Allied Vision

GigE Vision Cameras

Mako G

Technical Manual

V4.3.2

Allied Vision Technologies GmbH // Taschenweg 2a, 07646 Stadtroda / Germany

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Mako G at a glance

Mako G cameras have a Gigabit Ethernet (GigE) interface and work with Gigabit Ethernet hardware and cable lengths up to 100 m. Mako G cameras are GigE Vision V1.2 and GenICam Standard Feature Naming Convention (SFNC) V1.2.1 compliant.

Applied standards

GigE Vision®

The GigE Vision standard is an interface standard for digital machine vision cameras administered by the Automated Imaging Association (AIA) that is widely supported in the machine vision industry. In contrast, Gigabit Ethernet is the network GigE Vision is built upon.

GenICam™

GenICam is a machine vision standard hosted by the European Machine Vision Association (EMVA). The aim of GenICam is to provide a generic configuration interface for cameras and devices independent of the used interface technology (i.e., GigE Vision, USB3 Vision, DCAM IEEE 1394, Camera Link). This approach enables proper interoperability between GenICam compliant hardware and software solutions without the need for customization.

The GenICam standard consists of multiple modules that specify tasks to be solved. Allied Vision cameras and software make use of these modules, like the Standard Feature Naming Convention (SFNC) that standardizes feature names and types via an XML file or the transport layer interface (GenTL) that is used to grab images.

What else do you need?

Content	URL
Camera data sheets GigE Installation Manual GigE Features Reference Modular Concept 3D CAD STEP files Software and firmware downloads	https://www.alliedvision.com/en/support/technical-documentation/mako-g-documentation.html
Technical papers and knowledge base	https://www.alliedvision.com/en/support/technical-papers-knowledge-base.html

Read this manual carefully

Learn how to protect your camera from damage and fully understand its functions.

Contact us

Connect with Allied Vision by function

https://www.alliedvision.com/en/meta-header/contact.html

Find an Allied Vision office or Allied Vision distribution partner

https://www.alliedvision.com/en/about-us/where-we-are.html

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Contents

Document history and conventions

This chapter includes:

- Document history
- Layout styles and symbols used in this manual
- Product naming

Document history

Version	Date	Remarks
V2.0.0	2013-Aug-30	New manual release status
V2.0.1	2013-Sep-11	Added table of contents Added camera cleaning chapter Updated the specifications for Mako G-223 and G-419 series
V2.0.2	2013-Sep-16	Updated the frame rate information for Mako G-223 and G-419 series in the Specifications chapter Updated introduction to include link to Mako G documentation web page Updated Status LEDs section Added captions to tables in Camera lenses section Added links to *GigE Camera and Driver Features* document
V2.0.3	2013-Nov-27	Updated gain control values for Mako G-223B, G-223B NIR, G-223C, G-223B, G-223B NIR, and G-223C Updated Status LED 2 table Updated the note on `StreamHoldCapacity` in Notes on specifications and Frame memory sections Updated block diagrams in Image data flow chapter Updated the Index
V2.0.4	2014-Feb-28	Updated available color pixel formats for Mako G-223B, G-223B NIR, G-223C, G-223B, G-223B NIR, and G-223C Updated optional accessories in the Notes on specifications chapter Updated section Cross section: C-Mount and CS-Mount Added section Heat dissipation Updated the operating temperature specification for Mako G-032B, G-032C, G-125B, G-125C, G-223B, G-223B NIR, G-223C, G-223B, G-223B NIR, and G-223C Updated block diagrams in Image data flow to remove the RS232 mention Added Hirose cable information
V2.1.0	2014-Oct-07	Updated and rearranged Notes on specifications chapter Added Camera features comparison Added trigger latency and jitter values for Mako G-032B, G-032C, G-125B, and G-125C Updated Mako G standard housing drawing Updated Mako G-503C section Added camera lens information Updated Image data flow and Mechanical dimensions chapters

Table 1: Document history

Version	Date	Remarks
V3.0.0	2015-Jan-15	Updated Allied Vision logo Updated Cleaning optical components section Added Mako G-030, G-131, and G-192 series cameras Added Mako G-030B, G-030C, G-131B, G-131C, G-192B, and G-192C specifications and absolute QE plots Updated Mako G camera smart features table Added camera lens information Added ROI frame rate, ROI frame rate, and ROI frame rate sections Updated Image data flow and Mechanical dimensions chapters
V3.1.0	2015-Mar-10	Added Mako G-503 series camera Added Mako G-503B and G-503C specifications and absolute QE plots Added camera lens information Added ROI frame rate section Updated Image data flow and Mechanical dimensions chapters
V3.2.0	2015-Mar-20	Replaced old links with new Allied Vision website links Changed file name from *GigE Camera and Driver Features* to *GigE Features Reference* Changed chapter name from Description of data path to Camera data path
V4.0.0	2015-Nov-24	Changed the technical manual layout Changed chapter name from Camera data path to Image data flow Changed chapter name from Camera dimensions to Mechanical dimensions Merged the Resolution and ROI frame rate chapter of V3.2.0 into Specifications chapter Added Mako G at a glance section Added General safety notes section Added Regulations section in Safety and regulations chapter to replace Legal notice and Safety and regulations sections in V3.2.0 Moved Sensor position accuracy section from Appendix to Mechanical dimensions chapter Deleted Appendix Added Camera feature comparison section in Specifications chapter to replace Camera smart features and Camera features sections in V3.2.0 Added Cross section: C-Mount and CS-Mount section to replace Cross section: C-Mount and Cross section: CS-Mount sections in V3.2.0 Added Cleaning optical components chapter to replace Camera cleaning section of V3.2.0 Added Contact us section to replace Contacting Allied Vision section of V3.2.0

Table 1: Document history (continued)

Version	Date	Remarks
V4.0.0	2015-Nov-24	Added Mako G-234B and G-234C camera information Removed references to Mako G-050B, G-050C, G-095B, and G-095C models. The last time shipment period ends on December 31, 2015 as detailed in PCN 2015-05-03. Updated Camera Interfaces chapter
V4.1.0	2016-Oct-12	Added a tripod adapter warning message Added new models: Mako G-507B and G-507C Updated absolute QE plots for models with Sony sensors Added spectral response plots for models with Sony sensors Added REACH certification statement Added optical filter information to specification tables Added overlapping trigger note for Mako G-131 and G-192 in Specifications chapter and Camera interfaces chapter Updated image flow diagrams Updated Mako G-234B and G-234C specifications Added 10-bit, 12-bit switchability to Mako G-234B and G-234C
V4.2.0	2016-Nov-07	Added new models: Mako G-319B and G-319C Added missing information in specification tables
V4.2.1	2016-Nov-08	Corrected typographic issues Corrected Mako G-503 shutter type
V4.2.2	2016-Nov-23	`BinningHorizontalMode` and `BinningVerticalMode` options `Sum` and `Average` are supported by Mako G-131, G-192, and G-503 Updated the absolute QE plot and added a spectral response plot for the Mako G-032
V4.2.3	2016-Dec-21	Added missing absolute QE plots for NIR wavelength (Mako G-223B NIR and Mako G-419B NIR)
V4.3.0	2017-Mar-13	Added Piecewise Linear HDR option to Exposure Mode for the Mako G-223 and G-419 series. For more information, see the *GigE Features Reference*. Various minor corrections.

Table 1: Document history (continued)

Version	Date	Remarks
V4.3.1	2017-Apr-07	Added cable color to camera I/O connector pin assignment including pin assignment figure and cross reference to the Allied Vision I/O cable data sheet
V4.3.2	2017-Jul-31	Mako G-223 and G-419: Removed RGBA8Packed & BGRA8Packed pixel formats Mako G-234: Added Mono12 and Mono12Packed Corrected user trigger pulse statement Updated camera images to reflect the new black powder coating housing. For more information, see PCN-2017-03-05 CMOSIS renamed to CMOSIS/ams following the acquisition of CMOSIS by ams Sensors Belgium e2v renamed to Teledyne e2v following the acquisition of e2v by Teledyne Technologies Inc. Corrected user trigger rules Corrected exposure control values for Mako G-223 Updated technical drawing Updated body dimensions in specification tables Changed Cell size terminology to Pixel size

Table 1: Document history (continued)

Manual conventions

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols that are used.

Styles

Style	Function	Example
Bold	Program names, UI elements, highlighting important things	**bold**
Italics	Publication names, UI non-interactive elements	*Italics*
Courier New	Code listings, feature names	`Input`
Courier New Italics	Feature options	*`Mode`*
Blue	Cross references, web page URLs, email links	Link

Table 2: Character styles used in this manual

Symbols

Safety Note

Note to prevent physical injury.

Possible material damage

This symbol addresses important information to avoid material damage; however, is not related to physical injury.

Damage to the camera by electrostatic discharge (ESD)

This symbol addresses important information to avoid material damage by ESD.

Safety-related instructions to avoid malfunctions

This symbol indicates important or specific instructions or procedures that are related to product safety. You have to follow these instructions to avoid malfunctions.

Practical hint

This symbol highlights a practical hint that helps to better understand the camera‘s features and functions, and to make better use of it.

Further information available online

This symbol highlights URLs for further information. The URL itself is shown in blue. Example:

https://www.alliedvision.com

Product naming

Names of third-party products in this document are shortened to ease reading. Nevertheless, we respect all manufacturer rights and trademarks.

Official product name	Naming in this document	Manufacturer website
Sony Semiconductor Solutions	Sony	http://www.sony-semicon.co.jp/
ON Semiconductor	ON Semi	http://www.onsemi.com/
ams Sensors Belgium	CMOSIS/ams	http://www.cmosis.com/
Teledyne e2v	Teledyne e2v	https://www.e2v.com/

Table 3: Third-party product naming

Safety and regulations

This chapter includes:

- General safety notes for Mako G cameras
- Information about the legal requirements and restrictions for Mako G cameras based on current and relevant regulations.
  Particular emphasis has been given to regulations of the European Economic Area (CE, REACH, RoHS, WEEE) as well as regulations of the United States of America (FCC) and Canada (ICES)

General safety notes

Avoid damage to the camera by ESD

Inadequate protection of the camera from ESD can damage the camera permanently. Read the safety instructions and ESD warnings in the *GigE Installation Manual*.

Do not operate the camera beyond the environmental specifications

Due to the small packaging and high speed of Mako G cameras, ensure that housing temperature of the camera does not exceed 45 °C. The following are general guidelines for heat dissipation:

- Mount the camera on a heat sink such as a metal bracket.
- Lenses, when attached to a camera, act as a heat sink and help reduce housing temperature.
- Ensure sufficient air flow. Use a fan if necessary.

Avoid damage to the camera from high output current or voltage

- Connecting the camera to a device exceeding the allowed maximum current (20 mA per output) can damage the camera.
- Providing Isolated Out Power > 30 V may damage the camera.

Do not disassemble the camera housing

This camera contains sensitive internal components. The warranty is void if the camera is disassembled.

Camera housing temperature

Housing temperature of the camera increases during power-up and initial operation. This temperature will later stabilize.

Cleaning optical components

This product can be damaged by some volatile cleaning agents. Avoid cleaning the image sensor unless absolutely necessary. Please see instructions on optics cleaning in this document.

Allied Vision can clean your camera as a service for you, if necessary. For more information, contact Allied Vision support.

Regulations

European Economic Area requirements

CE and RoHS

Allied Vision Technologies declares under its sole responsibility that all standard cameras of the Allied Vision Mako G family to which this declaration relates are in conformity with the following standard(s) or other normative document(s):

- CE, following the provisions of 2004/108/EG directive
- RoHS (2011/65/EU)

REACH

Allied Vision Technologies products are in compliance with the Regulation (EC) No 1907/2006 REACH.

WEEE

This product must be disposed of in compliance with the directive 2002/96/EC on waste electrical and electronic equipment (WEEE).

FCC – Class B Device

For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However there is no guarantee that interferences will not occur in a particular installation. If the equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Use a different line outlet for the receiver.
- Consult a radio or TV technician for help.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules.

Industry Canada Equipment Standard for Digital Equipment (ICES)

CAN ICES-3 (A) / NMB-3 (A)

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in the Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life support applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Allied Vision Technologies customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Allied Vision Technologies for any damages resulting from such improper use or sale.

Other legal notices

Trademarks

Unless stated otherwise, all trademarks shown in this document of Allied Vision Technologies are brands protected by law. All other product or company names may be trademarks of their respective owners.

Warranty

The information provided by Allied Vision Technologies is supplied without any guarantees or warranty whatsoever, be it specific or implicit. Also excluded are all implicit warranties concerning the negotiability, the suitability for specific applications or the non-breaking of laws and patents. Even if we assume that the information supplied to us is accurate, errors and inaccuracy may still occur.

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.

Installation and hardware

This chapter describes the components required for your vision system including configuring the host computer, Ethernet adapter settings, and connecting your Mako G camera.

Configuring the host computer

Allied Vision GigE Vision cameras can operate on 10/100 or Gigabit speed Ethernet adapters. In order to reach the maximum camera frame rate, a Gigabit speed Ethernet adapter with jumbo packet support is required.

If your host computer has an available Ethernet interface, this can be used with Allied Vision GigE cameras. We recommend that your camera system uses a dedicated Ethernet interface not shared with Internet or local area networks. If more ports are needed, or your existing Ethernet adapter is unable to operate at Gigabit Ethernet speeds, installing additional hardware may be required.

Usage on mixed-use networks (with printers, Internet/email, etc.) is possible but may impact camera performance (e.g., framerate). Check with your IT administrator if required for network configuration.

Installing the Ethernet adapter driver

Install the network card driver from your network card manufacturer. If no installation application is provided, update the driver manually.

To update the driver manually

1. Click the **Start icon** and select *Control Panel* in the menu.
2. Click **View by Large Icons** and select *Device Manager* in the list.
3. Under *Network Adapters*, locate the Ethernet network adapter, right-click the entry, and select *Update Driver Software* in the menu.
4. Select the *Search automatically for updated driver software* or *Browse my computer for driver software*.
5. Click **Close** once the driver has been installed.

Optional: Modifying Ethernet adapter IP address

After initial Ethernet adapter hardware installation, connect the Ethernet adapter directly to the camera. The default configuration assigns an IP address automatically using the Link-Local Address range of 169.254.xxx.xxx or an address defined by the DHCP server, if present.

Users can fix the adapter address to minimize the time required for a camera to be recognized by the host application. Systems that employ multiple Ethernet adapters connected to multiple cameras will also be required to fix the address of the Ethernet adapter.

To connect to the camera, edit the host PC's adapter settings and configure the following settings:

- IP Address: 169.254.100.1
- Subnet mask: 255.255.0.0
- Default gateway: blank

Ethernet adapter driver settings

The Ethernet adapter should be adjusted to improve system performance when using a GigE Vision camera. This performance is related to minimizing CPU usage and dropped or resent packets.

Edit the Ethernet adapter driver properties according to the values in the table below. The names and availability of the properties listed may vary depending on adapter manufacturer and model.

Property	Value
Packet size/maximum transmission unit (MTU)	8228 bytes or larger
Interrupt Moderation	Enable
Interrupt Moderation Rate	Extreme
Receive Buffers	Maximum value configurable
Transmit Buffers	256 bytes

Default packet size

The default packet size of Allied Vision GigE cameras is 8228 bytes. The host network adapter needs to support a packet size of equal or larger size to stream from the camera.

Ethernet adapter

For desktop systems, use a PCI Express bus Ethernet adapter. For laptops, use an expansion slot via an ExpressCard®.

A list of Allied Vision recommended Ethernet adapters is available on the Allied Vision website. See the Hardware Selection for Allied Vision GigE Cameras application note:

https://www.alliedvision.com/en/support/technical-papers-knowledge-base.html

Ethernet adapter settings

The Ethernet adapter settings may also vary depending on your system configuration and the network adapter manufacturer.

Enabling jumbo packets

Jumbo Frames/Jumbo Packets

The properties listed for the network adapter may include either **Jumbo Packet** or **Jumbo Frames** depending on the manufacturer. If neither is listed under properties, your network card may not support this feature. You must use a network adapter that supports Jumbo Frames/Jumbo Packets.

To enable jumbo packets

1. Click the **Start** icon and select *Control Panel* in the menu.
2. Click **View by Large Icons** and select *Device Manager* in the list.
3. Under *Network Adapters*, locate the Ethernet network adapter, right-click the entry, and select *Properties* in the menu.
4. Select the *Advanced* tab.
5. Select the property *Jumbo Packet* and set the value to *9014 Bytes*.
6. Click **OK** to save the setting.

Connecting your camera

Use a Category 6 or higher rated Ethernet cable to connect the Mako G camera to the host adapter. Crossover cabling is not required but does work. The camera has circuitry to determine if a crossover cable is being used.

Allied Vision recommends Category 6 (Cat 6) or higher rated Ethernet cables for Mako G cameras. A different rating may not sustain peak interface bandwidth; leading to lost connectivity or image data coming from the camera.

Contact your Allied Vision Sales team or your local Allied Vision dealer for information on accessories and lens recommendations:

https://www.alliedvision.com/en/about-us/where-we-are.html

Downloading camera drivers

Allied Vision GigE cameras work with any or all of the following software options.

Vimba Viewer or Vimba SDK:

https://www.alliedvision.com/en/products/software

Third-party software solutions:

https://www.alliedvision.com/en/products/software/third-party-libraries.html

Powering up the camera

A camera power adapter for each GigE camera is available from Allied Vision. See the Specifications chapter for connector definition and voltage specifications.

For Mako cameras

- Use only DC power supplies with insulated cases.
- For all power connections use only shielded cables to avoid electromagnetic interferences.
- Mako cameras can source power from:
  - IEEE 802.3af (100 Mbit/s and 1000 Mbit/s), and
  - IEEE 802.3at compliant PoE power sourcing equipment (PSE) devices such as switches, injectors, or network interface controller (NIC).

Connecting to host application

Once you have installed the **Vimba Viewer** or third-party application to your host computer, you can connect your Allied Vision GigE camera via an Ethernet cable. If your camera is not PoE powered, connect the Hirose cable to power the camera.

GigE Installation Manual

For information on starting your camera and connecting to a host application, see the GigE Installation Manual:

https://www.alliedvision.com/en/support/technical-documentation/Mako-documentation.html

Allied Vision recommends Category 6 (Cat 6) or higher rated Ethernet cables for Mako G cameras. A different rating may not sustain peak interface bandwidth; leading to lost connectivity or image data coming from the camera.

Vimba Viewer documentation

Vimba Viewer documentation is included with the software download. Once Vimba Viewer is installed on your host PC, documentation is located under *\Program Files\Allied Vision\Vimba*.

Specifications

This chapter provides:

- Technical specifications
- Absolute quantum efficiency plots
- Spectral response plots
- ROI frame rate
- Comparison of feature availability in Mako G camera models

Notes on specifications

Dimensions and mass

The dimensions listed in the following tables are for Mako G standard housing models. Dimensions include connectors but not the tripod and lens.

The mass listed in the following table are for Mako G standard housing models. Mass does not include the tripod and lens.

Unless otherwise stated, frame rate, exposure time control, trigger latency, and trigger jitter values are for 8-bit and 12-bit pixel formats only; i.e., Mono8, Bayer8, Mono12Packed, Bayer12Packed, and YUV411Packed.

Monochrome and NIR models

As monochrome and NIR models do not have an optical filter. Always attach a dust cap when a lens is not attached to minimize the possibility of contaminants falling on the sensor surface.

Frame memory

Normally, an image is captured and transported in consecutive steps. The image is taken, read out from the sensor, digitized and sent over the GigE network. Mako G cameras are equipped with an image buffer. Specifications tables for each camera show how many frames can be stored by each model.

The number of frames (`StreamHoldCapacity`) depends on resolution, pixel format, and packet size. Stated number of frames is typical for full resolution, Mono8/Bayer8, and `GevSCPSPacketSize` = 8192.

The memory operates according to the FIFO principle. This makes addressing for individual images unnecessary.

Resolution and ROI frame rate

ROI frame rate is listed after the specification table. The resulting frame rate from changing sensor height from full image to a single line. Unless otherwise noted, sensors do not give an increase in readout speed with a reduction in width.

Resolution and ROI measurements

- Data was generated using `StreamBytesPerSecond` = 124 Mbit/s (full bandwidth) and an 8-bit pixel format. Frame rates may be lower if using network hardware incapable of 124 Mbit/s.
- ROIs are taken as center image for maximum speed advantage, where feature `OffsetY` = (full sensor height – ROI height)/2.
- `BinningVertical` is horizontal row summing on CCD before readout. The frame rate for an ROI at the same effective height as binning will be slower because the CCD still needs to read out the “fast readout rows” in ROI mode.

Frame rate and readout

Although the sensor is capable of higher frame rates, readout is limited by GigE bandwidth and exposure value. You can improve frame rates with a reduced region of interest and shorter exposure values.

Absolute quantum efficiency plots

Important notice before reading the specifications tables

All measurements were done without optical filters. With optical filters, quantum efficiency (QE) decreases by approximately 10%.

The uncertainty in measurement of the QE values is ±10.25%.

This is mainly due to uncertainties in the measuring apparatus itself (Ulbricht sphere, optometer, etc.).

Manufacturing tolerance of the sensor increases overall uncertainty.

Monochrome Sony CCD/CMOS sensors

The curve in the absolute QE plots shown in this chapter were calculated from a single measured quantum efficiency for monochrome sensors. The shape of the curve is from the sensor data sheet but the values have been adjusted based on this measured value.

Color Sony CCD/CMOS sensors

The curves in the absolute QE plots shown in this chapter were calculated from three measured quantum efficiency values for color sensors. The shape of the curves are from the sensor data sheet but the values have been adjusted based on these measured values.

ON Semi CCD/CMOS sensors & CMOSIS/ams and Teledyne e2v CMOS sensors

The curve in the absolute QE plots shown in this chapter is from the sensor manufacturer data sheet.

The information was correct at the time of publishing.

Wavelength

The wavelength range in the absolute QE plots reflects the information available in the sensor manufacturer data sheet at the time of publishing. Many color sensors are documented by the sensor manufacturer only for wavelengths from 400 nm to 700 nm.

For additional wavelength information, contact the sensor manufacturer.

Spectral response plots

For select models

The curves in the spectral response plots shown in this chapter were calculated from measured quantum efficiencies at 448 nm, 529 nm, and 632 nm. The shape of the curve is from the sensor data sheet but the values have been adjusted based on these measured values.

