL | Sony IMX541 | Color | BayerBG | 4512 × 4512 | 2.74 |
| MX203CG-SY-X2G2-FL-HDR | Sony IMX531 | Color | BayerBG | 4512 × 4512 | 2.74 |
| MX203CG-SY-X2G2-FV | Sony IMX541 | Color | BayerBG | 4512 × 4512 | 2.74 |
| MX203CG-SY-X2G2-FV-HDR | Sony IMX531 | Color | BayerBG | 4512 × 4512 | 2.74 |
| MX203MG-SY-X2G2-FF-HDR | Sony IMX531 | Monochrome | None | 4512 × 4512 | 2.74 |
| MX203MG-SY-X2G2-FL | Sony IMX541 | Monochrome | None | 4512 × 4512 | 2.74 |
| MX203MG-SY-X2G2-FL-HDR | Sony IMX531 | Monochrome | None | 4512 × 4512 | 2.74 |
| MX203MG-SY-X2G2-FV-HDR | Sony IMX531 | Monochrome | None | 4512 × 4512 | 2.74 |
| MX203MG-SY-X2G2-FV | Sony IMX541 | Monochrome | None | 4512 × 4512 | 2.74 |
| MX245CG-SY-X2G2-FF-HDR | Sony IMX530 | Color | BayerBG | 5328 × 4608 | 2.74 |
| MX245CG-SY-X2G2-FL | Sony IMX540 | Color | BayerBG | 5328 × 4608 | 2.74 |
| MX245CG-SY-X2G2-FL-HDR | Sony IMX530 | Color | BayerBG | 5328 × 4608 | 2.74 |
| MX245CG-SY-X2G2-FV | Sony IMX540 | Color | BayerBG | 5328 × 4608 | 2.74 |
| MX245CG-SY-X2G2-FV-HDR | Sony IMX530 | Color | BayerBG | 5328 × 4608 | 2.74 |
| MX245MG-SY-X2G2-FF-HDR | Sony IMX530 | Monochrome | None | 5328 × 4608 | 2.74 |
| MX245MG-SY-X2G2-FL | Sony IMX540 | Monochrome | None | 5328 × 4608 | 2.74 |
| MX245MG-SY-X2G2-FL-HDR | Sony IMX530 | Monochrome | None | 5328 × 4608 | 2.74 |
| MX245MG-SY-X2G2-FV | Sony IMX540 | Monochrome | None | 5328 × 4608 | 2.74 |
| MX245MG-SY-X2G2-FV-HDR | Sony IMX530 | Monochrome | None | 5328 × 4608 | 2.74 |

Table 3: List of camera models and their respective sensor models and filters

## 1.8 Accessories overview

The following accessories are available:

| Item P/N | Description |
|---|---|
| CBL-MX-X2G2-0M07 | 0.07 m flat ribbon cable for PCIe Gen 2 x2 (gold color) |
| CBL-MX-X2G2-0M10 | 0.1 m flat ribbon cable for PCIe Gen 2 x2 (gold color) |
| CBL-MX-X2G2-0M25 | 0.25 m flat ribbon cable for PCIe Gen 2 x2 (gold color) |
| CBL-MX-X2G2-0M50 | 0.5 m flat ribbon cable for PCIe Gen 2 x2 (gold color) |
| CBL-PCIEFLEX-X2G2-0M10 | 0.1 m flat ribbon cable for PCIe Gen 2 x2 (white color) |
| CBL-PCIEFLEX-X2G2-0M25 | 0.25 m flat ribbon cable for PCIe Gen 2 x2 (white color) |
| CBL-PCIEFLEX-X2G2-0M50 | 0.5 m flat ribbon cable for PCIe Gen 2 x2 cable (white color) |
| CBL-ECUE-X4G3-1M0 | 1 m FIREFLY™ cable for PCIe Gen 2 x2 (-FF) |
| CBL-ECUE-X4G3-2M0 | 2 m FIREFLY™ cable for PCIe Gen 2 x2 (-FF) |
| CBL-ECUE-X4G3-3M0 | 3 m FIREFLY™ cable for PCIe (-FF) |
| ADPT-MX-X2G2-IPASS-HOST | Breakout board from iPass X2G2 to X2G2 flat ribbon |
| ADPT-MX-X2G2-IPASS-TARGET | 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) |
| MECH-MC-BRACKET-KIT | xiX-XS / xiC series tripod mounting bracket |

Table 4: List of accessories available for xiX-XS camera models

# 2 Hardware specification

## 2.1 Power supply

The power consumption table can consist of several values:

**Supply voltage:** Voltage used for measuring the power consumption.

**Idle:** The average power consumption when the camera is powered, but not opened/initialized in software.

**Typical:** The average power consumption during streaming in the most power-intensive mode, (typically the one with the highest frame rate).

**Maximum:** The highest power consumption peak recorded during streaming in the most power-intensive mode, (measured using a current probe).

Power consumption of:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV MX023MG-SY-X2G2-FF
MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 2.87 W | 2.95 W |

[1]Supported voltage 12 - 24 V

Table 5: Power consumption of the specific models

Power consumption of:

MX031CG-SY-X2G2-FF MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV MX031MG-SY-X2G2-FF
MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL
MX050CG-SY-X2G2-FV MX050MG-SY-X2G2-FF MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 3.64 W | 3.72 W |

[1]Supported voltage 12 - 24 V

Table 6: Power consumption of the specific models

Power consumption of:

MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FF
MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL
MX042RG-CM-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 3.64 W | TBD |

[1]Supported voltage 12 - 24 V

Table 7: Power consumption of the specific models

Power consumption of:

MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FL MX051CG-SY-PG4-X2G2-FV MX051MG-SY-PG4-X2G2-FF MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 3.10 W | 3.20 W |

[1]Supported voltage 12 - 24 V

Table 8: Power consumption of the specific models

Power consumption of:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 4.01 W | 4.13 W |

[1]Supported voltage 12 - 24 V

Table 9: Power consumption of the specific models

Power consumption of:

MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 4.16 W | 4.23 W |

[1]Supported voltage 12 - 24 V

Table 10: Power consumption of the specific models

Power consumption of:

MX081CG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FV MX081MG-SY-PG4-X2G2-FF MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 3.17 W | 3.22 W |

[1]Supported voltage 12 - 24 V

Table 11: Power consumption of the specific models

Power consumption of:

MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL MX089CG-SY-X2G2-FV MX089MG-SY-X2G2-FF MX089MG-SY-X2G2-FL MX089MG-SY-X2G2-FV MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV MX124MG-SY-X2G2-FF MX124MG-SY-X2G2-FL MX124MG-SY-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 3.82 W | 3.88 W |

[1]Supported voltage 12 - 24 V

Table 12: Power consumption of the specific models

Power consumption of:

MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FV-HDR MX124MG-SY-PG4-X2G2-FF-HDR
MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 4.23 W | 4.28 W |

[1]Supported voltage 12 - 24 V

Table 13: Power consumption of the specific models

Power consumption of:

MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL MX124CG-SY-PG4-X2G2-FV MX124MG-SY-PG4-X2G2-FF
MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 24 V | 3.36 W | 3.44 W |

[1]Supported voltage 12 - 24 V

Table 14: Power consumption of the specific models

Power consumption of:

MX161CG-SY-X2G2-FL MX161CG-SY-X2G2-FV MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FV
MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FV MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FV
MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FV MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FV

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 4.8 W | 5.1 W |

[1]Supported voltage 12 - 24 V

Table 15: Power consumption of the specific models

Power consumption of:

MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR MX161CG-SY-X2G2-FF-HDR
MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL-HDR
MX161MG-SY-X2G2-FV-HDR MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR
MX203MG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR MX245CG-SY-X2G2-FF-HDR
MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL-HDR
MX245MG-SY-X2G2-FV-HDR

| Supply Voltage[1] | Consumption typical | Consumption maximum |
|---|---|---|
| 12 V | 5.4 W | 5.6 W |

[1]Supported voltage 12 - 24 V

Table 16: Power consumption of the specific models

### 2.1.1 Power input

Depending on the accessories used, cameras with a FireFly interface can be powered either through their respective sync cable or the FireFly connector. The xiX-XS cameras with a flex interface are powered via a flex cable from an external power supply of 12 to 24 V, with power consumption up to a maximum of 6 W (excluding the power needed for the lens). See section Camera interface.

The flex and FireFly interface cables for the cameras are equipped with a locking mechanism. When locked, pulling the cable may damage the connector or the camera. All cables must be connected while the system power is off. After powering the camera or recycling the power, the host system must be turned on or restarted.

## 2.2 General specification

### 2.2.1 Environment

| Description | Symbol | Value |
|---|---|---|
| Optimal ambient temperature operation | $T_{opt}$ | 10 to 25 °C |
| Ambient temperature operation | $T_{max}$ | 0 to 50 °C |
| Ambient temperature for storage and transportation | $T_{storage}$ | –25 to 60 °C |
| Relative Humidity, non-condensing | RH | 80 % |

Table 17: Environment

Housing temperature must not exceed 65 °C.

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

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

## 2.3 Lens mount

### 2.3.1 C/CS-mount

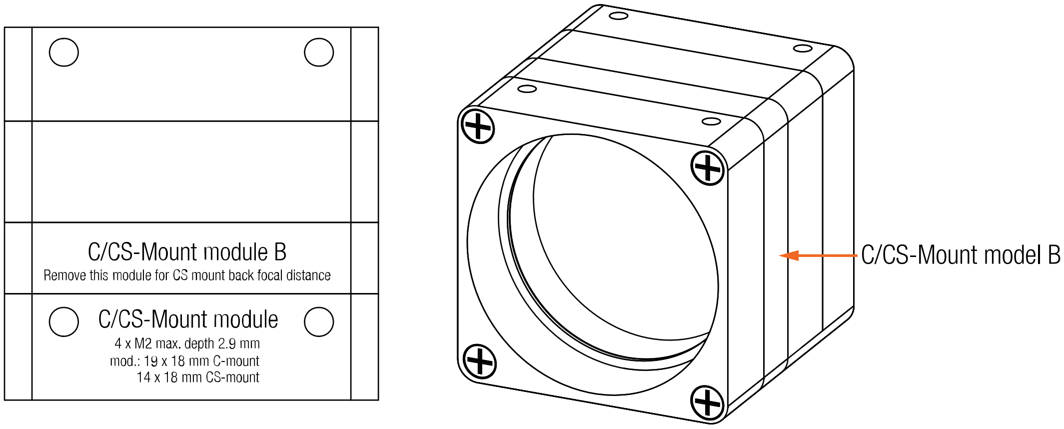



Figure 7: Lens mount adapter C/CS-mount

The cameras are initially equipped with a C-mount back focal length. Through the removal of the "C/CS-Mount module B", the camera can be transformed for CS-mount compatibility, effectively reducing the back focal distance and overall length of the camera by 5 mm. The required M2x8 mm special screws for this conversion are included in the camera delivery. The length of the lens thread measured at 6.5 mm. For detailed instructions, please refer to section Optical path.

Conversion between these two options is described here: Convert C to CS Mount

Lens mount adapter configuration:

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

The mentioned lens adapter is included in:
all models in this manual (refer to the table Models and sensors overview)

## 2.4 Mounting points

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

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

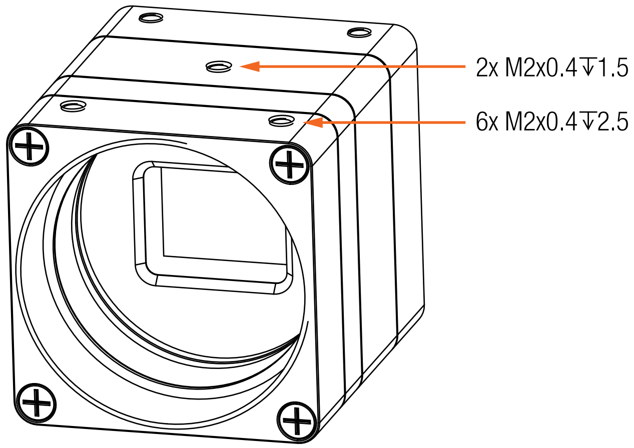



Figure 8: xiX-XS camera mounting points

## 2.5 Optical path

The optical path in cameras defines the course traversed by light from the observed object to the image captured by the sensor. It involves complex interactions with components (e.g. lenses).

The flange focal distance (FFD) or optical distance is the distance between a lens's mounting flange and a camera's sensor plane. In standard setups, it assumes that only air fills the space between the lens and the sensor. However, the introduction of additional elements like windows or filters can alter the focal plane through refraction, requiring an adjusted FFD for proper alignment.

The presence or absence of a filter or sensor window in the camera depends on the camera model. The distance from the flange to the sensor is designed (refer to the camera cross-section image below for visual information).

Do not use compressed air to clean the camera as this could push dust particles into the camera or potentially cause damage (e.g.scratches).

Cross-section corresponding to:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV MX023MG-SY-X2G2-FF
MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

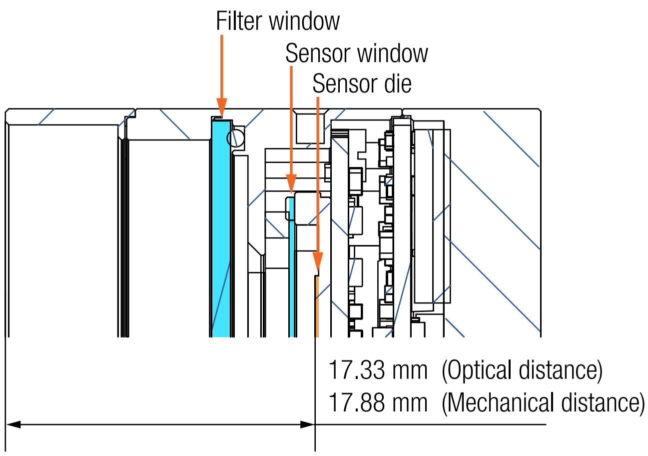



Figure 9: Cross section of MX023xG-SY-X2G2-Fx camera models

Cross-section corresponding to:

MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FF
MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL
MX042RG-CM-X2G2-FV

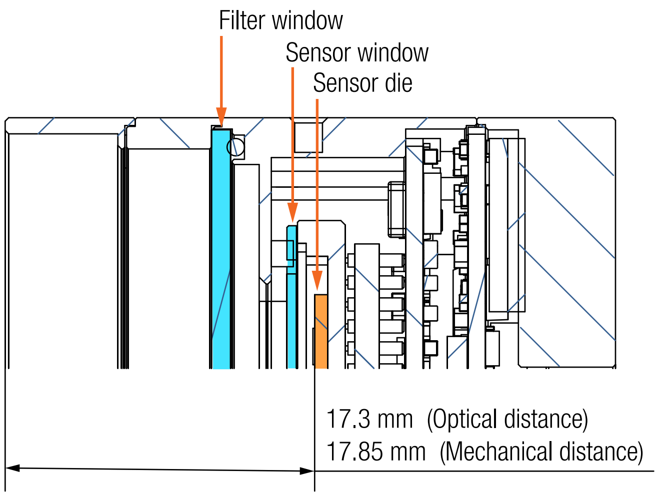



Figure 10: Cross section of MX022/042xG-X2G2-Fx camera models

Cross-section corresponding to:

| | | | |
|---|---|---|---|
| MX051CG-SY-PG4-X2G2-FF | MX051CG-SY-PG4-X2G2-FF-HDR | MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FL |
| MX051CG-SY-PG4-X2G2-FV-HDR | MX051CG-SY-PG4-X2G2-FV | MX051MG-SY-PG4-X2G2-FF-HDR | MX051MG-SY-PG4-X2G2-FF |
| MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL-HDR | MX051MG-SY-PG4-X2G2-FV-HDR | MX051MG-SY-PG4-X2G2-FV |
| MX081CG-SY-PG4-X2G2-FF-HDR | MX081CG-SY-PG4-X2G2-FF | MX081CG-SY-PG4-X2G2-FL | MX081CG-SY-PG4-X2G2-FL-HDR |
| MX081CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FF-HDR | MX081MG-SY-PG4-X2G2-FF |
| MX081MG-SY-PG4-X2G2-FL | MX081MG-SY-PG4-X2G2-FL-HDR | MX081MG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV |
| MX124CG-SY-PG4-X2G2-FF-HDR | MX124CG-SY-PG4-X2G2-FF | MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FL |
| MX124CG-SY-PG4-X2G2-FV-HDR | MX124CG-SY-PG4-X2G2-FV | MX124MG-SY-PG4-X2G2-FF | MX124MG-SY-PG4-X2G2-FF-HDR |
| MX124MG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FL-HDR | MX124MG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FV |

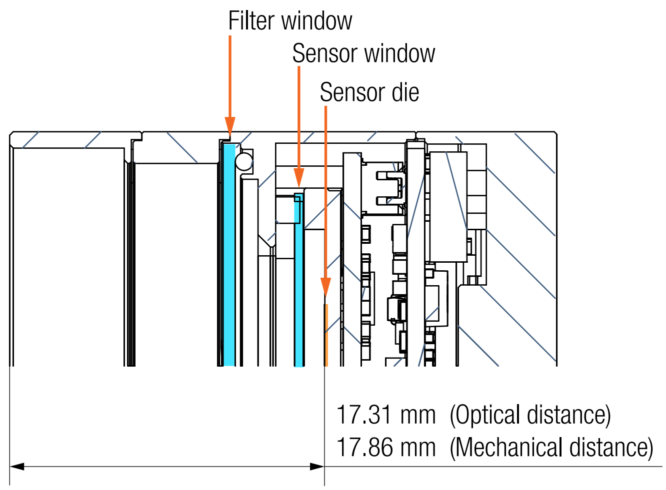



Figure 11: Cross section of MX051/081/124xG-SY-PG4-X2G2-Fx camera models

Cross-section corresponding to:

| | | | |
|---|---|---|---|
| MX031CG-SY-X2G2-FF | MX031CG-SY-X2G2-FL | MX031CG-SY-X2G2-FV | MX031MG-SY-X2G2-FF |
| MX031MG-SY-X2G2-FL | MX031MG-SY-X2G2-FV | MX050CG-SY-X2G2-FF | MX050CG-SY-X2G2-FL |
| MX050CG-SY-X2G2-FV | MX050MG-SY-X2G2-FF | MX050MG-SY-X2G2-FL | MX050MG-SY-X2G2-FV |
| MX089CG-SY-X2G2-FF | MX089CG-SY-X2G2-FL | MX089CG-SY-X2G2-FV | MX089MG-SY-X2G2-FF |
| MX089MG-SY-X2G2-FL | MX089MG-SY-X2G2-FV | MX124CG-SY-X2G2-FF | MX124CG-SY-X2G2-FL |
| MX124CG-SY-X2G2-FV | MX124MG-SY-X2G2-FF | MX124MG-SY-X2G2-FL | MX124MG-SY-X2G2-FV |

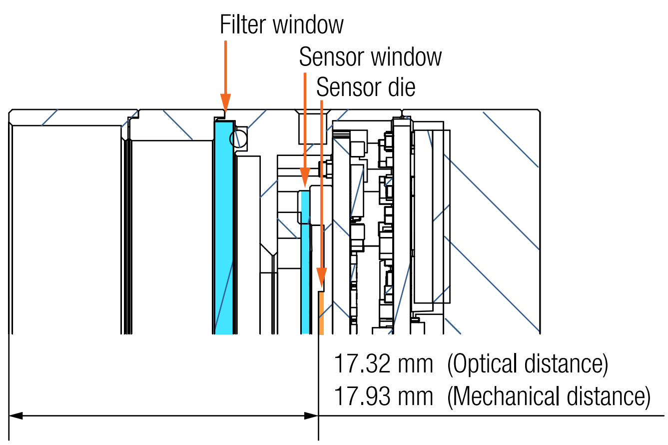



Figure 12: Cross section of MX031/050/089/124xG-SY-X2G2-Fx camera models

Cross-section corresponding to:

- MX081UG-SY-X2G2-FF-HDR
- MX081UG-SY-X2G2-FL-HDR
- MX081UG-SY-X2G2-FV-HDR
- MX161CG-SY-X2G2-FF-HDR
- MX161CG-SY-X2G2-FL-HDR
- MX161CG-SY-X2G2-FL
- MX161CG-SY-X2G2-FV
- MX161CG-SY-X2G2-FV-HDR
- MX161MG-SY-X2G2-FF-HDR
- MX161MG-SY-X2G2-FL
- MX161MG-SY-X2G2-FL-HDR
- MX161MG-SY-X2G2-FV
- MX161MG-SY-X2G2-FV-HDR
- MX203CG-SY-X2G2-FF-HDR
- MX203CG-SY-X2G2-FL
- MX203CG-SY-X2G2-FL-HDR
- MX203CG-SY-X2G2-FV
- MX203CG-SY-X2G2-FV-HDR
- MX203MG-SY-X2G2-FF-HDR
- MX203MG-SY-X2G2-FL
- MX203MG-SY-X2G2-FL-HDR
- MX203MG-SY-X2G2-FV-HDR
- MX203MG-SY-X2G2-FV
- MX245CG-SY-X2G2-FF-HDR
- MX245CG-SY-X2G2-FL
- MX245CG-SY-X2G2-FL-HDR
- MX245CG-SY-X2G2-FV
- MX245CG-SY-X2G2-FV-HDR
- MX245MG-SY-X2G2-FF-HDR
- MX245MG-SY-X2G2-FL
- MX245MG-SY-X2G2-FL-HDR
- MX245MG-SY-X2G2-FV
- MX245MG-SY-X2G2-FV-HDR

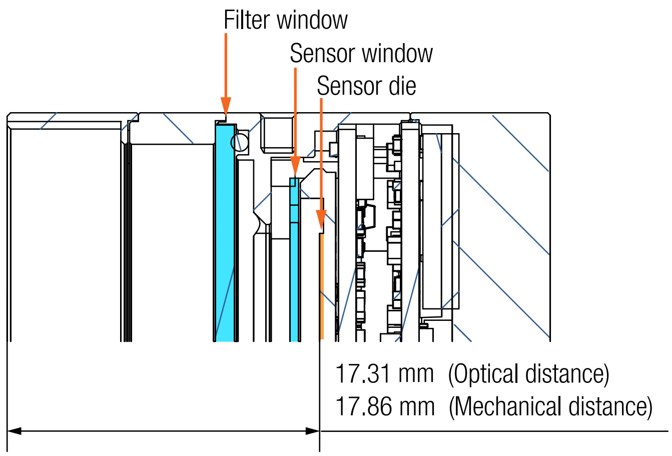



Figure 13: Cross section of MX081/161/203/245xG-SY-X2G2-Fx camera models

The following filter window is implemented in:

| | | | |
|---|---|---|---|
| MX023MG-SY-X2G2-FF | MX023MG-SY-X2G2-FL | MX023MG-SY-X2G2-FV | MX031MG-SY-X2G2-FF |
| MX031MG-SY-X2G2-FL | MX031MG-SY-X2G2-FV | MX042MG-CM-X2G2-FF | MX042MG-CM-X2G2-FL |
| MX042MG-CM-X2G2-FV | MX042RG-CM-X2G2-FF | MX042RG-CM-X2G2-FL | MX042RG-CM-X2G2-FV |
| MX050MG-SY-X2G2-FF | MX050MG-SY-X2G2-FL | MX050MG-SY-X2G2-FV | MX051MG-SY-PG4-X2G2-FF-HDR |
| MX051MG-SY-PG4-X2G2-FF | MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL-HDR | MX051MG-SY-PG4-X2G2-FV-HDR |
| MX051MG-SY-PG4-X2G2-FV | MX081MG-SY-PG4-X2G2-FF-HDR | MX081MG-SY-PG4-X2G2-FF | MX081MG-SY-PG4-X2G2-FL |
| MX081MG-SY-PG4-X2G2-FL-HDR | MX081MG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV | MX081UG-SY-X2G2-FF-HDR |
| MX081UG-SY-X2G2-FL-HDR | MX081UG-SY-X2G2-FV-HDR | MX089MG-SY-X2G2-FF | MX089MG-SY-X2G2-FL |
| MX089MG-SY-X2G2-FV | MX124MG-SY-PG4-X2G2-FF | MX124MG-SY-PG4-X2G2-FF-HDR | MX124MG-SY-PG4-X2G2-FL |
| MX124MG-SY-PG4-X2G2-FL-HDR | MX124MG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FV | MX124MG-SY-X2G2-FF |
| MX124MG-SY-X2G2-FL | MX124MG-SY-X2G2-FV | MX161MG-SY-X2G2-FF-HDR | MX161MG-SY-X2G2-FL |
| MX161MG-SY-X2G2-FL-HDR | MX161MG-SY-X2G2-FV | MX161MG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FF-HDR |
| MX203MG-SY-X2G2-FL | MX203MG-SY-X2G2-FL-HDR | MX203MG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FV |
| MX245MG-SY-X2G2-FF-HDR | MX245MG-SY-X2G2-FL | MX245MG-SY-X2G2-FL-HDR | MX245MG-SY-X2G2-FV |
| MX245MG-SY-X2G2-FV-HDR | | | |

| Filter | Coating | Thickness |
|---|---|---|
| Filter BK7 | ARx2 | 1.1 mm |

Table 18: BK7 filter window parameter

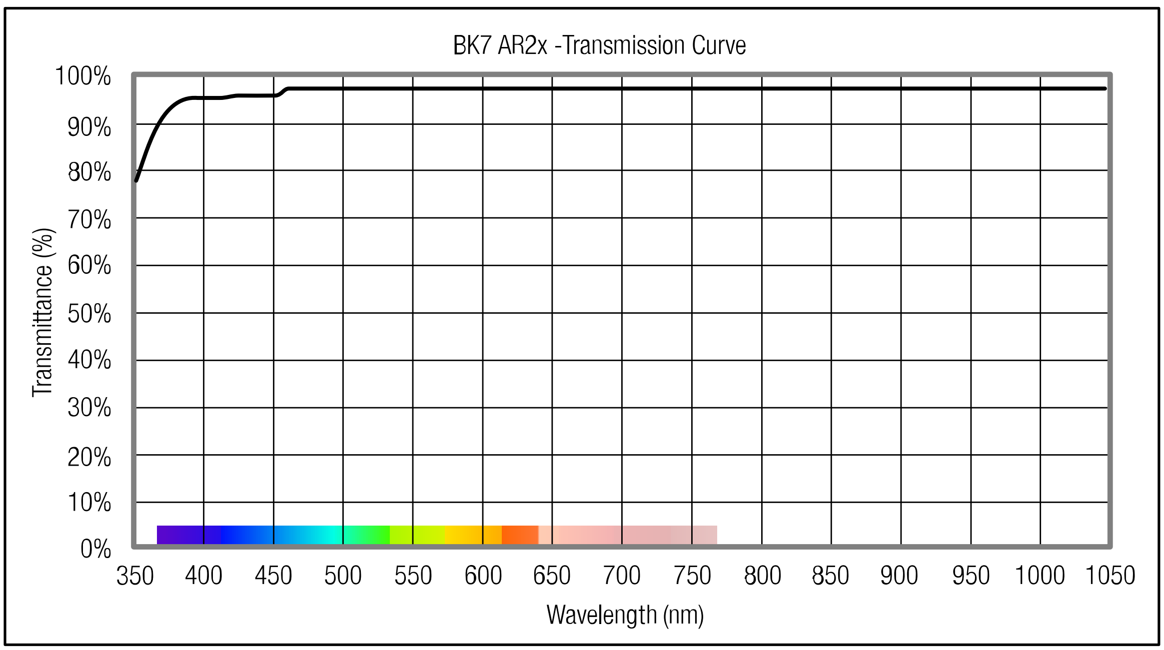



Figure 14: Filter glass BK7 AR2x Transmission Curve

The following filter window is implemented in:

| | | | |
|---|---|---|---|
| MX023CG-SY-X2G2-FF | MX023CG-SY-X2G2-FL | MX023CG-SY-X2G2-FV | MX031CG-SY-X2G2-FF |
| MX031CG-SY-X2G2-FL | MX031CG-SY-X2G2-FV | MX042CG-CM-X2G2-FF | MX042CG-CM-X2G2-FL |
| MX042CG-CM-X2G2-FV | MX050CG-SY-X2G2-FF | MX050CG-SY-X2G2-FL | MX050CG-SY-X2G2-FV |
| MX051CG-SY-PG4-X2G2-FF | MX051CG-SY-PG4-X2G2-FF-HDR | MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FL |
| MX051CG-SY-PG4-X2G2-FV-HDR | MX051CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FF-HDR | MX081CG-SY-PG4-X2G2-FF |
| MX081CG-SY-PG4-X2G2-FL | MX081CG-SY-PG4-X2G2-FL-HDR | MX081CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FV-HDR |
| MX089CG-SY-X2G2-FF | MX089CG-SY-X2G2-FL | MX089CG-SY-X2G2-FV | MX124CG-SY-PG4-X2G2-FF-HDR |
| MX124CG-SY-PG4-X2G2-FF | MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FL | MX124CG-SY-PG4-X2G2-FV-HDR |
| MX124CG-SY-PG4-X2G2-FV | MX124CG-SY-X2G2-FF | MX124CG-SY-X2G2-FL | MX124CG-SY-X2G2-FV |
| MX161CG-SY-X2G2-FF-HDR | MX161CG-SY-X2G2-FL-HDR | MX161CG-SY-X2G2-FL | MX161CG-SY-X2G2-FV |
| MX161CG-SY-X2G2-FV-HDR | MX203CG-SY-X2G2-FF-HDR | MX203CG-SY-X2G2-FL | MX203CG-SY-X2G2-FL-HDR |
| MX203CG-SY-X2G2-FV | MX203CG-SY-X2G2-FV-HDR | MX245CG-SY-X2G2-FF-HDR | MX245CG-SY-X2G2-FL |
| MX245CG-SY-X2G2-FL-HDR | MX245CG-SY-X2G2-FV | MX245CG-SY-X2G2-FV-HDR | |

| Filter | Coating | Thickness |
|---|---|---|
| IR Filter IR650 | ARx2 | 1.1 mm |

Table 19: IR650 filter window parameter

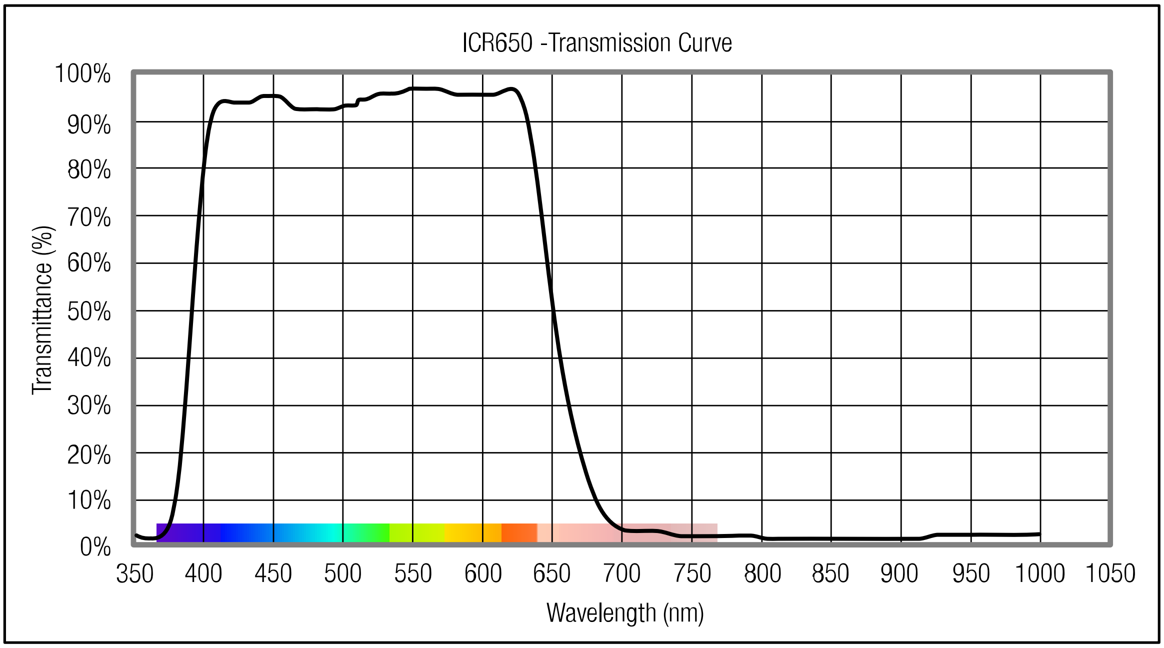



Figure 15: Filter glass ICR650 Transmission Curve

## 2.6 Sensor and camera characteristics

### 2.6.1 Sensor and camera parameters

Sensor parameters of:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV MX023MG-SY-X2G2-FF MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 1936 x 1216 | [px] |
| Active area size (H X V) | 11.345 x 7.126 | [mm] |
| Sensor diagonal | 13.4 | [mm] |
| Pixel size (H x V) | 5.86 x 5.86 | [µm] |

Table 20: Sensor parameters of the specific models

Sensor parameters of:

MX031CG-SY-X2G2-FF MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV MX031MG-SY-X2G2-FF MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 2064 x 1544 | [px] |
| Active area size (H X V) | 7.12 x 5.33 | [mm] |
| Sensor diagonal | 8.9 | [mm] |
| Pixel size (H x V) | 3.45 x 3.45 | [µm] |

Table 21: Sensor parameters of the specific models

Sensor parameters of:

MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FF MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL MX042RG-CM-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 2048 x 2048 | [px] |
| Active area size (H X V) | 11.27 x 11.27 | [mm] |
| Sensor diagonal | 15.9 | [mm] |
| Pixel size (H x V) | 5.5 x 5.5 | [µm] |

Table 22: Sensor parameters of the specific models

Sensor parameters of:

MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV MX050MG-SY-X2G2-FF
MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 2464 x 2056 | [px] |
| Active area size (H X V) | 8.5 x 7.09 | [mm] |
| Sensor diagonal | 11.1 | [mm] |
| Pixel size (H x V) | 3.45 x 3.45 | [µm] |

Table 23: Sensor parameters of the specific models

Sensor parameters of:

MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FL
MX051CG-SY-PG4-X2G2-FV-HDR MX051CG-SY-PG4-X2G2-FV MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FF
MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR MX051MG-SY-PG4-X2G2-FV

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

Table 24: Sensor parameters of the specific models

Sensor parameters of:

MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FL-HDR
MX081CG-SY-PG4-X2G2-FV MX081CG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FF
MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 2856 x 2848 | [px] |
| Active area size (H X V) | 7.82 x 7.80 | [mm] |
| Sensor diagonal | 11.1 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [µm] |

Table 25: Sensor parameters of the specific models

Sensor parameters of:

MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 2856 x 2848 | [px] |
| Active area size (H X V) | 7.82 x 7.8 | [mm] |
| Sensor diagonal | 11.1 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [μm] |

Table 26: Sensor parameters of the specific models

Sensor parameters of:

MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL MX089CG-SY-X2G2-FV MX089MG-SY-X2G2-FF
MX089MG-SY-X2G2-FL MX089MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 4112 x 2176 | [px] |
| Active area size (H X V) | 14.2 x 7.5 | [mm] |
| Sensor diagonal | 16.1 | [mm] |
| Pixel size (H x V) | 3.45 x 3.45 | [μm] |

Table 27: Sensor parameters of the specific models

Sensor parameters of:

MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FL
MX124CG-SY-PG4-X2G2-FV-HDR MX124CG-SY-PG4-X2G2-FV MX124MG-SY-PG4-X2G2-FF MX124MG-SY-PG4-X2G2-FF-HDR
MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR MX124MG-SY-PG4-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 4128 x 3008 | [px] |
| Active area size (H X V) | 11.31 x 8.42 | [mm] |
| Sensor diagonal | 14.0 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [μm] |

Table 28: Sensor parameters of the specific models

Sensor parameters of:

MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV MX124MG-SY-X2G2-FF
MX124MG-SY-X2G2-FL MX124MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 4112 x 3008 | [px] |
| Active area size (H X V) | 14.2 x 10.4 | [mm] |
| Sensor diagonal | 17.6 | [mm] |
| Pixel size (H x V) | 3.45 x 3.45 | [μm] |

Table 29: Sensor parameters of the specific models

Sensor parameters of:

MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FL MX161CG-SY-X2G2-FV
MX161CG-SY-X2G2-FV-HDR MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FL-HDR
MX161MG-SY-X2G2-FV MX161MG-SY-X2G2-FV-HDR

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 5328 x 3040 | [px] |
| Active area size (H X V) | 14.58 x 8.31 | [mm] |
| Sensor diagonal | 16.8 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [μm] |

Table 30: Sensor parameters of the specific models

Sensor parameters of:

MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV
MX203CG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FL-HDR
MX203MG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FV

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 4512 x 4512 | [px] |
| Active area size (H X V) | 12.34 x 12.34 | [mm] |
| Sensor diagonal | 17.5 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [μm] |

Table 31: Sensor parameters of the specific models

Sensor parameters of:

MX245CG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV
MX245CG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FL-HDR
MX245MG-SY-X2G2-FV MX245MG-SY-X2G2-FV-HDR

| Description | Value | Unit |
|---|---|---|
| Technology | CMOS | None |
| Pixel resolution (H x V) | 5328 x 4608 | [px] |
| Active area size (H X V) | 14.58 x 12.6 | [mm] |
| Sensor diagonal | 19.3 | [mm] |
| Pixel size (H x V) | 2.74 x 2.74 | [µm] |

Table 32: Sensor parameters of the specific models

## 2.6.2 Image quality parameters

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

Image quality parameters of:
MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 7.78 |
| Absolute sensitivity threshold | [ $e_-$ ] | 8.28 |
| Saturation capacity | [ k$e_-$ ] | 33.11 |
| Dynamic range | [ dB ] | 72.06 |
| MAX Signal-to-noise ratio | [ dB ] | 45.28 |
| Overall system gain | [ $e_-$/DN ] | 8.44 |
| Dark current | [ $e_-$/s ] | 55.5 |
| Dark current meas. temp. | [ °C ] | 60.1 |
| DSNU | [ $e_-$ ] | 1.21 |
| PRNU | [ % ] | 0.39 |
| Linearity error | [ % ] | 2.16 |

Table 33: Image quality parameters of the specific models

Image quality parameters of:
MX023MG-SY-X2G2-FF MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 7.66 |
| Absolute sensitivity threshold | [ $e_-$ ] | 8.16 |
| Saturation capacity | [ k$e_-$ ] | 32.94 |
| Dynamic range | [ dB ] | 72.11 |
| MAX Signal-to-noise ratio | [ dB ] | 45.27 |
| Overall system gain | [ $e_-$/DN ] | 8.39 |
| Dark current | [ $e_-$/s ] | 65.85 |
| Dark current meas. temp. | [ °C ] | 60.7 |
| DSNU | [ $e_-$ ] | 1.24 |
| PRNU | [ % ] | 0.42 |
| Linearity error | [ % ] | 1.98 |

Table 34: Image quality parameters of the specific models

Image quality parameters of:

MX031CG-SY-X2G2-FF MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.39 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.89 |
| Saturation capacity | [ k$e_-$ ] | 10.31 |
| Dynamic range | [ dB ] | 71.11 |
| MAX Signal-to-noise ratio | [ dB ] | 40.6 |
| Overall system gain | [ $e_-$/DN ] | 2.73 |
| Dark current | [ $e_-$/s ] | 32.81 |
| Dark current meas. temp. | [ °C ] | 60.5 |
| DSNU | [ $e_-$ ] | 0.78 |
| PRNU | [ % ] | 0.63 |
| Linearity error | [ % ] | 0.39 |

Table 35: Image quality parameters of the specific models

Image quality parameters of:

MX031MG-SY-X2G2-FF MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.41 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.91 |
| Saturation capacity | [ k$e_-$ ] | 10.64 |
| Dynamic range | [ dB ] | 71.22 |
| MAX Signal-to-noise ratio | [ dB ] | 40.77 |
| Overall system gain | [ $e_-$/DN ] | 2.75 |
| Dark current | [ $e_-$/s ] | 37.06 |
| Dark current meas. temp. | [ °C ] | 60.2 |
| DSNU | [ $e_-$ ] | 0.74 |
| PRNU | [ % ] | 0.57 |
| Linearity error | [ % ] | 0.39 |

