Allied Vision

GigE Vision Cameras

Mako G

Technical Manual

V4.0.0

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

2015-Nov-24

Mako G at a glance

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

Applied standards

GigE Vision®

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

GenICam™

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

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

What else do you need?

Content	Document name	Link
Hardware and software installation	GigE Installation Manual	*https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/installation-manual/GigE_Installation_Manual.pdf*
Camera feature description for software applications based on Vimba SDK	GigE Features Reference	*https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/features/GigE_Features_Reference.pdf*
Camera attribute description for software applications based on PvAPI SDK	GigE Camera and Driver Attributes	*https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/features/GigE_Camera_and_Driver_Attributes.pdf*
Modular options available for your Mako G camera	Modular Concept	*https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/modular-concept/Modular_concept_external.pdf*

Content	Document name	Link
Technical papers and knowledge base	n/a	*https://www.alliedvision.com/en/support/technical-papers-knowledge-base.html*
3D CAD files	n/a	*https://www.alliedvision.com/en/support/technical-documentation/mako-documentation.html*

Read this manual carefully

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

Software downloads

To download Vimba SDK, including Vimba Viewer for simple camera access, go to:
https://www.alliedvision.com/en/products/software.html

Firmware downloads

To download the latest firmware, go to:
https://www.alliedvision.com/en/support/firmware.html
Before updating the firmware, see *Firmware update* on page 91.

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 distributor

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

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Contents

Document history and conventions

This chapter includes:

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

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 Updated the specifications for G-223 and G-419
V2.0.2	2013-Sep-16	Updated the frame rate information for G-223 and G-419 in Specifications chapter Updated introduction to include link to Mako G literature 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-223B/NIR/C* and *Mako G-223B/NIR/C* Updated *Status LED 2* table Updated the note on StreamHoldCapacity in *Notes on specifications* and *Frame memory* sections Updated block diagrams in *Image data flow* chapter Updated the Index
V2.0.4	2014-Feb-28	Updated available color pixel formats for *Mako G-223B/NIR/C* and *Mako G-223B/NIR/C* Updated optional accessories in the *Notes on specifications* chapter Updated section *Cross section: C-Mount and CS-Mount* Added section Heat dissipation Updated the operating temperature specification for *Mako G-032B/C*, *Mako G-125B/C*, *Mako G-223B/NIR/C*, and *Mako G-223B/NIR/C* Updated block diagrams in *Image data flow* to remove the RS232 mention Added Hirose cable information
V2.1.0	2014-Oct-07	Updated and rearranged *Notes on specifications* chapter Added *Camera features comparison* Added trigger latency and jitter values for *Mako G-032B/C* and *Mako G-125B/C* Updated *Mako G standard housing* drawing Updated *G-503C* section Added camera lens information Updated *Image data flow* and *Mechanical dimensions* chapters

Table 1: *Document history*

Version	Date	Remarks
V3.0.0	2015-Jan-15	Updated Allied Vision logo Updated *Cleaning optical components* section Added G-030, G-131, and G-192 cameras Added *Mako G-030B/C*, *Mako G-131B/C*, and *Mako G-192B/C* specifications and spectral sensitivity plots Updated Mako G camera smart features table Added camera lens information Added *Mako G-030B/C ROI frame rate*, *Mako G-131B/C ROI frame rate*, and *Mako G-192B/C ROI frame rate* sections Updated *Image data flow* and *Mechanical dimensions* chapters
V3.1.0	2015-Mar-10	Added G-503 camera Added *Mako G-503B/C* specifications and spectral sensitivity plots Added camera lens information Added *Mako G-503B/C ROI frame rate* section Updated *Image data flow* and *Mechanical dimensions* chapters

Table 1: *Document history (Continued)*

Version	Date	Remarks
V3.2.0	2015-Mar-20	Replaced old links with new Allied Vision website links Changed file name from 'GigE Camera and Driver Features' to 'GigE Features Reference' Changed chapter name from 'Description of data path' to 'Camera data path'
V4.0.0	2015-Nov-24	Changed the technical manual layout Changed chapter name from 'Camera data path' to *Image data flow* Changed chapter name from 'Camera dimensions' to *Mechanical dimensions* Merged the 'Resolution and ROI frame rate' chapter of V3.2.0 into *Specifications* chapter Added *Mako G at a glance* section Added *General safety notes* section Added *Legislation* section in *Safety and legislation* chapter to replace 'Legal notice' and 'Conformity' 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 Added G-234B, G-234C camera information Removed all references to G-050 and G-095 Updated interfaces chapter

Table 1: *Document history (Continued)*

Manual conventions

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

Styles

Style	Function	Example
Bold	Programs, inputs or highlighting important things	**bold**
Courier	Code listings etc.	`Input`
Italics	Modes, fields	*Mode*
Blue italics	Links	*Link*

Symbols

Safety Note

Note to prevent physical injury.

Possible material damage

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

Damage to the camera by electrostatic discharge (ESD)

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

Safety-related instructions to avoid malfunctions

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

Practical hint

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

Further information available online

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

https://www.alliedvision.com

Safety and legislation

This chapter includes:

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

General safety notes

Avoid damage to the camera by ESD

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

Avoid damage to the camera due to high temperature

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

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

Avoid damage to the camera from high output current or voltage

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

Do not disassemble the camera housing

This camera contains sensitive internal components. Warranty is void if camera has been disassembled.

Camera housing temperature

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

Legislation

CE and RoHS

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

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

WEEE

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

FCC – Class B Device

For customers in the U.S.A.

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

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

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

For customers in Canada

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

Pour utilisateurs au Canada

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

Life support applications

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

Other legal notices

Trademarks

Unless stated otherwise, all trademarks appearing in this document of Allied Vision Technologies are brands protected by law.

Warranty

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

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Specifications

This chapter provides:

- Technical specifications
- Spectral sensitivity plots
- ROI height vs. Frame rate plots
- Comparison of feature availability in Mako G camera models

Notes on specifications

All measurements were done without protection glass / without filter. The uncertainty in measurement of the quantum efficiency values is ±10%.

This is due to:

- Manufacturing tolerance of the sensor.
- Uncertainties in the measuring apparatus itself (Ulbricht sphere, optometer, etc.).

Dimensions and mass

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

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

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 a FIFO image buffer. Specifications tables for each camera show how many frames can be stored by each model.

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

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

Resolution and ROI frame rate

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

Mako G-030B/C

Feature	Specification
Resolution	644 x 484
Sensor	G-030B: CMOSIS CMV300-3E7M1WP G-030C: CMOSIS CMV300-3E7C1WP
Type	Progressive Scan CMOS
Sensor size	Type 1/3
Cell size	7.4 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	309 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 99 frames at full resolution
Mono formats	Mono8, Mono12Packed, Mono12
Color formats	BayerRG8, BayerRG12Packed, BayerRG12, Mono8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed
Exposure control	83 µs to 2.0 s; 1 µs increments
Gain control	0 – 26 dB
Binning	N/A
Decimation	Horizontal and Vertical: 1, 2, 4 factor
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.1 W @ 12 VDC; 2.3 W PoE
Trigger latency[1]	Idle state: 3.1 µs; Frame valid state: 3.1 µs
Trigger jitter[1]	Idle state: 1.2 µs; Frame valid state: 3.1 µs
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10°C to +70 °C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

[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 2: *Mako G-030B/C camera specifications*

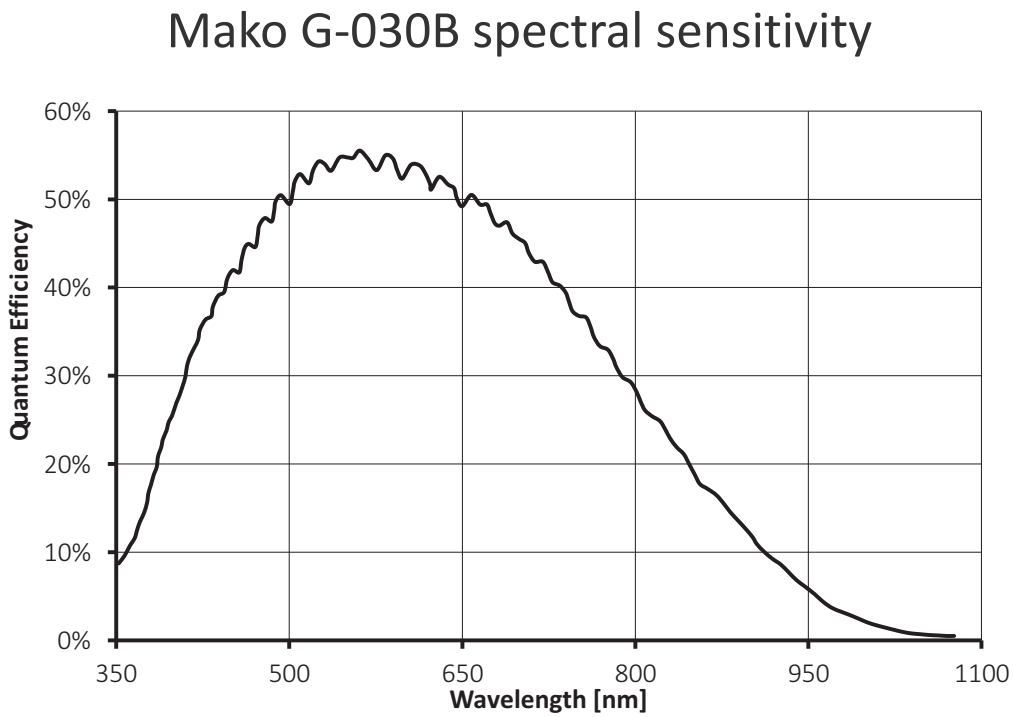


Figure 1: *Mako G-030B spectral sensitivity*

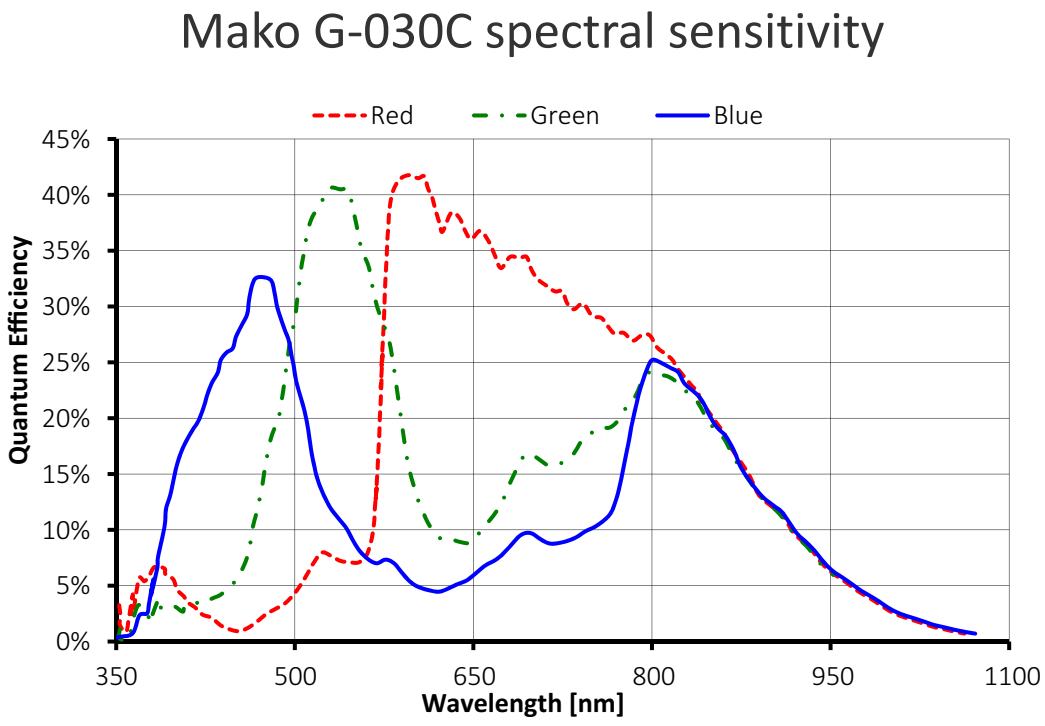


Figure 2: *Mako G-030C spectral sensitivity*

Mako G-030B/C 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

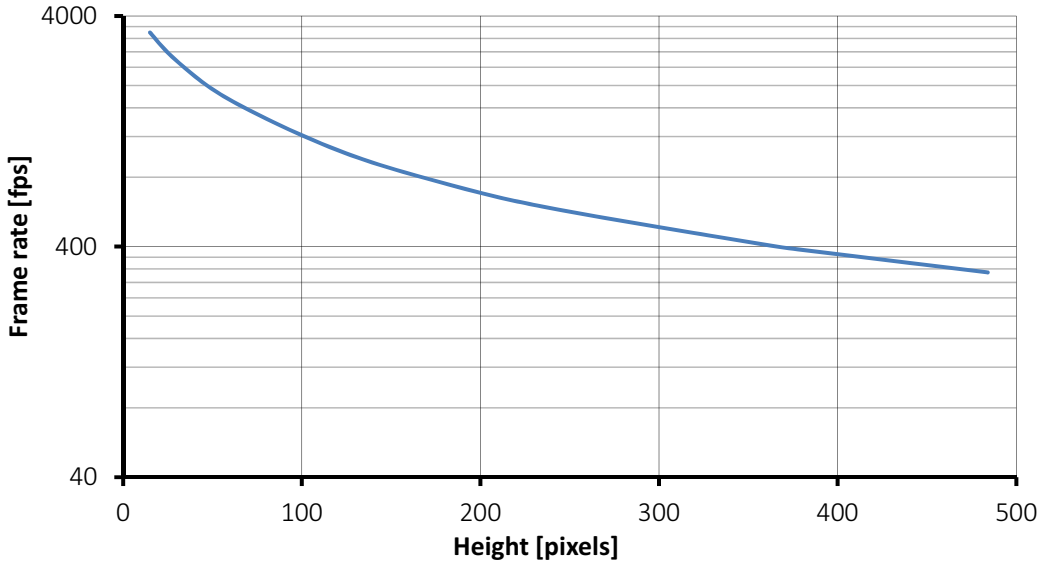


Figure 3: *Frame rate as a function of ROI height [width=644 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
484	644	309
480	644	312
384	644	384
360	644	407
240	644	586

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
180	644	752
120	644	1048
60	644	1727
30	644	2554
15	644	3393

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

Table 3: *Frame rate as a function of ROI height*

Mako G-032B/C

Feature	Specification
Resolution	658 x 492
Sensor	Sony ICX424AL/AQ with HAD technology
Type	Progressive Scan CCD
Sensor size	Type 1/3
Cell size	7.4 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	102 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 202 frames at full resolution
Mono formats	Mono8, Mono12Packed, Mono12
Color formats	BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed
Exposure control	10 µs to 93 s
Gain control	0 – 30 dB
Binning	Horizontal: 1 to 8 columns; Vertical: 1 to 14 rows
Decimation	N/A
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE
Trigger latency[1]	Idle state: 7.2 µs; Frame valid state: 16.9µs
Trigger jitter[1]	Idle state: 4.0 µs; Frame valid state: 13.7 µs
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10°C to +70°C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