Mako G-030B, G-030C

Feature	Specification	
	Mako G-030B	**Mako G-030C**
Resolution	644 (H) x 484 (V) 0.3 MP	
Sensor	CMOSIS/ams CMV300-3E7M1WP	CMOSIS/ams CMV300-3E7C1WP
Sensor type	CMOS	
Shutter type	Global	
Sensor size	Type 1/3 5.9 mm diagonal	
Pixel size	7.4 µm x 7.4 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	309 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 99 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12Packed, BayerRG12
Exposure time control	83 µs to 2 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Binning	n/a	
Decimation	Horizontal and Vertical: 1, 2, 4 factor	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.1 W @ 12 VDC; 2.3 W PoE	
Trigger latency[1]	Idle state: 3.1 µs; Frame valid state: 3.1 µs	
Trigger jitter[1]	Idle state: ±1.2 µs; Frame valid state: ±3.1 µs	
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	

Table 4: Mako G-030B, G-030C model specifications

Feature	Specification	
	Mako G-030B	Mako G-030C
Operating humidity	20 to 80% non-condensing	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bits per pixel and applicable in both Idle and Frame valid states:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 4: Mako G-030B, G-030C model specifications (continued)

Absolute QE

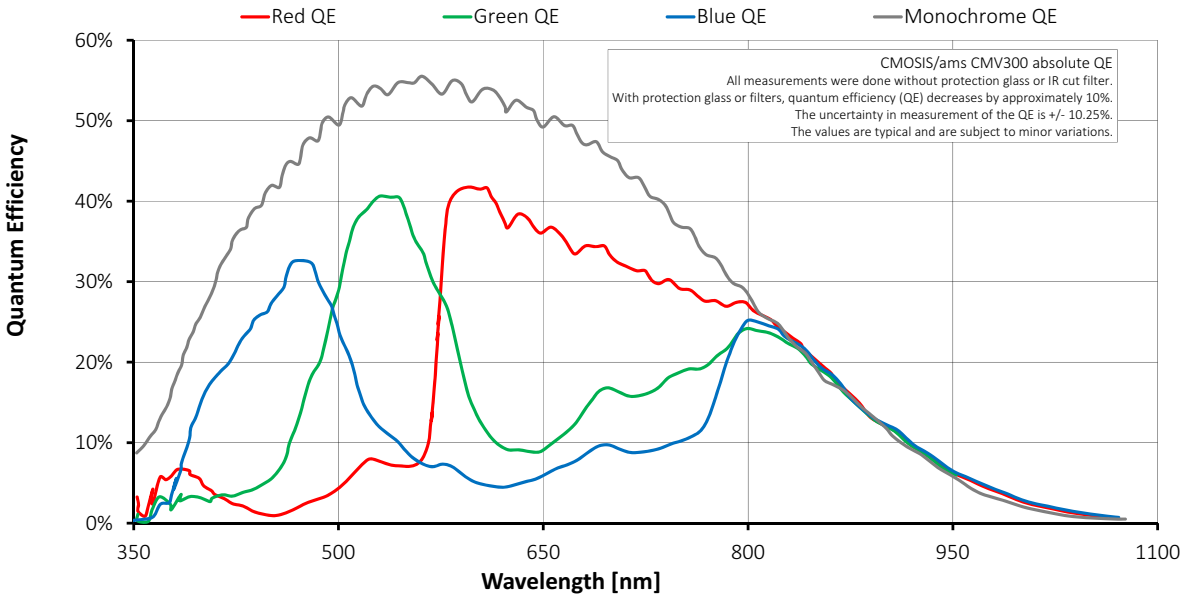


Figure 1: Mako G-030B, G-030C (CMOSIS/ams CMV300) absolute QE

ROI frame rate

$$\text{Max. frame rate} = \frac{1}{204\ \mu s + 6.25\ \mu s \times \text{ROI height}}$$

Maximum frame rate at full resolution according to formula: 309 fps

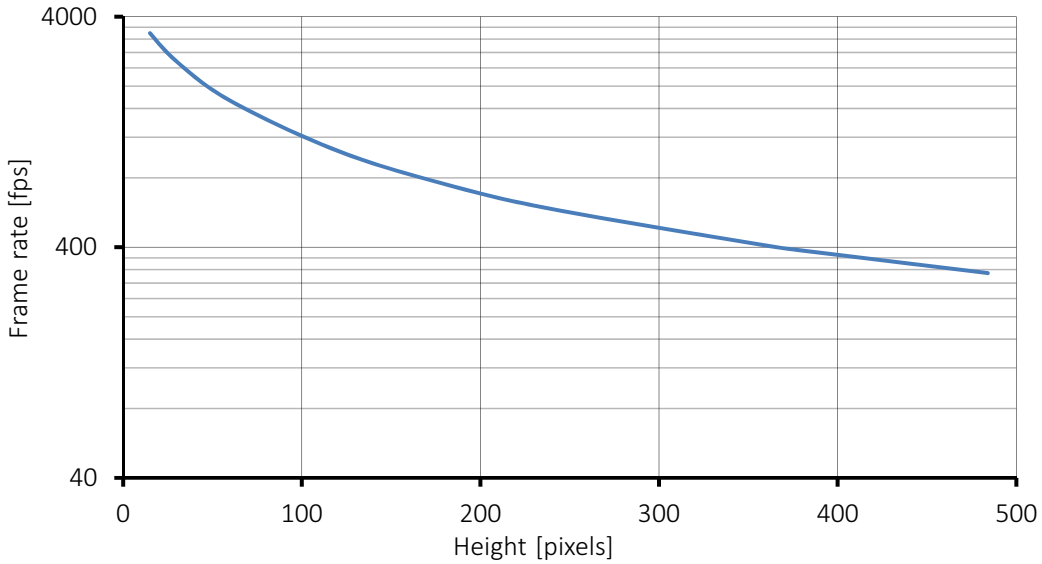


Figure 2: Frame rate as a function of ROI height

Height in pixels	Frame rate
484	309
480	312
384	384
360	407
240	586

Height in pixels	Frame rate
180	752
120	1048
60	1727
30	2554
15	3393

Width = 644 pixels

Table 5: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-032B, G-032C

Feature	Specification	
	Mako G-032B	**Mako G-032C**
Resolution	658 (H) x 492 (V) 0.3 MP	
Sensor	Sony ICX424AL with HAD CCD™ technology	Sony ICX424AQ with Wfine HADCCD™ technology
Sensor type	Interline CCD, Progressive Scan	
Shutter type	Global	
Sensor size	Type 1/3 6.0 mm diagonal	
Pixel size	7.4 µm x 7.4 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	102.3 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 202 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control	10 µs to 93 s; 1 µs increments	
Gain control	0 to 30 dB; 1 dB increments	
Binning	Horizontal: 1 to 8 columns Vertical: 1 to 14 rows	
Decimation	n/a	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE	
Trigger latency[1]	Idle state: 7.2 µs; Frame valid state: 16.9µs	
Trigger jitter[1]	Idle state: ±4.0 µs; Frame valid state: ±13.7 µs	

Table 6: Mako G-032B, G-032C model specifications

Feature	Specification	
	Mako G-032B	Mako G-032C
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10°C to +70°C ambient temperature (without condensation)	
Operating humidity	20 to 80% non-condensing	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] It is possible to start the exposure of next frame while previous frame is read out:
- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 6: Mako G-032B, G-032C model specifications (continued)

Absolute QE

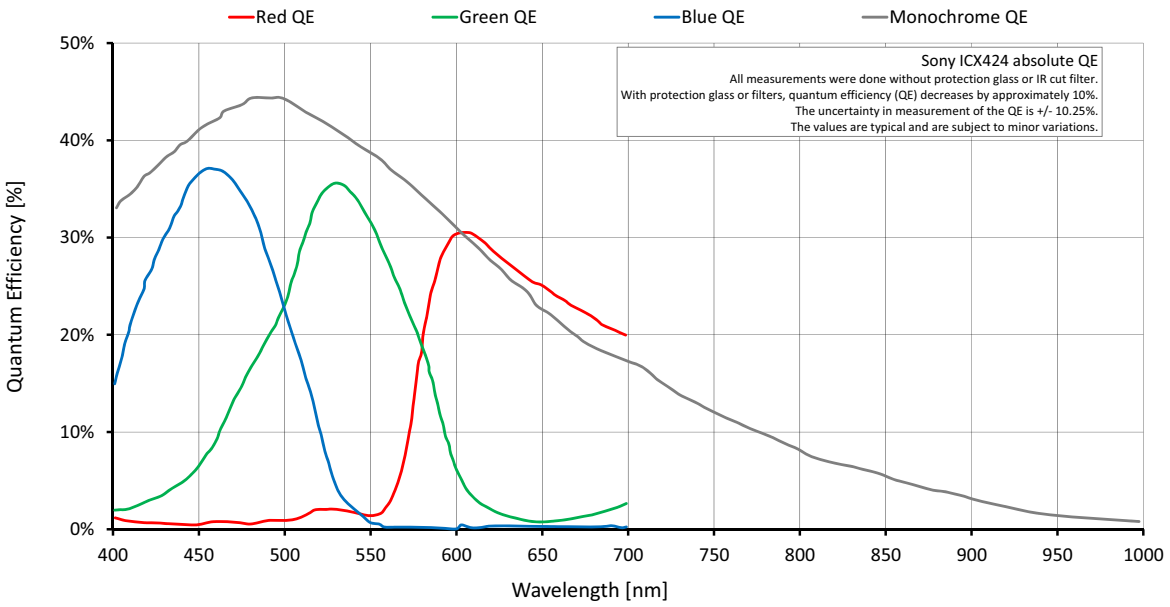


Figure 3: Mako G-032B, G-032C (Sony ICX424) absolute QE

Spectral response

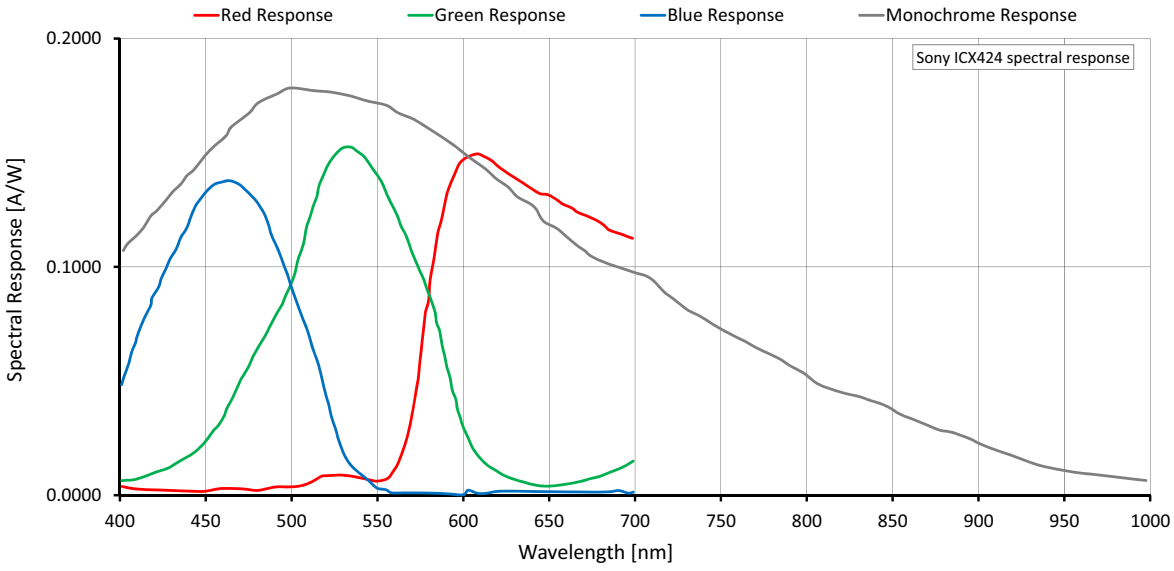


Figure 4: Mako G-032B, G-032C (Sony ICX424) spectral response

ROI frame rate

$$\text{Max. frame rate} = \frac{1}{19.46\ \mu s \times \text{ROI height} + 2.29\ \mu s \times (492 - \text{ROI height}) + 195.81\ \mu s}$$

Maximum frame rate at full resolution according to formula: 102.3 fps

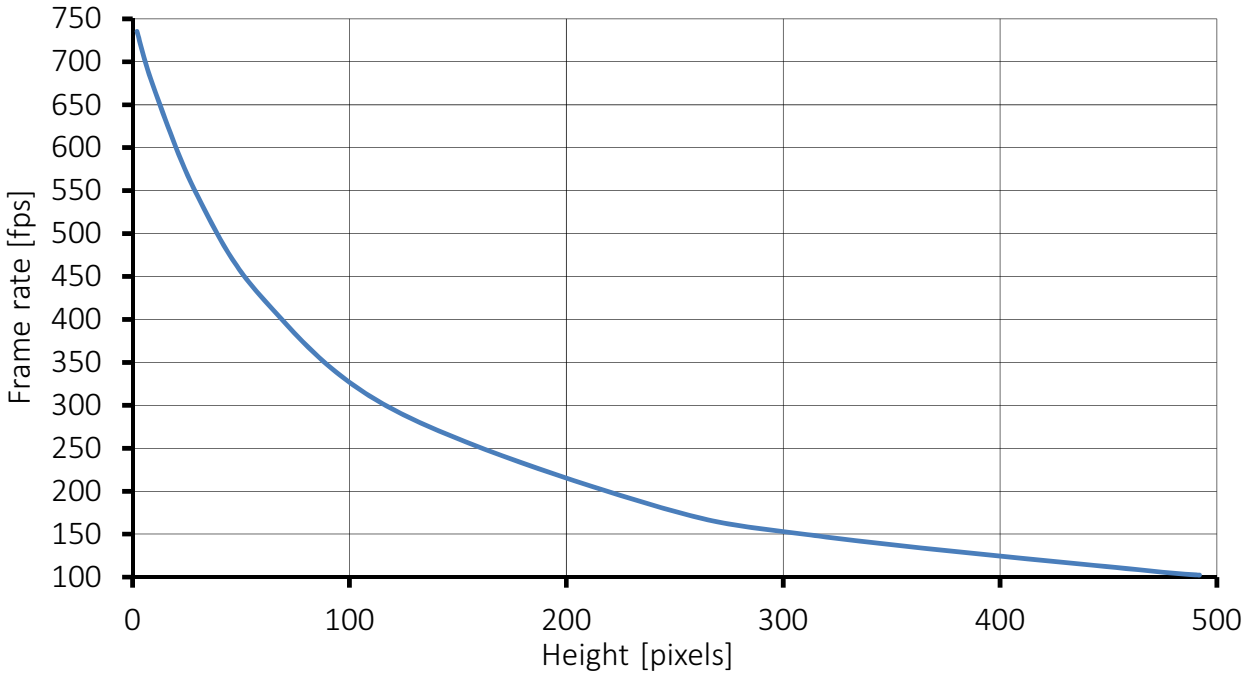


Figure 5: Frame rate as a function of ROI height

Height in pixels	Frame rate
492	102.3
480	104.5
320	146.6
240	183.5
120	295.3

Height in pixels	Frame rate
60	424.5
30	543.3
10	667.9
2	735.4

Width = 658 pixels

Table 7: Frame rate as a function of ROI height

Frame rate = theoretical maximum frame rate (in frames per second) of the CCD sensor according to given formula.

Mako G-125B, G-125C

Feature	Specification	
	Mako G-125B	**Mako G-125C**
Resolution	1292 (H) x 964 (V) 1.2 MP	
Sensor	Sony ICX445ALA with EXview HAD CCD™ technology	Sony ICX445AQA with EXview HAD CCD™ technology
Sensor type	Interline CCD, Progressive Scan	
Shutter type	Global	
Sensor size	Type 1/3 6.0 mm diagonal	
Pixel size	3.75 µm x 3.75 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	30.3 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 52 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control	12 µs to 84 s; 1 µs increments	
Gain control	0 to 30 dB; 1 dB increments	
Binning	Horizontal: 1 to 8 columns Vertical: 1 to 14 rows	
Decimation	n/a	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.3 W @ 12 VDC; 2.7 W PoE	
Trigger latency[1]	Idle state: 8.0 µs; Frame valid state: 25.0 µs	
Trigger jitter[1]	Idle state: ±4.0 µs; Frame valid state: ±21.0 µs	

Table 8: Mako G-125B, G-125C model specifications

Feature	Specification	
	Mako G-125B	Mako G-125C
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Operating humidity	20 to 80% non-condensing	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] It is possible to start the exposure of next frame while previous frame is read out:
- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 8: Mako G-125B, G-125C model specifications (continued)

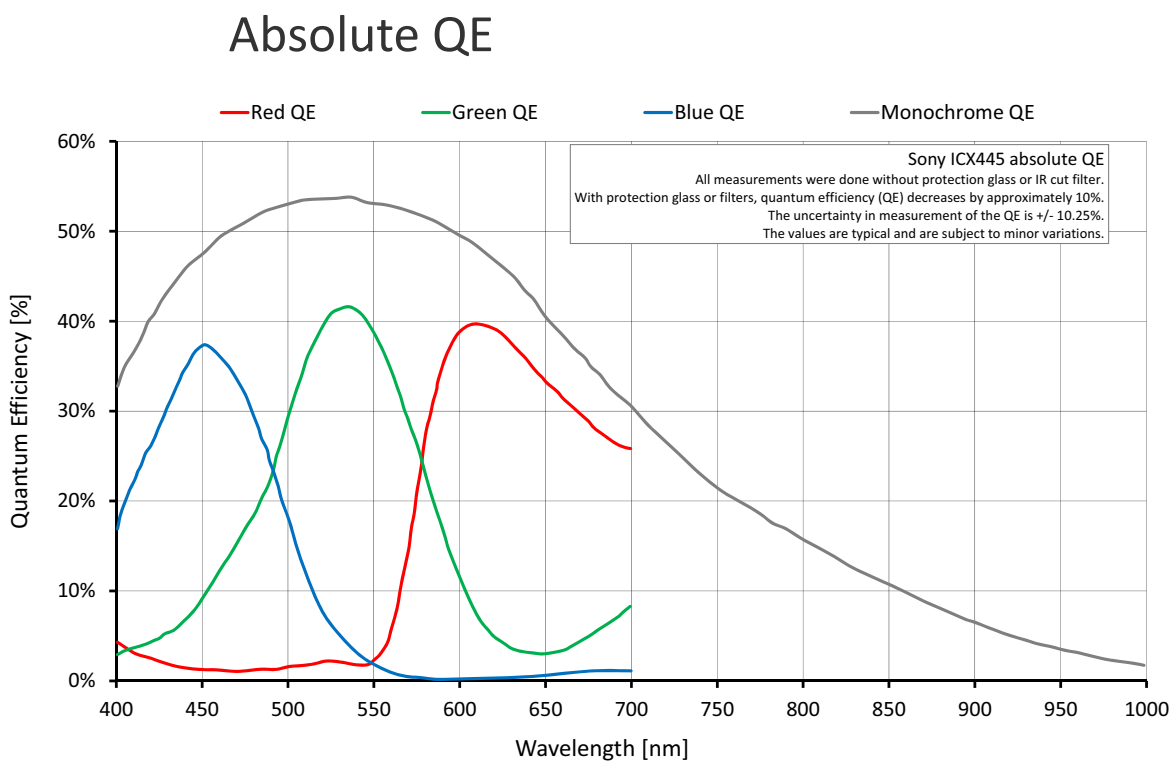


Figure 6: Mako G-125B, G-125C (Sony ICX445) absolute QE

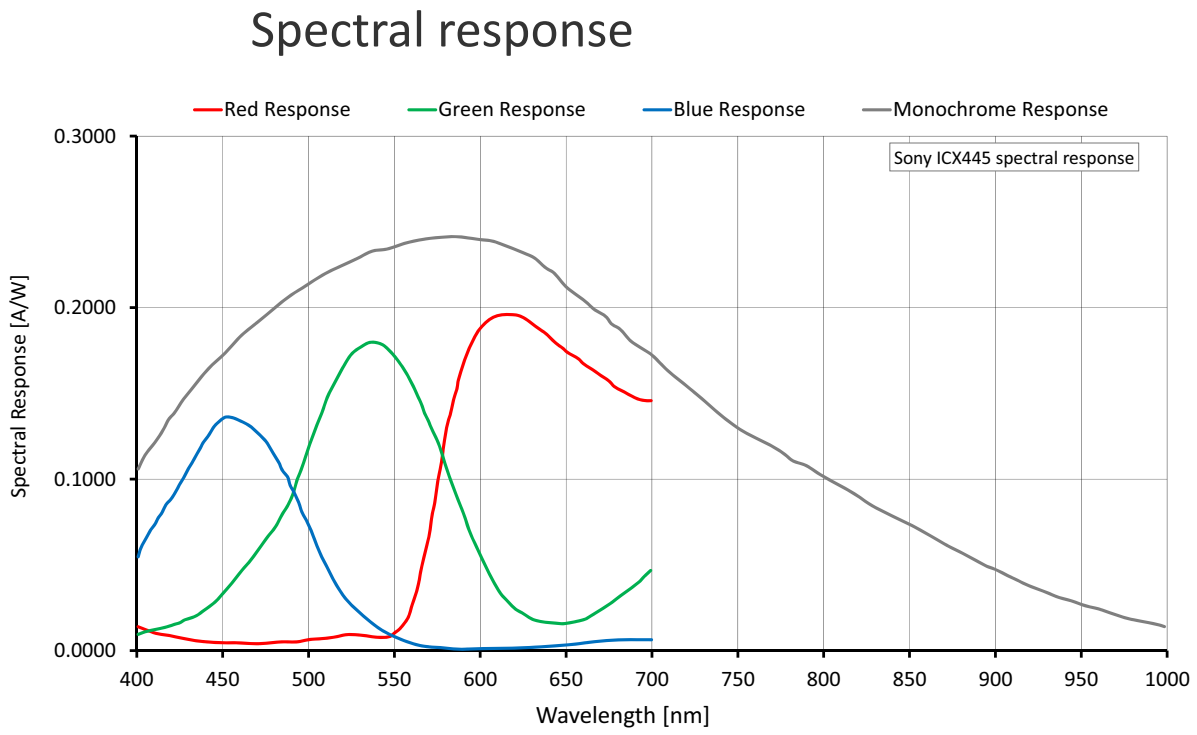


Figure 7: Mako G-125B, G-125C (Sony ICX445) spectral response

ROI frame rate

$$\text{Max. frame rate} = \frac{1}{34.01\ \mu s \times \text{ROI height} + 3.09\ \mu s \times (964 - \text{ROI height}) + 176.42\ \mu s}$$

Maximum frame rate at full resolution according to formula: 30.3 fps

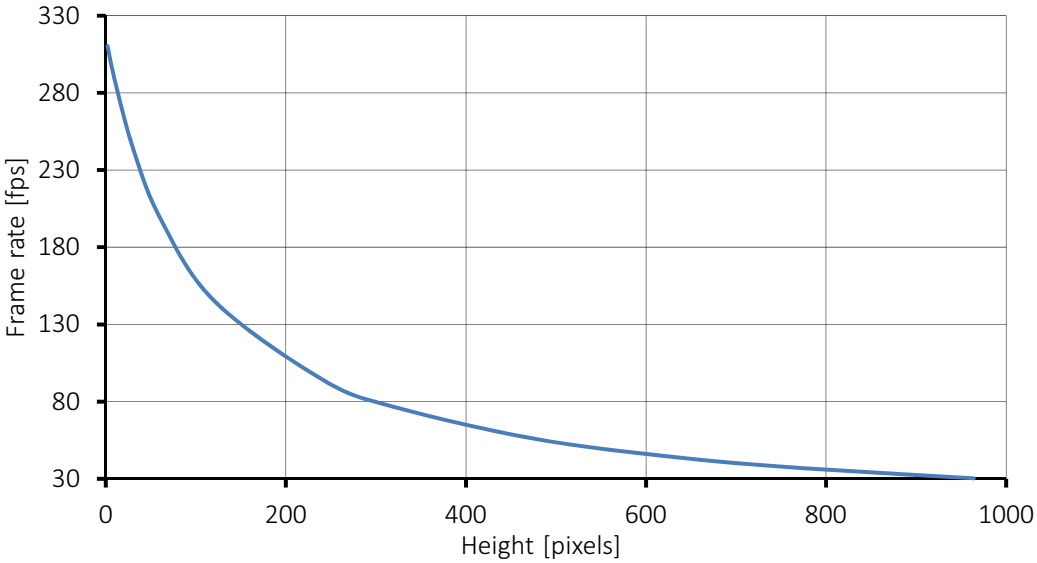


Figure 8: Frame rate as a function of ROI height

Height in pixels	Frame rate
964	30.3
960	30.4
768	37.1
640	43.5
480	55.5
320	76.5

Height in pixels	Frame rate
240	94.4
120	145.5
60	199.3
30	244.5
10	288.1
2	310.3

Width = 1292 pixels

Table 9: Frame rate as a function of ROI height

Frame rate = theoretical maximum frame rate (in frames per second) of the CCD sensor according to given formula.

Mako G-131B, G-131C

Feature	Specification			
	Mako G-131B		Mako G-131C	
Resolution	1280 (H) x 1024 (V) 1.3 MP			
Sensor	Teledyne e2v EV76C560			
Sensor type	CMOS			
Shutter type	Global, Global Reset, and Rolling			
Sensor size	Type 1/1.8 8.7 mm diagonal			
Pixel size	5.3 µm x 5.3 µm			
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*			
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*		Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*	
Maximum frame rate at full resolution	62 frames per second			
Maximum image bit depth	10-bit			
Image buffer	64 MB			
StreamHoldCapacity	Up to 50 frames at full resolution			
Monochrome formats	Mono8, Mono10		Mono8	
Color formats (YUV)	n/a		YUV411Packed, YUV422Packed, YUV444Packed	
Color formats (RGB)	n/a		RGB8Packed, BGR8Packed	
RAW formats	n/a		BayerBG8, BayerBG10	
Exposure time control	**Pixel format**	**Global shutter mode**	**Global Reset shutter mode**	**Rolling shutter mode**
	Mono8, Mono10, BayerBG8, BayerBG10, YUV411Packed, YUV422Packed	12 µs to 1.012 s; 1 µs increments	12 µs to 0.978 s; 1 µs increments	12 µs to 0.994 s; 1 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	12 µs to 2.124 s; 1 µs increments	12 µs to 2.053 s; 1 µs increments	12 µs to 2.086 s; 1 µs increments
Gain control	0 to 24 dB; 1 dB increments			

Table 10: Mako G-131B, G-131C model specifications

Feature	Specification	
	Mako G-131B	Mako G-131C
Binning[1]	Horizontal: 1 to 2 pixels Vertical: 1 to 2 rows Teledyne e2v sensors support 1x1 and 2x2 binning	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.0 W @ 12 VDC; 2.2 W PoE	
Trigger latency[2]	Idle state: 32.6 µs; Frame valid state: 32.6 µs	
Trigger jitter[2]	Idle state: ±8.1 µs; Frame valid state: ±8.1 µs	
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] The Mako G-131B, G-131C supports `BinningHorizontalMode` = *`Sum`* or *`Average`* and `BinningVerticalMode` = *`Sum`* or *`Average`*.

[2] These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bits per pixel and applicable in both Idle and Frame valid states:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.
- The Teledyne e2v sensor does not support exposure duration via external level trigger.

Table 10: Mako G-131B, G-131C model specifications (continued)

Overlapping exposure and readout

The Teledyne e2v sensor does not support overlapped exposure and readout in hardware trigger mode or in global reset mode.

