Allied Vision

GigE Vision Cameras

Mako G

Technical Manual

V4.4.0

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

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Mako G at a glance

Mako G is Allied Vision's ultra-compact format GigE Vision compliant camera. Mako G models incorporate high quality CCD or CMOS sensors from Sony, ON Semiconductor, Teledyne e2v, and CMOSIS/ams. Mako G cameras are offered with either a C-Mount or CS-Mount to support a wide range of lenses. An M12-Mount adapter is also available.

Applied standards

GigE Vision®

The GigE Vision standard is an interface standard for digital machine vision cameras administered by the 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 EMVA. The aim of GenICam is to provide a generic configuration interface for cameras and devices independent of the used interface technology (for example, 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 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
GigE Features Reference Camera data sheets 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

Email

For general inquiries, contact info@alliedvision.com

For technical support, contact support@alliedvision.com

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Contents

Document history and conventions

This chapter includes:

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

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 webpage • 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-223 and G-419 series • 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-223 and G-419 series • Updated optional accessories in the *Notes on specifications* section • 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-419B, G-419B NIR, G-419C • 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* section • Added *Camera features comparison* • Added trigger latency and jitter values for Mako G-032B, G-032C, G-125B, 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	• Initial commercial release: Mako G-030B and G-030C - CMOSIS/ams CMV300 CMOS sensor - Specifications, absolute QE, ROI frame rate information, camera lens information, and data path • Initial commercial release: Mako G-131B and G-131C - Teledyne e2v EV76C560 CMOS sensor - Specifications, absolute QE, ROI frame rate information, camera lens information, and data path • Initial commercial release: Mako G-192B and G-192C - Teledyne e2v EV76C570 CMOS sensor - Specifications, absolute QE, ROI frame rate information, camera lens information, and data path • Updated Allied Vision logo • Updated *Cleaning optical components* chapter • 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	• Initial commercial release: Mako G-503B and G-503C - ON Semi MT9P031/MT9P006 CMOS sensor - Specifications, absolute QE, ROI frame rate information, camera lens information, and data path • 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*

Table 1: Document history (continued)

Version	Date	Remarks
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
V4.0.0	2015-Nov-24	• Initial commercial release: Mako G-234B and G-234C - Sony IMX249 CMOS sensor - Specifications, absolute QE, spectral response, ROI frame rate information, camera lens information, and data path • 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	• Initial commercial release: Mako G-507B and G-507C - Sony IMX264 CMOS sensor - Specifications, absolute QE, spectral response, ROI frame rate information, camera lens information, and data path • Added a tripod adapter warning message • Updated absolute QE plots for models with Sony sensors • Added spectral response plots for models with Sony sensors • 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

Table 1: Document history (continued)

Version	Date	Remarks
V4.2.0	2016-Nov-07	• Initial commercial release: Mako G-319B and G-319C - Sony IMX265 CMOS sensor - Specifications, absolute QE, spectral response, ROI frame rate information, camera lens information, and data path • 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.
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*** and `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)

Version	Date	Remarks
V4.3.3	2017-Dec-11	• Added Removing IR cut filter section to cleaning chapter • Added *Specifications common to all models* to simplify the model specific tables • Simplified the *Contact us* section, click the link to find contact information for your region or email us at one of the provided email addresses. • Various other minor enhancements and corrections
V4.4.0	2018-Jul-11	• Initial commercial release: Mako G-040B and G-040C - Sony IMX287 CMOS sensor - Specifications, Chief Ray Angle, absolute QE, spectral response, ROI frame rate • Initial commercial release: Mako G-158B and G-158C - Sony IMX273 CMOS sensor - Specifications, Chief Ray Angle, absolute QE, spectral response, ROI frame rate • Updated Mako G-234 specifications (firmware 00.01.54.20339), see the GigE Firmware Release Notes for details on the changes • Updated Mako G-319 specifications (firmware 00.01.54.20339), see the GigE Firmware Release Notes for details on the changes • Updated Mako G-507 specifications (firmware 00.01.54.20339), see the GigE Firmware Release Notes for details on the changes • Updated installation chapter • Updated symbols used in this manual • Updated RoHS statement to include amendment 2015/863/EU • Added abbreviations and acronyms used in this manual • Various other minor enhancements and corrections

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 (example)	Function
Emphasis	Some important parts or items of the text are emphasized to make them more visible.
Italics	Publication names, UI non-interactive elements
`Feature names`	GigE features names are displayed as monos-paced text.
`Feature options`	Features options and register's options that are selectable by the user are displayed as mono-spaced italicized text.
UI Element	Text that is displayed, or output, by the system for the user, like parts of the GUI, dialog boxes, buttons, menus, important information, windows titles.
Web Reference	References to other documents or web pages, like web links, hypertext links, emails, but also cross references, that include a link the user can follow by clicking.

Table 2: Markup conventions used in this manual

Symbols and notes

NOTICE

Material damage

Precautions as described.

NOTICE

Material damage by ESD

Precautions as described.

CAUTION

Personal injuries

Precautions as described.

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

Abbreviations and acronyms

The following table provides a list of abbreviations and acronyms used in this manual.

Acronym or Abbreviation	Description
ADC	Analog to Digital Converter
AIA	Automated Imaging Association
CCD	Charge-coupled device
CMOS	Complementary metal-oxide semiconductor

Table 4: Abbreviations and acronyms used in this manual

Acronym or Abbreviation	Description
dB	Decibel
EMI	Electromagnetic Interference
EMVA	European Machine Vision Association
FIFO	First-in first-out
fps	Frames per second
Gbps	Gigabits per second
GigE	Gigabit Ethernet
GND	Ground (power)
GVSP	GigE Vision Streaming Protocol
H × V	Horizontal × Vertical (sensor resolution measurement)
Hz	Hertz
kΩ	Kiloohm
LUT	Look-up Table
mA	Milliampere
MB	Megabyte
Mbps	Megabits per second
MP	Megapixel
MSDS	Material Safety Data Sheet
NIR	Near-Infrared
nm	Nanometer
ns	Nanosecond
PoE	Power over Ethernet
QE	Quantum efficiency
RoHS	Restriction of Hazardous Substances Directive
ROI	Region of interest
SDK	Software Development Kit
SFNC	Standard Feature Naming Convention
t_{pdHL}	Propagation delay high-to-low
V	Volts
VDC	Volts of direct current
W	Watts
WEEE	Waste Electrical and Electronic Equipment
µm	Micrometer or micron
µs	Microsecond

Table 4: Abbreviations and acronyms used in this manual (continued)

Compliance and intended use

This chapter includes:

- Information about the legal requirements and restrictions for Mako G cameras based on current and relevant regulations
- Particular emphasis has been given to Europe, the U.S., and Canada
- Intended use statements

Compliance notifications

For customers in Europe

Allied Vision has demonstrated the fulfillment of the requirements relating to the Mako G camera family:

- Directive 2014/30/EU (Electromagnetic compatibility)
- Directive 2011/65/EU, including amendment 2015/863/EU (RoHS)

For customers in the U.S.

Class B digital device

Note: 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 in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, 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 separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

We caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For customers in Canada

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

CAN ICES-003

Pour utilisateurs au Canada

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

CAN ICES-003

Avoid electromagnetic interferences

For all power and interface connections, only use shielded cables or cables recommended by Allied Vision.

Camera applications and intended use

General use

- The user is responsible for operating the camera within the specifications that are defined in this document, and within appropriate environmental conditions and technical prerequisites, to ensure trouble-free camera operation.
- The camera is compliant with current data communication standards; however, those standards do not allow for self-monitoring. Thus, the camera cannot be used as a standalone device for security-related monitoring operations.
- The camera is a hardware product. Only when used with appropriate accompanying software, the camera will produce the desired results. The realization of intelligent solutions requires additional software that is suitable to run with the camera.
- The camera is a component, it is neither a complete product, nor is it a ready-made technical solution.
- The camera-supporting software can be obtained and installed separately from the camera. Usage of the software is solely the responsibility of the user.
- The camera must not be opened. For all repair tasks, contact Allied Vision or one of Allied Vision's authorized representatives.
- Observe the intended use. The camera must only be used for purposes that are in conformity with the stated intended use.
- Additionally, refer to the warranty information on the Allied Vision website.

Use in medical devices

The camera provides basic adequacy to be used in medical devices as well, however, is not specially designated for operation in medical devices. When used as part of a medical device, a review of the specific application is necessary. Users who integrate the camera into an application must comply with the rules and regulations concerning medical devices.

Copyright and trademarks

Installation and hardware

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

Precautions

Electrical connections

NOTICE

ESD

The phenomenon is commonly known: when walking on a carpet, we get charged. Touching a door handle, we get an electric shock. ESD is dangerous for electronic devices, especially when tools or hands get in contact with connectors. We recommend measures to avoid damage by ESD:

- Unpacking: Remove the camera from its anti-static packaging only when your body is grounded.
- Workplace: Use a static-safe workplace with static-dissipative mat and air ionization.
- Wrist strap: Wear a static-dissipative wrist strap to ground your body.
- Clothing: Wear ESD-protective clothing. Keep components away from your body and clothing. Even if you are wearing a wrist strap, your body is grounded but your clothes are not.

NOTICE

Do not operate the camera beyond the environmental specifications

See environmental specifications limits in the Specifications section of this document. Special care must be taken to maintain operating temperature as specified in the Specifications chapter.

NOTICE

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.

NOTICE

Verify all external connections

Verify all external connections in terms of voltage levels, power requirements, voltage polarity, and signal integrity prior to powering the device.

NOTICE

Heat dissipation

Operation outside the allowed temperature range can damage the camera. For best performance and to protect the camera from damage, keep the housing temperature in the specified operating temperature range. Housing temperature of the camera increases during power-up and initial operation. This temperature later stabilizes.

Observe the following:

- For maximum heat dissipation, affix the camera to a heat sink, using the mounting threads.
  - Use mounting base and heat sink with large surface areas.
  - Use a mounting base with a high thermal conductivity.
- Reduce ambient temperature. For example, in an outdoor application with direct sunlight, provide shading by an enclosure.
- Provide ventilation or other active cooling of camera, mounting base, and heat sink.

Optical components

NOTICE

Image sensor

Image sensors are sensitive to excessive radiation: focused sunlight, lasers, and X-rays can damage the sensor. Monochrome and NIR models are not fitted with filter or protection glass. Consider, when removing the lens or dust cap on these cameras, the sensor is not protected against dirt or scratches.

NOTICE

Cleaning optical components

This product can be damaged by some volatile cleaning agents. Avoid cleaning the image sensor unless absolutely necessary. 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 at https://www.alliedvision.com/en/support/contact-support-and-repair.html.

NOTICE

Lenses

Provide the following conditions to keep dirt and droplets out of the optical system of camera and lens:

- Dust-free environment
- Low relative humidity
- No condensation

To keep dirt out of the lens mount, hold the camera with the lens mount facing the ground. Keep filter and camera back lens clean, because dirt becomes more visible the closer it gets to the sensor.

NOTICE

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.

Configuring the host computer

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

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

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

Installing the network interface card 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** after the driver has been installed.

Optional: Modifying network interface card IP address

After initial network interface card hardware installation, connect the network interface card 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 network interface card address to minimize the time required for a camera to be recognized by the host application. Systems that employ multiple network interface cards connected to multiple cameras also require configuring the address of the network interface card.

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

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

Network interface card driver settings

The network interface card should be adjusted to improve system performance when using a Mako G camera. This performance is related to minimizing CPU usage and dropped or resent packets.

Edit the network interface card driver properties according to the values in the following table. The names and availability of the properties listed may vary depending on network interface card manufacturer and model.

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

Table 5: Network interface card settings

Default packet size

The default packet size of Mako G cameras is 8228 bytes. The host network interface card needs to support a packet size of equal or larger size to stream from the camera.

Network interface card

For desktop systems, use a PCI Express bus network interface card. For laptops, use an expansion slot via an ExpressCard®.

A list of recommended network interface cards 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

Network interface card settings

The network interface card settings may also vary depending on your system configuration and the network interface card manufacturer.

Enabling jumbo packets

Jumbo Frames or Jumbo Packets

The properties listed for the network interface card 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 interface card that supports Jumbo Frames or 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 network interface card. Crossover cabling is not required but does work. The camera has circuitry to determine if a crossover cable is being used.

We recommend 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 dropped frames coming from the camera.

Optics

Mako G cameras are offered with the following lens mounts: C-Mount, CS-Mount, or M12-Mount. Lenses can be purchased directly from Allied Vision or from an Allied Vision distributor. Users need to select the desired focal length of the lens and appropriate optical format for the target camera model.

For more information on lens mount options for your Mako G camera, see the *Modular Concept* at https://www.alliedvision.com/en/support/technical-documentation.html.

For information on available lenses and accessories for your camera, see the Accessories webpage at: https://www.alliedvision.com/en/products/accessories.html.

Contact your Allied Vision Sales representative or your Allied Vision distribution partner to order lenses and accessories:

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

Accessories

Allied Vision offers a wide range of accessories for the use of Allied Vision GigE cameras and the easy integration in already existing applications including:

- Gigabit Ethernet accessories, such as standard GigE components or PoE capable GigE components.

- Lenses for corresponding sensor sizes and resolutions.

For information on available lenses and accessories for your camera, see the **Accessories** webpage at: https://www.alliedvision.com/en/products/accessories.html.

Contact your Allied Vision Sales representative or your Allied Vision distribution partner to order lenses and accessories:

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

Recommended GigE components

A list of recommended GigE components is available on the Allied Vision website. See the *Hardware Selection for Allied Vision GigE Cameras* application note at https://www.alliedvision.com/en/support/technical-papers-knowledge-base.html.

Downloading camera drivers

Allied Vision GigE cameras work with 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 Mako G cameras is available from Allied Vision. See the *Specifications* chapter for connector definition and voltage specifications.

NOTICE

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

Connecting to host application

After you have installed the **Vimba Viewer** or third-party application to your host computer, 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.

Allied Vision software

All software packages provided by Allied Vision are free of charge and contain the following components:

- Drivers
- SDK for camera control and image acquisition
- Examples based on the provided APIs of the SDK
- Documentation and release notes
- Viewer application to operate/configure the cameras

Vimba Viewer documentation

Vimba Viewer documentation is included with the software download. After Vimba Viewer is installed on your host computer, documentation is located under `\Program Files\Allied Vision\Vimba`.

Third-party software

In addition to the software provided by Allied Vision, there are numerous GigE Vision standard compliant third-party software options available. In general, third-party software provides increased functionality such as image processing and video recording.

Allied Vision's Vimba SDK is based on the GenICam standard. GenICam-based third-party software automatically connects with Vimba's transport layers. Additionally, Vimba includes the Cognex Adapter for VisionPro.

Specifications

This chapter provides:

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

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; that is, *Mono8*, *Bayer8*, *Mono12Packed*, *Bayer12Packed*, and *YUV411Packed*.

NOTICE

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* or *BayerRG8*, 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* Mbps (full bandwidth) and an 8-bit pixel format. Frame rates may be lower if using network hardware incapable of 124 Mbps.
- 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 sensor before readout. The frame rate for an ROI at the same effective height as binning is slower because the sensor 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 QE plots

Important notice before reading the specifications tables

All measurements were done without optical filters. With optical filters, QE decreases by approximately 10 percent.

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).

Manufacturing tolerance of the sensor increases overall uncertainty.

Sony CCD and CMOS monochrome sensors

The curve in the absolute QE plots shown in this chapter were calculated from a single measured QE 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.

Sony CCD and CMOS color sensors

The curves in the absolute QE plots shown in this chapter were calculated from three measured QE 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 and 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.

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.

Specifications common to all models

Feature	Specification
Lens mount	Default: C-Mount Optional: See the *Modular Concept*
Opto-isolated I/Os	1 input, 3 outputs
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
Power requirements	12 to 24 VDC; PoE
Body dimensions (L × W × H)	60.5 × 29.2 × 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
Temperature monitoring	Available for main board only. Resolution: 0.031; Accuracy: ± 1 °C

Table 6: Specifications common to all Mako G models

Mako G-030B, G-030C

Feature	Specification	
	Mako G-030B	**Mako G-030C**
Resolution	644 (H) × 484 (V) 0.3 MP	
Sensor	CMOSIS/ams CMV300-3E7M1WP	CMOSIS/ams CMV300-3E7C1WP
Sensor type	CMOS	
Shutter type	Global	
Sensor format	Type 1/3	
Sensor size	5.9 mm diagonal	
Pixel size	7.4 µm × 7.4 µm	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	309 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 99 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12Packed, BayerRG12
Exposure time control	83 µs to 2 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Decimation	Horizontal and Vertical: 1, 2, 4 factor	
Power consumption	2.1 W at 12 VDC; 2.3 W PoE	
Trigger latency[1]	Idle state: 3.1 µs; Frame valid state: 3.1 µs	

Table 7: Mako G-030B, G-030C model specifications

Feature	Specification	
	Mako G-030B	Mako G-030C
Trigger jitter[1]	Idle state: ±1.2 µs; Frame valid state: ±3.1 µs	

[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 7: Mako G-030B, G-030C model specifications (continued)

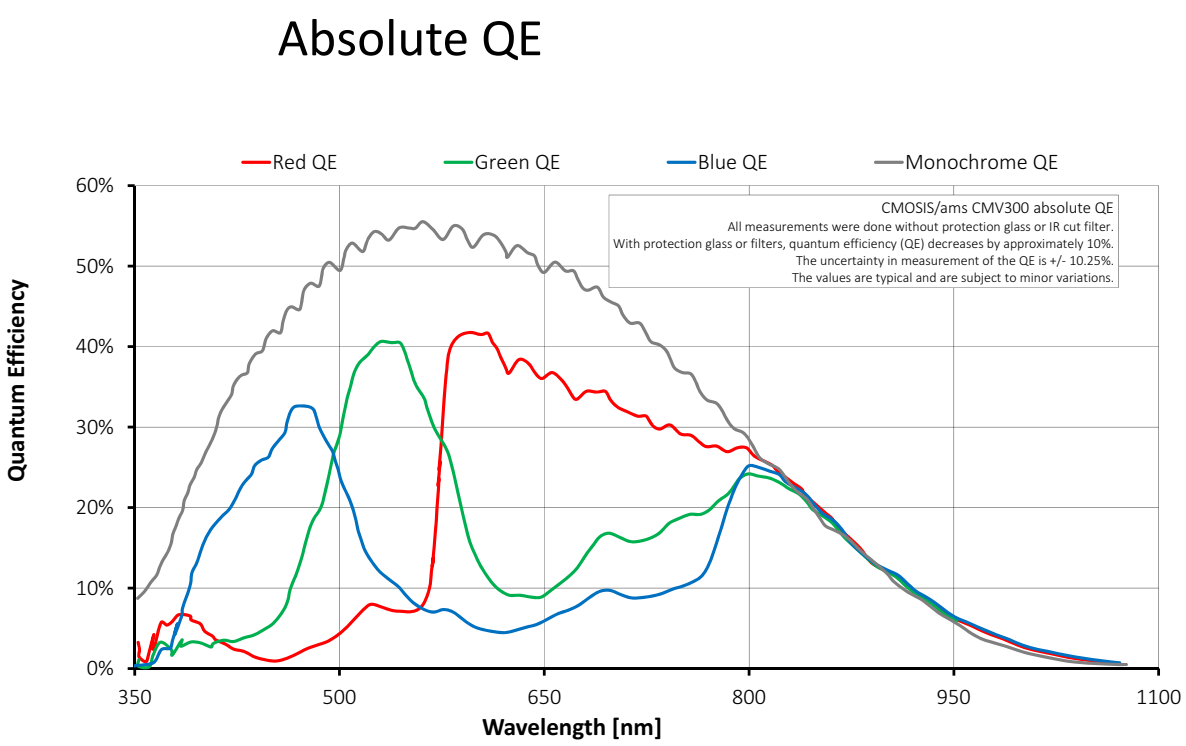


Figure 1: Mako G-030B, G-030C (CMOSIS/ams CMV300) absolute QE

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

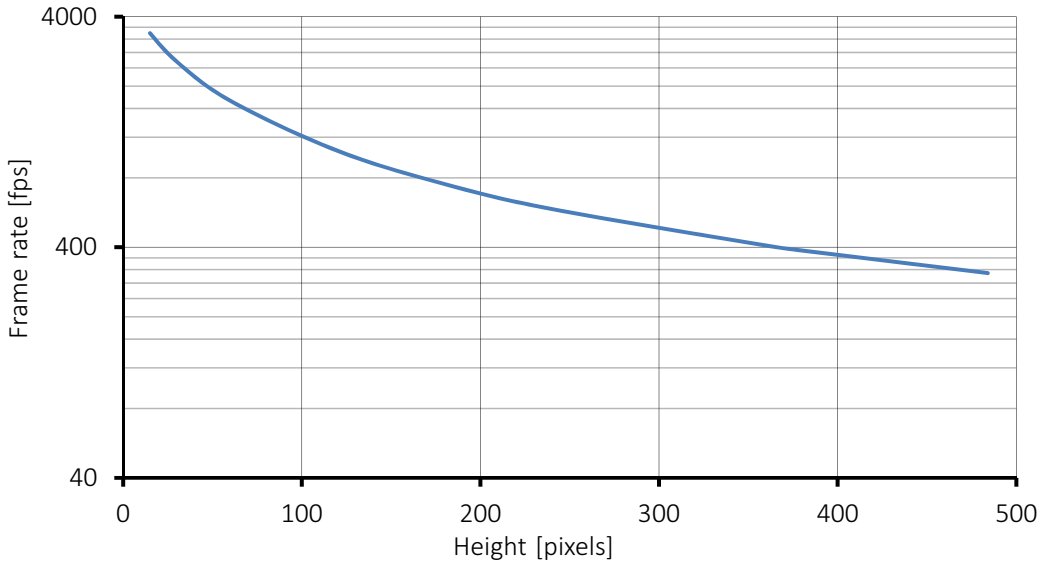


Figure 2: Mako G-030 frame rate as a function of ROI height

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

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

Width = 644 pixels

Table 8: Mako G-030 frame rate as a function of ROI height

There is 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) × 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 format	Type 1/3	
Sensor size	6.0 mm diagonal	
Pixel size	7.4 µm × 7.4 µm	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	102.3 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 202 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		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	
Power consumption	2.4 W at 12 VDC; 2.8 W PoE	
Trigger latency[1]	Idle state: 7.2 µs; Frame valid state: 16.9µs	

Table 9: Mako G-032B, G-032C model specifications

Feature	Specification	
	Mako G-032B	Mako G-032C
Trigger jitter[1]	Idle state: ±4.0 µs; Frame valid state: ±13.7 µs	

[1] It is possible to start the exposure of the next frame while the 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 9: Mako G-032B, G-032C model specifications (continued)