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

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

Table 4: *Mako G-032B/C camera specifications*

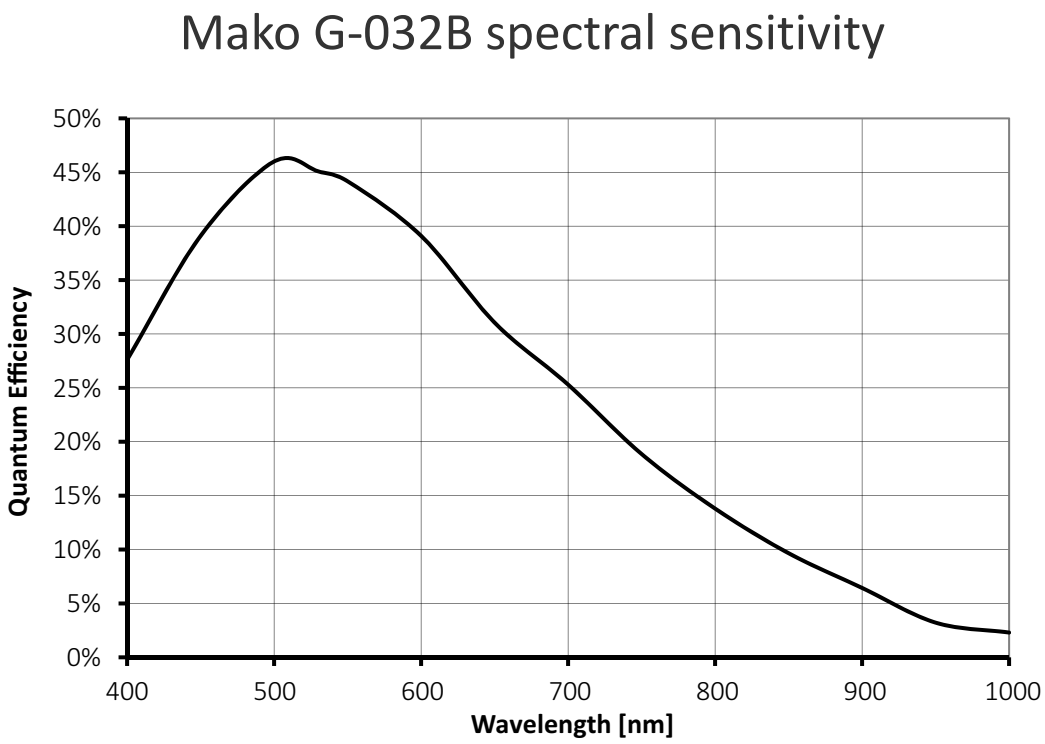


Figure 4: *Mako G-032B spectral sensitivity (without protection/cover glass)*

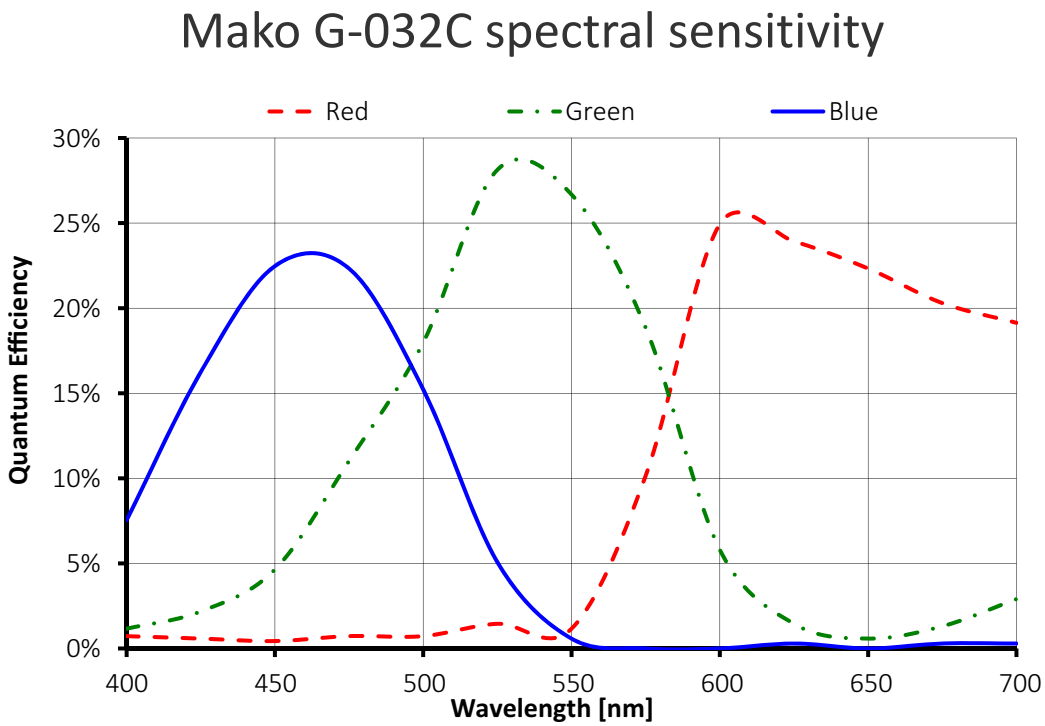


Figure 5: *Mako G-032C spectral sensitivity (with IR cut filter)*

Mako G-032B/C ROI frame rate

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

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

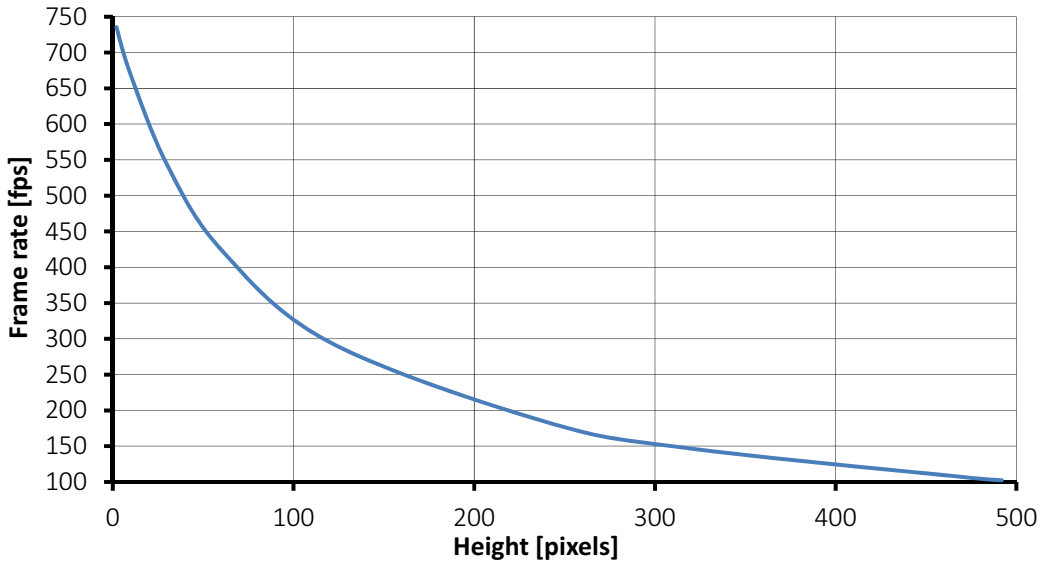


Figure 6: *Frame rate as a function of ROI height [width=658 pixels]*

ROI height [pixels]	Width [pixels]	Frame rate [fps][1]
492	658	102.3
480	658	104.5
320	658	146.6
240	658	183.5
120	658	295.3

ROI height [pixels]	Width [pixels]	Frame rate [fps][1]
60	658	424.5
30	658	543.3
10	658	667.9
2	658	735.4

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

Table 5: *Frame rate as a function of ROI height*

Mako G-125B/C

Feature	Specification
Resolution	1292 x 964
Sensor	Sony ICX445ALA/AQA with EXview HAD CCD™ technology
Type	Progressive Scan CCD
Sensor size	Type 1/3
Cell size	3.75 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	30 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 52 frames at full resolution
Mono formats	Mono8, Mono12Packed, Mono12
Color formats	BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed
Exposure control	12 µs to 84 s
Gain control	0 – 30 dB
Binning	Horizontal: 1 to 8 columns; Vertical: 1 to 14 rows
Decimation	N/A
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.3 W @ 12 VDC; 2.7 W PoE
Trigger latency[1]	Idle state: 8.0 µs; Frame valid state: 25.0 µs
Trigger jitter[1]	Idle state: 4.0 µs; Frame valid state: 21.0 µs
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10 °C to +70 °C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

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

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

Table 6: *Mako G-125B/C camera specifications*

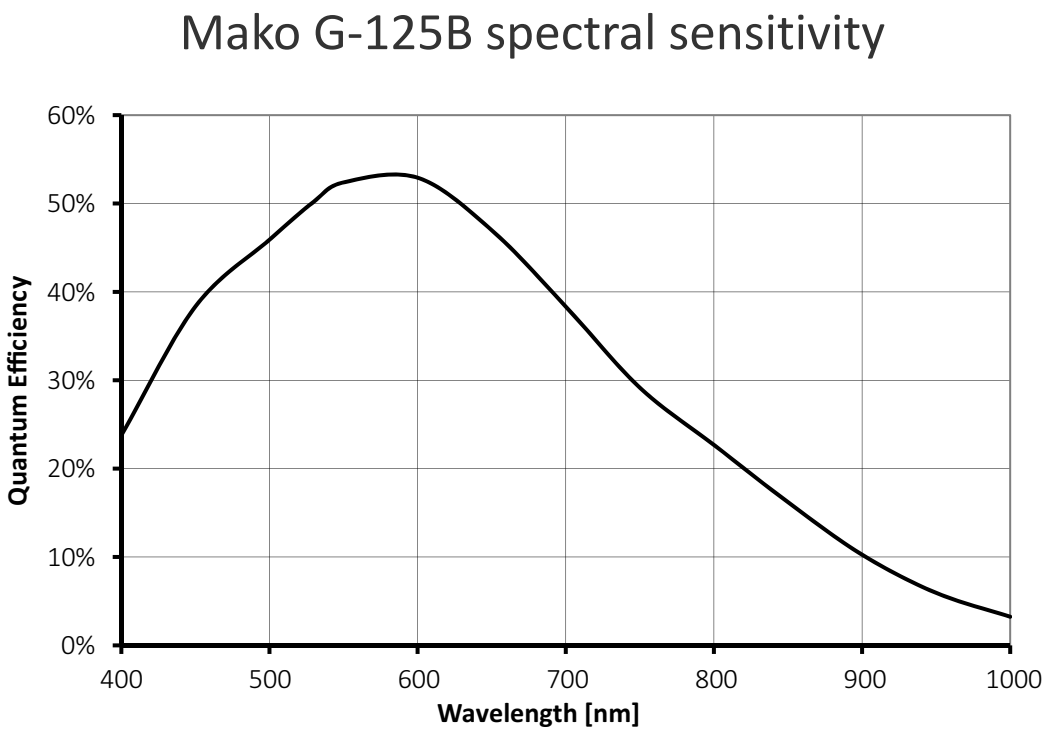


Figure 7: *Mako G-125B spectral sensitivity (without protection/cover glass)*

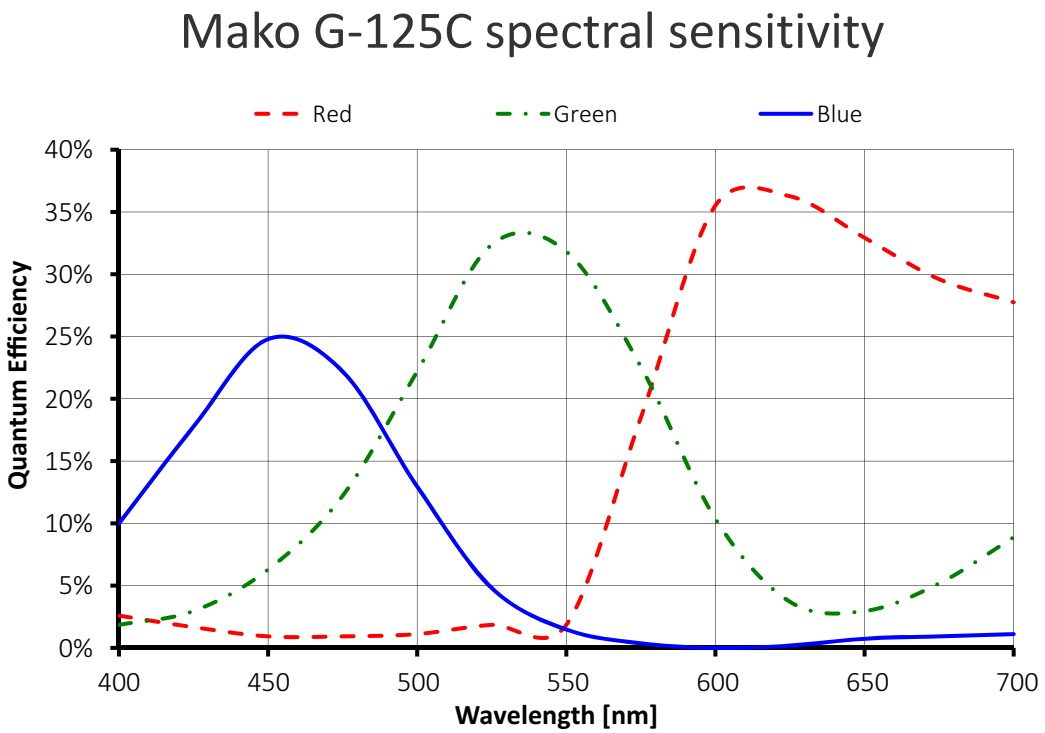


Figure 8: *Mako G-125C spectral sensitivity (with IR cut filter)*

Mako G-125B/C 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

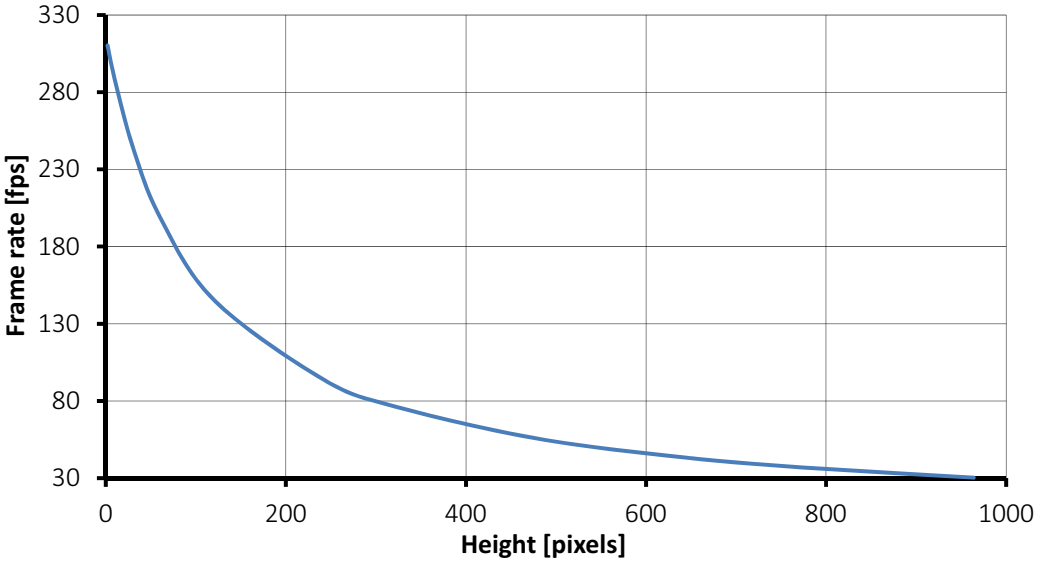


Figure 9: *Frame rate as a function of ROI height [width=1292 pixels]*

ROI height [pixels]	Width [pixels]	Frame rate [fps][1]
964	1292	30.3
960	1292	30.4
768	1292	37.1
640	1292	43.5
480	1292	55.5
320	1292	76.5