Table 36: Image quality parameters of the specific models

Image quality parameters of:
MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV

| Mode | | 10 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 10 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 15.06 |
| Absolute sensitivity threshold | [ $e_-$ ] | 15.56 |
| Saturation capacity | [ k$e_-$ ] | 8.05 |
| Dynamic range | [ dB ] | 53.91 |
| MAX Signal-to-noise ratio | [ dB ] | 39.19 |
| Overall system gain | [ $e_-$/DN ] | 9.64 |
| Dark current | [ $e_-$/s ] | 2895.15 |
| Dark current meas. temp. | [ °C ] | 59.3 |
| DSNU | [ $e_-$ ] | 21.58 |
| PRNU | [ % ] | 1.61 |
| Linearity error | [ % ] | 0.65 |

Table 37: Image quality parameters of the specific models

Image quality parameters of:
MX042MG-CM-X2G2-FF MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV

| Mode | | 10 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 10 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 16.05 |
| Absolute sensitivity threshold | [ $e_-$ ] | 16.55 |
| Saturation capacity | [ k$e_-$ ] | 9.76 |
| Dynamic range | [ dB ] | 55.55 |
| MAX Signal-to-noise ratio | [ dB ] | 40.07 |
| Overall system gain | [ $e_-$/DN ] | 11.92 |
| Dark current | [ $e_-$/s ] | 4264.8 |
| Dark current meas. temp. | [ °C ] | 59.1 |
| DSNU | [ $e_-$ ] | 21.19 |
| PRNU | [ % ] | 1.46 |
| Linearity error | [ % ] | 0.76 |

Table 38: Image quality parameters of the specific models

Image quality parameters of:

MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL MX042RG-CM-X2G2-FV

| Mode | | 10 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 10 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 16.2 |
| Absolute sensitivity threshold | [ $e_-$ ] | 16.7 |
| Saturation capacity | [ k$e_-$ ] | 10.63 |
| Dynamic range | [ dB ] | 56.32 |
| MAX Signal-to-noise ratio | [ dB ] | 40.55 |
| Overall system gain | [ $e_-$/DN ] | 12.44 |
| Dark current | [ $e_-$/s ] | 5715.17 |
| Dark current meas. temp. | [ °C ] | 59.3 |
| DSNU | [ $e_-$ ] | 23.24 |
| PRNU | [ % ] | 1.36 |
| Linearity error | [ % ] | 0.81 |

Table 39: Image quality parameters of the specific models

Image quality parameters of:

MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.44 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.94 |
| Saturation capacity | [ k$e_-$ ] | 10.57 |
| Dynamic range | [ dB ] | 71.12 |
| MAX Signal-to-noise ratio | [ dB ] | 40.73 |
| Overall system gain | [ $e_-$/DN ] | 2.74 |
| Dark current | [ $e_-$/s ] | 36.43 |
| Dark current meas. temp. | [ °C ] | 61.1 |
| DSNU | [ $e_-$ ] | 0.84 |
| PRNU | [ % ] | 0.63 |
| Linearity error | [ % ] | 0.34 |

Table 40: Image quality parameters of the specific models

Image quality parameters of:

MX050MG-SY-X2G2-FF MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.4 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.9 |
| Saturation capacity | [ k$e_-$ ] | 10.54 |
| Dynamic range | [ dB ] | 71.2 |
| MAX Signal-to-noise ratio | [ dB ] | 40.7 |
| Overall system gain | [ $e_-$/DN ] | 2.71 |
| Dark current | [ $e_-$/s ] | 34.29 |
| Dark current meas. temp. | [ °C ] | 60.8 |
| DSNU | [ $e_-$ ] | 0.91 |
| PRNU | [ % ] | 0.63 |
| Linearity error | [ % ] | 0.37 |

Table 41: Image quality parameters of the specific models

Image quality parameters of:

MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FL MX051CG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit |
|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 |
| Parameters | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.88 | 4.88 | 2.69 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.38 | 5.38 | 3.19 |
| Saturation capacity | [ k$e_-$ ] | 2.26 | 9.27 | 9.31 |
| Dynamic range | [ dB ] | 52.48 | 64.74 | 69.31 |
| MAX Signal-to-noise ratio | [ dB ] | 33.57 | 39.97 | 40.03 |
| Overall system gain | [ $e_-$/DN ] | 9.46 | 9.56 | 2.4 |
| Dark current | [ $e_-$/s ] | 21.08 | 28.02 | 29.28 |
| Dark current meas. temp. | [ °C ] | 58.4 | 60.2 | 60.7 |
| DSNU | [ $e_-$ ] | 0.64 | 0.69 | 0.62 |
| PRNU | [ % ] | 0.72 | 0.67 | 0.68 |
| Linearity error | [ % ] | 0.17 | 0.17 | 0.25 |

Table 42: Image quality parameters of the specific models

Image quality parameters of:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 5.0 | 5.06 | 2.71 | 2.11 | 2.19 | 1.88 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.5 | 5.56 | 3.21 | 2.61 | 2.69 | 2.38 |
| Saturation capacity | [ k$e_-$ ] | 2.21 | 9.71 | 9.6 | 2.37 | 9.81 | 9.72 |
| Dynamic range | [ dB ] | 52.08 | 64.84 | 69.51 | 59.19 | 71.25 | 72.24 |
| MAX Signal-to-noise ratio | [ dB ] | 33.02 | 40.03 | 40.04 | 33.8 | 40.23 | 40.12 |
| Overall system gain | [ $e_-$/DN ] | 9.76 | 9.86 | 2.44 | 0.04 | 0.15 | 0.15 |
| Dark current | [ $e_-$/s ] | 45.05 | 36.57 | 35.19 | 33.48 | 52.01 | 33.7 |
| Dark current meas. temp. | [ °C ] | 61.1 | 59.3 | 59.4 | 59.5 | 61.4 | 58.9 |
| DSNU | [ $e_-$ ] | 0.69 | 0.78 | 0.67 | 0.61 | 1.14 | 1.02 |
| PRNU | [ % ] | 0.47 | 0.4 | 0.38 | 0.42 | 0.34 | 0.34 |
| Linearity error | [ % ] | 0.49 | 0.37 | 0.11 | 0.34 | 0.7 | 0.28 |

Table 43: Image quality parameters of the specific models

Image quality parameters of:

MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit | 12 bit bin 2x2 |
|---|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. | - |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 | None |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | | | | |
| Temporal dark noise | [ $e^-$ ] | 5.0 | 5.06 | 2.71 | 2.11 | 2.19 | 1.88 | 2.86 |
| Absolute sensitivity threshold | [ $e^-$ ] | 5.5 | 5.56 | 3.21 | 2.61 | 2.69 | 2.38 | 3.36 |
| Saturation capacity | [ k$e^-$ ] | 2.21 | 9.71 | 9.6 | 2.37 | 9.81 | 9.72 | 9.41 |
| Dynamic range | [ dB ] | 52.08 | 64.84 | 69.51 | 59.19 | 71.25 | 72.24 | 68.95 |
| MAX Signal-to-noise ratio | [ dB ] | 33.02 | 40.03 | 40.04 | 33.8 | 40.23 | 40.12 | 39.81 |
| Overall system gain | [ $e^-$/DN ] | 9.76 | 9.86 | 2.44 | 0.04 | 0.15 | 0.15 | 2.44 |
| Dark current | [ $e^-$/s ] | 45.05 | 36.57 | 35.19 | 33.48 | 52.01 | 33.7 | 174.49 |
| Dark current meas. temp. | [ °C ] | 61.1 | 59.3 | 59.4 | 59.5 | 61.4 | 58.9 | 60.9 |
| DSNU | [ $e^-$ ] | 0.69 | 0.78 | 0.67 | 0.61 | 1.14 | 1.02 | 0.87 |
| PRNU | [ % ] | 0.47 | 0.4 | 0.38 | 0.42 | 0.34 | 0.34 | 0.69 |
| Linearity error | [ % ] | 0.49 | 0.37 | 0.11 | 0.34 | 0.7 | 0.28 | 0.12 |

Table 44: Image quality parameters of the specific models

Image quality parameters of:

MX051MG-SY-PG4-X2G2-FF MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit | 12 bit binning 2x2 |
|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 12 |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.9 | 5.13 | 2.67 | 2.77 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.4 | 5.63 | 3.17 | 3.27 |
| Saturation capacity | [ k$e_-$ ] | 2.27 | 9.52 | 9.5 | 9.46 |
| Dynamic range | [ dB ] | 52.46 | 64.56 | 69.52 | 69.22 |
| MAX Signal-to-noise ratio | [ dB ] | 33.57 | 40.05 | 40.0 | 39.79 |
| Overall system gain | [ $e_-$/DN ] | 9.48 | 9.69 | 2.44 | 2.43 |
| Dark current | [ $e_-$/s ] | 19.45 | 16.22 | 21.98 | 73.95 |
| Dark current meas. temp. | [ °C ] | 60.2 | 58.6 | 60.4 | 59.2 |
| DSNU | [ $e_-$ ] | 0.63 | 0.68 | 0.53 | 0.79 |
| PRNU | [ % ] | 0.55 | 0.48 | 0.47 | 0.46 |
| Linearity error | [ % ] | 0.28 | 0.14 | 0.22 | 0.16 |

Table 45: Image quality parameters of the specific models

Image quality parameters of:

MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.97 | 5.03 | 2.66 | 1.79 | 2.12 | 1.82 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.47 | 5.53 | 3.16 | 2.29 | 2.62 | 2.32 |
| Saturation capacity | [ k$e_-$ ] | 2.27 | 9.35 | 9.38 | 2.31 | 9.53 | 9.55 |
| Dynamic range | [ dB ] | 52.36 | 64.56 | 69.44 | 60.08 | 71.2 | 72.29 |
| MAX Signal-to-noise ratio | [ dB ] | 33.57 | 39.99 | 40.01 | 33.63 | 40.13 | 40.11 |
| Overall system gain | [ $e_-$/DN ] | 9.55 | 9.55 | 2.4 | 0.04 | 0.15 | 0.15 |
| Dark current | [ $e_-$/s ] | 29.11 | 24.73 | 25.37 | 19.33 | 27.54 | 27.61 |
| Dark current meas. temp. | [ °C ] | 61.2 | 59.8 | 59.4 | 60.0 | 60.9 | 60.7 |
| DSNU | [ $e_-$ ] | 0.89 | 1.32 | 1.25 | 1.2 | 2.32 | 2.32 |
| PRNU | [ % ] | 0.6 | 0.48 | 0.48 | 0.55 | 0.47 | 0.46 |
| Linearity error | [ % ] | 0.15 | 0.28 | 0.28 | 0.31 | 0.5 | 0.17 |

Table 46: Image quality parameters of the specific models

Image quality parameters of:

MX081CG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit |
|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 |
| Parameters | | | | |
| Temporal dark noise | [ $e_-$ ] | 5.04 | 5.12 | 2.68 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.54 | 5.62 | 3.18 |
| Saturation capacity | [ k$e_-$ ] | 2.23 | 9.41 | 9.53 |
| Dynamic range | [ dB ] | 52.09 | 64.47 | 69.52 |
| MAX Signal-to-noise ratio | [ dB ] | 33.43 | 39.96 | 40.02 |
| Overall system gain | [ $e_-$/DN ] | 9.49 | 9.64 | 2.44 |
| Dark current | [ $e_-$/s ] | 20.04 | 24.65 | 23.64 |
| Dark current meas. temp. | [ °C ] | 59.2 | 59.9 | 58.9 |
| DSNU | [ $e_-$ ] | 0.96 | 1.15 | 1.19 |
| PRNU | [ % ] | 0.59 | 0.52 | 0.52 |
| Linearity error | [ % ] | 0.25 | 0.14 | 0.24 |

Table 47: Image quality parameters of the specific models

Image quality parameters of:

MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit | bin 2x2 12 bit |
|---|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. | - |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 | None |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.97 | 5.03 | 2.66 | 1.79 | 2.12 | 1.82 | 2.8 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.47 | 5.53 | 3.16 | 2.29 | 2.62 | 2.32 | 3.3 |
| Saturation capacity | [ k$e_-$ ] | 2.27 | 9.35 | 9.38 | 2.31 | 9.53 | 9.55 | 9.45 |
| Dynamic range | [ dB ] | 52.36 | 64.56 | 69.44 | 60.08 | 71.2 | 72.29 | 69.13 |
| MAX Signal-to-noise ratio | [ dB ] | 33.57 | 39.99 | 40.01 | 33.63 | 40.13 | 40.11 | 39.88 |
| Overall system gain | [ $e_-$/DN ] | 9.55 | 9.55 | 2.4 | 0.04 | 0.15 | 0.15 | 2.4 |
| Dark current | [ $e_-$/s ] | 29.11 | 24.73 | 25.37 | 19.33 | 27.54 | 27.61 | 99.77 |
| Dark current meas. temp. | [ °C ] | 61.2 | 59.8 | 59.4 | 60.0 | 60.9 | 60.7 | 59.6 |
| DSNU | [ $e_-$ ] | 0.89 | 1.32 | 1.25 | 1.2 | 2.32 | 2.32 | 1.03 |
| PRNU | [ % ] | 0.6 | 0.48 | 0.48 | 0.55 | 0.47 | 0.46 | 0.48 |
| Linearity error | [ % ] | 0.15 | 0.28 | 0.28 | 0.31 | 0.5 | 0.17 | 0.19 |

Table 48: Image quality parameters of the specific models

Image quality parameters of:

MX081MG-SY-PG4-X2G2-FF MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit | 12 bit binning 2x2 |
|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 12 |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | |
| Temporal dark noise | [ $e_-$ ] | 5.04 | 5.12 | 2.68 | 2.81 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.54 | 5.62 | 3.18 | 3.31 |
| Saturation capacity | [ k$e_-$ ] | 2.23 | 9.41 | 9.53 | 9.57 |
| Dynamic range | [ dB ] | 52.09 | 64.47 | 69.52 | 69.22 |
| MAX Signal-to-noise ratio | [ dB ] | 33.43 | 39.96 | 40.02 | 39.92 |
| Overall system gain | [ $e_-$/DN ] | 9.49 | 9.64 | 2.44 | 2.43 |
| Dark current | [ $e_-$/s ] | 20.04 | 24.65 | 23.64 | 82.84 |
| Dark current meas. temp. | [ °C ] | 59.2 | 59.9 | 58.9 | 59.1 |
| DSNU | [ $e_-$ ] | 0.96 | 1.15 | 1.19 | 1.02 |
| PRNU | [ % ] | 0.59 | 0.52 | 0.52 | 0.51 |
| Linearity error | [ % ] | 0.25 | 0.14 | 0.24 | 0.14 |

Table 49: Image quality parameters of the specific models

Image quality parameters of:

MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit | 12 bit bin 2x2 |
|---|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. | - |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 | None |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | | | | |
| Temporal dark noise | [ $e^-$ ] | 4.45 | 5.16 | 2.77 | 1.48 | 2.07 | 1.99 | 2.97 |
| Absolute sensitivity threshold | [ $e^-$ ] | 4.95 | 5.66 | 3.27 | 1.98 | 2.57 | 2.49 | 3.47 |
| Saturation capacity | [ k$e^-$ ] | 2.31 | 9.35 | 9.39 | 2.36 | 9.48 | 9.51 | 9.55 |
| Dynamic range | [ dB ] | 53.46 | 64.36 | 69.16 | 61.53 | 71.36 | 71.64 | 68.79 |
| MAX Signal-to-noise ratio | [ dB ] | 33.63 | 39.85 | 39.89 | 33.77 | 39.94 | 39.95 | 39.88 |
| Overall system gain | [ $e^-$/DN ] | 9.67 | 9.67 | 2.43 | 0.04 | 0.15 | 0.15 | 2.44 |
| Dark current | [ $e^-$/s ] | 9.26 | 4.74 | 7.41 | 7.73 | 8.05 | 8.31 | 28.84 |
| Dark current meas. temp. | [ °C ] | 61.3 | 60.3 | 61.4 | 61.5 | 61.1 | 61.2 | 61.3 |
| DSNU | [ $e^-$ ] | 1.64 | 1.17 | 1.06 | 1.02 | 1.79 | 1.81 | 1.17 |
| PRNU | [ % ] | 1.45 | 0.75 | 0.74 | 2.62 | 1.31 | 1.32 | 0.84 |
| Linearity error | [ % ] | 0.34 | 0.2 | 0.1 | 0.42 | 0.42 | 0.09 | 0.14 |

Table 50: Image quality parameters of the specific models

Image quality parameters of:

MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL MX089CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e^-$ ] | 2.41 |
| Absolute sensitivity threshold | [ $e^-$ ] | 2.91 |
| Saturation capacity | [ k$e^-$ ] | 10.25 |
| Dynamic range | [ dB ] | 70.92 |
| MAX Signal-to-noise ratio | [ dB ] | 40.62 |
| Overall system gain | [ $e^-$/DN ] | 2.67 |
| Dark current | [ $e^-$/s ] | 37.44 |
| Dark current meas. temp. | [ °C ] | 60.9 |
| DSNU | [ $e^-$ ] | 1.37 |
| PRNU | [ % ] | 0.63 |
| Linearity error | [ % ] | 0.61 |

Table 51: Image quality parameters of the specific models

Image quality parameters of:
MX089MG-SY-X2G2-FF MX089MG-SY-X2G2-FL MX089MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.44 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.94 |
| Saturation capacity | [ k$e_-$ ] | 10.4 |
| Dynamic range | [ dB ] | 70.98 |
| MAX Signal-to-noise ratio | [ dB ] | 40.71 |
| Overall system gain | [ $e_-$/DN ] | 2.66 |
| Dark current | [ $e_-$/s ] | 33.54 |
| Dark current meas. temp. | [ °C ] | 59.8 |
| DSNU | [ $e_-$ ] | 1.11 |
| PRNU | [ % ] | 0.58 |
| Linearity error | [ % ] | 0.41 |

Table 52: Image quality parameters of the specific models

Image quality parameters of:
MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.97 | 4.73 | 2.55 | 1.31 | 2.04 | 1.65 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.47 | 5.23 | 3.05 | 1.81 | 2.54 | 2.15 |
| Saturation capacity | [ k$e_-$ ] | 2.28 | 9.0 | 9.06 | 2.3 | 9.12 | 9.09 |
| Dynamic range | [ dB ] | 52.38 | 64.71 | 69.44 | 62.06 | 71.11 | 72.51 |
| MAX Signal-to-noise ratio | [ dB ] | 33.47 | 39.79 | 39.86 | 33.63 | 39.86 | 39.97 |
| Overall system gain | [ $e_-$/DN ] | 9.61 | 9.2 | 2.33 | 0.04 | 0.15 | 0.14 |
| Dark current | [ $e_-$/s ] | 22.94 | 23.05 | 18.56 | 17.92 | 18.85 | 18.92 |
| Dark current meas. temp. | [ °C ] | 61.3 | 59.7 | 59.6 | 60.8 | 60.7 | 61.4 |
| DSNU | [ $e_-$ ] | 1.06 | 1.99 | 1.51 | 1.47 | 2.63 | 2.63 |
| PRNU | [ % ] | 0.68 | 0.6 | 0.53 | 0.7 | 0.61 | 0.6 |
| Linearity error | [ % ] | 0.22 | 0.31 | 0.35 | 0.32 | 0.54 | 0.18 |

Table 53: Image quality parameters of the specific models

Image quality parameters of:

MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL MX124CG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit |
|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 |
| Parameters | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.65 | 4.86 | 2.57 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.15 | 5.36 | 3.07 |
| Saturation capacity | [ k$e_-$ ] | 2.17 | 8.99 | 9.06 |
| Dynamic range | [ dB ] | 52.5 | 64.49 | 69.41 |
| MAX Signal-to-noise ratio | [ dB ] | 33.33 | 39.73 | 39.82 |
| Overall system gain | [ $e_-$/DN ] | 9.28 | 9.14 | 2.32 |
| Dark current | [ $e_-$/s ] | 27.8 | 19.82 | 27.28 |
| Dark current meas. temp. | [ °C ] | 60.5 | 59.0 | 60.8 |
| DSNU | [ $e_-$ ] | 1.04 | 1.14 | 1.36 |
| PRNU | [ % ] | 0.73 | 0.66 | 0.65 |
| Linearity error | [ % ] | 0.21 | 0.1 | 0.16 |

Table 54: Image quality parameters of the specific models

Image quality parameters of:

MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.46 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.96 |
| Saturation capacity | [ k$e_-$ ] | 10.52 |
| Dynamic range | [ dB ] | 70.98 |
| MAX Signal-to-noise ratio | [ dB ] | 40.82 |
| Overall system gain | [ $e_-$/DN ] | 2.69 |
| Dark current | [ $e_-$/s ] | 32.6 |
| Dark current meas. temp. | [ °C ] | 60.5 |
| DSNU | [ $e_-$ ] | 1.34 |
| PRNU | [ % ] | 0.62 |
| Linearity error | [ % ] | 0.42 |

Table 55: Image quality parameters of the specific models

Image quality parameters of:

MX124MG-SY-PG4-X2G2-FF MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FV

| Mode | | 8 bit | 10 bit | 12 bit | 12 bit binning 2x2 |
|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 12 |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.65 | 4.86 | 2.57 | 2.68 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.15 | 5.36 | 3.07 | 3.18 |
| Saturation capacity | [ k$e_-$ ] | 2.17 | 8.99 | 9.06 | 9.14 |
| Dynamic range | [ dB ] | 52.5 | 64.49 | 69.41 | 69.17 |
| MAX Signal-to-noise ratio | [ dB ] | 33.33 | 39.73 | 39.82 | 39.75 |
| Overall system gain | [ $e_-$/DN ] | 9.28 | 9.14 | 2.32 | 2.32 |
| Dark current | [ $e_-$/s ] | 27.8 | 19.82 | 27.28 | 97.62 |
| Dark current meas. temp. | [ °C ] | 60.5 | 59.0 | 60.8 | 60.2 |
| DSNU | [ $e_-$ ] | 1.04 | 1.14 | 1.36 | 1.05 |
| PRNU | [ % ] | 0.73 | 0.66 | 0.65 | 0.64 |
| Linearity error | [ % ] | 0.21 | 0.1 | 0.16 | 0.11 |

Table 56: Image quality parameters of the specific models

Image quality parameters of:

MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | 8 bit Dual ADC | 10 bit Dual ADC | 12 bit Dual ADC | 12 bit bin 2x2 |
|---|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. | - |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 | None |
| Binning (Hor.x Ver.) | - | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 1 x 1 | 2 x 1 |
| Parameters | | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.97 | 4.73 | 2.55 | 1.31 | 2.04 | 1.65 | 2.72 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.47 | 5.23 | 3.05 | 1.81 | 2.54 | 2.15 | 3.22 |
| Saturation capacity | [ k$e_-$ ] | 2.28 | 9.0 | 9.06 | 2.3 | 9.12 | 9.09 | 9.04 |
| Dynamic range | [ dB ] | 52.38 | 64.71 | 69.44 | 62.06 | 71.11 | 72.51 | 68.97 |
| MAX Signal-to-noise ratio | [ dB ] | 33.47 | 39.79 | 39.86 | 33.63 | 39.86 | 39.97 | 39.73 |
| Overall system gain | [ $e_-$/DN ] | 9.61 | 9.2 | 2.33 | 0.04 | 0.15 | 0.14 | 2.31 |
| Dark current | [ $e_-$/s ] | 22.94 | 23.05 | 18.56 | 17.92 | 18.85 | 18.92 | 91.62 |
| Dark current meas. temp. | [ °C ] | 61.3 | 59.7 | 59.6 | 60.8 | 60.7 | 61.4 | 59.8 |
| DSNU | [ $e_-$ ] | 1.06 | 1.99 | 1.51 | 1.47 | 2.63 | 2.63 | 1.15 |
| PRNU | [ % ] | 0.68 | 0.6 | 0.53 | 0.7 | 0.61 | 0.6 | 0.59 |
| Linearity error | [ % ] | 0.22 | 0.31 | 0.35 | 0.32 | 0.54 | 0.18 | 0.15 |

Table 57: Image quality parameters of the specific models

Image quality parameters of:

MX124MG-SY-X2G2-FF MX124MG-SY-X2G2-FL MX124MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.44 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.94 |
| Saturation capacity | [ k$e_-$ ] | 10.46 |
| Dynamic range | [ dB ] | 71.01 |
| MAX Signal-to-noise ratio | [ dB ] | 40.72 |
| Overall system gain | [ $e_-$/DN ] | 2.69 |
| Dark current | [ $e_-$/s ] | 35.26 |
| Dark current meas. temp. | [ °C ] | 60.2 |
| DSNU | [ $e_-$ ] | 1.51 |
| PRNU | [ % ] | 0.6 |
| Linearity error | [ % ] | 0.37 |

Table 58: Image quality parameters of the specific models

Image quality parameters of:

MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | None | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 16.0 | 16.0 | 16.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.79 | 5.12 | 2.35 | 1.59 | 2.16 | 1.72 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.29 | 5.62 | 2.85 | 2.09 | 2.66 | 2.22 |
| Saturation capacity | [ k$e_-$ ] | 2.38 | 9.89 | 9.31 | 2.3 | 9.68 | 9.22 |
| Dynamic range | [ dB ] | 53.06 | 64.91 | 70.3 | 60.84 | 71.23 | 72.36 |
| MAX Signal-to-noise ratio | [ dB ] | 33.74 | 40.37 | 40.2 | 33.65 | 40.26 | 40.13 |
| Overall system gain | [ $e_-$/DN ] | 0.04 | 0.16 | 2.4 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 23.18 | 20.22 | 22.53 | 12.4 | 26.78 | 32.39 |
| Dark current meas. temp. | [ °C ] | 59.8 | 60.4 | 60.6 | 58.9 | 61.1 | 61.6 |
| DSNU | [ $e_-$ ] | 1.29 | 1.26 | 1.32 | 1.22 | 2.42 | 2.42 |
| PRNU | [ % ] | 0.89 | 0.83 | 0.69 | 0.84 | 0.81 | 0.82 |
| Linearity error | [ % ] | 0.56 | 0.4 | 0.18 | 1.54 | 0.48 | 0.22 |

Table 59: Image quality parameters of the specific models

Image quality parameters of:

MX161CG-SY-X2G2-FL MX161CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.36 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.86 |
| Saturation capacity | [ k$e_-$ ] | 9.46 |
| Dynamic range | [ dB ] | 70.4 |
| MAX Signal-to-noise ratio | [ dB ] | 40.3 |
| Overall system gain | [ $e_-$/DN ] | 2.43 |
| Dark current | [ $e_-$/s ] | 20.21 |
| Dark current meas. temp. | [ °C ] | 60.8 |
| DSNU | [ $e_-$ ] | 1.45 |
| PRNU | [ % ] | 0.73 |
| Linearity error | [ % ] | 0.46 |

Table 60: Image quality parameters of the specific models

Image quality parameters of:
MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL-HDR MX161MG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | None | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.93 | 5.17 | 2.36 | 1.46 | 2.08 | 1.77 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.43 | 5.67 | 2.86 | 1.96 | 2.58 | 2.27 |
| Saturation capacity | [ k$e_-$ ] | 2.33 | 9.89 | 9.46 | 2.34 | 9.92 | 9.39 |
| Dynamic range | [ dB ] | 52.64 | 64.83 | 70.4 | 61.54 | 71.71 | 72.34 |
| MAX Signal-to-noise ratio | [ dB ] | 33.46 | 40.42 | 40.29 | 33.65 | 40.46 | 40.24 |
| Overall system gain | [ $e_-$/DN ] | 10.13 | 10.2 | 2.42 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 10.91 | 10.37 | 23.17 | 17.47 | 21.82 | 19.64 |
| Dark current meas. temp. | [ °C ] | 52.0 | 52.4 | 60.4 | 60.6 | 61.3 | 60.2 |
| DSNU | [ $e_-$ ] | 1.0 | 1.46 | 1.71 | 1.57 | 3.34 | 3.22 |
| PRNU | [ % ] | 0.82 | 0.75 | 0.5 | 0.65 | 0.6 | 0.6 |
| Linearity error | [ % ] | 0.87 | 0.4 | 0.17 | 0.62 | 0.24 | 0.52 |

Table 61: Image quality parameters of the specific models

Image quality parameters of:
MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.41 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.91 |
| Saturation capacity | [ k$e_-$ ] | 9.33 |
| Dynamic range | [ dB ] | 70.12 |
| MAX Signal-to-noise ratio | [ dB ] | 40.11 |
| Overall system gain | [ $e_-$/DN ] | 2.38 |
| Dark current | [ $e_-$/s ] | 25.91 |
| Dark current meas. temp. | [ °C ] | 59.9 |
| DSNU | [ $e_-$ ] | 1.73 |
| PRNU | [ % ] | 0.81 |
| Linearity error | [ % ] | 0.41 |

Table 62: Image quality parameters of the specific models

Image quality parameters of:

MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| **Parameters** | | |
| Temporal dark noise | [ $e_-$ ] | 2.37 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.87 |
| Saturation capacity | [ k$e_-$ ] | 9.49 |
| Dynamic range | [ dB ] | 70.45 |
| MAX Signal-to-noise ratio | [ dB ] | 40.53 |
| Overall system gain | [ $e_-$/DN ] | 2.42 |
| Dark current | [ $e_-$/s ] | 16.88 |
| Dark current meas. temp. | [ °C ] | 60.8 |
| DSNU | [ $e_-$ ] | 1.36 |
| PRNU | [ % ] | 0.64 |
| Linearity error | [ % ] | 0.61 |

Table 63: Image quality parameters of the specific models

Image quality parameters of:

MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | None | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| **Parameters** | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.87 | 5.32 | 2.33 | 1.58 | 2.12 | 1.77 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.37 | 5.82 | 2.83 | 2.08 | 2.62 | 2.27 |
| Saturation capacity | [ k$e_-$ ] | 2.46 | 10.04 | 9.29 | 2.43 | 10.12 | 9.48 |
| Dynamic range | [ dB ] | 53.23 | 64.73 | 70.31 | 61.35 | 71.75 | 72.43 |
| MAX Signal-to-noise ratio | [ dB ] | 33.85 | 40.57 | 40.15 | 33.85 | 40.61 | 40.37 |
| Overall system gain | [ $e_-$/DN ] | 10.33 | 10.36 | 2.42 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 33.02 | 29.58 | 26.58 | 14.38 | 25.82 | 22.86 |
| Dark current meas. temp. | [ °C ] | 61.8 | 62.2 | 60.3 | 59.0 | 61.1 | 61.4 |
| DSNU | [ $e_-$ ] | 1.57 | 3.25 | 2.07 | 2.19 | 5.14 | 4.73 |
| PRNU | [ % ] | 0.85 | 0.81 | 0.7 | 0.82 | 0.8 | 0.81 |
| Linearity error | [ % ] | 0.69 | 0.36 | 0.25 | 0.62 | 0.29 | 0.39 |

Table 64: Image quality parameters of the specific models

Image quality parameters of:

MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| **Parameters** | | |
| Temporal dark noise | [ $e_-$ ] | 2.39 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.89 |
| Saturation capacity | [ k$e_-$ ] | 9.54 |
| Dynamic range | [ dB ] | 70.42 |
| MAX Signal-to-noise ratio | [ dB ] | 40.57 |
| Overall system gain | [ $e_-$/DN ] | 2.45 |
| Dark current | [ $e_-$/s ] | 22.14 |
| Dark current meas. temp. | [ °C ] | 60.4 |
| DSNU | [ $e_-$ ] | 1.93 |
| PRNU | [ % ] | 0.69 |
| Linearity error | [ % ] | 0.66 |

Table 65: Image quality parameters of the specific models

Image quality parameters of:

MX203MG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| **Parameters** | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.84 | 5.32 | 2.4 | 1.45 | 2.09 | 1.79 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.34 | 5.82 | 2.9 | 1.95 | 2.59 | 2.29 |
| Saturation capacity | [ k$e_-$ ] | 2.42 | 10.11 | 9.52 | 2.4 | 9.98 | 9.45 |
| Dynamic range | [ dB ] | 53.11 | 64.8 | 70.33 | 61.79 | 71.73 | 72.3 |
| MAX Signal-to-noise ratio | [ dB ] | 33.81 | 40.58 | 40.33 | 33.85 | 40.44 | 40.24 |
| Overall system gain | [ $e_-$/DN ] | 10.09 | 10.3 | 2.43 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 33.31 | 37.64 | 26.49 | 14.72 | 26.91 | 27.87 |
| Dark current meas. temp. | [ °C ] | 62.0 | 63.3 | 61.6 | 58.8 | 60.5 | 61.9 |
| DSNU | [ $e_-$ ] | 1.57 | 2.98 | 2.57 | 2.09 | 4.93 | 4.79 |
| PRNU | [ % ] | 0.62 | 0.53 | 0.53 | 0.65 | 0.54 | 0.54 |
| Linearity error | [ % ] | 0.76 | 0.32 | 0.21 | 0.79 | 0.2 | 0.21 |

Table 66: Image quality parameters of the specific models

Image quality parameters of:

MX245CG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | - | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 5.11 | 5.27 | 2.36 | 1.42 | 2.08 | 1.76 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.61 | 5.77 | 2.86 | 1.92 | 2.58 | 2.26 |
| Saturation capacity | [ k$e_-$ ] | 2.45 | 10.17 | 9.27 | 2.45 | 10.09 | 9.51 |
| Dynamic range | [ dB ] | 52.82 | 64.92 | 70.23 | 62.1 | 71.86 | 72.47 |
| MAX Signal-to-noise ratio | [ dB ] | 33.82 | 40.42 | 40.12 | 33.9 | 40.34 | 40.19 |
| Overall system gain | [ $e_-$/DN ] | 10.32 | 10.42 | 0.15 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 23.71 | 25.12 | 19.4 | 15.71 | 22.47 | 24.12 |
| Dark current meas. temp. | [ °C ] | 59.9 | 61.1 | 59.5 | 59.3 | 60.4 | 61.3 |
| DSNU | [ $e_-$ ] | 1.51 | 2.64 | 1.65 | 2.31 | 4.59 | 4.5 |
| PRNU | [ % ] | 0.91 | 0.87 | 0.95 | 0.89 | 0.86 | 0.87 |
| Linearity error | [ % ] | 0.71 | 0.33 | 0.17 | 0.69 | 0.19 | 0.22 |

Table 67: Image quality parameters of the specific models

Image quality parameters of:

MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.34 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.84 |
| Saturation capacity | [ k$e_-$ ] | 9.46 |
| Dynamic range | [ dB ] | 70.47 |
| MAX Signal-to-noise ratio | [ dB ] | 40.41 |
| Overall system gain | [ $e_-$/DN ] | 2.42 |
| Dark current | [ $e_-$/s ] | 17.36 |
| Dark current meas. temp. | [ °C ] | 59.6 |
| DSNU | [ $e_-$ ] | 2.17 |
| PRNU | [ % ] | 0.71 |
| Linearity error | [ % ] | 0.53 |

Table 68: Image quality parameters of the specific models

Image quality parameters of:

MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL-HDR MX245MG-SY-X2G2-FV-HDR

| Mode | | 8 bit | 10 bit | 12 bit | Dual ADC 8 bit | Dual ADC 10 bit | Dual ADC 12 bit |
|---|---|---|---|---|---|---|---|
| Sensor bit/px | [ bit/px ] | 8 | 10 | 12 | 8 | 10 | 12 |
| Dual ADC | - | - | - | None | Non-Comb. | Non-Comb. | Non-Comb. |
| Gain Ratio | [ dB ] | None | None | None | 24.0 | 24.0 | 24.0 |
| Parameters | | | | | | | |
| Temporal dark noise | [ $e_-$ ] | 4.81 | 5.16 | 2.35 | 1.45 | 2.14 | 1.84 |
| Absolute sensitivity threshold | [ $e_-$ ] | 5.31 | 5.66 | 2.85 | 1.95 | 2.64 | 2.34 |
| Saturation capacity | [ k$e_-$ ] | 2.42 | 9.99 | 9.46 | 2.39 | 10.03 | 9.43 |
| Dynamic range | [ dB ] | 53.16 | 64.93 | 70.42 | 61.77 | 71.61 | 72.09 |
| MAX Signal-to-noise ratio | [ dB ] | 33.77 | 40.51 | 40.31 | 33.76 | 40.53 | 40.28 |
| Overall system gain | [ $e_-$/DN ] | 10.14 | 10.26 | 2.41 | 0.04 | 0.16 | 0.15 |
| Dark current | [ $e_-$/s ] | 23.81 | 27.15 | 25.27 | 14.53 | 24.08 | 23.63 |
| Dark current meas. temp. | [ °C ] | 60.2 | 61.8 | 60.9 | 59.9 | 61.3 | 61.6 |
| DSNU | [ $e_-$ ] | 1.66 | 3.25 | 1.6 | 2.52 | 5.62 | 5.42 |
| PRNU | [ % ] | 0.58 | 0.56 | 0.67 | 0.53 | 0.53 | 0.54 |
| Linearity error | [ % ] | 0.46 | 0.31 | 0.21 | 0.63 | 0.25 | 0.24 |

Table 69: Image quality parameters of the specific models

Image quality parameters of:

MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FV

| Mode | | 12 bit |
|---|---|---|
| Sensor bit/px | [ bit/px ] | 12 |
| Parameters | | |
| Temporal dark noise | [ $e_-$ ] | 2.31 |
| Absolute sensitivity threshold | [ $e_-$ ] | 2.81 |
| Saturation capacity | [ k$e_-$ ] | 9.3 |
| Dynamic range | [ dB ] | 70.38 |
| MAX Signal-to-noise ratio | [ dB ] | 39.99 |
| Overall system gain | [ $e_-$/DN ] | 2.38 |
| Dark current | [ $e_-$/s ] | 16.77 |
| Dark current meas. temp. | [ °C ] | 60.4 |
| DSNU | [ $e_-$ ] | 2.56 |
| PRNU | [ % ] | 0.48 |
| Linearity error | [ % ] | 0.5 |