Absolute QE

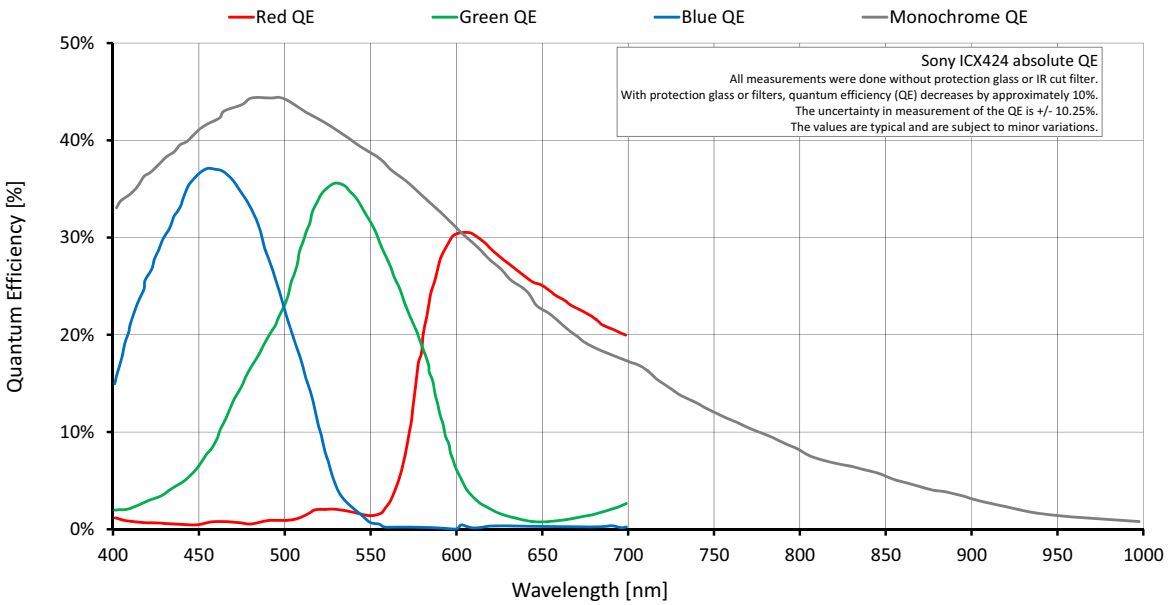


Figure 3: Mako G-032B, G-032C (Sony ICX424) absolute QE

Spectral response

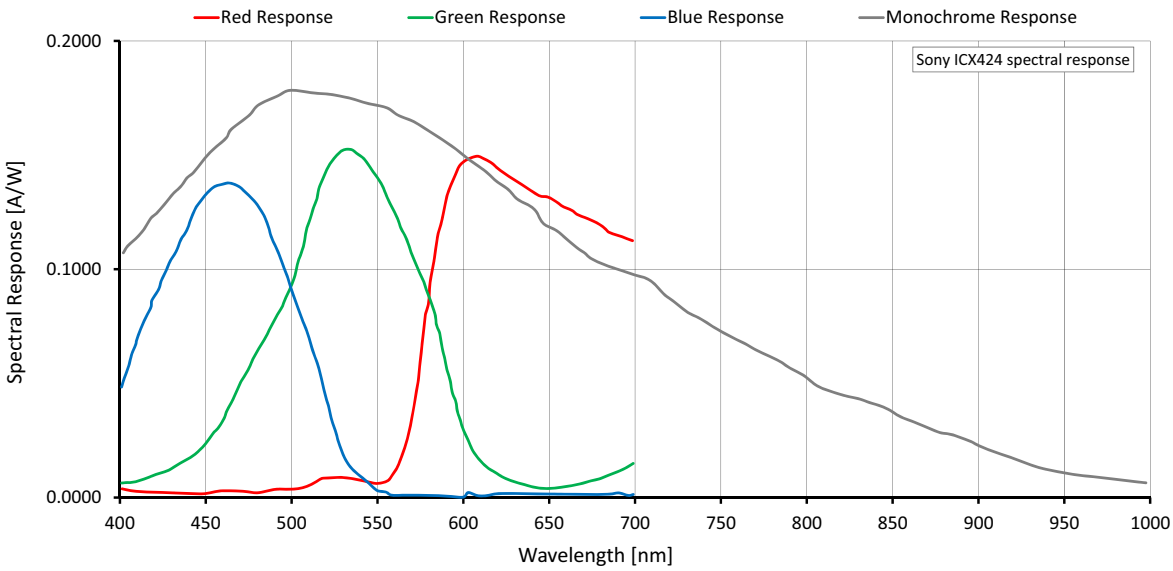


Figure 4: Mako G-032B, G-032C (Sony ICX424) spectral response

ROI frame rate

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

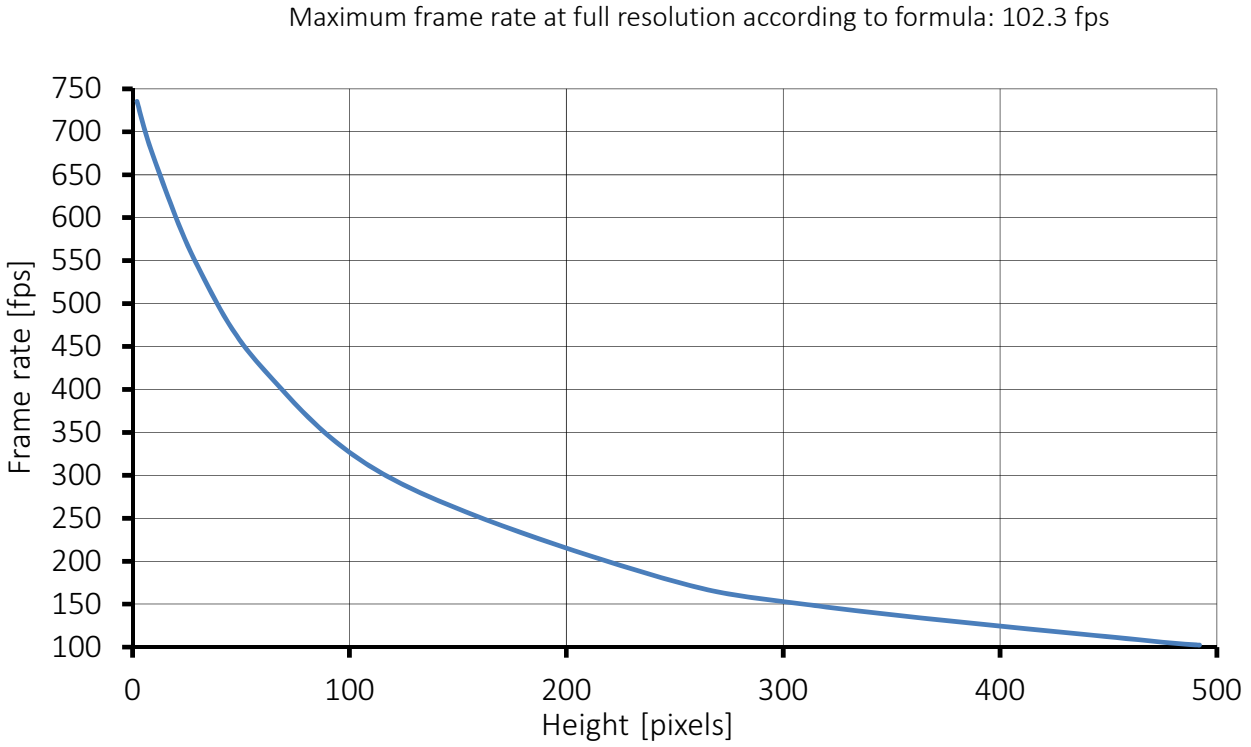


Figure 5: Mako G-032 frame rate as a function of ROI height

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

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

Width = 658 pixels

Table 10: Mako G-032 frame rate as a function of ROI height

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

Mako G-040B, G-040C

Feature	Specification	
	Mako G-040B	**Mako G-040C**
Resolution	728 (H) × 544 (V) 0.40 MP	
Sensor	Sony IMX287LLR Exmor with Pregius® global shutter technology	Sony IMX287LQR Exmor with Pregius® global shutter technology
Type	CMOS	
Shutter type	Global	
Sensor format	Type 1/2.9	
Sensor size	6.3 mm diagonal	
Pixel size	6.9 µm × 6.9 µm	
Chief Ray Angle[1]	0.0°	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	286 fps 295.7 fps (burst mode)	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 160 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	19 µs to 85.9 s; 5.76 µs increments
	Mono12, BayerRG12, YUV422Packed	21 µs to 85.9 s; 7.68 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	25 µs to 85.9 s; 11.52 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	

Table 11: Mako G-040B, G-040C model specifications

Feature	Specification	
	Mako G-040B	**Mako G-040C**
Binning	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Power consumption	2.43 W at 12 VDC; 2.69 W PoE	
Trigger latency[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	17.28 µs
	Mono12, BayerRG12, YUV422Packed	23.04 µs
	RGB8Packed, BGR8Packed, YUV444Packed	34.56 µs
Trigger jitter[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±2.88 µs
	Mono12, BayerRG12, YUV422Packed	±3.84 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±5.76 µs
Time between exposures	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	101 µs
	Mono12, BayerRG12, YUV422Packed	140 µs
	RGB8Packed, BGR8Packed, YUV444Packed	217 µs

1 For more information on Chief Ray Angle, contact Allied Vision support.

[2] Whenever pixel format is changed, exposure adjusts itself to the nearest multiple of the exposure increment.

[3] It is possible to start the exposure of the next frame while the 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 11: Mako G-040B, G-040C model specifications (continued)

Absolute QE

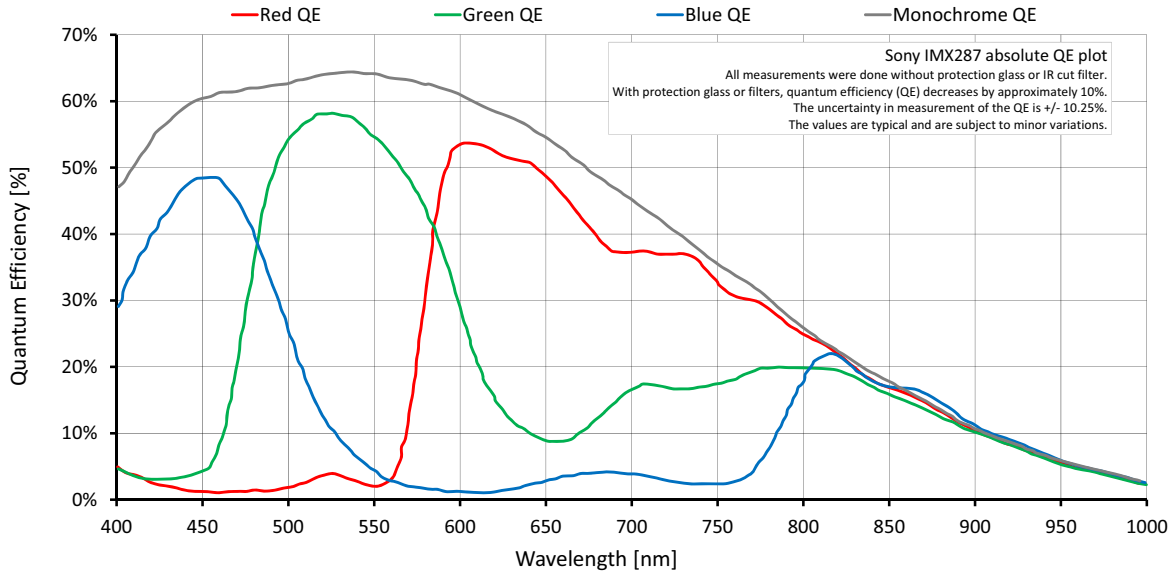


Figure 6: Mako G-040B, G-040C (Sony IMX287) absolute QE

Spectral response

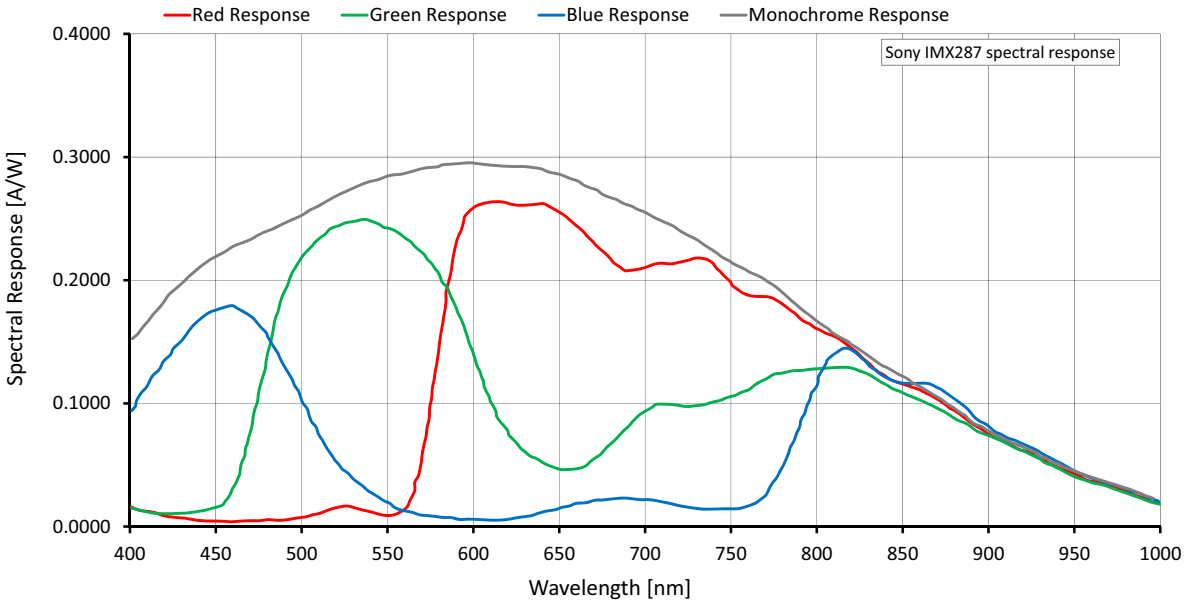


Figure 7: Mako G-040B, G-040C (Sony IMX287) spectral response

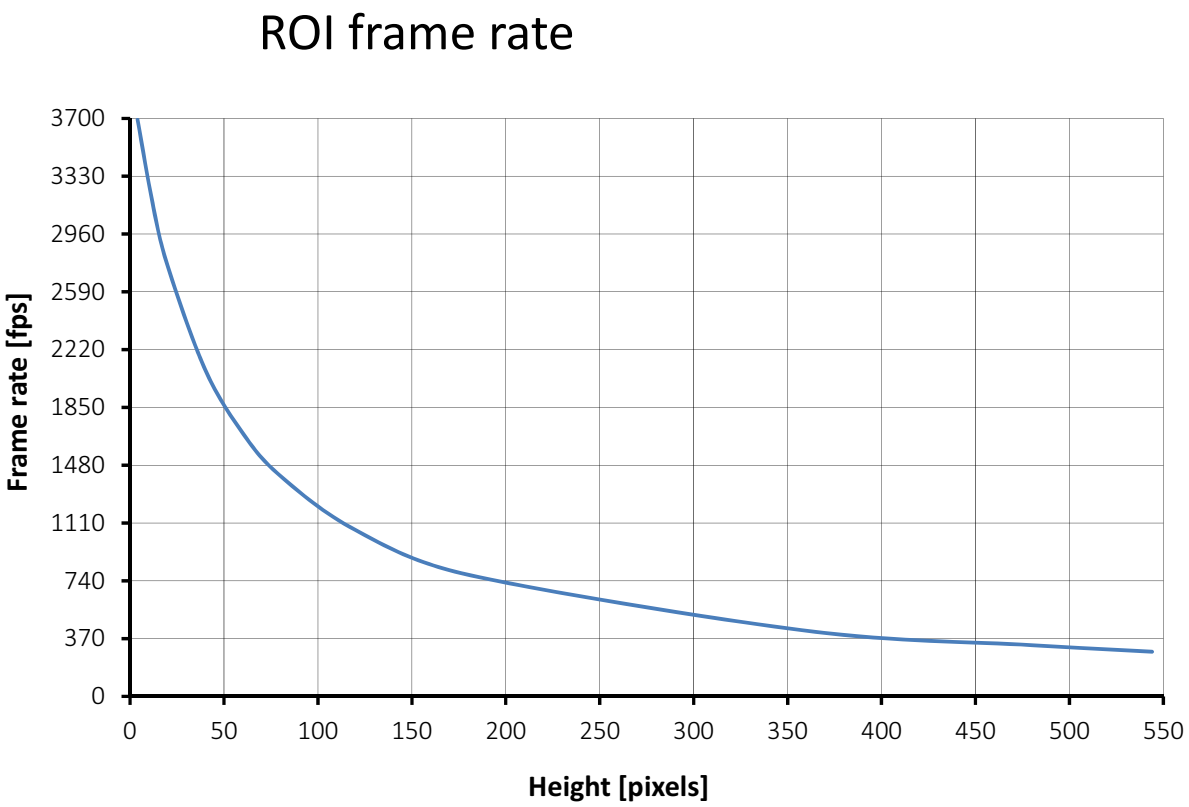


Figure 8: Mako G-040 frame rate as a function of ROI height

Height (pixels)	Frame rate
544	286
480	328.2
360	420.4
180	778.5
120	1065
80	1411.4

Height (pixels)	Frame rate
60	1685.5
40	2091.6
20	2755.6
12	3156.5
4	3692.7

Width = 728 pixels

Table 12: Mako G-040 frame rate as a function of ROI height

There is 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-125B, G-125C

Feature	Specification	
	Mako G-125B	**Mako G-125C**
Resolution	1292 (H) × 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 format	Type 1/3	
Sensor size	6.0 mm diagonal	
Pixel size	3.75 µm × 3.75 µm	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	30.3 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 52 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		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	
Power consumption	2.3 W at 12 VDC; 2.7 W PoE	
Trigger latency[1]	Idle state: 8.0 µs; Frame valid state: 25.0 µs	

Table 13: Mako G-125B, G-125C model specifications

Feature	Specification	
	Mako G-125B	Mako G-125C
Trigger jitter[1]	Idle state: ±4.0 µs; Frame valid state: ±21.0 µs	

[1] It is possible to start the exposure of the next frame while the 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 13: Mako G-125B, G-125C model specifications (continued)

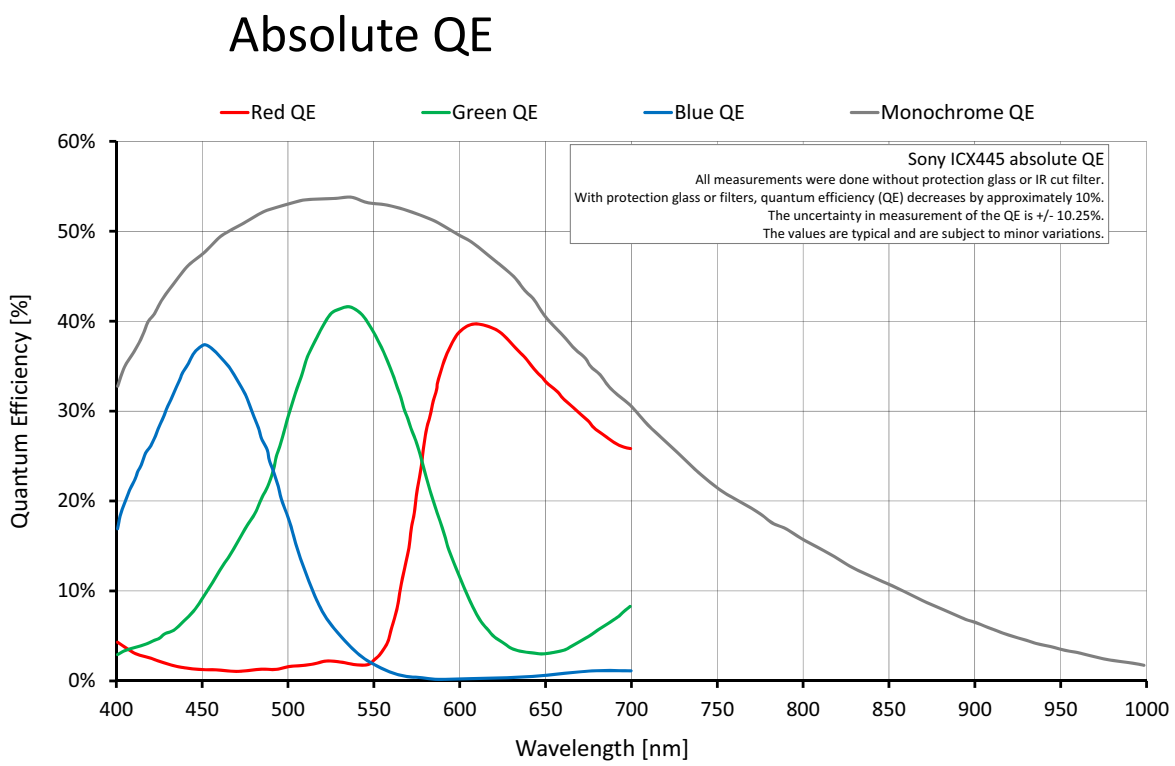


Figure 9: Mako G-125B, G-125C (Sony ICX445) absolute QE

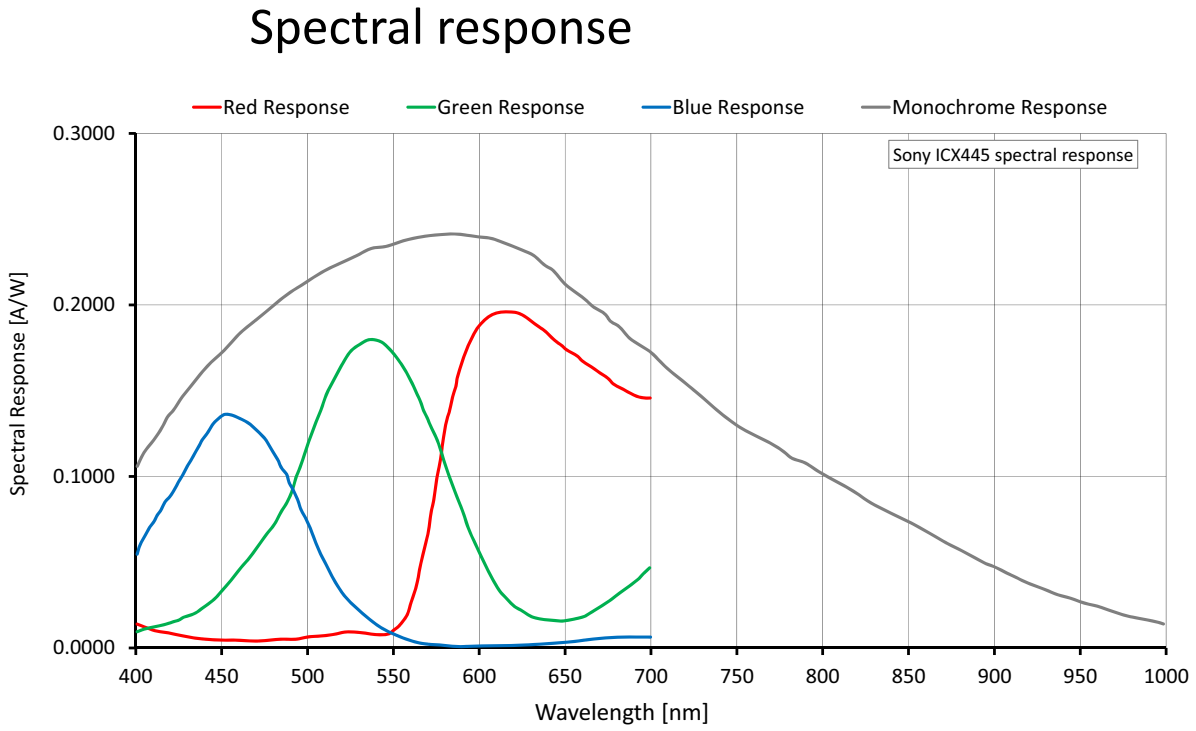


Figure 10: Mako G-125B, G-125C (Sony ICX445) spectral response

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

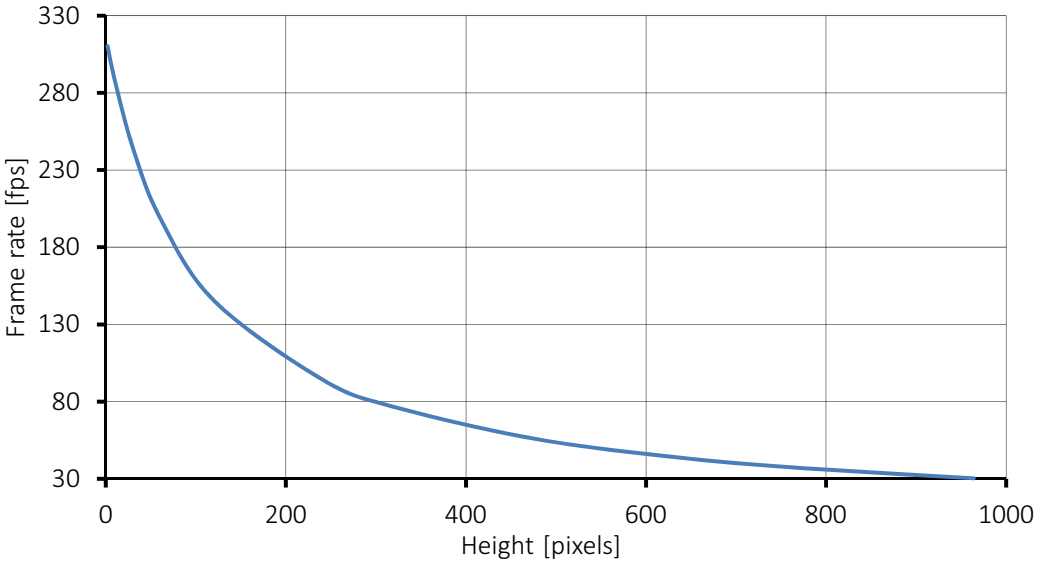


Figure 11: Mako G-125 frame rate as a function of ROI height

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

Height (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 14: Mako G-125 frame rate as a function of ROI height

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

Mako G-131B, G-131C

Feature	Specification			
	Mako G-131B		Mako G-131C	
Resolution	1280 (H) × 1024 (V) 1.3 MP			
Sensor	Teledyne e2v EV76C560			
Sensor type	CMOS			
Shutter type	Global, Global Reset, and Rolling			
Sensor format	Type 1/1.8			
Sensor size	8.7 mm diagonal			
Pixel size	5.3 µm × 5.3 µm			
Chief Ray Angle[1]	12°			
Optical filter	Default: No optical filter Optional: See the *Modular Concept*		Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*	
Maximum frame rate at full resolution	62 fps			
Maximum image bit depth	10-bit			
Image buffer	64 MB			
StreamHoldCapacity	Up to 50 frames at full resolution			
Monochrome pixel formats	Mono8, Mono10		Mono8	
YUV color pixel formats			YUV411Packed, YUV422Packed, YUV444Packed	
RGB color pixel formats			RGB8Packed, BGR8Packed	
RAW pixel formats			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

Table 15: Mako G-131B, G-131C model specifications

Feature	Specification	
	Mako G-131B	Mako G-131C
Gain control	0 to 24 dB; 1 dB increments	
Binning[2]	Horizontal: 1 to 2 pixels Vertical: 1 to 2 rows Teledyne e2v sensors support 1×1 and 2×2 binning	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Power consumption	2.0 W at 12 VDC; 2.2 W PoE	
Trigger latency[3]	Idle state: 32.6 µs; Frame valid state: 32.6 µs	
Trigger jitter[3]	Idle state: ±8.1 µs; Frame valid state: ±8.1 µs	

1 For more information on Chief Ray Angle, contact Allied Vision support.

[2] The Mako G-131B, G-131C 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.
- The Teledyne e2v sensor does not support exposure duration via external level trigger.