ROI height [pixels]	Width [pixels]	Frame rate [fps][1]
240	1292	94.4
120	1292	145.5
60	1292	199.3
30	1292	244.5
10	1292	288.1
2	1292	310.3

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

Table 7: *Frame rate as a function of ROI height*

Mako G-131B/C

Feature	Specification			
Resolution	1280 x 1024			
Sensor	e2v EV76C560			
Type	Progressive Scan CMOS			
Sensor size	Type 1/1.8			
Cell size	5.3 µm			
Lens mount	C / CS-Mount			
Maximum frame rate at full resolution	62 fps			
Maximum image bit depth	10-bit			
On-board FIFO image buffer	64 MB, up to 50 frames at full resolution			
Mono formats	Mono8, Mono10			
Color formats	BayerGB8, BayerGB10, Mono8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed			
Exposure control	PixelFormat	ShutterMode: Global	ShutterMode: GlobaReset	ShutterMode: Rolling
	Mono8, Mono10, BayerGB8, BayerGB10, YUV411Packed, YUV422Packed	12 µs to 1.012 s	12 µs to 0.978 s	12 µs to 0.994 s
	RGB8Packed, BGR8Packed, YUV444Packed	12 µs to 2.124 s	12 µs to 2.053 s	12 µs to 2.086 s
Gain control	0 – 24 dB			
Binning	Horizontal: 1 to 2 pixels; Vertical: 1 to 2 rows			
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor			
Opto-isolated I/Os	1 input, 3 outputs			
Voltage requirements	12–24 VDC or PoE			
Power consumption	2.0 W @ 12 VDC; 2.2 W PoE			
Trigger latency[1]	Idle state: 32.6 µs; Frame valid state: 32.6 µs			
Trigger jitter[1]	Idle state: 8.1 µs; Frame valid state: 8.1 µs			
Operating temperature	+5 °C to +45 °C housing temperature			
Storage temperature	-10 °C to +70 °C ambient temperature without condensation			
Body dimensions (L x W x H)	60.5 x 29 x 29 mm			
Mass	80 g			
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX			
Software interface standard	GigE Vision Standard V1.2			
Camera control interface	GenICam SFNC V1.2.1 compliant			

Table 8: *Mako G-131B/C camera specifications*

Feature	Specification
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

[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.
- The e2v sensor does not support exposure duration via external level trigger.

Table 8: *Mako G-131B/C camera specifications (Continued)*

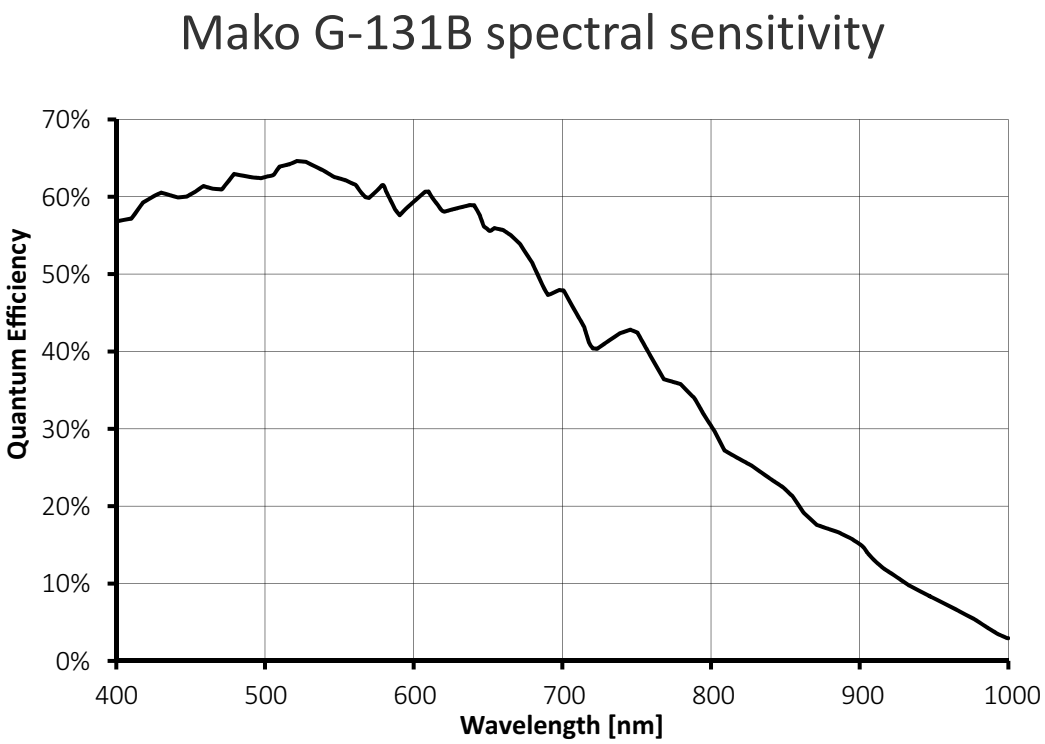


Figure 10: *Mako G-131B spectral sensitivity*

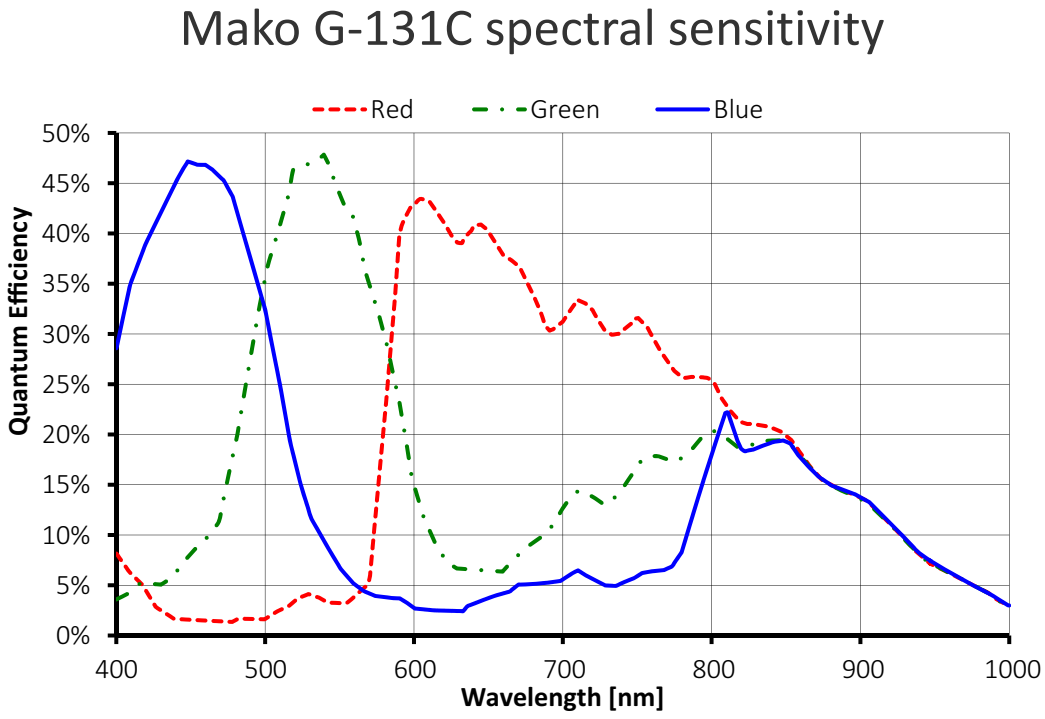


Figure 11: *Mako G-131C spectral sensitivity*

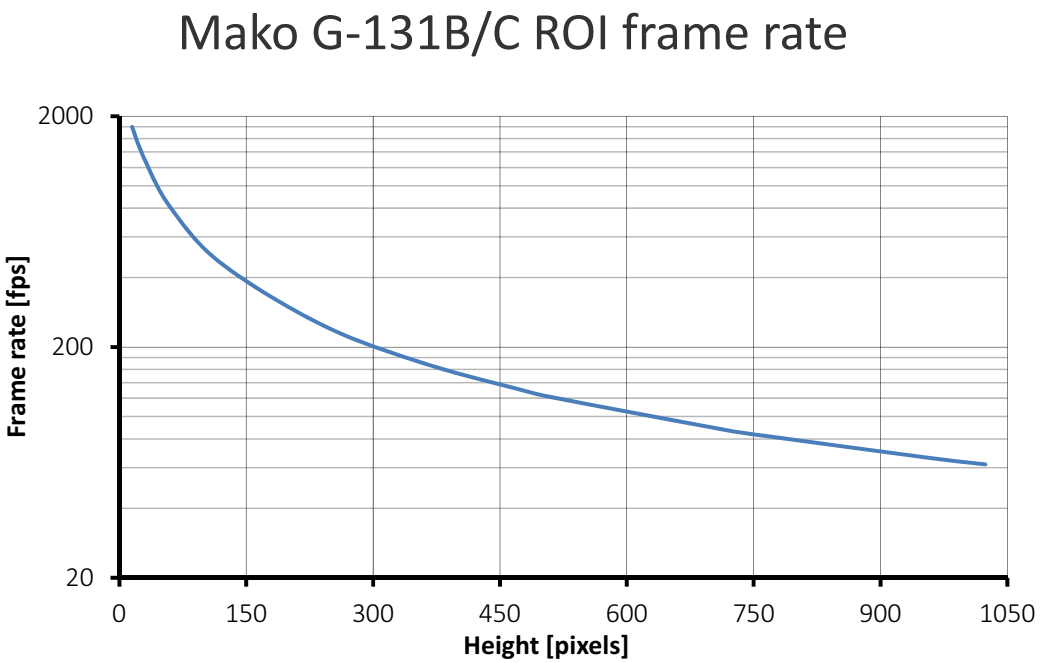


Figure 12: *Frame rate as a function of ROI height [width=1280 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
1024	1280	62
960	1280	66
768	1280	82
720	1280	87
512	1280	121
480	1280	129

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
360	1280	170
240	1280	249
120	1280	462
60	1280	809
30	1280	1295
15	1280	1798

[1] There will be an increase in frame rate with reduced width for color cameras if it is bandwidth limited.

Table 9: *Frame rate as a function of ROI height*

Mako G-192B/C

Feature	Specification		
Resolution	1600 x 1200		
Sensor	e2v EV76C570		
Type	Progressive Scan CMOS		
Sensor size	Type 1/1.8		
Cell size	4.5 µm		
Lens mount	C / CS-Mount		
Maximum frame rate at full resolution	60 fps		
Maximum image bit depth	10-bit		
On-board FIFO image buffer	64 MB, up to 34 frames at full resolution		
Mono formats	Mono8, Mono10		
Color formats	BayerGB8, BayerGB10, Mono 8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed		
Exposure control	PixelFormat	ShutterMode: Global / Rolling	ShutterMode: GlobaReset
	Mono8, Mono10, BayerGB8, BayerGB10, YUV411Packed, YUV422Packed	14 µs to 0.891 s	14 µs to 0.874 s
	RGB8Packed, BGR8Packed, YUV444Packed	14 µs to 1.870 s	14 µs to 1.835 s
Gain control	0 – 24 dB		
Binning	Horizontal: 1 to 2 pixels; Vertical: 1 to 2 rows		
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor		
Opto-isolated I/Os	1 input, 3 outputs		
Voltage requirements	12–24 VDC or PoE		
Power consumption	2.1 W @ 12 VDC; 2.4 W PoE		
Trigger latency[1]	Idle state: 27.7 µs; Frame valid state: 27.7 µs		
Trigger jitter[1]	Idle state: 6.9 µs; Frame valid state: 6.9 µs		
Operating temperature	+5 °C to +45 °C housing temperature		
Storage temperature	-10 °C to +70 °C ambient temperature without condensation		
Body dimensions (L x W x H)	60.5 x 29 x 29 mm		
Mass	80 g		
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX		
Software interface standard	GigE Vision Standard V1.2		
Camera control interface	GenICam SFNC V1.2.1 compliant		

Table 10: *Mako G-192B/C camera specifications*

Feature	Specification
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

[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 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 e2V sensor does not support exposure duration via external level trigger.