Table 70: Image quality parameters of the specific models

### 2.6.3 Sensor read-out modes

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

Sensor Read-out modes of:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 10 | 1936 x 1216 | 8 | 166.1 |
| 1 x 1 | 10 | 1936 x 1216 | 10 | 166.1 |
| 1 x 1 | 12 | 1936 x 1216 | 12 | 129.5 |
| 1 x 1 | 12 | 1936 x 1216 | 16 | 129.5 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 71: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX023MG-SY-X2G2-FF MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 10 | 1936 x 1216 | 8 | 166.1 |
| Dec.2 x 2 | 10 | 968 x 608 | 8 | 323.5 |
| 1 x 1 | 10 | 1936 x 1216 | 10 | 166.1 |
| Dec.2 x 2 | 10 | 968 x 608 | 10 | 323.5 |
| 1 x 1 | 12 | 1936 x 1216 | 12 | 129.5 |
| Dec.2 x 2 | 12 | 968 x 608 | 12 | 252.1 |
| 1 x 1 | 12 | 1936 x 1216 | 16 | 129.5 |
| Dec.2 x 2 | 12 | 968 x 608 | 16 | 252.1 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 72: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX031CG-SY-X2G2-FF MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2064 x 1544 | 8 | 218.5 |
| Dec.2 x 1 | 8 | 1032 x 1544 | 8 | 218.5 |
| Dec.1 x 2 | 8 | 2064 x 772 | 8 | 426.7 |
| Dec.2 x 2 | 8 | 1032 x 772 | 8 | 426.7 |
| 1 x 1 | 10 | 2064 x 1544 | 10 | 193.5 |
| Dec.2 x 1 | 10 | 1032 x 1544 | 10 | 193.5 |
| Dec.1 x 2 | 10 | 2064 x 772 | 10 | 377.9 |
| Dec.2 x 2 | 10 | 1032 x 772 | 10 | 377.9 |
| 1 x 1 | 12 | 2064 x 1544 | 12 | 119.7 |
| Dec.2 x 1 | 12 | 1032 x 1544 | 12 | 119.7 |
| Dec.1 x 2 | 12 | 2064 x 772 | 12 | 233.8 |
| Dec.2 x 2 | 12 | 1032 x 772 | 12 | 233.8 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 73: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX031MG-SY-X2G2-FF MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2064 x 1544 | 8 | 218.5 |
| Dec.2 x 1 | 8 | 1032 x 1544 | 8 | 218.5 |
| Dec.1 x 2 | 8 | 2064 x 772 | 8 | 426.7 |
| Dec.2 x 2 | 8 | 1032 x 772 | 8 | 426.7 |
| Bin.1 x 2 | 8 | 2064 x 772 | 8 | 426.7 |
| Bin.1 x 2, Dec.2 x 1 | 8 | 1032 x 772 | 8 | 426.7 |
| 1 x 1 | 10 | 2064 x 1544 | 10 | 193.5 |
| Dec.2 x 1 | 10 | 1032 x 1544 | 10 | 193.5 |
| Dec.1 x 2 | 10 | 2064 x 772 | 10 | 377.9 |
| Dec.2 x 2 | 10 | 1032 x 772 | 10 | 377.9 |
| Bin.1 x 2 | 10 | 2064 x 772 | 10 | 377.9 |
| Bin.1 x 2, Dec.2 x 1 | 10 | 1032 x 772 | 10 | 377.9 |
| 1 x 1 | 12 | 2064 x 1544 | 12 | 119.7 |
| Dec.2 x 1 | 12 | 1032 x 1544 | 12 | 119.7 |
| Dec.1 x 2 | 12 | 2064 x 772 | 12 | 233.8 |
| Dec.2 x 2 | 12 | 1032 x 772 | 12 | 233.8 |
| Bin.1 x 2 | 12 | 2064 x 772 | 12 | 233.8 |
| Bin.1 x 2, Dec.2 x 1 | 12 | 1032 x 772 | 12 | 233.8 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 74: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FF
MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL
MX042RG-CM-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 10 | 2048 x 2048 | 8 | 180.7 |
| 1 x 1 | 10 | 2048 x 2048 | 10 | 170.8 |
| 1 x 1 | 10 | 2048 x 2048 | 12 | 142.4 |
| 1 x 1 | 10 | 2048 x 2048 | 16 | 106.9 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 75: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2464 x 2056 | 8 | 165.1 |
| Dec.2 x 1 | 8 | 1232 x 2056 | 8 | 164.3 |
| Dec.1 x 2 | 8 | 2464 x 1028 | 8 | 324.2 |
| Dec.2 x 2 | 8 | 1232 x 1028 | 8 | 322.7 |
| 1 x 1 | 10 | 2464 x 2056 | 10 | 139.5 |
| Dec.2 x 1 | 10 | 1232 x 2056 | 10 | 137.8 |
| Dec.1 x 2 | 10 | 2464 x 1028 | 10 | 274.1 |
| Dec.2 x 2 | 10 | 1232 x 1028 | 10 | 270.6 |
| 1 x 1 | 12 | 2464 x 2056 | 12 | 90.4 |
| Dec.2 x 1 | 12 | 1232 x 2056 | 12 | 90.4 |
| Dec.1 x 2 | 12 | 2464 x 1028 | 12 | 177.7 |
| Dec.2 x 2 | 12 | 1232 x 1028 | 12 | 177.7 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 76: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX050MG-SY-X2G2-FF MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2464 x 2056 | 8 | 165.1 |
| Dec.2 x 1 | 8 | 1232 x 2056 | 8 | 164.3 |
| Dec.1 x 2 | 8 | 2464 x 1028 | 8 | 324.2 |
| Dec.2 x 2 | 8 | 1232 x 1028 | 8 | 322.7 |
| Bin.1 x 2 | 8 | 2464 x 1028 | 8 | 324.2 |
| Bin.1 x 2, Dec.2 x 1 | 8 | 1232 x 1028 | 8 | 322.7 |
| 1 x 1 | 10 | 2464 x 2056 | 10 | 139.5 |
| Dec.2 x 1 | 10 | 1232 x 2056 | 10 | 137.8 |
| Dec.1 x 2 | 10 | 2464 x 1028 | 10 | 274.1 |
| Dec.2 x 2 | 10 | 1232 x 1028 | 10 | 270.6 |
| Bin.1 x 2 | 10 | 2464 x 1028 | 10 | 274.1 |
| Bin.1 x 2, Dec.2 x 1 | 10 | 1232 x 1028 | 10 | 270.6 |
| 1 x 1 | 12 | 2464 x 2056 | 12 | 90.4 |
| Dec.2 x 1 | 12 | 1232 x 2056 | 12 | 90.4 |
| Dec.1 x 2 | 12 | 2464 x 1028 | 12 | 177.7 |
| Dec.2 x 2 | 12 | 1232 x 1028 | 12 | 177.7 |
| Bin.1 x 2 | 12 | 2464 x 1028 | 12 | 177.7 |
| Bin.1 x 2, Dec.2 x 1 | 12 | 1232 x 1028 | 12 | 177.7 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 77: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FL MX051CG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2472 x 2064 | 8 | 124.2 |
| 1 x 1 | 10 | 2472 x 2064 | 10 | 109.8 |
| 1 x 1 | 12 | 2472 x 2064 | 12 | 83.3 |
| Dec.2 x 2 | 8 | 1232 x 1032 | 8 | 237.8 |
| Dec.2 x 2 | 10 | 1232 x 1032 | 10 | 227.3 |
| Dec.2 x 2 | 12 | 1232 x 1032 | 12 | 161.2 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 78: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | None | 8 | 2472 x 2064 | 8 | 133.3 |
| 1 x 1 | None | 10 | 2472 x 2064 | 10 | 109.1 |
| 1 x 1 | None | 12 | 2472 x 2064 | 12 | 92.6 |
| Dec.2 x 2 | None | 8 | 1236 x 1032 | 8 | 407.5 |
| Dec.2 x 2 | None | 10 | 1236 x 1032 | 10 | 343.4 |
| Dec.2 x 2 | None | 12 | 1236 x 1032 | 12 | 298.0 |
| 1 x 1 | Non-Comb. | 8 | 2472 x 2064 | 8 | 68.6 |
| 1 x 1 | Non-Comb. | 10 | 2472 x 2064 | 10 | 55.9 |
| 1 x 1 | Non-Comb. | 12 | 2472 x 2064 | 12 | 47.4 |
| 1 x 1 | Combined | 8 | 2472 x 2064 | 8 | 89.3 |
| 1 x 1 | Combined | 12 | 2472 x 2064 | 12 | 89.3 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 79: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 2472 x 2064 | 8 | 133.0 |
| 1 x 1 | - | 10 | 2472 x 2064 | 10 | 108.9 |
| 1 x 1 | - | 12 | 2472 x 2064 | 12 | 92.4 |
| Dec.2 x 2 | - | 8 | 1236 x 1032 | 8 | 401.1 |
| Dec.2 x 2 | - | 10 | 1236 x 1032 | 10 | 337.9 |
| Dec.2 x 2 | - | 12 | 1236 x 1032 | 12 | 293.2 |
| Bin.2 x 2 | - | 8 | 1236 x 1032 | 8 | 401.1 |
| Bin.2 x 2 | - | 10 | 1236 x 1032 | 10 | 337.9 |
| Bin.2 x 2 | - | 12 | 1236 x 1032 | 12 | 293.2 |
| 1 x 1 | Non-Comb. | 8 | 2472 x 2064 | 8 | 68.6 |
| 1 x 1 | Non-Comb. | 10 | 2472 x 2064 | 10 | 55.9 |
| 1 x 1 | Non-Comb. | 12 | 2472 x 2064 | 12 | 47.3 |
| 1 x 1 | Combined | 8 | 2472 x 2064 | 8 | 89.1 |
| 1 x 1 | Combined | 12 | 2472 x 2064 | 12 | 89.1 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 80: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX051MG-SY-PG4-X2G2-FF MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2472 x 2064 | 8 | 124.2 |
| 1 x 1 | 10 | 2472 x 2064 | 10 | 109.8 |
| 1 x 1 | 12 | 2472 x 2064 | 12 | 83.3 |
| Dec.2 x 2 | 8 | 1236 x 1032 | 8 | 408.8 |
| Dec.2 x 2 | 10 | 1236 x 1032 | 10 | 344.6 |
| Dec.2 x 2 | 12 | 1236 x 1032 | 12 | 299.0 |
| Bin.2 x 2 | 8 | 1236 x 1032 | 8 | 408.8 |
| Bin.2 x 2 | 10 | 1236 x 1032 | 10 | 344.6 |
| Bin.2 x 2 | 12 | 1236 x 1032 | 12 | 299.0 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 81: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 2856 x 2848 | 8 | 88.0 |
| 1 x 1 | - | 10 | 2856 x 2848 | 10 | 71.6 |
| 1 x 1 | - | 12 | 2856 x 2848 | 12 | 60.7 |
| Dec.2 x 2 | - | 8 | 1428 x 1424 | 8 | 283.3 |
| Dec.2 x 2 | - | 10 | 1428 x 1424 | 10 | 235.6 |
| Dec.2 x 2 | - | 12 | 1428 x 1424 | 12 | 202.7 |
| 1 x 1 | Non-Comb. | 8 | 2856 x 2848 | 8 | 44.9 |
| 1 x 1 | Non-Comb. | 10 | 2856 x 2848 | 10 | 36.4 |
| 1 x 1 | Non-Comb. | 12 | 2856 x 2848 | 12 | 30.8 |
| 1 x 1 | Combined | 8 | 2856 x 2848 | 8 | 65.9 |
| 1 x 1 | Combined | 12 | 2856 x 2848 | 12 | 61.0 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 82: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX081CG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2856 x 2848 | 8 | 88.5 |
| 1 x 1 | 10 | 2856 x 2848 | 10 | 72.0 |
| 1 x 1 | 12 | 2856 x 2848 | 12 | 61.0 |
| Dec.2 x 2 | 8 | 1428 x 1424 | 8 | 178.1 |
| Dec.2 x 2 | 10 | 1428 x 1424 | 10 | 169.9 |
| Dec.2 x 2 | 12 | 1428 x 1424 | 12 | 120.0 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 83: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 2856 x 2848 | 8 | 87.9 |
| 1 x 1 | - | 10 | 2856 x 2848 | 10 | 71.5 |
| 1 x 1 | - | 12 | 2856 x 2848 | 12 | 60.6 |
| Dec.2 x 2 | - | 8 | 1428 x 1424 | 8 | 280.6 |
| Dec.2 x 2 | - | 10 | 1428 x 1424 | 10 | 233.2 |
| Dec.2 x 2 | - | 12 | 1428 x 1424 | 12 | 200.2 |
| Bin.2 x 2 | - | 8 | 1428 x 1424 | 8 | 280.6 |
| Bin.2 x 2 | - | 10 | 1428 x 1424 | 10 | 233.2 |
| Bin.2 x 2 | - | 12 | 1428 x 1424 | 12 | 200.2 |
| 1 x 1 | Non-Comb. | 8 | 2856 x 2848 | 8 | 44.9 |
| 1 x 1 | Non-Comb. | 10 | 2856 x 2848 | 10 | 36.4 |
| 1 x 1 | Non-Comb. | 12 | 2856 x 2848 | 12 | 30.8 |
| 1 x 1 | Combined | 8 | 2856 x 2848 | 8 | 65.8 |
| 1 x 1 | Combined | 12 | 2856 x 2848 | 12 | 60.9 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 84: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX081MG-SY-PG4-X2G2-FF MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 2856 x 2848 | 8 | 88.5 |
| 1 x 1 | 10 | 2856 x 2848 | 10 | 72.0 |
| 1 x 1 | 12 | 2856 x 2848 | 12 | 61.0 |
| Dec.2 x 2 | 8 | 1428 x 1424 | 8 | 284.0 |
| Dec.2 x 2 | 10 | 1428 x 1424 | 10 | 236.1 |
| Dec.2 x 2 | 12 | 1428 x 1424 | 12 | 203.2 |
| Bin.2 x 2 | 8 | 1428 x 1424 | 8 | 284.0 |
| Bin.2 x 2 | 10 | 1428 x 1424 | 10 | 236.1 |
| Bin.2 x 2 | 12 | 1428 x 1424 | 12 | 203.2 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 85: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL MX089CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4112 x 2176 | 8 | 95.4 |
| Dec.2 x 1 | 8 | 2056 x 2176 | 8 | 95.2 |
| Dec.1 x 2 | 8 | 4112 x 1088 | 8 | 187.6 |
| Dec.2 x 2 | 8 | 2056 x 1088 | 8 | 187.1 |
| 1 x 1 | 10 | 4112 x 2176 | 10 | 79.1 |
| Dec.2 x 1 | 10 | 2056 x 2176 | 10 | 90.3 |
| Dec.1 x 2 | 10 | 4112 x 1088 | 10 | 155.5 |
| Dec.2 x 2 | 10 | 2056 x 1088 | 10 | 177.6 |
| 1 x 1 | 12 | 4112 x 2176 | 12 | 64.9 |
| Dec.2 x 1 | 12 | 2056 x 2176 | 12 | 64.9 |
| Dec.1 x 2 | 12 | 4112 x 1088 | 12 | 127.6 |
| Dec.2 x 2 | 12 | 2056 x 1088 | 12 | 127.6 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 86: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX089MG-SY-X2G2-FF MX089MG-SY-X2G2-FL MX089MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4112 x 2176 | 8 | 95.4 |
| Dec.2 x 2 | 8 | 2056 x 1088 | 8 | 187.1 |
| Bin.2 x 1, Dec.1 x 2 | 8 | 2056 x 1088 | 8 | 187.1 |
| Bin.1 x 2, Dec.2 x 1 | 8 | 2056 x 1088 | 8 | 187.1 |
| 1 x 1 | 10 | 4112 x 2176 | 10 | 79.1 |
| Dec.2 x 2 | 10 | 2056 x 1088 | 10 | 177.6 |
| Bin.2 x 1, Dec.1 x 2 | 10 | 2056 x 1088 | 10 | 177.6 |
| Bin.1 x 2, Dec.2 x 1 | 10 | 2056 x 1088 | 10 | 177.6 |
| 1 x 1 | 12 | 4112 x 2176 | 12 | 64.9 |
| Dec.2 x 2 | 12 | 2056 x 1088 | 12 | 127.6 |
| Bin.2 x 1, Dec.1 x 2 | 12 | 2056 x 1088 | 12 | 127.6 |
| Bin.1 x 2, Dec.2 x 1 | 12 | 2056 x 1088 | 12 | 127.6 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 87: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 4128 x 3008 | 8 | 61.4 |
| 1 x 1 | - | 10 | 4128 x 3008 | 10 | 49.7 |
| 1 x 1 | - | 12 | 4128 x 3008 | 12 | 42.0 |
| Dec.2 x 2 | - | 8 | 2064 x 1504 | 8 | 210.1 |
| Dec.2 x 2 | - | 10 | 2064 x 1504 | 10 | 173.3 |
| Dec.2 x 2 | - | 12 | 2064 x 1504 | 12 | 148.5 |
| 1 x 1 | Non-Comb. | 8 | 4128 x 3008 | 8 | 31.2 |
| 1 x 1 | Non-Comb. | 10 | 4128 x 3008 | 10 | 25.2 |
| 1 x 1 | Non-Comb. | 12 | 4128 x 3008 | 12 | 21.3 |
| 1 x 1 | Combined | 8 | 4128 x 3008 | 8 | 61.8 |
| 1 x 1 | Combined | 12 | 4128 x 3008 | 12 | 42.3 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 88: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL MX124CG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4128 x 3008 | 8 | 61.8 |
| 1 x 1 | 10 | 4128 x 3008 | 10 | 50.0 |
| 1 x 1 | 12 | 4128 x 3008 | 12 | 42.3 |
| Dec.2 x 2 | 8 | 2064 x 1504 | 8 | 169.4 |
| Dec.2 x 2 | 10 | 2064 x 1504 | 10 | 161.6 |
| Dec.2 x 2 | 12 | 2064 x 1504 | 12 | 114.0 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 89: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4112 x 3008 | 8 | 69.4 |
| Dec.2 x 1 | 8 | 2056 x 3008 | 8 | 69.4 |
| Dec.1 x 2 | 8 | 4112 x 1504 | 8 | 137.0 |
| Dec.2 x 2 | 8 | 2056 x 1504 | 8 | 137.0 |
| 1 x 1 | 10 | 4112 x 3008 | 10 | 57.5 |
| Dec.2 x 1 | 10 | 2056 x 3008 | 10 | 65.7 |
| Dec.1 x 2 | 10 | 4112 x 1504 | 10 | 113.6 |
| Dec.2 x 2 | 10 | 2056 x 1504 | 10 | 129.7 |
| 1 x 1 | 12 | 4112 x 3008 | 12 | 47.2 |
| Dec.2 x 1 | 12 | 2056 x 3008 | 12 | 47.2 |
| Dec.1 x 2 | 12 | 4112 x 1504 | 12 | 93.2 |
| Dec.2 x 2 | 12 | 2056 x 1504 | 12 | 93.2 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 90: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124MG-SY-PG4-X2G2-FF MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4128 x 3008 | 8 | 61.8 |
| 1 x 1 | 10 | 4128 x 3008 | 10 | 50.0 |
| 1 x 1 | 12 | 4128 x 3008 | 12 | 42.3 |
| Dec.2 x 2 | 8 | 2064 x 1504 | 8 | 210.6 |
| Dec.2 x 2 | 10 | 2064 x 1504 | 10 | 173.7 |
| Dec.2 x 2 | 12 | 2064 x 1504 | 12 | 148.8 |
| Bin.2 x 2 | 8 | 2064 x 1504 | 8 | 210.6 |
| Bin.2 x 2 | 10 | 2064 x 1504 | 10 | 173.7 |
| Bin.2 x 2 | 12 | 2064 x 1504 | 12 | 148.8 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 91: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 4128 x 3008 | 8 | 61.3 |
| 1 x 1 | - | 10 | 4128 x 3008 | 10 | 49.6 |
| 1 x 1 | - | 12 | 4128 x 3008 | 12 | 42.0 |
| Dec.2 x 2 | - | 8 | 2064 x 1504 | 8 | 207.6 |
| Dec.2 x 2 | - | 10 | 2064 x 1504 | 10 | 172.0 |
| Dec.2 x 2 | - | 12 | 2064 x 1504 | 12 | 147.0 |
| Bin.2 x 2 | - | 8 | 2064 x 1504 | 8 | 207.6 |
| Bin.2 x 2 | - | 10 | 2064 x 1504 | 10 | 172.0 |
| Bin.2 x 2 | - | 12 | 2064 x 1504 | 12 | 147.0 |
| 1 x 1 | Non-Comb. | 8 | 4128 x 3008 | 8 | 31.2 |
| 1 x 1 | Non-Comb. | 10 | 4128 x 3008 | 10 | 25.2 |
| 1 x 1 | Non-Comb. | 12 | 4128 x 3008 | 12 | 21.3 |
| 1 x 1 | Combined | 8 | 4128 x 3008 | 8 | 61.7 |
| 1 x 1 | Combined | 12 | 4128 x 3008 | 12 | 42.2 |

[1] Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 92: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX124MG-SY-X2G2-FF MX124MG-SY-X2G2-FL MX124MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4112 x 3008 | 8 | 69.4 |
| Dec.2 x 2 | 8 | 2056 x 1504 | 8 | 137.0 |
| Bin.2 x 2 | 8 | 2056 x 1504 | 8 | 137.0 |
| 1 x 1 | 10 | 4112 x 3008 | 10 | 57.5 |
| Dec.2 x 2 | 10 | 2056 x 1504 | 10 | 129.7 |
| Bin.2 x 2 | 10 | 2056 x 1504 | 10 | 129.7 |
| 1 x 1 | 12 | 4112 x 3008 | 12 | 47.2 |
| Dec.2 x 2 | 12 | 2056 x 1504 | 12 | 93.2 |
| Bin.2 x 2 | 12 | 2056 x 1504 | 12 | 93.2 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 93: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 5328 x 3040 | 8 | 45.6 |
| Dec.2 x 2 | - | 8 | 2664 x 1520 | 8 | 150.9 |
| 1 x 1 | - | 10 | 5328 x 3040 | 10 | 36.7 |
| Dec.2 x 2 | - | 10 | 2664 x 1520 | 10 | 122.2 |
| 1 x 1 | - | 12 | 5328 x 3040 | 12 | 33.1 |
| Dec.2 x 2 | - | 12 | 2664 x 1520 | 12 | 119.9 |
| 1 x 1 | Combined | 8 | 5328 x 3040 | 8 | 45.8 |
| 1 x 1 | Combined | 12 | 5328 x 3040 | 12 | 33.3 |
| 1 x 1 | Non-Comb. | 8 | 5328 x 3040 | 8 | 23.0 |
| 1 x 1 | Non-Comb. | 10 | 5328 x 3040 | 10 | 18.5 |
| 1 x 1 | Non-Comb. | 12 | 5328 x 3040 | 12 | 16.7 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 94: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX161CG-SY-X2G2-FL MX161CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 5328 x 3040 | 8 | 45.8 |
| Dec.2 x 2 | 8 | 2664 x 1520 | 8 | 152.0 |
| 1 x 1 | 10 | 5328 x 3040 | 10 | 36.9 |
| Dec.2 x 2 | 10 | 2664 x 1520 | 10 | 123.1 |
| 1 x 1 | 12 | 5328 x 3040 | 12 | 33.3 |
| Dec.2 x 2 | 12 | 2664 x 1520 | 12 | 111.9 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 95: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL-HDR MX161MG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 5328 x 3040 | 8 | 45.6 |
| Dec.2 x 2 | - | 8 | 2664 x 1520 | 8 | 149.4 |
| Bin.2 x 2 | - | 8 | 2664 x 1520 | 8 | 150.2 |
| 1 x 1 | - | 10 | 5328 x 3040 | 10 | 36.7 |
| Dec.2 x 2 | - | 10 | 2664 x 1520 | 10 | 120.7 |
| Bin.2 x 2 | - | 10 | 2664 x 1520 | 10 | 121.3 |
| 1 x 1 | - | 12 | 5328 x 3040 | 12 | 33.1 |
| Dec.2 x 2 | - | 12 | 2664 x 1520 | 12 | 118.7 |
| Bin.2 x 2 | - | 12 | 2664 x 1520 | 12 | 118.7 |
| 1 x 1 | Combined | 8 | 5328 x 3040 | 8 | 45.8 |
| 1 x 1 | Combined | 12 | 5328 x 3040 | 12 | 33.3 |
| 1 x 1 | Non-Comb. | 8 | 5328 x 3040 | 8 | 23.0 |
| 1 x 1 | Non-Comb. | 10 | 5328 x 3040 | 10 | 18.5 |
| 1 x 1 | Non-Comb. | 12 | 5328 x 3040 | 12 | 16.7 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 96: Sensor read-out modes of the specific models

Sensor Read-out modes of:
MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 5328 x 3040 | 8 | 45.8 |
| Dec.2 x 2 | 8 | 2664 x 1520 | 8 | 151.3 |
| Bin.2 x 2 | 8 | 2664 x 1520 | 8 | 151.3 |
| 1 x 1 | 10 | 5328 x 3040 | 10 | 36.9 |
| Dec.2 x 2 | 10 | 2664 x 1520 | 10 | 122.5 |
| Bin.2 x 2 | 10 | 2664 x 1520 | 10 | 122.5 |
| 1 x 1 | 12 | 5328 x 3040 | 12 | 33.3 |
| Dec.2 x 2 | 12 | 2664 x 1520 | 12 | 120.2 |
| Bin.2 x 2 | 12 | 2664 x 1520 | 12 | 120.2 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 97: Sensor read-out modes of the specific models

Sensor Read-out modes of:
MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4512 x 4512 | 8 | 35.8 |
| Dec.2 x 2 | 8 | 2256 x 2256 | 8 | 109.8 |
| 1 x 1 | 10 | 4512 x 4512 | 10 | 28.9 |
| Dec.2 x 2 | 10 | 2256 x 2256 | 10 | 97.8 |
| 1 x 1 | 12 | 4512 x 4512 | 12 | 26.4 |
| Dec.2 x 2 | 12 | 2256 x 2256 | 12 | 76.5 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 98: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 4512 x 4512 | 8 | 35.7 |
| Dec.2 x 2 | - | 8 | 2256 x 2256 | 8 | 120.2 |
| 1 x 1 | - | 10 | 4512 x 4512 | 10 | 28.8 |
| Dec.2 x 2 | - | 10 | 2256 x 2256 | 10 | 97.5 |
| 1 x 1 | - | 12 | 4512 x 4512 | 12 | 26.3 |
| Dec.2 x 2 | - | 12 | 2256 x 2256 | 12 | 95.7 |
| 1 x 1 | Combined | 8 | 4512 x 4512 | 8 | 35.9 |
| 1 x 1 | Combined | 12 | 4512 x 4512 | 12 | 26.4 |
| 1 x 1 | Non-Comb. | 8 | 4512 x 4512 | 8 | 18.0 |
| 1 x 1 | Non-Comb. | 10 | 4512 x 4512 | 10 | 14.5 |
| 1 x 1 | Non-Comb. | 12 | 4512 x 4512 | 12 | 13.3 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 99: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 4512 x 4512 | 8 | 35.8 |
| Dec.2 x 2 | 8 | 2256 x 2256 | 8 | 120.4 |
| Bin.2 x 2 | 8 | 2256 x 2256 | 8 | 120.4 |
| 1 x 1 | 10 | 4512 x 4512 | 10 | 28.9 |
| Dec.2 x 2 | 10 | 2256 x 2256 | 10 | 97.6 |
| Bin.2 x 2 | 10 | 2256 x 2256 | 10 | 97.6 |
| 1 x 1 | 12 | 4512 x 4512 | 12 | 26.4 |
| Dec.2 x 2 | 12 | 2256 x 2256 | 12 | 95.9 |
| Bin.2 x 2 | 12 | 2256 x 2256 | 12 | 95.9 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 100: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX203MG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 4512 x 4512 | 8 | 35.7 |
| Dec.2 x 2 | - | 8 | 2256 x 2256 | 8 | 119.6 |
| Bin.2 x 2 | - | 8 | 2256 x 2256 | 8 | 119.6 |
| 1 x 1 | - | 10 | 4512 x 4512 | 10 | 28.9 |
| Dec.2 x 2 | - | 10 | 2256 x 2256 | 10 | 96.8 |
| Bin.2 x 2 | - | 10 | 2256 x 2256 | 10 | 96.8 |
| 1 x 1 | - | 12 | 4512 x 4512 | 12 | 26.4 |
| Dec.2 x 2 | - | 12 | 2256 x 2256 | 12 | 95.1 |
| Bin.2 x 2 | - | 12 | 2256 x 2256 | 12 | 95.1 |
| 1 x 1 | Combined | 8 | 4512 x 4512 | 8 | 35.9 |
| 1 x 1 | Combined | 12 | 4512 x 4512 | 12 | 26.4 |
| 1 x 1 | Non-Comb. | 8 | 4512 x 4512 | 8 | 18.0 |
| 1 x 1 | Non-Comb. | 10 | 4512 x 4512 | 10 | 14.5 |
| 1 x 1 | Non-Comb. | 12 | 4512 x 4512 | 12 | 13.3 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 101: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX245CG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 5328 x 4608 | 8 | 30.5 |
| Dec.2 x 2 | - | 8 | 2664 x 2304 | 8 | 101.8 |
| 1 x 1 | - | 10 | 5328 x 4608 | 10 | 24.5 |
| Dec.2 x 2 | - | 10 | 2664 x 2304 | 10 | 82.3 |
| 1 x 1 | - | 12 | 5328 x 4608 | 12 | 22.1 |
| Dec.2 x 2 | - | 12 | 2664 x 2304 | 12 | 80.7 |
| 1 x 1 | Combined | 8 | 5328 x 4608 | 8 | 30.6 |
| 1 x 1 | Combined | 12 | 5328 x 4608 | 12 | 22.2 |
| 1 x 1 | Non-Comb. | 8 | 5328 x 4608 | 8 | 15.3 |
| 1 x 1 | Non-Comb. | 10 | 5328 x 4608 | 10 | 12.3 |
| 1 x 1 | Non-Comb. | 12 | 5328 x 4608 | 12 | 11.1 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 102: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 5328 x 4608 | 8 | 30.6 |
| Dec.2 x 2 | 8 | 2664 x 2304 | 8 | 102.3 |
| 1 x 1 | 10 | 5328 x 4608 | 10 | 24.6 |
| Dec.2 x 2 | 10 | 2664 x 2304 | 10 | 82.7 |
| 1 x 1 | 12 | 5328 x 4608 | 12 | 22.2 |
| Dec.2 x 2 | 12 | 2664 x 2304 | 12 | 75.1 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 103: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL-HDR MX245MG-SY-X2G2-FV-HDR

| Downsampling (Hor.x Ver.) | Dual ADC | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|---|
| 1 x 1 | - | 8 | 5328 x 4608 | 8 | 30.5 |
| Dec.2 x 2 | - | 8 | 2664 x 2304 | 8 | 101.1 |
| Bin.2 x 2 | - | 8 | 2664 x 2304 | 8 | 101.1 |
| 1 x 1 | - | 10 | 5328 x 4608 | 10 | 24.5 |
| Dec.2 x 2 | - | 10 | 2664 x 2304 | 10 | 81.6 |
| Bin.2 x 2 | - | 10 | 2664 x 2304 | 10 | 81.6 |
| 1 x 1 | - | 12 | 5328 x 4608 | 12 | 22.1 |
| Dec.2 x 2 | - | 12 | 2664 x 2304 | 12 | 80.2 |
| Bin.2 x 2 | - | 12 | 2664 x 2304 | 12 | 80.2 |
| 1 x 1 | Combined | 8 | 5328 x 4608 | 8 | 30.6 |
| 1 x 1 | Combined | 12 | 5328 x 4608 | 12 | 22.2 |
| 1 x 1 | Non-Comb. | 8 | 5328 x 4608 | 8 | 15.3 |
| 1 x 1 | Non-Comb. | 10 | 5328 x 4608 | 10 | 12.3 |
| 1 x 1 | Non-Comb. | 12 | 5328 x 4608 | 12 | 11.1 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 104: Sensor read-out modes of the specific models

Sensor Read-out modes of:

MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FV

| Downsampling (Hor.x Ver.) | Sensor bit/px | Resolution (Wid x Hei) | Transport bit/px | Frame rate[1] |
|---|---|---|---|---|
| 1 x 1 | 8 | 5328 x 4608 | 8 | 30.6 |
| Dec.2 x 2 | 8 | 2664 x 2304 | 8 | 102.0 |
| Bin.2 x 2 | 8 | 2664 x 2304 | 8 | 102.0 |
| 1 x 1 | 10 | 5328 x 4608 | 10 | 24.6 |
| Dec.2 x 2 | 10 | 2664 x 2304 | 10 | 82.5 |
| Bin.2 x 2 | 10 | 2664 x 2304 | 10 | 82.5 |
| 1 x 1 | 12 | 5328 x 4608 | 12 | 22.2 |
| Dec.2 x 2 | 12 | 2664 x 2304 | 12 | 80.9 |
| Bin.2 x 2 | 12 | 2664 x 2304 | 12 | 80.9 |

[1]Frame rate was measured using the transport format at bandwidth limit 900.0 MB/s

Table 105: Sensor read-out modes of the specific models

## 2.6.4 Quantum efficiency curves

Quantum efficiency curves for:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV MX023MG-SY-X2G2-FF MX023MG-SY-X2G2-FL MX023MG-SY-X2G2-FV

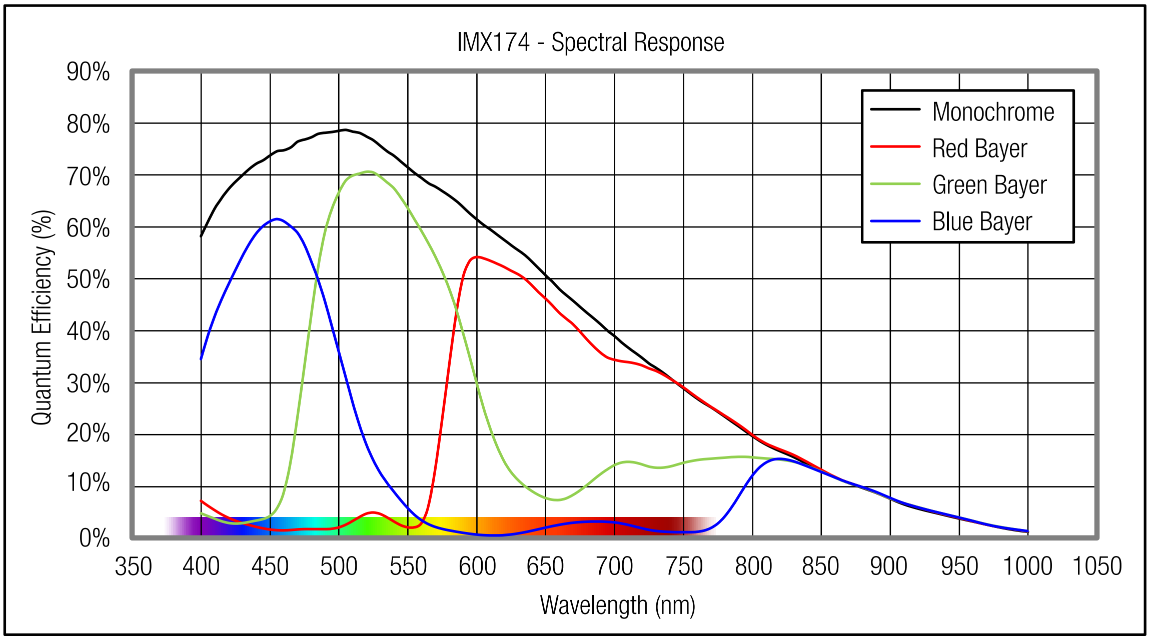



Figure 16: Graph quantum efficiency of Sony IMX174

Quantum efficiency curves for:

MX031CG-SY-X2G2-FF MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV MX031MG-SY-X2G2-FF MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV

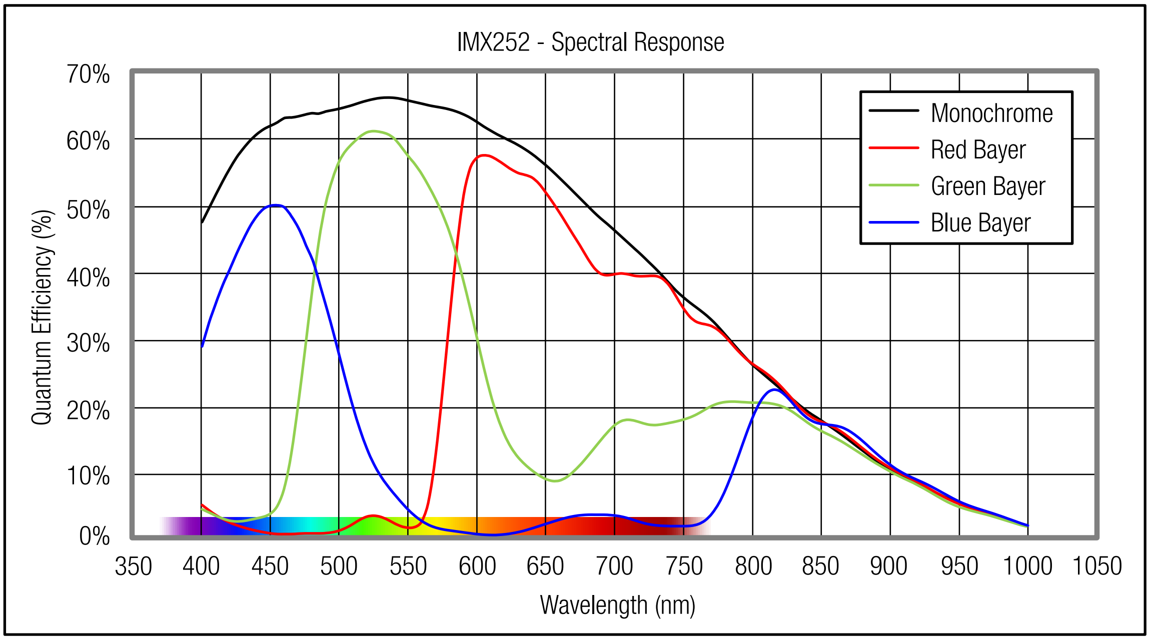



Figure 17: Graph quantum efficiency of Sony IMX252

Quantum efficiency curves for:

MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FF
MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FF MX042RG-CM-X2G2-FL
MX042RG-CM-X2G2-FV

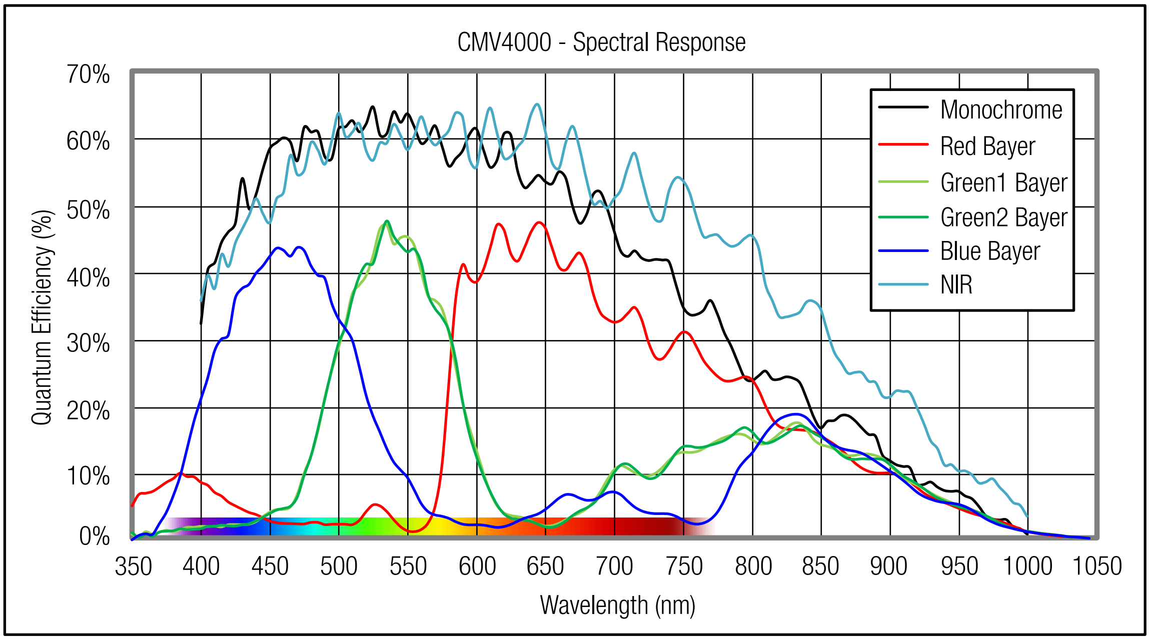



Figure 18: Graph quantum efficiency of CMOSIS CMV4000

Quantum efficiency curves for:

MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV MX050MG-SY-X2G2-FF
MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

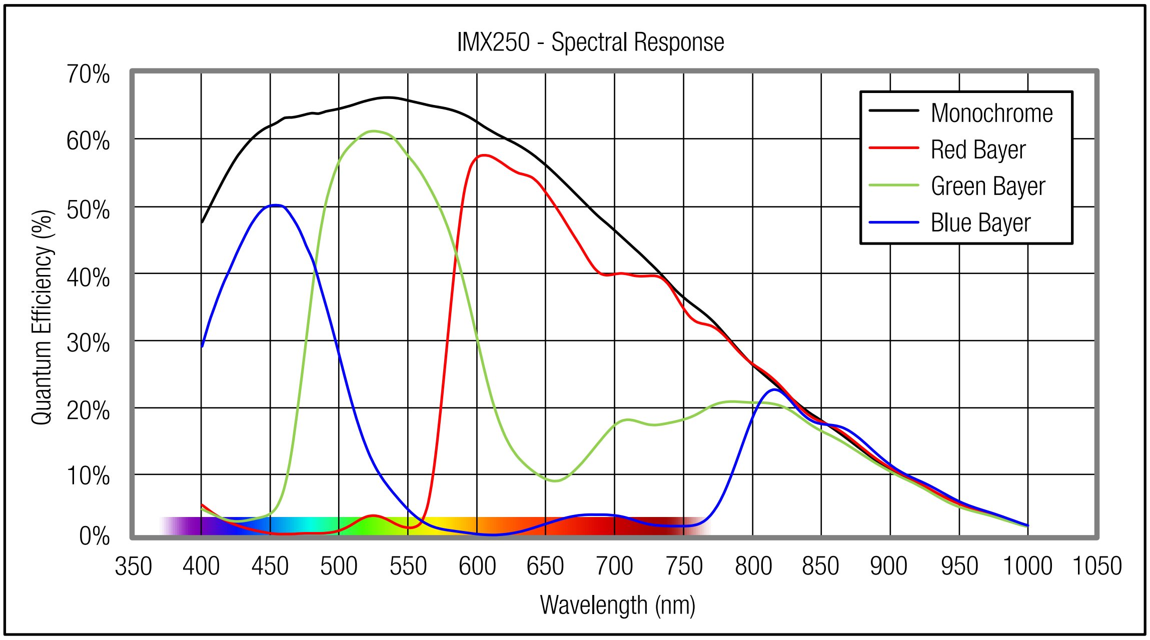



Figure 19: Graph quantum efficiency of Sony IMX250

Quantum efficiency curves for:

MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FL MX051CG-SY-PG4-X2G2-FV MX051MG-SY-PG4-X2G2-FF
MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FV

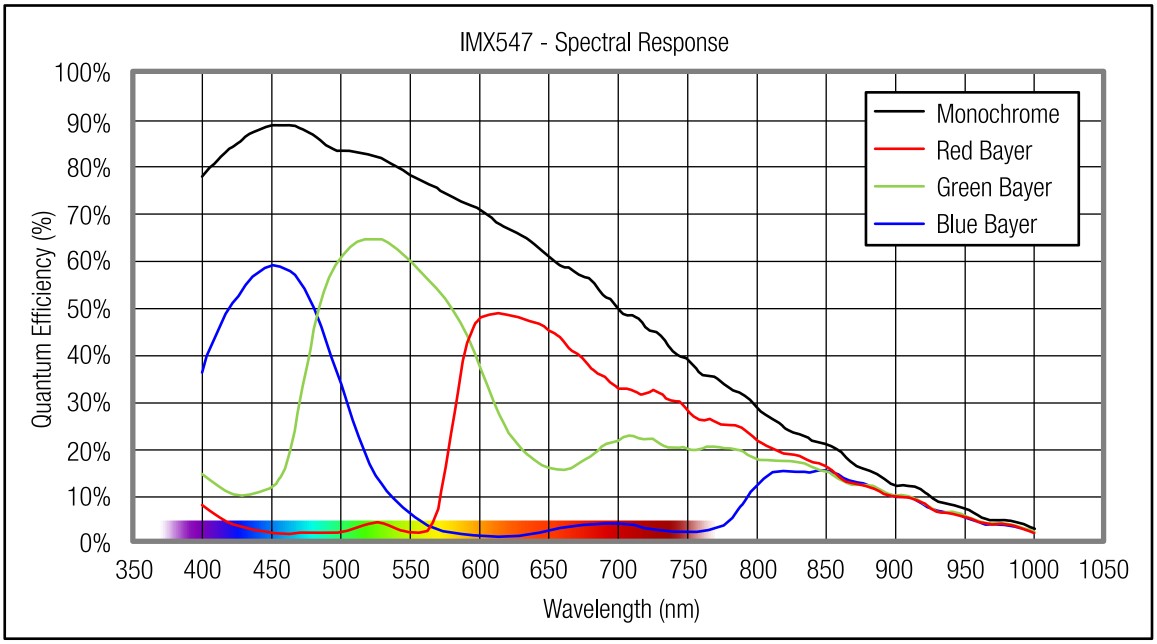



Figure 20: Graph quantum efficiency of Sony IMX547

Quantum efficiency curves for:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR MX051MG-SY-PG4-X2G2-FF-HDR
MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR

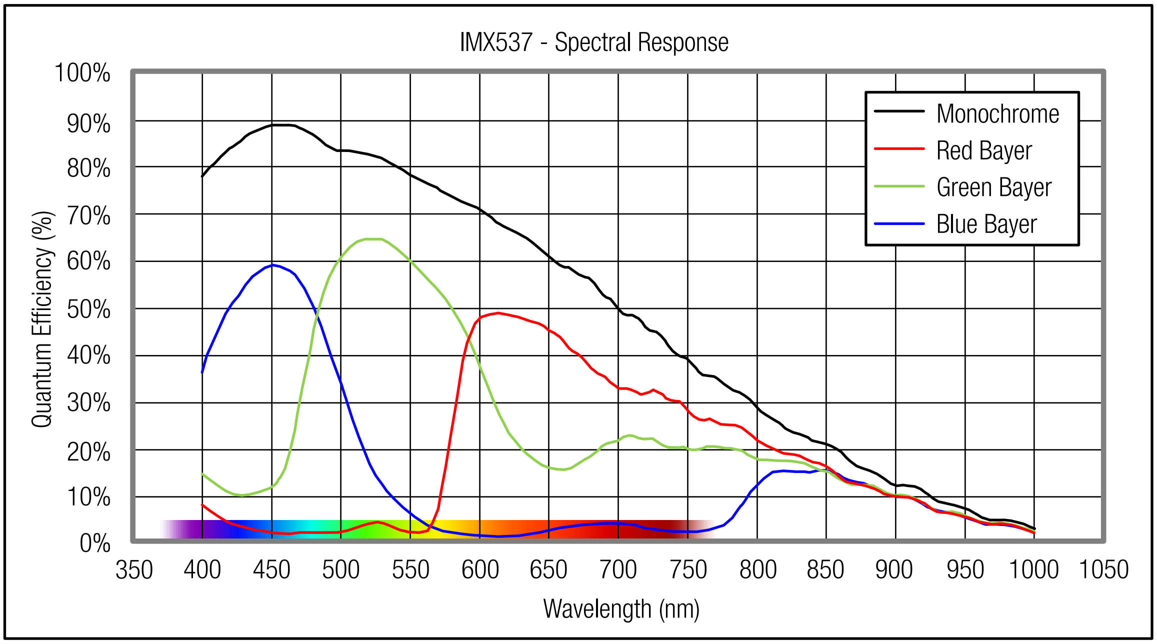



Figure 21: Graph quantum efficiency of Sony IMX537

Quantum efficiency curves for:

MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR

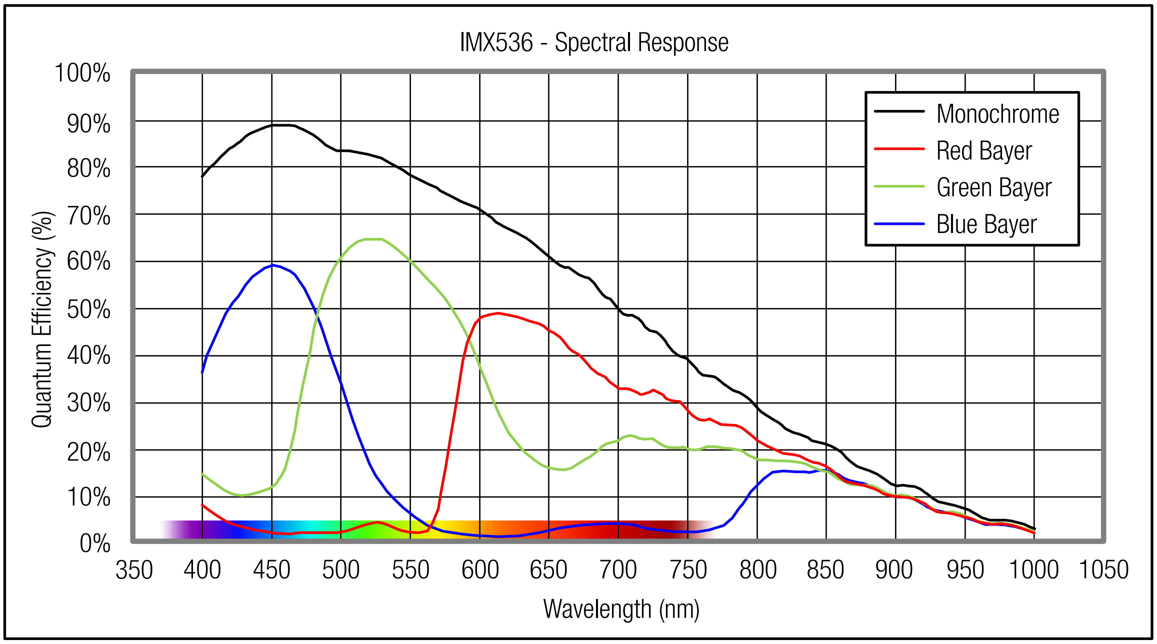



Figure 22: Graph quantum efficiency of Sony IMX536

Quantum efficiency curves for:

MX081CG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FV MX081MG-SY-PG4-X2G2-FF MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FV

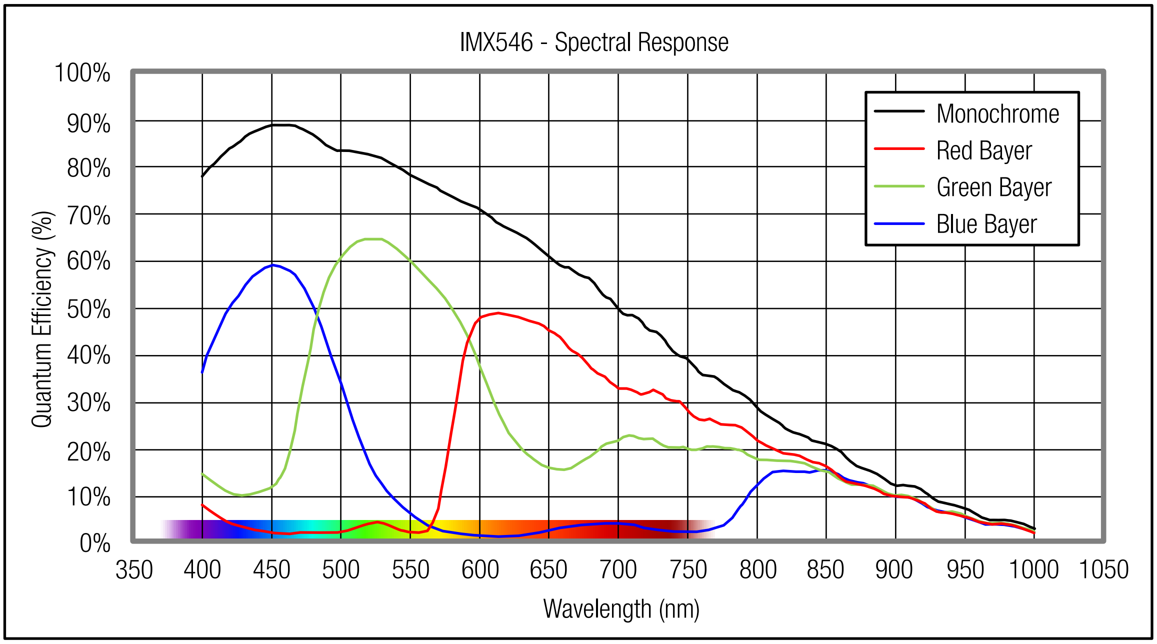



Figure 23: Graph quantum efficiency of Sony IMX546

Quantum efficiency curves for:

MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR

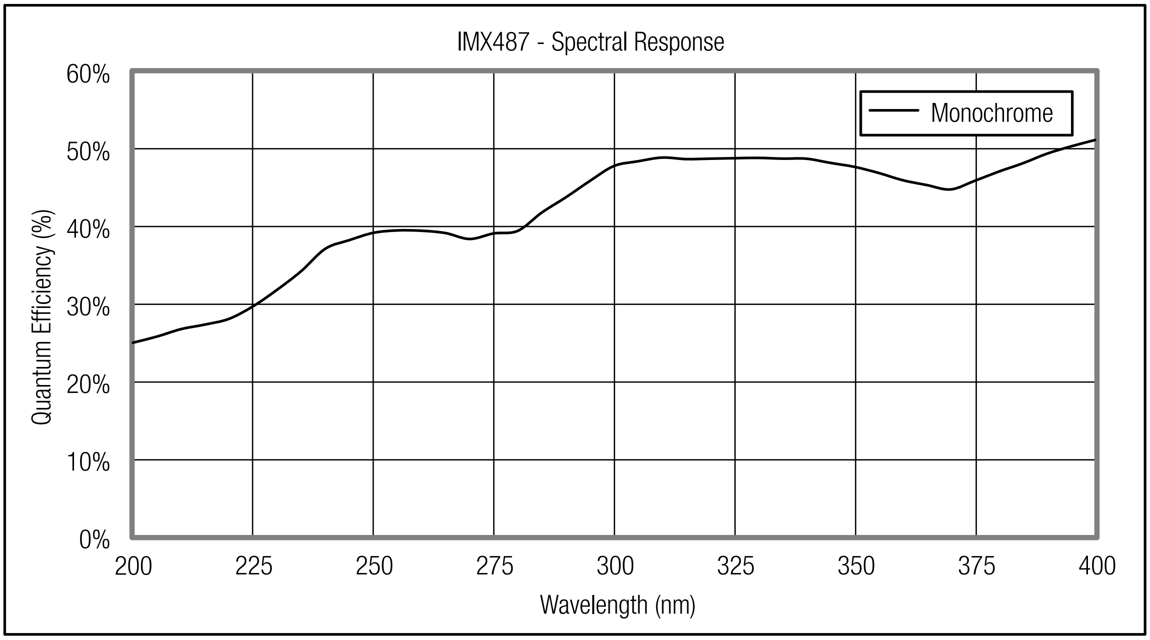



Figure 24: Graph quantum efficiency of Sony IMX487

Quantum efficiency curves for:

MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL MX089CG-SY-X2G2-FV MX089MG-SY-X2G2-FF
MX089MG-SY-X2G2-FL MX089MG-SY-X2G2-FV

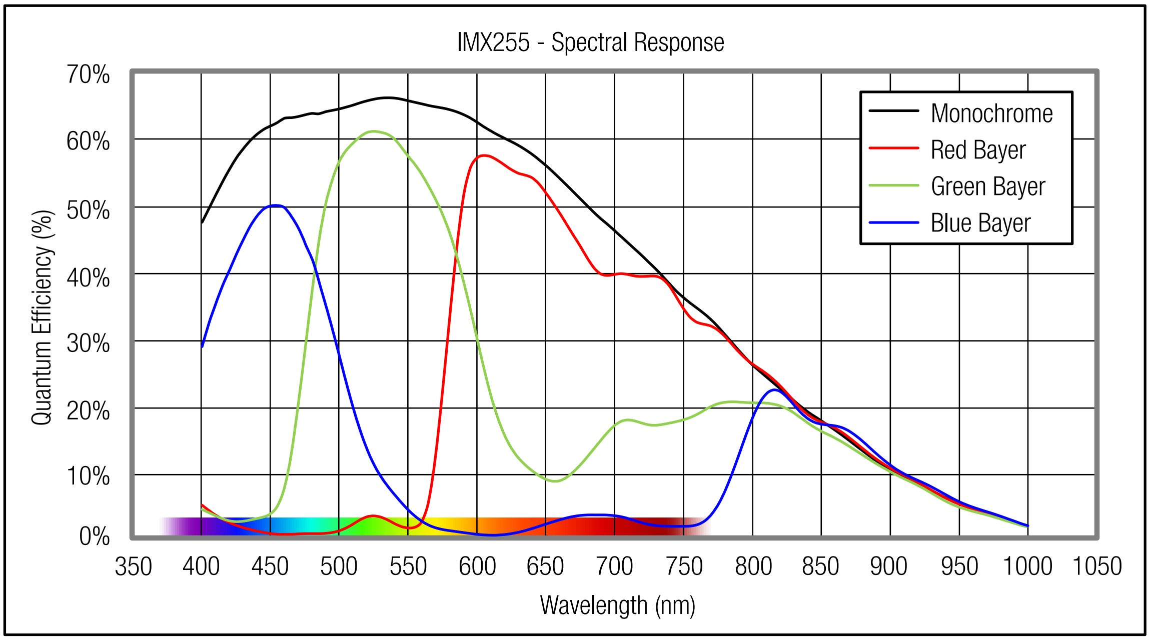



Figure 25: Graph quantum efficiency of Sony IMX255

Quantum efficiency curves for:

MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FV-HDR MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR

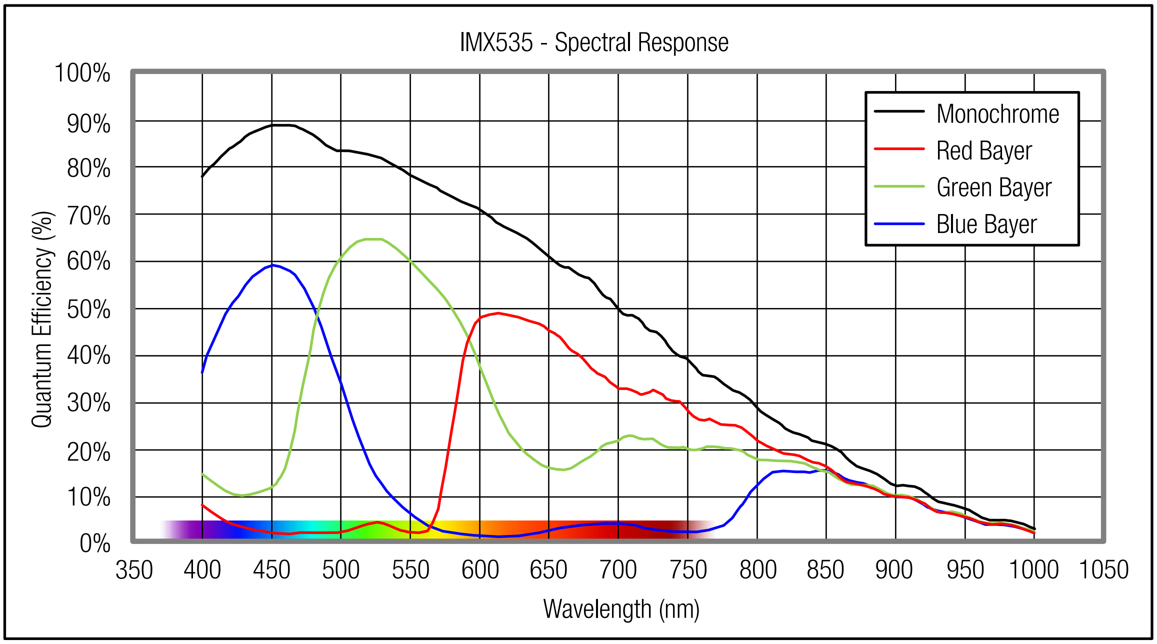



Figure 26: Graph quantum efficiency of Sony IMX535

Quantum efficiency curves for:

MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV MX124MG-SY-X2G2-FF MX124MG-SY-X2G2-FL MX124MG-SY-X2G2-FV

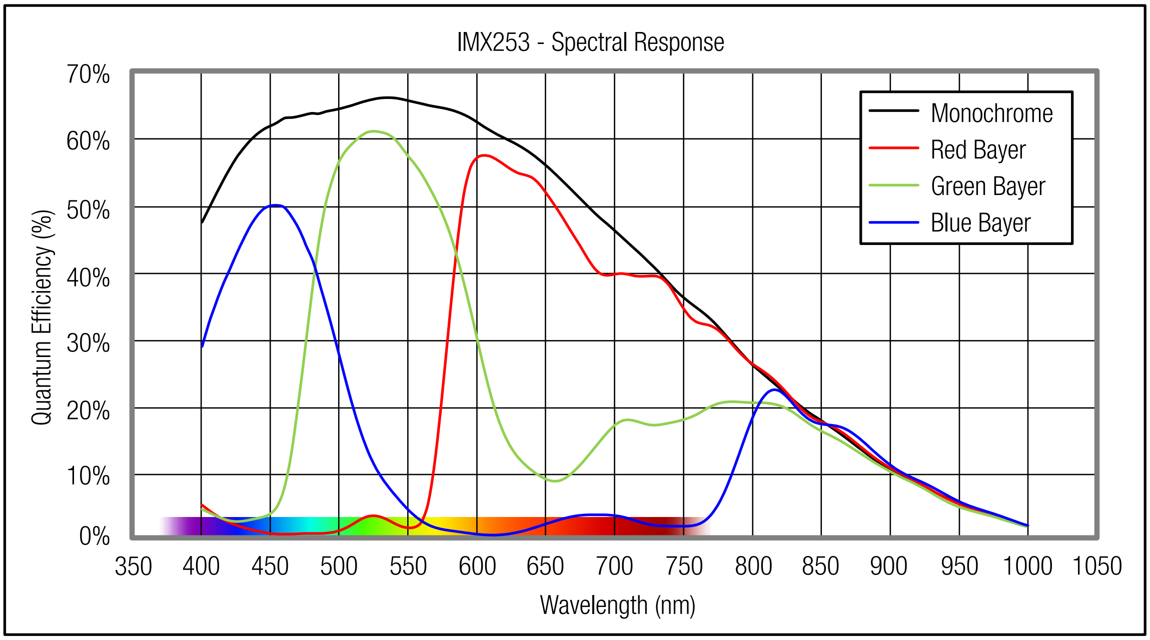



Figure 27: Graph quantum efficiency of Sony IMX253

Quantum efficiency curves for:

MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL MX124CG-SY-PG4-X2G2-FV MX124MG-SY-PG4-X2G2-FF
MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FV

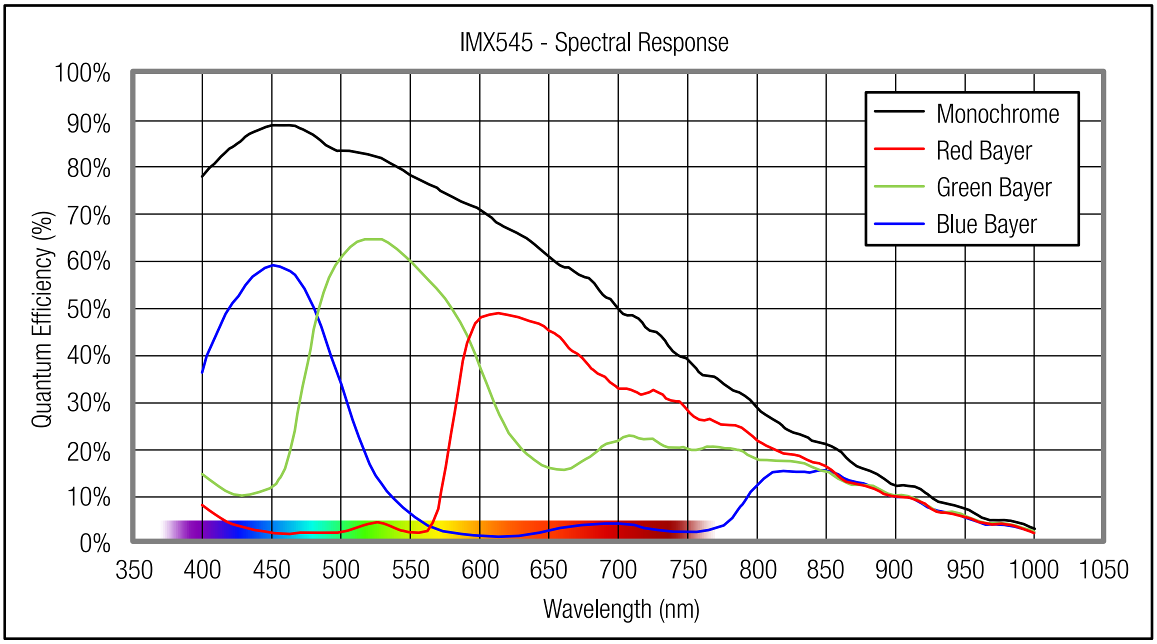



Figure 28: Graph quantum efficiency of Sony IMX545

Quantum efficiency curves for:

MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR MX161MG-SY-X2G2-FF-HDR
MX161MG-SY-X2G2-FL-HDR MX161MG-SY-X2G2-FV-HDR

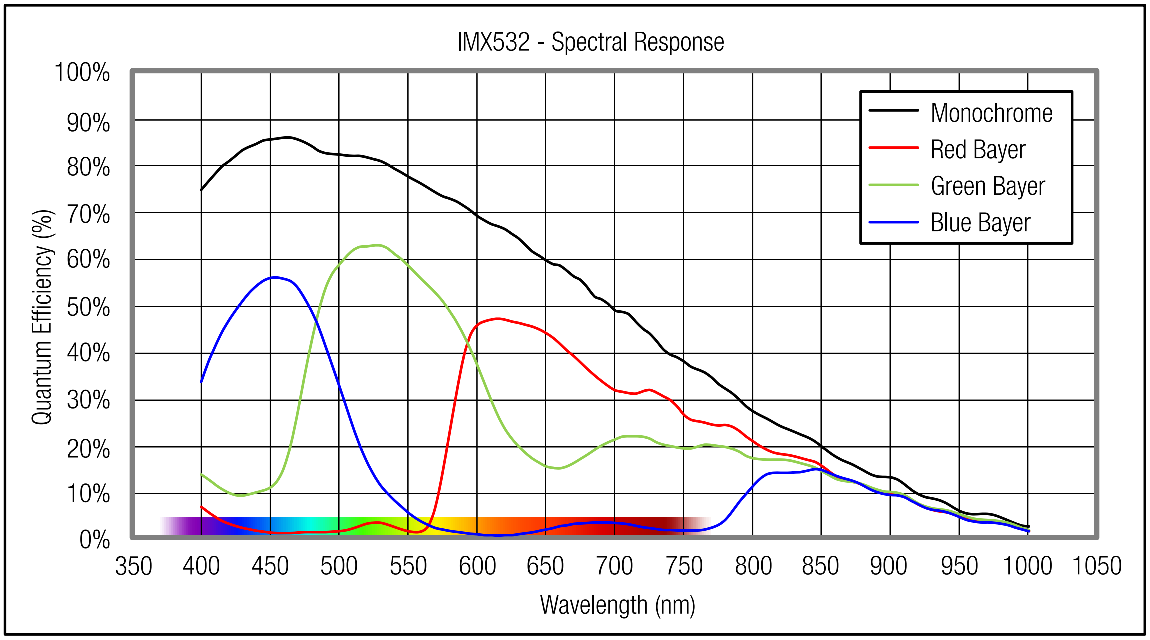



Figure 29: Graph quantum efficiency of Sony IMX532

Quantum efficiency curves for:

MX161CG-SY-X2G2-FL MX161CG-SY-X2G2-FV MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FV

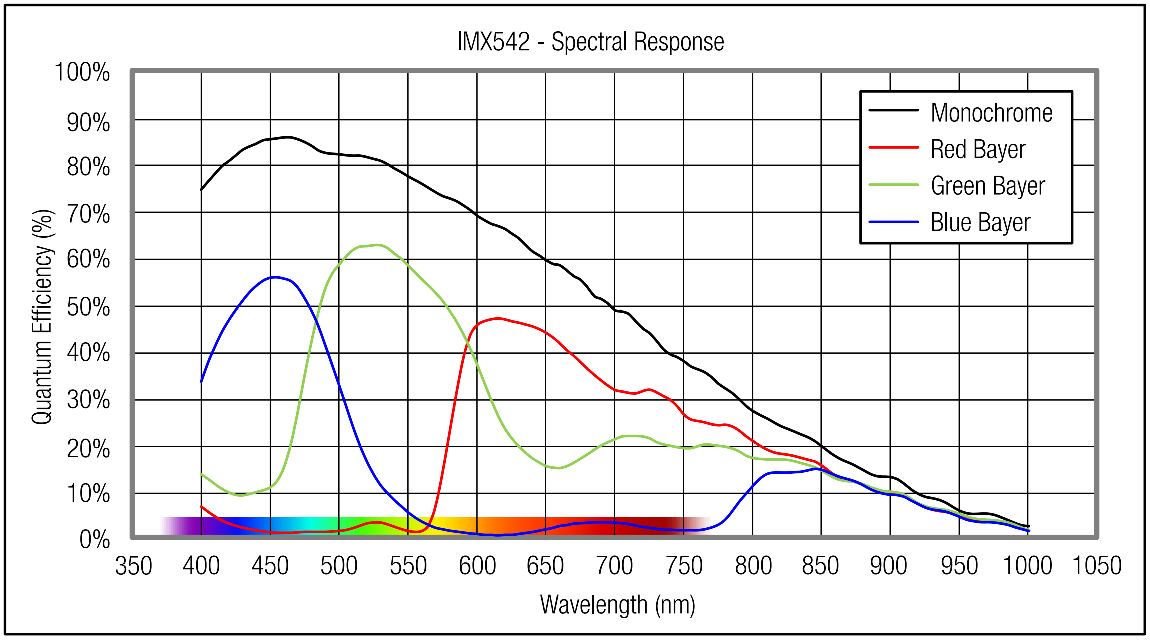



Figure 30: Graph quantum efficiency of Sony IMX542

Quantum efficiency curves for:

MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FV MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FV

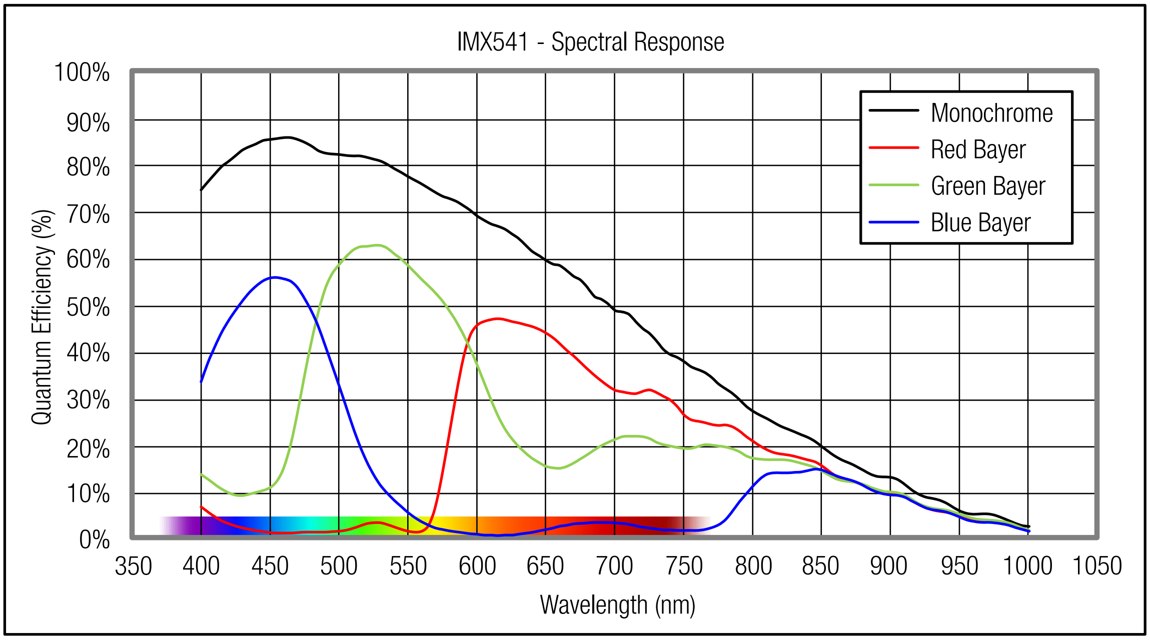



Figure 31: Graph quantum efficiency of Sony IMX541

Quantum efficiency curves for:

MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FF-HDR
MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR

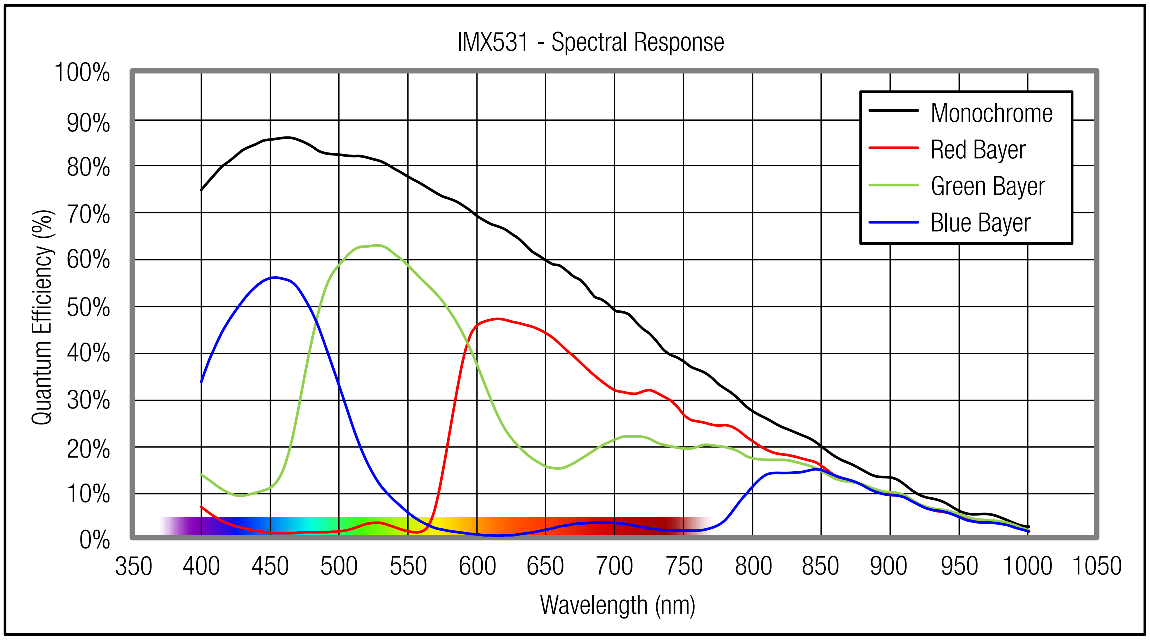



Figure 32: Graph quantum efficiency of Sony IMX531

Quantum efficiency curves for:

MX245CG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FF-HDR
MX245MG-SY-X2G2-FL-HDR MX245MG-SY-X2G2-FV-HDR

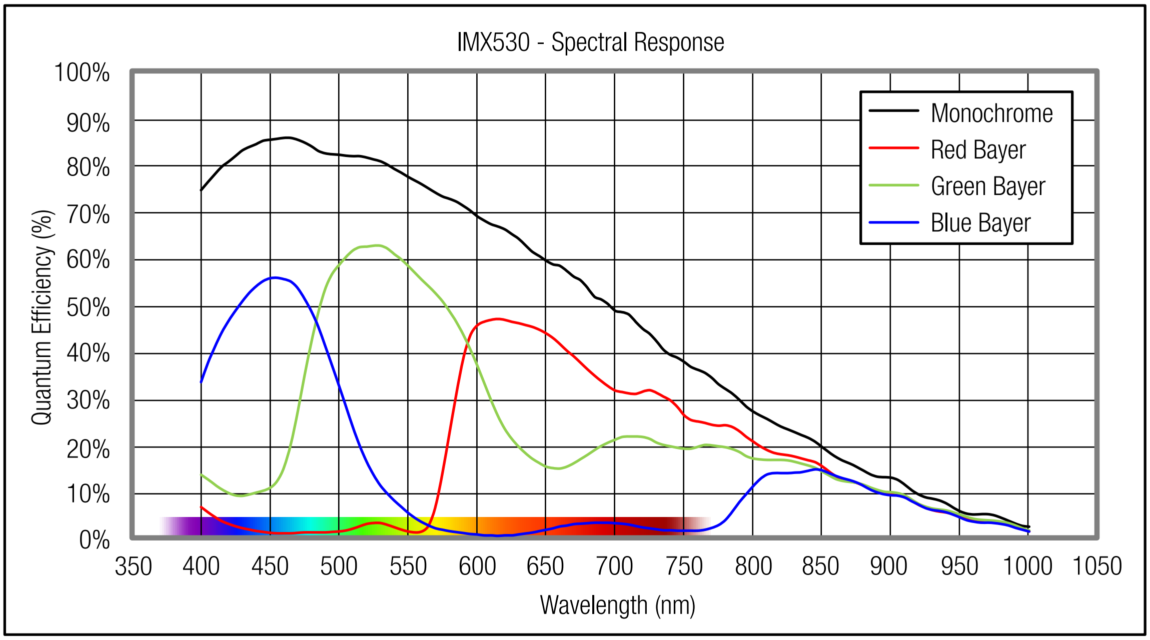



Figure 33: Graph quantum efficiency of Sony IMX530

Quantum efficiency curves for:

MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FV MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FV

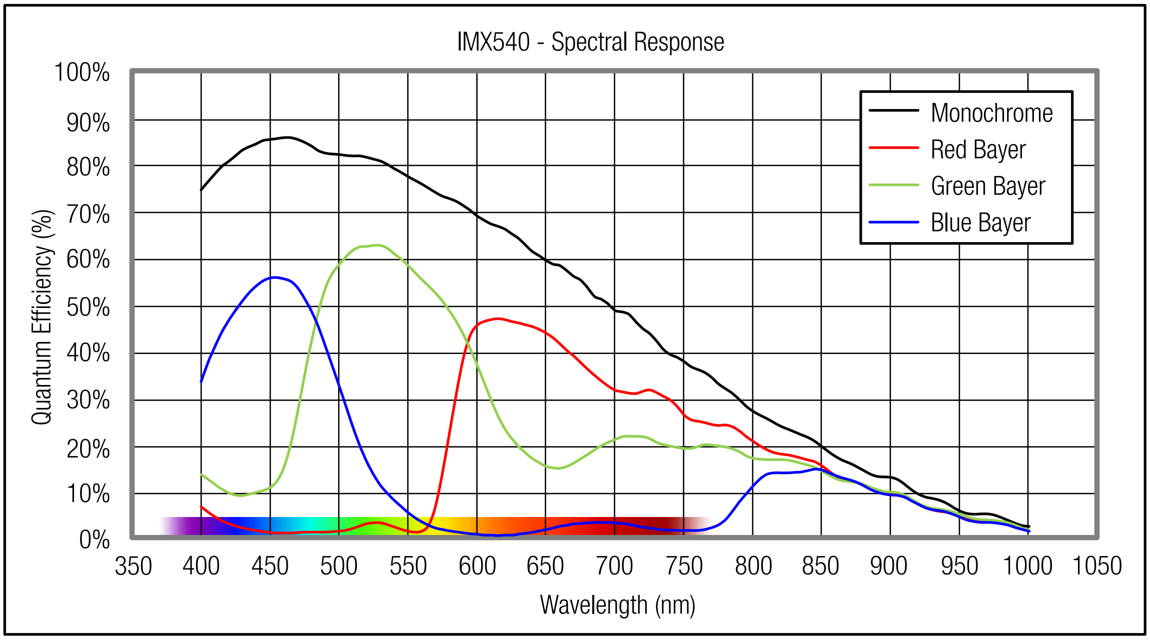



Figure 34: Graph quantum efficiency of Sony IMX540

## 2.7 Mechanical characteristics

### 2.7.1 Dimensions and mass

Dimensions and mass of:

MX031CG-SY-X2G2-FF MX031MG-SY-X2G2-FF MX050CG-SY-X2G2-FF MX050MG-SY-X2G2-FF

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 32.5 mm | 30 g |

[1]without adapters

Table 106: Camera parameters of the specific models

Dimensions and mass of:

MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV MX031MG-SY-X2G2-FL MX031MG-SY-X2G2-FV
MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV MX050MG-SY-X2G2-FL MX050MG-SY-X2G2-FV

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 30.8 mm | 30 g |

[1]without adapters

Table 107: Camera parameters of the specific models

Dimensions and mass of:

MX042CG-CM-X2G2-FL MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FL MX042MG-CM-X2G2-FV
MX042RG-CM-X2G2-FL MX042RG-CM-X2G2-FV

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 35.2 mm | 30 g |

[1]without adapters

Table 108: Camera parameters of the specific models

Dimensions and mass of:

MX042CG-CM-X2G2-FF MX042MG-CM-X2G2-FF MX042RG-CM-X2G2-FF

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 36.9 mm | 30 g |

[1]without adapters

Table 109: Camera parameters of the specific models

Dimensions and mass of:

MX051CG-SY-PG4-X2G2-FF
MX051CG-SY-PG4-X2G2-FF-HDR
MX051MG-SY-PG4-X2G2-FF-HDR
MX051MG-SY-PG4-X2G2-FF
MX081CG-SY-PG4-X2G2-FF-HDR
MX081CG-SY-PG4-X2G2-FF
MX081MG-SY-PG4-X2G2-FF-HDR
MX081MG-SY-PG4-X2G2-FF
MX124CG-SY-PG4-X2G2-FF-HDR
MX124CG-SY-PG4-X2G2-FF
MX124MG-SY-PG4-X2G2-FF
MX124MG-SY-PG4-X2G2-FF-HDR

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 32.1 mm | 29.9 g |

[1] without adapters

Table 110: Camera parameters of the specific models

Dimensions and mass of:

MX051CG-SY-PG4-X2G2-FV-HDR
MX051CG-SY-PG4-X2G2-FV
MX051MG-SY-PG4-X2G2-FV-HDR
MX051MG-SY-PG4-X2G2-FV
MX081CG-SY-PG4-X2G2-FV
MX081CG-SY-PG4-X2G2-FV-HDR
MX081MG-SY-PG4-X2G2-FV-HDR
MX081MG-SY-PG4-X2G2-FV
MX124CG-SY-PG4-X2G2-FV-HDR
MX124CG-SY-PG4-X2G2-FV
MX124MG-SY-PG4-X2G2-FV-HDR
MX124MG-SY-PG4-X2G2-FV

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 31.04 mm | 29.3 g |

[1] without adapters

Table 111: Camera parameters of the specific models

Dimensions and mass of:

MX023CG-SY-X2G2-FF
MX023MG-SY-X2G2-FF
MX089CG-SY-X2G2-FF
MX089MG-SY-X2G2-FF
MX124CG-SY-X2G2-FF
MX124MG-SY-X2G2-FF

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 32.6 mm | 30 g |

[1] without adapters

Table 112: Camera parameters of the specific models

Dimensions and mass of:

MX023CG-SY-X2G2-FL
MX023CG-SY-X2G2-FV
MX023MG-SY-X2G2-FL
MX023MG-SY-X2G2-FV
MX089CG-SY-X2G2-FL
MX089CG-SY-X2G2-FV
MX089MG-SY-X2G2-FL
MX089MG-SY-X2G2-FV
MX124CG-SY-X2G2-FL
MX124CG-SY-X2G2-FV
MX124MG-SY-X2G2-FL
MX124MG-SY-X2G2-FV

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 30.9 mm | 30 g |

[1] without adapters

Table 113: Camera parameters of the specific models

Dimensions and mass of:

MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FL MX051MG-SY-PG4-X2G2-FL-HDR
MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FL MX081MG-SY-PG4-X2G2-FL-HDR
MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FL MX124MG-SY-PG4-X2G2-FL-HDR

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 31.04 mm | 28.9 g |

[1]without adapters

Table 114: Camera parameters of the specific models

Dimensions and mass of:

MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FL
MX161CG-SY-X2G2-FV MX161CG-SY-X2G2-FV-HDR MX161MG-SY-X2G2-FL MX161MG-SY-X2G2-FL-HDR
MX161MG-SY-X2G2-FV MX161MG-SY-X2G2-FV-HDR MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FL-HDR
MX203CG-SY-X2G2-FV MX203CG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FL MX203MG-SY-X2G2-FL-HDR
MX203MG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FV MX245CG-SY-X2G2-FL MX245CG-SY-X2G2-FL-HDR
MX245CG-SY-X2G2-FV MX245CG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FL MX245MG-SY-X2G2-FL-HDR
MX245MG-SY-X2G2-FV MX245MG-SY-X2G2-FV-HDR

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 31 mm | 30 g |

[1]without adapters

Table 115: Camera parameters of the specific models

Dimensions and mass of:

MX081UG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FF-HDR
MX203MG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FF-HDR

| Width [ W ] | Height [ H ] | Depth [ D ] | Mass[1] [ M ] |
|---|---|---|---|
| 26.4 mm | 26.4 mm | 32 mm | 30 g |

[1]without adapters

Table 116: Camera parameters of the specific models

## 2.7.2 Dimensional drawings

Dimensional drawings of:

MX023CG-SY-X2G2-FL MX023MG-SY-X2G2-FL

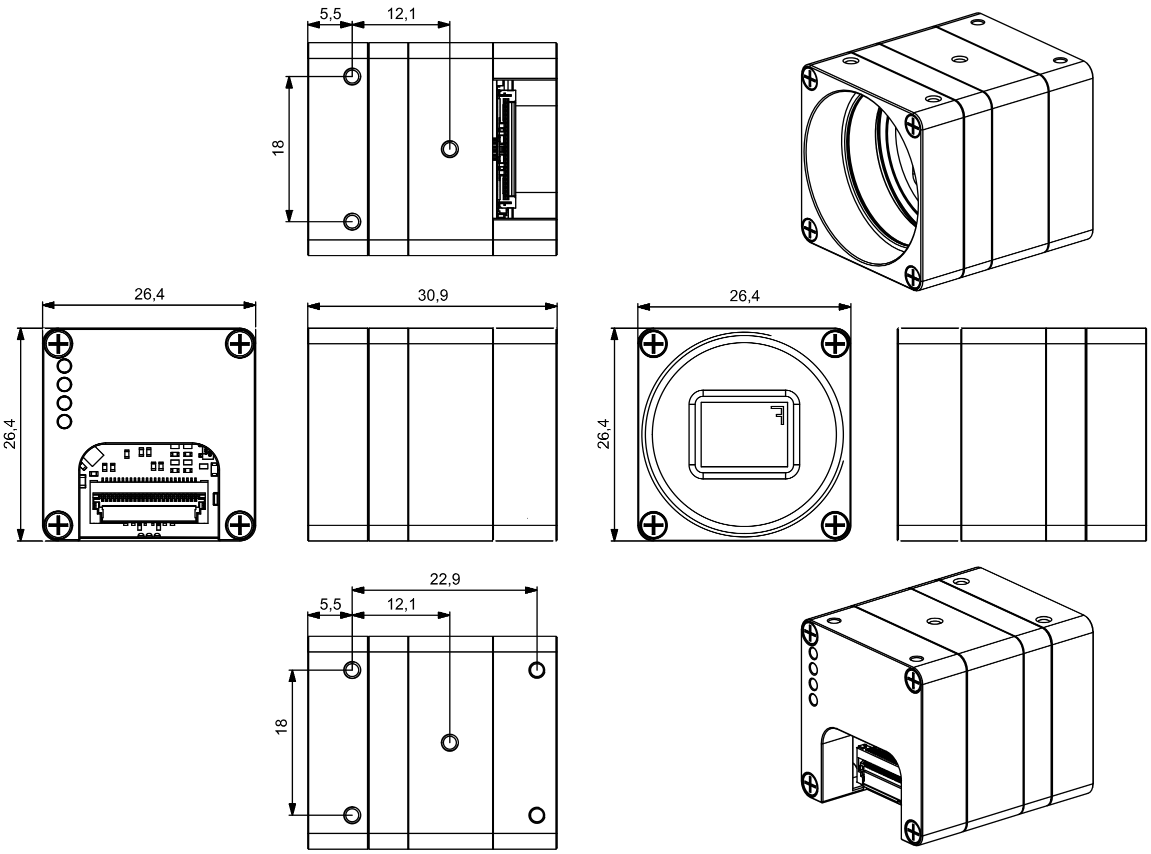



Figure 35: Dimensional drawing of MX023xG-SY-X2G2-FL (C-mount (with C-mount module B))

Dimensional drawings of:

MX023CG-SY-X2G2-FV MX023MG-SY-X2G2-FV

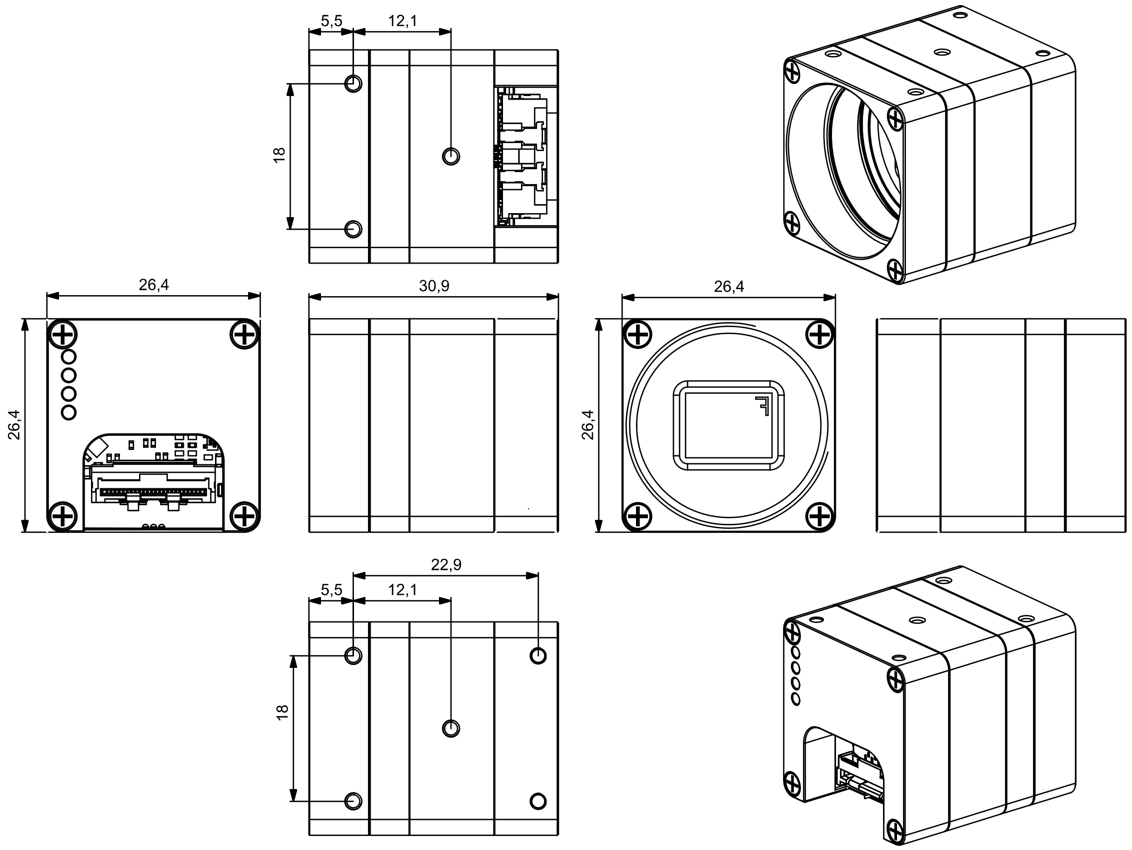



Figure 36: Dimensional drawing of MX023xG-SY-X2G2-FV (C-mount (with C mount module B))

Dimensional drawings of:

MX031CG-SY-X2G2-FF MX031MG-SY-X2G2-FF MX050CG-SY-X2G2-FF MX050MG-SY-X2G2-FF

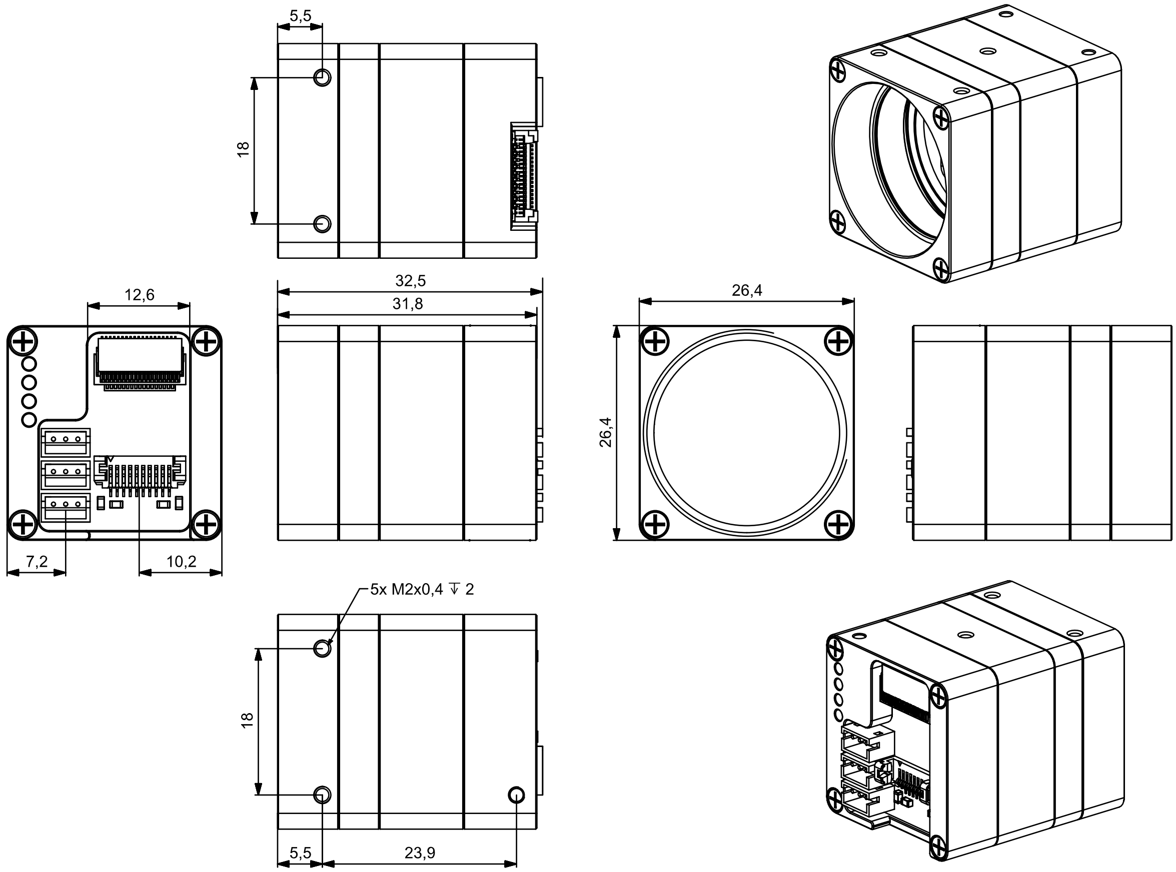



Figure 37: Dimensional drawing of MX031/050xG-SY-X2G2-FF (C-mount (with C-mount module B))

Dimensional drawings of:

MX031CG-SY-X2G2-FL MX031MG-SY-X2G2-FL MX050CG-SY-X2G2-FL MX050MG-SY-X2G2-FL

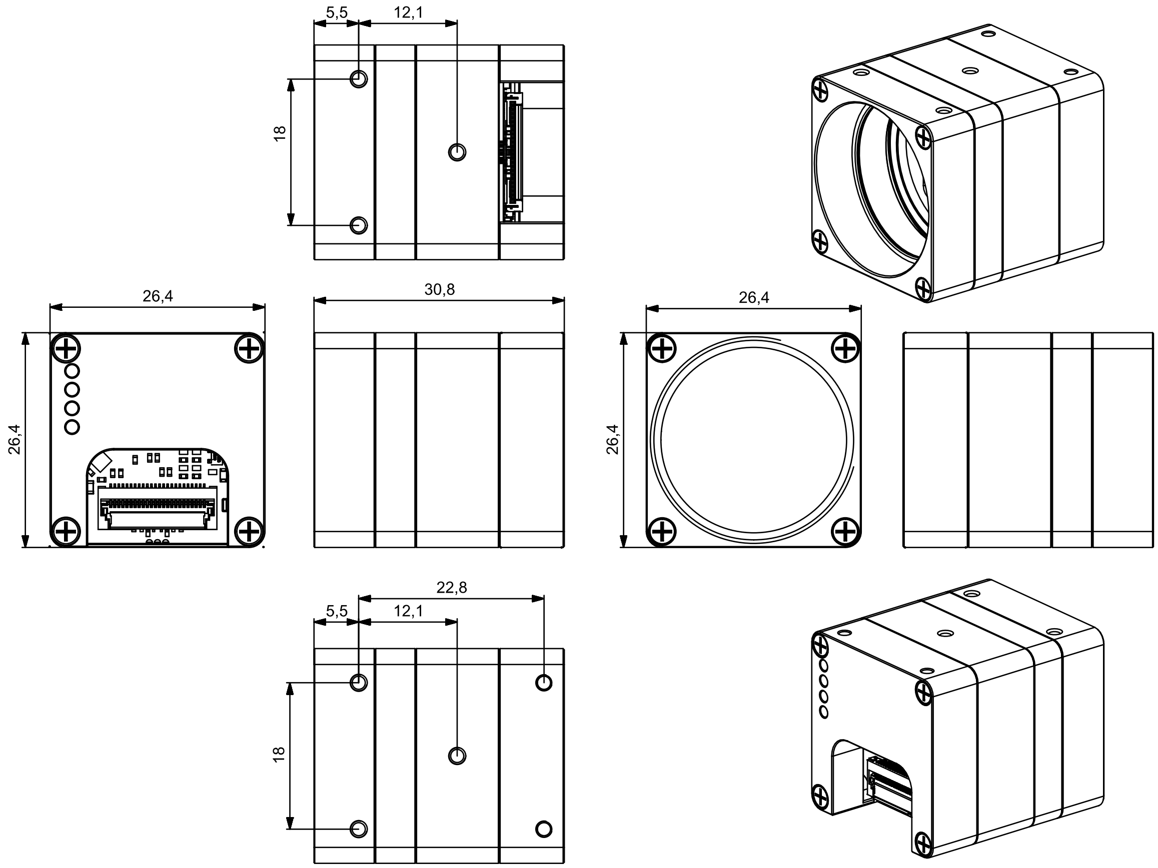



Figure 38: Dimensional drawing of MX031/050xG-SY-X2G2-FL (C-mount (with C-mount module B))

Dimensional drawings of:

MX042CG-CM-X2G2-FL MX042MG-CM-X2G2-FL MX042RG-CM-X2G2-FL

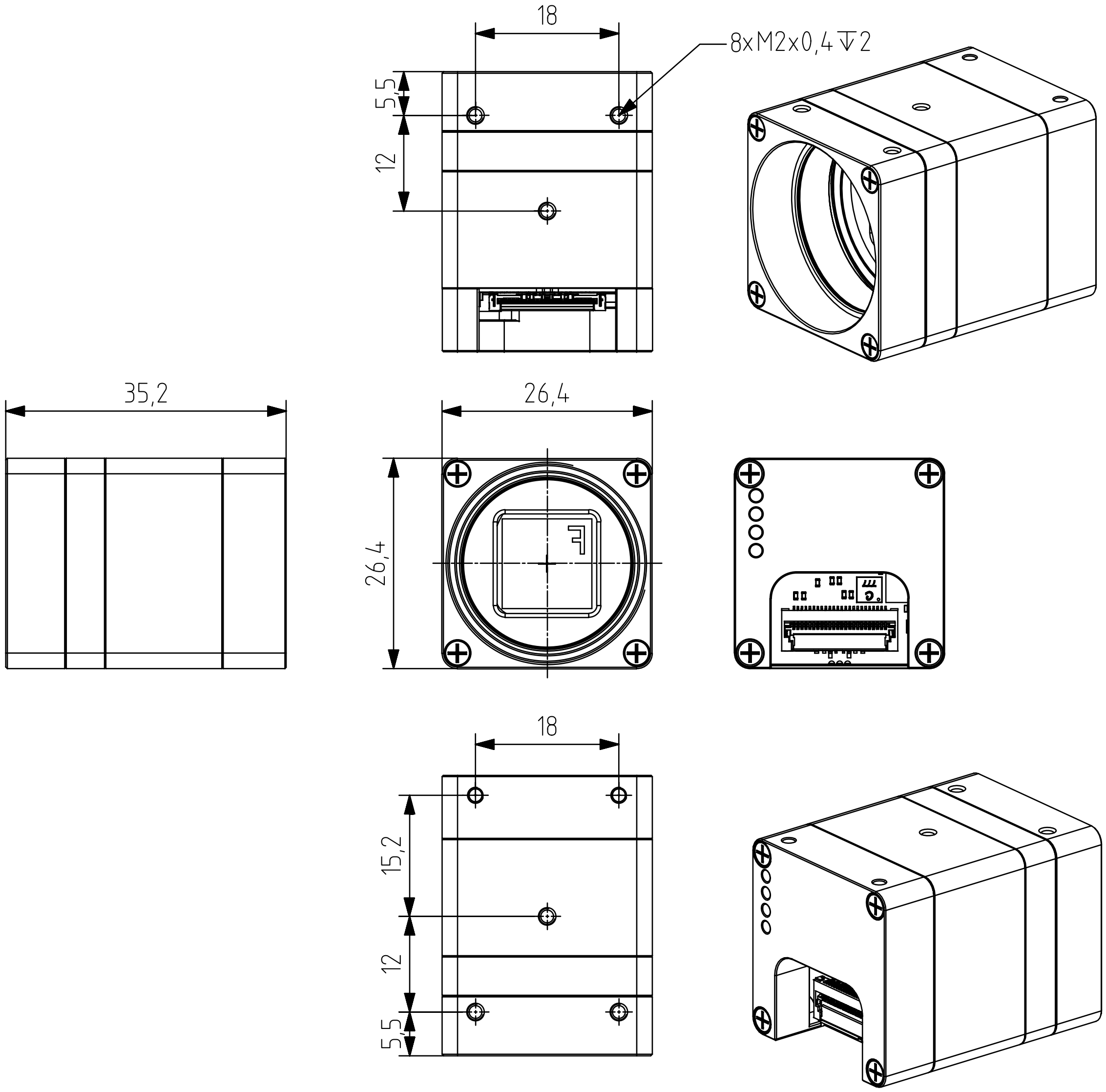



Figure 39: Dimensional drawing of MX042xG-CM-X2G2-FL (C-mount (with C-mount module B))

Dimensional drawings of:

MX042CG-CM-X2G2-FF MX042MG-CM-X2G2-FF MX042RG-CM-X2G2-FF

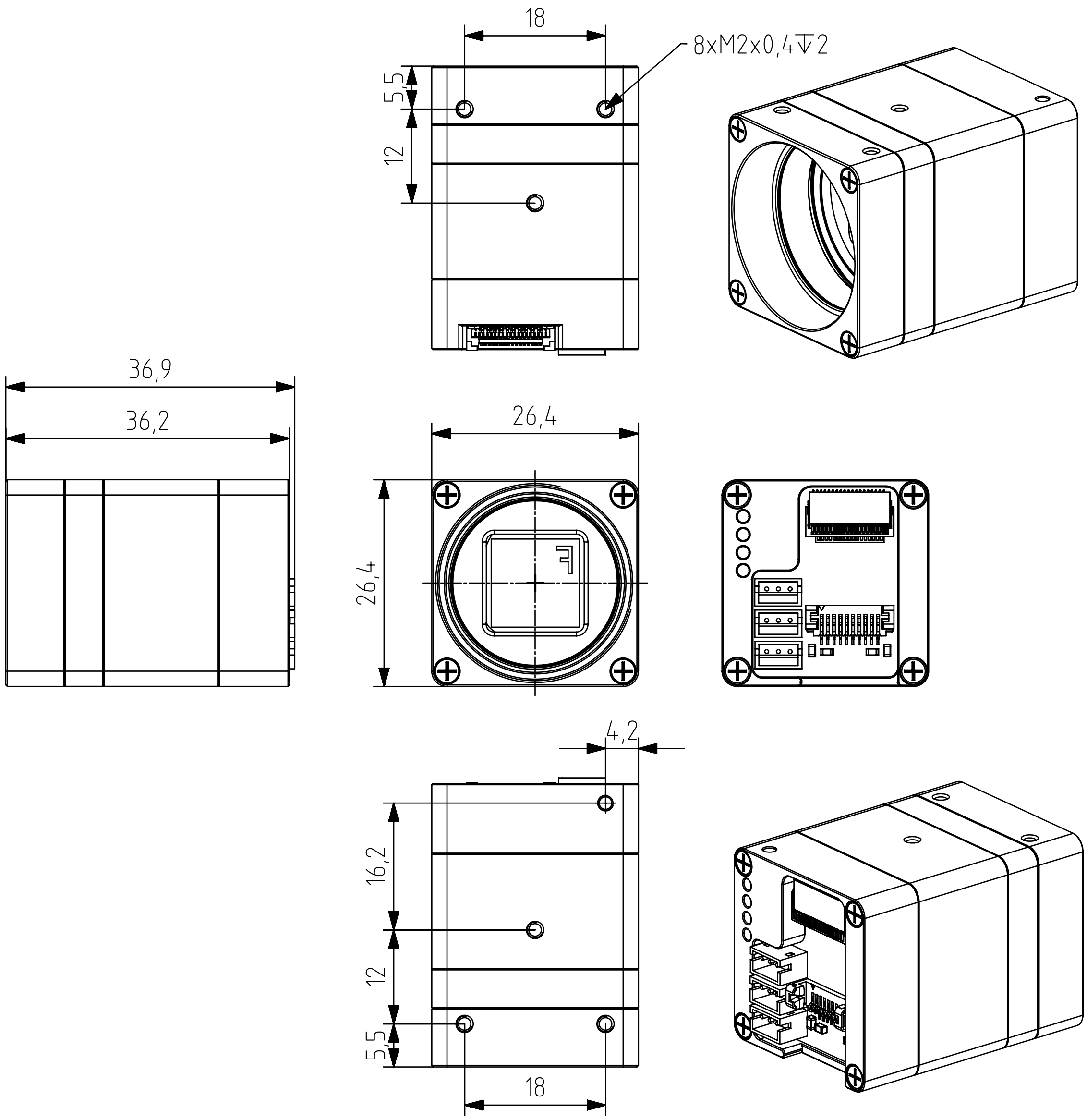



Figure 40: Dimensional drawing of MX042xG-CM-X2G2-FF (C-mount (with C-mount module B))

Dimensional drawings of:
MX042CG-CM-X2G2-FV MX042MG-CM-X2G2-FV MX042RG-CM-X2G2-FV

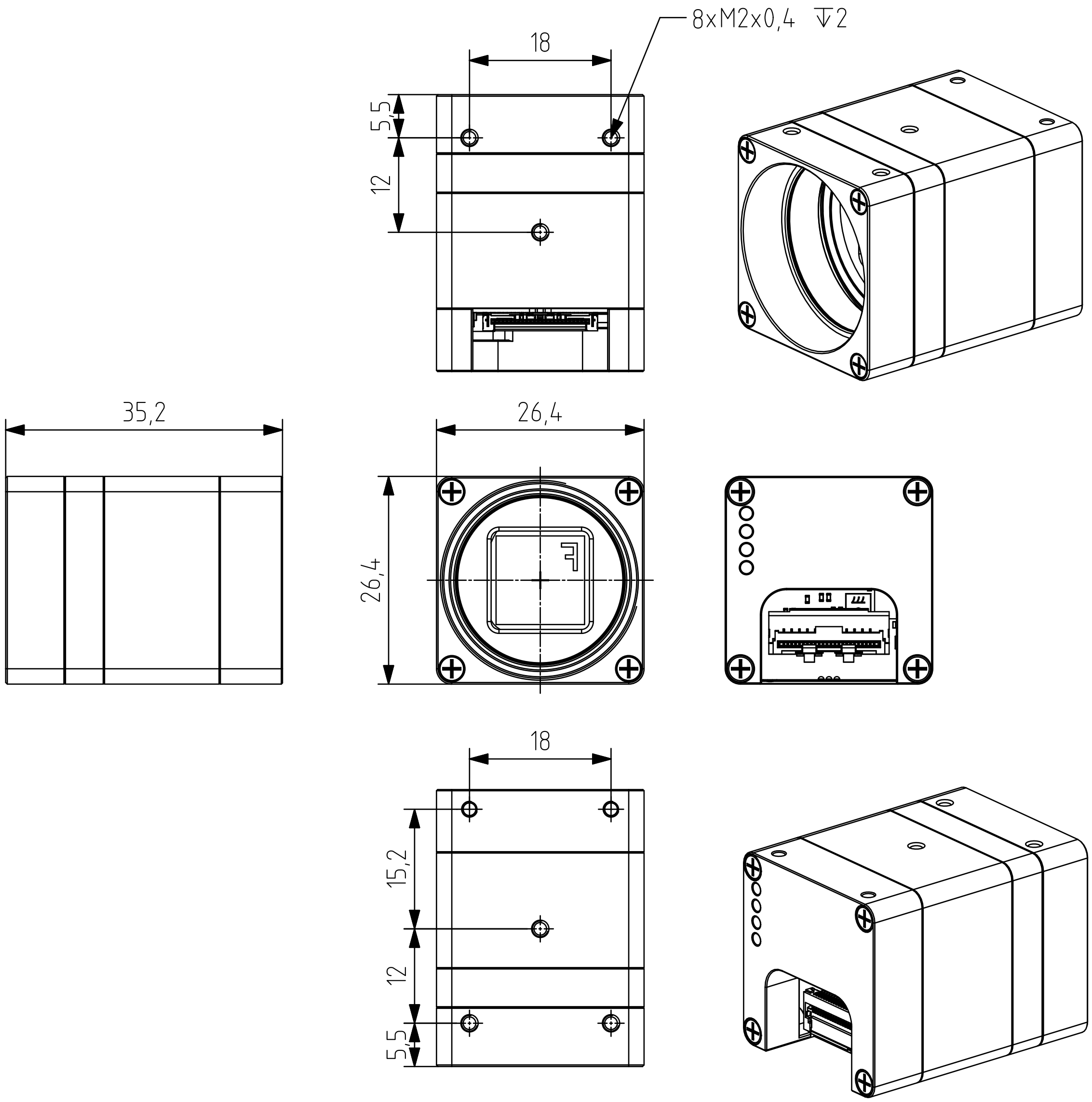



Figure 41: Dimensional drawing of MX042xG-CM-X2G2-FV (C-mount (with C-mount module B))

Dimensional drawings of:

MX031CG-SY-X2G2-FV MX031MG-SY-X2G2-FV MX050CG-SY-X2G2-FV MX050MG-SY-X2G2-FV

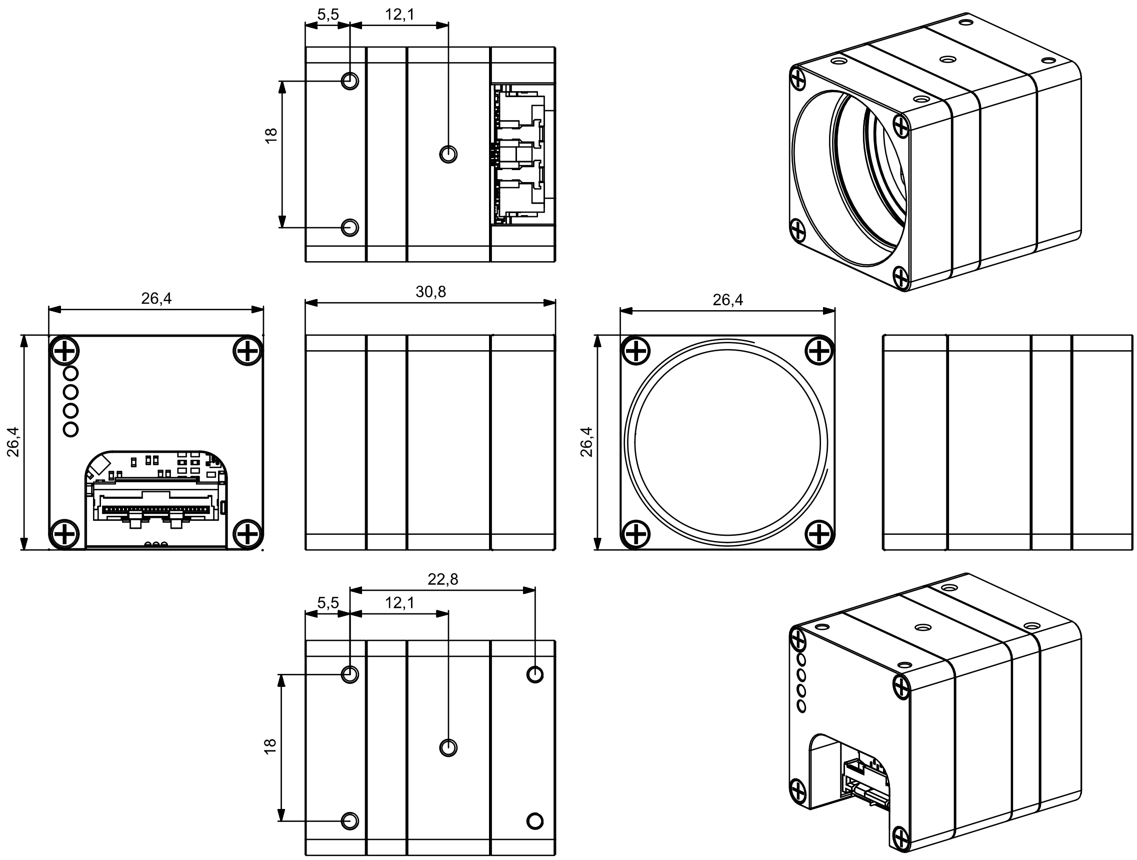



Figure 42: Dimensional drawing of MX031/050xG-SY-X2G2-FV (C-mount (with C-mount module B))

Dimensional drawings of:

| | | | |
|---|---|---|---|
| MX051CG-SY-PG4-X2G2-FF | MX051CG-SY-PG4-X2G2-FF-HDR | MX051MG-SY-PG4-X2G2-FF-HDR | MX051MG-SY-PG4-X2G2-FF |
| MX081CG-SY-PG4-X2G2-FF-HDR | MX081CG-SY-PG4-X2G2-FF | MX081MG-SY-PG4-X2G2-FF-HDR | MX081MG-SY-PG4-X2G2-FF |
| MX124CG-SY-PG4-X2G2-FF-HDR | MX124CG-SY-PG4-X2G2-FF | MX124MG-SY-PG4-X2G2-FF | MX124MG-SY-PG4-X2G2-FF-HDR |

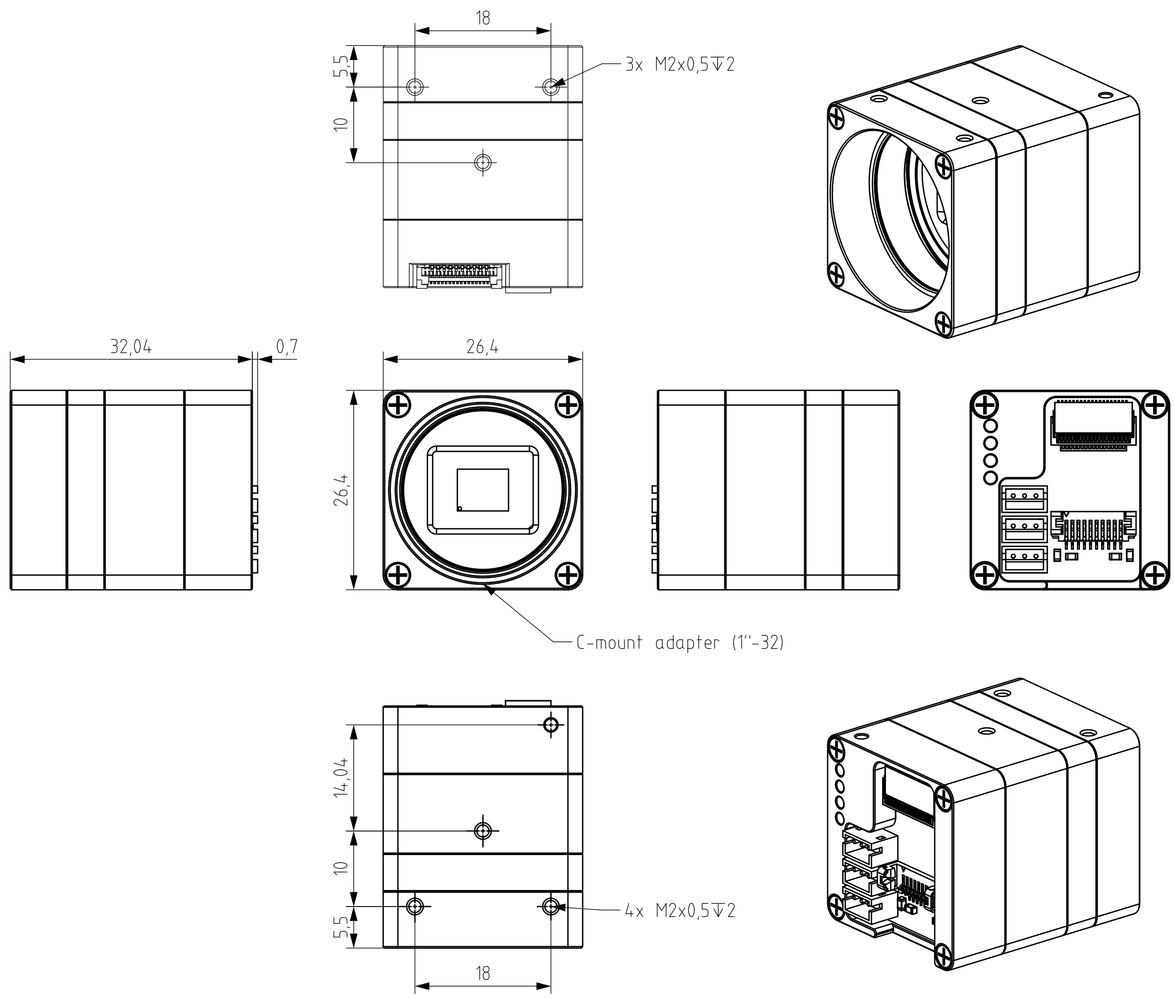



Figure 43: Dimensional drawings of MX051/081/124xG-SY-PG4-X2G2-FF

Dimensional drawings of:

| | | | |
|---|---|---|---|
| MX051CG-SY-PG4-X2G2-FV-HDR | MX051CG-SY-PG4-X2G2-FV | MX051MG-SY-PG4-X2G2-FV-HDR | MX051MG-SY-PG4-X2G2-FV |
| MX081CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV |
| MX124CG-SY-PG4-X2G2-FV-HDR | MX124CG-SY-PG4-X2G2-FV | MX124MG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FV |

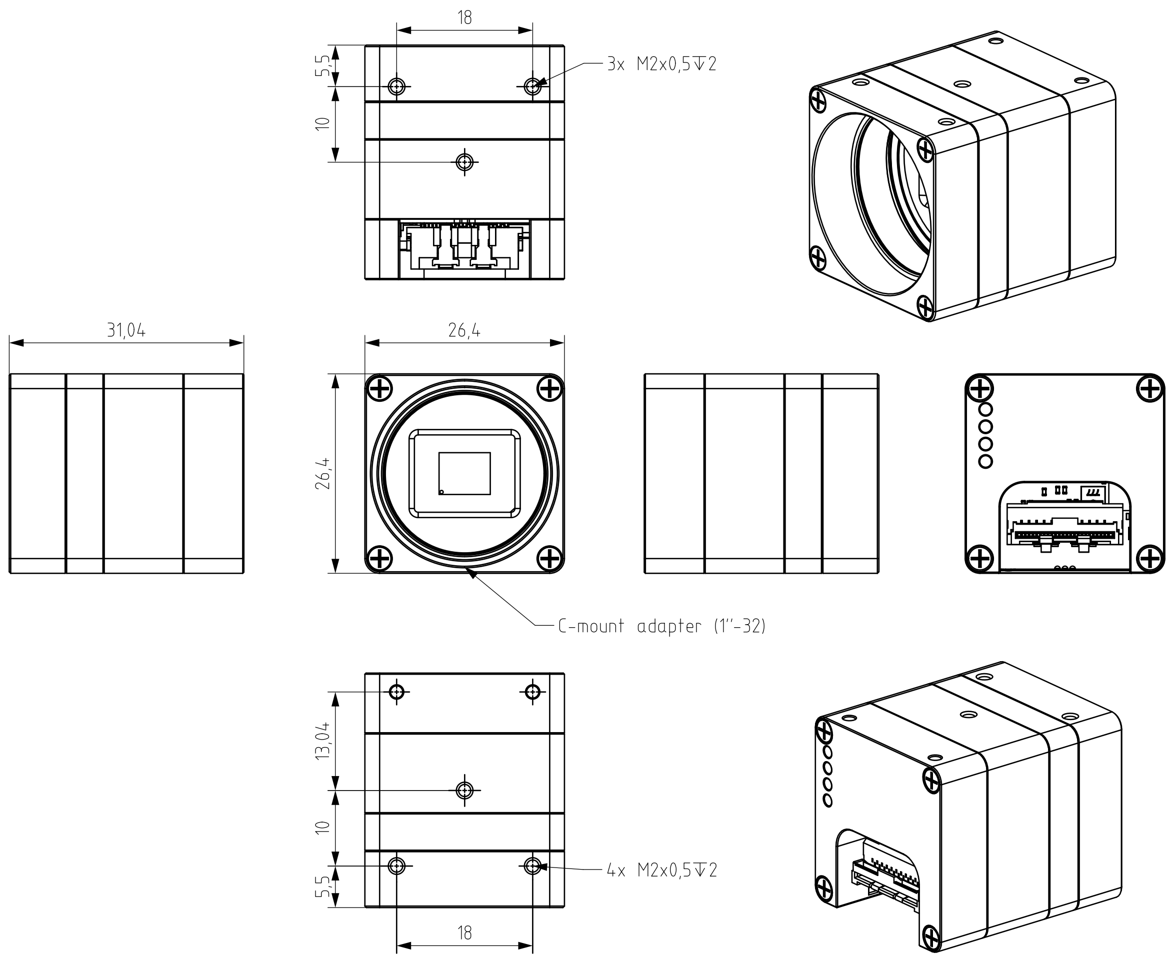



Figure 44: Dimensional drawings of MX051/081/124xG-SY-PG4-X2G2-FV

Dimensional drawings of:

MX089CG-SY-X2G2-FL MX089MG-SY-X2G2-FL MX124CG-SY-X2G2-FL MX124MG-SY-X2G2-FL

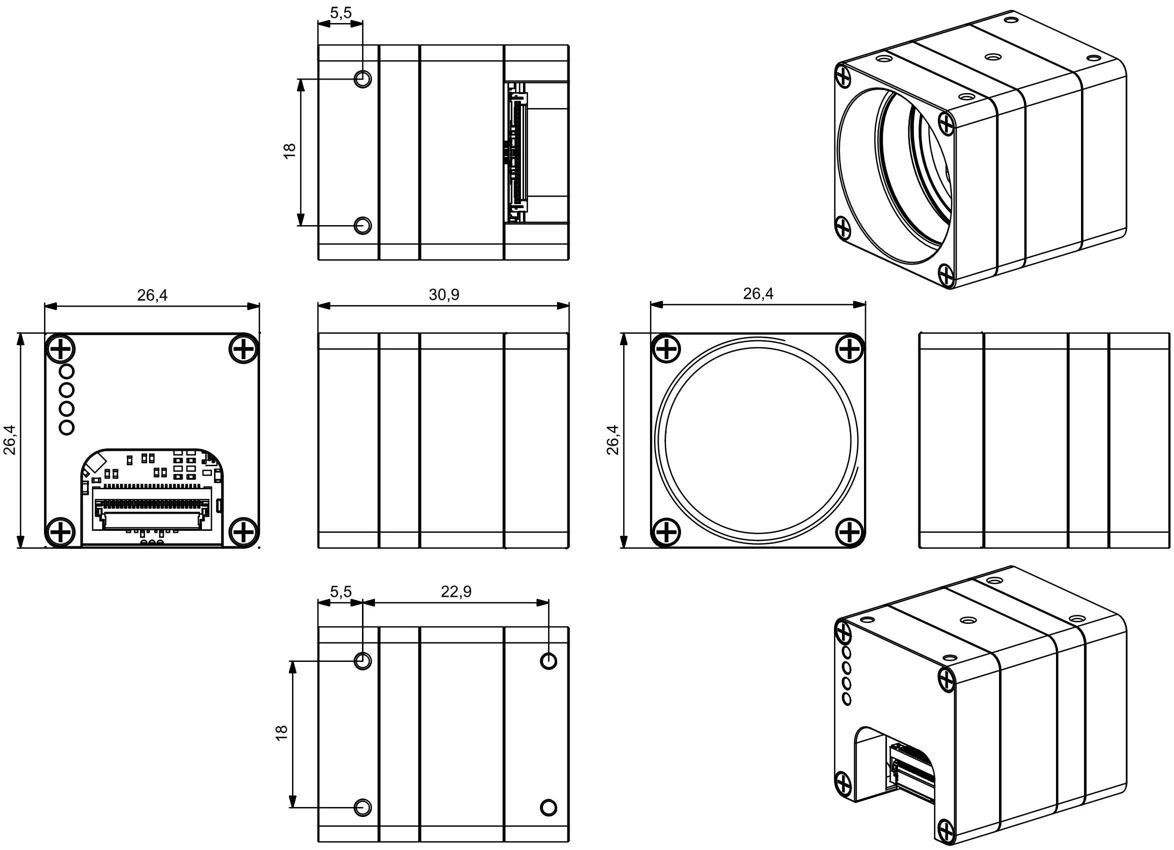



Figure 45: Dimensional drawing of MX089/124xG-SY-X2G2-FL (C-mount (with C-mount module B))

Dimensional drawings of:

MX023CG-SY-X2G2-FF MX023MG-SY-X2G2-FF MX089CG-SY-X2G2-FF MX089MG-SY-X2G2-FF
MX124CG-SY-X2G2-FF MX124MG-SY-X2G2-FF

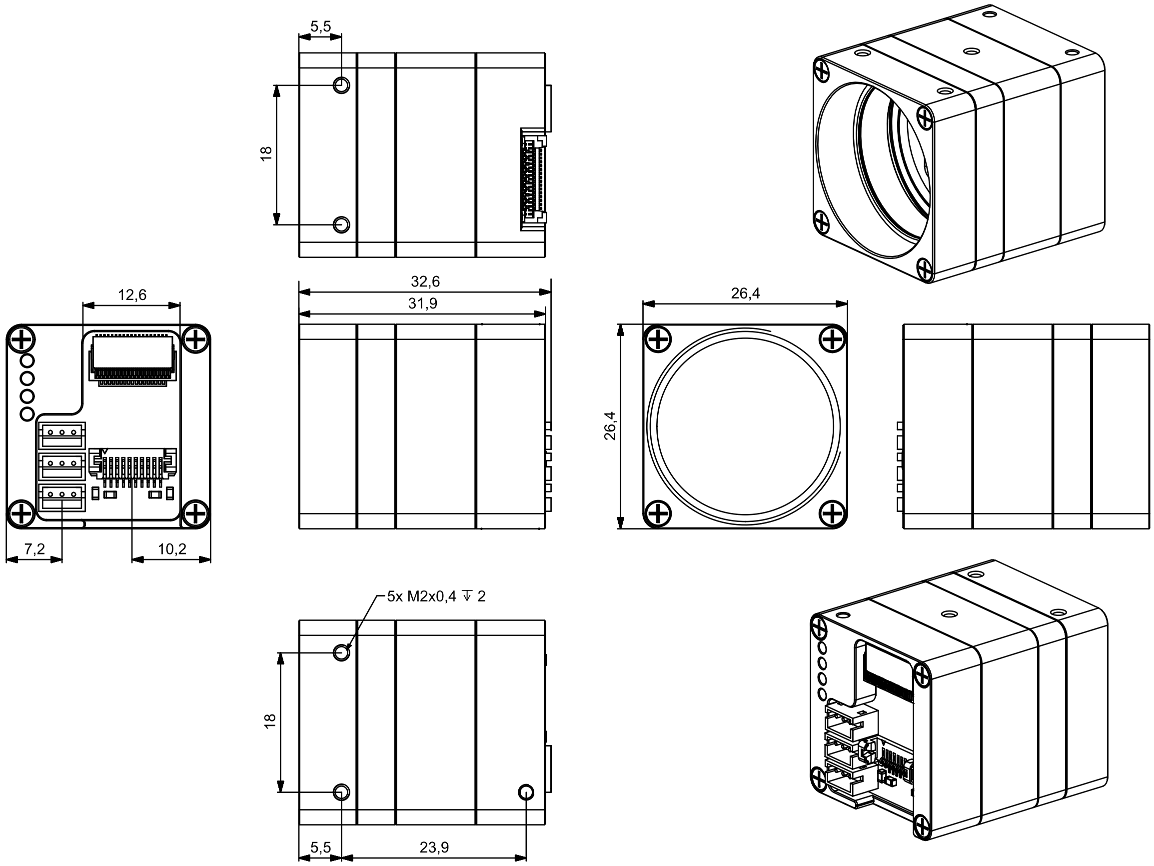



Figure 46: Dimensional drawing of MX023/089/124xG-SY-X2G2-FF (C-mount (with C-mount module B))

Dimensional drawings of:

MX089CG-SY-X2G2-FV MX089MG-SY-X2G2-FV MX124CG-SY-X2G2-FV MX124MG-SY-X2G2-FV

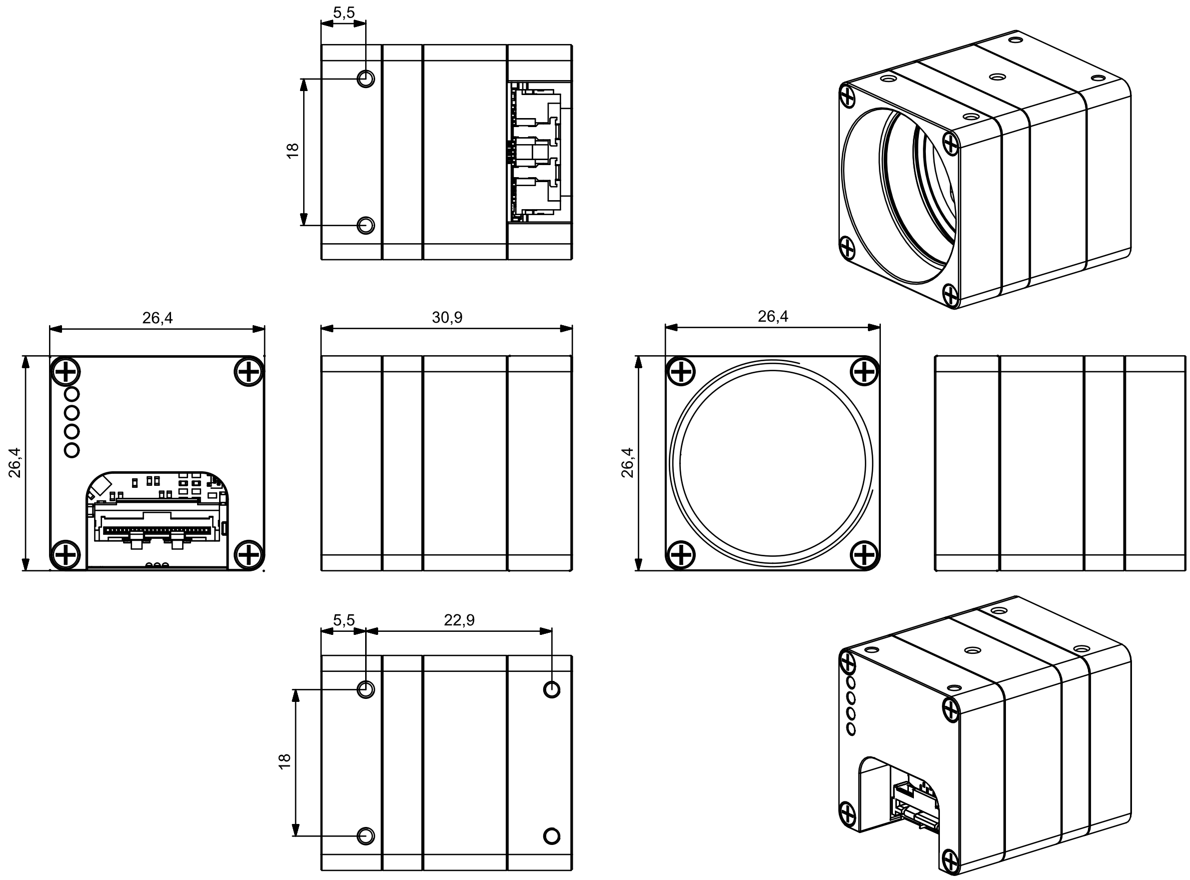



Figure 47: Dimensional drawing of MX089/124xG-SY-X2G2-FV (C-mount (with C-mount module B))

Dimensional drawings of:

| | | | |
|---|---|---|---|
| MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL-HDR |
| MX081CG-SY-PG4-X2G2-FL | MX081CG-SY-PG4-X2G2-FL-HDR | MX081MG-SY-PG4-X2G2-FL | MX081MG-SY-PG4-X2G2-FL-HDR |
| MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FL-HDR |

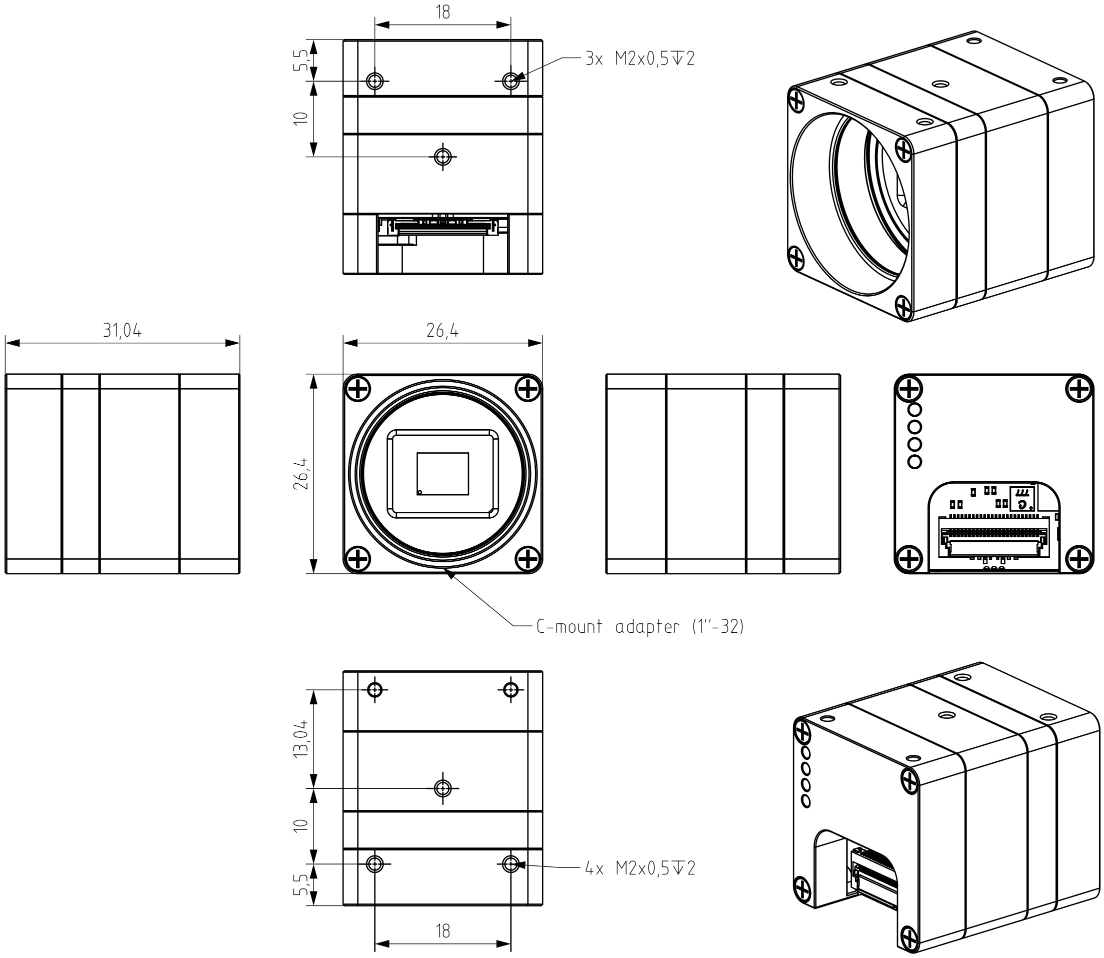



Figure 48: Dimensional drawings of MX051/081/124xG-SY-PG4-X2G2-FL

Dimensional drawings of:

MX081UG-SY-X2G2-FL-HDR
MX161MG-SY-X2G2-FL-HDR
MX203MG-SY-X2G2-FL-HDR
MX245MG-SY-X2G2-FL-HDR
MX161CG-SY-X2G2-FL-HDR
MX203CG-SY-X2G2-FL
MX245CG-SY-X2G2-FL
MX161CG-SY-X2G2-FL
MX203CG-SY-X2G2-FL-HDR
MX245CG-SY-X2G2-FL-HDR
MX161MG-SY-X2G2-FL
MX203MG-SY-X2G2-FL
MX245MG-SY-X2G2-FL

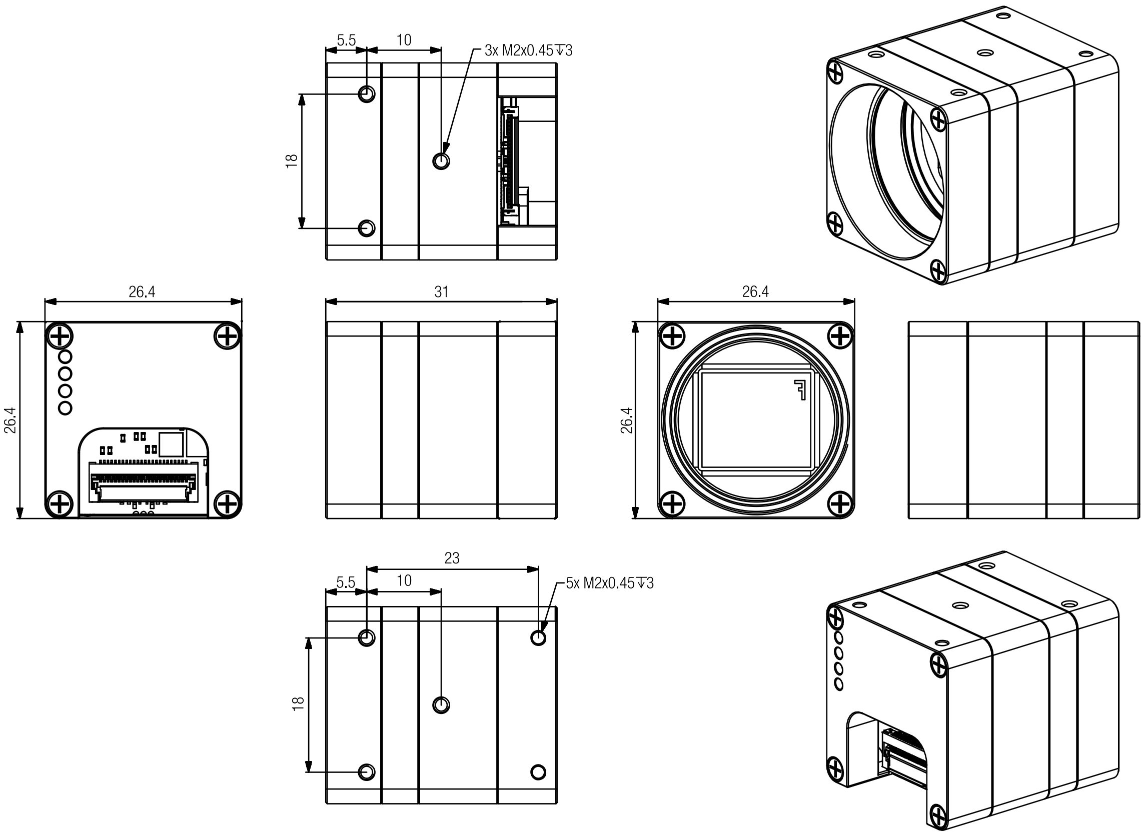



Figure 49: Dimensional drawing of MX081/161/203/245xG-SY-X2G2-FL-HDR (C-mount (with C-mount module B))

Dimensional drawings of:

| | | | |
|---|---|---|---|
| MX081UG-SY-X2G2-FV-HDR | MX161CG-SY-X2G2-FV | MX161CG-SY-X2G2-FV-HDR | MX161MG-SY-X2G2-FV |
| MX161MG-SY-X2G2-FV-HDR | MX203CG-SY-X2G2-FV | MX203CG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FV-HDR |
| MX203MG-SY-X2G2-FV | MX245CG-SY-X2G2-FV | MX245CG-SY-X2G2-FV-HDR | MX245MG-SY-X2G2-FV |
| MX245MG-SY-X2G2-FV-HDR | | | |

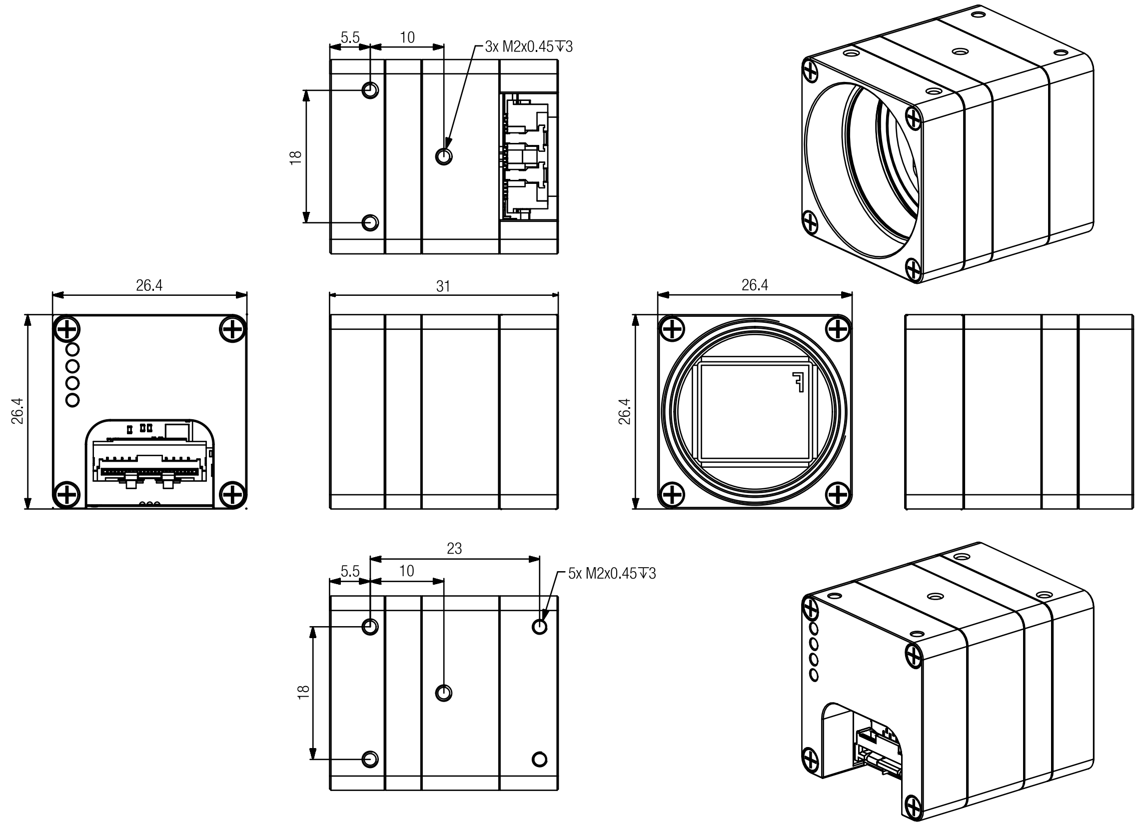



Figure 50: Dimensional drawing of MX081/161/203/245xG-SY-X2G2-FV-HDR (C-mount (with C-mount module B))

Dimensional drawings of:

MX081UG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FF-HDR
MX203MG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FF-HDR

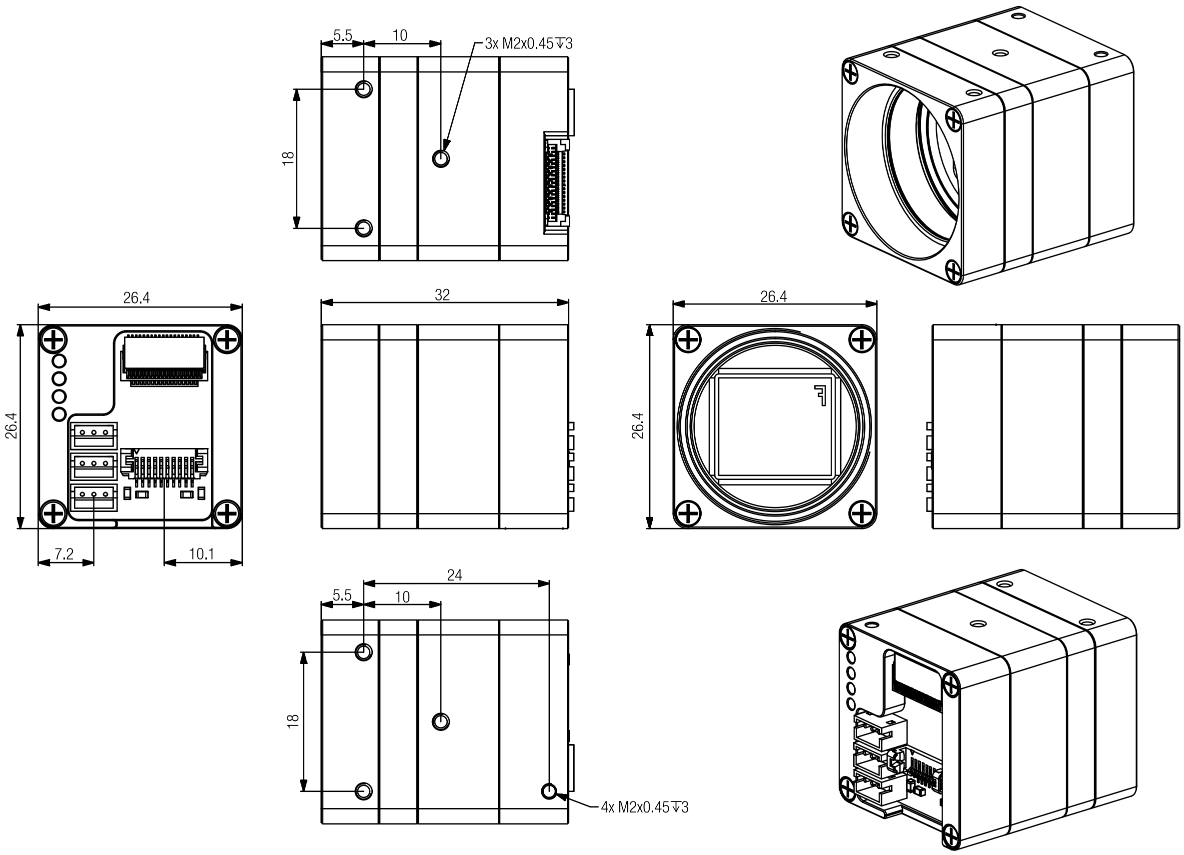



Figure 51: Dimensional drawing of MX081/161/203/245xG-SY-X2G2-FF-HDR (C-mount (with C-mount module B))

## 2.8 User interface – LEDs

| LED | Color | Defaults | Note |
|---|---|---|---|
| 1 | Green | PCIe Lanes | User configurable |
| 2 | Red | PCIe Clock Present | User configurable |
| 3 | Blue | PCIe Clock Present | User configurable |
| 4 | Orange | PCIe Link Speed | User configurable |

Table 117: LED output description during camera power up

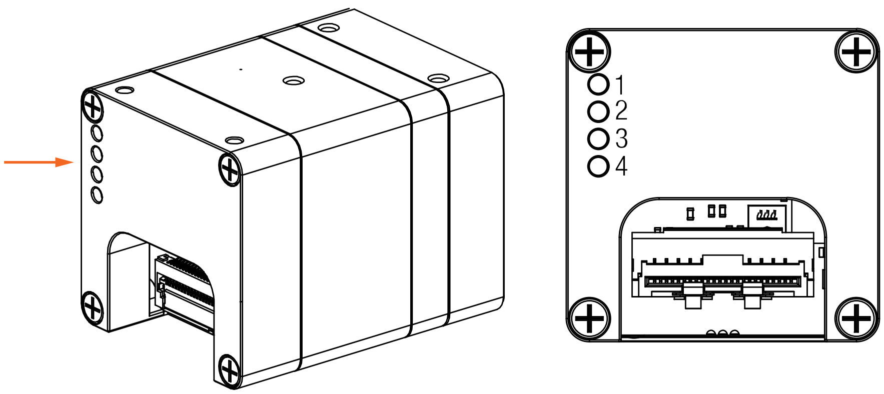



Figure 52: Position of LEDs on xiX-XS camera

LED statuses during boot sequence of:
all models in this manual (refer to the table Models and sensors overview)

| Status | LED 1 | LED 2 | LED 3 | LED 4 |
|---|---|---|---|---|
| Off | Off | Off | Off | Off |
| Power | On | Off | Off | Off |
| Camera booted no PCIe | Off | Off | On | On |
| Golden 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 | flash | flash | flash | flash |

[1]Golden 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 please start xiCOP. See: XIMEA control panel.

Table 118: LED statuses during boot sequence

## 2.9 Camera interface

NOTE: It is important that the power is turned off when inserting/detaching the cable. General ESD precautions need to be applied. Failing this requirement may lead to camera damage.

The following section applies to:

| | | | |
|---|---|---|---|
| MX023CG-SY-X2G2-FL | MX023CG-SY-X2G2-FV | MX023MG-SY-X2G2-FL | MX023MG-SY-X2G2-FV |
| MX031CG-SY-X2G2-FL | MX031CG-SY-X2G2-FV | MX031MG-SY-X2G2-FL | MX031MG-SY-X2G2-FV |
| MX042CG-CM-X2G2-FL | MX042CG-CM-X2G2-FV | MX042MG-CM-X2G2-FL | MX042MG-CM-X2G2-FV |
| MX042RG-CM-X2G2-FL | MX042RG-CM-X2G2-FV | MX050CG-SY-X2G2-FL | MX050CG-SY-X2G2-FV |
| MX050MG-SY-X2G2-FL | MX050MG-SY-X2G2-FV | MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FL |
| MX051CG-SY-PG4-X2G2-FV-HDR | MX051CG-SY-PG4-X2G2-FV | MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL-HDR |
| MX051MG-SY-PG4-X2G2-FV-HDR | MX051MG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FL | MX081CG-SY-PG4-X2G2-FL-HDR |
| MX081CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FL | MX081MG-SY-PG4-X2G2-FL-HDR |
| MX081MG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV | MX081UG-SY-X2G2-FL-HDR | MX081UG-SY-X2G2-FV-HDR |
| MX089CG-SY-X2G2-FL | MX089CG-SY-X2G2-FV | MX089MG-SY-X2G2-FL | MX089MG-SY-X2G2-FV |
| MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FL | MX124CG-SY-PG4-X2G2-FV-HDR | MX124CG-SY-PG4-X2G2-FV |
| MX124CG-SY-X2G2-FL | MX124CG-SY-X2G2-FV | MX124MG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FL-HDR |
| MX124MG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FV | MX124MG-SY-X2G2-FL | MX124MG-SY-X2G2-FV |
| MX161CG-SY-X2G2-FL-HDR | MX161CG-SY-X2G2-FL | MX161CG-SY-X2G2-FV | MX161CG-SY-X2G2-FV-HDR |
| MX161MG-SY-X2G2-FL | MX161MG-SY-X2G2-FL-HDR | MX161MG-SY-X2G2-FV | MX161MG-SY-X2G2-FV-HDR |
| MX203CG-SY-X2G2-FL | MX203CG-SY-X2G2-FL-HDR | MX203CG-SY-X2G2-FV | MX203CG-SY-X2G2-FV-HDR |
| MX203MG-SY-X2G2-FL | MX203MG-SY-X2G2-FL-HDR | MX203MG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FV |
| MX245CG-SY-X2G2-FL | MX245CG-SY-X2G2-FL-HDR | MX245CG-SY-X2G2-FV | MX245CG-SY-X2G2-FV-HDR |
| MX245MG-SY-X2G2-FL | MX245MG-SY-X2G2-FL-HDR | MX245MG-SY-X2G2-FV | MX245MG-SY-X2G2-FV-HDR |

### 2.9.1 Flex cable interface

The flex cable interface is located on the back of the camera and comes with two different options based on the orientation the cable plugs into the camera. The (FL) version of the camera allows the cable to approach from the bottom of the camera and the (FV) version has the cable connecting to the camera perpendicular to the sensor surface. The flex line cameras have one input, one output and two input-output (GPIO) available through the flex line (see Digital inputs / outputs (GPIO) interface for pinout description).

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

Table 119: Flex cable interface mating connector description

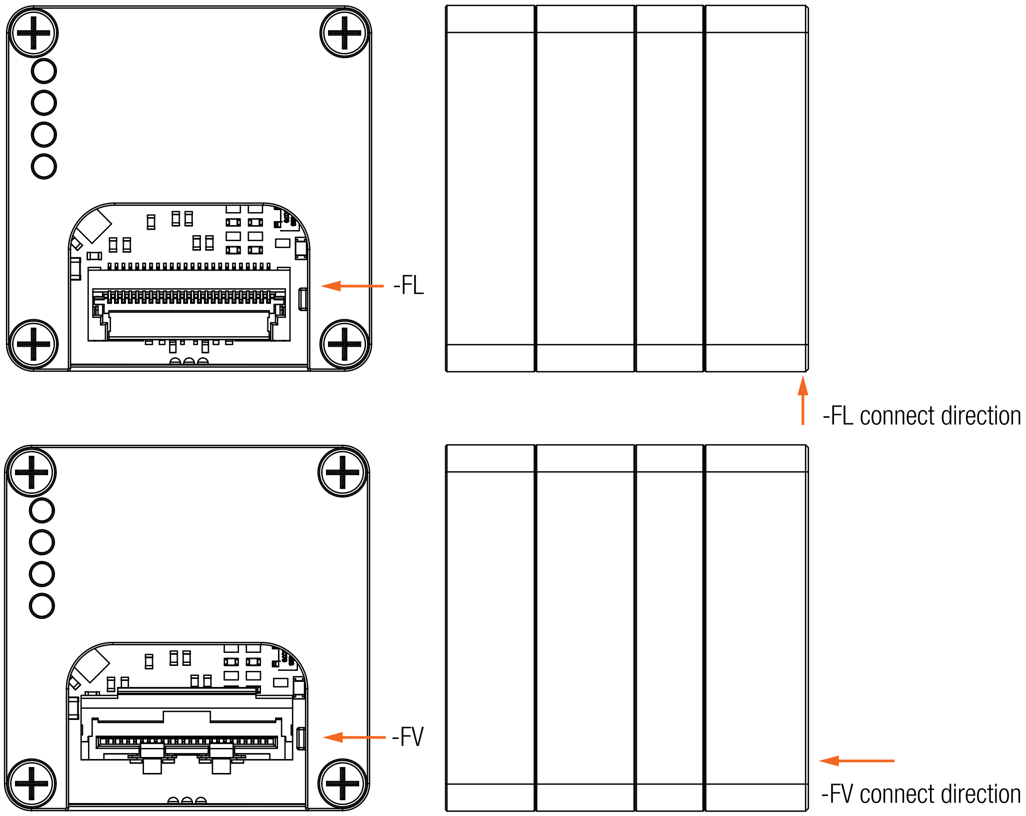



Figure 53: Flex connector location

The following section applies to:

| | | | |
|---|---|---|---|
| MX023CG-SY-X2G2-FF | MX023MG-SY-X2G2-FF | MX031CG-SY-X2G2-FF | MX031MG-SY-X2G2-FF |
| MX042CG-CM-X2G2-FF | MX042MG-CM-X2G2-FF | MX042RG-CM-X2G2-FF | MX050CG-SY-X2G2-FF |
| MX050MG-SY-X2G2-FF | MX051CG-SY-PG4-X2G2-FF | MX051CG-SY-PG4-X2G2-FF-HDR | MX051MG-SY-PG4-X2G2-FF-HDR |
| MX051MG-SY-PG4-X2G2-FF | MX081CG-SY-PG4-X2G2-FF-HDR | MX081CG-SY-PG4-X2G2-FF | MX081MG-SY-PG4-X2G2-FF-HDR |
| MX081MG-SY-PG4-X2G2-FF | MX081UG-SY-X2G2-FF-HDR | MX089CG-SY-X2G2-FF | MX089MG-SY-X2G2-FF |
| MX124CG-SY-PG4-X2G2-FF-HDR | MX124CG-SY-PG4-X2G2-FF | MX124CG-SY-X2G2-FF | MX124MG-SY-PG4-X2G2-FF |
| MX124MG-SY-PG4-X2G2-FF-HDR | MX124MG-SY-X2G2-FF | MX161CG-SY-X2G2-FF-HDR | MX161MG-SY-X2G2-FF-HDR |
| MX203CG-SY-X2G2-FF-HDR | MX203MG-SY-X2G2-FF-HDR | MX245CG-SY-X2G2-FF-HDR | MX245MG-SY-X2G2-FF-HDR |

### 2.9.2 PCIe / FireFly interface

The interface connector is used for data transmission, camera control, power and IO (see section Digital inputs / outputs (GPIO) interface for connector IO pinout description).

| Item | Value |
|---|---|
| Connector | Samtec (UEC5-019-1-H-D-RA-1-A + UCC8-010-1-H-S-1-A) |
| Signals | PCIe x2 Gen2; IO[1] |
| Mating Connectors | CBL-ECUE-X4G3-1M0, CBL-ECUE-X4G3-2M0, CBL-PCUE-X4G3 |

[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

Table 120: Firefly interface mating connector description

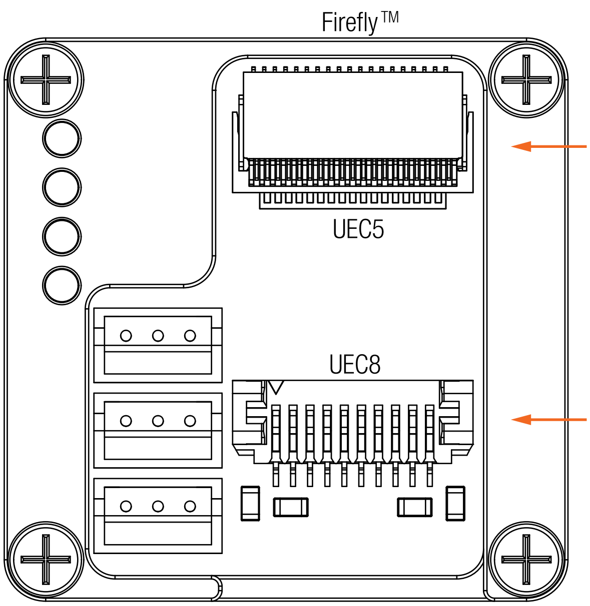
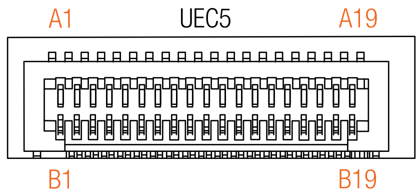



Figure 54: PCIe / FireFly connector location



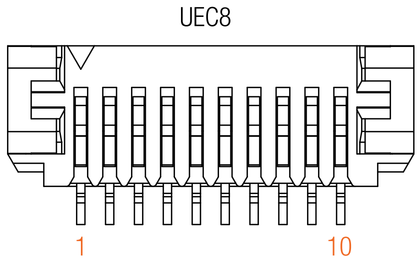




Figure 55: PCIe / FireFly connector pinout MX-XS

| Pin | Name | Type |
|---|---|---|
| 1 | VCC_TX | Power output |
| 2 | GND | Ground |
| 3 | NC | None |
| 4 | SELECT | PCIe lines multiplexer selector |
| 5 | PCIe_RST0_N_IN | PCIe reset |
| 6 | NC | None |
| 7 | NC | None |
| 8 | NC | None |
| 9 | OUT1 | Optically isolated Digital Output (OUT) |
| 10 | VCC_RX | Power output |

Table 121: FireFly UCC8 connector pin assignment

| Pin | Name | Type | Pin | Name | Type |
|---|---|---|---|---|---|
| A1 | GND | Signal and power ground | B1 | GND | Signal and power ground |
| A2 | PCIe_PETN_2 | PCIe TX differential pair 2 | B2 | PCIe_PETN_3 | PCIe TX differential pair 3 |
| A3 | PCIe_PETP_2 | PCIe TX differential pair 2 | B3 | PCIe_PETP_3 | PCIe TX differential pair 3 |
| A4 | GND | Signal | B4 | GND | Signal and power ground |
| A5 | PCIe_PETN_1 | PCIe TX differential pair 1 | B5 | PCIe_PETN_0 | PCIe TX differential pair 0 |
| A6 | PCIe_PETP_1 | PCIe TX differential pair 1 | B6 | PCIe_PETP_0 | PCIe TX differential pair 0 |
| A7 | GND | Signal and power ground | B7 | GND | Signal and power ground |
| A8 | IN1 | Optically isolated Digital Input (IN) | B8 | OUT1 | Optically isolated Digital Output (OUT) |
| A9 | IN1_GND | Ground for opto-isolated Input 1 | B9 | OUT1_GND | Ground for opto-isolated Output 1 |
| A10 | GND | Signal and power ground | B10 | GND | Signal and power ground |
| A11 | PCIe_RST0_N_IN | PCIe reset | B11 | PWR | Power input |
| A12 | NC | None | B12 | PWR | Power input |
| A13 | GND | Signal and power ground | B13 | GND | Signal and power ground |
| A14 | PCIe_PERP_2 | PCIe RX differential pair 2 | B14 | PCIe_PERN_3 | PCIe RX differential pair 3 |
| A15 | PCIe_PERN_2 | PCIe RX differential pair 2 | B15 | PCIe_PERP_3 | PCIe RX differential pair 3 |
| A16 | GND | Signal and power ground | B16 | GND | Signal and power ground |
| A17 | PCIe_PERP_1 | PCIe RX differential pair 1 | B17 | PCIe_PERN_0 | PCIe RX differential pair 0 |
| A18 | PCIe_PERN_1 | PCIe RX differential pair 1 | B18 | PCIe_PERP_0 | PCIe RX differential pair 0 |
| A19 | GND | Signal and power ground | B19 | GND | Signal and power ground |