Table 15: 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.

Absolute QE

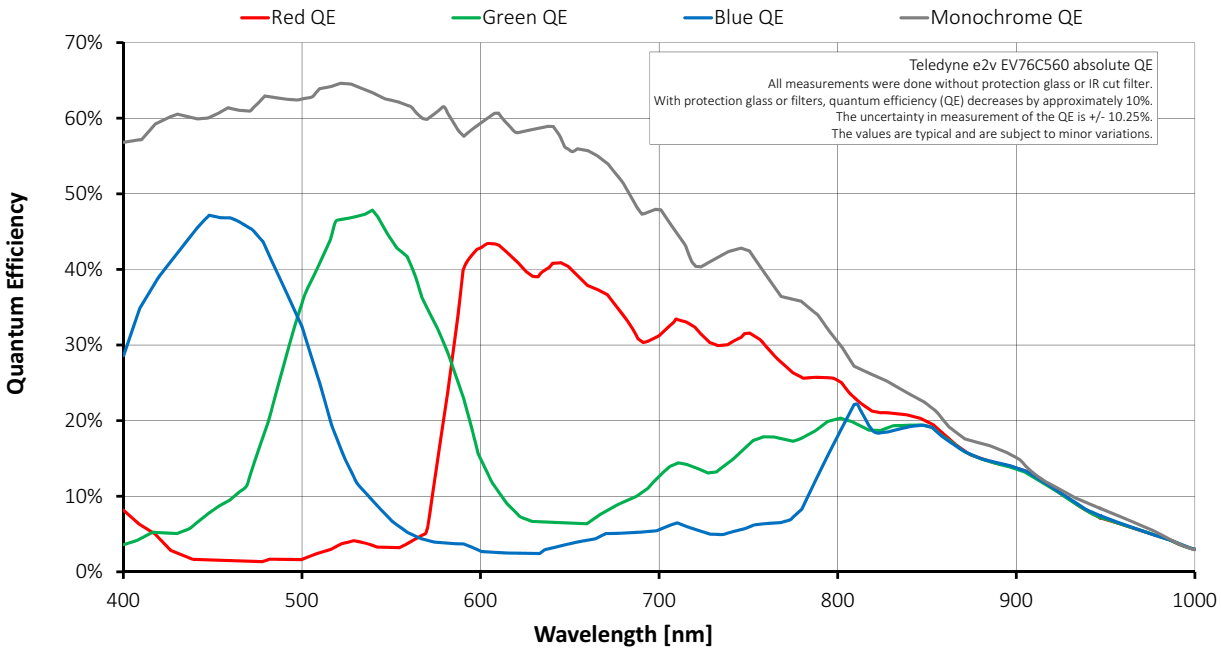


Figure 12: Mako G-131B, G-131C (Teledyne e2v EV76C560) absolute QE

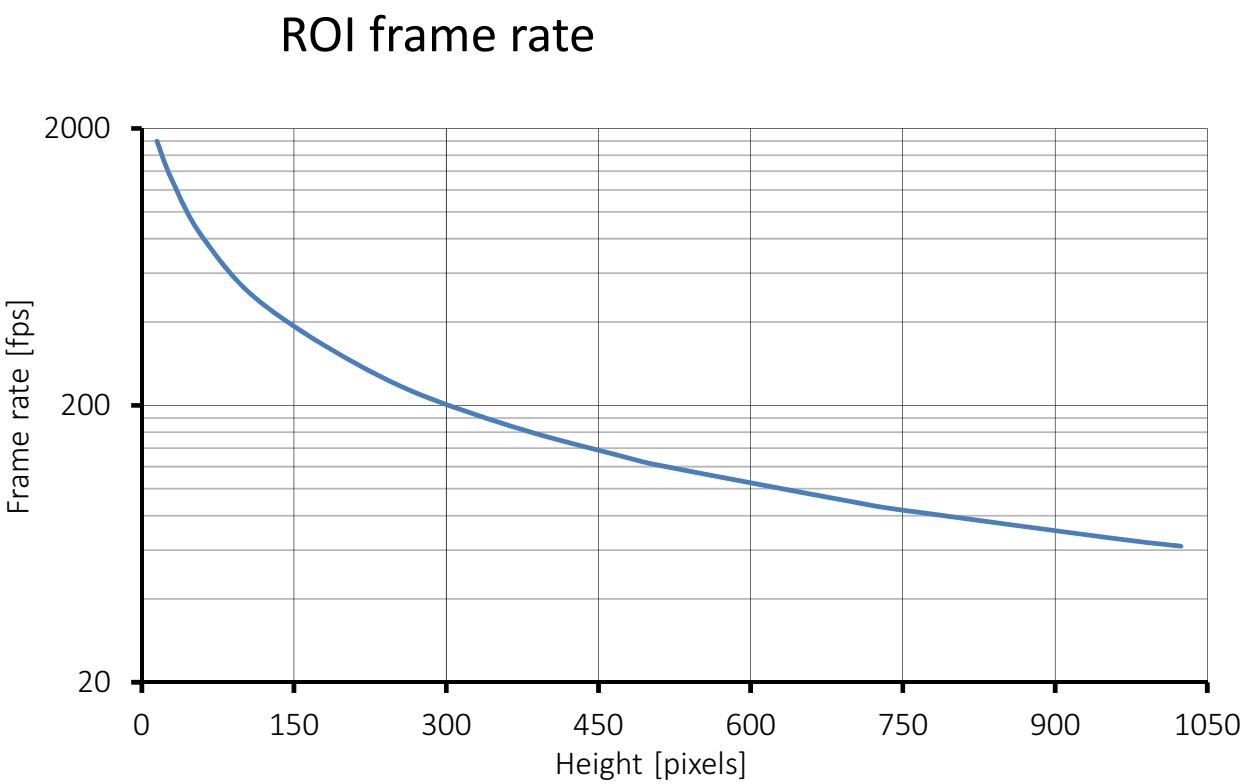


Figure 13: Mako G-131 frame rate as a function of ROI height

Height (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 16: Mako G-131 frame rate as a function of ROI height

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

Mako G-158B, G-158C

Feature	Specification	
	Mako G-158B	**Mako G-158C**
Resolution	1456 (H) × 1088 (V) 1.58 MP	
Sensor	Sony IMX273LLR Exmor with Pregius® global shutter technology	Sony IMX273LQR Exmor with Pregius® global shutter technology
Type	CMOS	
Shutter type	Global	
Sensor format	Type 1/2.9	
Sensor size	6.3 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
Chief Ray Angle[1]	0.0°	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	75.2 fps 78.9 fps (burst mode)	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 41 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	24 µs to 85.9 s; 11.2 µs increments
	Mono12, BayerRG12, YUV422Packed	28 µs to 85.9 s; 14.88 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	36 µs to 85.9 s; 22.4 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	

Table 17: Mako G-158B, G-158C model specifications

Feature	Specification	
	Mako G-158B	**Mako G-158C**
Binning	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Power consumption	2.43 W at 12 VDC; 2.68 W PoE	
Trigger latency[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	33.6 µs
	Mono12, BayerRG12, YUV422Packed	44.64 µs
	RGB8Packed, BGR8Packed, YUV444Packed	67.2 µs
Trigger jitter[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±5.6 µs
	Mono12, BayerRG12, YUV422Packed	±7.44 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±11.2 µs
Time between exposures	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	210 µs
	Mono12, BayerRG12, YUV422Packed	285 µs
	RGB8Packed, BGR8Packed, YUV444Packed	434 µs

[1] For more information on Chief Ray Angle, contact Allied Vision support.

[2] Whenever pixel format is changed, exposure adjusts itself to the nearest multiple of the exposure increment.

[3] It is possible to start the exposure of the next frame while the 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 17: Mako G-158B, G-158C model specifications (continued)

Absolute QE

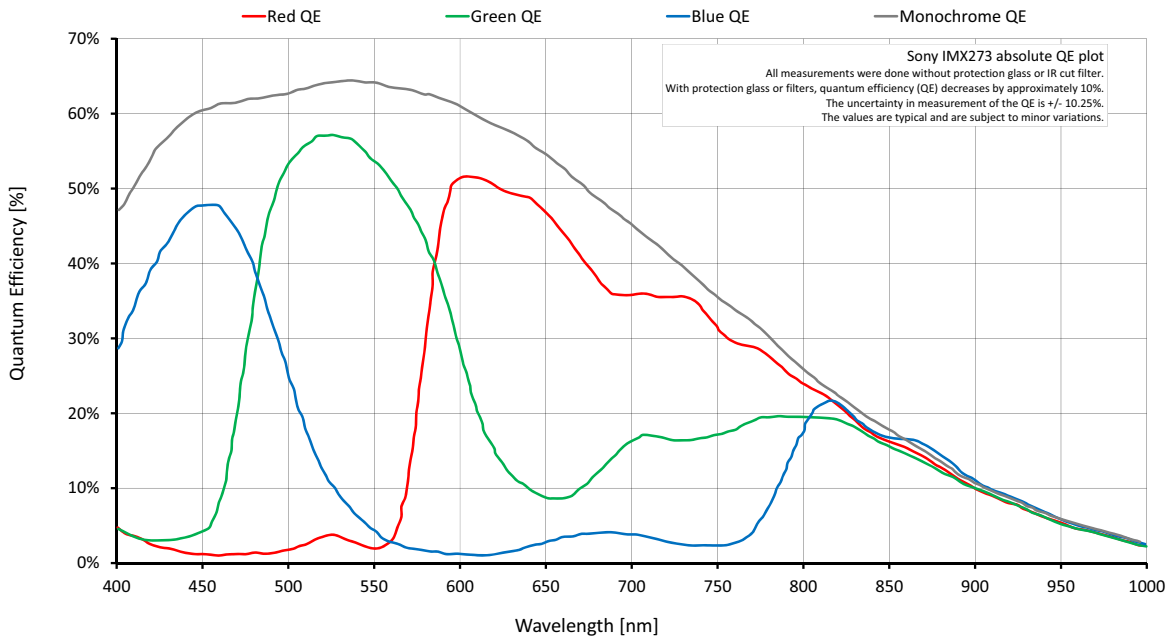


Figure 14: Mako G-158B, G-158C (Sony IMX273) absolute QE

Spectral response

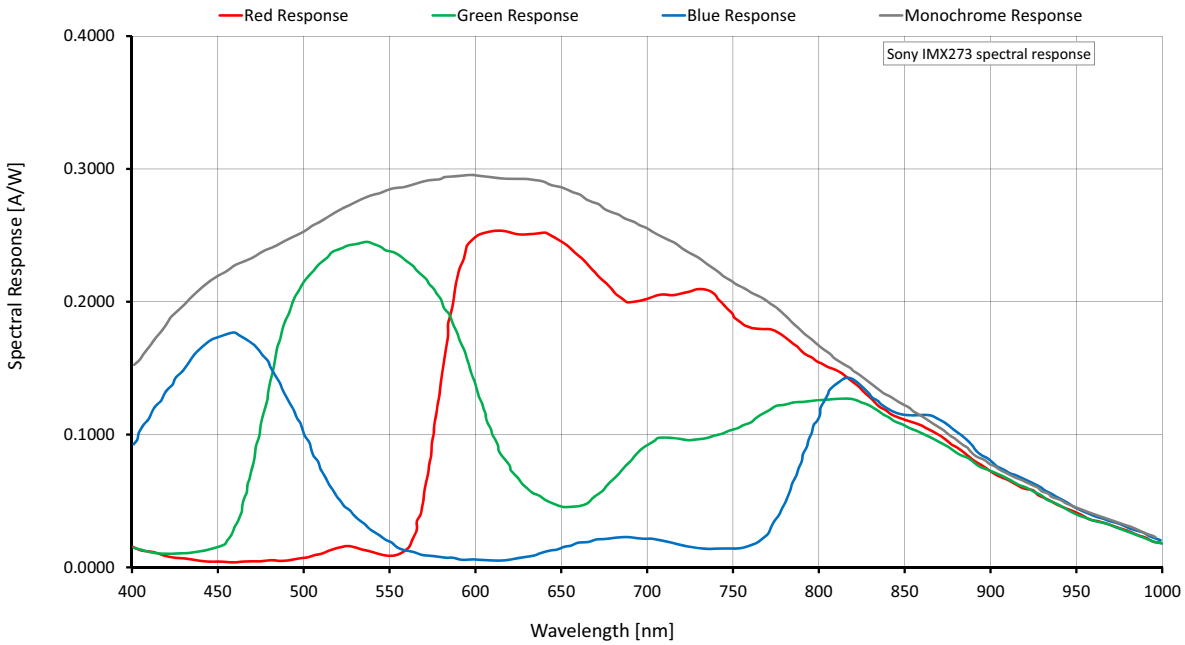


Figure 15: Mako G-158B, G-158C (Sony IMX273) spectral response

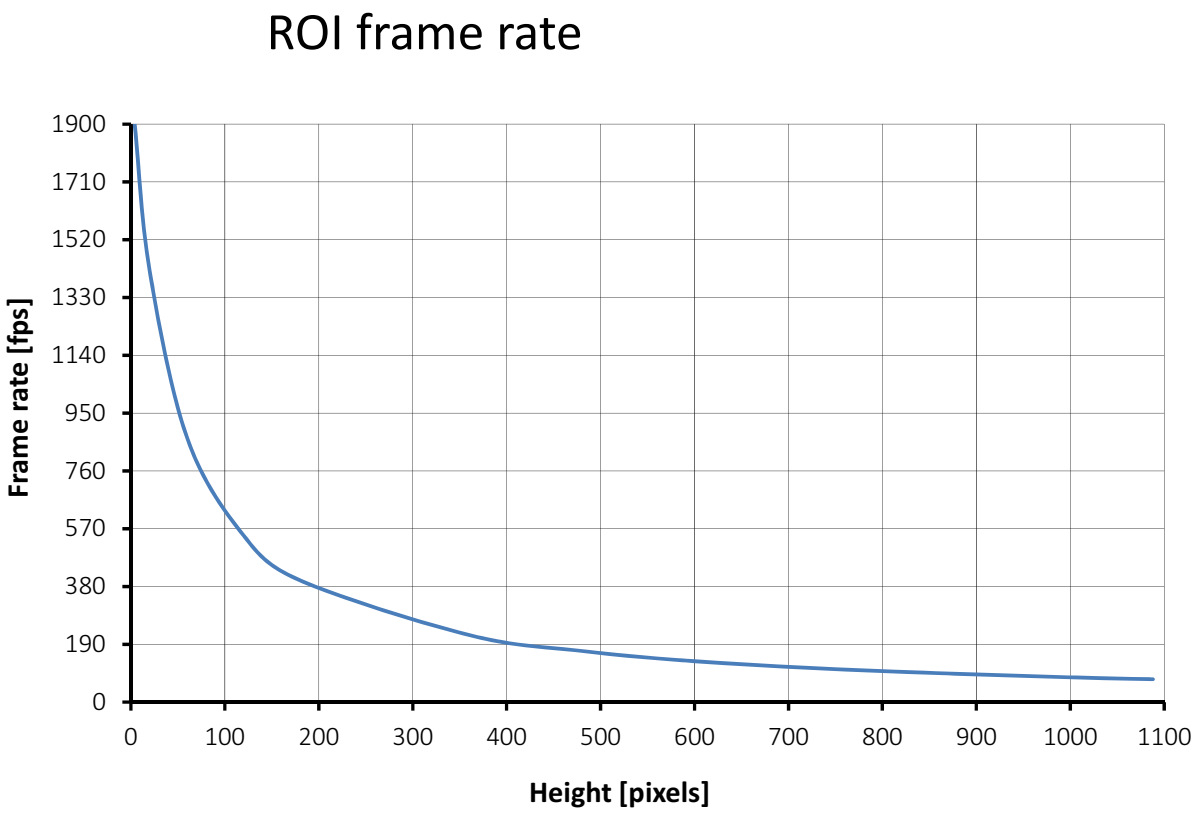


Figure 16: Mako G-158 frame rate as a function of ROI height

Height (pixels)	Frame rate
1088	75.2
1080	75.6
1024	79.6
960	85.2
768	105.9
600	134.5
480	168.1

Height (pixels)	Frame rate
360	220.5
180	400.4
120	547.8
60	866.9
20	1417.2
4	1899.7

Width = 1456 pixels

Table 18: Mako G-158 frame rate as a function of ROI height

There is 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-192B, G-192C

Feature	Specification			
	Mako G-192B	Mako G-192C		
Resolution	1600 (H) × 1200 (V) 1.9 MP			
Sensor	Teledyne e2v EV76C570			
Sensor type	CMOS			
Shutter type	Global, Global Reset, and Rolling			
Sensor format	Type 1/1.8			
Sensor size	9 mm diagonal			
Pixel size	4.5 µm × 4.5 µm			
Chief Ray Angle[1]	12°			
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*		
Maximum frame rate at full resolution	60 fps			
Maximum image bit depth	10-bit			
Image buffer	64 MB			
StreamHoldCapacity	Up to 34 frames at full resolution			
Monochrome pixel formats	Mono8, Mono10	Mono8		
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed		
RGB color pixel formats		RGB8Packed, BGR8Packed		
RAW pixel formats		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			

Table 19: Mako G-192B, G-192C model specifications

Feature	Specification	
	Mako G-192B	Mako G-192C
Binning[2]	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	
Power consumption	2.1 W at 12 VDC; 2.4 W PoE	
Trigger latency[3]	Idle state: 27.7 µs; Frame valid state: 27.7 µs	
Trigger jitter[3]	Idle state: ±6.9 µs; Frame valid state: ±6.9 µs	

[1] For more information on Chief Ray Angle, contact Allied Vision support.

[2] The Mako G-192B, G-192C 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 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 19: 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

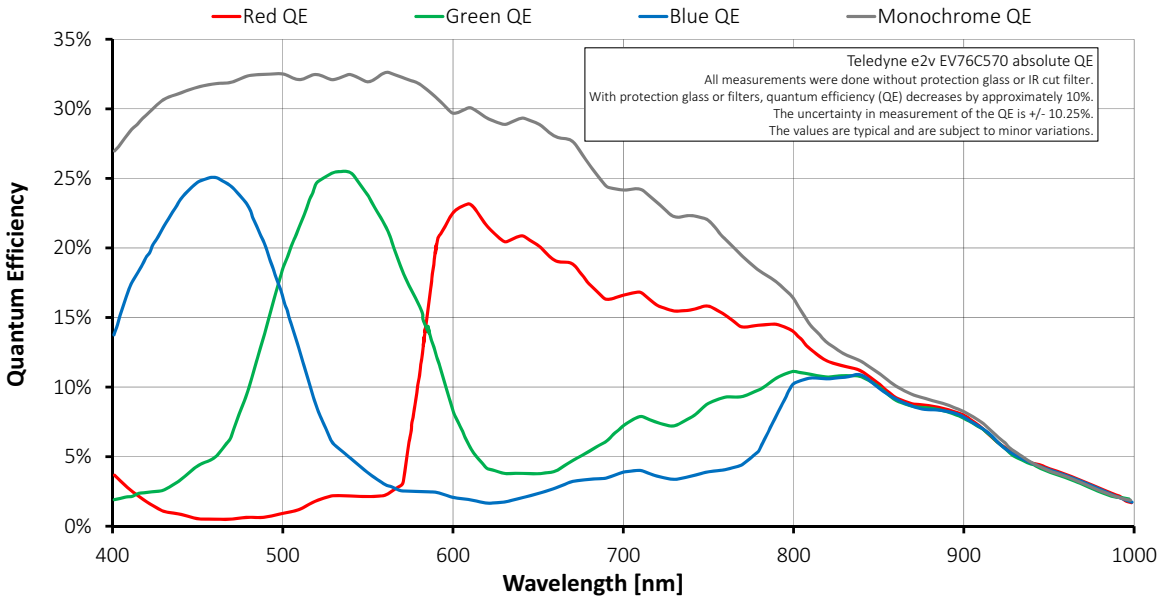


Figure 17: Mako G-192B, G-192C (Teledyne e2v EV76C570) absolute QE

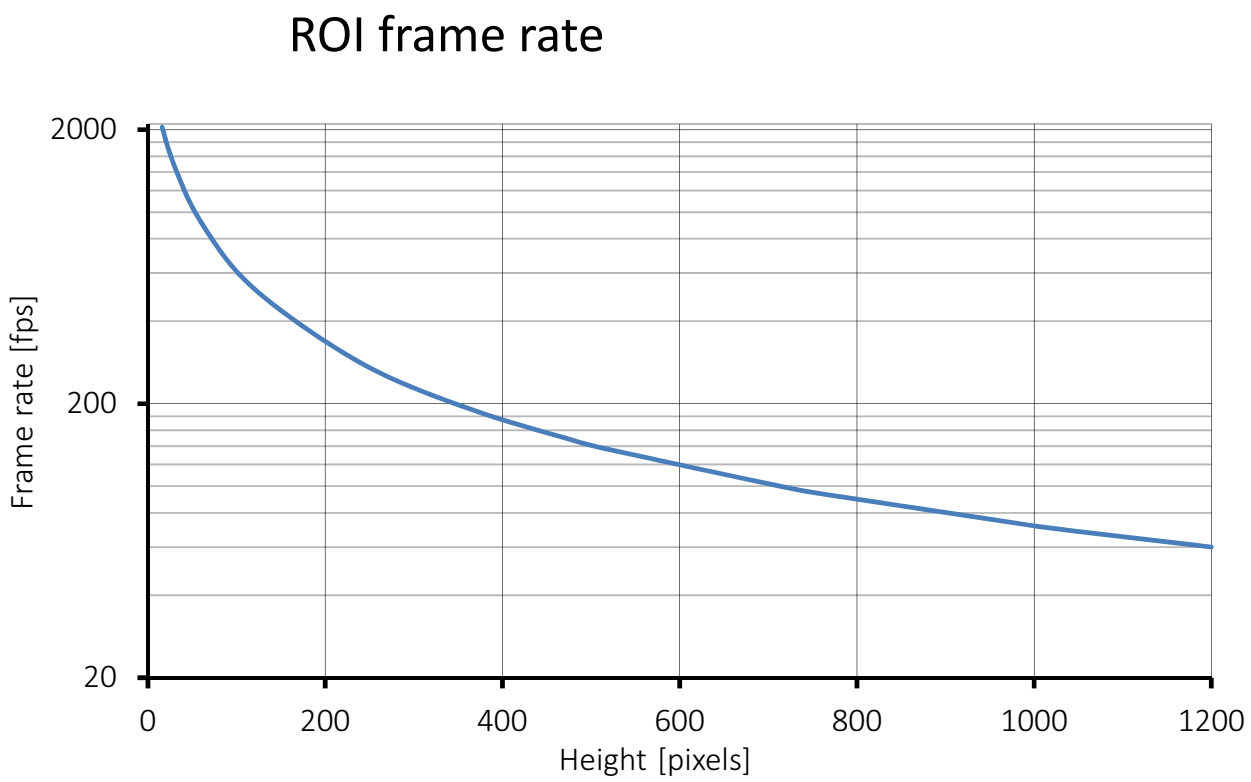


Figure 18: Mako G-192 frame rate as a function of ROI height

Height (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 20: Mako G-192 frame rate as a function of ROI height

There is 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) × 1088 (V) 2.2 MP	
Sensor	CMOSIS/ams CMV2000	
Sensor type	CMOS	
Shutter type	Global	
Sensor format	Type 2/3	
Sensor size	12.7 mm diagonal	
Pixel size	5.5 µm × 5.5 µm	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	49.5 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 29 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerGB8, BayerGB12, BayerGB12Packed
Exposure time control[1]	30 µs to 153 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Power consumption	2.4 W at 12 VDC; 2.8 W PoE	
Trigger latency	T.B.D.	
Trigger jitter	T.B.D.	