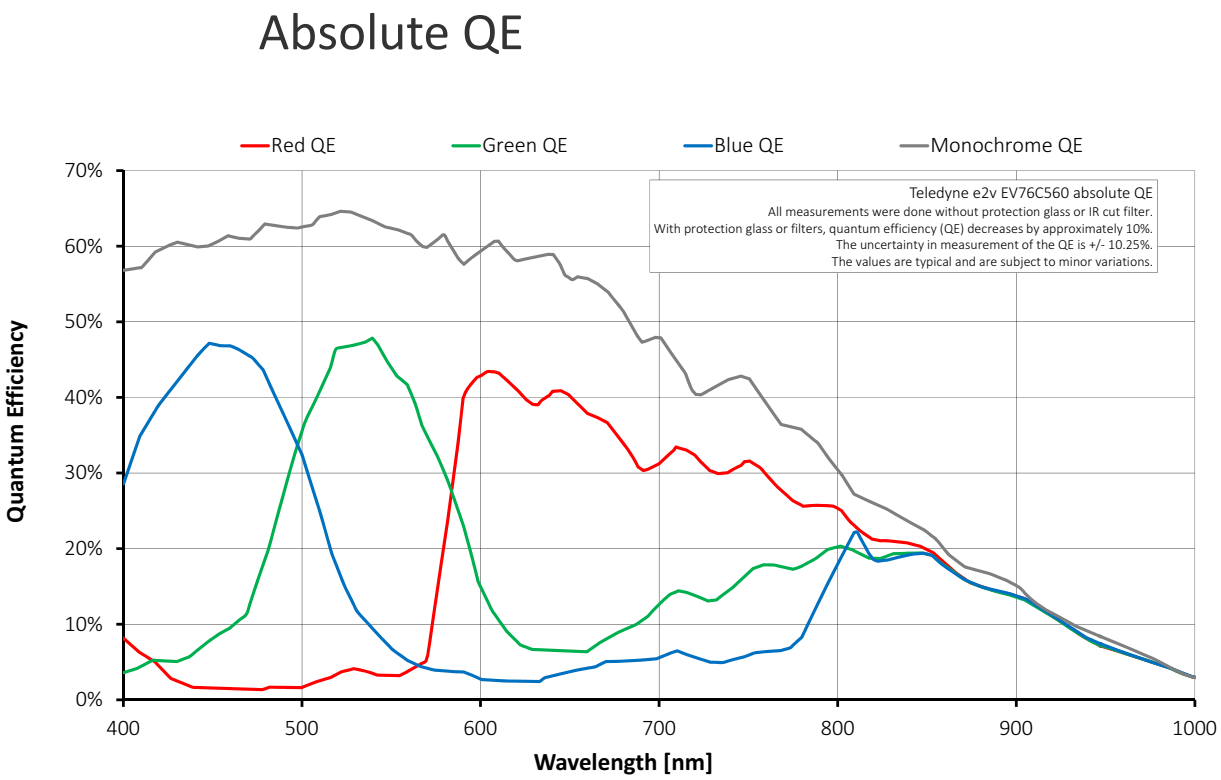


Figure 9: Mako G-131B, G-131C (Teledyne e2v EV76C560) absolute QE

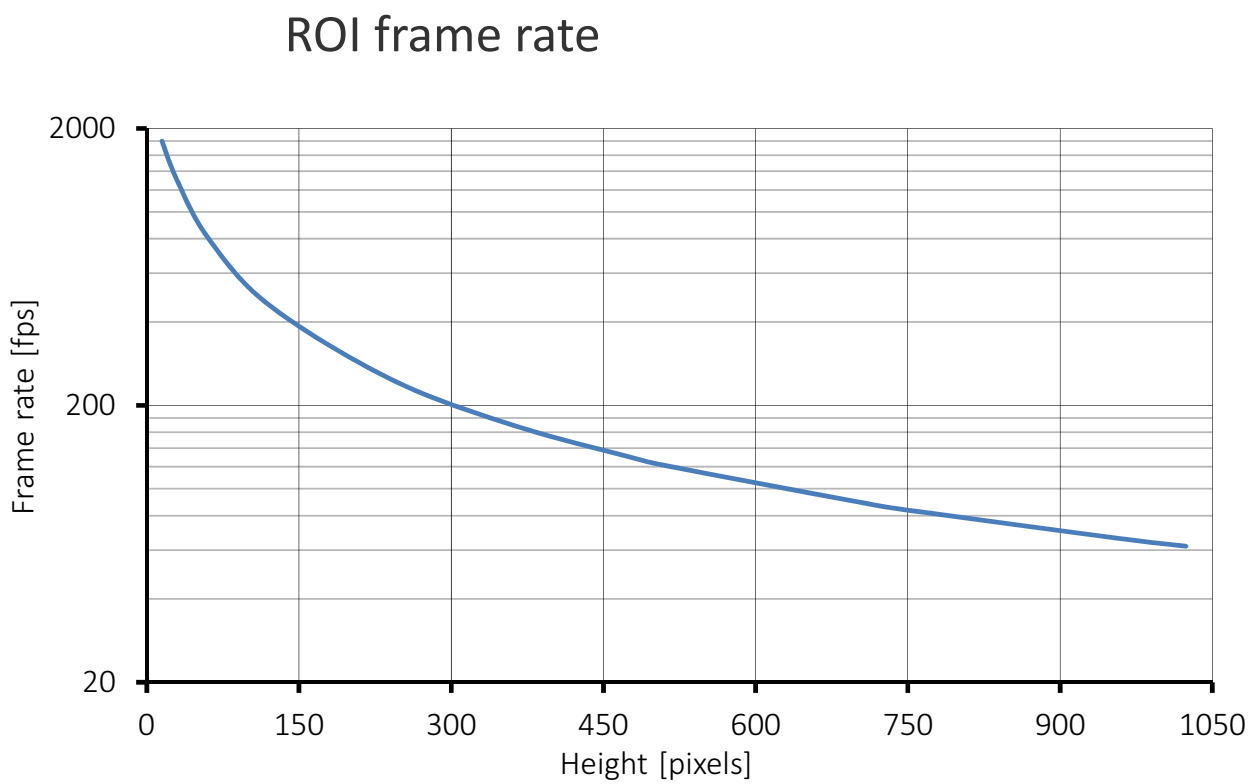


Figure 10: Frame rate as a function of ROI height

Height in pixels	Frame rate
1024	62
960	66
768	82
720	87
512	121
480	129
360	170
240	249
120	462
60	809
30	1295
15	1798

Width = 1280 pixels

Table 11: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-192B, G-192C

Feature	Specification		
	Mako G-192B	**Mako G-192C**	
Resolution	1600 (H) x 1200 (V) 1.9 MP		
Sensor	Teledyne e2v EV76C570		
Sensor type	CMOS		
Shutter type	Global, Global Reset, and Rolling		
Sensor size	Type 1/1.8 9 mm diagonal		
Pixel size	4.5 µm x 4.5 µm		
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*		
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*	
Maximum frame rate at full resolution	60 frames per second		
Maximum image bit depth	10-bit		
Image buffer	64 MB		
StreamHoldCapacity	Up to 34 frames at full resolution		
Monochrome formats	Mono8, Mono10	Mono8	
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed	
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed	
RAW formats	n/a	BayerBG8, BayerBG10	
Exposure time control	**Pixel format**	**Global or Rolling shutter mode**	**Global Reset shutter mode**
	Mono8, Mono10, BayerBG8, BayerBG10, YUV411Packed, YUV422Packed	14 µs to 0.891 s; 1 µs increments	14 µs to 0.874 s; 1 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	14 µs to 1.870 s; 1 µs increments	14 µs to 1.835 s; 1 µs increments
Gain control	0 to 24 dB; 1 dB increments		
Binning[1]	Horizontal: 1 to 2 pixels Vertical: 1 to 2 rows Teledyne e2v sensors support 1x1 and 2x2 binning.		
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor		

Table 12: Mako G-192B, G-192C model specifications

Feature	Specification	
	Mako G-192B	Mako G-192C
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.1 W @ 12 VDC; 2.4 W PoE	
Trigger latency[2]	Idle state: 27.7 µs; Frame valid state: 27.7 µs	
Trigger jitter[2]	Idle state: ±6.9 µs; Frame valid state: ±6.9 µs	
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] The Mako G-192B, G-192C supports `BinningHorizontalMode` = *`Sum`* or *`Average`* and `BinningVerticalMode` = *`Sum`* or *`Average`*.

[2] These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bits per pixel and applicable in both Idle and Frame valid state:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.
- The Teledyne e2v sensor does not support exposure duration via external level trigger.

Table 12: Mako G-192B, G-192C model specifications (continued)

Overlapping exposure and readout

The Teledyne e2v sensor does not support overlapped exposure and readout in hardware trigger mode or in global reset mode.

Absolute QE

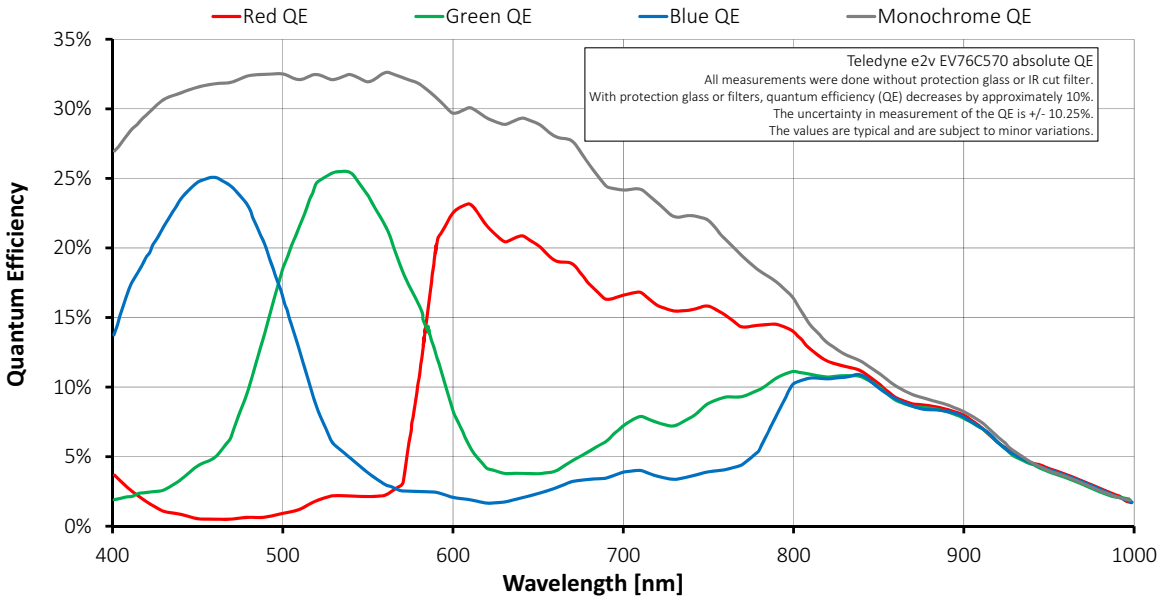


Figure 11: Mako G-192B, G-192C (Teledyne e2v EV76C570) absolute QE

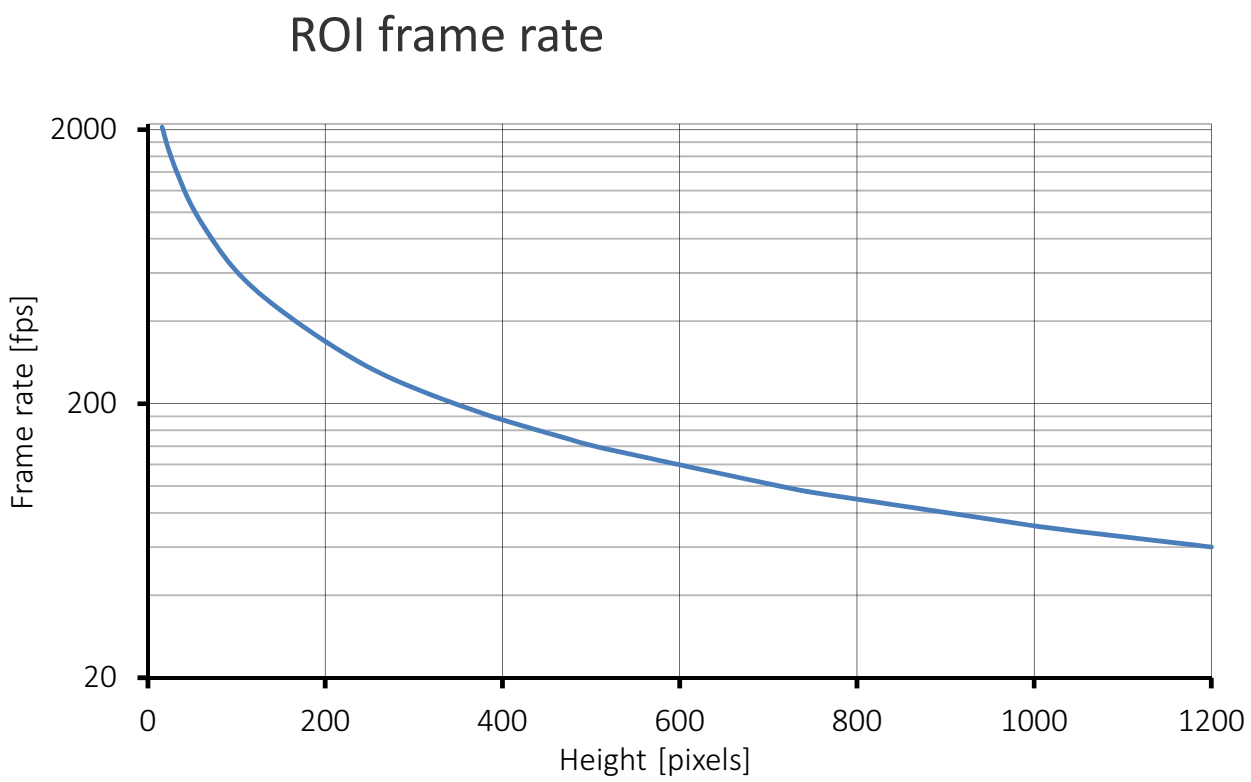


Figure 12: Frame rate as a function of ROI height

Height in pixels	Frame rate
1200	60
1024	70
960	75
768	93
720	99
512	138
480	147
360	193
240	282
120	525
60	919
30	1470
16	2042

Width = 1600 pixels

Table 13: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-223B, G-223B NIR, G-223C

Feature	Specification	
	Mako G-223B, G-223B NIR	**Mako G-223C**
Resolution	2048 (H) x 1088 (V) 2.2 MP	
Sensor	CMOSIS/ams CMV2000	
Sensor type	CMOS	
Shutter type	Global	
Sensor size	Type 2/3 12.7 mm diagonal	
Pixel size	5.5 µm x 5.5 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	49.5 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 29 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerGB8, BayerGB12, BayerGB12Packed
Exposure time control[1]	30 µs to 153 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Binning	n/a	
Decimation	n/a	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE	
Trigger latency	Please contact support for more information.	
Trigger jitter	Please contact support for more information.	
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	

Table 14: Mako G-223B, G-223B NIR, G-223C model specifications

Feature	Specification	
	Mako G-223B, G-223B NIR	Mako G-223C
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	
[1] Camera firmware version ≤ 01.52.8151 or later shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor data sheet for details on frame overhead time.		

Table 14: Mako G-223B, G-223B NIR, G-223C model specifications (continued)

Absolute QE

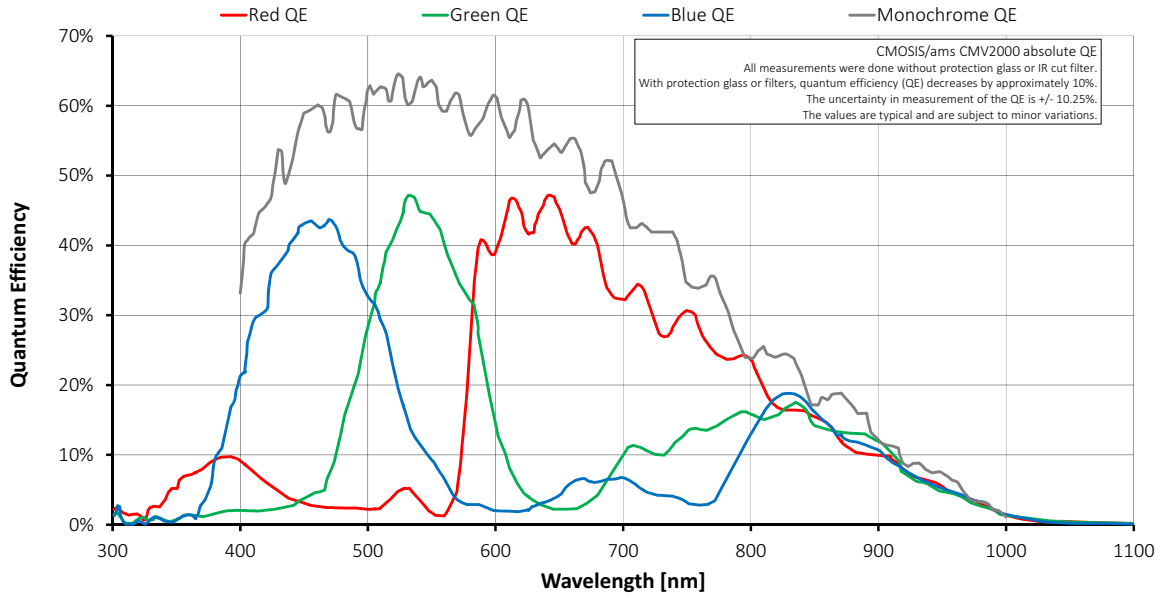


Figure 13: Mako G-223B, G-223C (CMOSIS/ams CMV2000) absolute QE

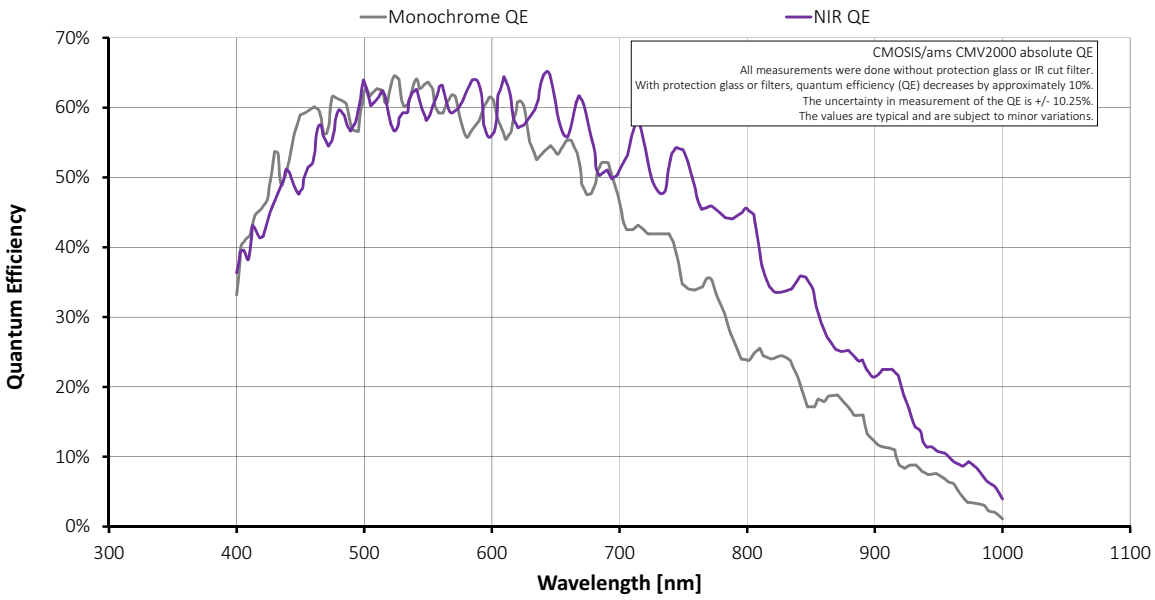


Figure 14: Mako G-223B, G-223B NIR (CMOSIS/ams CMV2000) absolute QE

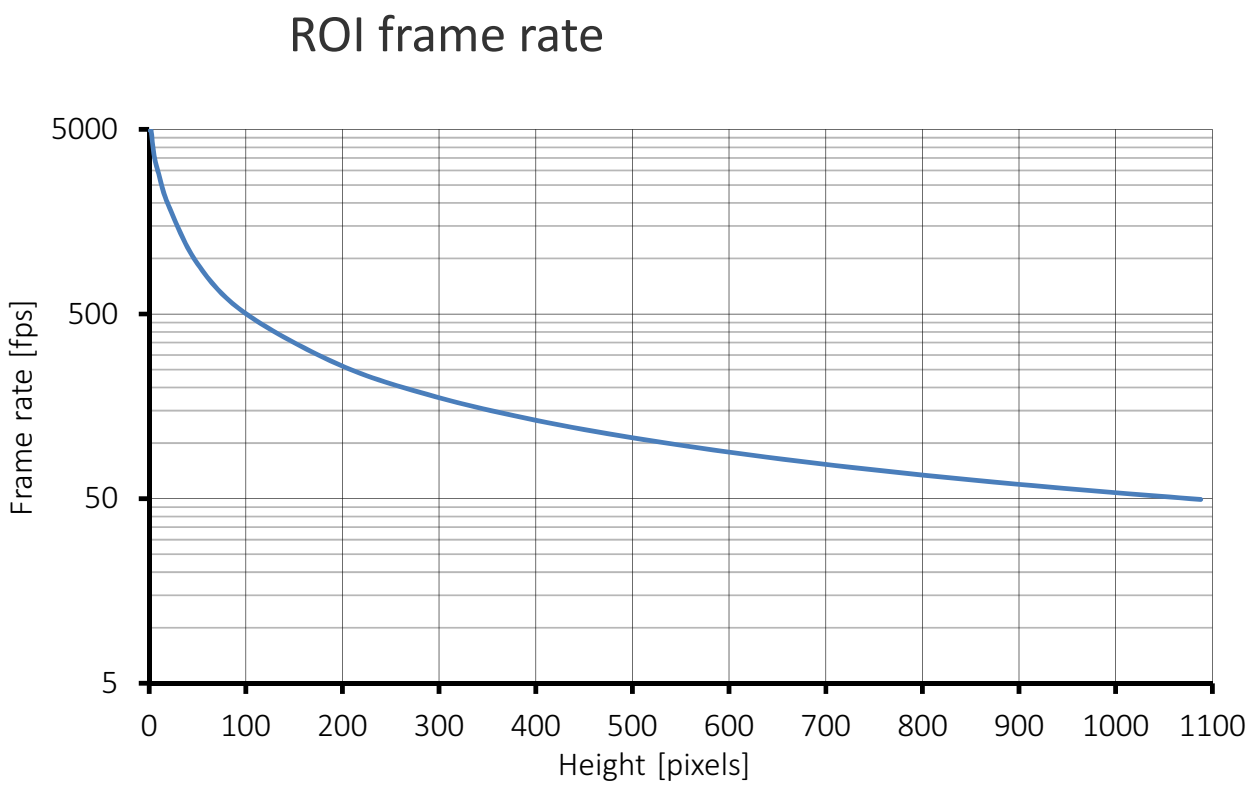


Figure 15: Frame rate as a function of ROI height

Height in pixels	Frame rate
1088	49.5
1000	53.8
900	59.7
800	67.1
700	76.6
600	89.2
500	106.8
400	132.9
300	176.1

Height in pixels	Frame rate
200	260.8
100	502.1
50	934.6
20	1933.8
10	2847.3
5	3624.5
2	4906.7
1	4926.1

Width = 2048 pixels

Table 15: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-234B, G-234C

Feature	Specification	
	Mako G-234B	**Mako G-234C**
Resolution	1936 (H) x 1216 (V) 2.35 MP	
Sensor	Sony IMX249LLJ Exmor with Pregius® global shutter	Sony IMX249LQJ Exmor with Pregius® global shutter
Sensor type	CMOS	
Shutter type	Global	
Sensor size	Type 1/1.2 13.4 mm diagonal	
Pixel size	5.86 µm x 5.86 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Sensor output	10-bit or 12-bit	
Maximum frame rate at full resolution	41.2 frames per second (10-bit) 31.8 frames per second (12-bit)	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 28 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[1]	**Pixel format**	**Value**
	Mono8, Mono12, Mono12Packed, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	52 µs to 71 s; 19.3 µs increments (10-bit) 63 µs to 71 s; 25 µs increments (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	91 µs to 71 s; 38.6 µs increments (10-bit) 113 µs to 71 s; 50 µs increments (12-bit)
Gain control	0 to 40 dB; 0.1 dB increments	
Binning	Horizontal: 1 to 4 pixels Vertical: 1 to 4 rows	

Table 16: Mako G-234B, G-234C model specifications

Feature	Specification	
	Mako G-234B	**Mako G-234C**
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE	
Trigger latency[2]	**Pixel format**	**Value**
	Mono8, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	58.2 µs (10-bit), 75.6 µs (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	116.4 µs (10-bit), 151.2 µs (12-bit)
Trigger jitter[2]	**Pixel format**	**Value**
	Mono8, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	±9.6 µs (10-bit), ±12.5 µs (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	±19.3 µs (10-bit), ±25 µs (12-bit)
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] Whenever pixel format is changed, Exposure will adjust itself to the nearest multiple of Exposure increment.

[2] It is possible to start the exposure of next frame while previous frame is read out:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 16: Mako G-234B, G-234C model specifications (continued)

With 10-bit sensor readout mode you can achieve a higher frame rate. The sensor is capable of higher frame rates but readout is limited by GigE bandwidth and exposure value. You can improve frame rates with a reduced region of interest and shorter exposure values.

SensorReadoutMode

For more information on `SensorReadoutMode`, see the *GigE Features Reference*.