Table 122: FireFly UEC5 connector pin assignment

## 2.10 Digital inputs / outputs (GPIO) interface

The description of the GPIO interface below applies to:

| | | | |
|---|---|---|---|
| MX023CG-SY-X2G2-FL | MX023CG-SY-X2G2-FV | MX023MG-SY-X2G2-FL | MX023MG-SY-X2G2-FV |
| MX031CG-SY-X2G2-FL | MX031CG-SY-X2G2-FV | MX031MG-SY-X2G2-FL | MX031MG-SY-X2G2-FV |
| MX042CG-CM-X2G2-FL | MX042CG-CM-X2G2-FV | MX042MG-CM-X2G2-FL | MX042MG-CM-X2G2-FV |
| MX042RG-CM-X2G2-FL | MX042RG-CM-X2G2-FV | MX050CG-SY-X2G2-FL | MX050CG-SY-X2G2-FV |
| MX050MG-SY-X2G2-FL | MX050MG-SY-X2G2-FV | MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FL |
| MX051CG-SY-PG4-X2G2-FV-HDR | MX051CG-SY-PG4-X2G2-FV | MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FL-HDR |
| MX051MG-SY-PG4-X2G2-FV-HDR | MX051MG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FL | MX081CG-SY-PG4-X2G2-FL-HDR |
| MX081CG-SY-PG4-X2G2-FV | MX081CG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FL | MX081MG-SY-PG4-X2G2-FL-HDR |
| MX081MG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FV | MX081UG-SY-X2G2-FL-HDR | MX081UG-SY-X2G2-FV-HDR |
| MX089CG-SY-X2G2-FL | MX089CG-SY-X2G2-FV | MX089MG-SY-X2G2-FL | MX089MG-SY-X2G2-FV |
| MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FL | MX124CG-SY-PG4-X2G2-FV-HDR | MX124CG-SY-PG4-X2G2-FV |
| MX124CG-SY-X2G2-FL | MX124CG-SY-X2G2-FV | MX124MG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FL-HDR |
| MX124MG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FV | MX124MG-SY-X2G2-FL | MX124MG-SY-X2G2-FV |
| MX161CG-SY-X2G2-FL-HDR | MX161CG-SY-X2G2-FL | MX161CG-SY-X2G2-FV | MX161CG-SY-X2G2-FV-HDR |
| MX161MG-SY-X2G2-FL | MX161MG-SY-X2G2-FL-HDR | MX161MG-SY-X2G2-FV | MX161MG-SY-X2G2-FV-HDR |
| MX203CG-SY-X2G2-FL | MX203CG-SY-X2G2-FL-HDR | MX203CG-SY-X2G2-FV | MX203CG-SY-X2G2-FV-HDR |
| MX203MG-SY-X2G2-FL | MX203MG-SY-X2G2-FL-HDR | MX203MG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FV |
| MX245CG-SY-X2G2-FL | MX245CG-SY-X2G2-FL-HDR | MX245CG-SY-X2G2-FV | MX245CG-SY-X2G2-FV-HDR |
| MX245MG-SY-X2G2-FL | MX245MG-SY-X2G2-FL-HDR | MX245MG-SY-X2G2-FV | MX245MG-SY-X2G2-FV-HDR |

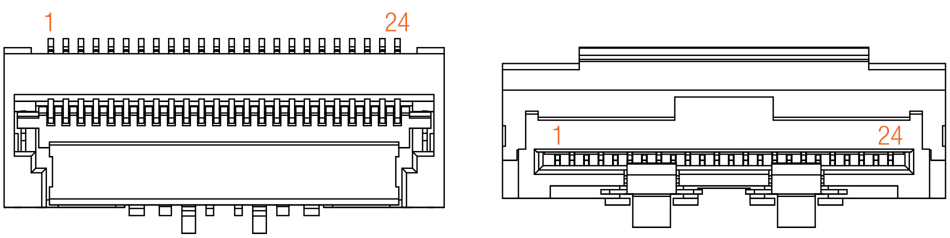



Figure 56: Flex / IO connector pinning

| Pin | Name | GPI/GPO index API | Type |
|---|---|---|---|
| 1 | GND | None | Ground return |
| 2 | PCIe_REFCLK_P | None | PCIe reference clock diff. pair, pos. |
| 3 | PCIe_REFCLK_N | None | PCIe reference clock diff. pair, neg. |
| 4 | GND | None | Ground return |
| 5 | PCIe_PERP_1 | None | PCIe RX differential pair 1, pos. |
| 6 | PCIe_PERN_1 | None | PCIe RX differential pair 1, neg. |
| 7 | GND | None | Ground return |
| 8 | PCIe_PERP_0 | None | PCIe RX differential pair 0, pos. |
| 9 | PCIe_PERN_0 | None | PCIe RX differential pair 0, neg. |
| 10 | GND | None | Ground return |
| 11 | PCIe_PETP_1 | None | PCIe TX differential pair 1, pos. |
| 12 | PCIe_PETN_1 | None | PCIe TX differential pair 1, neg. |
| 13 | GND | None | Ground return |
| 14 | PCIe_PETP_0 | None | PCIe TX differential pair 0, pos. |
| 15 | PCIe_PETN_0 | None | PCIe TX differential pair 0, neg. |
| 16 | GND | None | Ground return |
| 17 | PCIe_RST0_N_IN | None | PCIe reset |
| 18 | PWR | None | Power input |
| 19 | PWR | None | Power input |
| 20 | INOUT1 | 2/2 | Non-isolated digital lines - Digital Input-Output (INOUT) |
| 21 | INOUT2 | 3/3 | Non-isolated digital lines - Digital Input-Output (INOUT) |
| 22 | IN1 | 1/- | Optically isolated Digital Input (IN) |
| 23 | IN_OUT_GND | None | Common ground for opto-isolated IO |
| 24 | OUT1 | -/1 | Optically isolated Digital Output (OUT) |

Table 123: I/O connector pin assignment

The description of the GPIO interface below applies to:

MX023CG-SY-X2G2-FF MX023MG-SY-X2G2-FF MX031CG-SY-X2G2-FF MX031MG-SY-X2G2-FF
MX042CG-CM-X2G2-FF MX042MG-CM-X2G2-FF MX042RG-CM-X2G2-FF MX050CG-SY-X2G2-FF
MX050MG-SY-X2G2-FF MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FF-HDR
MX051MG-SY-PG4-X2G2-FF MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FF MX081MG-SY-PG4-X2G2-FF-HDR
MX081MG-SY-PG4-X2G2-FF MX081UG-SY-X2G2-FF-HDR MX089CG-SY-X2G2-FF MX089MG-SY-X2G2-FF
MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FF MX124CG-SY-X2G2-FF MX124MG-SY-PG4-X2G2-FF
MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-X2G2-FF MX161CG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FF-HDR
MX203CG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FF-HDR

| Pin | Name | GPI/GPO index API | Type |
|---|---|---|---|
| Pinout FireFly UCC8 connector | | | |
| 9 | OUT1 | -/1 | Optically isolated Digital Output (OUT) |
| Pinout FireFly UEC5 connector | | | |
| A8 | IN1 | 1/- | Optically isolated Digital Input (IN) |
| B8 | OUT1 | -/1 | Optically isolated Digital Output (OUT) |

Table 124: FireFly connector I/O pin assignment

| Item | Value |
|---|---|
| Connector | JST B3B-ZR(LF)(SN) |
| Signals | Opto-isolated IO, Non-isolated IO, Auxiliary power |
| Mating Connectors | JST ZHR3, JST 03ZR-8M-P, JST 03ZR-3H-P |

Table 125: GPIO and Power mating connector description

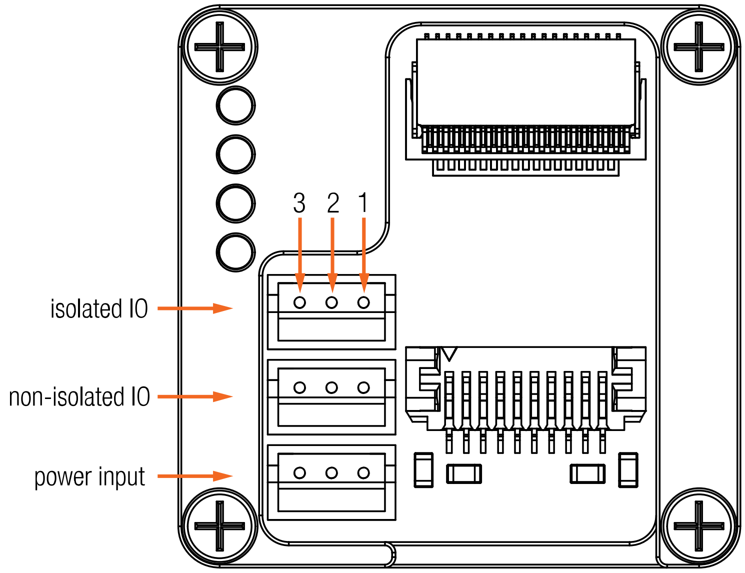



Figure 57: I/O and power connectors position

| Pin | Name | GPI/GPO index API | Type |
| --- | --- | --- | --- |
| Optically isolated IO pin assignment | | | |
| 1 | IN1 | 1/- | Optically isolated Digital Input (IN) |
| 2 | IN/OUT_GND | None | Common pole |
| 3 | OUT1 | -/1 | Optically isolated Digital Output (OUT) |
| Non-isolated IO pin assignment | | | |
| 1 | INOUT1 | 2/2 | Non-isolated digital lines - Digital Input-Output (INOUT) |
| 2 | GND | None | Common pole for non-isolated IO (same as power GND) |
| 3 | INOUT2 | 3/3 | Non-isolated digital lines - Digital Input-Output (INOUT) |

Table 126: I/O connector pin assignment

| Pin | Name | Type |
| --- | --- | --- |
| 1 | PWR | Power input |
| 2 | GND | Ground return |
| 3 | PWR | Power input |

Table 127: Power connector pin assignment

### 2.10.1 Optically isolated Digital Input (IN)

The description of optically isolated digital input below applies to:
all models in this manual (refer to the table Models and sensors overview)

| Item | Parameter | Note |
|---:|---|---|
| Maximal input voltage | 24 V DC | None |
| Common pole | True | IN GND |
| Effect of incorrect input terminal connection | Reverse voltage polarity protected | None |
| Effects when withdrawing/inserting input module under power | no damage, no lost data | None |
| Maximal recommended cable length | 10m | None |
| Input Level for logical 0 | Voltage < 2.5 V / Current < 1 mA | None |
| Input Level for logical 1 | Voltage > 4.0 V / Current > 1 mA | None |
| Input debounce filter | False | None |
| Input delay - rising edge | 1+-0.2 µs | VINPUT=10 V,TAMBIENT=25 °C |
| Input delay - falling edge | 5+-0.2 µs | VINPUT=10 V,TAMBIENT=25 °C |
| External trigger mapping | True | None |
| Input functions | Trigger | Rising or falling edge are supported for trigger |

Table 128: General info for optically isolated digital input

## 2.10.2 Optically isolated Digital Output (OUT)

The description of optically isolated digital output below applies to:
all models in this manual (refer to the table Models and sensors overview)

| Item | Parameter | Note |
|---:|---|---|
| Maximal open circuit voltage | 24 V DC | None |
| Output port type | Open collector NPN | None |
| Common pole | True | OUT GND |
| Protection | short-circuit / over-current / Reverse voltage | None |
| Protection circuit | PTC Resettable Fuse | None |
| Maximal sink current | 36 mA | None |
| Trip current | 71 mA | Self-restarting when failure mode current disconnected |
| Inductive loads | false | None |
| Effect of incorrect output terminal connection | Protected against reverse voltage connection | None |
| Maximal output dropout | 1 V | Sink current 25 mA |
| Output delay - ON -> OFF | 26us | VOUTPUT=10 V,TAMBIENT=25 °C |
| Output delay - OFF -> ON | 1.5us | VOUTPUT=10 V,TAMBIENT=25 °C |
| Strobe output mapping | True | None |

Table 129: General info for optically isolated digital output

### 2.10.3 Non-isolated digital lines - Digital Input-Output (INOUT)

The description of non-isolated digital lines below applies to:
all models in this manual (refer to the table Models and sensors overview)

| Item | Parameter | Note |
|---|---|---|
| Maximal input voltage | 24 V DC | None |
| Common pole | YES | None |
| Effect of incorrect input terminal connection | Reverse voltage polarity protected | None |
| Effects when withdrawing/inserting input module under power | no damage, no lost data | None |
| Protection | short-circuit / over-current / Reverse voltage | None |
| Maximal output sink current | 30 µA | Maximal advised load = 60 kΩ |
| Inductive loads | false | None |
| Output Level logical 0 | < 0.4 V | Load 100 kΩ |
| Output Level logical 1 | > 2.5 V | Load 100 kΩ |
| Output delay - rising edge | 400 ns | Load 100 kΩ threshold 2 V |
| Output delay - falling edge | 450 ns | Load 100 kΩ threshold 0.5 V |
| Input Impedance- minimum | 15 kΩ | None |
| Input Level for logical 0 | < 0.7 V | None |
| Input Level for logical 1 | > 2.4 V | None |
| Input debounce filter | NO | None |
| Input delay - rising edge | 750 ns | VINPUT=5 V |
| Input delay - falling edge | 1200 ns | VINPUT=5 V |
| Input functions | Trigger | Rising or falling edge are supported for trigger |
| Output functions | false | Signal inversion supported |

Table 130: General info for non-isolated digital in/out trigger lines

## 2.11 Accessories

### 2.11.1 CBL-PCIEFLEX-X2G2-0M10/0M25/0M50

10 cm / 25 cm / 50 cm flex ribbon cable.

X2G2 cameras can be connected to host via flex cable. For connecting to different host via vast range of adapters. 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.

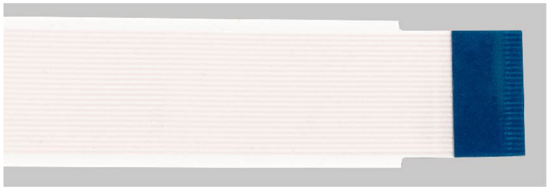


Figure 58: CBL-PCIEFLEX-X2G2-0M10

### 2.11.2 CBL-MX-X2G2-0M07/0M10/0M25/0M50

7 cm / 10 cm / 25 cm / 50 cm flex ribbon cable.

X2G2 cameras can be connected to host via flex cable. For connecting to different host via vast range of adapters. 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.

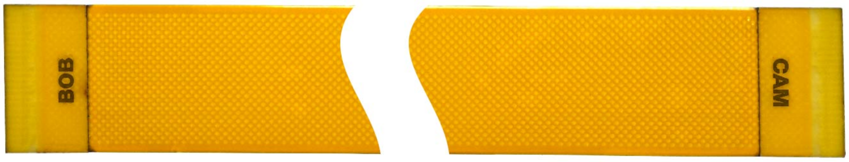



Figure 59: CBL-MX-X2G2-0M10

### 2.11.3 CBL-ECUE-X4G3-1M0/2M0/3M0

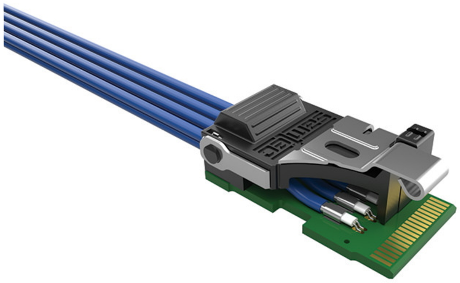


Figure 60: CBL-ECUE-X4G3-1M0

The FireFly copper cables are bidirectional and flexible. PCIe Gen3 x4 lanes with 14 Gbps. Both sides are equipped with locking mechanism. Please check the Accessories overview for supported lengths of the FireFly cables.

Cameras can be connected to host via cable with FireFly connector. The EMI/EMC performance should be evaluated by customer. For connecting to different host via vast range of adapters, please see our website Cameras Adapters

## 2.11.4 MECH-MC-BRACKET-KIT

Figure 61: MECH-MC-BRACKET-KIT adapter

Tripod mounting bracket with 1/4-20 thread. Mass without screws: 11.4 g.
Use 4x SROB-M2x4-CUST screws (included) for mounting. Bracket can be mounted on the bottom or top side of the camera.

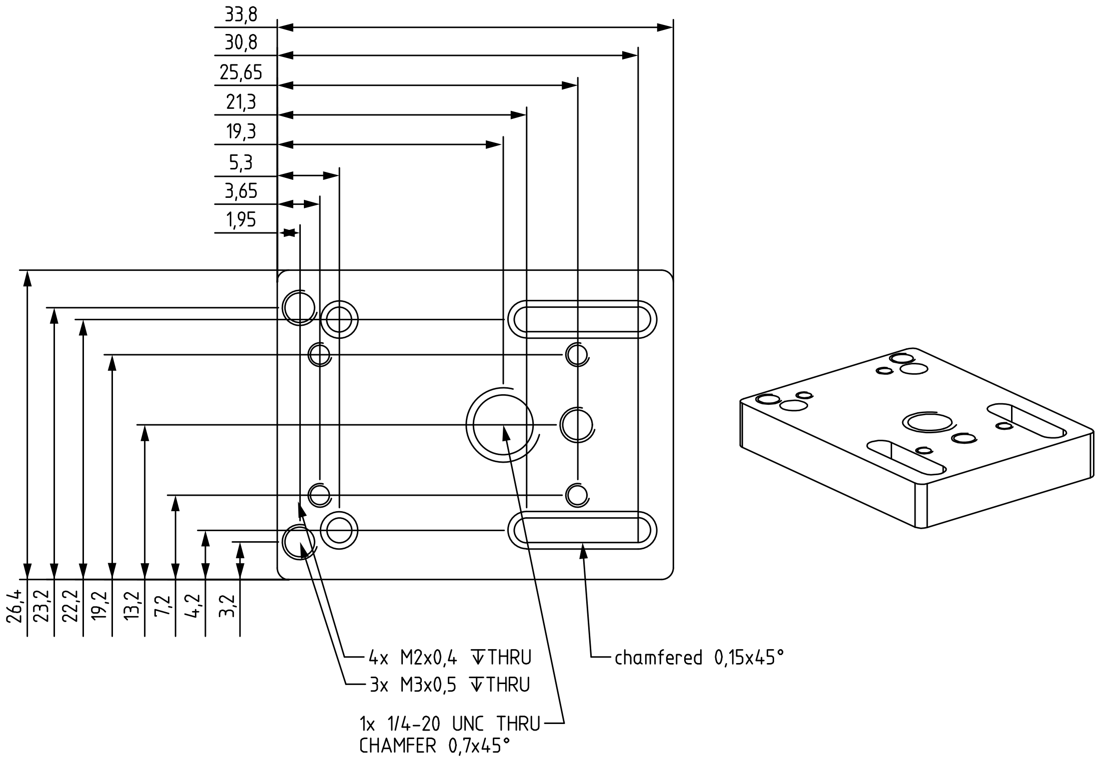



Figure 62: Dimensional drawing of tripod adapter

### 2.11.5 PCIe host adapter cards

Ximea offers several host adapter cards.
Please check our website for the latest information on available cards for your PC:

- XIMEA Host Adapters
- XIMEA Adapter Boards

# 3 General features

## 3.1 Camera features

### 3.1.1 ROIs – Region of interest

ROI, also called area-of-interest (AOI) or windowing, allows the user to specify a sub-area of the original sensor size for read-out. ROI can be set by specifying the size (width and height) as well as the position (based on upper left corner) of the of the sub-area.

### 3.1.2 Downsampling modes

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

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

They can be divided into:

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

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

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

#### Binning

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

#### Decimation – Skipping

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

### 3.1.3 Image data output formats

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

This table is applicable to:

| | | | |
|---|---|---|---|
| MX023MG-SY-X2G2-FF | MX023MG-SY-X2G2-FL | MX023MG-SY-X2G2-FV | MX031MG-SY-X2G2-FF |
| MX031MG-SY-X2G2-FL | MX031MG-SY-X2G2-FV | MX042MG-CM-X2G2-FF | MX042MG-CM-X2G2-FL |
| MX042MG-CM-X2G2-FV | MX042RG-CM-X2G2-FF | MX042RG-CM-X2G2-FL | MX042RG-CM-X2G2-FV |
| MX050MG-SY-X2G2-FF | MX050MG-SY-X2G2-FL | MX050MG-SY-X2G2-FV | MX051MG-SY-PG4-X2G2-FF |
| MX051MG-SY-PG4-X2G2-FL | MX051MG-SY-PG4-X2G2-FV | MX081MG-SY-PG4-X2G2-FF | MX081MG-SY-PG4-X2G2-FL |
| MX081MG-SY-PG4-X2G2-FV | MX089MG-SY-X2G2-FF | MX089MG-SY-X2G2-FL | MX089MG-SY-X2G2-FV |
| MX124MG-SY-PG4-X2G2-FF | MX124MG-SY-PG4-X2G2-FL | MX124MG-SY-PG4-X2G2-FV | MX124MG-SY-X2G2-FF |
| MX124MG-SY-X2G2-FL | MX124MG-SY-X2G2-FV | MX161MG-SY-X2G2-FL | MX161MG-SY-X2G2-FV |
| MX203MG-SY-X2G2-FL | MX203MG-SY-X2G2-FV | MX245MG-SY-X2G2-FL | MX245MG-SY-X2G2-FV |

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

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

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

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

Table 131: Image data output formats

This table is applicable to:

MX023CG-SY-X2G2-FF MX023CG-SY-X2G2-FL MX023CG-SY-X2G2-FV MX031CG-SY-X2G2-FF
MX031CG-SY-X2G2-FL MX031CG-SY-X2G2-FV MX042CG-CM-X2G2-FF MX042CG-CM-X2G2-FL
MX042CG-CM-X2G2-FV MX050CG-SY-X2G2-FF MX050CG-SY-X2G2-FL MX050CG-SY-X2G2-FV
MX051CG-SY-PG4-X2G2-FF MX051CG-SY-PG4-X2G2-FL MX051CG-SY-PG4-X2G2-FV MX081CG-SY-PG4-X2G2-FF
MX081CG-SY-PG4-X2G2-FL MX081CG-SY-PG4-X2G2-FV MX089CG-SY-X2G2-FF MX089CG-SY-X2G2-FL
MX089CG-SY-X2G2-FV MX124CG-SY-PG4-X2G2-FF MX124CG-SY-PG4-X2G2-FL MX124CG-SY-PG4-X2G2-FV
MX124CG-SY-X2G2-FF MX124CG-SY-X2G2-FL MX124CG-SY-X2G2-FV MX161CG-SY-X2G2-FL
MX161CG-SY-X2G2-FV MX203CG-SY-X2G2-FL MX203CG-SY-X2G2-FV MX245CG-SY-X2G2-FL
MX245CG-SY-X2G2-FV

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

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

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

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

Table 132: Image data output formats

This table is applicable to:

MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FF-HDR
MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR
MX081UG-SY-X2G2-FV-HDR MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR
MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL-HDR MX161MG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FF-HDR
MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL-HDR
MX245MG-SY-X2G2-FV-HDR

| Mode | Description |
|---:|---|
| XI_MONO8 | 8 bits per pixel. [Intensity][1,2] |
| XI_MONO16 | 16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2] |
| XI_RAW8 | 8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output) |
| XI_RAW8X2 | 8 bits per pixel raw data from sensor(2 components in a row) |
| XI_RAW16 | 16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data |
| XI_RAW16X2 | 16 bits per pixel raw data from sensor(2 components in a row) |
| XI_FRM_TRANSPORT | Data from transport layer (e.g. packed). Depends on data on the transport layer[3] |

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

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

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

Table 133: Image data output formats

This table is applicable to:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR MX081CG-SY-PG4-X2G2-FF-HDR
MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR
MX124CG-SY-PG4-X2G2-FV-HDR MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR
MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR MX245CG-SY-X2G2-FF-HDR
MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR

| Mode | Description |
|---:|---|
| XI_MONO8 | 8 bits per pixel. [Intensity][1,2] |
| XI_MONO16 | 16 bits per pixel. [Intensity LSB] [Intensity MSB][1,2] |
| XI_RAW8 | 8 bits per pixel raw data from sensor. [pixel byte] raw data from transport (camera output) |
| XI_RAW8X2 | 8 bits per pixel raw data from sensor(2 components in a row) |
| XI_RAW16 | 16 bits per pixel raw data from sensor. [pixel byte low] [pixel byte high] 16 bits (depacked) raw data |
| XI_RAW16X2 | 16 bits per pixel raw data from sensor(2 components in a row) |
| XI_RGB16_PLANAR | RGB16 planar data format |
| XI_RGB24 | RGB data format. [Blue][Green][Red][1] |
| XI_RGB32 | RGBA data format. [Blue][Green][Red][0][1] |
| XI_RGB48 | RGB data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high][1] |
| XI_RGB64 | RGBA data format. [Blue low byte][Blue high byte][Green low][Green high][Red low][Red high][0][0][1] |
| XI_RGB_PLANAR | RGB planar data format. [Red][Red]...[Green][Green]...[Blue][Blue]...[1] |
| XI_FRM_TRANSPORT | Data from transport layer (e.g. packed). Depends on data on the transport layer[3] |

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

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

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

Table 134: Image data output formats

### 3.1.4 Digitization bit depth

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

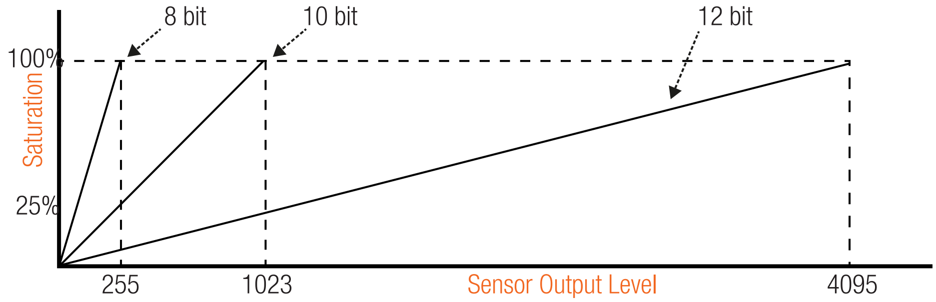



Figure 63: Saturation vs sensor output for different digitization bit depths

Cameras featuring 2nd and 4th generation of Sony Pregius sensors have special 8-bit digitization mode, which features the same conversion gain as 10-bit mode using only ¼ of the saturation. This leads to four times brighter images compared to 10-bit and 12-bit modes.

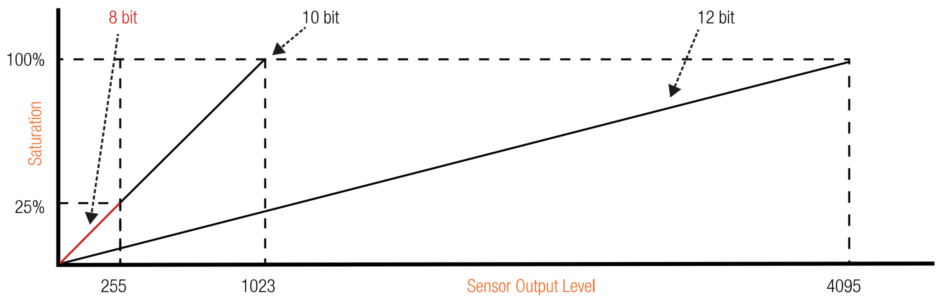



Figure 64: Saturation vs Sensor output for different digitization bit depths 2nd generation IMX sensors

## 3.2 Acquisition modes

### 3.2.1 Free-Run

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

For all sensors the exposure of the next frame overlaps with the data readout of the previous frame.
This Overlap mode gives the highest number of frames per second (FPS).

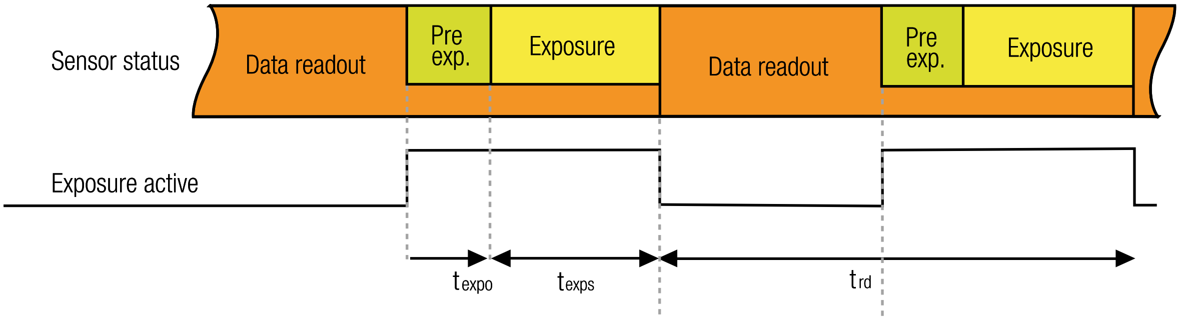



Figure 65: Acquisition mode - free run

The frame rate in free run mode depends inversely on the frame time. In general the frame time roughly equals to the readout time or to the exposure time, depending on which one of the two is larger. This means that when exposure time is larger than the readout time, the frame rate gradually decreases with increasing exposure time (frame_rate $\sim$ 1/t_exp).

In this mode the timing depends on the Exposure Time and Data Readout Time. In situation when the exposure time is comparable or longer than readout time, the exposure active signal might have constant active level during acquisition. This might be caused also by different propagation delay for rising and falling edge of opto isolated outputs. Polarity inversion might help to make visible the separated exposure pulses. Some camera models support limiting of FPS. When set the camera will limit the frame rate so it does not exceed the set value. Please see: Frame_Rate_Control. This is also applicable in case of triggered acquisition.

### 3.2.2 Trigger controlled acquisition/exposure

Unlike in the free-run, each image exposure can also be triggered with an input trigger signal. In this mode, the sensor waits in stage until the trigger signal arrives. Only then, the exposure of first frame is started, which is followed by the data readout. XIMEA cameras supports several triggered modes along with single image exposure after one trigger. The trigger signal can be either edge sensitive or level sensitive. In the case of “level sensitive”, it can be used to control length of exposure or acquisition itself. Generally trigger sources can be divided into two groups:

#### Software trigger

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

#### Hardware trigger

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

## Triggered mode - Single frame

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

### Sensor timing in Exposure Overlapped with Data Readout Mode

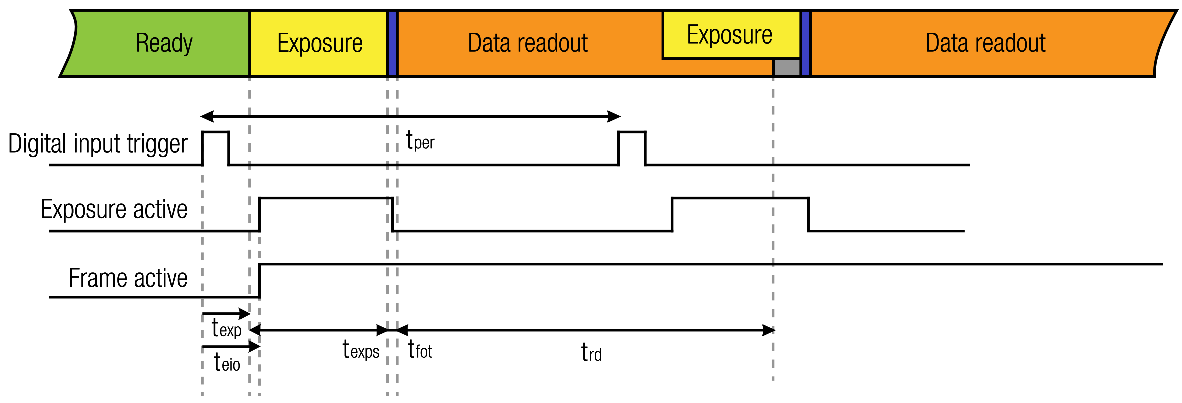



Figure 66: Acquisition mode - triggered with overlap

### Description

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

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

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

$t_{fot}$ Frame overhead time (FOT)

$t_{rd}$ readout time (Readout Time)

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

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

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

The delay between trigger input and start of exposure:

$t_{delay}$ – Delay inside camera caused by internal electronics. This depends on input type. Please refer to: Optically isolated Digital Input (IN)

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

$t_{odelay}$ – Delay inside camera caused by internal electronics. This depends on output type. Please refer to: Optically isolated Digital Output (OUT)

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

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

## Triggered mode - Burst of frames

For more information please see: Frame Burst Modes

### Frame Burst Start

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

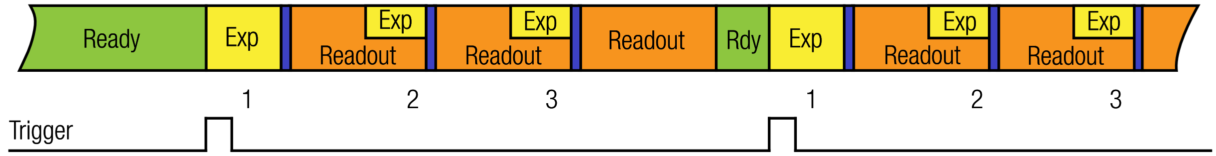



Figure 67: Triggered burst of frames – frame burst start

### Frame Burst Active

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

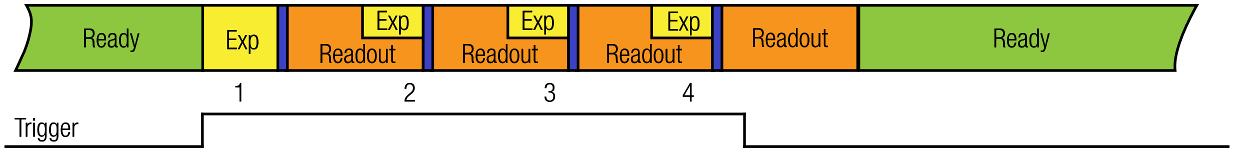



Figure 68: Triggered burst of frames – frame burst active

## Triggered mode - 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. Please see: Exposure Defined by Trigger Pulse Length

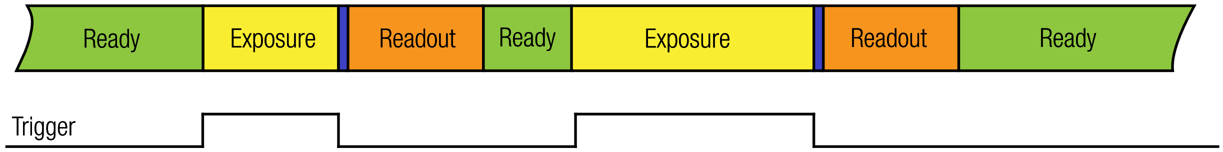



Figure 69: Exposure defined by trigger pulse length

## Triggered mode - Multiple exposures in one frame

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

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

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

It can operate in two modes:

### Exposure defined by xiApi parameter "XI_PRM_EXPOSURE"

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

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

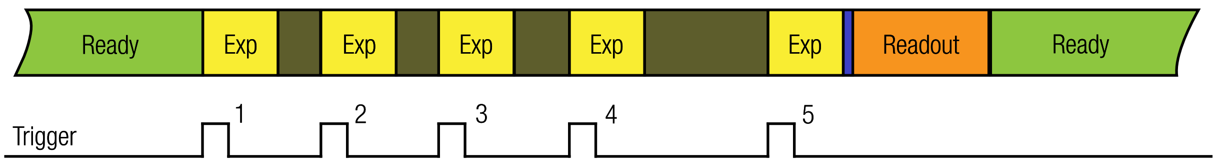



Figure 70: Multiple exposures - defined exposure time number - of exposures set to 5

### Exposure is defined by length of trigger pulse

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

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

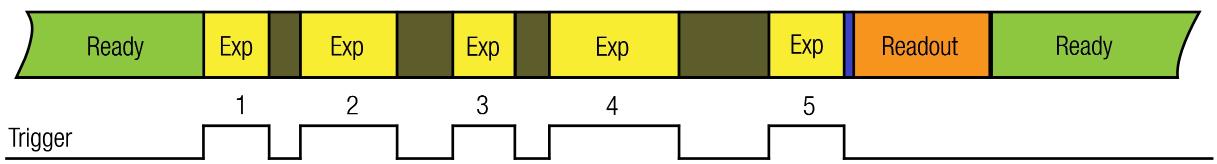



Figure 71: Multiple exposures - exposure time defined by trigger pulse length - number of exposures set to 5

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.

## Short interval shutter mode

Cameras based on the IMX530, IMX531, IMX532, IMX535, IMX536, IMX537 IMX540, IMX541, IMX542, IMX545, IMX546, and IMX547 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.

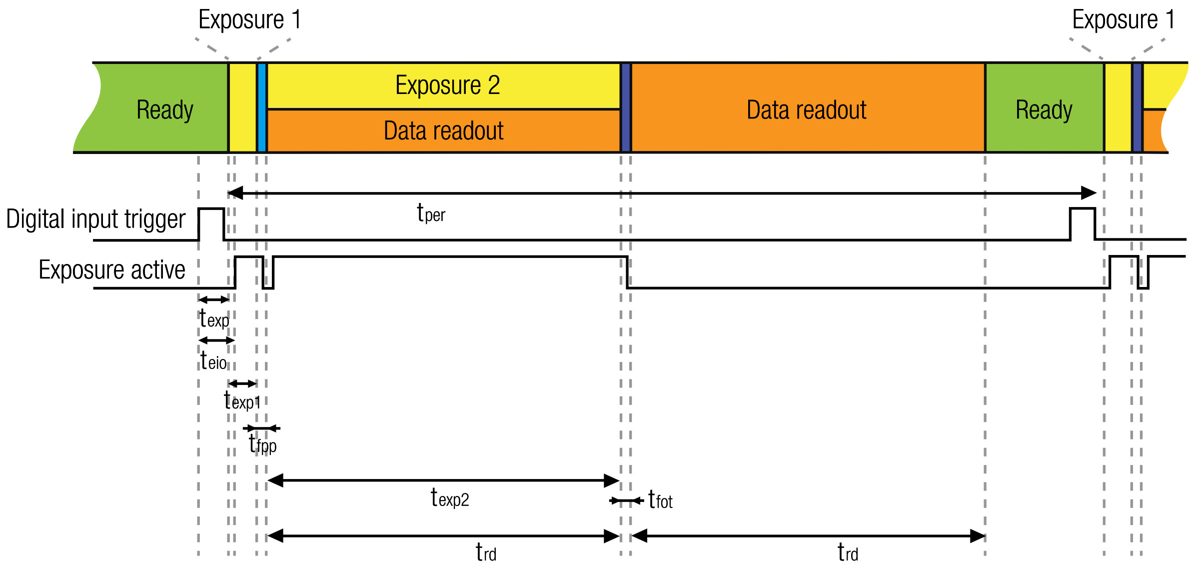



Figure 72: Short interval shutter mode – triggered

| | |
|---|---|
| $t_{eio}$ | Trigger (Digital Input) to Exposure Active (Digital Output) |
| $t_{exp}$ | Trigger (Digital Input) to start of exposure |
| $t_{exp}1$ | TExposure Time of the first image |
| $t_{exp}2$ | TExposure Exposure Time of the second image |
| $t_{fpp}$ | Flash Prohibited Period |
| $t_{fot}$ | Frame overhead time (FOT) |
| $t_{rd}$ | readout time (Readout Time) |

The timing strongly depends on camera settings.