Table 10: *Mako G-192B/C camera specifications (Continued)*

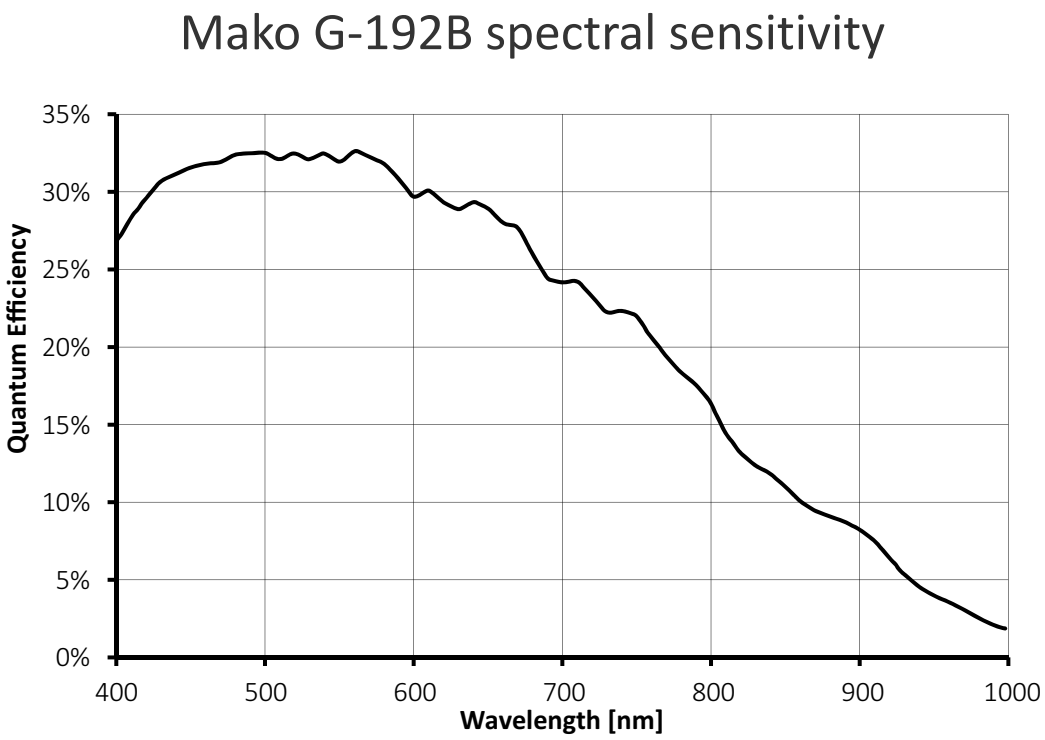


Figure 13: *Mako G-192B spectral sensitivity*

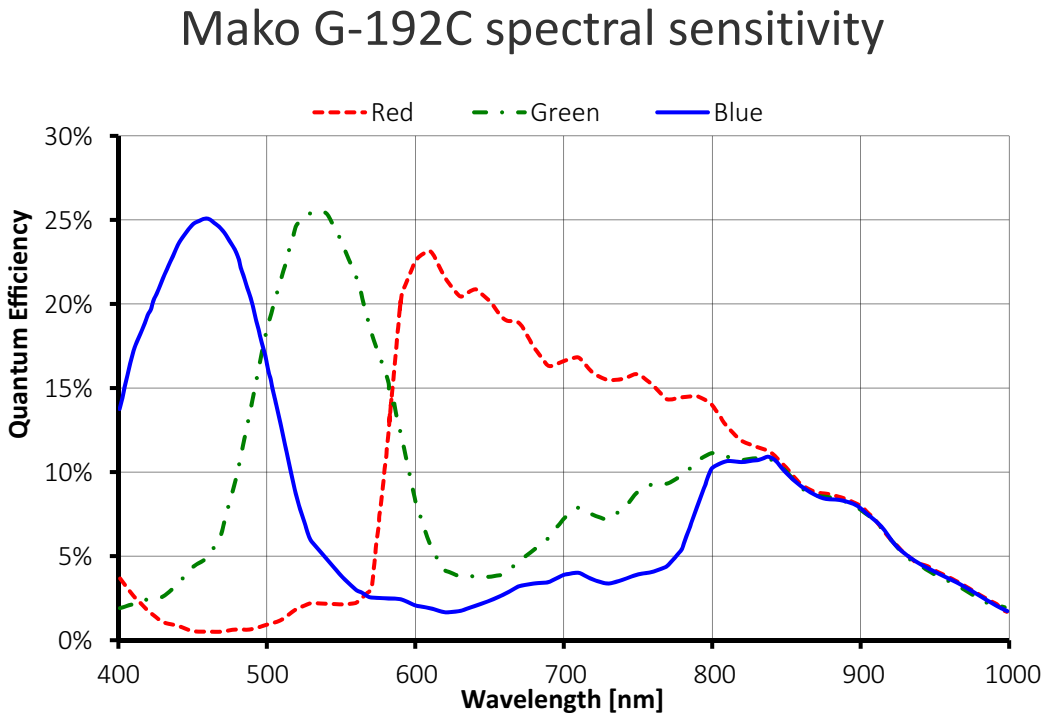


Figure 14: *Mako G-192C spectral sensitivity*

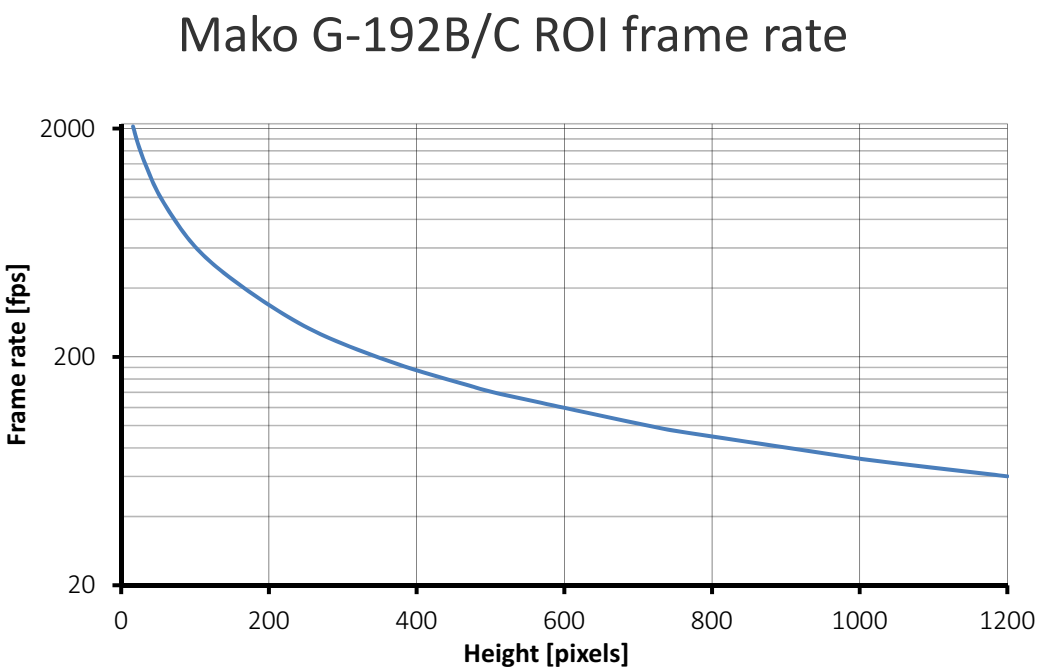


Figure 15: *Frame rate as a function of ROI height [width=1600 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
1200	1600	60
1024	1600	70
960	1600	75
768	1600	93
720	1600	99
512	1600	138
480	1600	147
360	1600	193
240	1600	282
120	1600	525
60	1600	919
30	1600	1470
16	1600	2042

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

Table 11: *Frame rate as a function of ROI height*

Mako G-223B/NIR/C

Feature	Specification
Resolution	2048 x 1088
Sensor	CMOSIS CMV2000 with microlenses and global shutter
Type	CMOS
Sensor size	Type 2/3
Cell size	5.5 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	49.5 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 29 frames at full resolution
Mono formats	Mono8, Mono12Packed, Mono12
Color formats	BayerGB8, BayerGB12, BayerGB12Packed, Mono8, RGB8Packed, BGR8Packed, RGBA8Packed, BGRA8Packed, YUV411Packed, YUV422Packed, YUV444Packed
Exposure control[1]	21 µs to 153 s
Gain control	0 – 26 dB
Binning	N/A
Decimation	N/A
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE
Trigger latency	N/A
Trigger jitter	N/A
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10 °C to +70 °C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

[1] Camera firmware v1.52.8151 shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor data sheet for details on frame overhead time. This will be fixed in the next firmware release.

Table 12: *Mako G-223B/NIR/C camera specifications*

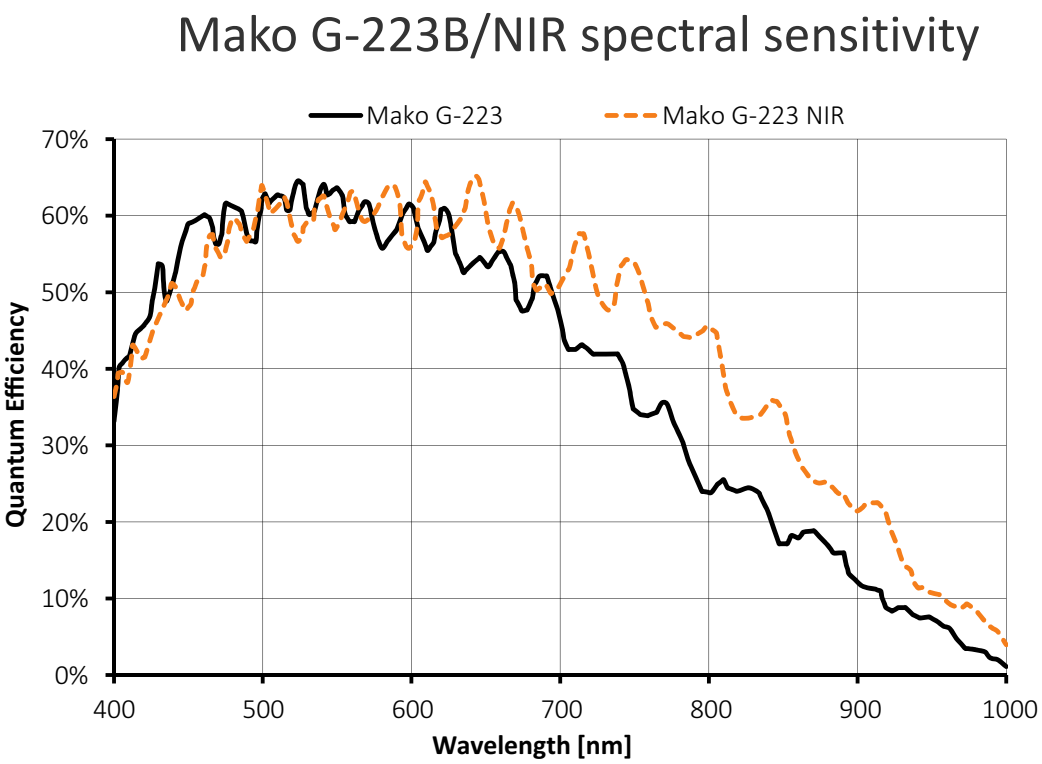


Figure 16: *Mako G-223B and G-223B NIR spectral sensitivity*

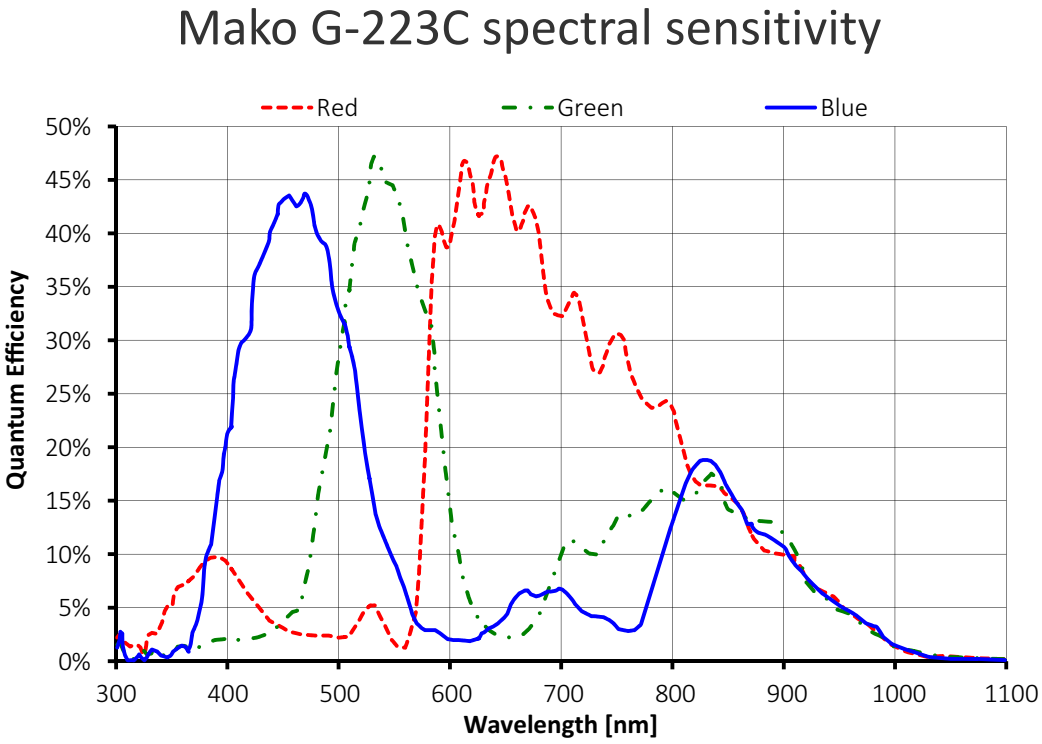


Figure 17: *Mako G-223C spectral sensitivity (without IR cut filter)*

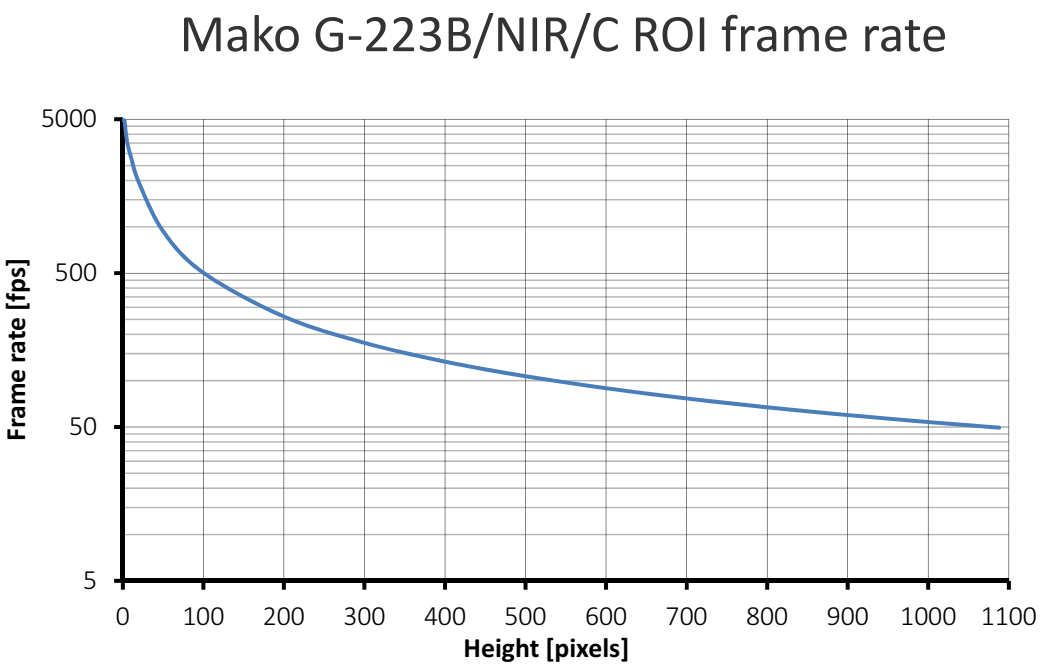


Figure 18: *Frame rate as a function of ROI height [width = 2048 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
1088	2048	49.5
1000	2048	53.8
900	2048	59.7
800	2048	67.1
700	2048	76.6
600	2048	89.2
500	2048	106.8
400	2048	132.9
300	2048	176.1

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
200	2048	260.8
100	2048	502.1
50	2048	934.6
20	2048	1933.8
10	2048	2847.3
5	2048	3624.5
2	2048	4906.7
1	2048	4926.1

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

Table 13: *Frame rate as a function of ROI height*

Mako G-234B/C

Feature	Specification	
Resolution	1936 x 1216	
Sensor	G-234B: Sony IMX249LLJ G-234C: Sony IMX249LQJ	
Type	CMOS	
Sensor size	Type 1/1.2	
Cell size	5.86 µm	
Lens mount	C / CS-Mount	
Sensor output	Sensor Output is fixed based on Pixel Format. 10-bit for BayerRG8, Mono8, YUV411Packed, YUV422Packed, YUV444Packed, RGB8Packed, BGR8Packed 12-bit for BayerRG12, Mono12, BayerRG12Packed,Mono12Packed	
Maximum frame rate at full resolution	PixelFormat	Frame rate
	RGB8Packed, BGR8Packed, YUV444Packed	17 fps
	BayerRG12, Mono12, YUV422Packed	25 fps
	Bayer12Packed, Mono12Packed	30 fps
	YUV411Packed	34 fps
	BayerRG8, Mono8	40 fps
Maximum image bit depth	12-bit	
On-board FIFO image buffer	64 MB, up to 28 frames at full resolution	
Mono formats	Mono8, Mono12Packed, Mono12	
Color formats	BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed	
Exposure control[1]	PixelFormat	Exposure range
	BayerRG8, Mono8, YUV411Packed, YUV422Packed	53 µs to 73 s in increments of 19.86 µs
	BayerRG12, Mono12, BayerRG12Packed, Mono12Packed	65 µs to 73 s in increments of 25.68 µs
	YUV444Packed, RG88Packed, BGR8Packed	93 µs to 73 s in increments of 39.73 µs
Gain control	0–40 dB (in increments of 0.1 dB)	
Binning	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows	
Decimation	Horizontal and Vertical: 1, 2, 4, 8 factor	
Opto-isolated I/Os	1 input, 3 outputs	
Voltage requirements	12–24 VDC or PoE	
Power consumption	2.4 W @ 12 VDC; 2.8 W PoE	