Absolute QE

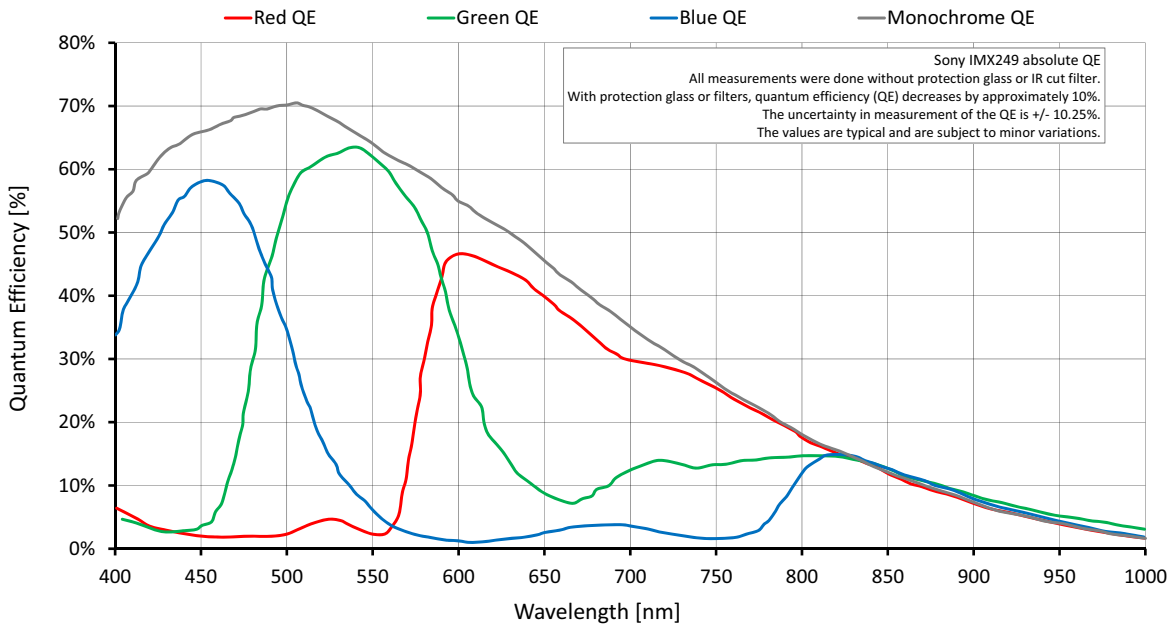


Figure 16: Mako G-234B, G-234C (Sony IMX249) absolute QE

Spectral response

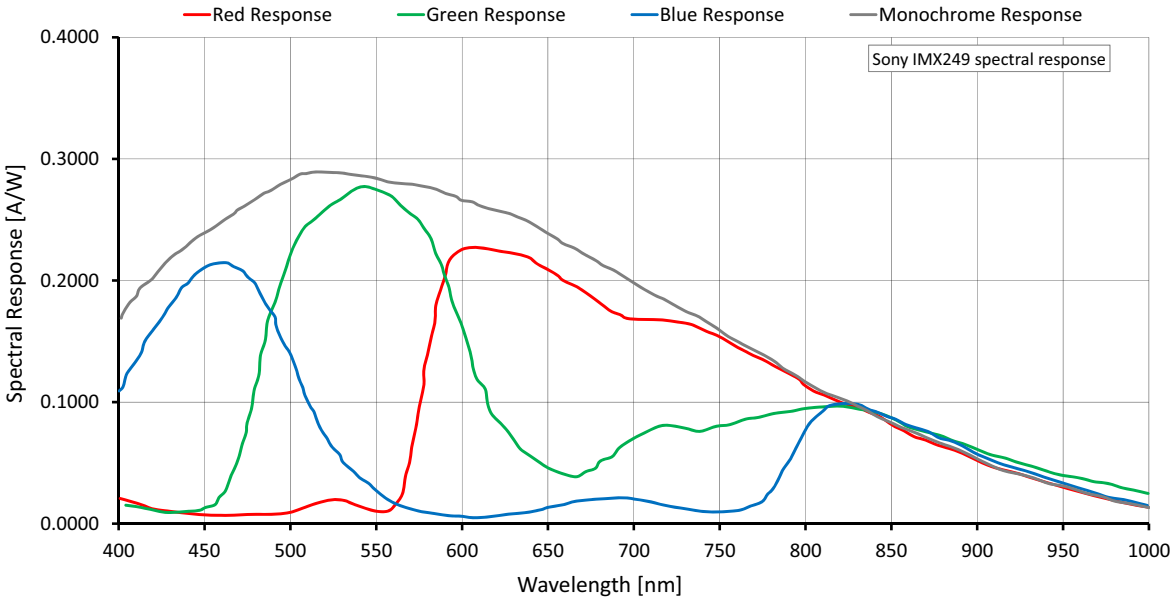


Figure 17: Mako G-234B, G-234C (Sony IMX249) spectral response

ROI frame rate

12-bit sensor readout

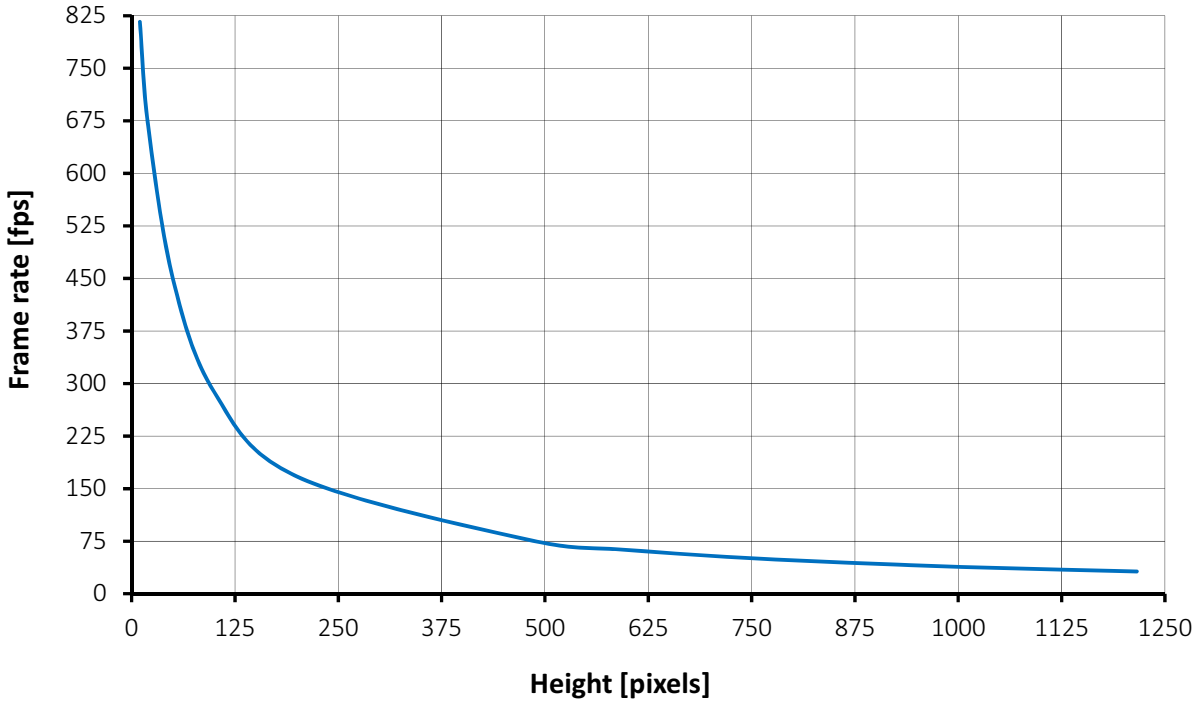


Figure 18: 12-bit sensor frame rate as a function of ROI height

Height in pixels	Frame rate	Height in pixels	Frame rate
1216	31.8	480	77.0
1080	35.7	200	167.3
1024	37.6	100	287.7
960	40.0	50	449.4
768	49.5	20	677.9
600	62.5	10	816.3

Width = 1936 pixels

Table 17: 12-bit sensor frame rate as a function of ROI height

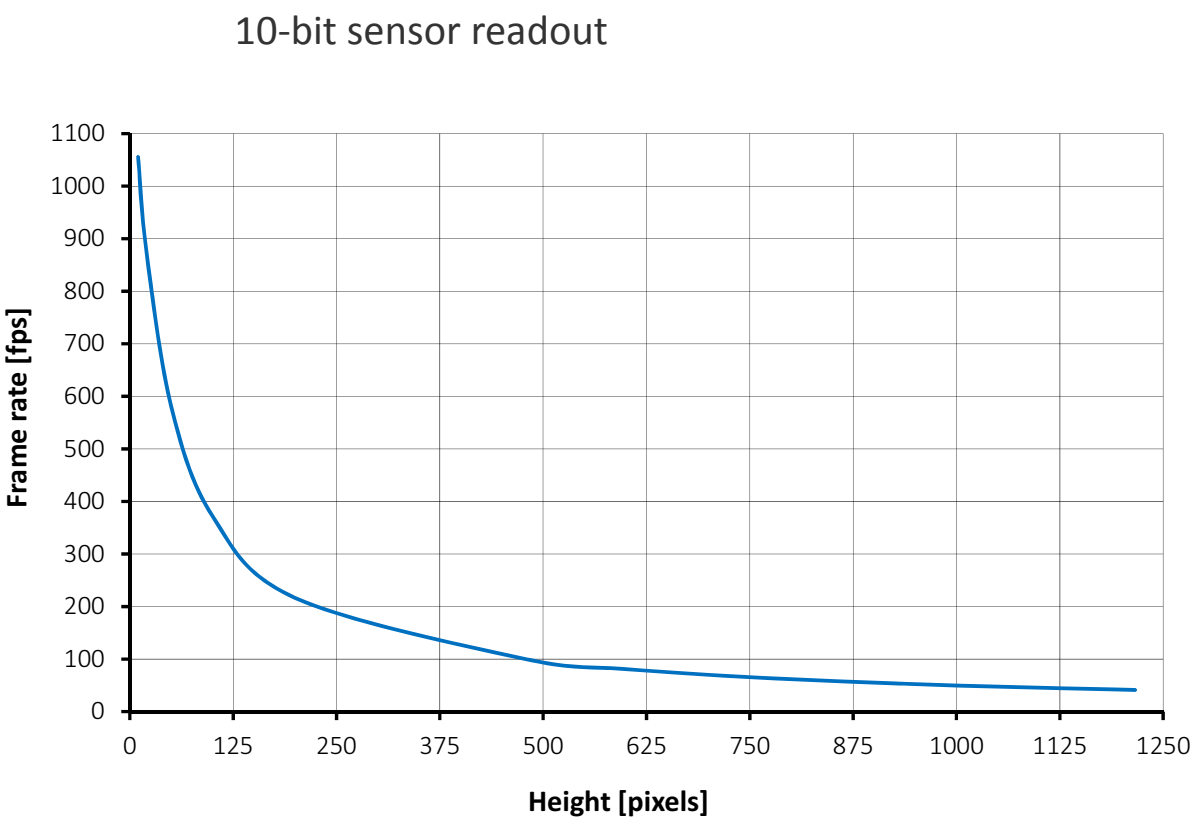


Figure 19: 10-bit sensor frame rate as a function of ROI height

Height in pixels	Frame rate	Height in pixels	Frame rate
1216	41.2	480	99.6
1080	46.2	200	216.4
1024	48.6	100	372.1
960	51.7	50	581.1
768	64.0	20	876.6
600	80.9	10	1055.6

Width = 1936 pixels

Table 18: Frame rate as a function of ROI height

Mako G-319B, G-319C

Feature	Specification	
	Mako G-319B	**Mako G-319C**
Resolution	2064 (H) x 1544 (V) 3.2 MP	
Sensor	Sony IMX265LLR Exmor with Pregius® global shutter	Sony IMX265LQR Exmor with Pregius® global shutter
Type	CMOS	
Shutter type	Global	
Sensor size	Type 1/1.8 8.9 mm diagonal	
Pixel size	3.45 µm x 3.45 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	37.5 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 20 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[1]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	46 µs to 85.9 s; 16.5 µs increments
	Mono12, BayerRG12, YUV422Packed	57 µs to 85.9 s; 21.9 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	79 µs to 85.9 s; 32.9 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	
Binning	Horizontal: 1 to 4 pixels Vertical: 1 to 4 rows	Horizontal: 1 to 4 pixels
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Opto-isolated I/Os	1 input, 3 outputs	

Table 19: Mako G-319B, G-319C model specifications

Feature	Specification	
	Mako G-319B	**Mako G-319C**
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.5 W @ 12 VDC; 2.7 W PoE	
Trigger latency[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	49.4 µs
	Mono12, BayerRG12, YUV422Packed	65.8 µs
	RGB8Packed, BGR8Packed, YUV444Packed	98.9 µs
Trigger jitter[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±8.1 µs
	Mono12, BayerRG12, YUV422Packed	±10.9 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±16.5 µs
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C	

[1] Whenever `PixelFormat` is changed, exposure will adjust itself to the nearest multiple of exposure increment.

[2] It is possible to start the exposure of next frame while previous frame is read out:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 19: Mako G-319B, G-319C model specifications (continued)

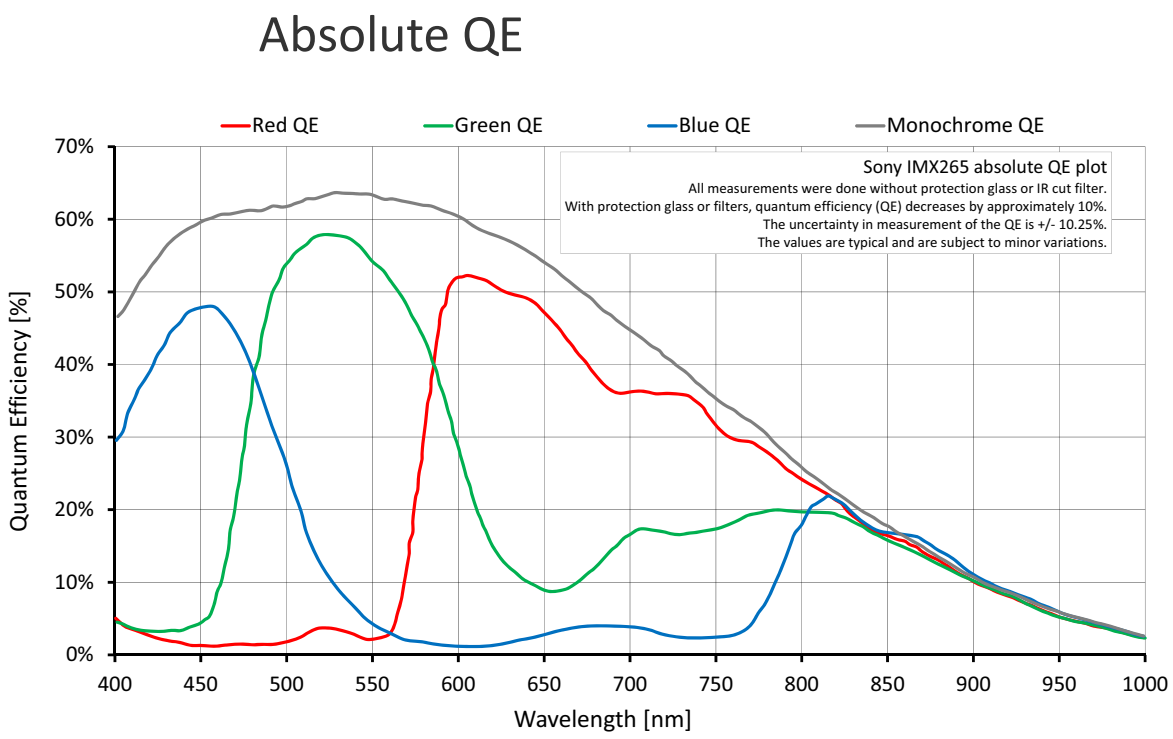


Figure 20: Mako G-319B, G-319C (Sony IMX265) absolute QE

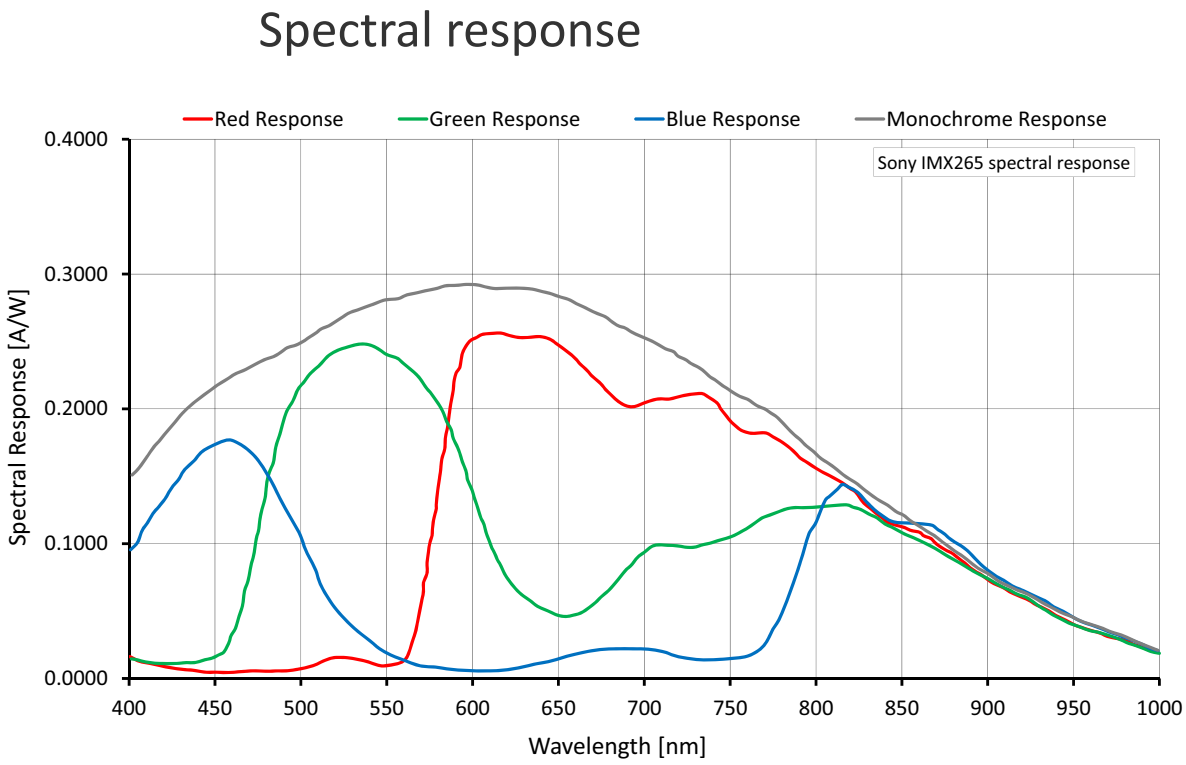


Figure 21: Mako G-319B, G-319C (Sony IMX265) spectral response

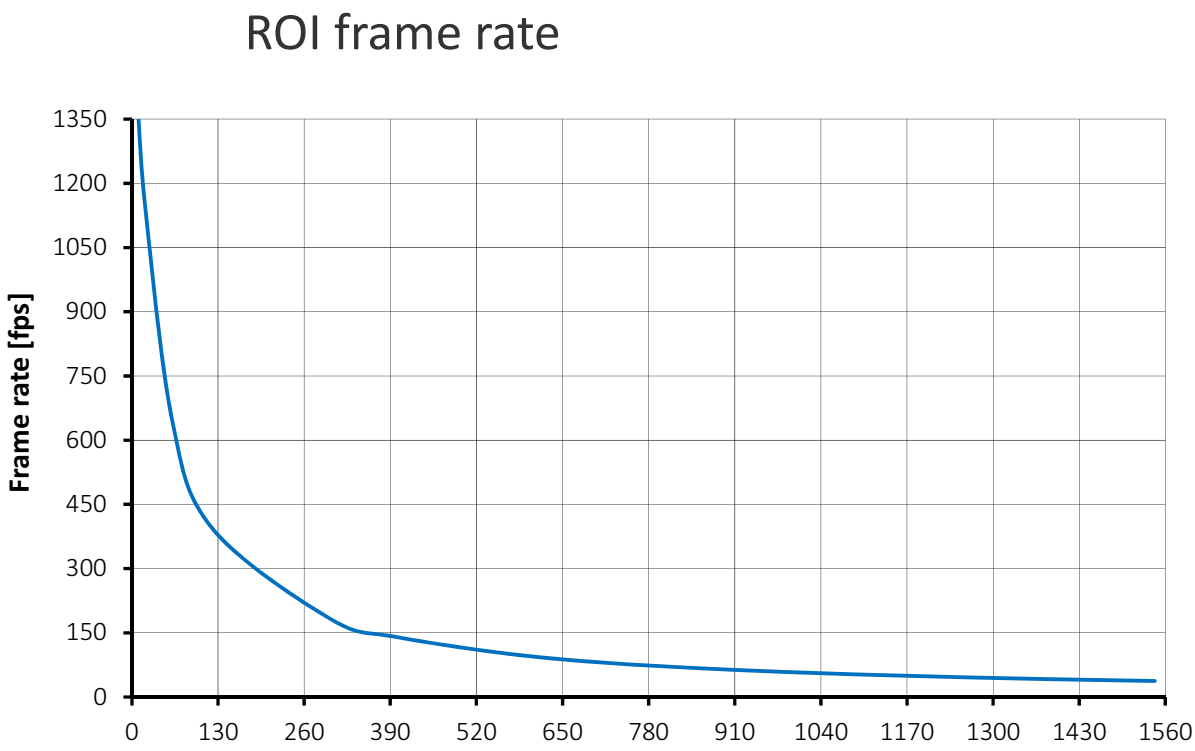


Figure 22: Frame rate as a function of ROI height

Height in pixels	Frame rate
1544	37.5
1280	45.3
1024	56.5
800	71.9
600	95.4
400	140.1
300	182.2
120	396.5
60	652.4
20	1144.8
10	1348.4

Width = 2064 pixels

Table 20: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited. Reducing the exposure time may result in higher frame rates.

Mako G-419B, G-419B NIR, G-419C

Feature	Specification	
	Mako G-419B, G-419B NIR	**Mako G-419C**
Resolution	2048 (H) x 2048 (V) 4.2 MP	
Sensor	CMOSIS/ams CMV4000	
Sensor type	CMOS	
Shutter type	Global	
Sensor size	Type 1 16.0 mm diagonal	
Pixel size	5.5 µm x 5.5 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	26.3 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 15 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerGB8, BayerGB12, BayerGB12Packed
Exposure time control[1]	41 µs to 153 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Binning	n/a	
Decimation	n/a	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.3 W @ 12 VDC; 2.7 W PoE	
Trigger latency	Please contact support for more information.	
Trigger jitter	Please contact support for more information.	
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	

Table 21: Mako G-419B, G-419B NIR, G-419C model specifications

Feature	Specification	
	Mako G-419B, G-419B NIR	Mako G-419C
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only Resolution: 0.031; Accuracy: ± 1 °C	
[1] Camera firmware version ≤ 01.52.8151 shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor data sheet for details on frame overhead time.		