[1] Camera firmware version ≤ 01.52.8151 or later shows minimum exposure values without frame overhead time, that is, 1 µs. See sensor data sheet for details on frame overhead time.

Table 21: Mako G-223B, G-223B NIR, G-223C model specifications

Absolute QE

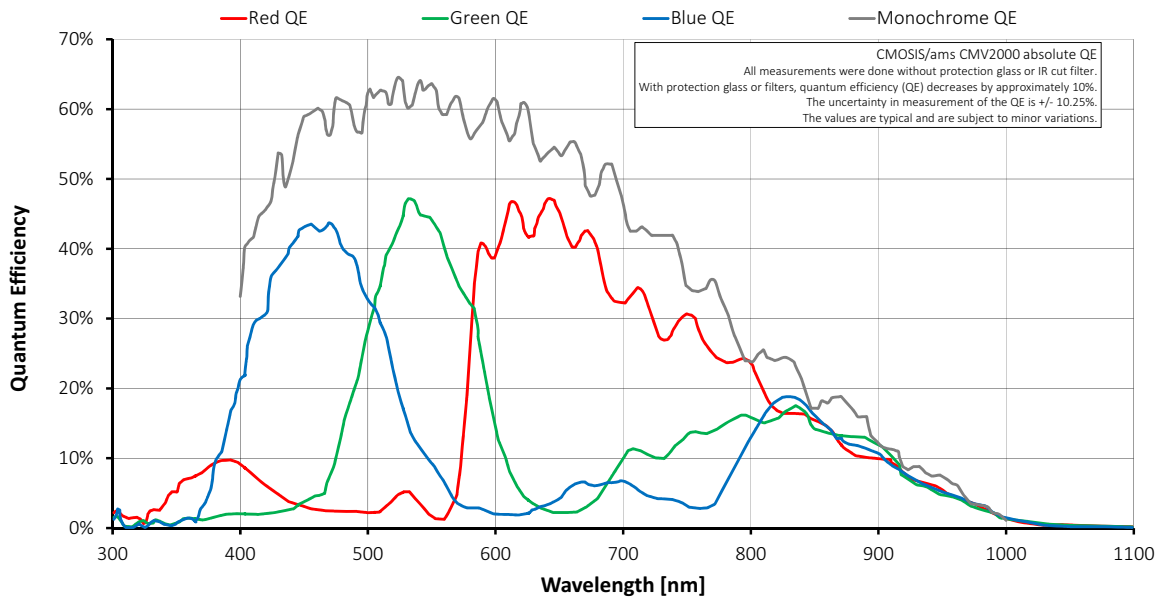


Figure 19: Mako G-223B, G-223C (CMOSIS/ams CMV2000) absolute QE

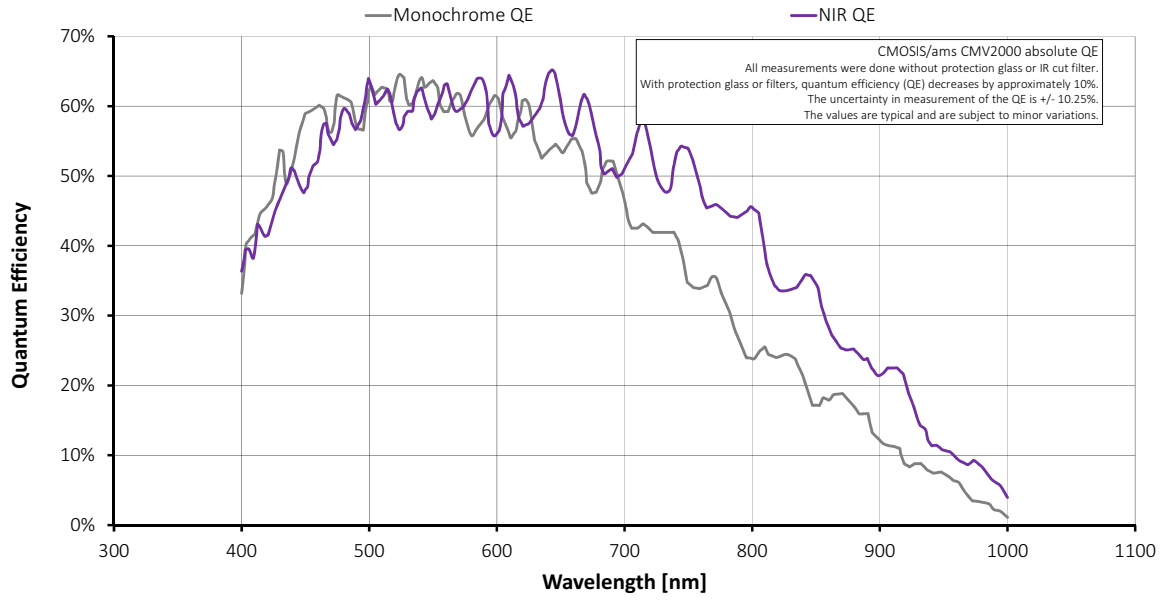


Figure 20: Mako G-223B, G-223B NIR (CMOSIS/ams CMV2000) absolute QE

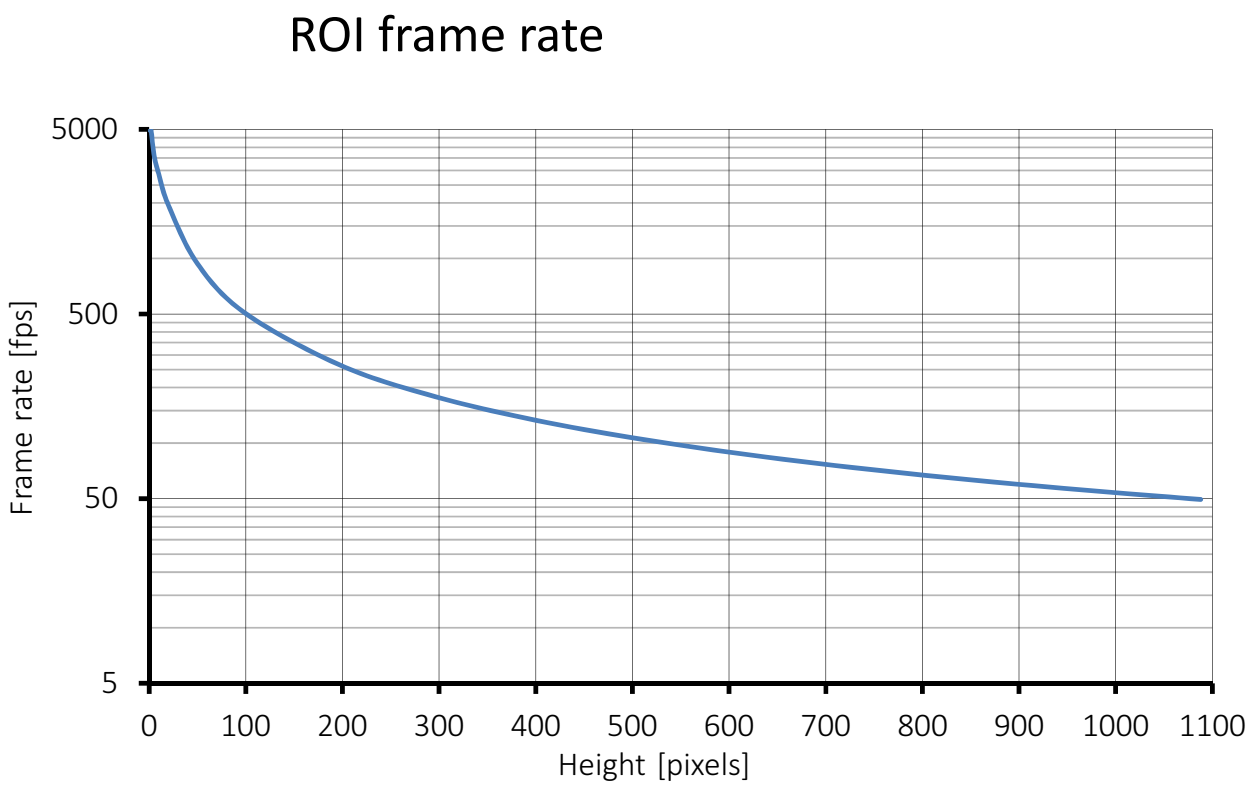


Figure 21: Mako G-223 frame rate as a function of ROI height

Height (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
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 22: Mako G-223 frame rate as a function of ROI height

There is 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) × 1216 (V) 2.35 MP	
Sensor	Sony IMX249LLJ Exmor with Pregius® global shutter technology	Sony IMX249LQJ Exmor with Pregius® global shutter technology
Sensor type	CMOS	
Shutter type	Global	
Sensor format	Type 1/1.2	
Sensor size	13.4 mm diagonal	
Pixel size	5.86 µm × 5.86 µm	
Chief Ray Angle[1]	0.0°	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Sensor output	10-bit or 12-bit	
Maximum frame rate at full resolution	41.5 fps (10-bit) 32.3 fps (12-bit)	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 28 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[2]	**Pixel format**	**Value**
	Mono8, Mono12, Mono12Packed, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	32 µs to 71.6 s; 19.2 µs increments (10-bit) 38 µs to 85.9 s; 24.64 µs increments (12-bit)

Table 23: Mako G-234B, G-234C model specifications

Feature	Specification	
	Mako G-234B	**Mako G-234C**
	RGB8Packed, BGR8Packed, YUV444Packed	52 µs to 71.6 s; 38.4 µs increments (10-bit) 63 µs to 85.9 s; 49.28 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	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Power consumption	2.4 W at 12 VDC; 2.8 W PoE	
Trigger latency[3]	**Pixel format**	**Value**
	Mono8, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	57.6 µs (10-bit), 73.92 µs (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	115.2 µs (10-bit), 147.84 µs (12-bit)
Trigger jitter[3]	**Pixel format**	**Value**
	Mono8, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	±9.6 µs (10-bit), ±12.32 µs (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	±19.2 µs (10-bit), ±24.64 µs (12-bit)
Time between exposures	**Pixel format**	**Value**
	Mono8, BayerRG8, BayerRG12, BayerRG12Packed, YUV411Packed, YUV422Packed	275 µs (10-bit), 356 µs (12-bit)
	RGB8Packed, BGR8Packed, YUV444Packed	563 µs (10-bit), 726 µs (12-bit)

[1] For more information on Chief Ray Angle, contact Allied Vision support.

[2] Whenever pixel format is changed, Exposure adjusts itself to the nearest multiple of the exposure increment.

[3] It is possible to start the exposure of the next frame while the 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 23: 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

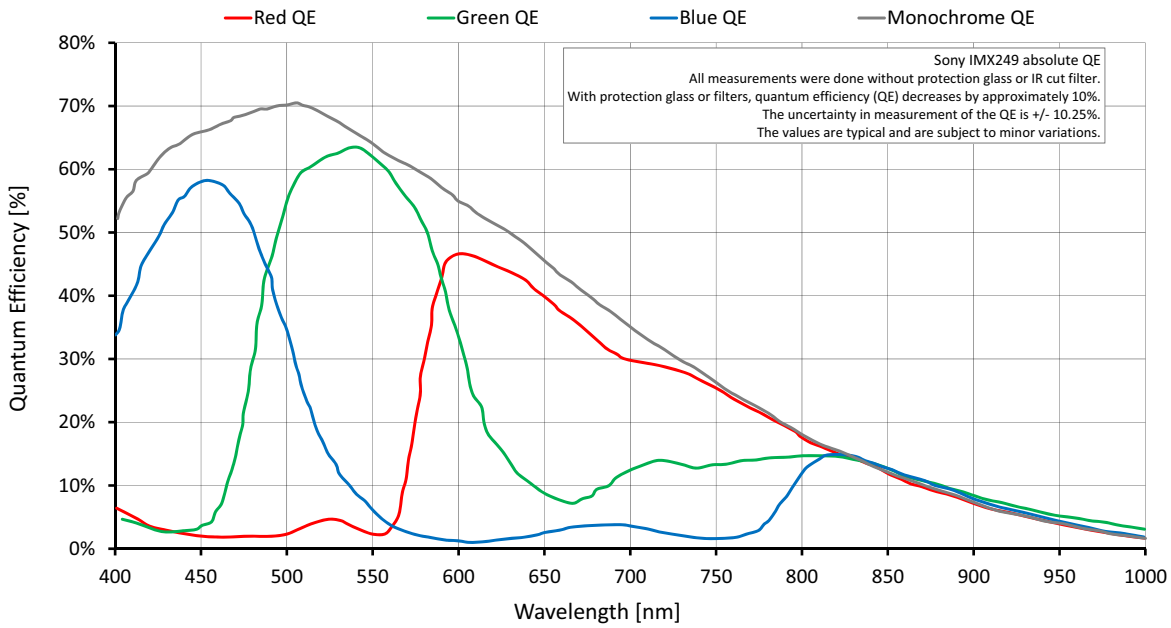


Figure 22: Mako G-234B, G-234C (Sony IMX249) absolute QE

Spectral response

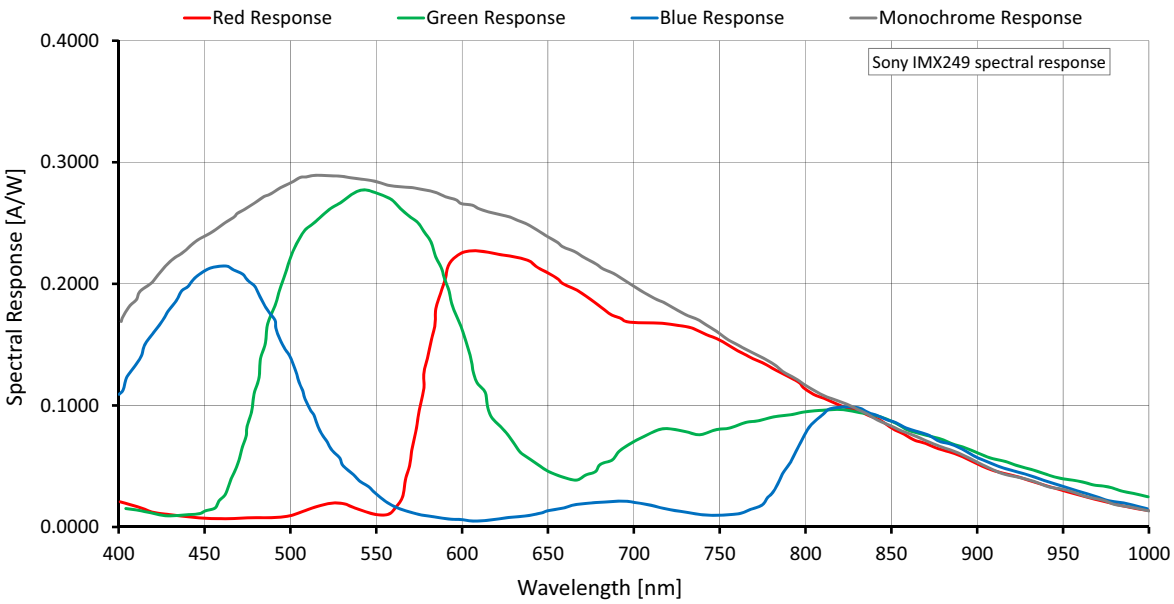


Figure 23: Mako G-234B, G-234C (Sony IMX249) spectral response

ROI frame rate

12-bit sensor readout

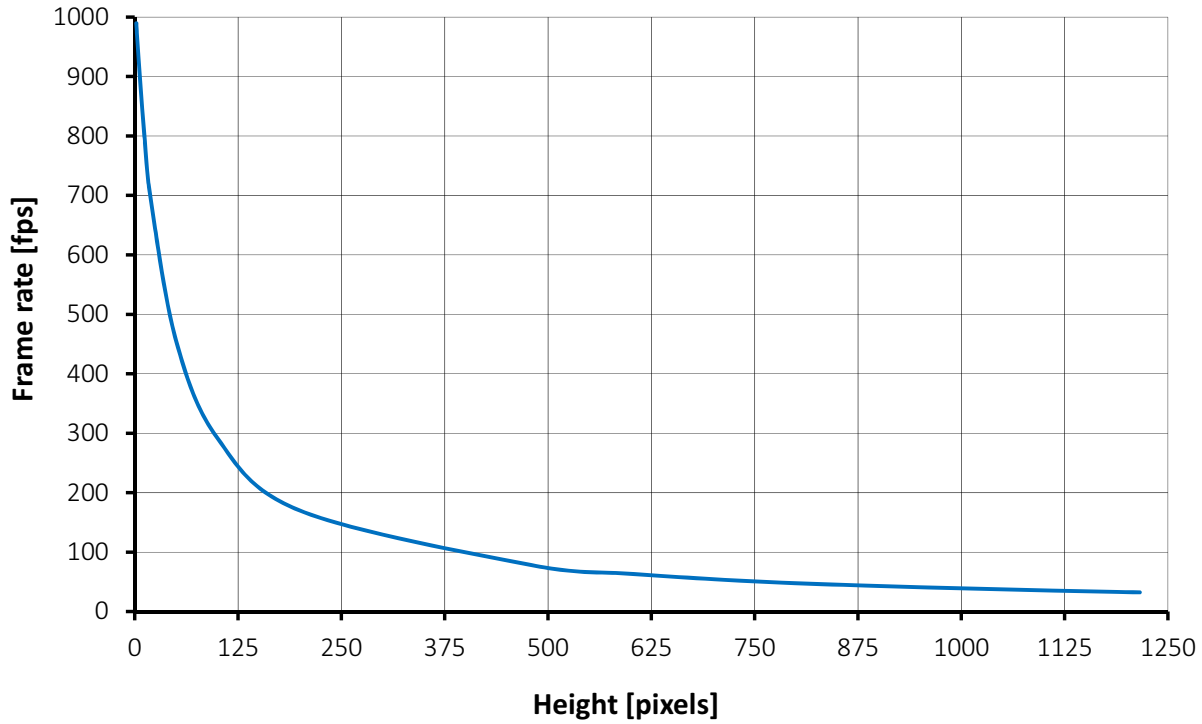


Figure 24: Mako G-234 12-bit sensor frame rate as a function of ROI height

Height (pixels)	Frame rate
1216	32.3
1080	36.3
1024	38.2
960	40.6
768	50.3
600	63.5
480	78.2
200	169.8

Height (pixels)	Frame rate
100	292
50	456
20	687.8
12	795.7
4	943.7
2	989.8

Width = 1936 pixels

Table 24: Mako G-234 12-bit sensor frame rate as a function of ROI height

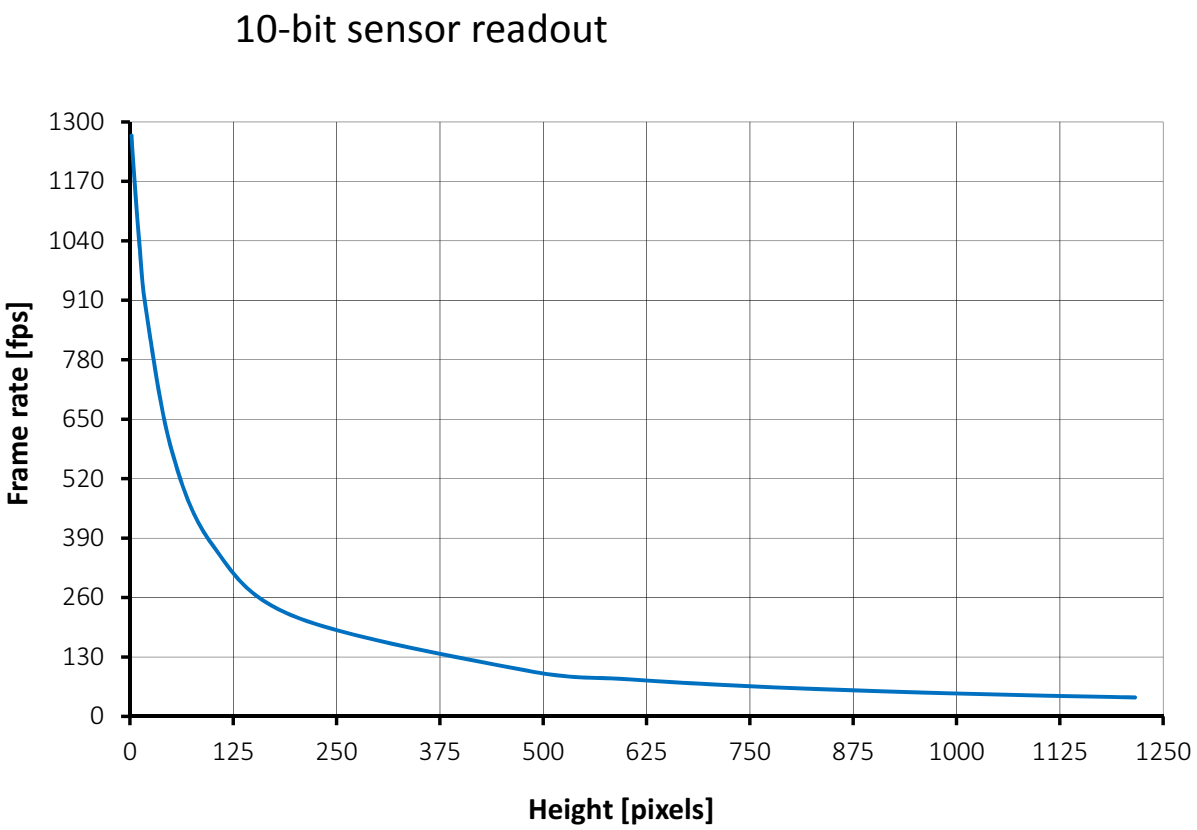


Figure 25: Mako G-234 10-bit sensor frame rate as a function of ROI height

Height (pixels)	Frame rate	Height (pixels)	Frame rate
1216	41.5	200	217.9
1080	46.5	100	374.7
1024	49	50	585.2
960	52.1	20	882.8
768	64.5	12	1021.2
600	81.5	4	1211.2
480	100.3	2	1270.3

Width = 1936 pixels

Table 25: Mako G-234 10-bit sensor frame rate as a function of ROI height

Mako G-319B, G-319C

Feature	Specification	
	Mako G-319B	**Mako G-319C**
Resolution	2064 (H) × 1544 (V) 3.2 MP	
Sensor	Sony IMX265LLR Exmor with Pregius® global shutter technology	Sony IMX265LQR Exmor with Pregius® global shutter technology
Type	CMOS	
Shutter type	Global	
Sensor format	Type 1/1.8	
Sensor size	8.9 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
Chief Ray Angle[1]	0.0°	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	37.6 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 20 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	29 µs to 85.9 s; 16 µs increments
	Mono12, BayerRG12, YUV422Packed	35 µs to 85.9 s; 21.28 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	45 µs to 85.9 s; 32 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	

Table 26: Mako G-319B, G-319C model specifications

Feature	Specification	
	Mako G-319B	**Mako G-319C**
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	
Power consumption	2.5 W at 12 VDC; 2.7 W PoE	
Trigger latency[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	48 µs
	Mono12, BayerRG12, YUV422Packed	63.84 µs
	RGB8Packed, BGR8Packed, YUV444Packed	96 µs
Trigger jitter[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±8 µs
	Mono12, BayerRG12, YUV422Packed	±10.64 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±16 µs
Time between exposures	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	227 µs
	Mono12, BayerRG12, YUV422Packed	306 µs
	RGB8Packed, BGR8Packed, YUV444Packed	467 µs

[1] For more information on Chief Ray Angle, contact Allied Vision support.