Table 14: *Mako G-234B/C camera specifications*

Feature	Specification	
Trigger latency[2]	PixelFormat	Latency in µs
	BayerRG8, Mono8, YUV411Packed, YUV422Packed	69.6 µs
	BayerRG12, Mono12, BayerRG12Packed, Mono12Packed	90.1 µs
	YUV444Packed, RG88Packed, BGR8Packed	139.3 µs
Trigger jitter[2]	PixelFormat	Jitter in µs
	BayerRG8, Mono8, YUV411Packed, YUV422Packed	9.8 µs
	BayerRG12, Mono12, BayerRG12Packed, Mono12Packed	12.8 µs
	YUV444Packed, RG88Packed, BGR8Packed	19.85 µs
Operating temperature	+5 °C to +45 °C housing temperature	
Storage temperature	-10 °C to +70 °C ambient temperature without condensation	
Body dimensions (L x W x H)	60.5 x 29 x 29 mm	
Mass	80 g	
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX	
Software interface standard	GigE Vision Standard V1.2	
Camera control interface	GenICam SFNC V1.2.1 compliant	
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE	

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

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

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

Table 14: *Mako G-234B/C camera specifications (Continued)*

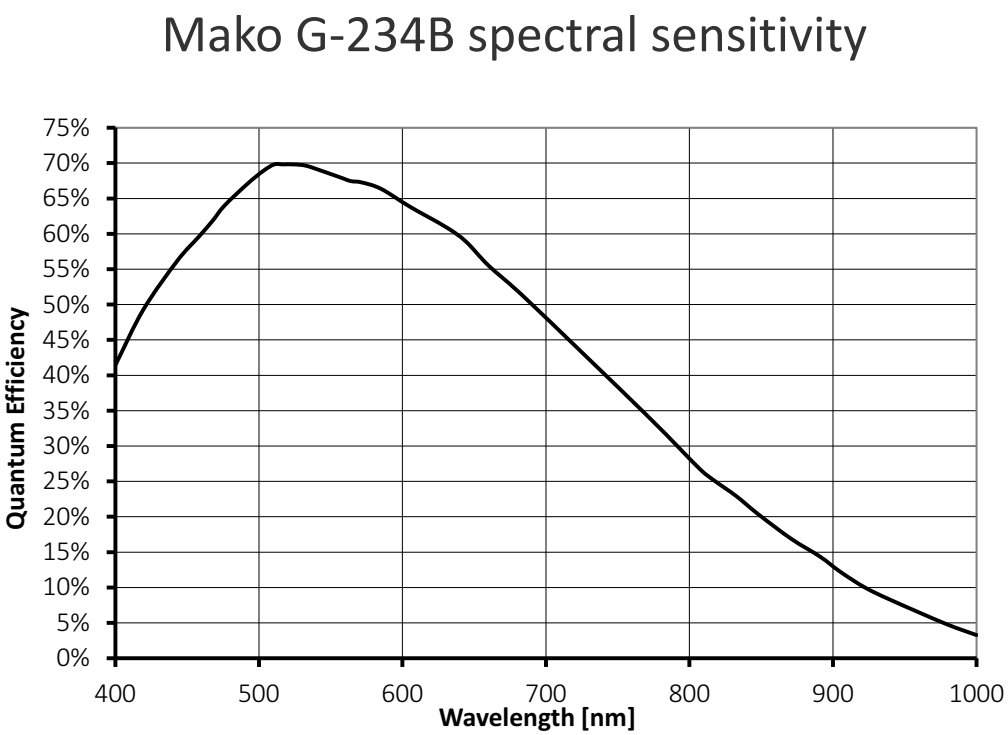


Figure 19: *Mako G-234B spectral sensitivity (without protection/cover glass)*

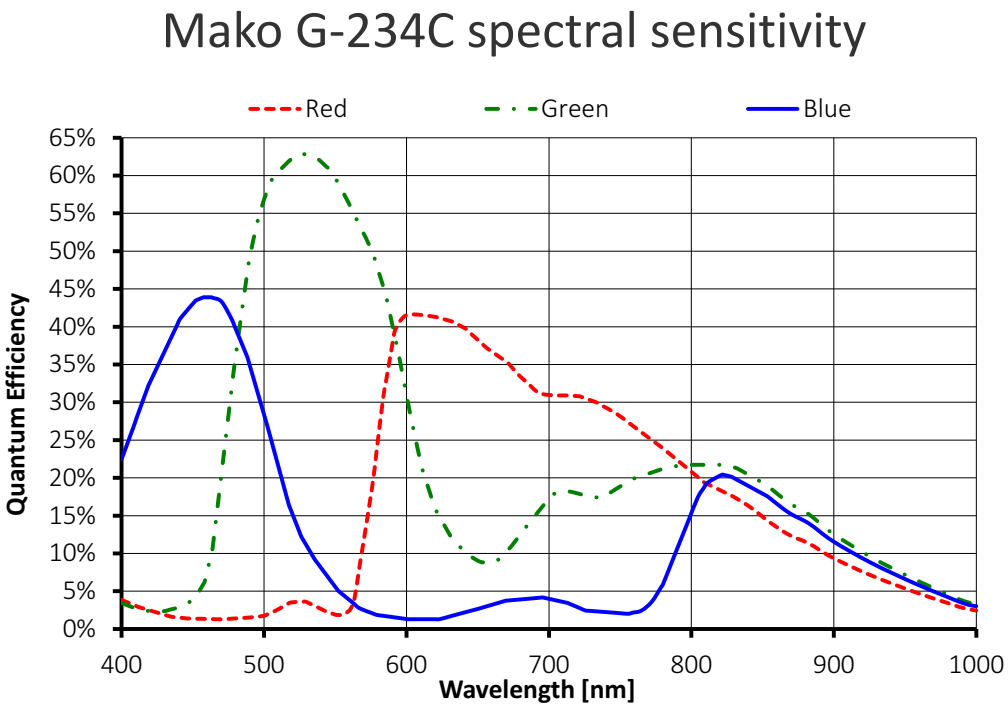


Figure 20: *Mako G-234C spectral sensitivity (with IR cut filter)*

Mako G-234B/C ROI frame rate

Maximum frame rate at full resolution measured with 12-bit sensor (Bayer12Packed, Mono12Packed): 31 fps

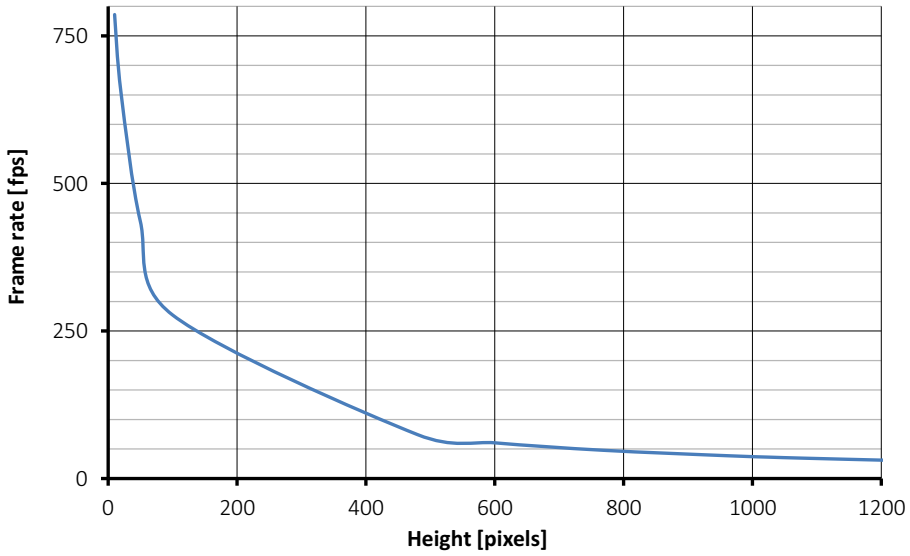


Figure 21: *12-bit sensor frame rate as a function of ROI height [width=1936]*

Maximum frame rate at full resolution measured with 10-bit sensor (BayerRG8, Mono8): 40.1 fps

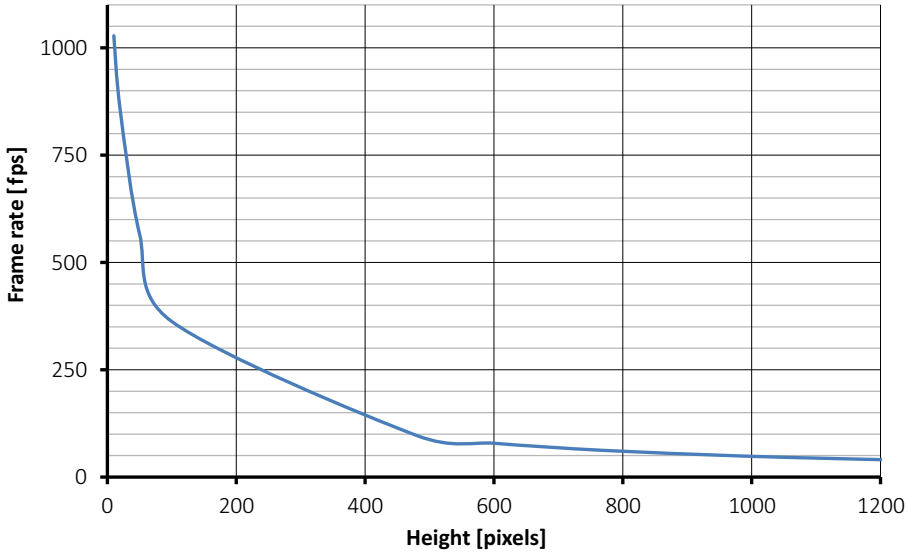


Figure 22: *10-bit sensor frame rate as a function of ROI height [width=1936]*

ROI height	Frame rate [10-bit]	Frame rate [12-bit]
1216	40.1	31.0
1200	40.6	31.4
1080	44.9	34.8
1024	47.3	36.6
960	50.4	38.9
768	62.3	48.2

ROI height	Frame rate [10-bit]	Frame rate [12-bit]
600	78.8	60.8
480	96.9	74.9
100	362.4	280.2
50	566.0	437.7
20	853.8	660.3
10	1028.1	795.0

Table 15: *Frame rate as a function of ROI height [width=1936]*

Mako G-419B/NIR/C

Feature	Specification
Resolution	2048 x 2048
Sensor	CMOSIS CMV4000 with microlenses and global shutter
Type	CMOS
Sensor size	Type 1
Cell size	5.5 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	26.3 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 15 frames at full resolution
Mono formats	Mono8, Mono12Packed, Mono12
Color formats	BayerGB8, BayerGB12, BayerGB12Packed, Mono8, RGB8Packed, BGR8Packed, RGBA8Packed, BGRA8Packed, YUV411Packed, YUV422Packed, YUV444Packed
Exposure control[1]	41 µs to 153 s
Gain control	0 – 26 dB
Binning	N/A
Decimation	N/A
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.3 W @ 12 VDC; 2.7 W PoE
Trigger latency	N/A
Trigger jitter	N/A
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10 °C to +70 °C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

[1] Camera firmware v1.52.8151 shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor data sheet for details on frame overhead time. This will be fixed in the next firmware release.