Table 21: Mako G-419B, G-419B NIR, G-419C model specifications (continued)

Absolute QE

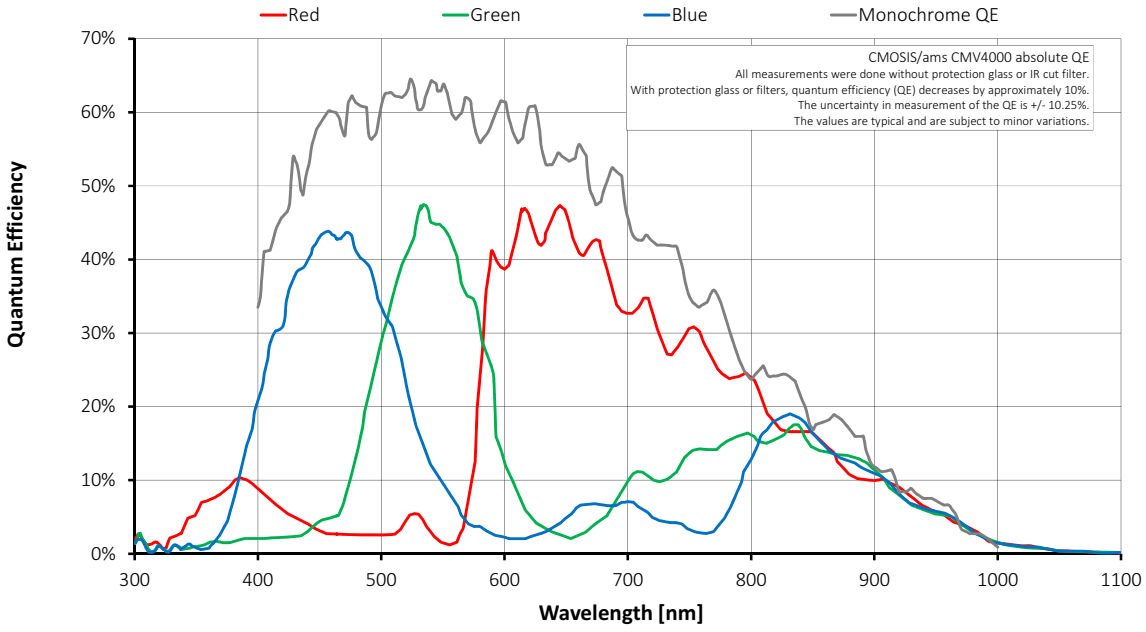


Figure 23: Mako G-419B, G-419C (CMOSIS/ams CMV4000) absolute QE

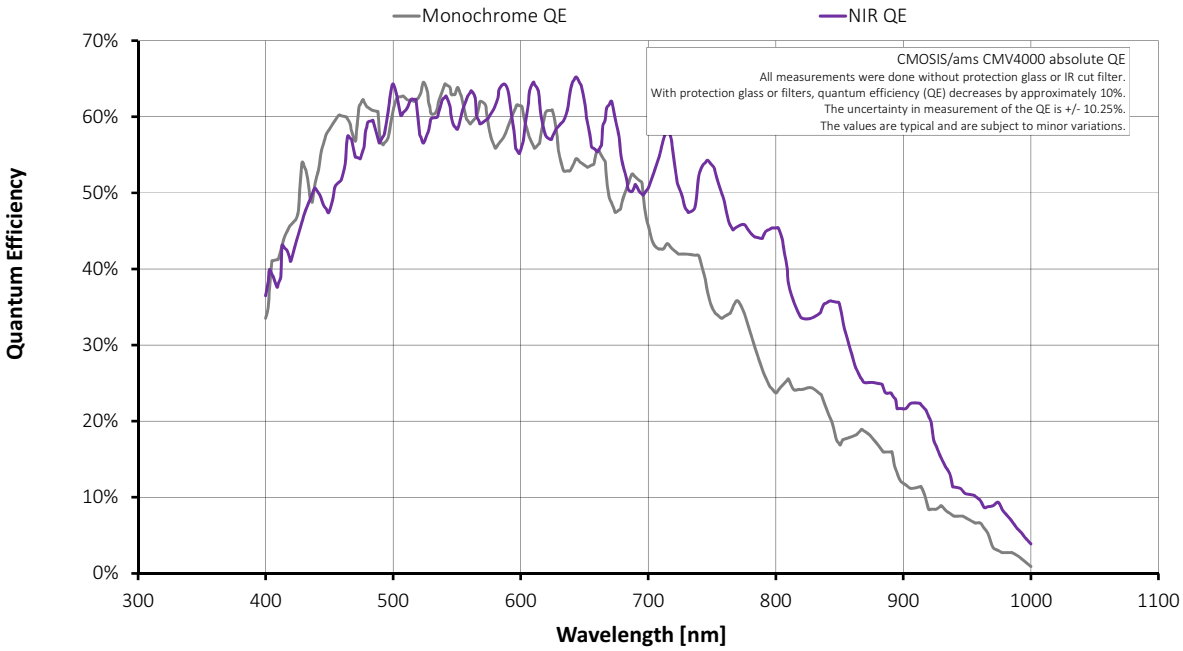


Figure 24: Mako G-419B, G-419B NIR (CMOSIS/ams CMV4000) absolute QE

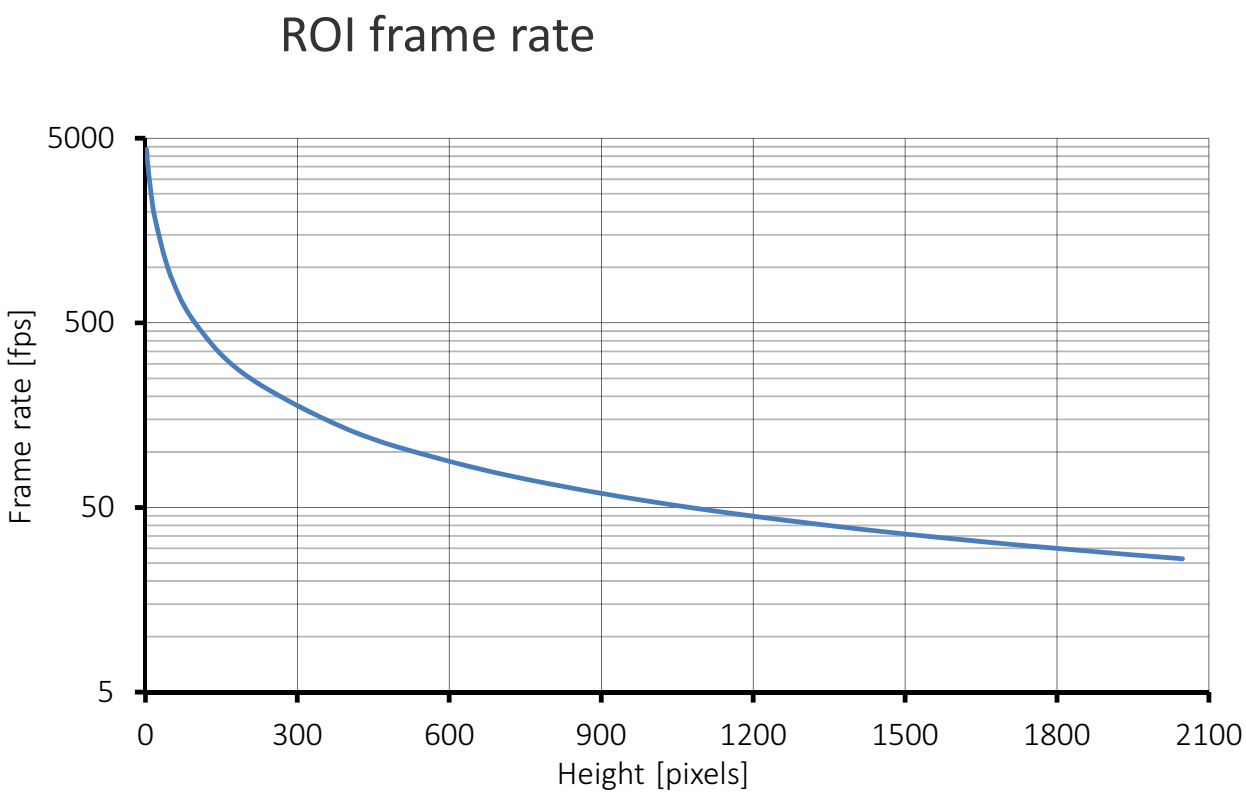


Figure 25: Frame rate as a function of ROI height

Height in pixels	Frame rate
2048	26.3
2000	26.9
1800	29.9
1600	33.6
1400	38.4
1200	44.8
1000	53.7
800	66.9
600	88.8

Height in pixels	Frame rate
400	132.1
200	257.7
100	490.8
50	895.9
20	1775.5
10	2639.2
5	3486.7
2	4342.1

Width = 2048 pixels

Table 22: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-503B, G-503C

Feature	Specification	
	Mako G-503B	**Mako G-503C**
Resolution	2592 (H) x 1944 (V) 5 MP	
Sensor	ON Semi MT9P031	ON Semi MT9P006
Sensor type	CMOS	
Shutter type	Global Reset, Rolling	
Sensor size	Type 1/2.5 7.13 mm diagonal	
Pixel size	2.2 µm x 2.2 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	14 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 13 frames at full resolution	
Monochrome formats	Mono8, Mono12, Mono12Packed	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerGR8, BayerGR12Packed, BayerGR12
Exposure time control[1]	31 µs to 1 s; 36.4 µs increments	
Gain control	0 to 24 dB; 1 dB increments	
Binning[2]	Horizontal: 1 to 4 pixels Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4 factor	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.0 W @ 12 VDC; 2.2 W PoE	
Trigger latency[3]	Idle state: 73.4 µs; Frame valid state: 73.4 µs	
Trigger jitter[3]	Idle state: ±18.4 µs; Frame valid state: ±18.4 µs	
Operating temperature	+5 °C to +45 °C housing temperature	

Table 23: Mako G-503B, G-503C model specifications

Feature	Specification	
	Mako G-503B	Mako G-503C
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only Resolution: 0.031; Accuracy: ± 1 °C	

[1] These exposure time control values are only valid with factory/default settings. Exposure time control values vary depending upon pixel format and width.

[2] The Mako G-503B, G-503C supports `BinningHorizontalMode` = *`Sum`* or *`Average`* and `BinningVerticalMode` = *`Sum`* or *`Average`*.

[3] These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bits per pixel and applicable in both Idle and Frame valid states:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 23: Mako G-503B, G-503C model specifications (continued)

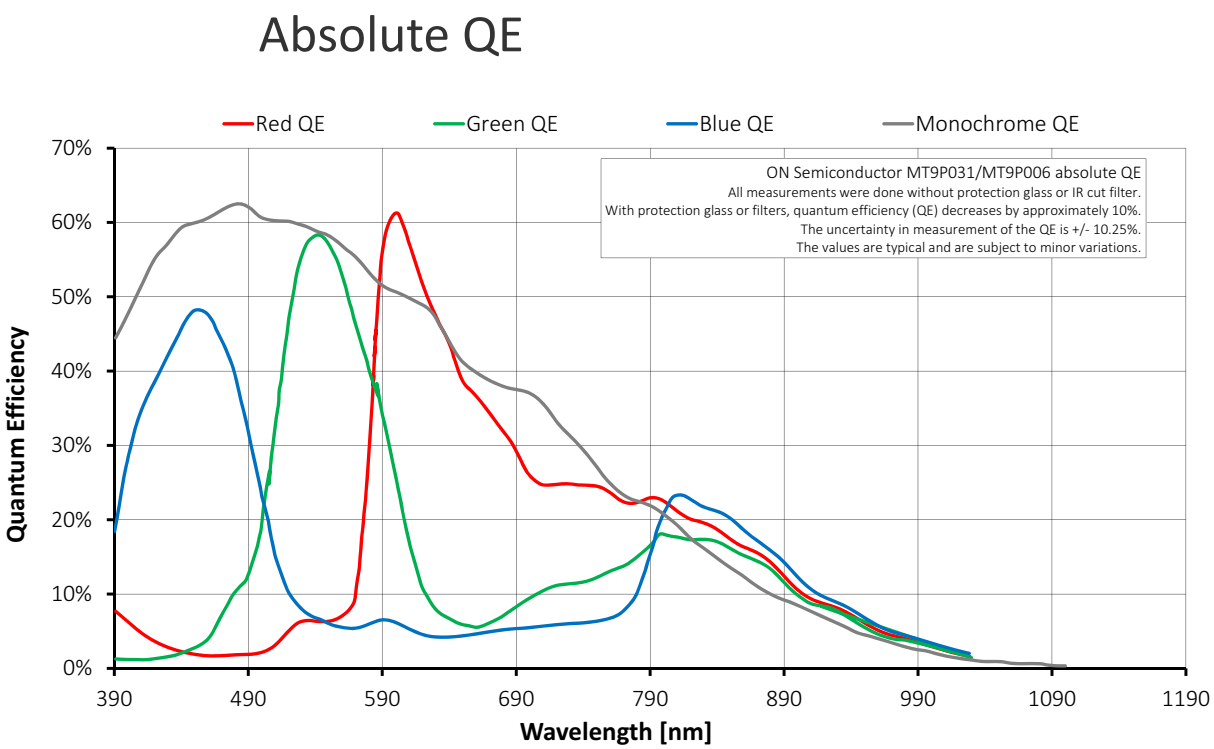


Figure 26: Mako G-503B, G-503C (ON Semi MT9P031/MT9P006) absolute QE

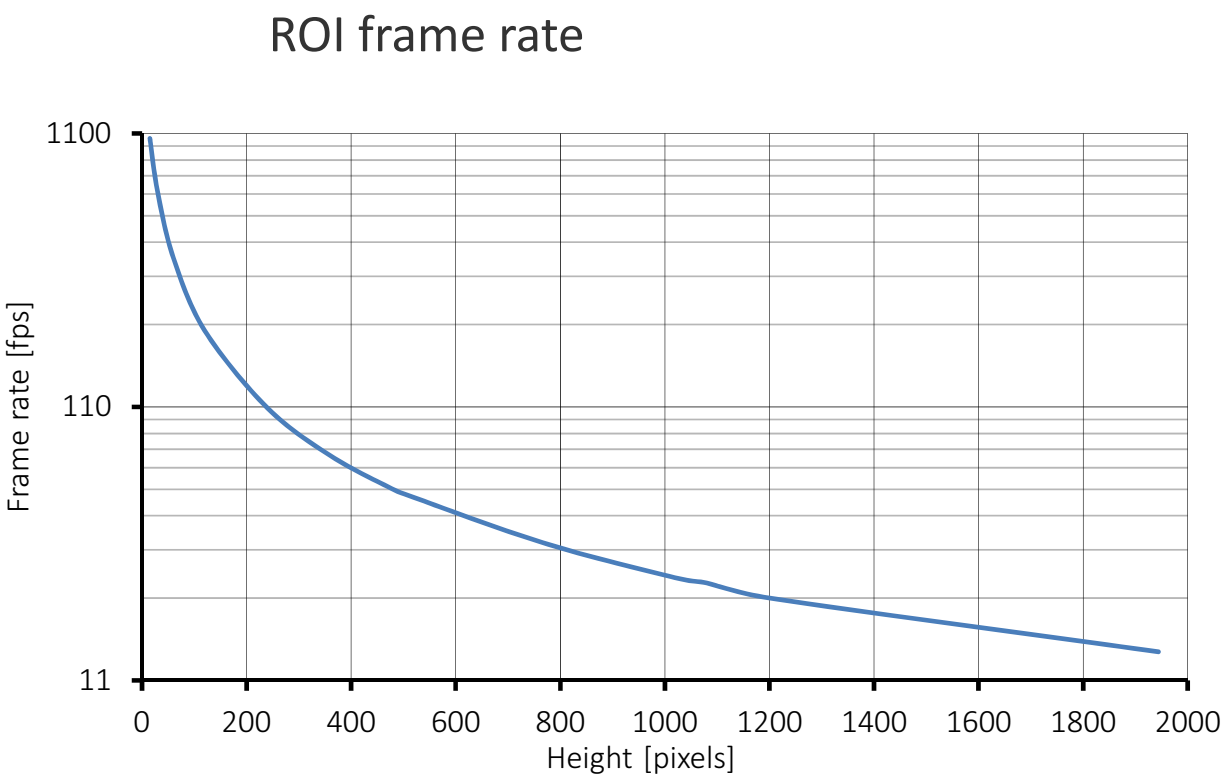


Figure 27: Frame rate as a function of ROI height

Height in pixels	Frame rate
1944	14
1200	22
1080	25
1024	26
768	35
512	52
480	55

Height in pixels	Frame rate
360	73
240	109
120	209
60	386
30	669
15	1055

Width = 2592 pixels

Table 24: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

Mako G-507B, G-507C

Feature	Specification	
	Mako G-507B	**Mako G-507C**
Resolution	2464 (H) x 2056 (V) 5.1 MP	
Sensor	Sony IMX264LLR Exmor with Pregius® global shutter	Sony IMX264LQR Exmor with Pregius® global shutter
Type	CMOS	
Shutter type	Global	
Sensor size	Type 2/3 11.1 mm diagonal	
Pixel size	3.45 µm x 3.45 µm	
Lens mount	Standard: C-Mount Optional: See the *Modular Concept*	
Optical filter	Standard: No optical filter Optional: See the *Modular Concept*	Standard: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	23.7 frames per second	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 13 frames at full resolution	
Monochrome formats	Mono8, Mono12Packed, Mono12	Mono8
Color formats (YUV)	n/a	YUV411Packed, YUV422Packed, YUV444Packed
Color formats (RGB)	n/a	RGB8Packed, BGR8Packed
RAW formats	n/a	BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[1]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	52 µs to 85.9 s; 19.5 µs increments
	Mono12, BayerRG12, YUV422Packed	65 µs to 85.9 s; 26 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	91 µs to 85.9 s; 39.0 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	
Binning	Horizontal: 1 to 4 pixels Vertical: 1 to 4 rows	Horizontal: 1 to 4 pixels
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Opto-isolated I/Os	1 input, 3 outputs	

Table 25: Mako G-507B, G-507C model specifications

Feature	Specification	
	Mako G-507B	**Mako G-507C**
Voltage requirements	12 to 24 VDC; PoE	
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE	
Trigger latency[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	58.6 µs
	Mono12, BayerRG12, YUV422Packed	78 µs
	RGB8Packed, BGR8Packed, YUV444Packed	117.1 µs
Trigger jitter[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±9.8 µs
	Mono12, BayerRG12, YUV422Packed	±13 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±19.5 µs
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature (without condensation)	
Body dimensions (L x W x H)	60.5 x 29.2 x 29.2 mm	
Mass (typical)	80 g	
Interface	IEEE 802.3 1000BASE-T (Gigabit Ethernet), IEEE 802.3af (PoE)	
Interface standard	GigE Vision Standard V1.2	
Camera control standard	GenICam SFNC V1.2.1	
Regulations	CE, RoHS, REACH, WEEE, FCC, ICES	
Temperature monitoring	Available for main board only Resolution: 0.031; Accuracy: ± 1 °C	

[1] Whenever pixel format is changed, exposure will adjust itself to the nearest multiple of exposure increment.

[2] It is possible to start the exposure of next frame while previous frame is read out:

- Idle state: sensor is ready and camera is idle, waiting for the next trigger.
- Frame valid state: sensor is reading out and camera is busy. If next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state.

Table 25: Mako G-507B, G-507C model specifications (continued)

Absolute QE

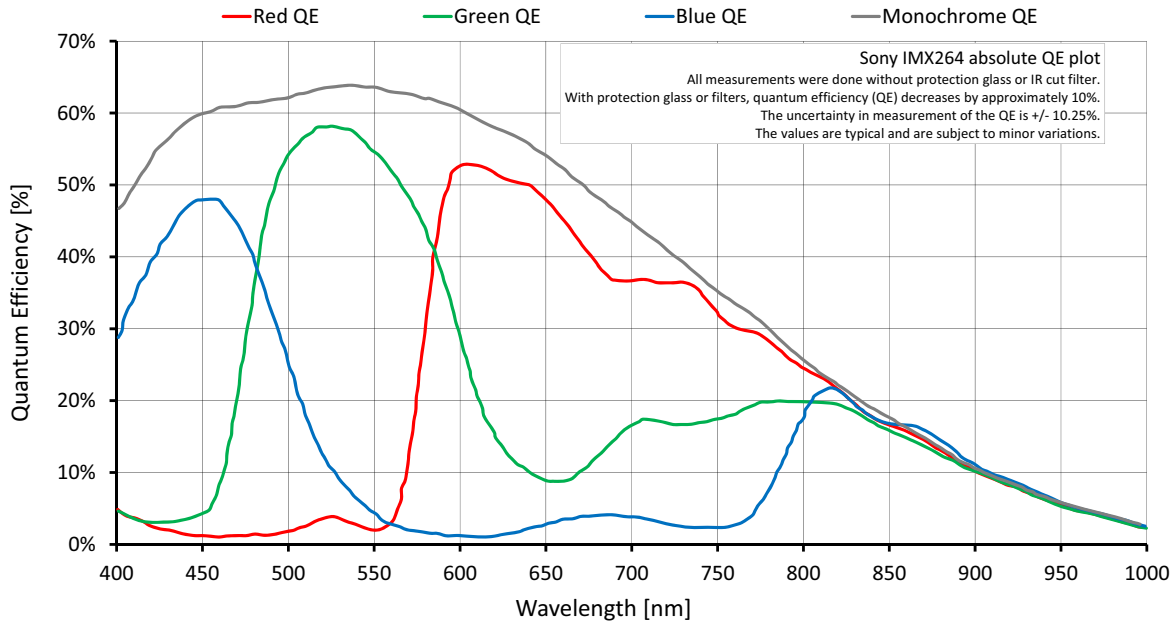


Figure 28: Mako G-507B, G-507C (Sony IMX264) absolute QE

Spectral response

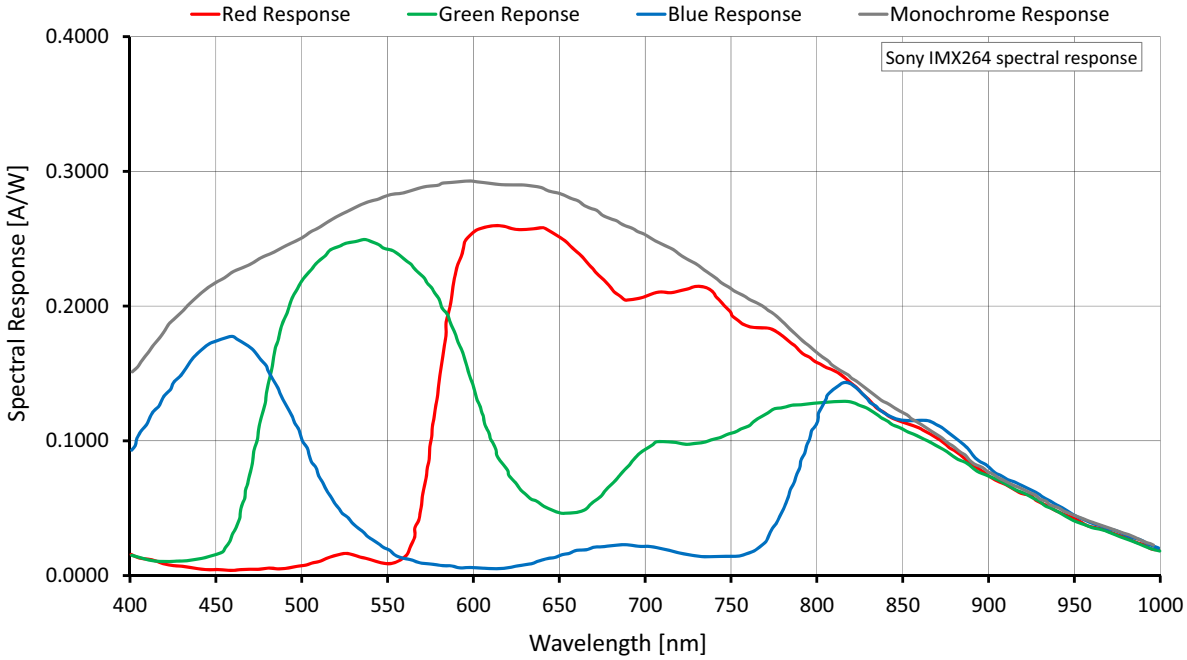


Figure 29: Mako G-507B, G-507C (Sony IMX264) spectral response

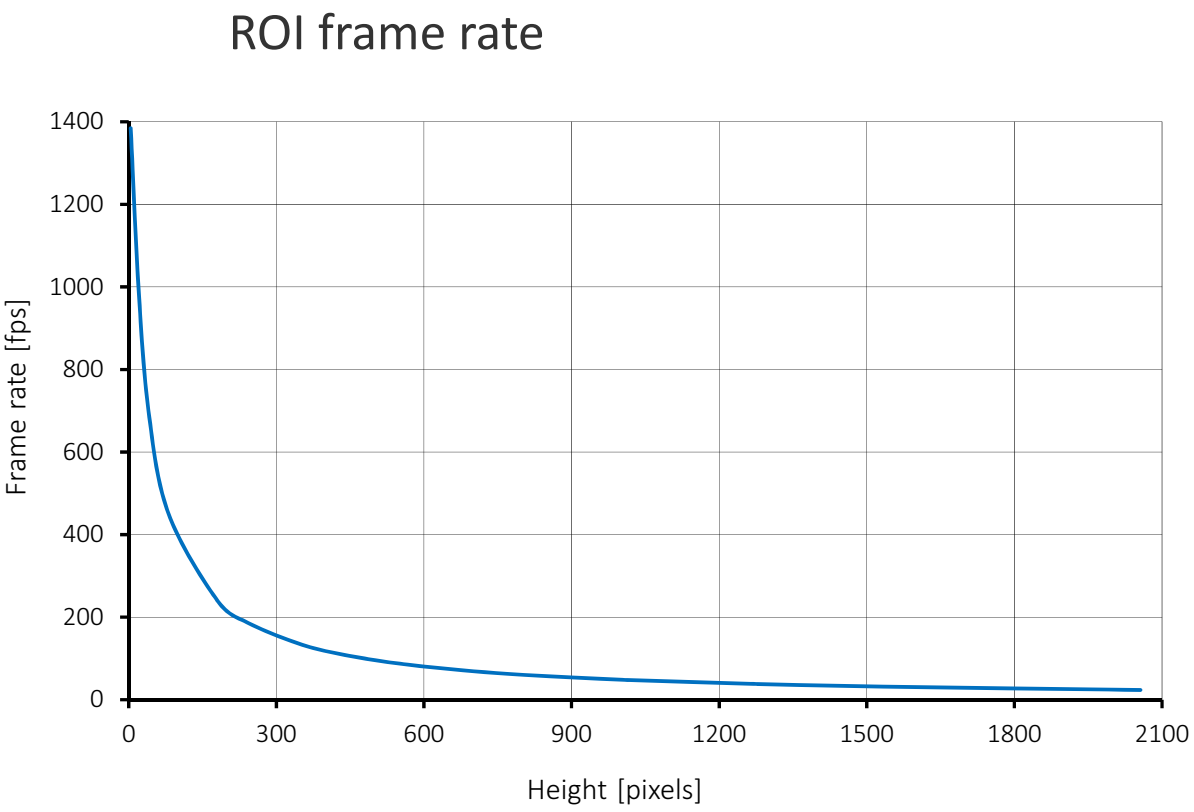


Figure 30: Frame rate as a function of ROI height

Height in pixels	Frame rate	Height in pixels	Frame rate
2056	23.7	480	99.9
1544	31.5	360	130.4
1324	36.8	240	187.7
1280	38.0	180	240.5
1024	47.4	80	453.4
960	50.6	40	701.8
768	62.9	20	996.6
600	80.5	4	1384.5

Width = 2464 pixels

Table 26: Frame rate as a function of ROI height

There will be an increase in frame rate with reduced width if the camera is bandwidth limited. Reducing the exposure time may result in higher frame rates.

Camera feature comparison

Allied Vision cameras support a number of standard and extended features. The table below identifies a selection of capabilities and compares the availability of features in Mako G camera models.

Camera feature references

A complete listing of camera features, including feature definitions can be found online:

- Vimba and third-party users: *GigE Features Reference*
- PvAPI users: *GigE Camera and Driver Attributes* document

https://www.alliedvision.com/en/products/cameras.html

Some features are firmware dependent, please refer to the *GigE Release Notes* for more information.