[2] Whenever `PixelFormat` is changed, exposure adjusts itself to the nearest multiple of the exposure increment.

[3] It is possible to start the exposure of the next frame while the 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 26: Mako G-319B, G-319C model specifications (continued)

Absolute QE

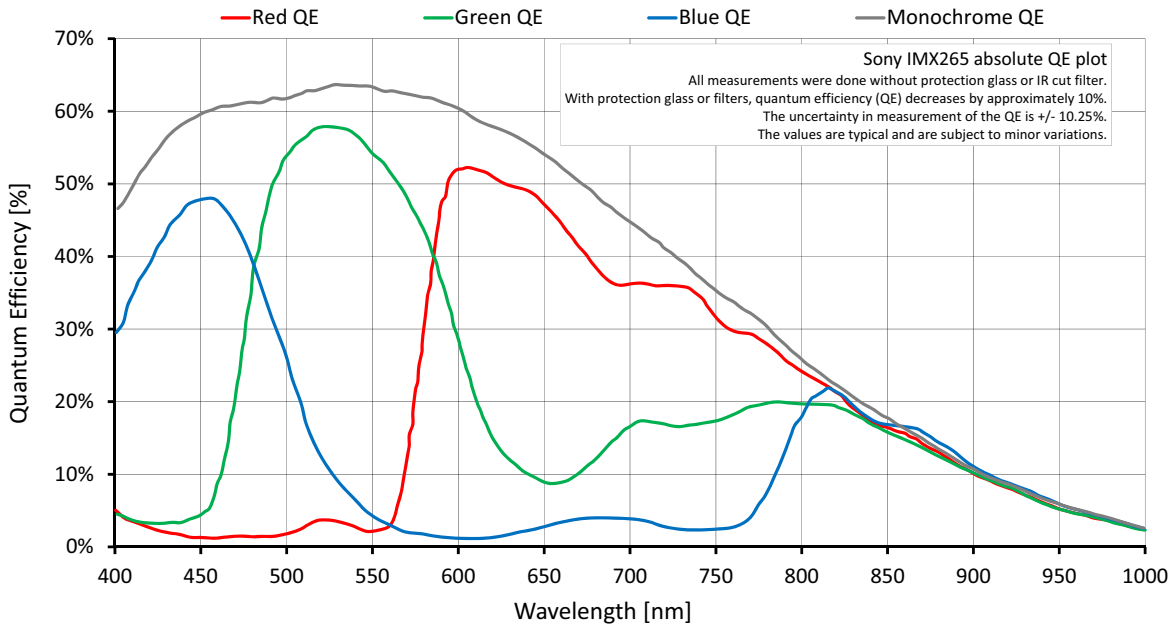


Figure 26: Mako G-319B, G-319C (Sony IMX265) absolute QE

Spectral response

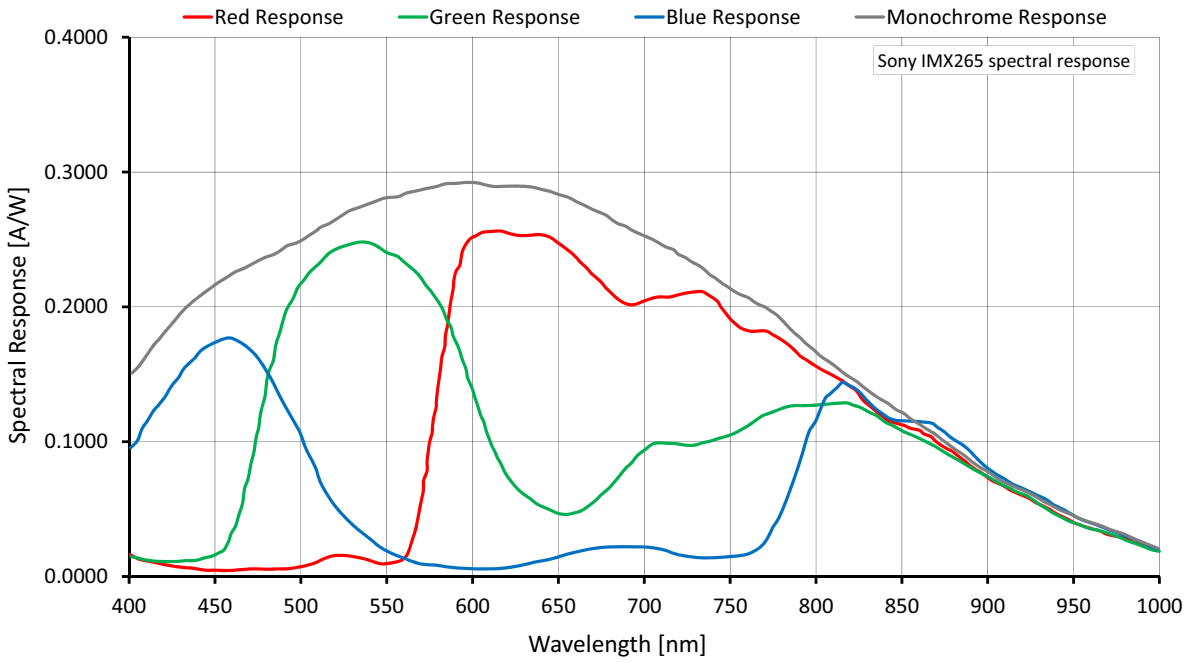


Figure 27: Mako G-319B, G-319C (Sony IMX265) spectral response

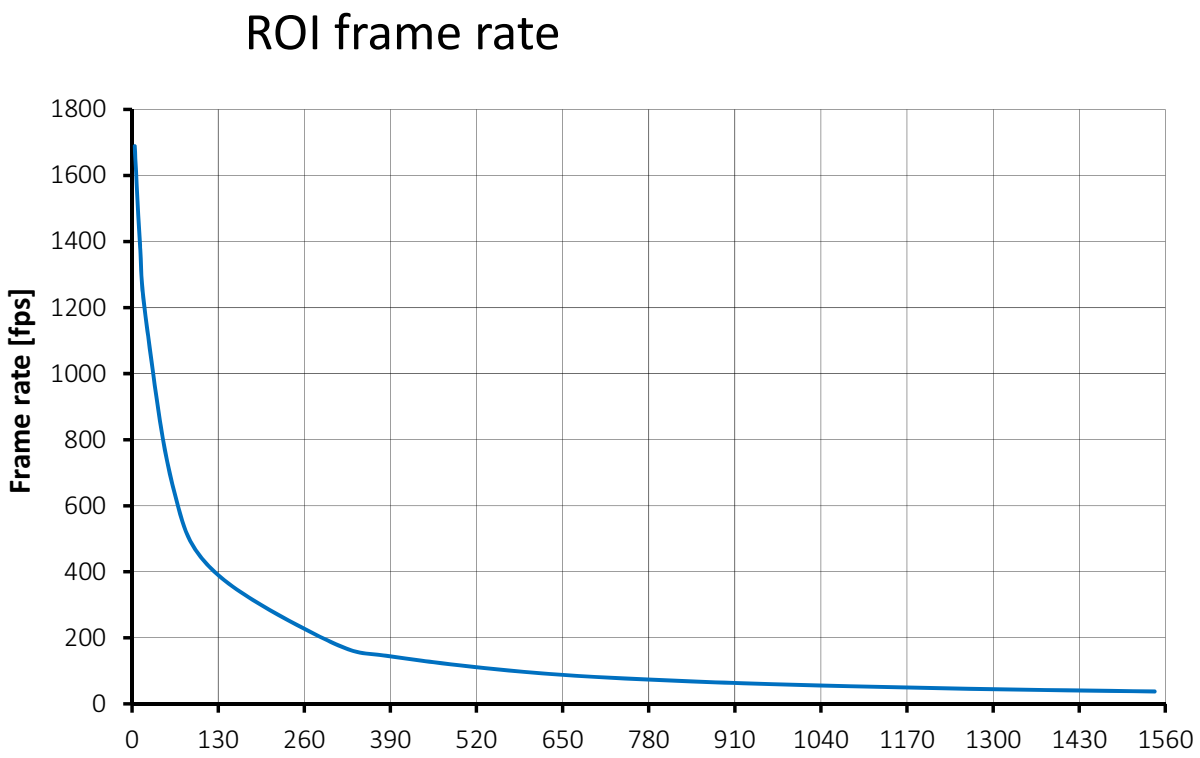


Figure 28: Mako G-319 frame rate as a function of ROI height

Height (pixels)	Frame rate	Height (pixels)	Frame rate
1544	37.6	300	187.7
1280	45.2	120	408.5
1024	56.5	60	672
800	71.9	20	1179.2
600	95.4	12	1388.9
400	141.4	4	1689.2

Width = 2064 pixels

Table 27: Mako G-319 frame rate as a function of ROI height

There is 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) × 2048 (V) 4.2 MP	
Sensor	CMOSIS/ams CMV4000	
Sensor type	CMOS	
Shutter type	Global	
Sensor format	Type 1	
Sensor size	16.0 mm diagonal	
Pixel size	5.5 µm × 5.5 µm	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	26.3 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 15 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerGB8, BayerGB12, BayerGB12Packed
Exposure time control[1]	41 µs to 153 s; 1 µs increments	
Gain control	0 to 26 dB; 1 dB increments	
Power consumption	2.3 W at 12 VDC; 2.7 W PoE	
Trigger latency	T.B.D.	
Trigger jitter	T.B.D.	

[1] Camera firmware version ≤ 01.52.8151 shows minimum exposure values without frame overhead time; 1 µs. See sensor data sheet for details on frame overhead time.

Table 28: Mako G-419B, G-419B NIR, G-419C model specifications

Absolute QE

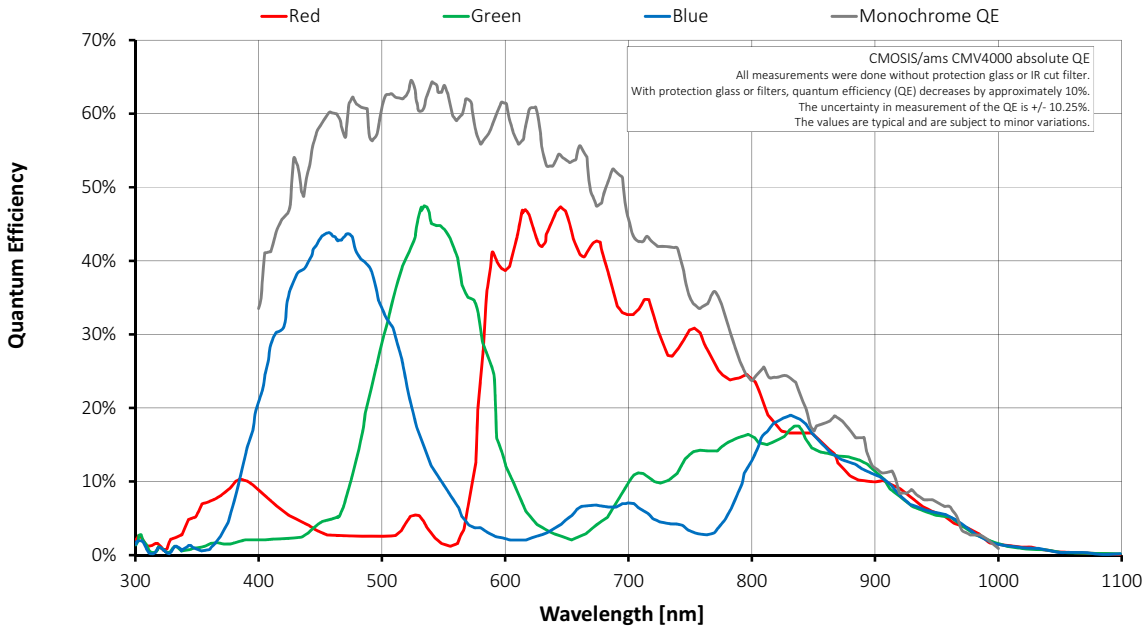


Figure 29: Mako G-419B, G-419C (CMOSIS/ams CMV4000) absolute QE

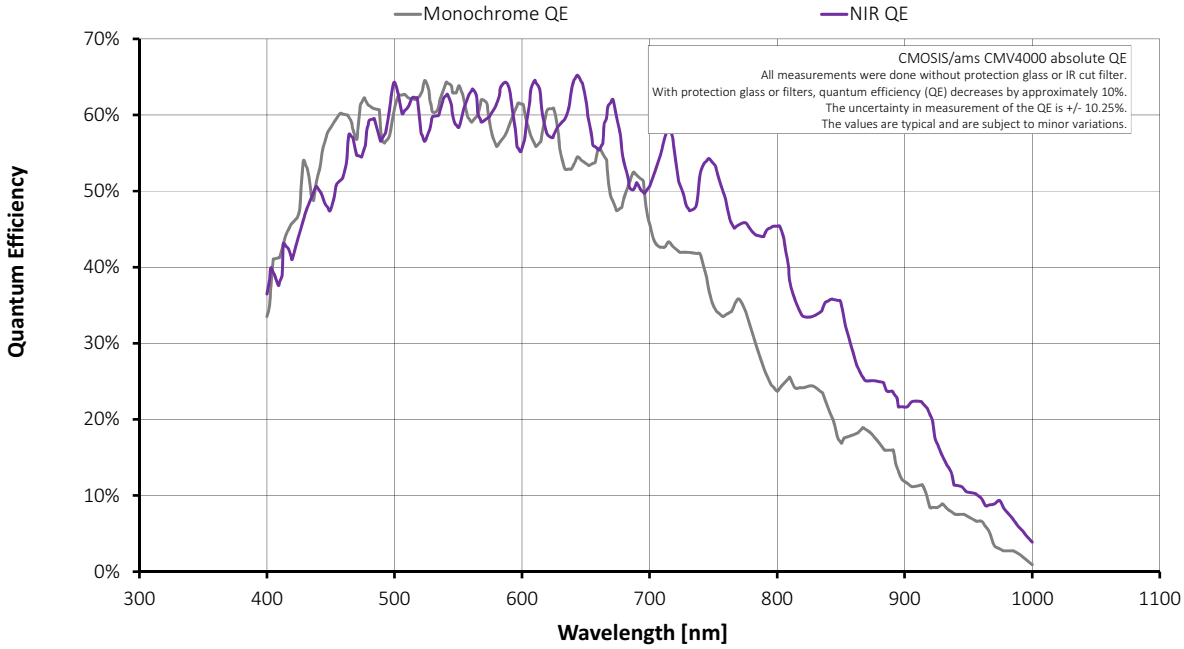


Figure 30: Mako G-419B, G-419B NIR (CMOSIS/ams CMV4000) absolute QE

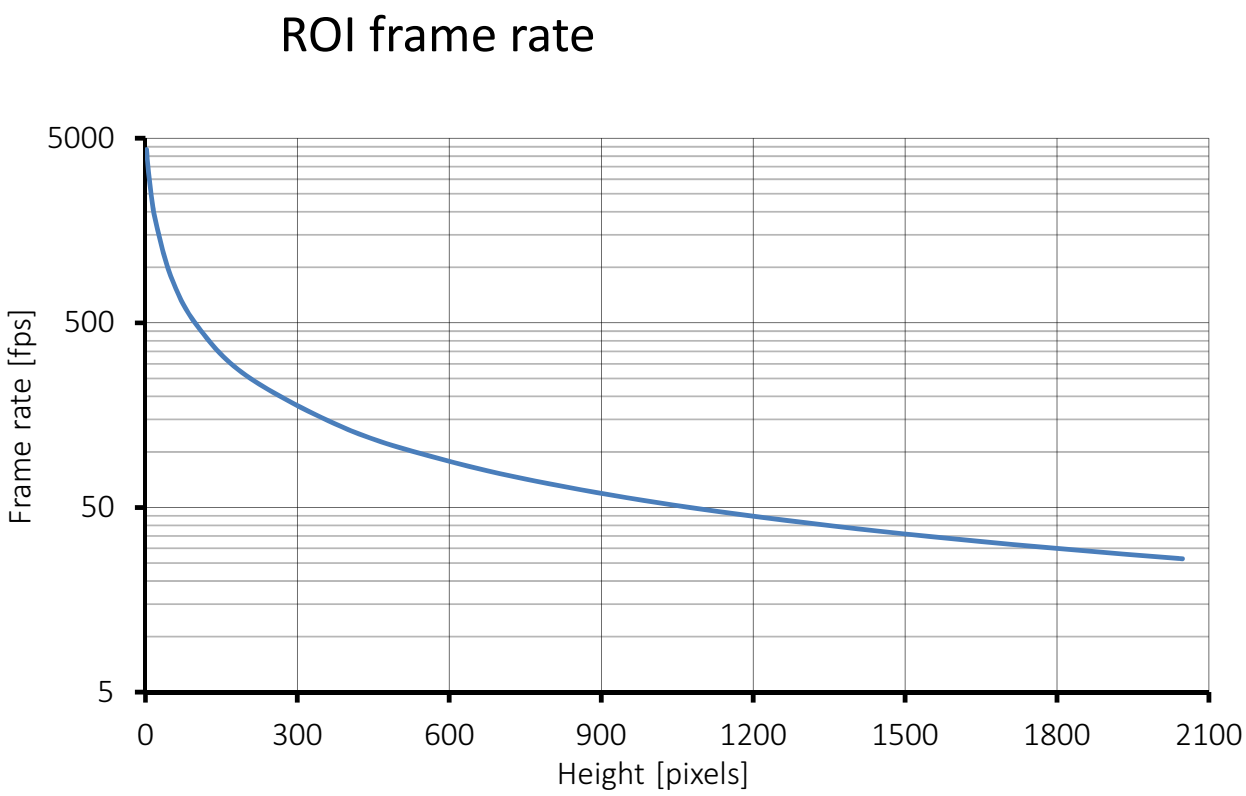


Figure 31: Mako G-419 frame rate as a function of ROI height

Height (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 (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 29: Mako G-419 frame rate as a function of ROI height

There is 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) × 1944 (V) 5 MP	
Sensor	ON Semi MT9P031	ON Semi MT9P006
Sensor type	CMOS	
Shutter type	Global Reset, Rolling	
Sensor format	Type 1/2.5	
Sensor size	7.13 mm diagonal	
Pixel size	2.2 µm × 2.2 µm	
Chief Ray Angle[1]	7°	7°, 27°
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	14 fps	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 13 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12, Mono12Packed	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerGR8, BayerGR12Packed, BayerGR12
Exposure time control[2]	31 µs to 1 s; 36.4 µs increments	
Gain control	0 to 24 dB; 1 dB increments	
Binning[3]	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4 factor	
Power consumption	2.0 W at 12 VDC; 2.2 W PoE	
Trigger latency[4]	Idle state: 73.4 µs; Frame valid state: 73.4 µs	

Table 30: Mako G-503B, G-503C model specifications

Feature	Specification	
	Mako G-503B	Mako G-503C
Trigger jitter[4]	Idle state: ±18.4 µs; Frame valid state: ±18.4 µs	

[1] For more information on Chief Ray Angle, contact Allied Vision support.