Table 16: *Mako G-419B/NIR/C camera specifications*

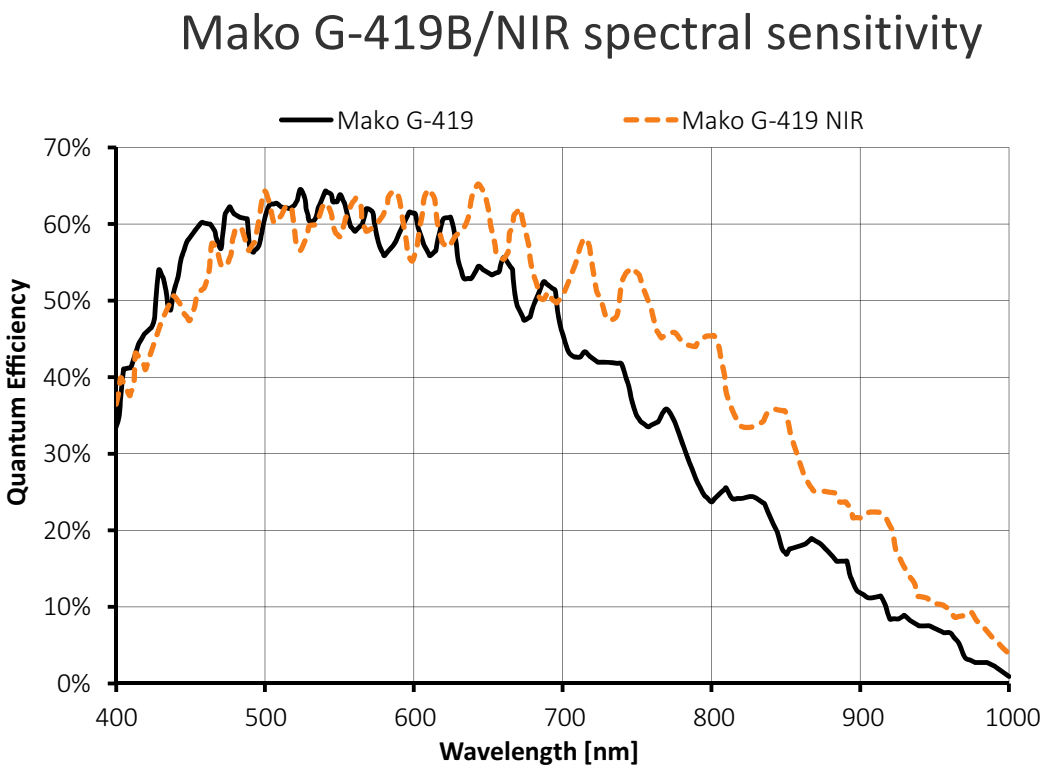


Figure 23: *Mako G-419B and G-419B NIR spectral sensitivity*

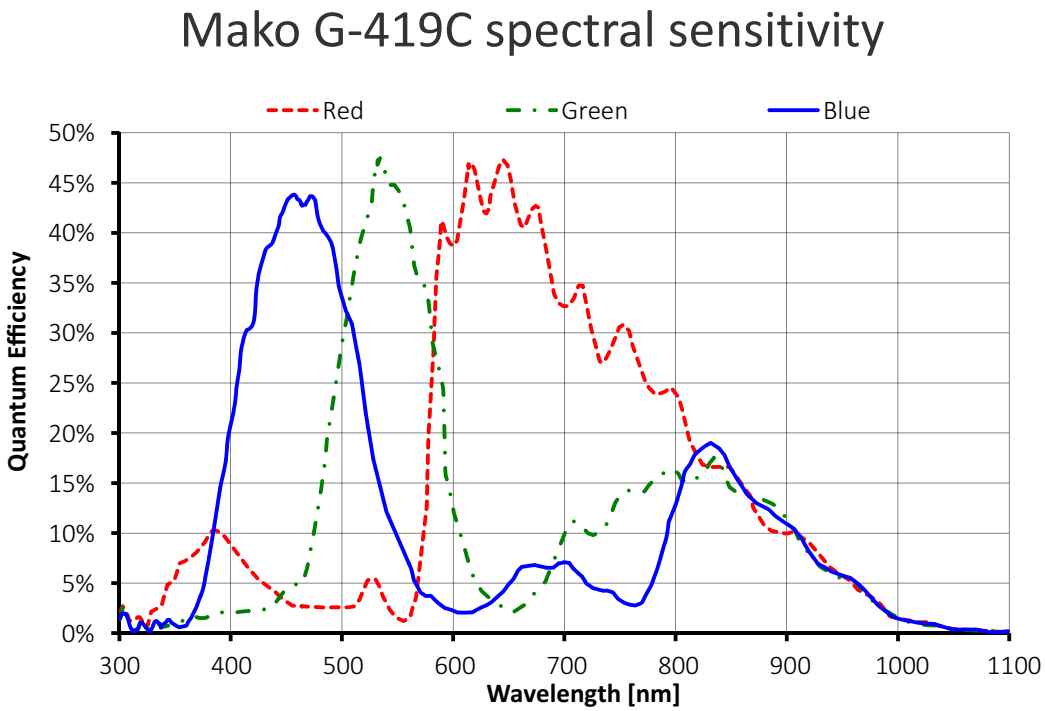


Figure 24: *Mako G-419C spectral sensitivity (without IR cut filter)*

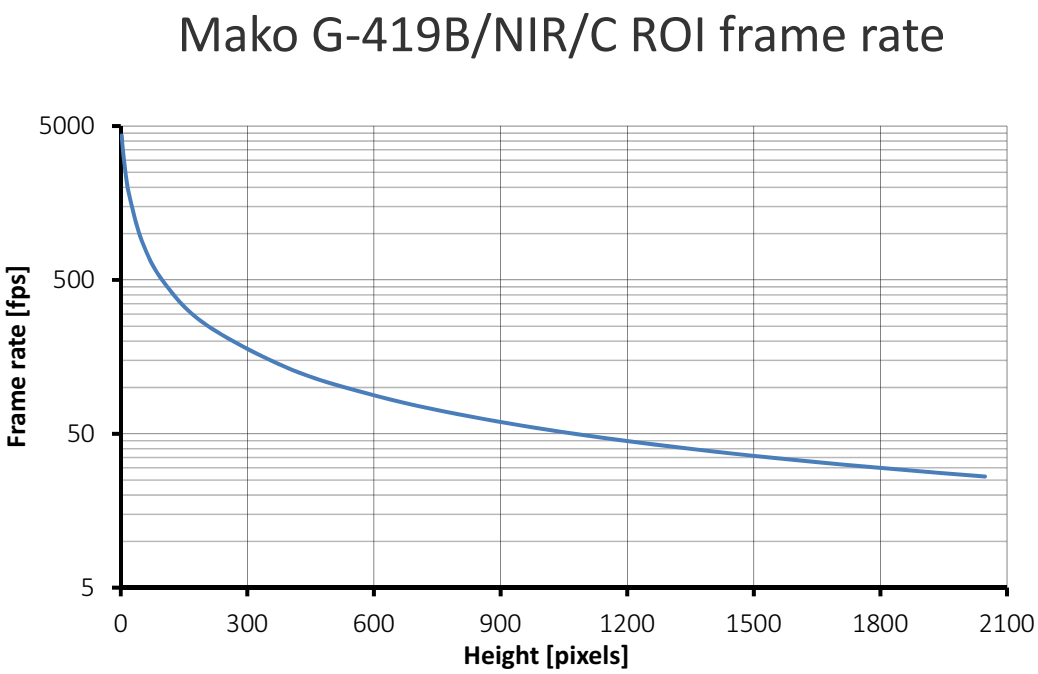


Figure 25: *Frame rate as a function of ROI height [width=2048 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
2048	2048	26.3
2000	2048	26.9
1800	2048	29.9
1600	2048	33.6
1400	2048	38.4
1200	2048	44.8
1000	2048	53.7
800	2048	66.9
600	2048	88.8

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
400	2048	132.1
200	2048	257.7
100	2048	490.8
50	2048	895.9
20	2048	1775.5
10	2048	2639.2
5	2048	3486.7
2	2048	4342.1

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

Table 17: *Frame rate as a function of ROI height*

Mako G-503B/C

Feature	Specification
Resolution	2592 x 1944
Sensor	G-503B: Aptina MT9p031 G-503C: Aptina MT9p006
Type	Progressive Scan CMOS
Sensor size	Type 1/2.5
Cell size	2.2 µm
Lens mount	C / CS-Mount
Maximum frame rate at full resolution	14 fps
Maximum image bit depth	12-bit
On-board FIFO image buffer	64 MB, up to 13 frames at full resolution
Mono formats	Mono8, Mono12, Mono12Packed
Color formats	BayerGR8, BayerGR12Packed, BayerGR12, Mono8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed
Exposure control[1]	31 µs to 1 s; 36.375 µs increments
Gain control	0 – 24 dB
Binning	Horizontal: 1 to 4 pixels; Vertical: 1 to 4 rows
Decimation	Horizontal and Vertical: 1, 2, 4 factor
Opto-isolated I/Os	1 input, 3 outputs
Voltage requirements	12–24 VDC or PoE
Power consumption	2.0 W @ 12 VDC; 2.2 W PoE
Trigger latency[2]	Idle state: 73.4 µs; Frame valid state: 73.4 µs
Trigger jitter[2]	Idle state: 18.4 µs; Frame valid state: 18.4 µs
Operating temperature	+5 °C to +45 °C housing temperature
Storage temperature	-10 °C to +70 °C ambient temperature without condensation
Body dimensions (L x W x H)	60.5 x 29 x 29 mm
Mass	80 g
Hardware interface standard	PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX
Software interface standard	GigE Vision Standard V1.2
Camera control interface	GenICam SFNC V1.2.1 compliant
Regulatory	CE, FCC Class B, RoHS (2011/65/EU), WEEE

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

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

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

Table 18: *Mako G-503B/C camera specifications*

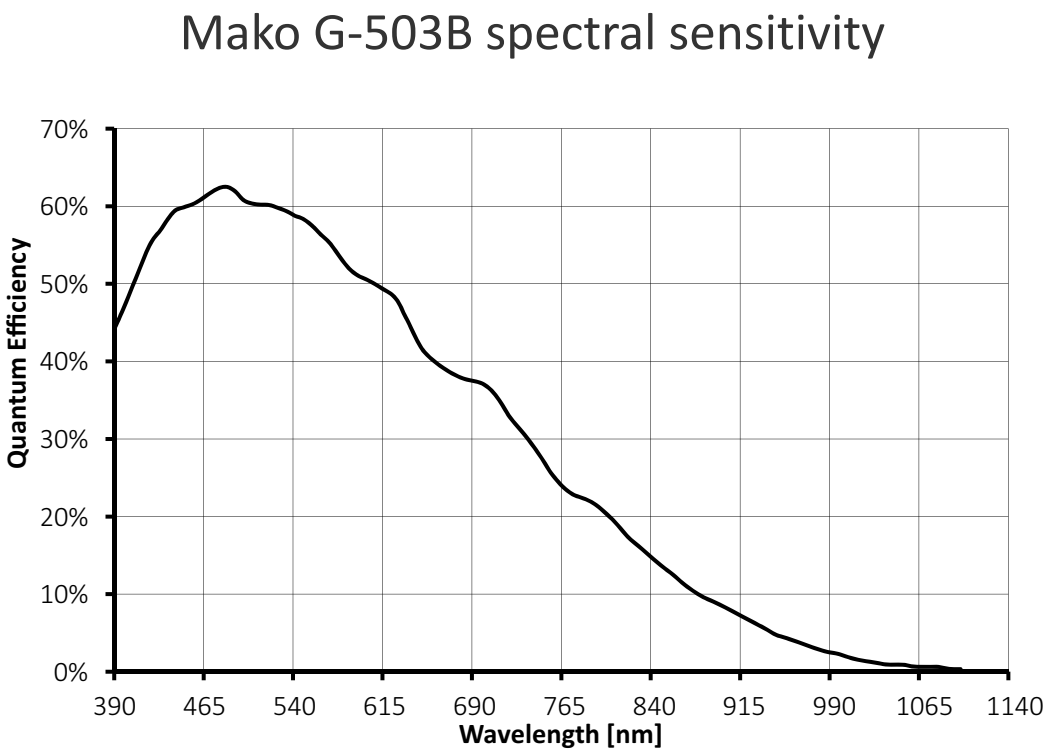


Figure 26: *Mako G-503B spectral sensitivity*

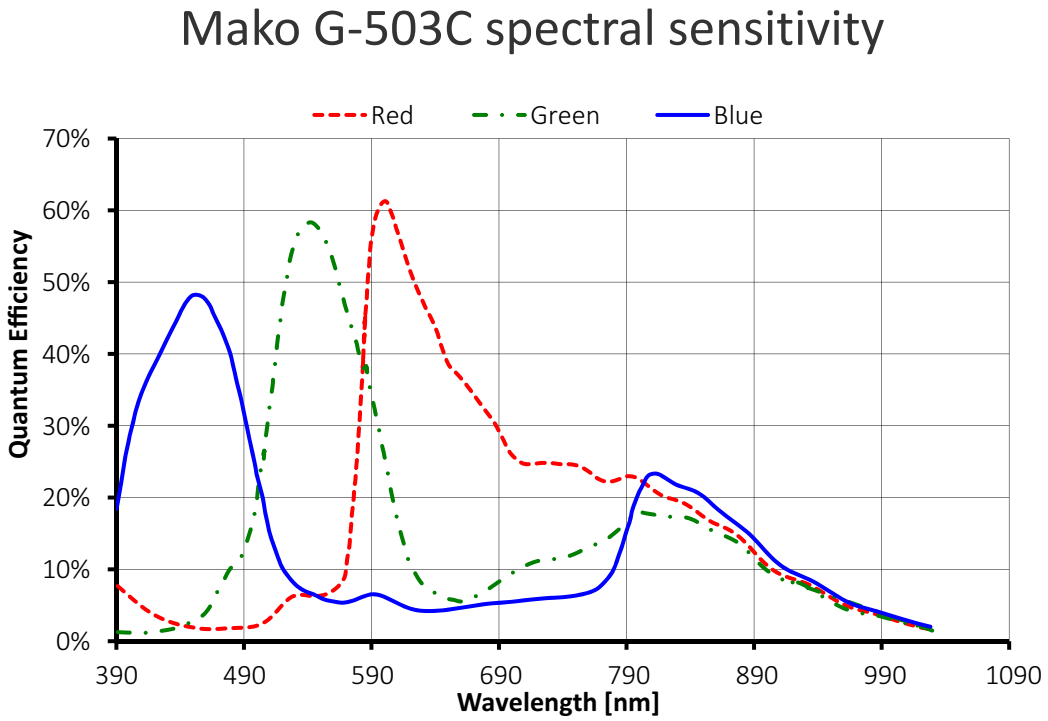


Figure 27: *Mako G-503C spectral sensitivity*

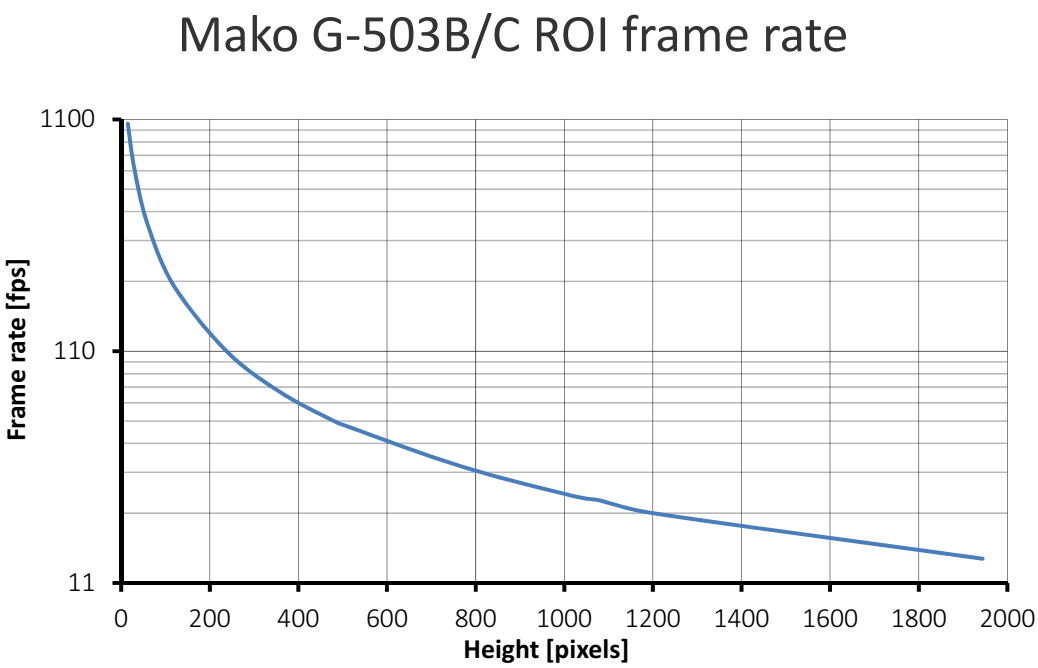


Figure 28: *Frame rate as a function of ROI height [width=2592 pixels]*

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
1944	2592	14
1200	2592	22
1080	2592	25
1024	2592	26
768	2592	35
512	2592	52
480	2592	55

ROI height [pixels]	Width [pixels][1]	Frame rate [fps]
360	2592	73
240	2592	109
120	2592	209
60	2592	386
30	2592	669
15	2592	1055

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

Table 19: *Frame rate as a function of ROI height*

Camera feature comparison

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

Camera control documents:

A complete listing of camera controls, including control definitions can be found online:

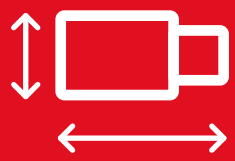
- PvAPI users: *GigE Camera and Driver Attributes* document
- VIMBA and third-party users: *GigE Features Reference*

		G-030	G-032	G-125	G-131	G-192	G-223	G-234	G-419	G-503
Image Control	Binning	–	✓	✓	✓	✓	–	✓	–	✓
	Decimation	✓	–	–	✓	✓	–	✓	–	✓
	Defect masking	✓	–	–	✓	✓	✓[1]	–	✓[1]	✓
	Gamma	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ROI	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Auto gain / Auto exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓
	White balance[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Color correction / Hue / Saturation[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Look up tables (LUTs)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	BlackLevel (Offset)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ReverseX/Y	✓	–	–	✓	✓	–	✓	–	✓
	Switchable sensor shutter mode	–	–	–	Global, Rolling, GlobalReset	Global, Rolling, GlobalReset	–	Global	–	Rolling, GlobalReset
	Piecewise linear HDR	✓	–	–	–	–	–	–	–	–
Camera Control/Feedback	Event channel	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Image chunk data	✓	✓	✓	✓	✓	✓	✓	✓	✓
	UserSets (config files)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Temperature readout[3] (main board)	✓	✓	✓	✓	✓	✓	✓	✓	✓

[1] Column defect masking only
[2] Only available for color models
[3] Accuracy ±1 °C, resolution 0.031

Table 20: *Mako G feature comparison by model*

Mechanical dimensions



This chapter includes:

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

Mako G standard housing

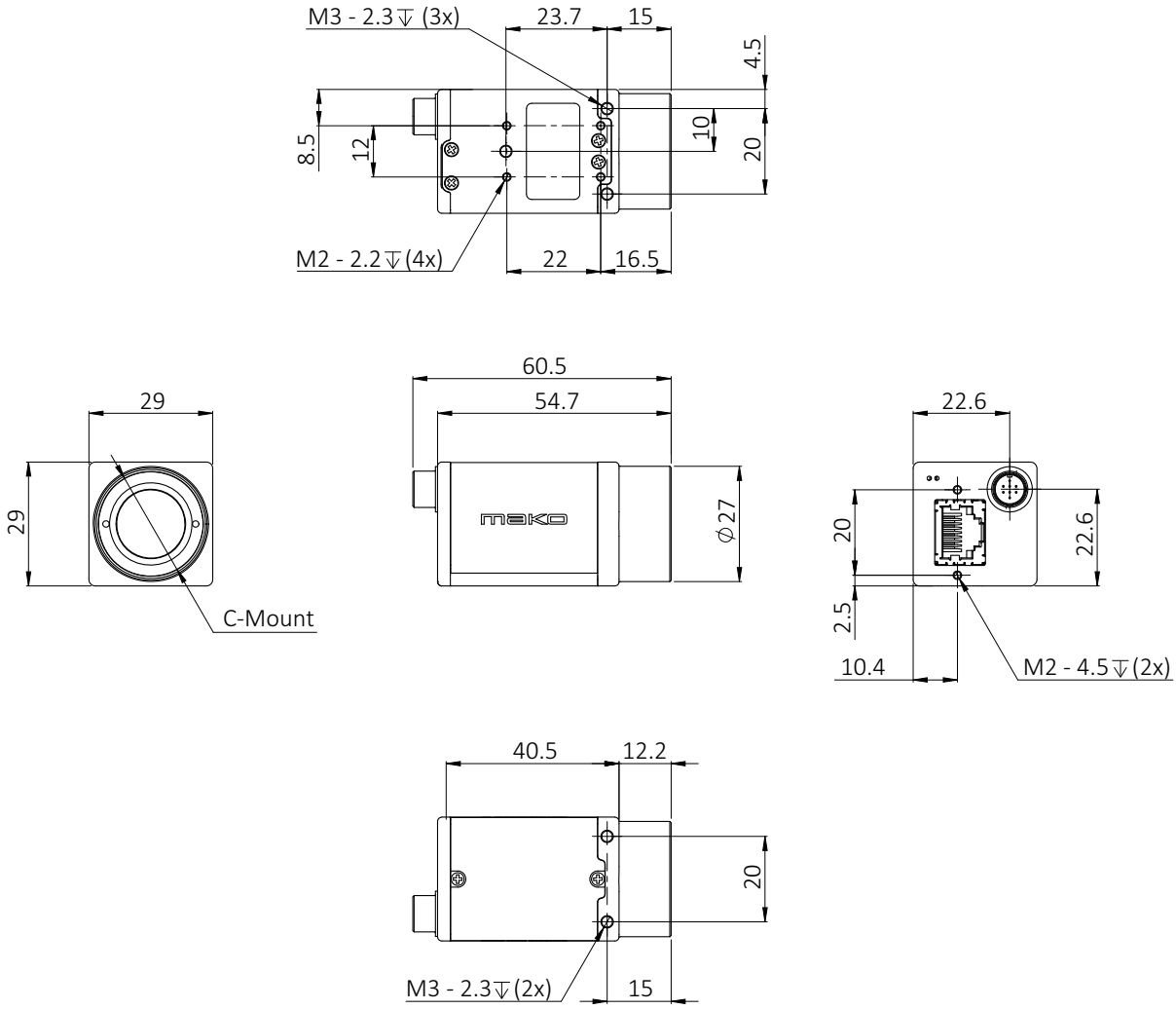


Figure 29: *Mako G standard housing dimensions (including connectors)*

Tripod adapter

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

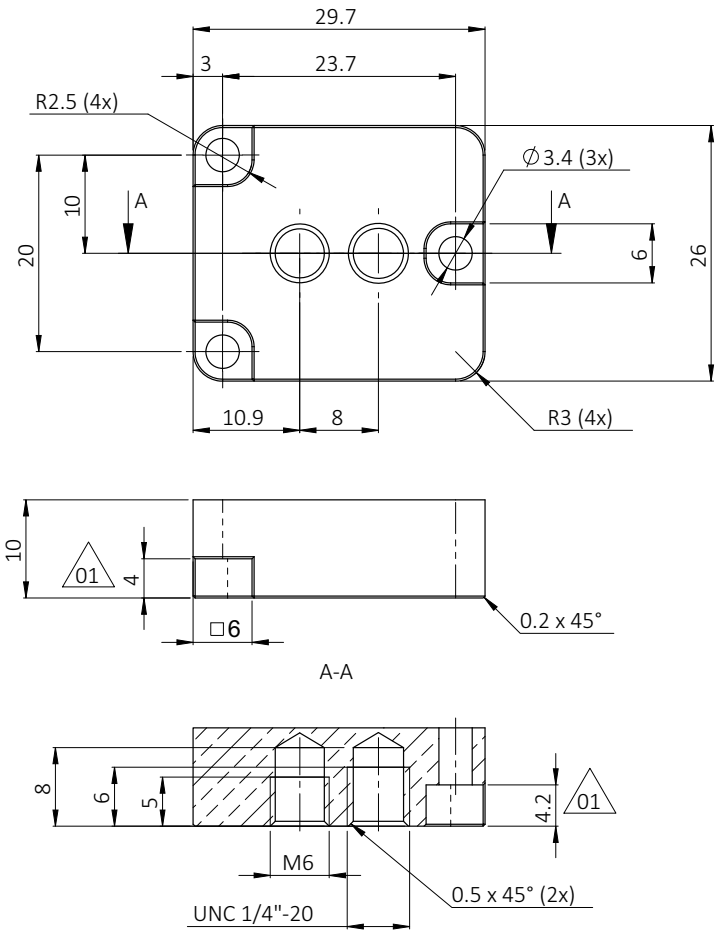


Figure 30: *Tripod adapter dimensions (in mm)*

Sensor position accuracy

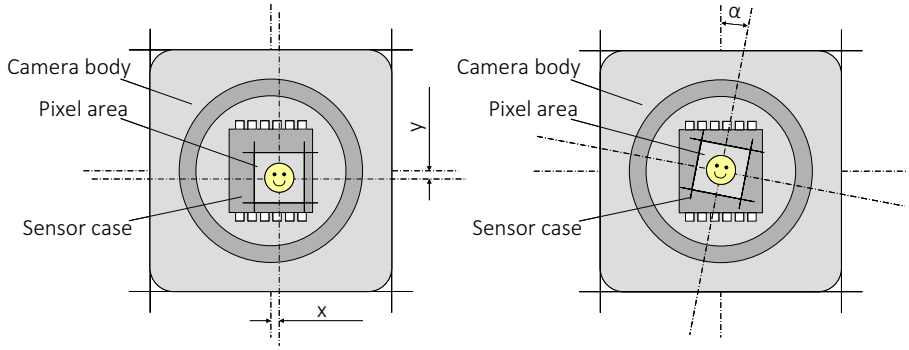


Figure 31: *Allied Vision sensor position accuracy*

Method of positioning

Optical alignment of the photo sensitive sensor area into the camera front module (lens mount front flange).

Reference points

Sensor: Center of the pixel area (photo sensitive cells).
Camera: Center of the camera front flange (outer case edges).

Accuracy

x/y: ±150 µm (sensor shift)

z: 0 µm to-150 µm (optical back focal length)

α: ±0.5° (sensor rotation)

Cross section: C-Mount and CS-Mount

All standard color Mako G cameras are equipped with a Hoya C5000 *IR cut filter* with a 16 mm or 22 mm diameter. Standard monochrome Mako G cameras are not equipped with any filter or protection glass.

Filter and protection glass options

Allied Vision offers several filter options for both monochrome and color Mako G cameras. Choose protection glass or filter according to the Modular Concept document.

https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/modular-concept/Modular_concept_external.pdf

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.

Model: G-030, G-032, G-050, G-095, G-125, G-131, G-192, G-234, G-503
Filter size: 16 mm diameter

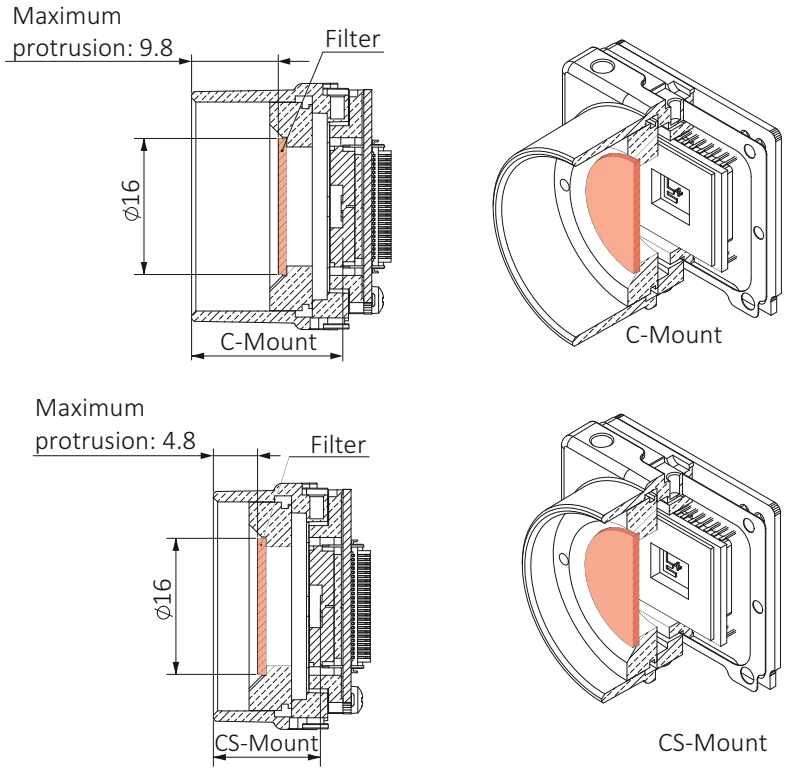


Figure 32: *C-Mount and CS-Mount dimensions for Mako G models with a 16 mm filter*

Model: G-223, G-419
Filter size: 22 mm diameter

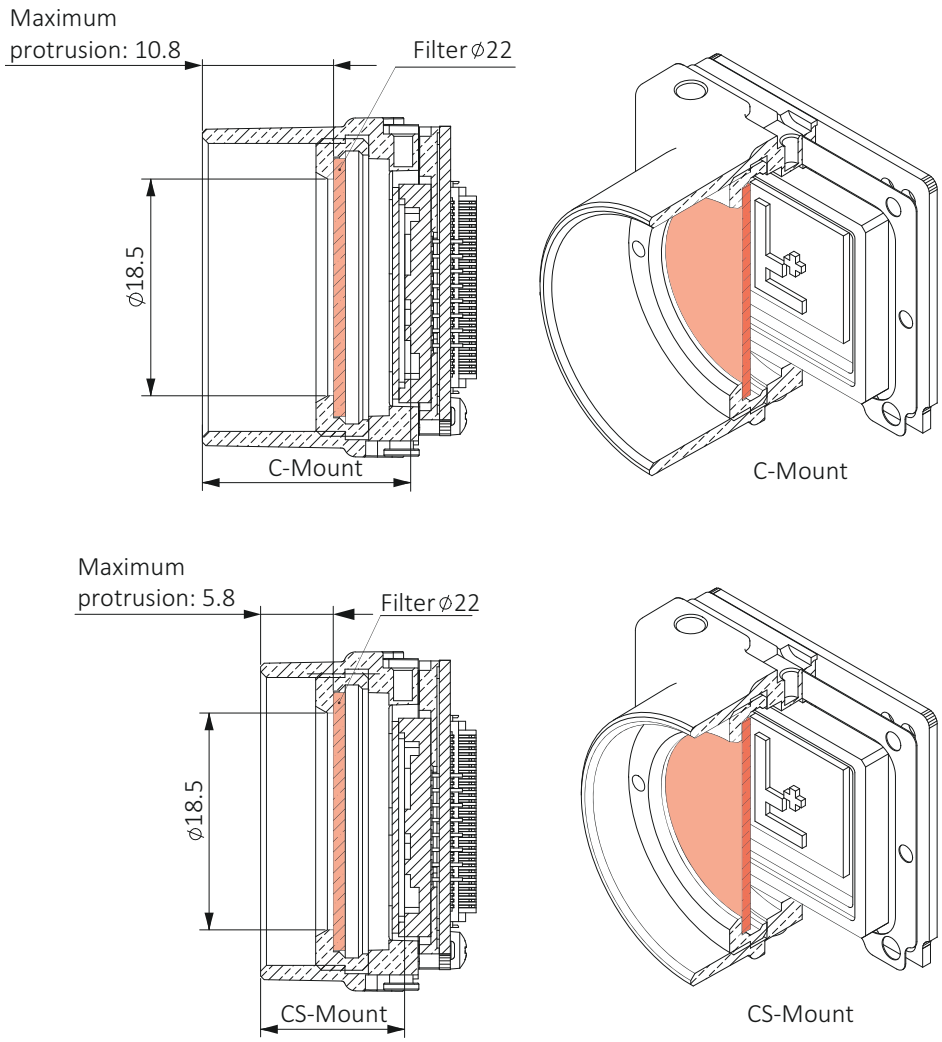


Figure 33: *C-Mount and CS-Mount dimensions for Mako G models with a 22 mm filter*

Adjusting C-Mount and CS-Mount

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

Dimensional mount adjustment

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

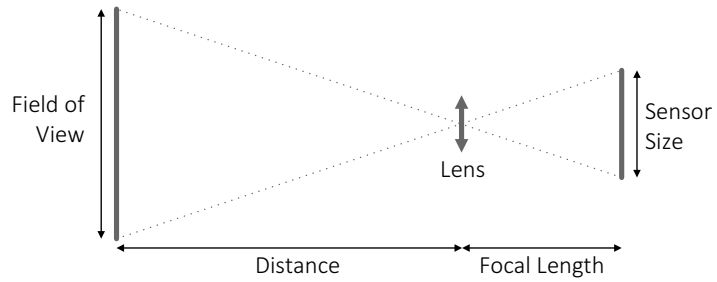
Filter and lenses

This chapter includes information on:

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

Camera lenses

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



Accessories

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

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

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

Mako G-030B/C

Focal length for type 1/3 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	495 x 371 mm	995 x 746 mm
8 mm	295 x 221 mm	595 x 446 mm
12.5 mm	187 x 140 mm	379 x 284 mm
16 mm	145 x 109 mm	295 x 221 mm
25 mm	91 x 68 mm	187 x 140 mm
50 mm	43 x 32 mm	91 x 68 mm

Table 21: *Mako G-030B/C focal length vs. field of view*

Mako G-032B/C

Focal length for type 1/3 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.0 mm	608 x 446 mm	1220 x 896 mm
4.8 mm	506 x 371 mm	1016 x 746 mm
8 mm	301 x 221 mm	608 x 446 mm
12 mm	199 x 146 mm	403 x 296 mm
16 mm	148 x 109 mm	301 x 221 mm
25 mm	93 x 68 mm	191 x 140 mm
35 mm	65 x 48 mm	135 x 99 mm

Table 22: *Mako G-032B/C focal length vs. field of view*

Mako G-125B/C

Focal length for type 1/3 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.0 mm	595 x 446 mm	1195 x 896 mm
4.8 mm	495 x 371 mm	995 x 746 mm
8 mm	295 x 221 mm	595 x 446 mm
12 mm	195 x 146 mm	395 x 296 mm
16 mm	145 x 109 mm	295 x 221 mm
25 mm	91 x 68 mm	187 x 140 mm
35 mm	64 x 48 mm	132 x 99 mm

Table 23: *Mako G-125B/C focal length vs. field of view*

Mako G-131B/C

Focal length for type 1/1.8 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.5 mm	760 x 606 mm	1526 x 1217 mm
6 mm	568 x 453 mm	1143 x 911 mm
10 mm	338 x 270 mm	683 x 545 mm
17 mm	196 x 156 mm	399 x 318 mm
25 mm	131 x 105 mm	269 x 215 mm
35 mm	92 x 73 mm	190 x 152 mm