		Mako G-030	Mako G-032	Mako G-125	Mako G-131	Mako G-192	Mako G-223	Mako G-234	Mako G-319	Mako G-419	Mako G-503	Mako G-507
Image optimization features	Auto gain	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Auto exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Auto white balance[1]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	BinningHorizontal		✓	✓	✓	✓		✓	✓		✓	✓
	BinningVertical		✓	✓	✓	✓		✓	✓[2]		✓	✓[2]
	Black level (offset)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Decimation	✓			✓	✓		✓	✓		✓	✓
	Column defect masking						✓			✓		
	Pixel defect masking	✓			✓	✓					✓	
	Gamma correction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hue, saturation, color transformation[1]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Look-up table (LUT)(1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Region of interest (ROI)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Piecewise linear HDR mode	✓					✓			✓		
	Reverse X/Y	✓			✓	✓		✓	✓		✓	✓
	Sensor shutter mode[3]	2	2	2	1	1	2	2	2	2	3	2

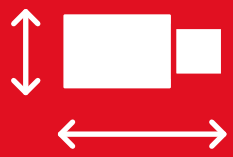
Table 27: Feature comparison by model

		Mako G-030	Mako G-032	Mako G-125	Mako G-131	Mako G-192	Mako G-223	Mako G-234	Mako G-319	Mako G-419	Mako G-503	Mako G-507
Camera control features	10/12 bit sensor output mode							✓				
	Event channel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Image chunk data	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Storable user sets (config files)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Stream hold	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Sync out modes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Temperature monitoring (main board only)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

[1] Color models only
[2] Monochrome models only
[3] Sensor shutter mode: (1) Global, Rolling, Global Reset, (2) Global, (3) Global Reset, Rolling

Table 27: Feature comparison by model (continued)

Mechanical dimensions



This chapter includes:

- Mechanical drawing and dimensions of standard housing model and tripod adapter
- Sensor position accuracy
- Maximum protrusion distance and filter diameter for C-Mount and CS-Mount

Mako G standard housing

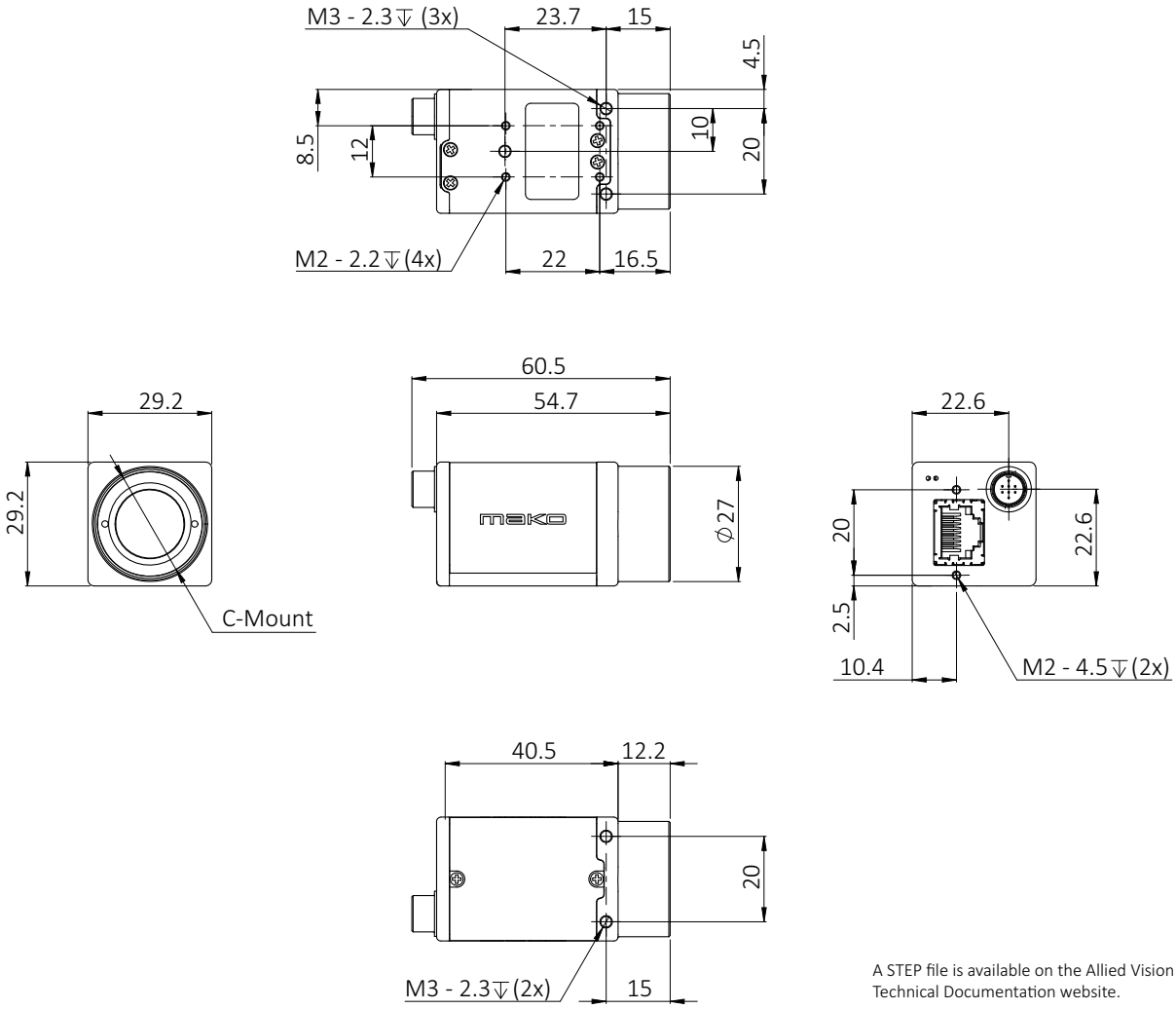


Figure 31: Mako G standard housing dimensions (including connectors)

STEP file available online

The STEP file for the Mako G standard housing with C-Mount is available at:

https://www.alliedvision.com/en/support/technical-documentation/mako-g-documentation.html

Tripod adapter

This tripod adapter (Allied Vision order number 4807) can be used for all Mako G cameras with the standard housing.

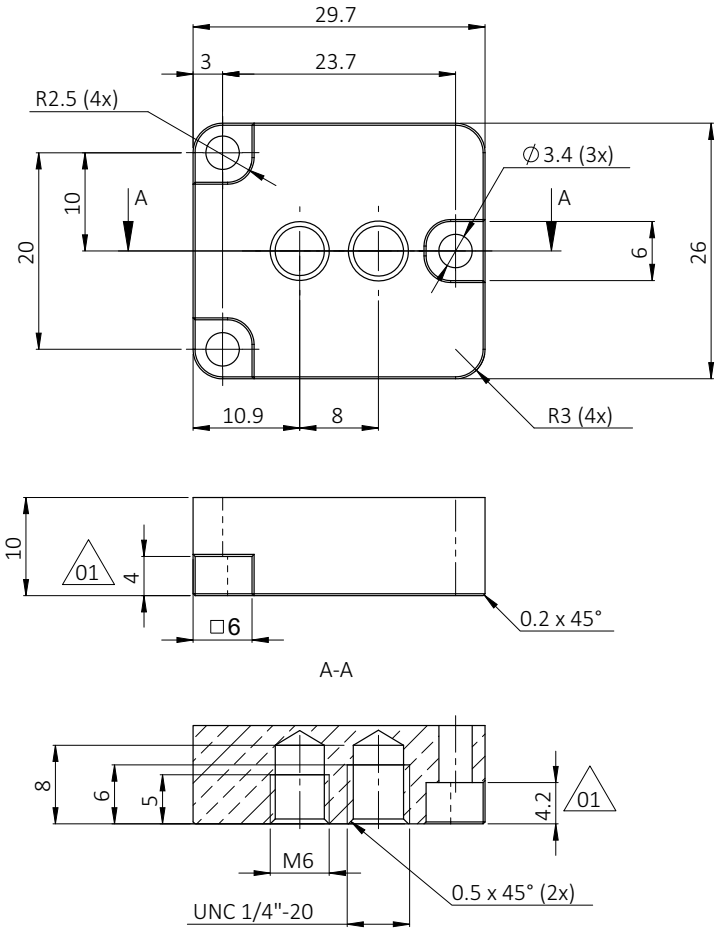


Figure 32: Tripod adapter dimensions (in mm)

Avoid damage to the camera by using inappropriate accessories

The Mako U tripod adapter is not compatible with Mako G cameras.

Sensor position accuracy

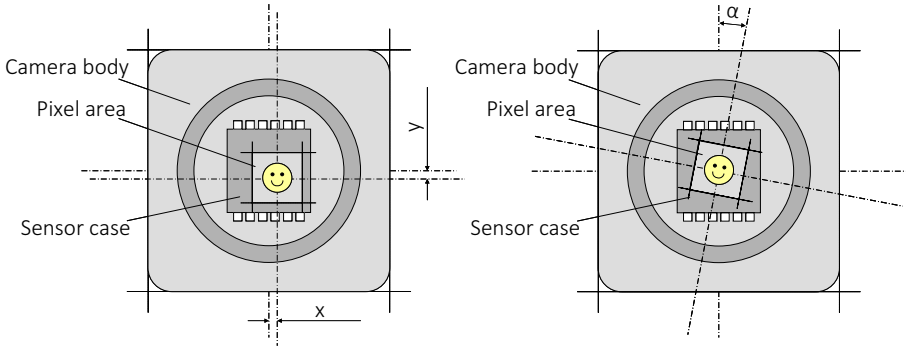


Figure 33: Allied Vision sensor position accuracy

Unless stated otherwise, the following values are applicable:

Criteria	Subject	Properties
Alignment method		Optical alignment of photo sensitive sensor area into camera front module (lens mount front flange).
Reference points	Sensor	Center of pixel area (photo sensitive cells)
	Camera	Center of camera front flange (outer case edges)
Accuracy	x/y	±150 µm (sensor shift)
	z	0 µm to-150 µm (optical back focal length)
	α	±0.5° (sensor rotation as the deviation from the parallel to the camera bottom)

Table 28: Sensor position accuracy criteria

Cross section: C-Mount and CS-Mount

All standard color Mako G cameras are equipped with a Hoya C-5000 IR cut filter with a 22 mm diameter. Standard monochrome Mako G cameras are not equipped with any optical filter.

Optical filter options

Allied Vision offers several optical filter options for both monochrome and color Mako G cameras. Choose an optical filter according to the *Modular Concept*.

https://www.alliedvision.com/en/support/technical-documentation.html

Product change notice

Monochrome Mako G cameras with serial number 536873083 or higher are shipped without a cover ring in the C-Mount thread. Refer to product change notice for more details.

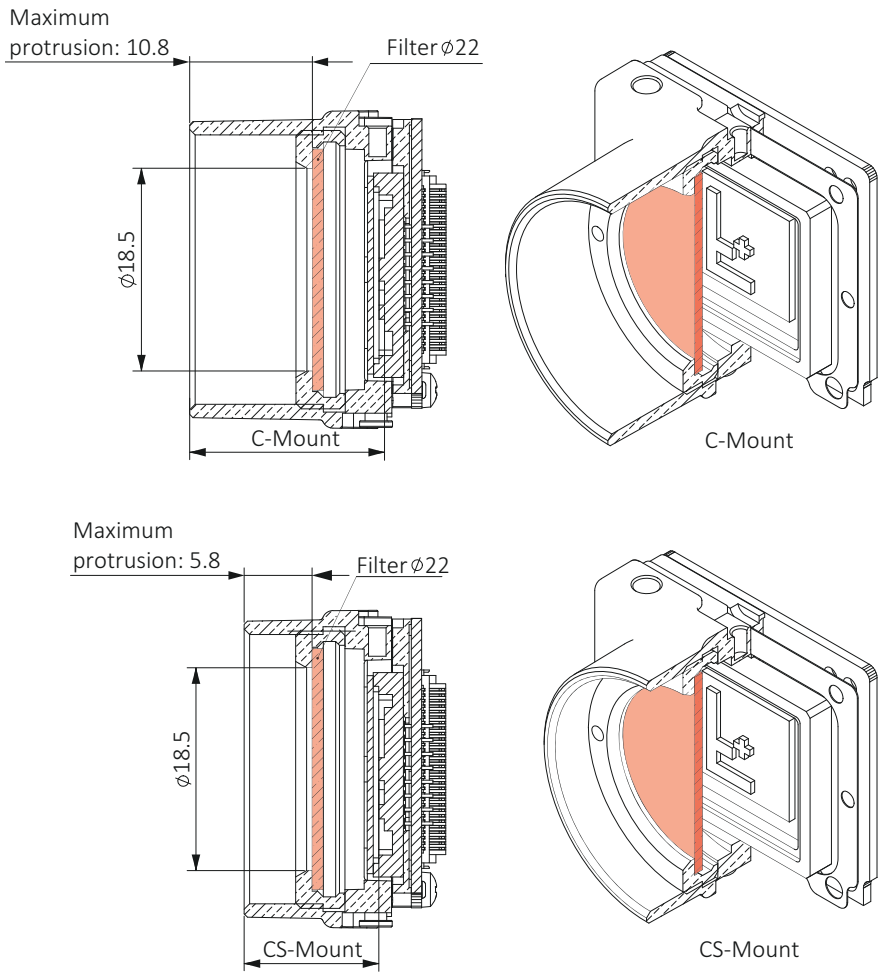


Figure 34: C-Mount and CS-Mount dimensions for Mako G models

Adjusting C-Mount and CS-Mount

The dimensional adjustment cannot be done by the customer. All modifications have to be done by Allied Vision.

Dimensional mount adjustment

Dimensional mount adjustment cannot be done by the customer. If you need any mount related adjustments, please contact Allied Vision.

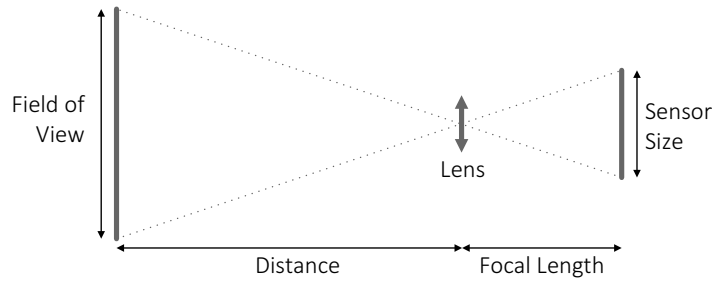
Filter and lenses

This chapter includes information on:

- Suitable lens formats for Mako G camera models
- Standard IR cut filter and its transmission characteristics

Camera lenses

Allied Vision offers different lenses from a variety of manufacturers. This section presents tables that list selected image field of view (width x height) depending on sensor size, distance and focal length of the lens.



Accessories

Please contact Allied Vision sales representative or your Allied Vision distribution partner for information on accessories offered by Allied Vision:

https://www.alliedvision.com/en/about-us/where-we-are.html

Lenses with focal lengths < 8 mm may show shading in the edges of the image due to microlenses on the sensor. The exact values vary and depend on the respective lens.

Mako G-030B, G-030C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	495 x 371 mm	995 x 746 mm
8 mm	295 x 221 mm	595 x 446 mm
12.5 mm	187 x 140 mm	379 x 284 mm
16 mm	145 x 109 mm	295 x 221 mm
25 mm	91 x 68 mm	187 x 140 mm
50 mm	43 x 32 mm	91 x 68 mm

Table 29: Mako G-030B, G-030C focal length vs. field of view

Mako G-032B, G-032C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.0 mm	608 x 446 mm	1220 x 896 mm
4.8 mm	506 x 371 mm	1016 x 746 mm
8 mm	301 x 221 mm	608 x 446 mm
12 mm	199 x 146 mm	403 x 296 mm
16 mm	148 x 109 mm	301 x 221 mm
25 mm	93 x 68 mm	191 x 140 mm
35 mm	65 x 48 mm	135 x 99 mm

Table 30: Mako G-032B, G-032C focal length vs. field of view

Mako G-125B, G-125C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.0 mm	595 x 446 mm	1195 x 896 mm
4.8 mm	495 x 371 mm	995 x 746 mm
8 mm	295 x 221 mm	595 x 446 mm
12 mm	195 x 146 mm	395 x 296 mm
16 mm	145 x 109 mm	295 x 221 mm
25 mm	91 x 68 mm	187 x 140 mm
35 mm	64 x 48 mm	132 x 99 mm

Table 31: Mako G-125B, G-125C focal length vs. field of view

Mako G-131B, G-131C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.5 mm	760 x 606 mm	1526 x 1217 mm
6 mm	568 x 453 mm	1143 x 911 mm
10 mm	338 x 270 mm	683 x 545 mm
17 mm	196 x 156 mm	399 x 318 mm
25 mm	131 x 105 mm	269 x 215 mm
35 mm	92 x 73 mm	190 x 152 mm

Table 32: Mako G-131B, G-131C focal length vs. field of view

Mako G-192B, G-192C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.5 mm	793 x 595 mm	1593 x 1195 mm
6 mm	593 x 445 mm	1193 x 895 mm
10 mm	353 x 265 mm	713 x 535 mm
17 mm	205 x 153 mm	416 x 312 mm
25 mm	137 x 103 mm	281 x 211 mm
35 mm	96 x 72 mm	199 x 149 mm

Table 33: Mako G-192B, G-192C focal length vs. field of view

Mako G-223B, G-223B NIR, G-223C

Focal length[1]	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	1162 x 617 mm	2335 x 1240 mm
6 mm	927 x 492 mm	1865 x 991 mm
6.5 mm	855 x 454 mm	1721 x 914 mm
8 mm	692 x 368 mm	1396 x 742 mm
10 mm	552 x 293 mm	1114 x 597 mm
12 mm	458 x 243 mm	927 x 492 mm
16 mm	341 x 181 mm	692 x 369 mm
25 mm	214 x 114 mm	439 x 223 mm
35 mm	150 x 79 mm	310 x 165 mm
50 mm	101 x 54 mm	214 x 114 mm
75 mm	64 x 34 mm	139 x 74 mm
90 mm	51 x 27 mm	114 x 60 mm

[1] A 2/3 inch lens may cause vignetting (1 inch lens recommended)

Table 34: Mako G-223B, G-223B NIR, G-223C focal length vs. field of view

Mako G-234B, G-234C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
12 mm	461 x 290 mm	933 x 586 mm
16 mm	343 x 215 mm	697 x 438 mm
25 mm	215 x 135 mm	442 x 278 mm
35 mm	150 x 94 mm	312 x 196 mm
50 mm	102 x 64 mm	215 x 135 mm

Table 35: Mako G-234B, G-234C focal length vs. field of view

Mako G-319B, G-319C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
5 mm	705 x 525 mm	1417 x 1055 mm
6 mm	586 x 436 mm	1180 x 878 mm
8 mm	438 x 326 mm	883 x 657 mm
10 mm	349 x 260 mm	705 x 525 mm
12 mm	290 x 216 mm	586 x 436 mm
16 mm	215 x 160 mm	438 x 326 mm
25 mm	135 x 101 mm	278 x 207 mm
35 mm	95 x 70 mm	196 x 146 mm
50 mm	64 x 48 mm	135 x 101 mm
75 mm	40 x 30 mm	88 x 65 mm

Table 36: Mako G-319B, G-319C focal length vs. field of view

Mako G-419B, G-419B NIR, G-419C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
8 mm	692 x 692mm	1396 x 1396 mm
10 mm	552 x 552 mm	1114 x 1114 mm
12 mm	458 x 458 mm	928 x 928 mm
16 mm	340 x 340 mm	692 x 692 mm
25 mm	214 x 214 mm	439 x 439 mm
35 mm	150 x 150 mm	310 x 310 mm
50 mm	101 x 101 mm	214 x 214 mm
75 mm	64 x 64 mm	139 x 139 mm
90 mm	51 x 51 mm	104 x 104 mm

Table 37: Mako G-419B, G-419B NIR, G-419C focal length vs. field of view

Mako G-503B, G-503C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	588 x 442 mm	1182 x 887 mm
8 mm	351 x 263 mm	707 x 531 mm
12 mm	232 x 174 mm	469 x 352 mm
16 mm	172 x 129 mm	351 x 263 mm
25 mm	108 x 81 mm	222 x 167 mm
35 mm	76 x 57 mm	157 x 118 mm

Figure 35: Mako G-503B, G-503C focal length vs. field of view

Mako G-507B, G-507C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
5 mm	842 x 703 mm	1692 x 1413 mm
8 mm	526 x 437 mm	1054 x 880 mm
10 mm	417 x 348 mm	842 x 703 mm
12 mm	346 x 289 mm	700 x 585 mm
16 mm	257 x 215 mm	523 x 437 mm
25 mm	162 x 135 mm	332 x 277 mm
35 mm	113 x 94 mm	234 x 196 mm
50 mm	77 x 64 mm	162 x 135 mm
75 mm	48 x 40 mm	105 x 88 mm

Figure 36: Mako G-507B, G-507C focal length vs. field of view

IR cut filter

Color cameras are equipped with IR cut filter. The following illustration shows the spectral transmission of the IR cut filter.

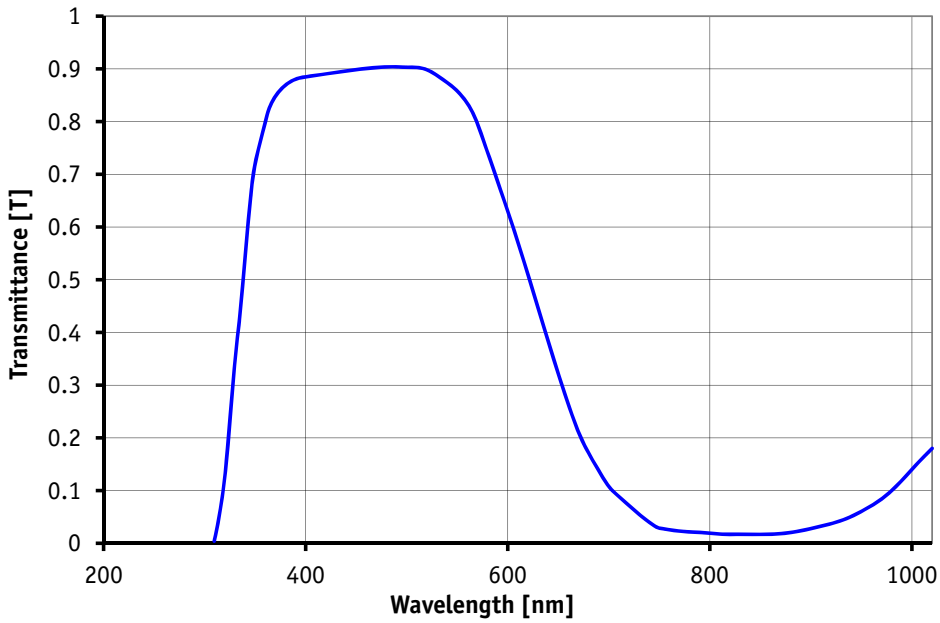
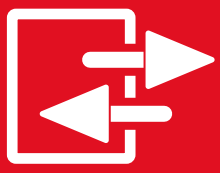


Figure 37: Approximate spectral transmission of IR cut filter type Hoya C-5000 (may vary slightly by filter lot)

Camera interfaces



This chapter includes:

- A general description of the inputs and outputs (including trigger features)
- I/O connector pin assignments
- I/O block diagrams
- A general description of trigger rules including a timing diagram and definitions

Back panel

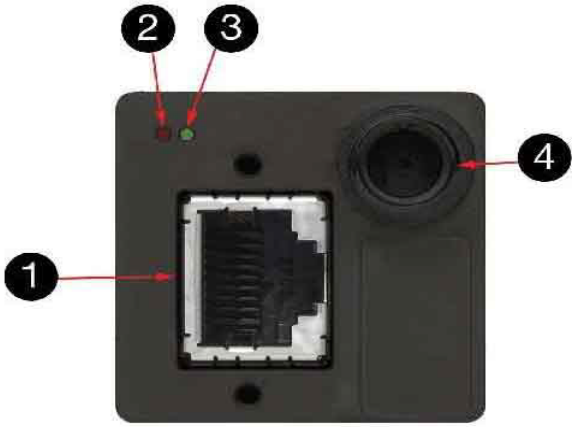


Figure 38: Rear view of Mako G camera

1	Gigabit Ethernet interface
2	LED 1 (orange)
3	LED 2 (green)
4	Hirose I/O port

Status LEDs

The tables below describe the status LEDs of Mako G cameras.

LED 1 color	Status
Solid orange	Ethernet link established
Flashing orange	Network traffic

Table 38: Status LED 1

LED 2 color	Status
Solid green	Camera powered
Slow flashing green	Booting routine
Four rapid flashes per second	Transmission error Contact support@alliedvision.com

Table 39: Status LED 2

Gigabit Ethernet interface

The Gigabit Ethernet interface conforms to the IEEE 802.3 1000BASE-T standard for Gigabit Ethernet over copper. To prevent electromagnetic interference (EMI) and for best performance, Category 6 (or higher) cables with S/STP shielding and connectors are recommended. Applications with longer cable lengths or harsh EMI conditions require Category 7 (or higher) cables.

- Cable lengths up to 100 m are supported.
- The 8-pin RJ-45 jack provides a pin assignment according to the Ethernet standard, IEEE 802.3 1000BASE-T.
- All Mako G cameras are PoE capable (IEEE 802.3af-2003).
- If both the Hirose I/O port and Gigabit Ethernet interface (via PoE) are used for power, the camera will only use the power from the Hirose I/O port.