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

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

$t_{odelay}$ - Delay inside camera caused by internal electronics. This depends on output type. Please refer to Optically isolated Digital Output (OUT)

## 3.3 Exposure time

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

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

## 3.4 Gain

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

## 3.5 Dual ADC modes

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

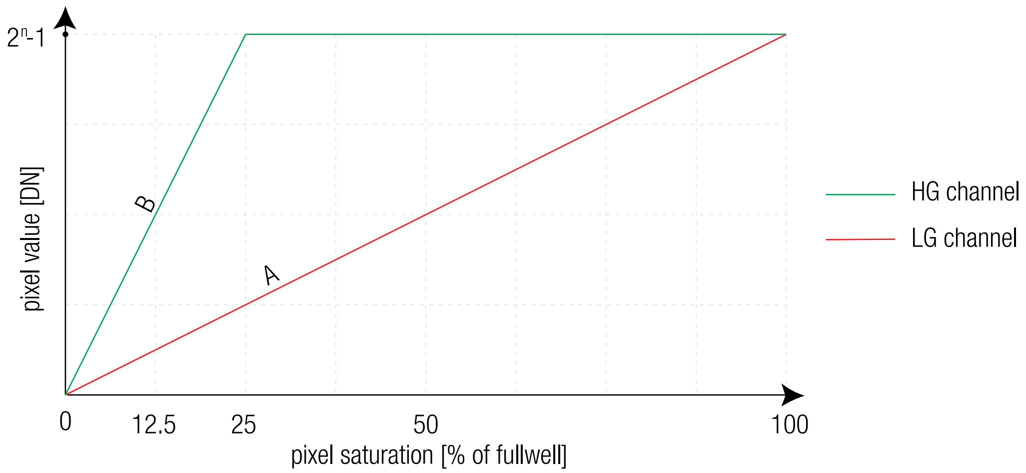



Figure 73: Dual ADC mode non-combined without merging

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

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

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

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

### 3.5.1 Combined mode

Following camera models support Combined mode:

MX051CG-SY-PG4-X2G2-FF-HDR MX051CG-SY-PG4-X2G2-FL-HDR MX051CG-SY-PG4-X2G2-FV-HDR MX051MG-SY-PG4-X2G2-FF-HDR MX051MG-SY-PG4-X2G2-FL-HDR MX051MG-SY-PG4-X2G2-FV-HDR MX081CG-SY-PG4-X2G2-FF-HDR MX081CG-SY-PG4-X2G2-FL-HDR MX081CG-SY-PG4-X2G2-FV-HDR MX081MG-SY-PG4-X2G2-FF-HDR MX081MG-SY-PG4-X2G2-FL-HDR MX081MG-SY-PG4-X2G2-FV-HDR MX081UG-SY-X2G2-FF-HDR MX081UG-SY-X2G2-FL-HDR MX081UG-SY-X2G2-FV-HDR MX124CG-SY-PG4-X2G2-FF-HDR MX124CG-SY-PG4-X2G2-FL-HDR MX124CG-SY-PG4-X2G2-FV-HDR MX124MG-SY-PG4-X2G2-FF-HDR MX124MG-SY-PG4-X2G2-FL-HDR MX124MG-SY-PG4-X2G2-FV-HDR MX161CG-SY-X2G2-FF-HDR MX161CG-SY-X2G2-FL-HDR MX161CG-SY-X2G2-FV-HDR MX161MG-SY-X2G2-FF-HDR MX161MG-SY-X2G2-FL-HDR MX161MG-SY-X2G2-FV-HDR MX203CG-SY-X2G2-FF-HDR MX203CG-SY-X2G2-FL-HDR MX203CG-SY-X2G2-FV-HDR MX203MG-SY-X2G2-FF-HDR MX203MG-SY-X2G2-FL-HDR MX203MG-SY-X2G2-FV-HDR MX245CG-SY-X2G2-FF-HDR MX245CG-SY-X2G2-FL-HDR MX245CG-SY-X2G2-FV-HDR MX245MG-SY-X2G2-FF-HDR MX245MG-SY-X2G2-FL-HDR MX245MG-SY-X2G2-FV-HDR

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.

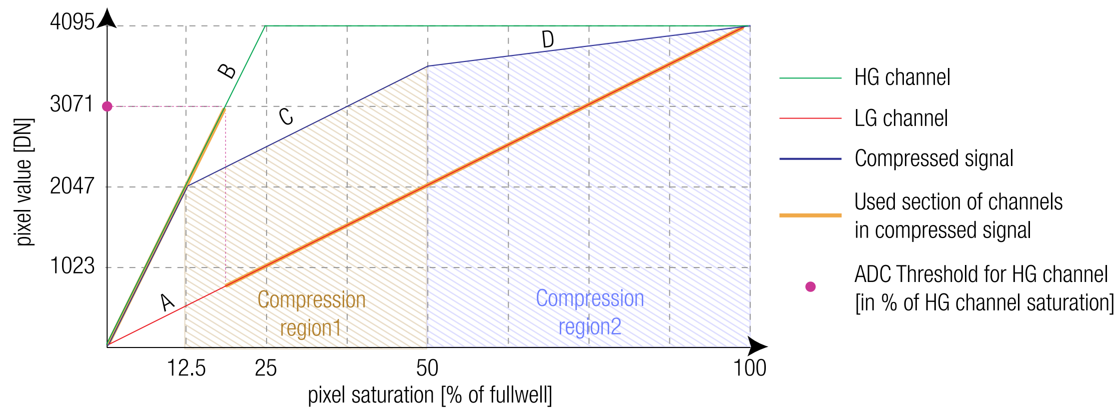



Figure 74: Dual ADC mode combined

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

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

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

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

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

### 3.5.2 Non-combined mode

Following camera models support Non-combined mode:

| | | | |
|---|---|---|---|
| MX051CG-SY-PG4-X2G2-FF-HDR | MX051CG-SY-PG4-X2G2-FL-HDR | MX051CG-SY-PG4-X2G2-FV-HDR | MX051MG-SY-PG4-X2G2-FF-HDR |
| MX051MG-SY-PG4-X2G2-FL-HDR | MX051MG-SY-PG4-X2G2-FV-HDR | MX081CG-SY-PG4-X2G2-FF-HDR | MX081CG-SY-PG4-X2G2-FL-HDR |
| MX081CG-SY-PG4-X2G2-FV-HDR | MX081MG-SY-PG4-X2G2-FF-HDR | MX081MG-SY-PG4-X2G2-FL-HDR | MX081MG-SY-PG4-X2G2-FV-HDR |
| MX081UG-SY-X2G2-FF-HDR | MX081UG-SY-X2G2-FL-HDR | MX081UG-SY-X2G2-FV-HDR | MX124CG-SY-PG4-X2G2-FF-HDR |
| MX124CG-SY-PG4-X2G2-FL-HDR | MX124CG-SY-PG4-X2G2-FV-HDR | MX124MG-SY-PG4-X2G2-FF-HDR | MX124MG-SY-PG4-X2G2-FL-HDR |
| MX124MG-SY-PG4-X2G2-FV-HDR | MX161CG-SY-X2G2-FF-HDR | MX161CG-SY-X2G2-FL-HDR | MX161CG-SY-X2G2-FV-HDR |
| MX161MG-SY-X2G2-FF-HDR | MX161MG-SY-X2G2-FL-HDR | MX161MG-SY-X2G2-FV-HDR | MX203CG-SY-X2G2-FF-HDR |
| MX203CG-SY-X2G2-FL-HDR | MX203CG-SY-X2G2-FV-HDR | MX203MG-SY-X2G2-FF-HDR | MX203MG-SY-X2G2-FL-HDR |
| MX203MG-SY-X2G2-FV-HDR | MX245CG-SY-X2G2-FF-HDR | MX245CG-SY-X2G2-FL-HDR | MX245CG-SY-X2G2-FV-HDR |
| MX245MG-SY-X2G2-FF-HDR | MX245MG-SY-X2G2-FL-HDR | MX245MG-SY-X2G2-FV-HDR | |

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

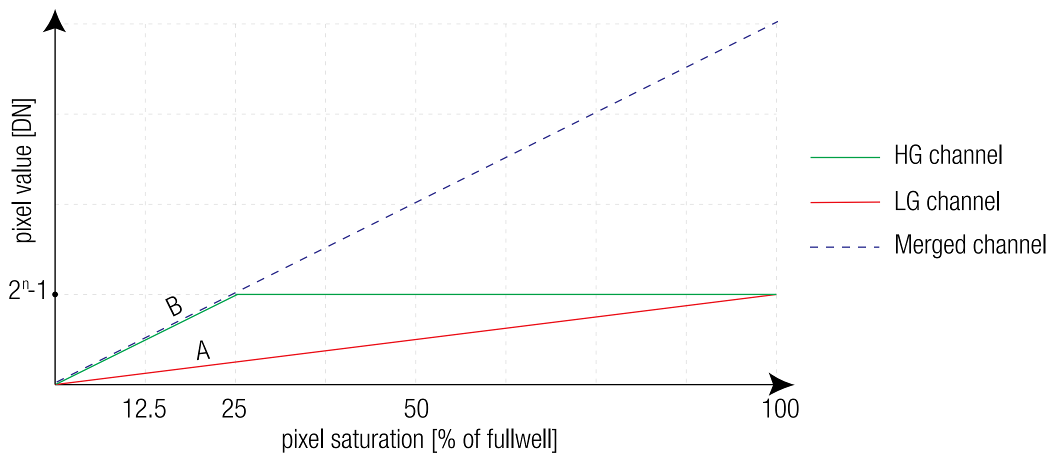



Figure 75: Dual ADC mode non-combined with merging

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

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

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

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

## 3.6 API Features

Host-assisted image processing features available in xiAPI

### 3.6.1 Exposure – Auto gain

When AEAG is used, every captured image is evaluated for its mean intensity. Based on the result, the exposure and gain values are modified with the objective to achieve a target intensity level for the following image. Further, the maximum applicable exposure and gain values can be defined. Since both, exposure and gain, have an influence on the intensity, the ratio between those two parameters in their contribution to the algorithm can also be set (exposure priority).

### 3.6.2 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.

#### Assisted manual white balance

This feature measures the white balance a single time and sets the white balance coefficient to achieve a mean grey (neutral) tint. The measurement is performed on the central rectangle of the image, with 1/8th of its width and height. The function expects a white sheet of paper exposed to 50% of the intensity values (8 Bit RGB values should be around 128) to be visible.

#### Auto White Balance

The white balance is measured across the full image for every 4th image that is acquired, and the white balance coefficients are set to to achieve a neutral colour tint.

### 3.6.3 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.

### 3.6.4 Sharpness

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

### 3.6.5 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.

### 3.6.6 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.

### 3.6.7 Flat field correction

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

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

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

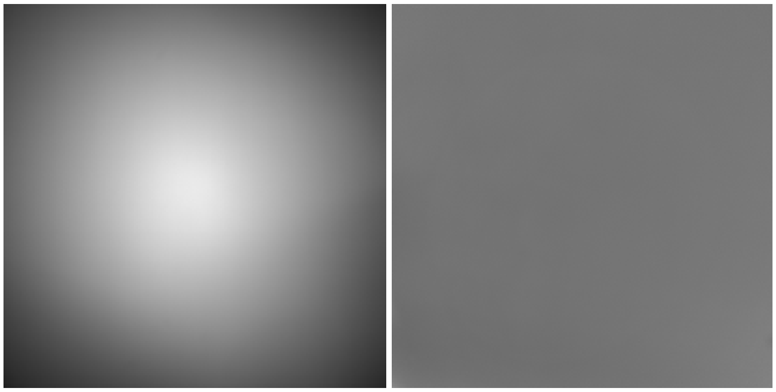


Figure 76: Flat field correction - images comparison

## Acquisition of calibration images

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


Figure 77: Flat field correction - new FFC

### Dark Image

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

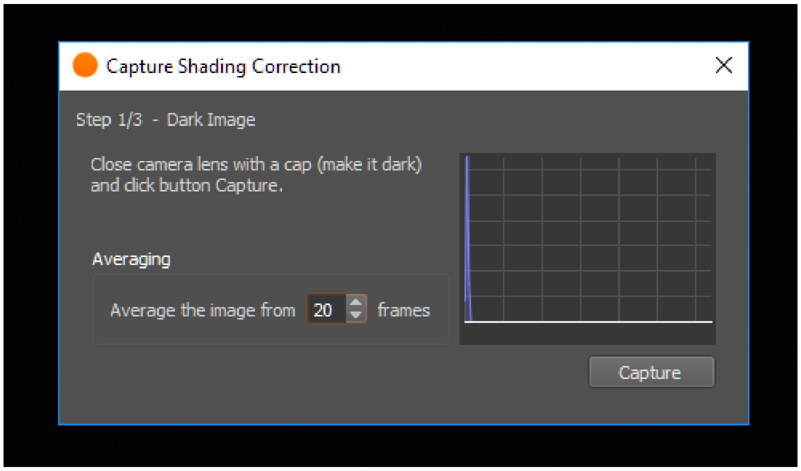



Figure 78: Flat field correction - Dark image

### Mid-saturated image

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

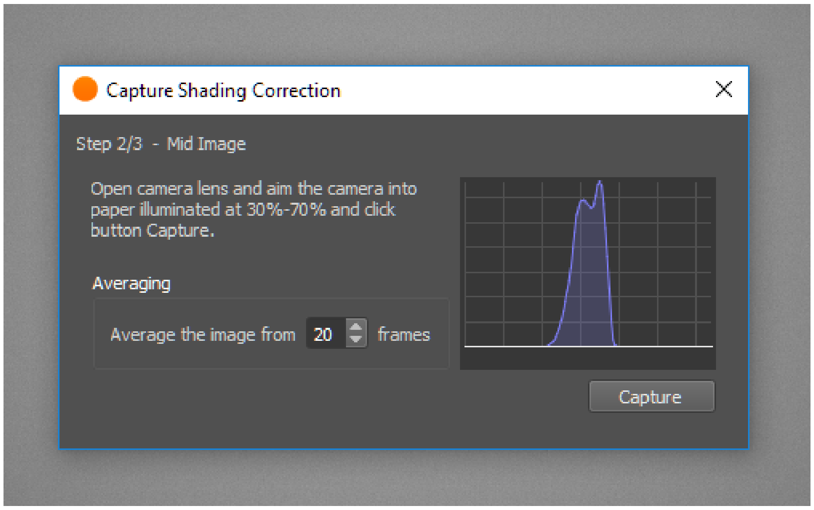



Figure 79: Flat field correction - Mid- saturated image

### Save TIFF files

Save the new preset how it be displayed in CamTool.

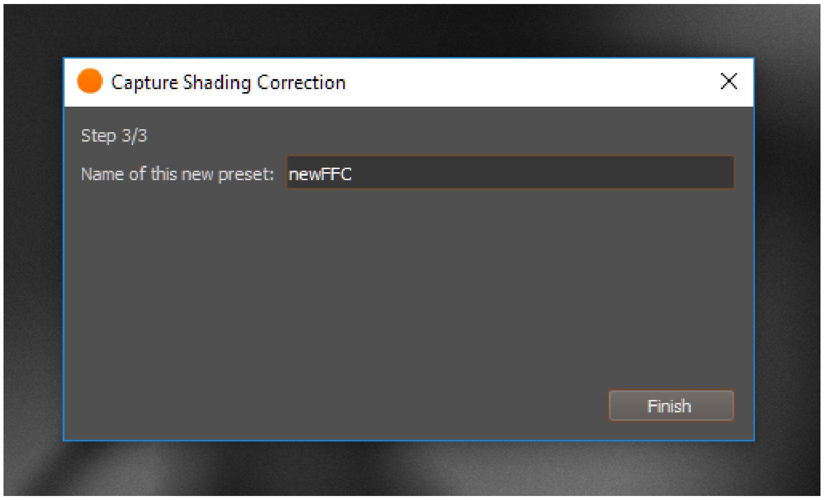



Figure 80: Flat field correction - new preset

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


Figure 81: Flat field correction - Enabling FFC

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

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

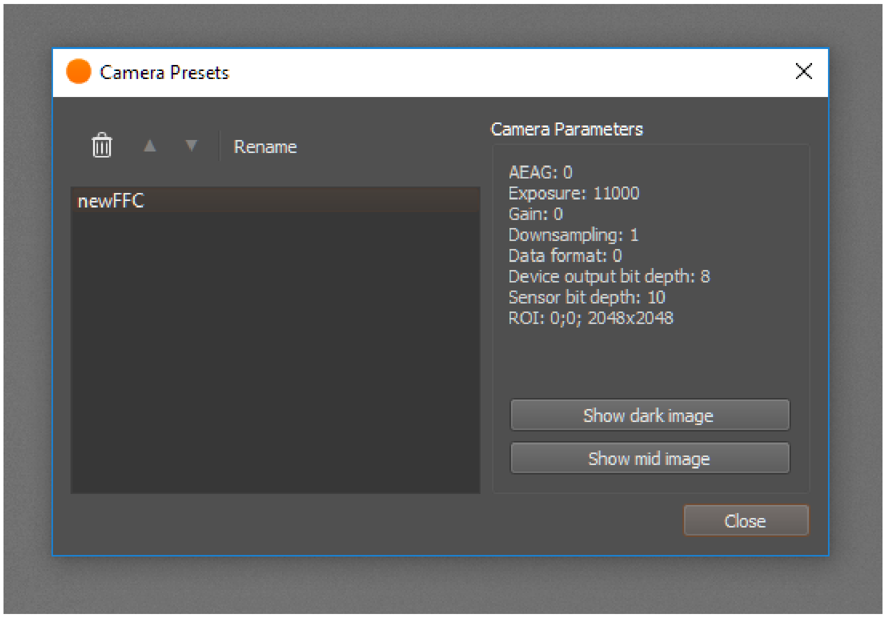



Figure 82: Flat field correction - FFC management

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

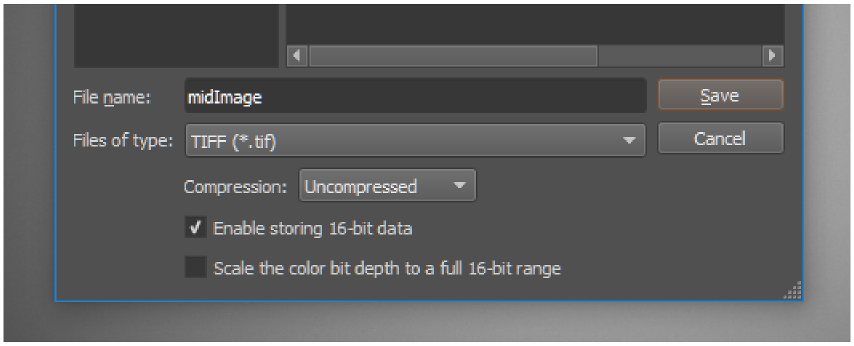



Figure 83: Flat field correction - Safe TIFF

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

`%LOCALAPPDATA%\xiCamTool\shading`

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

## Applying FFC in xiAPI

### xiAPI command sequence:

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

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

- Enable XI_PRM_FFC.

Sample code:

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

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

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

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

# 4 Operation

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

## 4.1 System requirements

### 4.1.1 Software requirements

Cameras are compatible with the following operating systems:

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

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

## 4.2 XIMEA software packages

### 4.2.1 XIMEA Windows software package

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

#### Contents

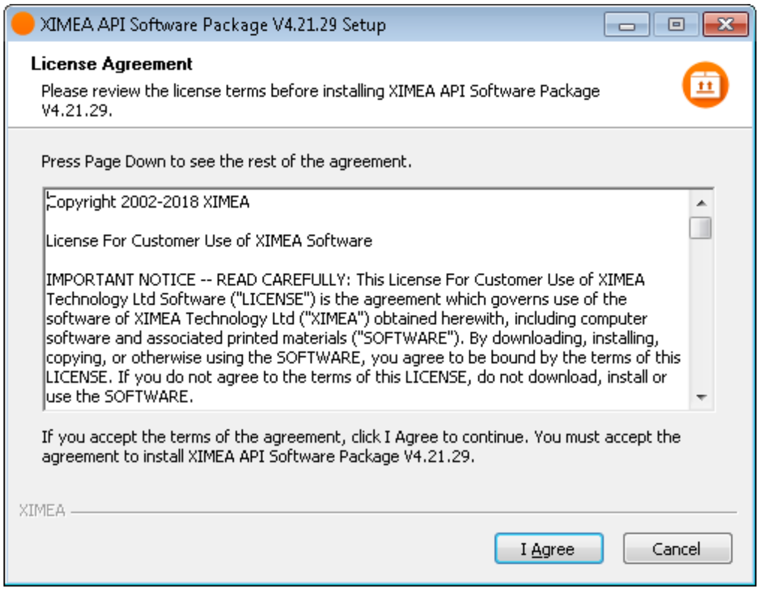
The package contains:

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

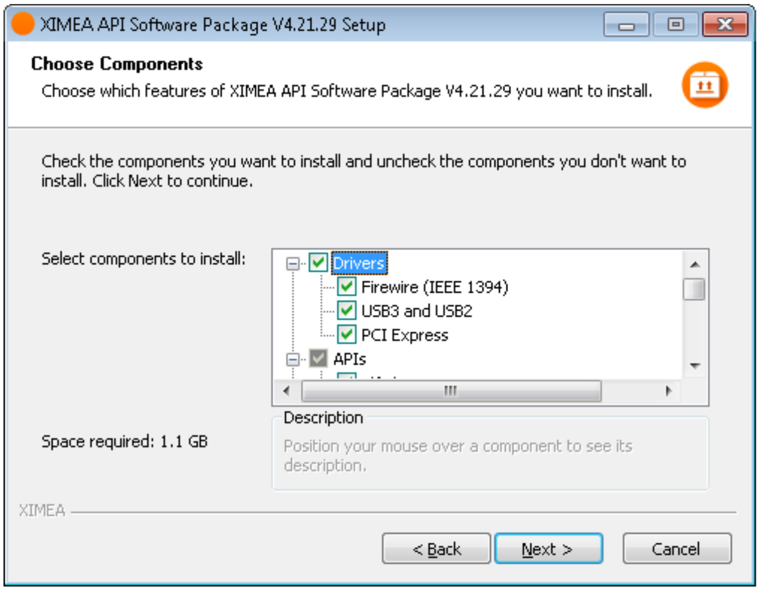
#### Installation

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

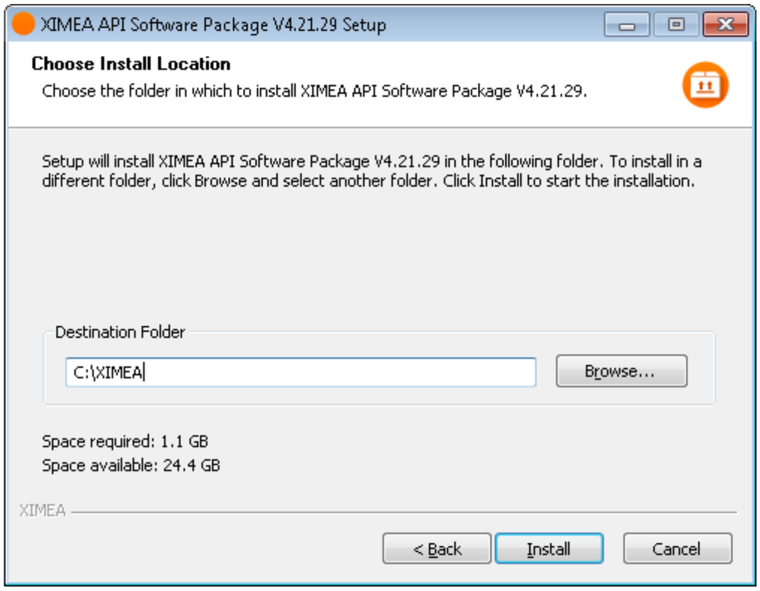
  Be sure that you have administrator privileges or start the Installer with administrator rights (right click and select “run as administrator”):



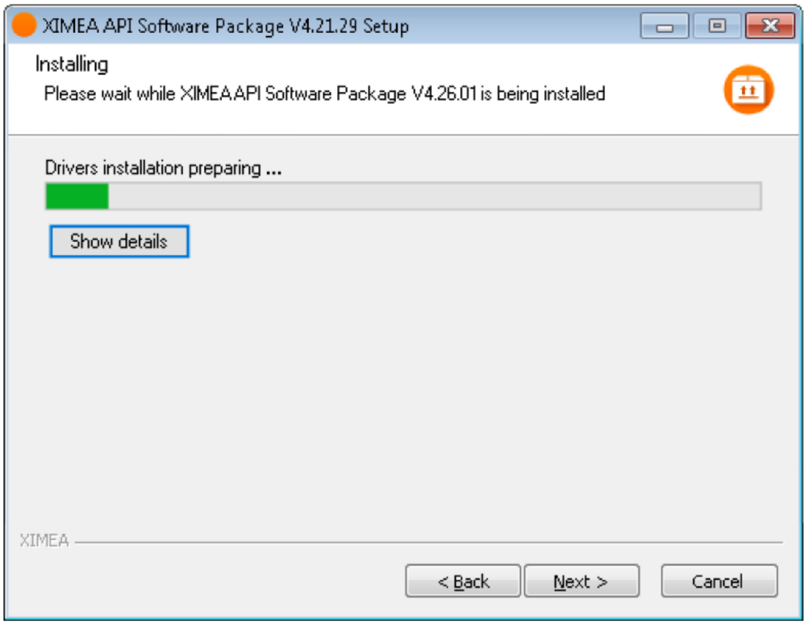
- Select the Software components you want to install. You can uncheck the components you don't want to install, but it is recommended to leave them all checked



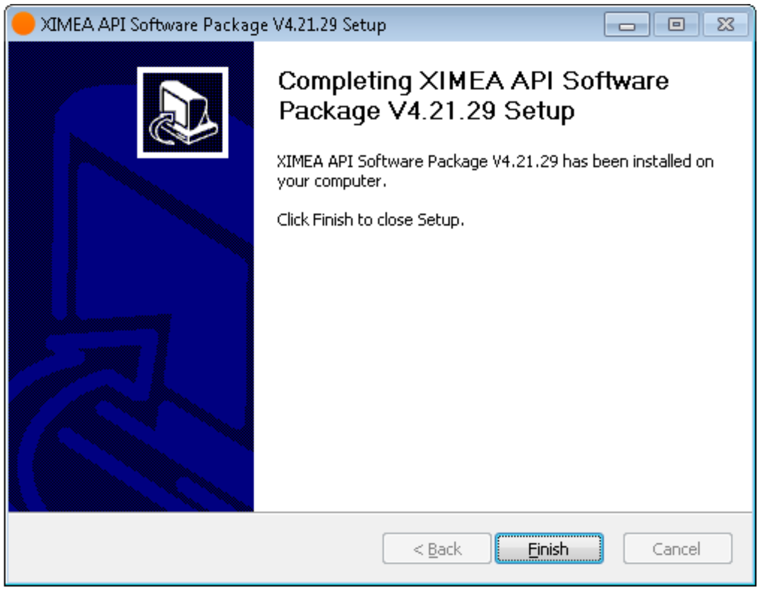

- Specify the install location - you can leave the default location or change it to your desired location



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




- Installation is completed
- Finish



## 4.2.2 XIMEA Linux software package

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

### Contents

The package contains:

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

### Instalation

- Download XIMEA Linux Software Package:

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

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

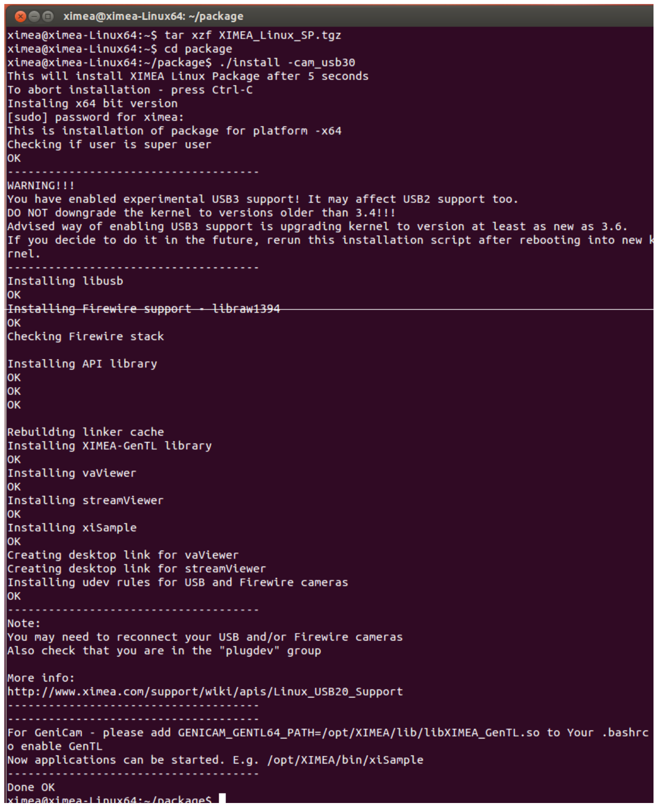

- Untar

  `tar xzf XIMEA_Linux_SP.tgz`

  `cd package`

- Start installation script

`./install`



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

Installing API library
OK
OK
OK

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

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

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

### 4.2.3 XIMEA macOS software package

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

#### Contents

The package contains:

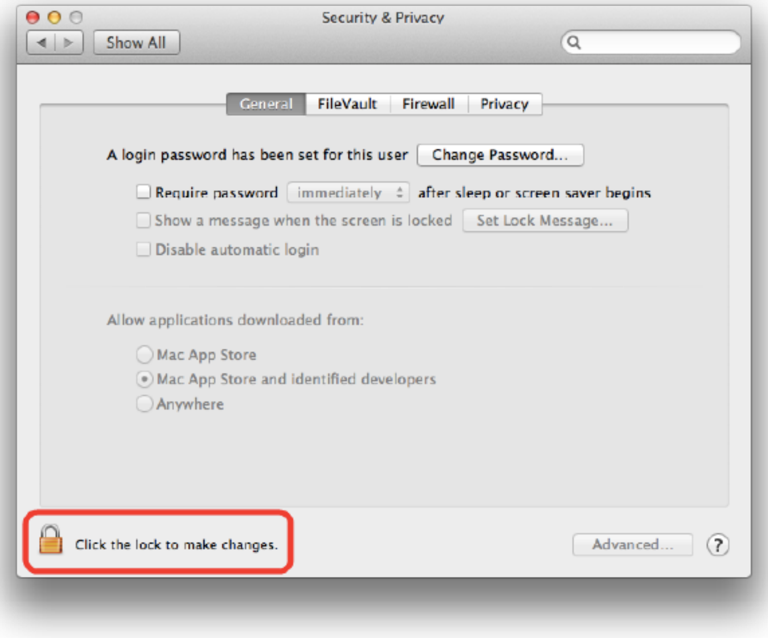
- Driver (beta version) for XIMEA USB2 and USB3 cameras
- xiAPI
- XIMEA CamTool
- Examples:
  - xiSample - sample showing basic image acquisition in xiAPI

#### Installation

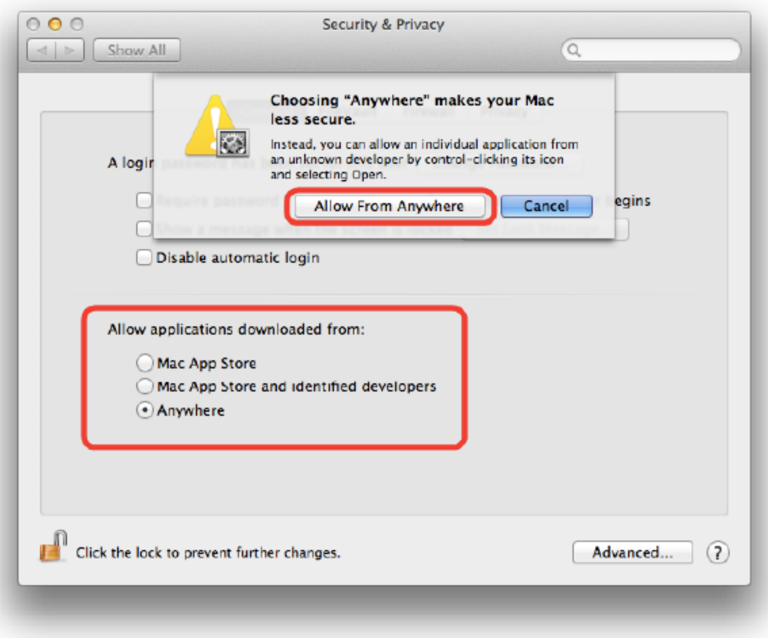
Before installing XIMEA macOS Software Package it may be necessary to modify security settings on your computer. The new feature of OS X 10.8 called GateKeeper can prevent you from using our macOS Software Package due to the fact that the current version is unsigned.

- Open System Preferences application and click on Security & Privacy

- Click on the lock to allow changes to be made




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




- Download XIMEA macOS Software:

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

## Start XIMEA CamTool

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


## Short description

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

## 4.3 XIMEA CamTool

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

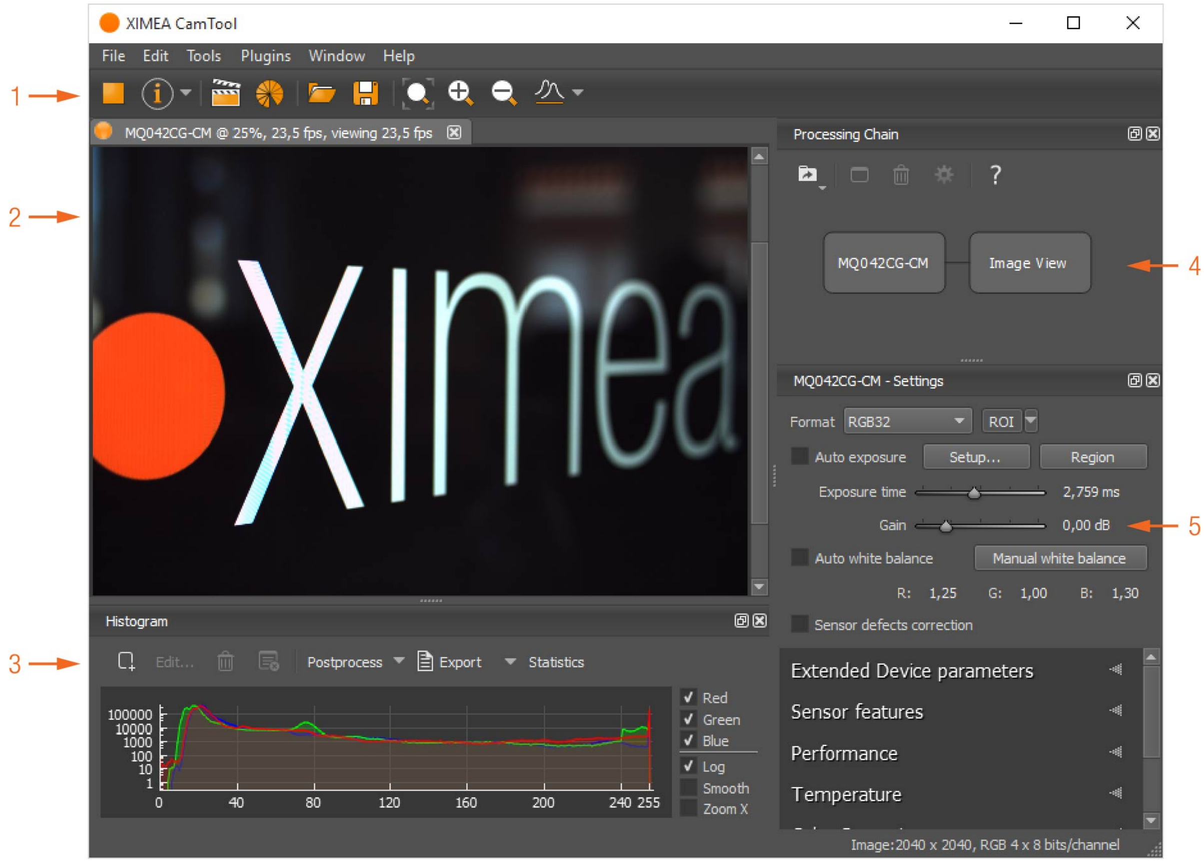



Figure 84: CamTool preview

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

Table 135: CamTool layout

### Functions

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

## 4.4 XIMEA control panel

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

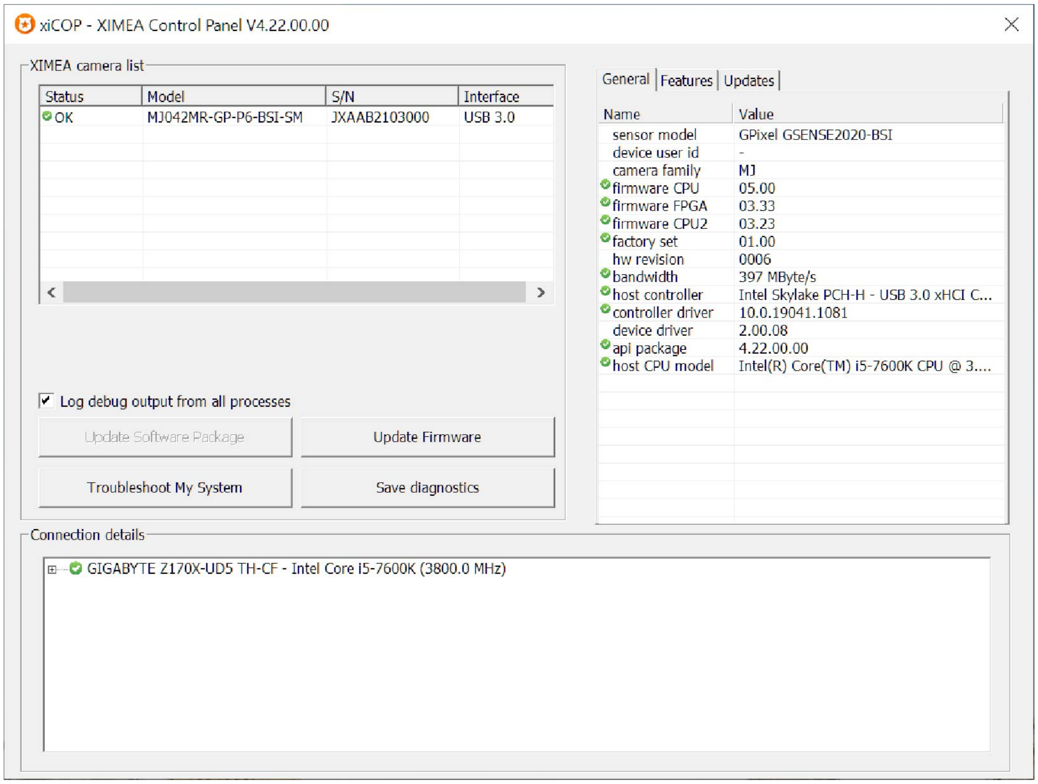



Figure 85: xiCOP example

### Features

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

## 4.5 Supported vision libraries

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

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

### 4.5.1 MathWorks MATLAB

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

### 4.5.2 MVTec HALCON

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

### 4.5.3 National Instruments LabVIEW vision library

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

### 4.5.4 OpenCV

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

## 4.6 Programming

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

### 4.6.1 Standard interface

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

#### GenICam/GenTL

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

### 4.6.2 xiAPI

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

#### Architecture

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

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

#### Installation

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

#### xiAPI functions description

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

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

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

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

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

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

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

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

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

## xiAPI parameters description

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

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

## xiAPI examples

### Connect device

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

```
HANDLE xiH = NULL;

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

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

### Parameterize device

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

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

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

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

## Acquire images

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

```
        xiStartAcquisition(xiH);

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

## Hardware trigger and exposure active output

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

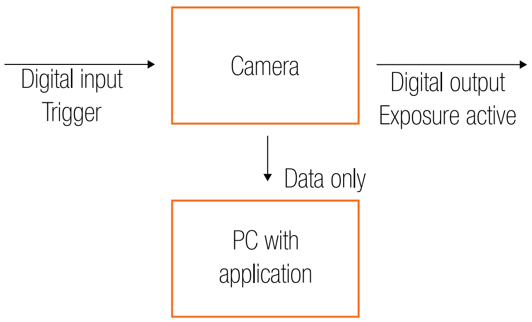



Figure 86: GPIO scheme

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

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

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

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

xiStartAcquisition(handle1);

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

### xiAPI Auto Bandwidth Calculation

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

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

## xiAPI.NET

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

## xiApiPython

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

# 5 Appendix

## 5.1 Troubleshooting and support

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

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

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

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

### 5.1.1 Worldwide support

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

### 5.1.2 Before contacting technical support

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

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

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

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

## 5.2 Frequently Asked Questions

- Frequently Asked Questions
- Knowledge Base

## 5.3 Product service request (PSR)

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

### Step 1 – Contact support

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

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

### Step 2 – Create product service request (PSR)

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

### Step 3 – Wait for PSR approval

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

### Step 4 – Sending the camera to XIMEA

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

### Step 5 – Waiting for service conclusion

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

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

Table 136: Service operations overview

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

### Step 6 – Waiting for return delivery

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

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

## 5.4 Safety instructions and precautions

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

## 5.5 Warranty

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

## 5.6 Standard Terms & Conditions of XIMEA GmbH

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

## 5.7 List of Trademarks

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

## 5.8 Copyright

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

# Glossary

**API** Application Programming Interface 127

**CMOS** Complementary Metal-Oxide-Semiconductor 130

**DMA** Direct Memory Access 9

**ESD** Electrostatic discharge 104

**FPGA** Field Programmable Gate Array 119

**FPS** Frame Per Second 125

**PCB** Printed Circuit Board (same as PWB) 11

**PSR** Product Service Request 156

**ROI** Region Of Interest 119

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