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

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

[4] 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 30: Mako G-503B, G-503C model specifications (continued)

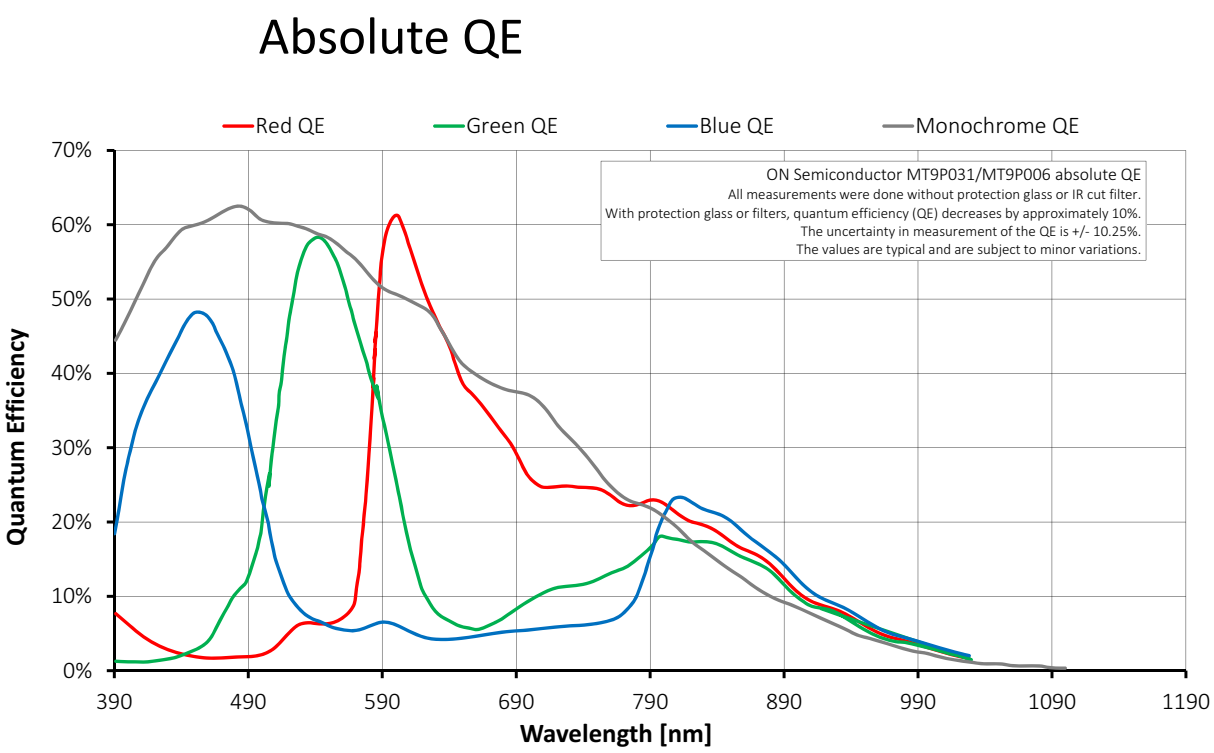


Figure 32: Mako G-503B, G-503C (ON Semi MT9P031/MT9P006) absolute QE

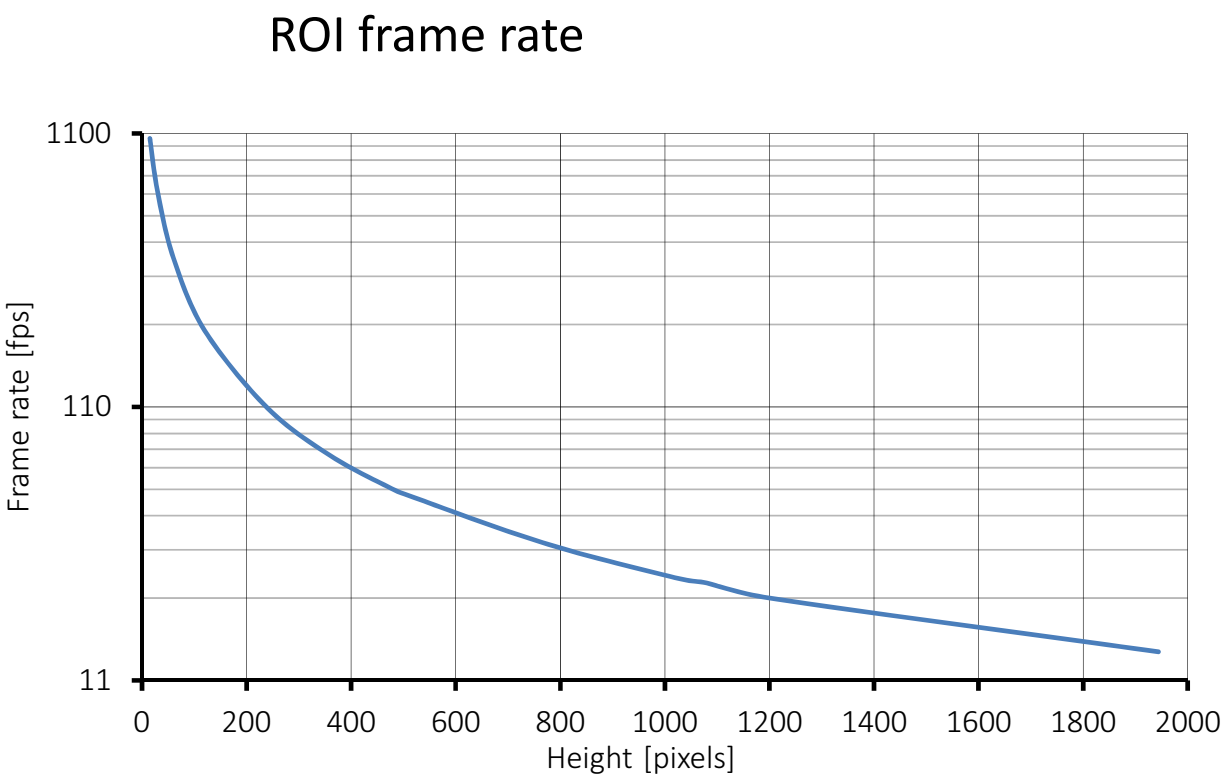


Figure 33: Mako G-503 frame rate as a function of ROI height

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

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

Width = 2592 pixels

Table 31: Mako G-503 frame rate as a function of ROI height

There is 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) × 2056 (V) 5.1 MP	
Sensor	Sony IMX264LLR Exmor with Pregius® global shutter technology	Sony IMX264LQR Exmor with Pregius® global shutter technology
Type	CMOS	
Shutter type	Global	
Sensor format	Type 2/3	
Sensor size	11.1 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
Chief Ray Angle[1]	0.0°	
Optical filter	Default: No optical filter Optional: See the *Modular Concept*	Default: Hoya C-5000 IR cut filter Optional: See the *Modular Concept*
Maximum frame rate at full resolution	23.7 fps 25.3 fps (burst mode)	
Maximum image bit depth	12-bit	
Image buffer	64 MB	
StreamHoldCapacity	Up to 13 frames at full resolution	
Monochrome pixel formats	Mono8, Mono12Packed, Mono12	Mono8
YUV color pixel formats		YUV411Packed, YUV422Packed, YUV444Packed
RGB color pixel formats		RGB8Packed, BGR8Packed
RAW pixel formats		BayerRG8, BayerRG12, BayerRG12Packed
Exposure time control[2]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	32 µs to 85.9 s; 18.88 µs increments
	Mono12, BayerRG12, YUV422Packed	38 µs to 85.9 s; 25.12 µs increments
	RGB8Packed, BGR8Packed, YUV444Packed	51 µs to 85.9 s; 37.76 µs increments
Gain control	0 to 40 dB; 0.1 dB increments	

Table 32: Mako G-507B, G-507C model specifications

Feature	Specification	
	Mako G-507B	**Mako G-507C**
Binning	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Power consumption	2.4 W at 12 VDC; 2.8 W PoE	
Trigger latency[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	56.64 µs
	Mono12, BayerRG12, YUV422Packed	75.36 µs
	RGB8Packed, BGR8Packed, YUV444Packed	113.28 µs
Trigger jitter[3]	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	±9.44 µs
	Mono12, BayerRG12, YUV422Packed	±12.56 µs
	RGB8Packed, BGR8Packed, YUV444Packed	±18.88 µs
Time between exposures	**Pixel format**	**Value**
	Mono8, Mono12Packed, BayerRG8 BayerRG12Packed, YUV411Packed	270 µs
	Mono12, BayerRG12, YUV422Packed	363 µs
	RGB8Packed, BGR8Packed, YUV444Packed	554 µs

[1] For more information on Chief Ray Angle, contact Allied Vision support.

[2] Whenever pixel format is changed, exposure adjusts itself to the nearest multiple of the exposure increment.

[3] It is possible to start the exposure of the next frame while the 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 32: Mako G-507B, G-507C model specifications (continued)

Absolute QE

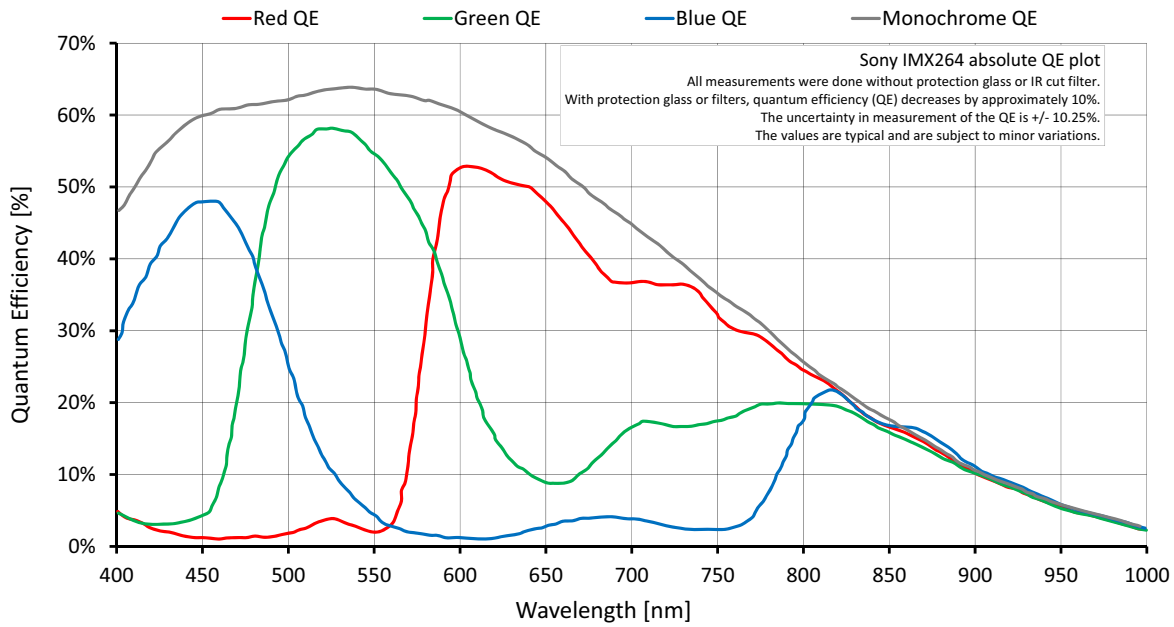


Figure 34: Mako G-507B, G-507C (Sony IMX264) absolute QE

Spectral response

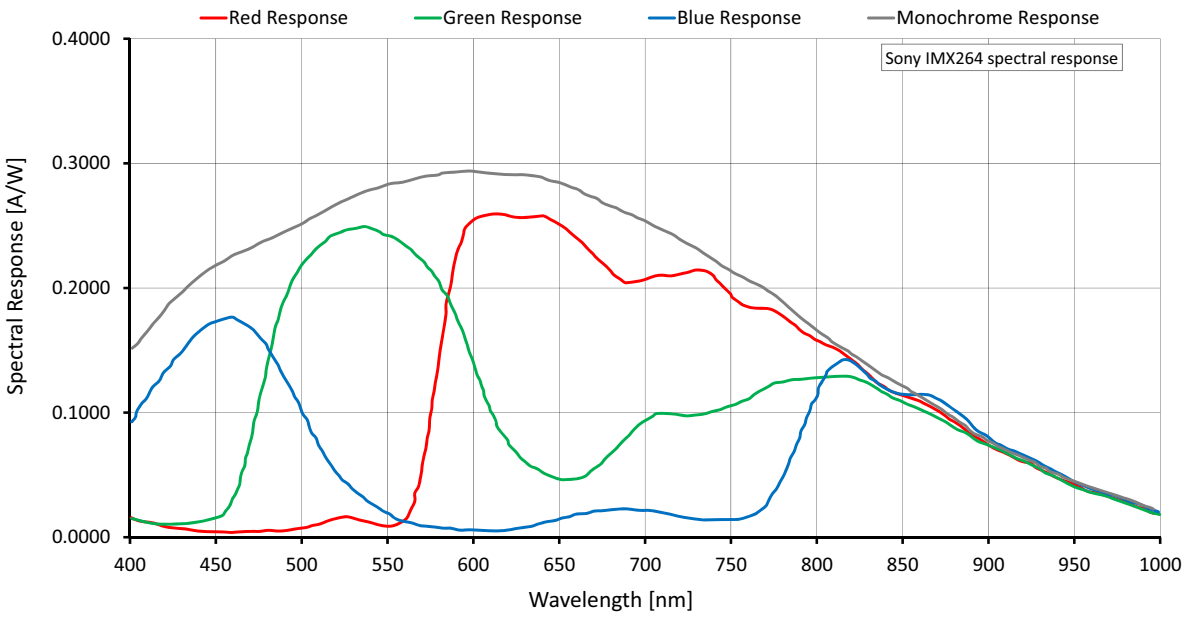


Figure 35: Mako G-507B, G-507C (Sony IMX264) spectral response

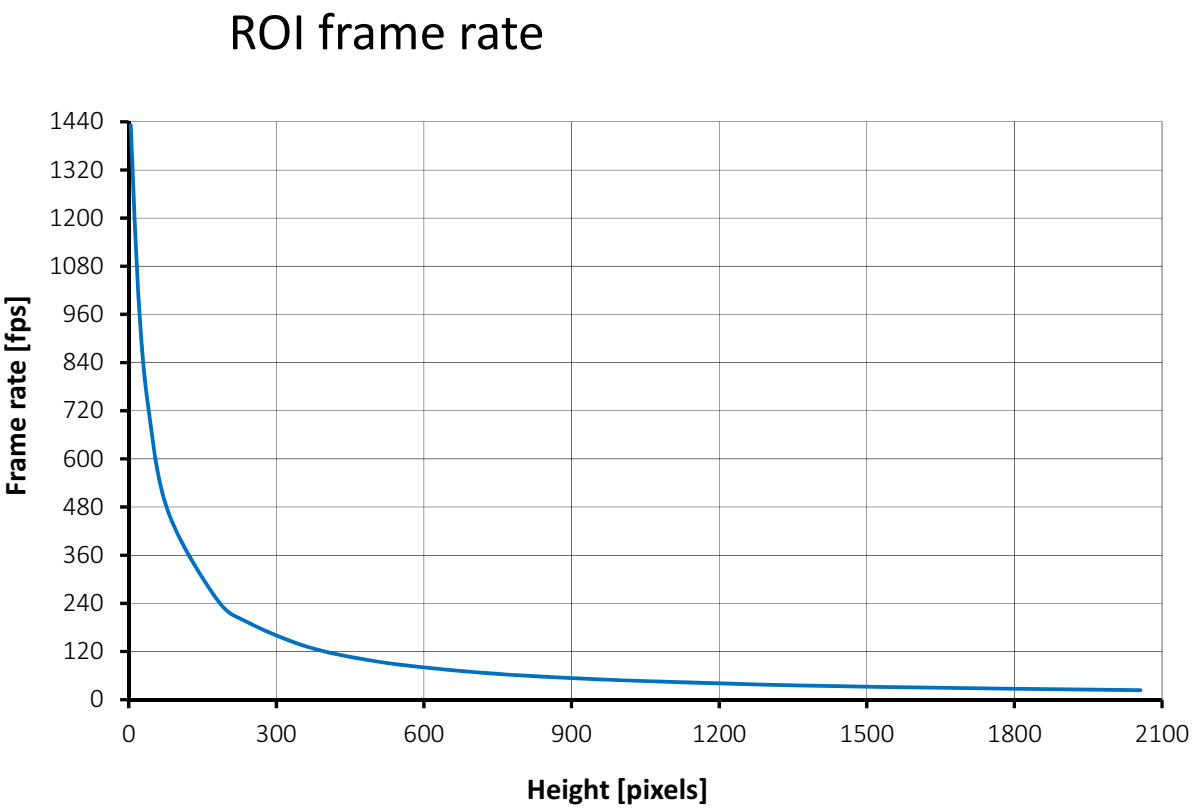


Figure 36: Mako G-507 frame rate as a function of ROI height

Height (pixels)	Frame rate
2056	23.7
1544	31.5
1324	36.8
1280	38.0
1024	47.4
960	50.6
768	62.9
600	80.6
480	100.3
360	133
240	194
180	248.7
80	468.7
40	725.5
20	999.3
4	1431.4

Width = 2464 pixels

Table 33: Mako G-507 frame rate as a function of ROI height

There is 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

Mako G cameras support a number of standard and extended features. The following table 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, refer to the *GigE Release Notes* for more information.

		Mako G-030	Mako G-032	Mako G-040	Mako G-125	Mako G-131	Mako G-158	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	✓		✓		✓	✓	✓		✓	✓		✓	✓
	Pixel defect masking	✓				✓		✓	✓			✓	✓	
	Gamma correction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hue, saturation, color transformation[1]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	One look-up table (LUT)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Region of interest (ROI)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Piecewise linear HDR mode	✓							✓			✓		
	Reverse X/Y	✓		✓		✓	✓	✓		✓	✓		✓	✓
	Sensor shutter mode[3]	2	2	2	2	1	2	1	2	2	2	2	3	2

Table 34: Feature comparison by model

		Mako G-030	Mako G-032	Mako G-040	Mako G-125	Mako G-131	Mako G-158	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 34: Feature comparison by model (continued)

Mechanical dimensions

Mako G standard housing

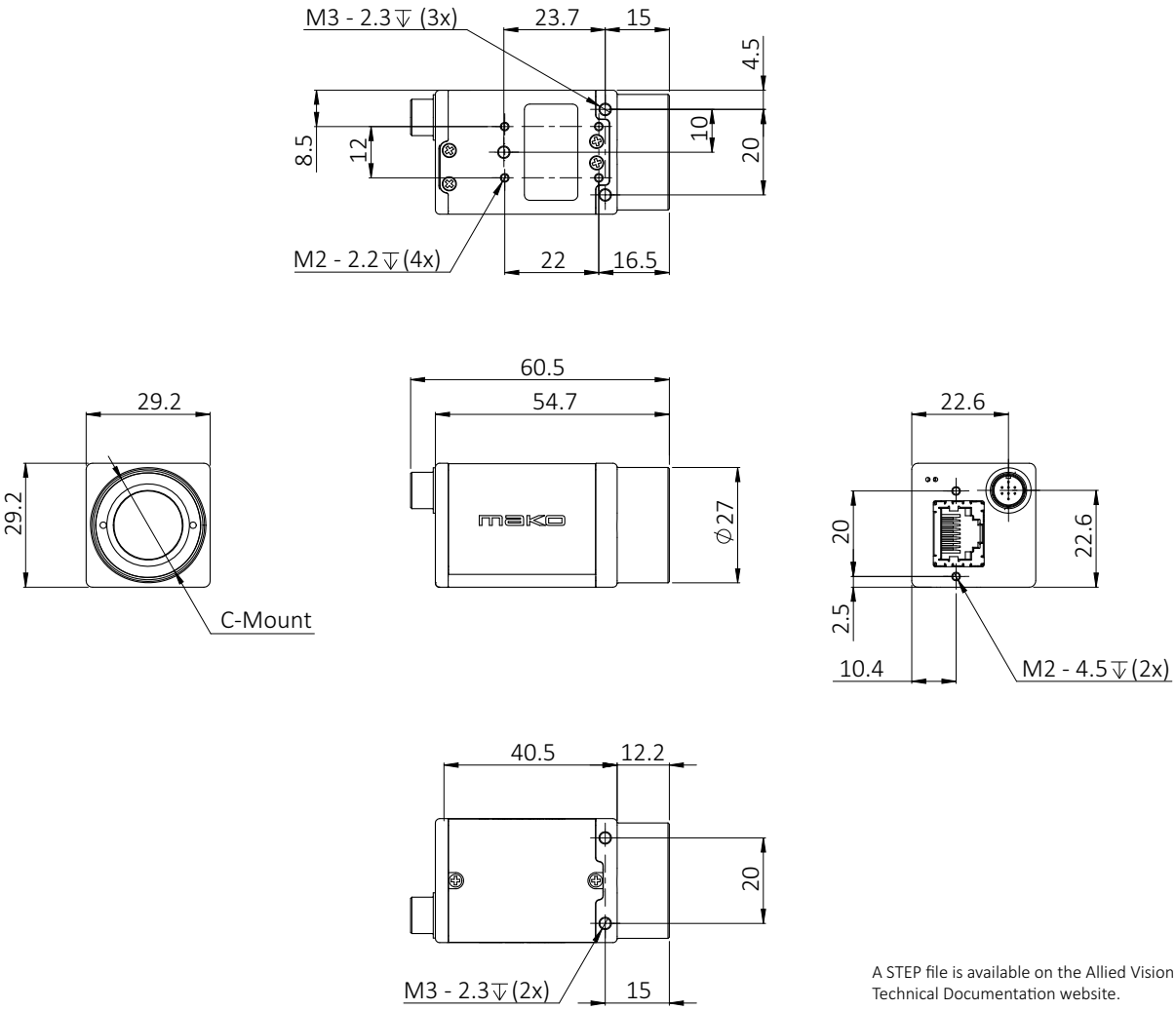


Figure 37: Mako G standard housing dimensions (including connectors)

STEP file available online

The STEP files for the Mako G with C-Mount and CS-Mount are 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.

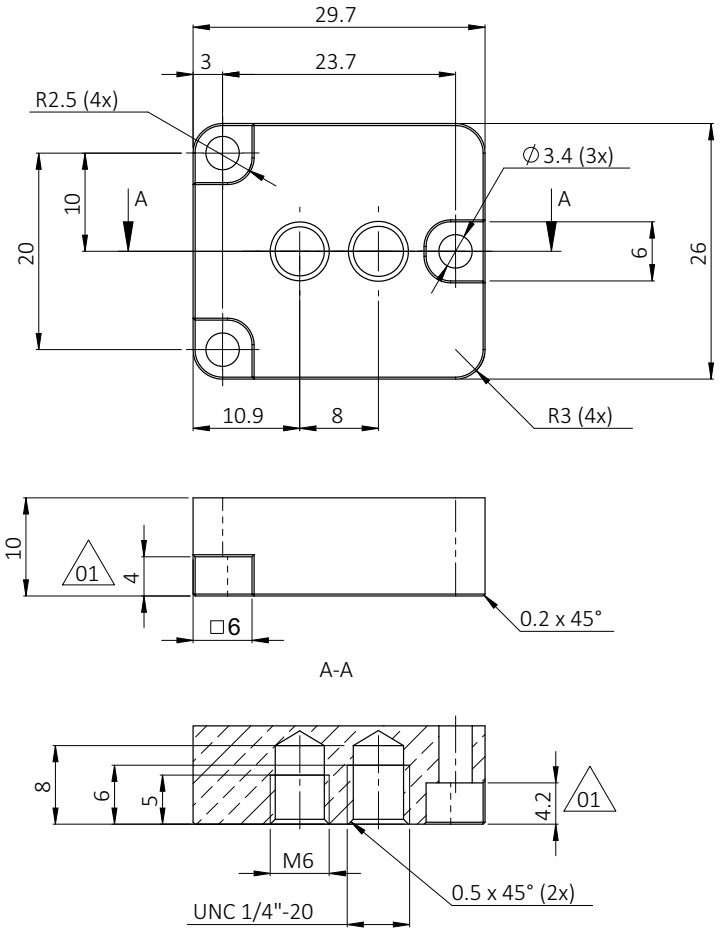


Figure 38: Tripod adapter dimensions (in mm)

NOTICE

Avoid damage to the camera by using inappropriate accessories

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

Sensor position accuracy

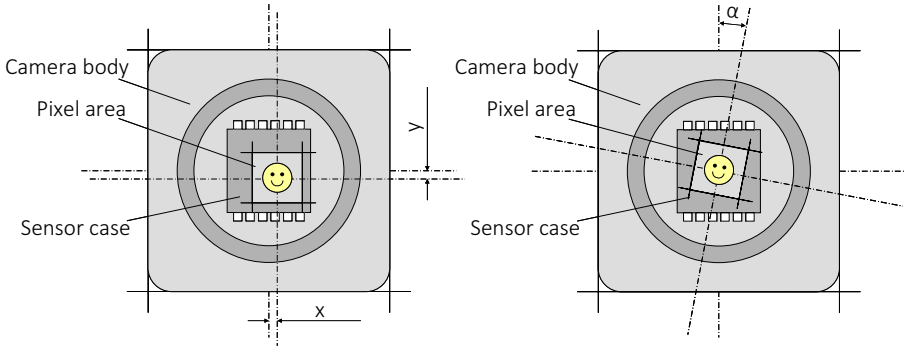


Figure 39: Sensor position accuracy

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-axis y-axis	±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 35: 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 and NIR Mako G cameras are not equipped with any optical filter.

Optical filter options

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

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

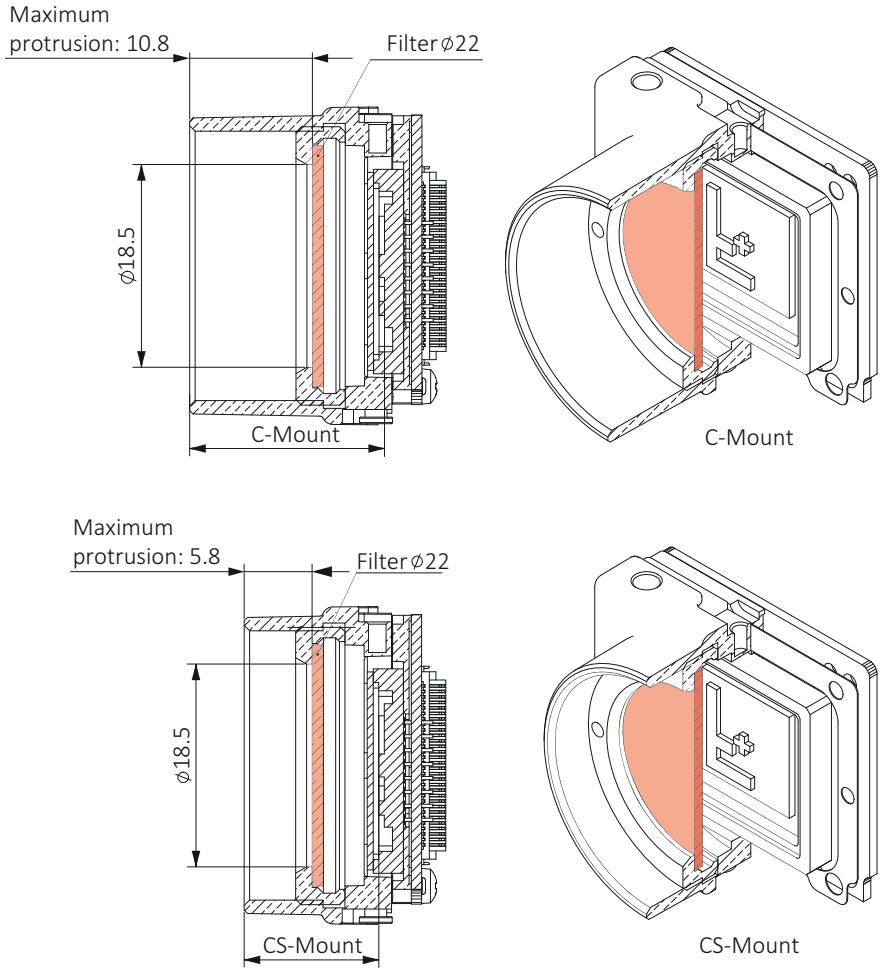


Figure 40: C-Mount and CS-Mount dimensions for Mako G models

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.