Accessories

Please contact Allied Vision sales representative or your Allied Vision distribution partner for information on accessories offered by Allied Vision:

https://www.alliedvision.com/en/about-us/where-we-are.html

Camera I/O connector pin assignment

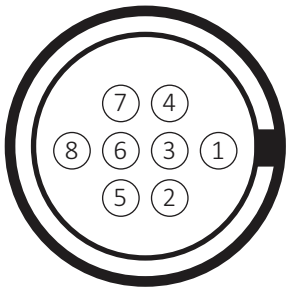
The general purpose I/O port uses a Hirose HR25-7TR-8PA(73) connector on the camera side. The mating cable connector is Hirose HR25-7TP-8S.

Safety-related instructions to avoid malfunctions

Read all *Notes and Cautions* in the *GigE Installation Manual* before using the Hirose I/O connector.

Hirose connector

The cable side Hirose connector is available for purchase from Allied Vision (order code K7600503).



Camera side Hirose HR25-7TR-8PA(73) connector					Trigger cable color code
Pin	**Signal**	**Direction**	**Level**	**Description**	
1	Out 1	Out	Open emitter, maximum 20 mA	Opto-isolated output 1	Yellow dot Red
2	Out 2	Out	Open emitter, maximum 20 mA	Opto-isolated output 2	Yellow dot Black
3	Out 3	Out	Open emitter, maximum 20 mA	Opto-isolated output 3	Grey dot Red
4	In 1	In	U_{in}(high) = 3.0 to 24.0 V up to 36 V with external resistor of 3.3 kΩ in series U_{in}(low) = 0 to 1.0 V	Opto-isolated input 1	Grey dot Black
5	Isolated In GND	In	---	Isolated input signal ground	Pink dot Black
6	Isolated Out Power	In	Common VCC for outputs maximum 30 VDC	Power input for opto-isolated outputs	Pink dot Red
7	Camera Power	In	12 to 24 VDC ± 10%	Camera power supply	Orange dot Black
8	Camera GND	In	GND for external power	Ground for camera power supply	Orange dot Red

Table 40: Camera I/O connector pin assignment and Mako G trigger cable color coding

Cable color and pin out

For cable color and pin out information, see the *Allied Vision I/O cable data sheet*:

https://www.alliedvision.com/en/support/technical-documentation/accessories-data-sheets.html

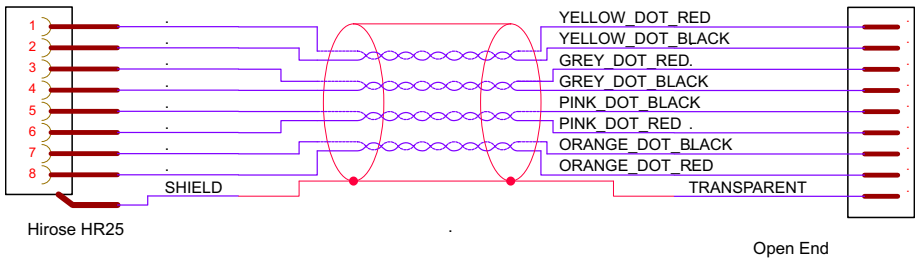


Figure 39: Mako G cable color coding

Input block diagram

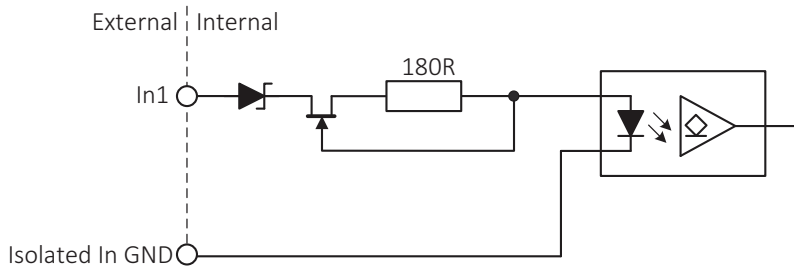


Figure 40: Input block diagram

The input can be connected directly to the system for voltages up to 24 VDC. An external resistor is not necessary.

Cycle delay

Parameter	Value
U_{in} (low)	0 to 1.0 V
U_{in} (high)	3 to 24 V
Current (constant-current source)	3 to 4 mA

Table 41: Input parameters

Minimum pulse width

The minimum pulse width for all Mako G cameras is:

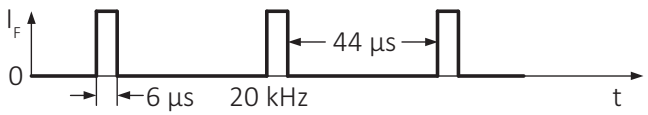


Figure 41: Minimum pulse width

Test conditions

The input signal was driven with 3.3 V and no external additional series resistor.

Output block diagram

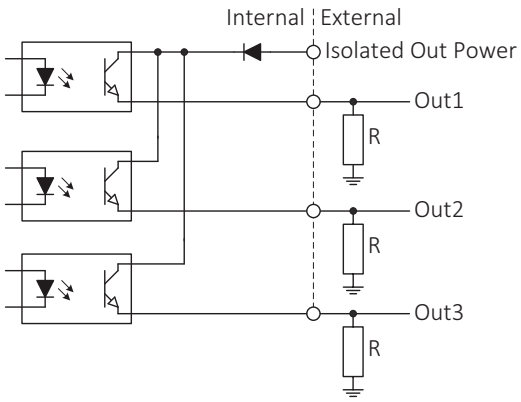


Figure 42: Output block diagram

Output and isolated out power

- Maximum 20 mA per output
- Isolated out power > 30 V may damage the camera

Isolated Out Power	Resistor value[1]	
5 V	1.0 kΩ	at ~ 5 mA minimum required current draw
12 V	2.4 kΩ	
24 V	4.7 kΩ	

[1] Resistor required if Out1/2/3 connected to a device with < 5 mA draw, i.e. high impedance

Table 42: Isolated Out Power and external resistor

Output switching times

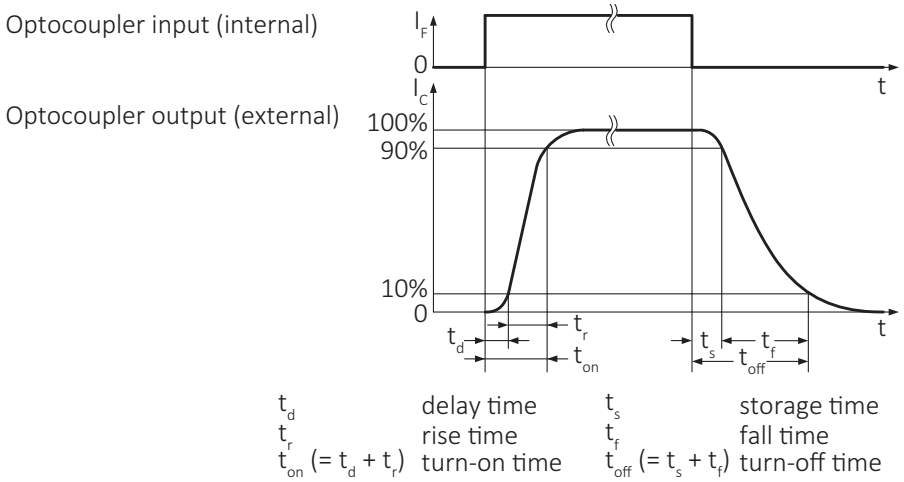


Figure 43: Output switching times

Parameter and value	
$t_d \approx 1$ µs	$t_s \approx 26$ µs
$t_r \approx 1$ µs	$t_f \approx 21$ µs
$t_{on} = t_d + t_r \approx 2$ µs	$t_{off} = t_s + t_f \approx 47$ µs (t_{off} can deviate by ± 5 µs)

Table 43: Parameters

Test conditions

Output: external 2.4 kΩ resistor to GND, Isolated Out Power set to 12 V.

- Higher external values increase the times in table 43 above.
- It is recommended to trigger on the rising edge. This guarantees the fastest possible reaction time.

Control signals

The inputs and outputs of the camera can be configured by software. The different modes are described below. All input and output signals that pass the I/O connector are controlled by the I/O strobe commands.

Input block diagram

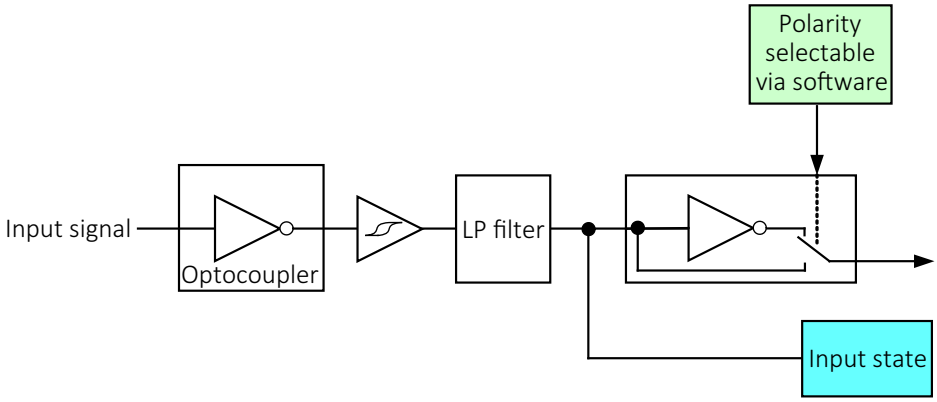


Figure 44: Input block diagram

Output signals

Output signals are configured by software. Any signal can be placed on any output. The main output signals are described below:

Signal	Description
GPO	Configured to be a general purpose output, control is assigned to SyncOutGpoLevels.
AcquisitionTriggerReady	Active once the camera has been recognized by the host PC and is ready to start acquisition.
FrameTriggerReady	Active when the camera is in a state that will accept the next frame trigger.
FrameTrigger	Active when an image has been initiated to start. This is a logic trigger internal to the camera, which is initiated by an external trigger or software trigger event.
Exposing	Active for the duration of sensor exposure.
FrameReadout	Active during frame readout, i.e., the transferring of image data from the CCD to the camera memory.
Imaging	Imaging is high when the camera image sensor is either exposing and/or reading out data.
Acquiring	Active during an acquisition stream.
SyncIn1	Active when there is an external trigger at SyncIn1.
Strobe1	The output signal is controlled according to Strobe1 settings.

Table 44: Output signals

Output block diagram

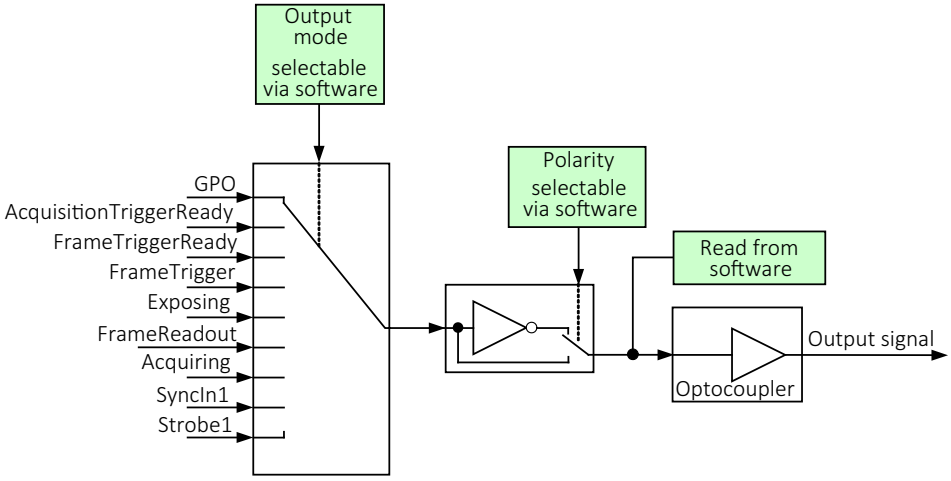


Figure 45: Output block diagram

Trigger timing diagram

The following diagram explains the general trigger concept.

Further information available online

For trigger description on camera control basis, see *GigE Features Reference*:

https://www.alliedvision.com/en/support/technical-documentation/mako-g-documentation.html

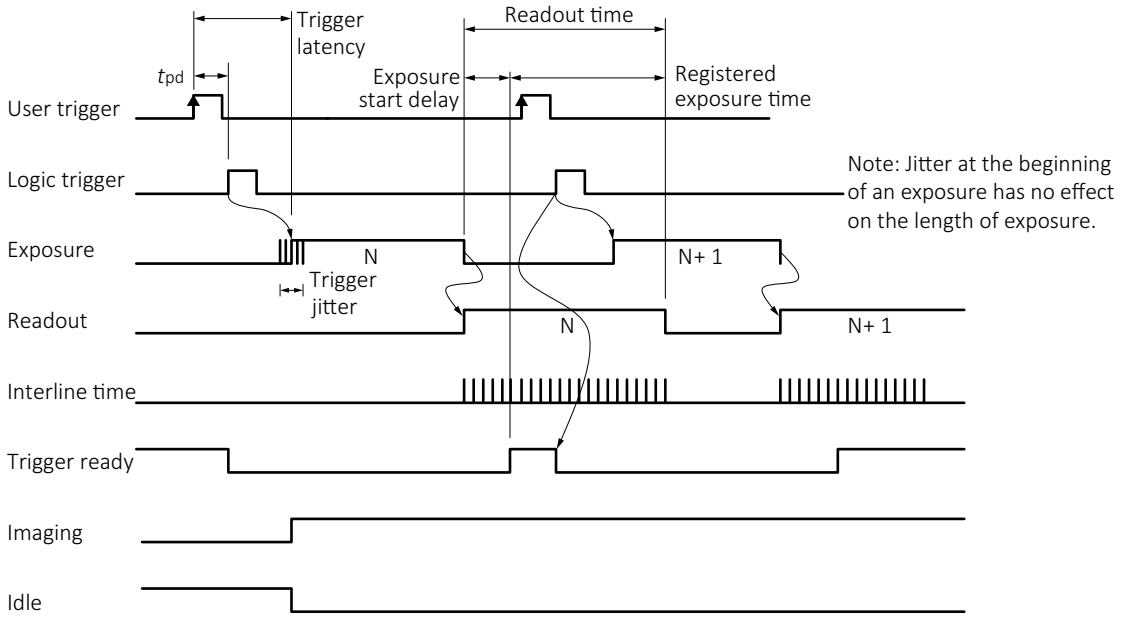


Figure 46: Trigger timing diagram

Trigger definitions

Term	Definition
User trigger	Trigger signal applied by the user (hardware trigger, software trigger)
Logic trigger	Trigger signal seen by the camera internal logic (not visible to the user)
Propagation delay (t_{pd})	Propagation delay between the user trigger and the logic trigger
Exposure	High when the camera image sensor is integrating light
Readout	High when the camera image sensor is reading out data
Trigger latency	Time delay between user trigger and start of exposure
Trigger jitter	Error in the trigger latency time
Trigger ready	Indicates that the camera will accept the next trigger
Registered exposure time	Exposure time value currently stored in the camera memory
Exposure start delay	Registered exposure time subtracted from the readout time and indicates when the next exposure cycle can begin such that the exposure will end after the current readout
Interline time	Time between sensor row readout cycles (CCD models only)
Imaging	High when the camera image sensor is either exposing and/or reading out data
Idle	High if the camera image sensor is not exposing and/or reading out data

Table 45: Trigger definitions

Trigger rules

Overlapping exposure and readout (Mako G-131 and G-192)

The Teledyne e2v sensor does not support overlapped exposure and readout in hardware trigger mode or in global reset mode.

- The user trigger pulse width should be at least 6 µs.
- The end of exposure will always trigger the next readout.
- The end of exposure must always end after the current readout.
- The start of exposure must always correspond with the interline time if readout is true.
- Exposure start delay equals the readout time minus the registered exposure time.

Triggering during the idle state

For applications requiring the shortest possible trigger latency and the smallest possible trigger jitter, the user trigger signal should be applied when imaging is false and idle is true.

Triggering during the readout state

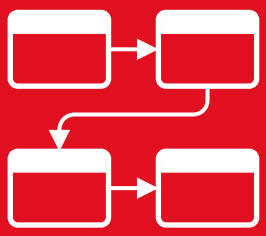
For applications requiring the fastest triggering cycle time whereby the camera image sensor is exposing and reading out simultaneously, the user trigger signal should be applied as soon as a valid trigger ready is detected.

In this case, trigger latency and trigger jitter can be up to 1 line time since exposure must always begin on an Interline boundary.

For a more detailed description of the trigger concept for advanced users and special scenarios, see the *Triggering Concept* application note:

https://www.alliedvision.com/en/support/technical-papers-knowledge-base.html

Image data flow



This chapter presents diagrams that illustrate data flow and bit resolution of the image data.

Camera feature references

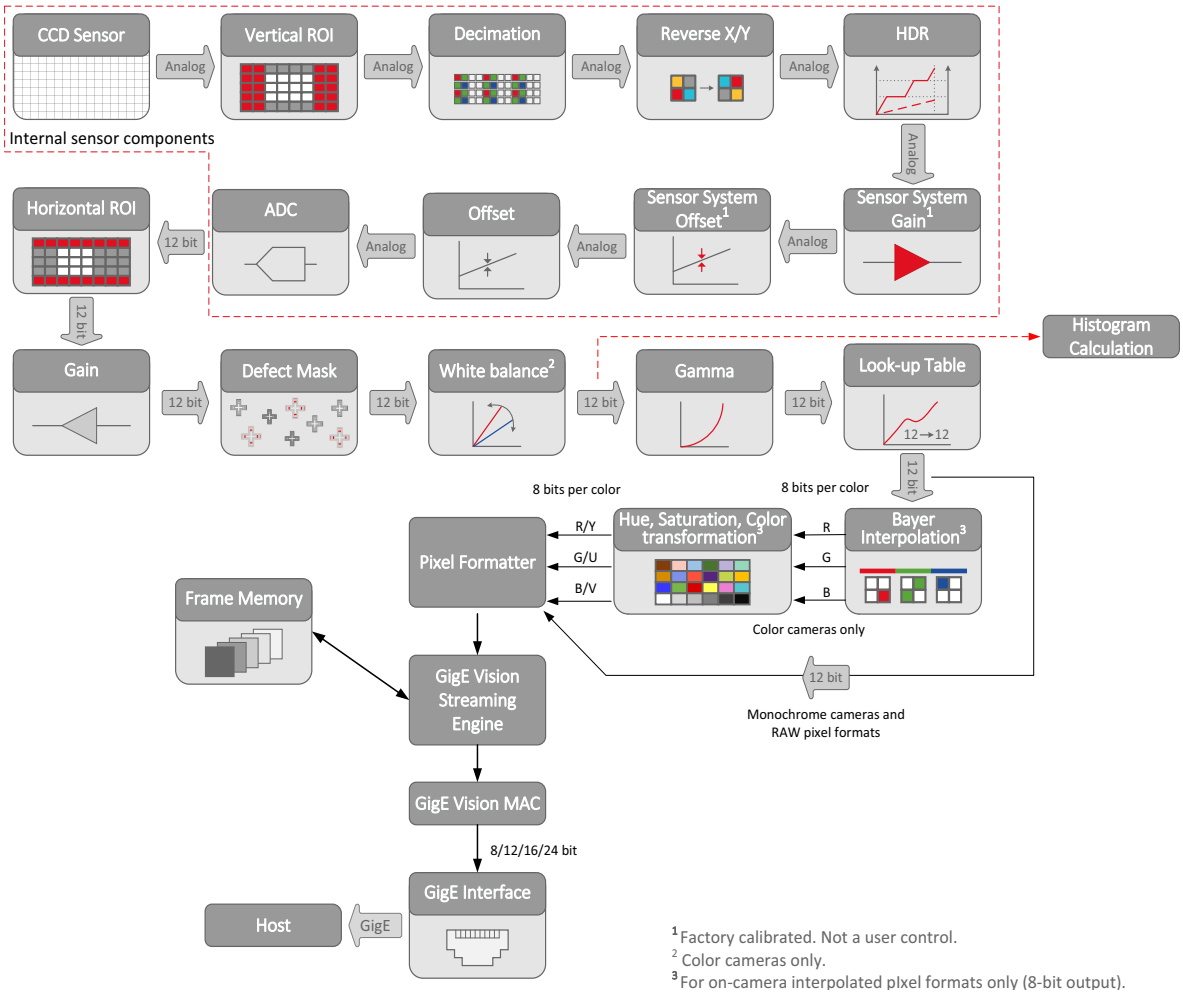
A complete listing of camera features, including feature definitions can be found online:

- Vimba and third-party users: *GigE Features Reference*
- PvAPI users: *GigE Camera and Driver Attributes* document

https://www.alliedvision.com/en/products/cameras.html

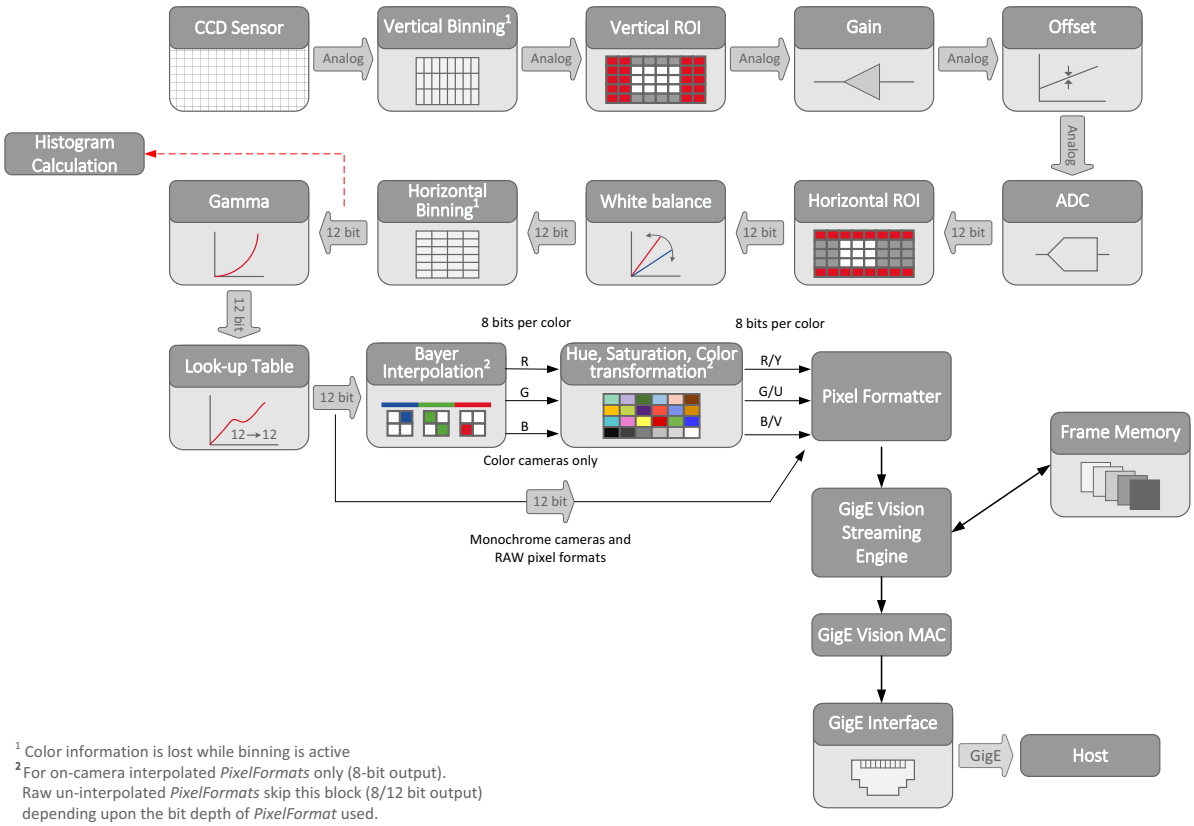
Mako G models with CCD sensors

Mako G-030



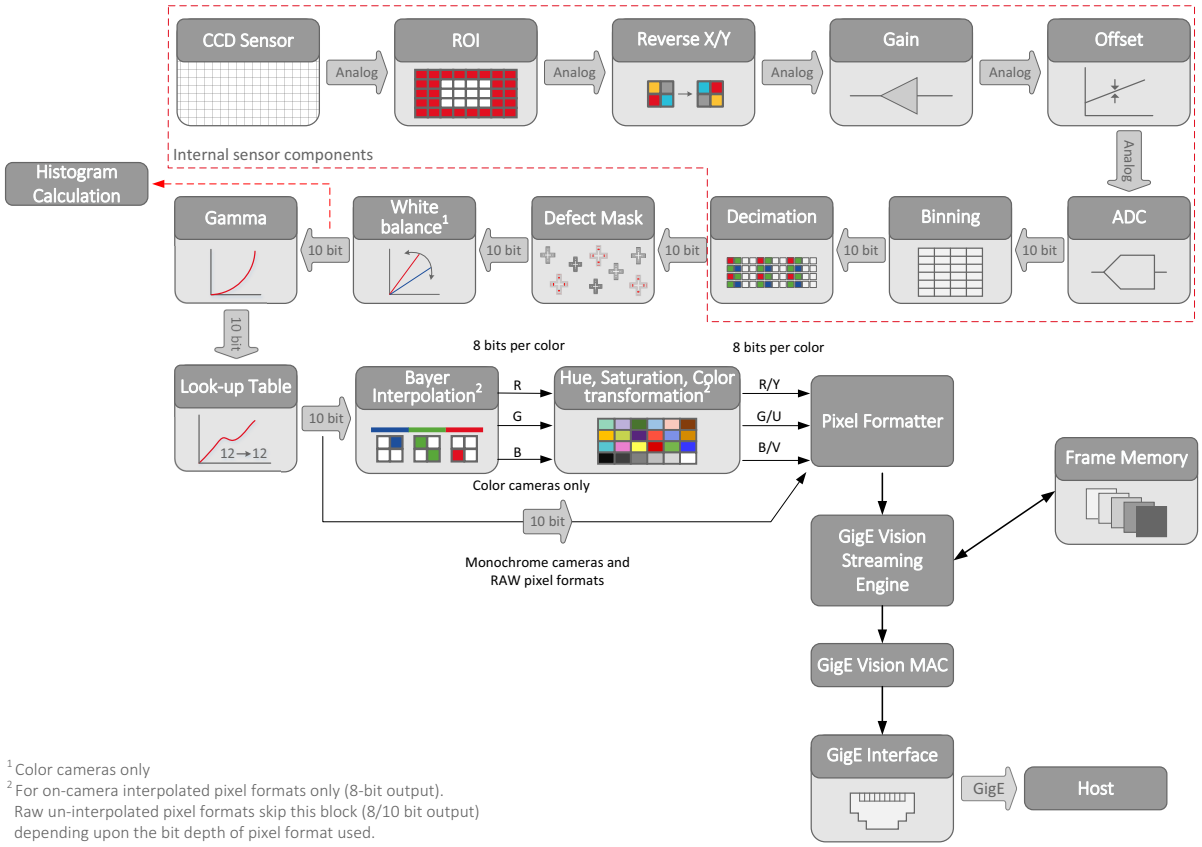
[1] Factory calibrated. Not a user control.
[2] Color cameras only.
[3] For on-camera interpolated pixel formats only (8-bit output).

Mako G-032, G-125



[1] Color information is lost while binning is active
[2] For on-camera interpolated *PixelFormats* only (8-bit output). Raw un-interpolated *PixelFormats* skip this block (8/12 bit output) depending upon the bit depth of *PixelFormat* used.

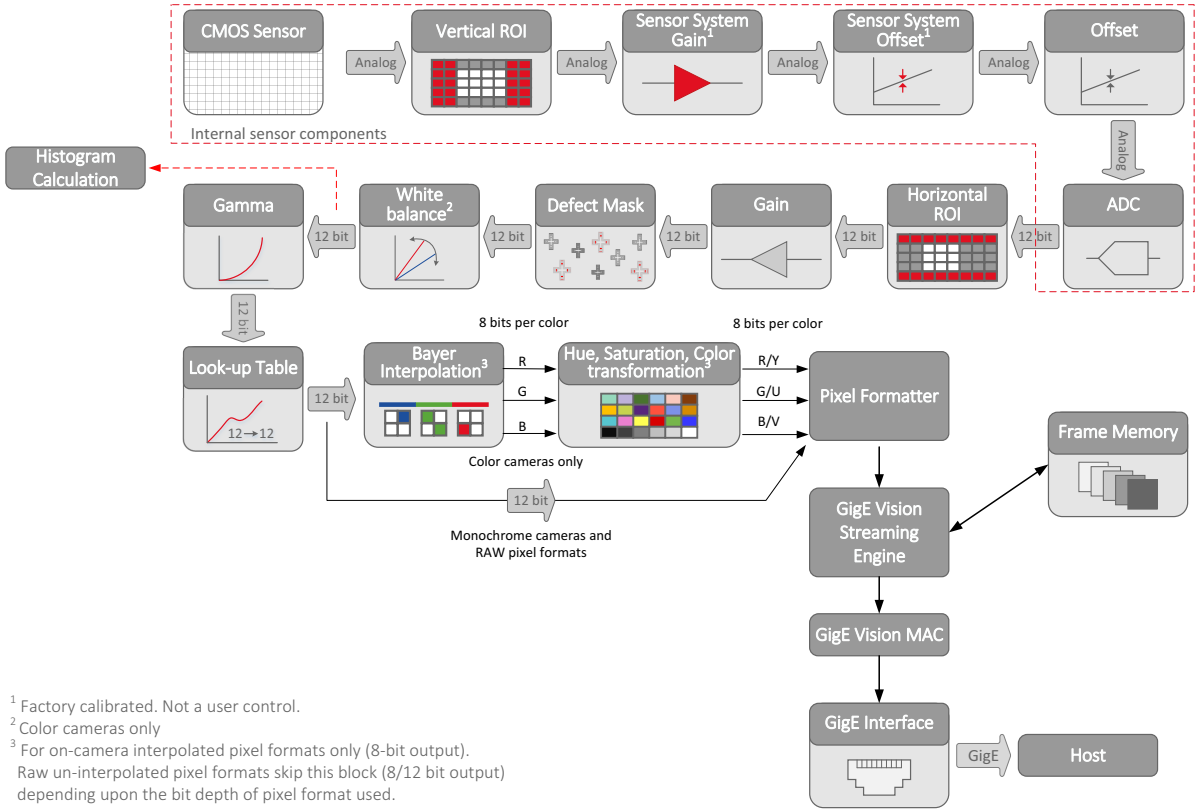
Mako G-131, G-192



[1] Color cameras only
[2] For on-camera interpolated pixel formats only (8-bit output). Raw un-interpolated pixel formats skip this block (8/10 bit output) depending upon the bit depth of pixel format used.

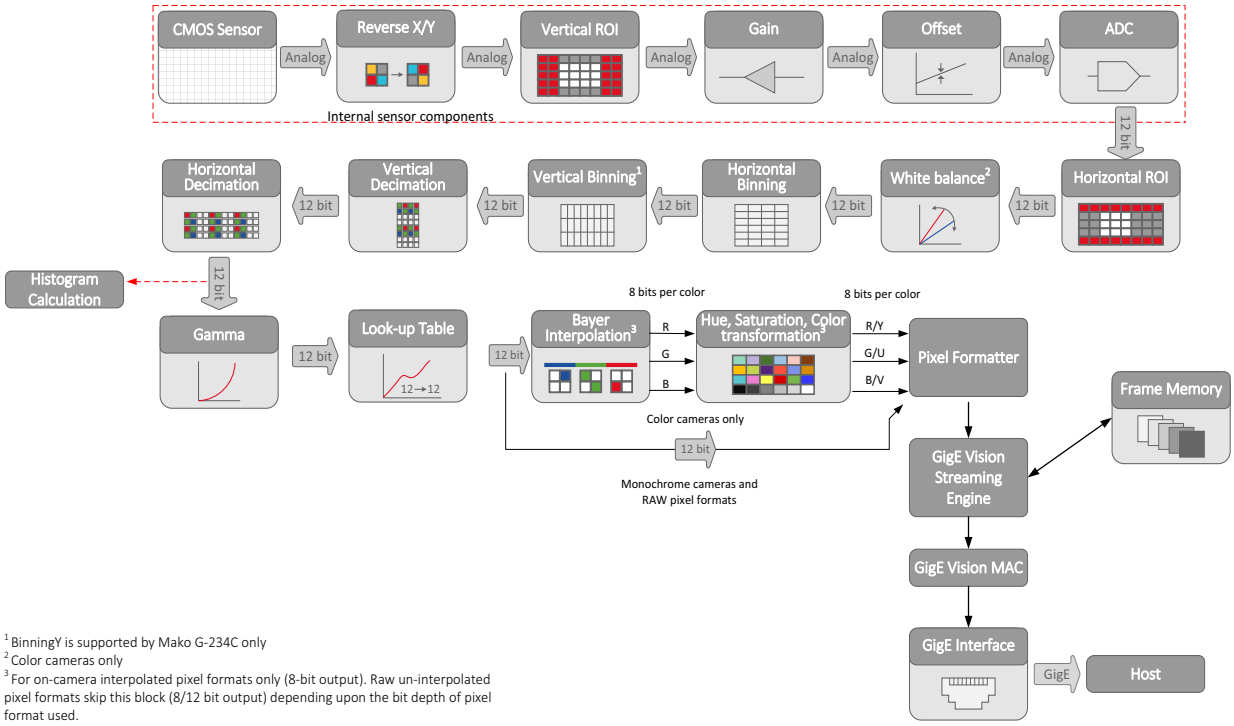
Mako G models with CMOS sensors

Mako G-223, G-419



[1] Factory calibrated. Not a user control.
[2] Color cameras only
[3] For on-camera interpolated pixel formats only (8-bit output). Raw un-interpolated pixel formats skip this block (8/12 bit output) depending upon the bit depth of pixel format used.

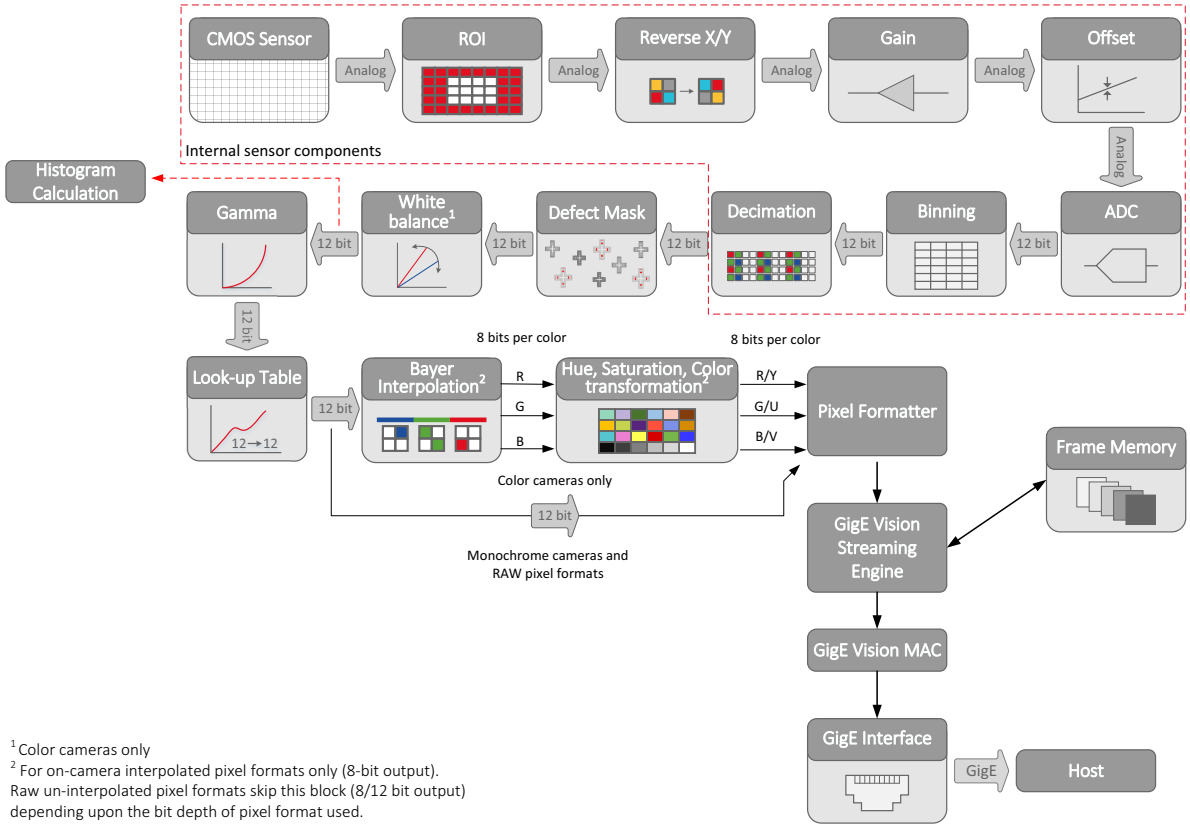
Mako G-234, G-319, G-507



[1] BinningY is supported by Mako G-234C only
[2] Color cameras only
[3] For on-camera interpolated pixel formats only (8-bit output). Raw un-interpolated pixel formats skip this block (8/12 bit output) depending upon the bit depth of pixel format used.

Mako G-234B, G-234C supports 10-bit and 12-bit sensor readout mode. 10-bit data will still be processed as 12-bit data with 2 LSB bits padded with zeros.

Mako G-503



[1] Color cameras only
[2] For on-camera interpolated pixel formats only (8-bit output).
Raw un-interpolated pixel formats skip this block (8/12 bit output) depending upon the bit depth of pixel format used.

Cleaning optical components

This chapter describes safety instructions and cautions for cleaning lenses, optical filters, and sensors.

Important instructions to be read first

Please read these instructions before you contact Allied Vision or your Allied Vision distribution partner for assistance.

Ask Allied Vision or your Allied Vision distribution partner if you are not familiar with the procedures described below.

Monochrome and NIR models

As monochrome and NIR models do not have an optical filter, always attach a dust cap when a lens is not attached to minimize the possibility of contaminants falling on the sensor surface.

Warranty

Warranty information available online

For details about camera warranty duration and sensor warranty terms, go to:

https://www.alliedvision.com/en/support/warranty

Warranty precautions

To ensure your warranty remains in effect:

- Do not open the camera housing.
- Follow instructions described below.
- Use only optical quality tissue/cloth if you must clean a lens or optical filter.
- Use only optics cleaner. Do not use aggressive cleaners like benzine or spirit. Such cleaners may destroy the optical component's surface.
- Do not use compressed air which can push dust into camera and lens unless you are trained to clean a camera using this method.

Allied Vision does not warranty against any physical damage to the sensor, optical filter, or lenses. Use utmost care when cleaning optical components.

Keep optical components clean

The best way to ensure the camera remains clean is to avoid penetration of foreign substances into the camera.

When screwing/unscrewing the camera lens or dust cap, hold the camera with the C-Mount or CS-Mount opening towards the floor. This minimizes the possibility of any contaminants falling on the glass surface. Always store cameras and lenses with dust-caps on.

Figure 47: Illustration of camera orientation when removing lens or dust cap

Identifying impurities

If you observe any image artifacts in your video preview of your Mako G camera you may have impurities either on the lens, optical filter, or on the sensor surface. Every Mako G camera is cleaned prior to sealing and shipment; however, impurities may develop due to handling or unclean environments.

As shown in figure *48*, impurities (dust, particles or fluids) on the sensor or optical components appear as a dark area, patch or spot on the image and remain fixed in the preview window while you rotate the camera over the target.

Do not confuse this with a pixel defect which appears as a distinct point. Particles can either rest loosely or can be more or less stuck to the optical surface.

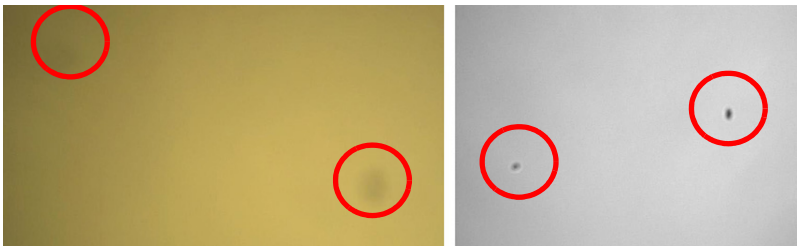


Figure 48: Image with tiny dust on the filter (left) and dust on the sensor (right)

Locating impurities

Before you dismount the lens you should find out if the impurity is on the optical filter, lens, or sensor.

1. Start acquiring a uniform image (e.g. a white sheet of paper) with the camera.
2. To identify the affected surface, move the suspected optical component and see if the contamination follows this movement.
   a. If you move only the lens (not the camera) and the impurity moves as well, the impurity is on the lens.
   b. If you move the optical filter window and the impurity moves as well, the impurity is on the optical filter. Carefully remove the optical filter and clean it on both sides using the techniques explained in the next section.

3. If the impurity is neither on the lens nor the optical filter, it is probably on the sensor.

Removing optical filter

To remove the optical filter use the special tool (Allied Vision order code 3851; 22 mm filter).

Materials for cleaning optical components

Use only these cleaning materials for optical components

- Optic approved lens cotton, cloth, or tissue that is chemically pure and free from silicones and other additives.
- Optic approved low residue cleaning liquid.

Never use these cleaning materials for optical components

- Dry swabs or tissue may cause scratches.
- Metal tools may cause scratches.
- Disposable cotton cosmetic swabs may contain contaminants harmful to optical glass.
- Cosmetic cotton my cause scratches or get caught in small gaps.
- Consumer eyeglass cleaning cloths may be pretreated with silicone harmful to optical glass.
- Aggressive cleaners like benzine, acetone, or spirits may damage the surface.

Optical cleaning liquid material safety data sheets

Read the material safety data sheet (MSDS) for the optical cleaning liquid before cleaning your camera and/or optics. The MSDS provides important information including hazard identification, first aid measures, handling and storage, and PPE.

Cleaning Instructions

Workplace conditions

- Perform all cleaning operations (lenses, optical filter, and sensor) in a dust-free clean-room.
- Avoid touching the optical components with your fingers or any hard material.
- Nitrile cleanroom gloves or powder free latex gloves are recommended to maintain low particulate levels.
- Use an ESD mat to prevent damage from an electrostatic discharge.

1. Unplug the camera from any power supply before cleaning.
2. Apply a small amount of cleaning liquid to a new lens cleaning cotton, cloth, or tissue. The cotton, cloth, or lens tissue should be moist, but not dripping.

3. Hold the camera sensor diagonally upwards. Ensure that the camera is away from your body to prevent particles like skin flakes from falling on the sensor.

4. Wipe the glass surface with a spiral motion from the center to the rim. Normally, several spiral wipes are recommended. Wipe only on glass avoiding contact to metal surfaces, because microscopic dirt could be released and could cause scratches on the glass.
5. When you have finished cleaning, examine the surface in a strong light. Take an out-of-focus picture of a flat, illuminated surface to see if any dirt or dust remains.
6. If dust spots remain, repeat this procedure using new clean lens tissue (as described above).

Cleaning issues

If you notice that the camera lens or sensor is not clean after attempting to clean twice, or if you have any questions regarding cleaning your camera, please contact your Allied Vision distribution partner.

Cleaning with compressed air

Allied Vision does not recommend cleaning Mako G cameras with compressed air.

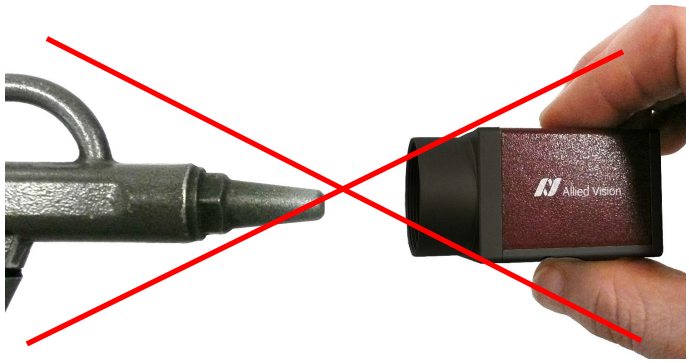


Figure 49: Do not use compressed air

Possible material damage

- Compressed air at high pressure and/or shorter operating distances may push dust into the camera/lens and physically damage the camera, sensor, or optical components.
- Propellant from non-optic approved compressed air products may leave a residue on the camera or lens and may physically damage the camera, sensor, or optical components.
- Compressed air may contain oil or moisture that could contaminate or damage the optical components.
- Use an air blower/compressed air only if you are familiar with cleaning a camera using this method.

If you want to clean your camera with compressed air despite of all the warnings:

- Use an optic approved compressed air product or compressor.
- Use an anti-static ionizer attachment to reduce the risk of static-caused damage.
- Use a filter to remove moisture and oil from the air.
- Use short directed bursts of air to remove impurities.

Compressed air pressure and operating distance

- Keep the compressed air pressure at a moderate strength only. Pressure at the nozzle should be less than 1 bar (15 psi).
- Operating distance from the camera should be 5 to 30 cm.

Firmware update

This chapter includes instruction on how to update the firmware on your Allied Vision Mako G camera.

Download the latest GigE firmware loader from the Allied Vision website:

https://www.alliedvision.com/en/support/firmware

Saved camera user sets

If new firmware contains a new feature or control, saved camera UserSets/ ConfigFiles will be invalidated and erased!

Before loading new firmware, backup your current camera settings.

Vimba Viewer: select the **Save Camera Settings** icon from the **Cameras** window to export the camera settings file (XML) to the host PC.

GigE SampleViewer: select the **Disk** icon from the **Cameras** window to export camera settings file (XML) to the host PC.

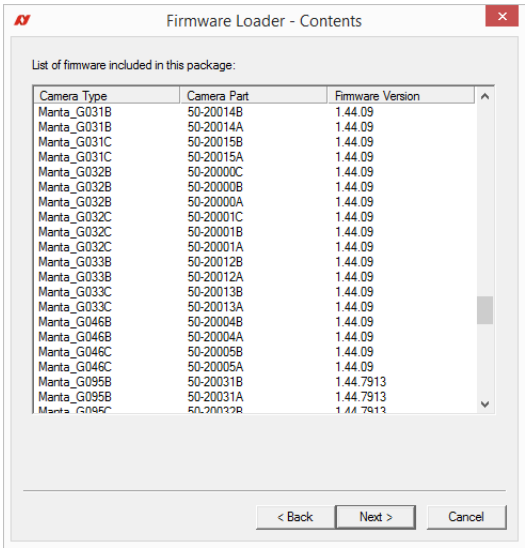
Possible material damage

Do not unplug the GigE cable or camera power supply during the update procedure.

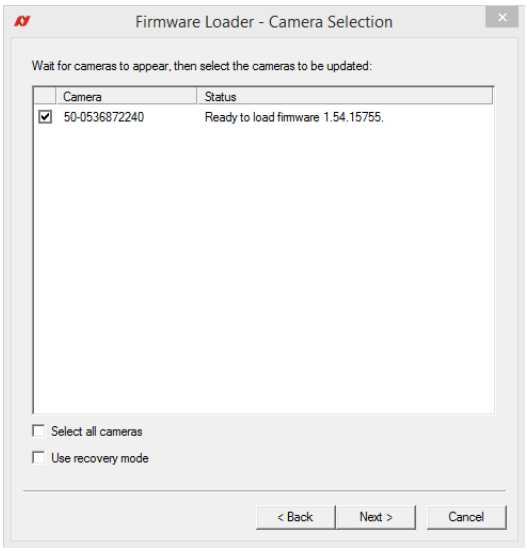
To update the firmware on your Allied Vision GigE camera

1. Launch the *Allied Vision Firmware Loader*.

2. Click **Next**. The *Firmware Loader* displays a list of firmware included in the package



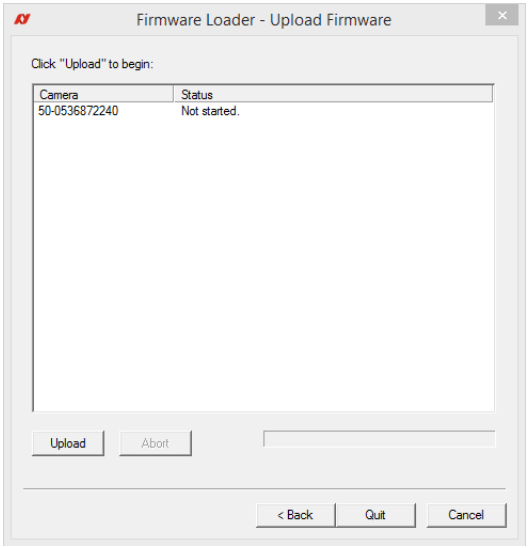
3. Click **Next**. You can select your camera model on this page.



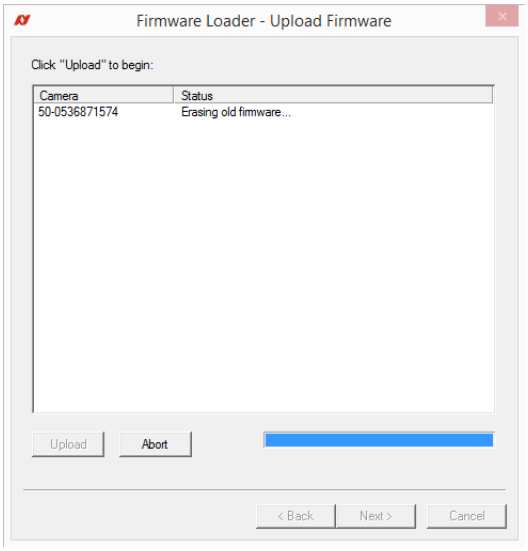
Recovery Mode

Select the **Use recovery mode** checkbox if the connected GigE camera is not found by the firmware loader, or if the GigE camera is listed as unavailable. When selected, power cycle the camera to enter the **Boot Loader** mode.

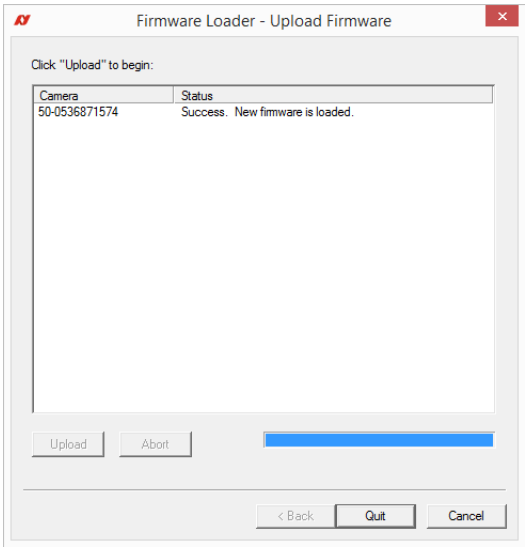
4. Click **Next**.



5. Click **Upload** to start the update. The existing firmware will be erased and the new firmware will be updated to the camera.



6. The *Firmware Loader* displays a success status upon completion. Click **Quit** to exit the loader.



Power cycle after upgrade or downgrade

You should always power cycle the camera after a firmware upgrade or downgrade.

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