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

If you need any mount related adjustments, contact Allied Vision.

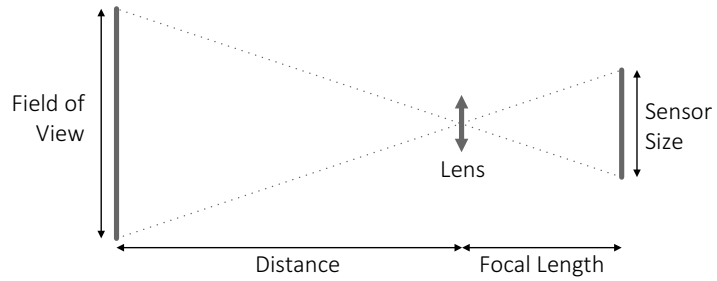
Filter and lenses

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 × height) depending on sensor size, distance and focal length of the lens.



Accessories

For information on available accessories for your camera, see the **Accessories** webpage at: https://www.alliedvision.com/en/products/accessories.html.

Contact your Allied Vision Sales representative or your Allied Vision distribution partner to order accessories:

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

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

Table 36: Mako G-030B, G-030C focal length versus field of view

Mako G-032B, G-032C

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

Table 37: Mako G-032B, G-032C focal length versus field of view

Mako G-040B, G-040C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
2.8 mm	888 × 666 mm	1781 × 1336 mm
4 mm	620 × 465 mm	1245 × 934 mm
4.2 mm	590 × 443 mm	1185 × 889 mm
4.8 mm	516 × 387 mm	1037 × 778 mm
6 mm	412 × 309 mm	828 × 621 mm
6.5 mm	380 × 285 mm	764 × 573 mm
8 mm	308 × 231 mm	620 × 465 mm
12 mm	203 × 153 mm	412 × 309 mm
16 mm	151 × 113 mm	308 × 231 mm
25 mm	95 × 71 mm	195 × 146 mm

Table 38: Mako G-040B, G-040C focal length versus field of view

Mako G-131B, G-131C

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

Table 39: Mako G-131B, G-131C focal length versus field of view

Mako G-158B, G-158C

Focal length	Field of view	
	Distance = 500 mm	Distance = 1000 mm
2.8 mm	888 × 666 mm	1781 × 1336 mm
4 mm	620 × 465 mm	1245 × 934 mm
4.2 mm	590 × 443 mm	1185 × 889 mm
4.8 mm	516 × 387 mm	1037 × 778 mm
6 mm	412 × 309 mm	828 × 621 mm
6.5 mm	380 × 285 mm	764 × 573 mm
8 mm	308 × 231 mm	620 × 465 mm
12 mm	203 × 153 mm	412 × 309 mm
16 mm	151 × 113 mm	308 × 231 mm
25 mm	95 × 71 mm	195 × 146 mm

Table 40: Mako G-158B, G-158C focal length versus field of view

Mako G-192B, G-192C

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

Table 41: Mako G-192B, G-192C focal length versus 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 × 617 mm	2335 × 1240 mm
6 mm	927 × 492 mm	1865 × 991 mm
6.5 mm	855 × 454 mm	1721 × 914 mm
8 mm	692 × 368 mm	1396 × 742 mm
10 mm	552 × 293 mm	1114 × 597 mm
12 mm	458 × 243 mm	927 × 492 mm
16 mm	341 × 181 mm	692 × 369 mm
25 mm	214 × 114 mm	439 × 223 mm
35 mm	150 × 79 mm	310 × 165 mm
50 mm	101 × 54 mm	214 × 114 mm
75 mm	64 × 34 mm	139 × 74 mm
90 mm	51 × 27 mm	114 × 60 mm

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

Table 42: Mako G-223B, G-223B NIR, G-223C focal length versus field of view

Mako G-234B, G-234C

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

Table 43: Mako G-234B, G-234C focal length versus field of view

Mako G-319B, G-319C

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

Table 44: Mako G-319B, G-319C focal length versus field of view

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

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

Table 45: Mako G-419B, G-419B NIR, G-419C focal length versus field of view

Mako G-503B, G-503C

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

Figure 41: Mako G-503B, G-503C focal length versus field of view

Mako G-507B, G-507C

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

Figure 42: Mako G-507B, G-507C focal length versus field of view

IR cut filter

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

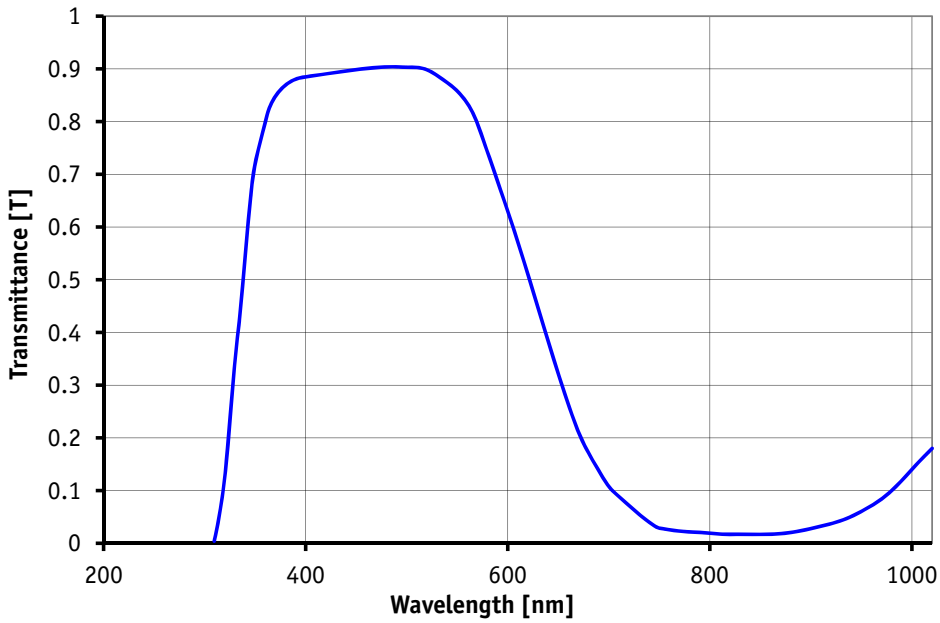
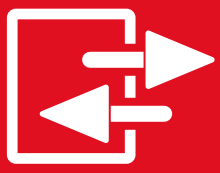


Figure 43: Approximate spectral transmission of IR cut filter type Hoya C-5000 (may vary slightly by filter lot)

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

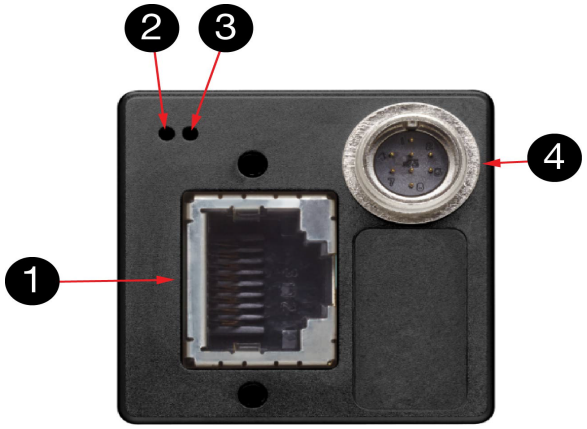


Figure 44: Rear view of Mako G camera

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

Status LEDs

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

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

Table 46: 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 47: Status LED 2

Gigabit Ethernet port

The Gigabit Ethernet port 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 meters 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 port (via PoE) are used for power, the camera only uses the power from the Hirose I/O port.

Accessories

For information on available accessories for your camera, see the **Accessories** webpage at: https://www.alliedvision.com/en/products/accessories.html.

Contact Allied Vision Sales representative or your Allied Vision distribution partner to order accessories:

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

Camera I/O connector pin assignment

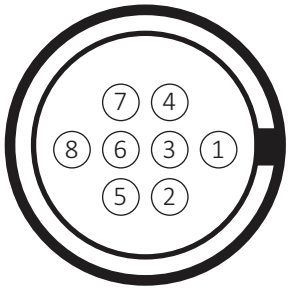
The general purpose I/O port uses a Hirose HR25-7TR-8PA(73) connector on the camera side. The mating cable connector is Hirose HR25-7TP-8S.

Safety-related instructions to avoid malfunctions

Read all *Notes and Cautions* in the *Hardware and Installation* chapter 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					I/O 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 48: Camera I/O connector pin assignment and I/O 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

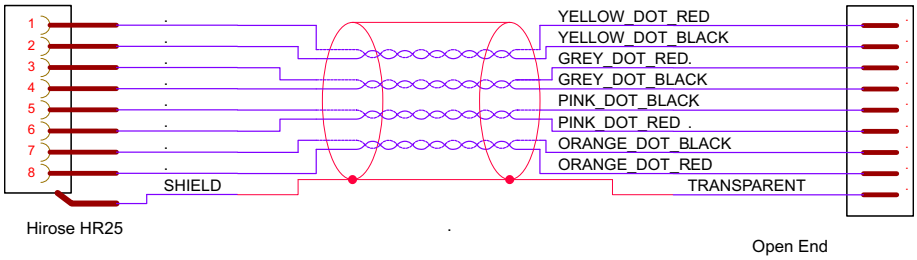


Figure 45: Mako G cable color coding

Input block diagram

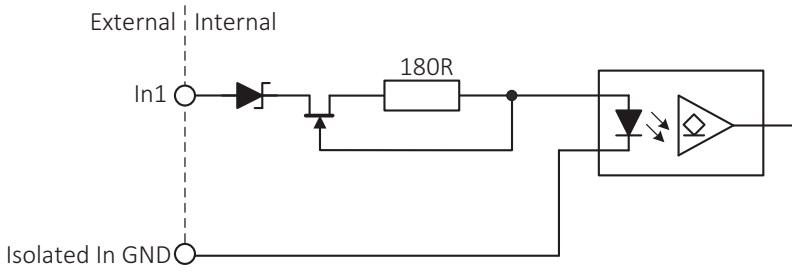


Figure 46: Input block diagram

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 49: Input parameters

Minimum pulse width

The minimum pulse width for all Mako G cameras is:

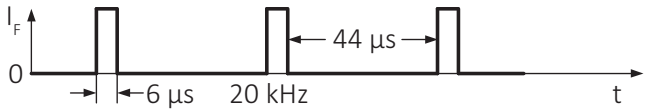


Figure 47: Minimum pulse width

Test conditions

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

Output block diagram

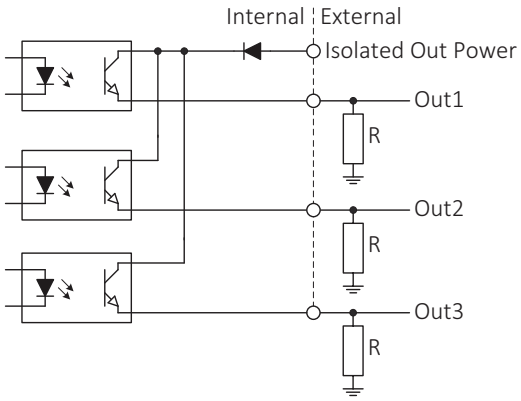


Figure 48: Output block diagram

NOTICE

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, that is, high impedance

Table 50: Isolated Out Power and external resistor

Output switching times

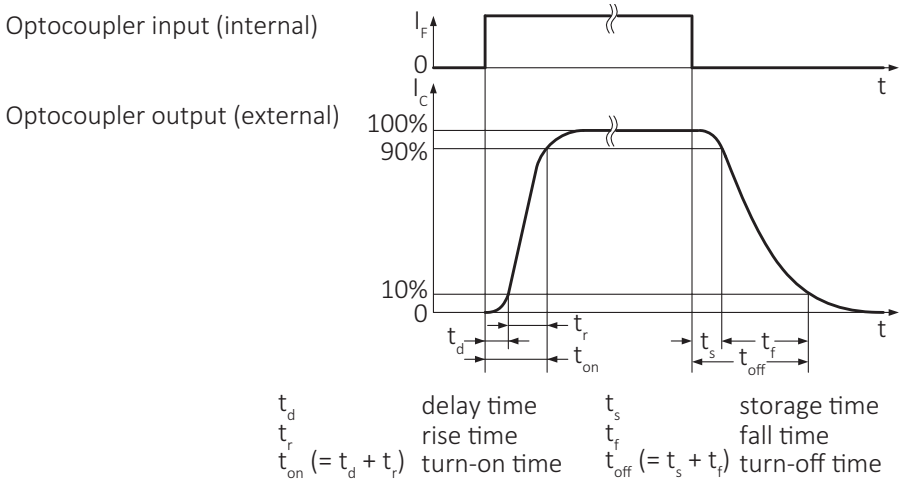


Figure 49: Output switching times

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 51: Parameters

Test conditions

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

- Higher external values increase the times.
- 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 in this section. All input and output signals that pass the I/O connector are controlled by the I/O strobe commands.

Input block diagram

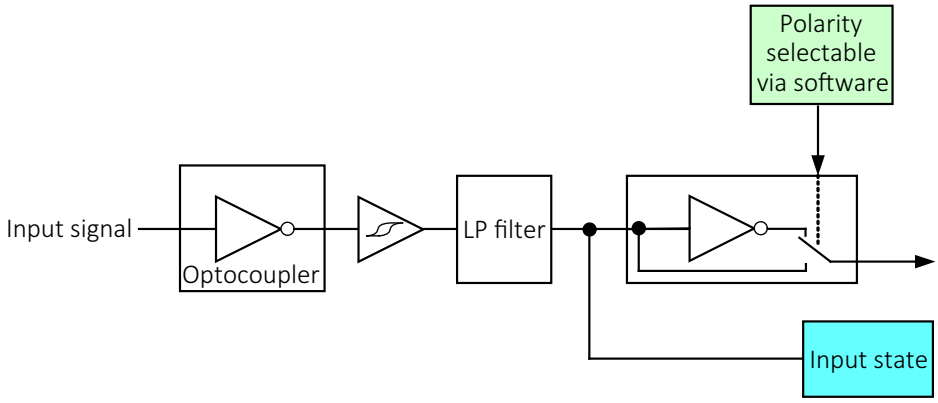


Figure 50: Input block diagram

Output signals

Output signals are configured by software. Any signal can be placed on any output. The main output signals are described in the following table.

Signal	Description
GPO	Configured to be a general purpose output, control is assigned to `SyncOutGpoLevels`.
AcquisitionTriggerReady	Active after the camera has been recognized by the host computer and is ready to start acquisition.

Table 52: Output signals

Signal	Description
FrameTriggerReady	Active when the camera is in a state that accepts 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, that is, the transferring of image data from the sensor 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 52: Output signals (continued)

Output block diagram

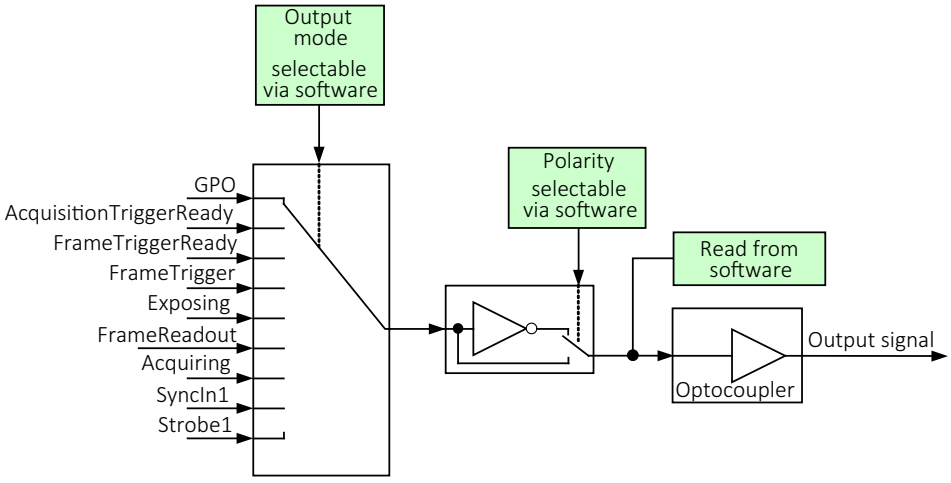


Figure 51: Output block diagram

Trigger timing diagram

The following diagram explains the general trigger concept.

Further information available online

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

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

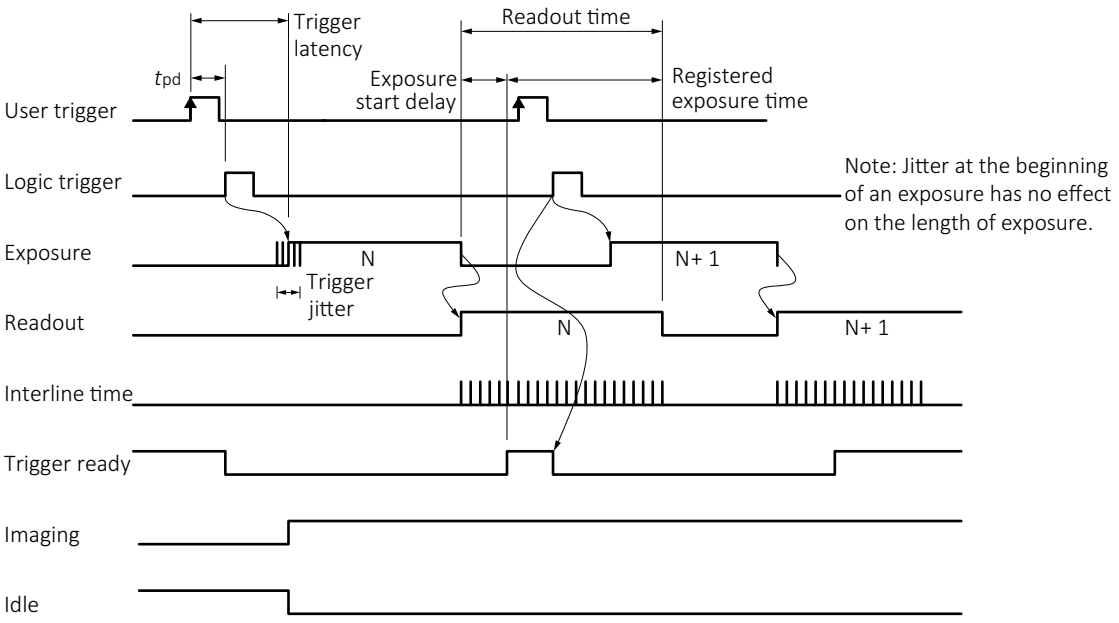


Figure 52: Trigger timing diagram

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

Table 53: Trigger definitions

Term	Definition
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 53: Trigger definitions (continued)

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 always triggers 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

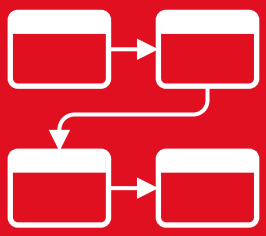
For applications requiring the fastest triggering cycle time whereby the camera image sensor is exposing and reading out simultaneously, the user trigger signal should be applied as soon as a valid trigger ready is detected.

In this case, trigger latency and trigger jitter can be up to one 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

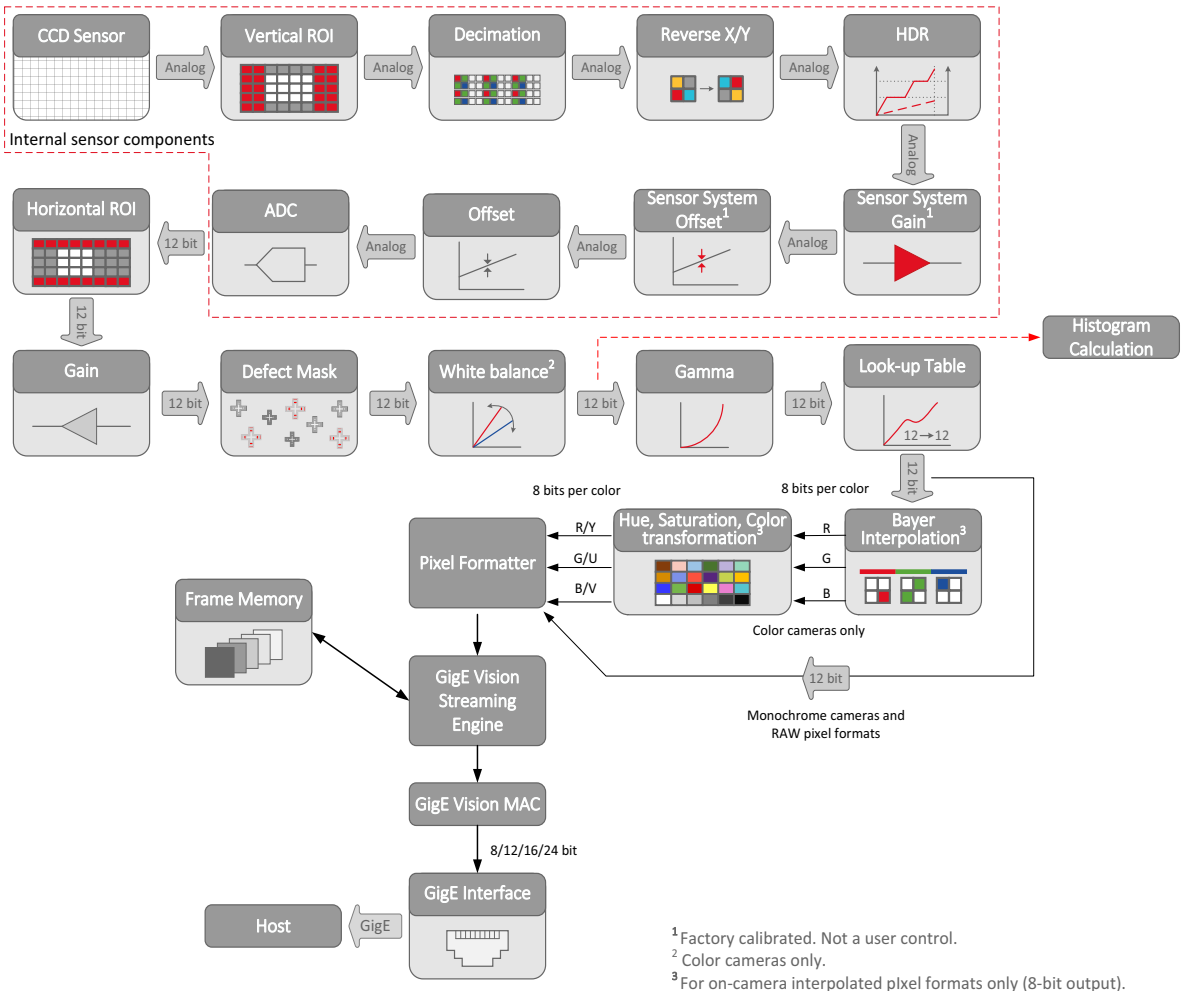
A complete listing of camera features, including feature definitions can be found online:

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

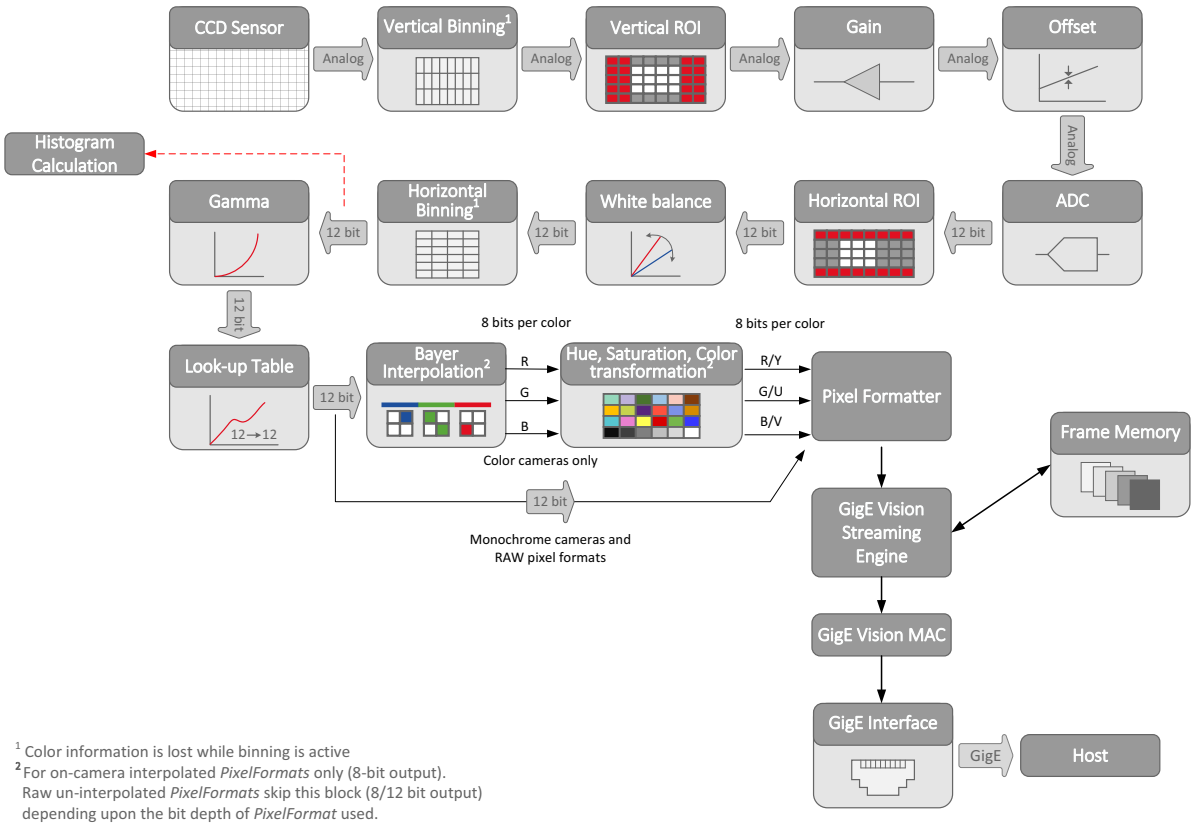
https://www.alliedvision.com/en/products/cameras.html

Mako G models with CCD sensors

Mako G-030

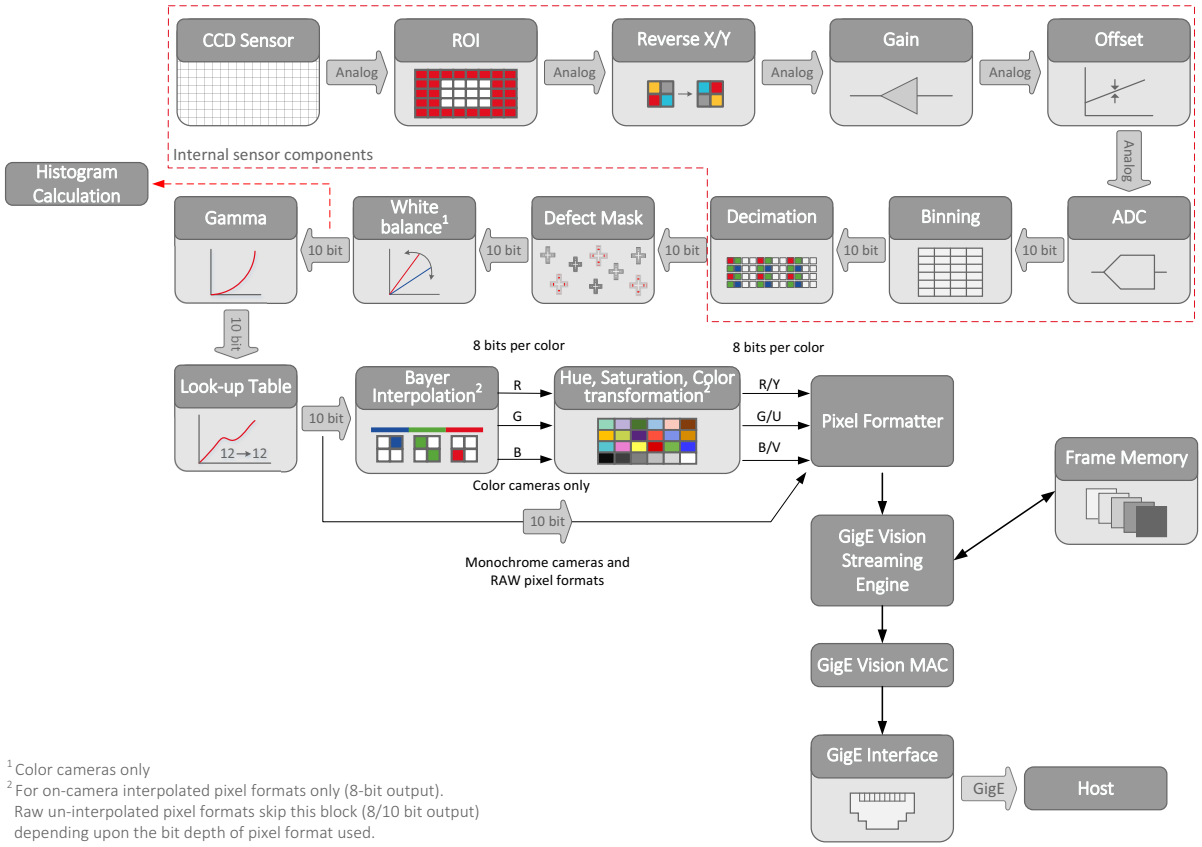


Mako G-032, G-125



[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.

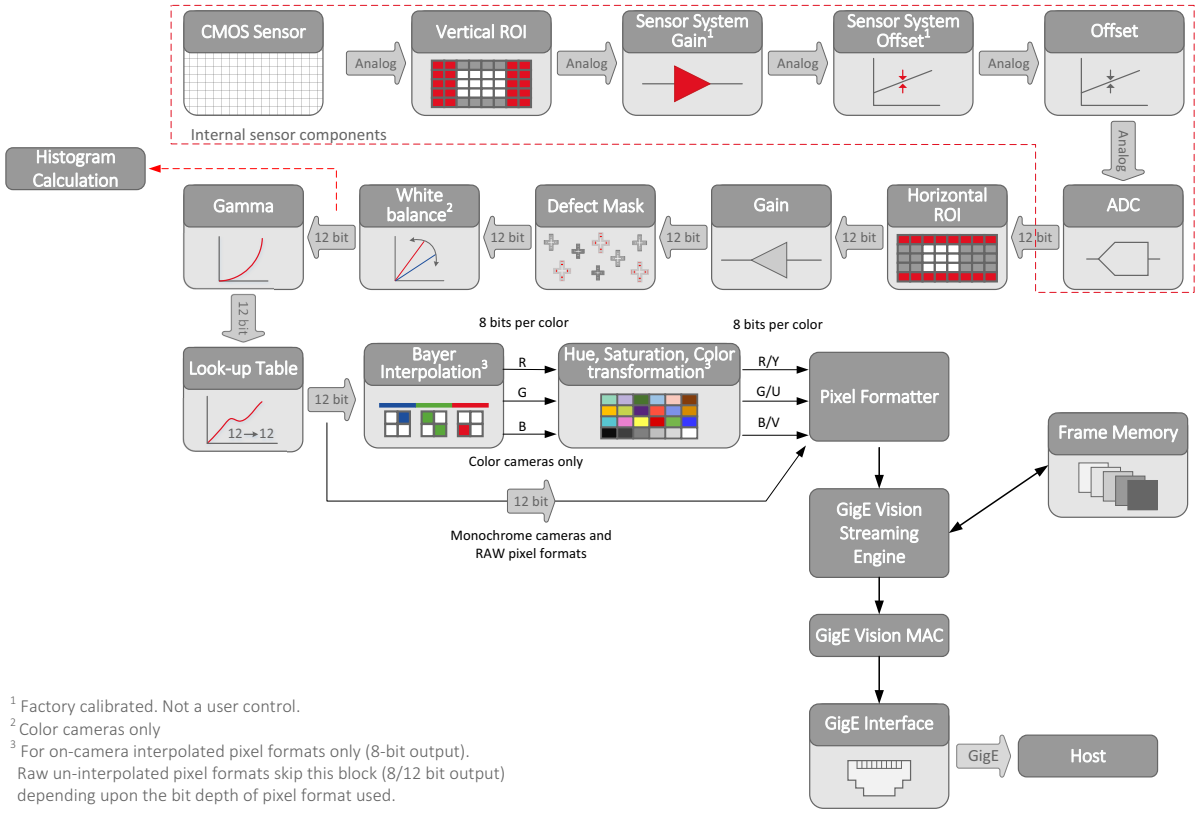
Mako G-131, G-192



[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.

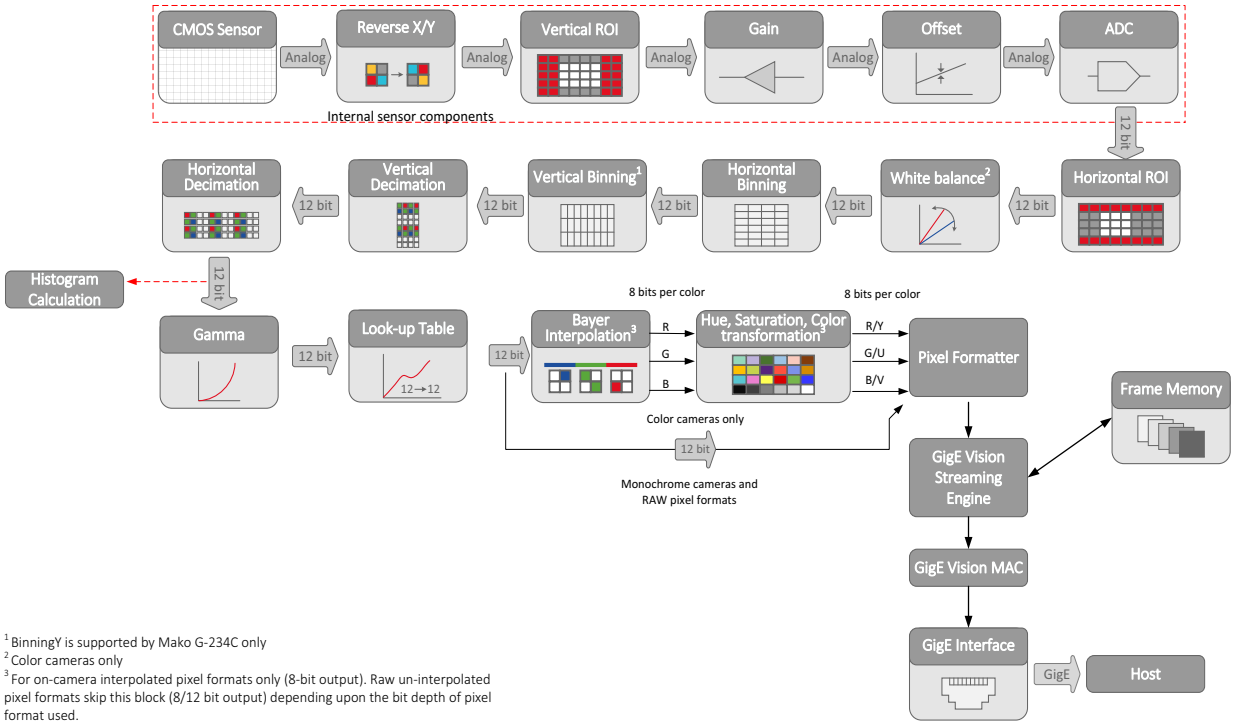
Mako G models with CMOS sensors

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.

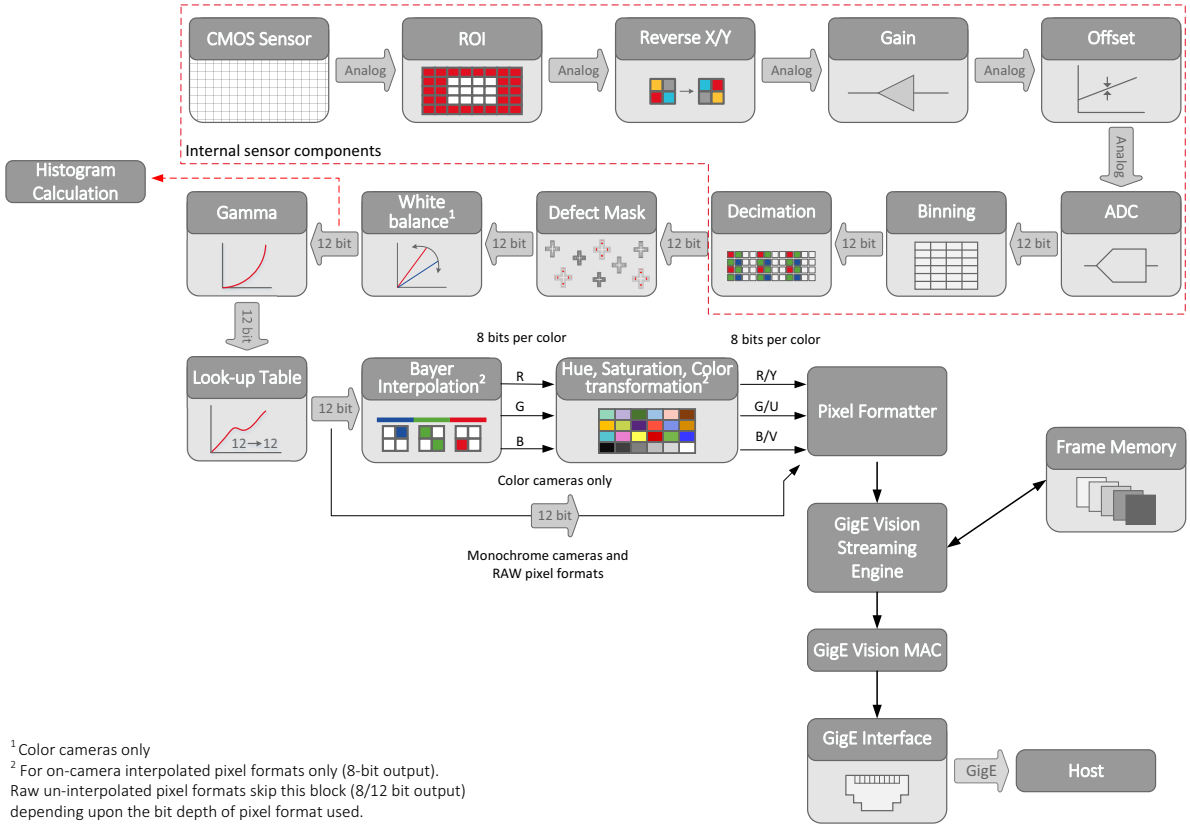
Mako G-040, G-158, G-234, G-319, G-507



[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 is 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

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

Contact Allied Vision or your Allied Vision distribution partner if you are not familiar with the procedures described in this chapter.

NOTICE

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

Ensuring your warranty remains in effect:

- Do not open the camera housing.
- Follow instructions described in this chapter.
- Use only optical quality tissue or 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.

Keeping optical components clean

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

When screwing or 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 53: 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 the following figure, 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.

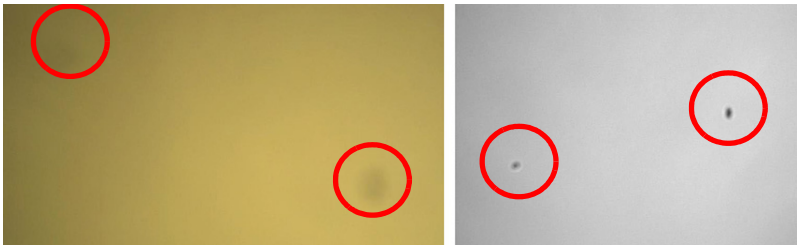


Figure 54: Image with tiny dust on the filter (left) and dust on the sensor (right)

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 (for example 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.

NOTICE

Removing optical filter

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

Removing IR cut filter

Standard Mako G-507C models with SN ≥ 536883430 and all other standard Mako G models with SN ≥ 536884750 are equipped with 22 mm diameter IR cut filter. Filters can be removed with the E9020001 filter removal tool.

For other Mako G cameras, see the following table.

Model	Serial number	Filter glass diameter	Removal tool	Pin distance
Mako G-507C	≥ 536883430	22 mm	E9020001	21 mm
	< 536883430	16 mm	E9020001	21 mm
	< 536883430	22 mm	3581	22 mm
Other models	≥ 536884750	22 mm	E9020001	21 mm
	< 536884750	16 mm	E9020001	21 mm
	< 536884750	22 mm	3581	22 mm

Table 54: Filter removal tools for Mako G cameras

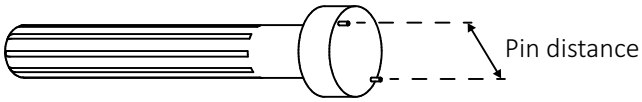


Figure 55: Pin distance for E9020001 filter removal tool

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.

NOTICE

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 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 previously described).

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, contact your Allied Vision distribution partner.

Cleaning with compressed air

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

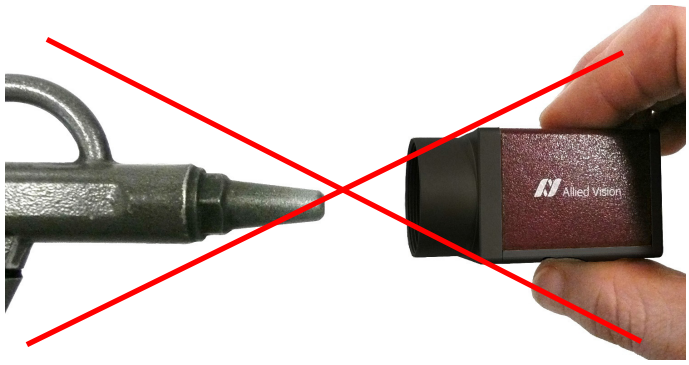


Figure 56: Do not use compressed air

NOTICE

Possible material damage

- Compressed air at high pressure and/or shorter operating distances may push dust into the camera or 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 or 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 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 are 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 computer.
- **GigE SampleViewer**: select the **Disk** icon from the **Cameras** window to export camera settings file (XML) to the host computer.

NOTICE

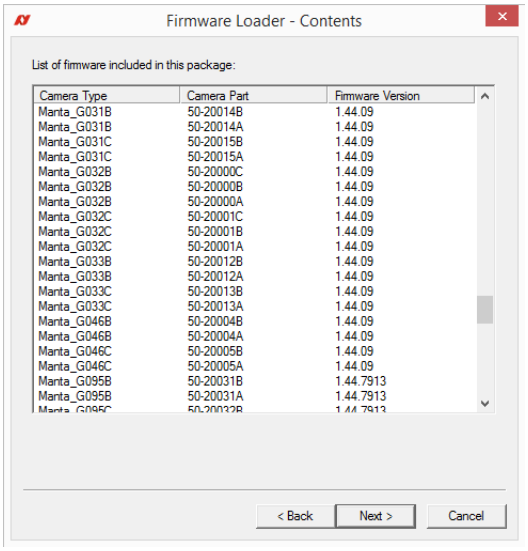
Material damage

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

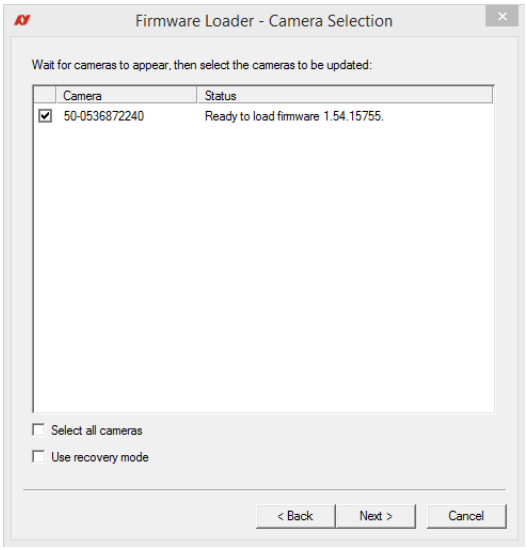
Updating the firmware on your Mako G camera

1. Launch the **Allied Vision Firmware Loader**.

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



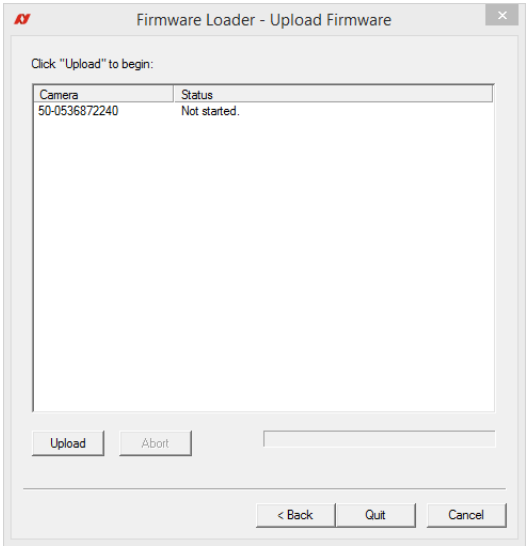
3. Click **Next**. You can select your camera model on this page.



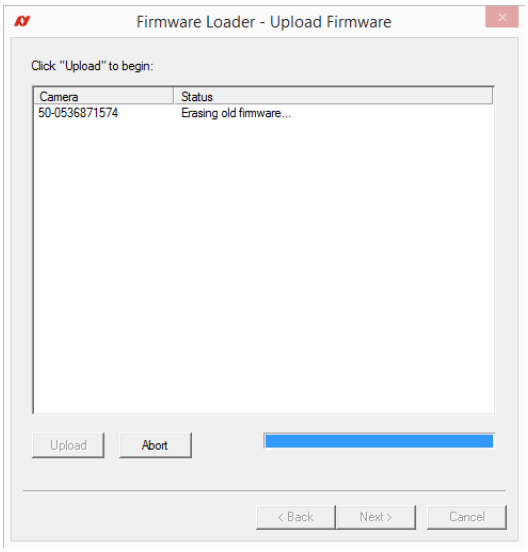
Recovery Mode

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.

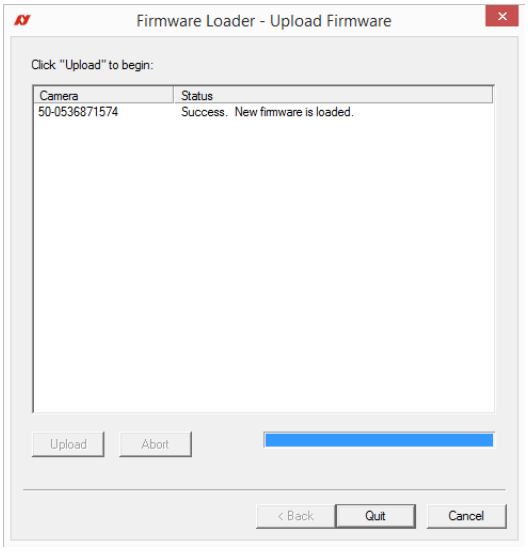
4. Click **Next**.



5. Click **Upload** to start the update. The existing firmware is erased and the new firmware is 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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