Table 24: *Mako G-131B/C focal length vs. field of view*

Mako G-192B/C

Focal length for type 1/1.8 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.5 mm	793 x 595 mm	1593 x 1195 mm
6 mm	593 x 445 mm	1193 x 895 mm
10 mm	353 x 265 mm	713 x 535 mm
17 mm	205 x 153 mm	416 x 312 mm
25 mm	137 x 103 mm	281 x 211 mm
35 mm	96 x 72 mm	199 x 149 mm

Table 25: *Mako G-192 focal length vs. field of view*

Mako G-223B/NIR/C

Focal length for type 2/3 sensor[1]	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	1162 x 617 mm	2335 x 1240 mm
6 mm	927 x 492 mm	1865 x 991 mm
6.5 mm	855 x 454 mm	1721 x 914 mm
8 mm	692 x 368 mm	1396 x 742 mm
10 mm	552 x 293 mm	1114 x 597 mm
12 mm	458 x 243 mm	927 x 492 mm
16 mm	341 x 181 mm	692 x 369 mm
25 mm	214 x 114 mm	439 x 223 mm
35 mm	150 x 79 mm	310 x 165 mm
50 mm	101 x 54 mm	214 x 114 mm
75 mm	64 x 34 mm	139 x 74 mm
90 mm	51 x 27 mm	114 x 60 mm

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

Table 26: *Mako 223B/NIR/C focal length vs. field of view*

Mako G-234B/C

Focal length for type 1/1.2 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
12 mm	461 x 290 mm	933 x 586 mm
16 mm	343 x 215 mm	697 x 438 mm
25 mm	215 x 135 mm	442 x 278 mm
35 mm	150 x 94 mm	312 x 196 mm
50 mm	102 x 64 mm	215 x 135 mm

Table 27: *Mako G-234B/C focal length vs. field of view*

Mako G-419B/NIR/C

Focal length for type 1 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
8 mm	692 x 692mm	1396 x 1396 mm
10 mm	552 x 552 mm	1114 x 1114 mm
12 mm	458 x 458 mm	928 x 928 mm
16 mm	340 x 340 mm	692 x 692 mm
25 mm	214 x 214 mm	439 x 439 mm
35 mm	150 x 150 mm	310 x 310 mm
50 mm	101 x 101 mm	214 x 214 mm
75 mm	64 x 64 mm	139 x 139 mm
90 mm	51 x 51 mm	104 x 104 mm

Table 28: *Mako G-419B/NIR/C focal length vs. field of view*

Mako G-503B/C

Focal length for type 1/2.5 sensor	Field of view	
	Distance = 500 mm	Distance = 1000 mm
4.8 mm	588 x 442 mm	1182 x 887 mm
8 mm	351 x 263 mm	707 x 531 mm
12 mm	232 x 174 mm	469 x 352 mm
16 mm	172 x 129 mm	351 x 263 mm
25 mm	108 x 81 mm	222 x 167 mm
35 mm	76 x 57 mm	157 x 118 mm

Figure 34: *Mako G-503B/C focal length vs. field of view*

IR cut filter

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

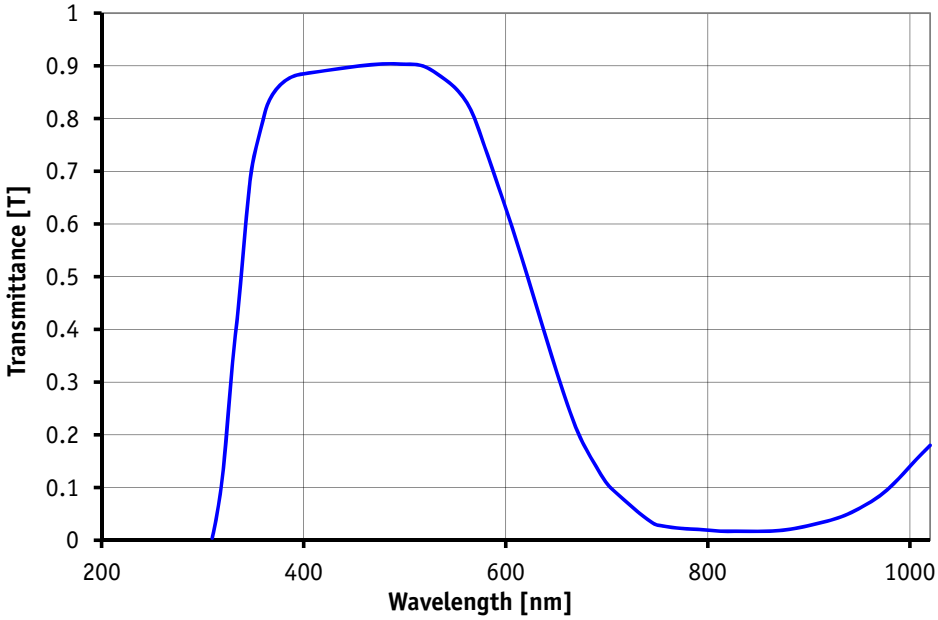
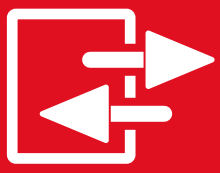


Figure 35: *Approximate spectral transmission of IR cut filter type Hoya C5000 (may vary slightly by filter lot)*

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

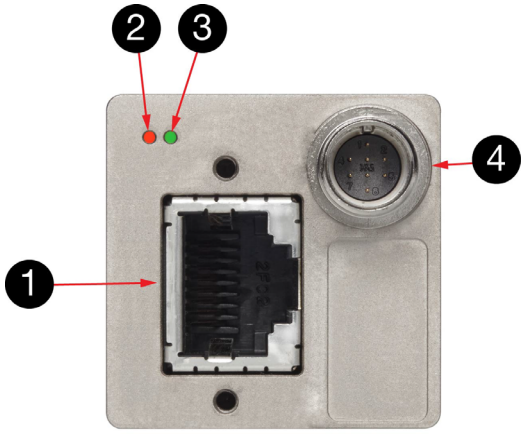


Figure 36: *Rear view of Mako G camera*

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

Status LEDs

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

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

Table 29: *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 30: *Status LED 2*

Gigabit Ethernet interface

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

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

Accessories

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

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

Camera I/O connector pin assignment

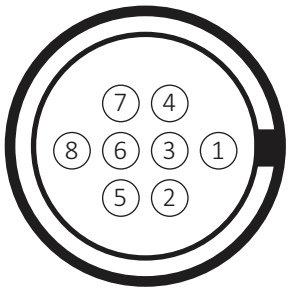
The general purpose I/O port uses a Hirose HR25-7TR-8PA(73) connector on the camera side. The mating cable connector is Hirose HR25-7TP-8S.

Safety-related instructions to avoid malfunctions

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

Hirose connector

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



Pin	Signal	Direction	Level	Description
1	Out 1	Out	Open emitter, maximum 20 mA	Opto-isolated output 1
2	Out 2	Out	Open emitter, maximum 20 mA	Opto-isolated output 2
3	Out 3	Out	Open emitter, maximum 20 mA	Opto-isolated output 3
4	In 1	In	U_{in}(high) = 3.0–24.0 V up to 36 V with external resistor of 3.3 kΩ in series U_{in}(low) = 0–1.0 V	Opto-isolated input 1
5	Isolated In GND	In	---	Isolated input signal ground
6	Isolated Out Power	In	Common VCC for outputs maximum 30 VDC	Power input for opto-isolated outputs
7	Camera Power	In	12–24 VDC +/- 10%	Camera power supply
8	Camera GND	In	GND for external power	Ground for camera power supply

Table 31: *I/O connector pin assignment*

Input block diagram

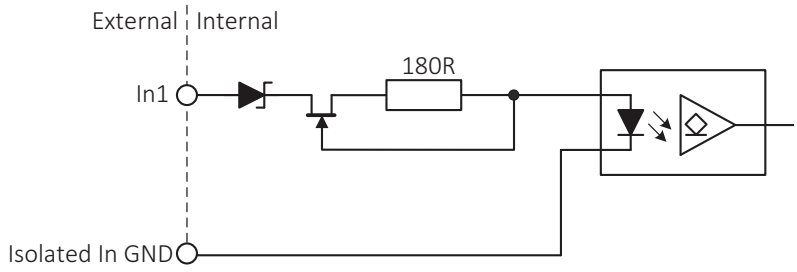


Figure 37: *Input block diagram*

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)	0–1.0 V
U_{in} (high)	3–24 V
Current (constant-current source)	3–4 mA

Table 32: *Input parameters*

Minimum pulse width

The minimum pulse width for all Mako G cameras is:

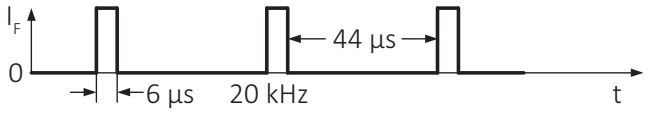


Figure 38: *Minimum pulse width*

Test conditions

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

Output block diagram

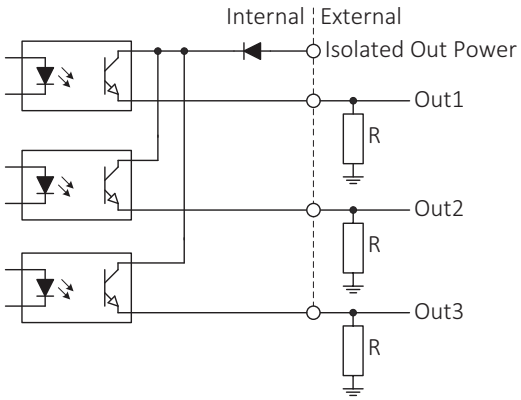


Figure 39: *Output block diagram*

Output and isolated out power

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

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

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

Table 33: *Isolated Out Power and external resistor*

Output switching times

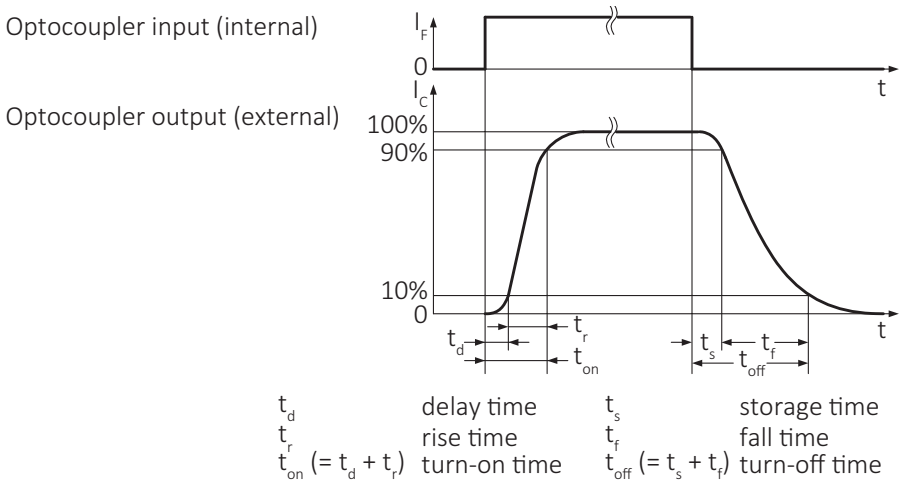


Figure 40: *Output switching times*

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

Table 34: *Parameters*

Test conditions

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

- Higher external values increase the times in table 34 above.
- It is recommended to trigger on the rising edge. This guarantees the fastest possible reaction time.

Control signals

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

Input block diagram

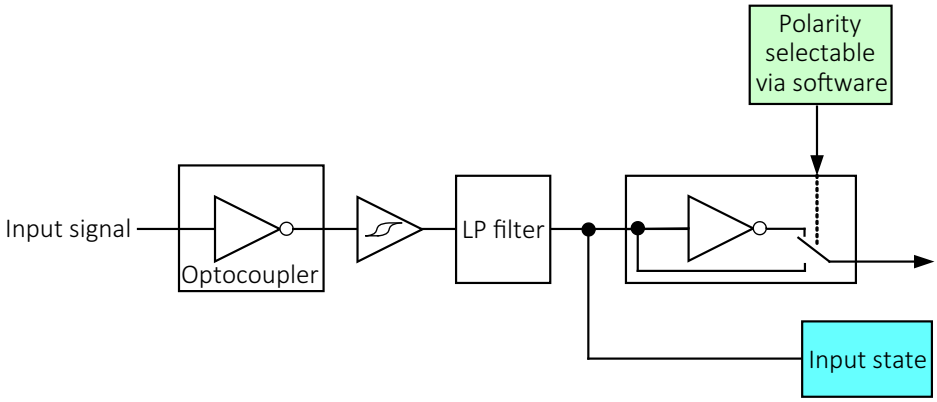


Figure 41: *Input block diagram*

Output signals

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

Signal	Description
GPO	Configured to be a general purpose output, control is assigned to SyncOutGpoLevels.
AcquisitionTriggerReady	Active once the camera has been recognized by the host PC and is ready to start acquisition.
FrameTriggerReady	Active when the camera is in a state that will accept the next frame trigger.

Table 35: *Output signals*

Signal	Description
FrameTrigger	Active when an image has been initiated to start. This is a logic trigger internal to the camera, which is initiated by an external trigger or software trigger event.
Exposing	Active for the duration of sensor exposure.
FrameReadout	Active during frame readout, i.e., the transferring of image data from the CCD to the camera memory.
Imaging	Imaging is high when the camera image sensor is either exposing and/or reading out data.
Acquiring	Active during an acquisition stream.
SyncIn1	Active when there is an external trigger at SyncIn1.
Strobe1	The output signal is controlled according to Strobe1 settings.

Table 35: *Output signals (Continued)*

Output block diagram

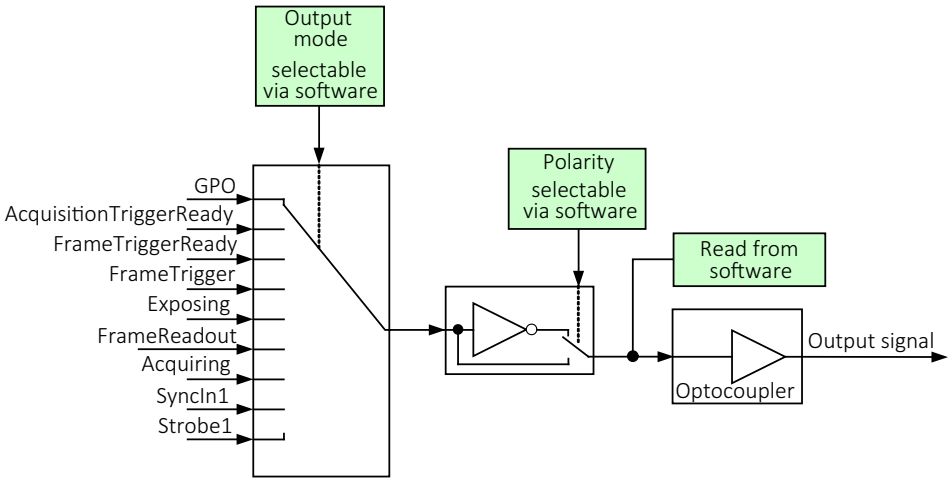


Figure 42: *Output block diagram*

Trigger timing diagram

The following diagram explains the general trigger concept.

Further information available online

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

https://www.alliedvision.com/fileadmin/content/documents/products/cameras/various/features/GigE_Features_Reference.pdf

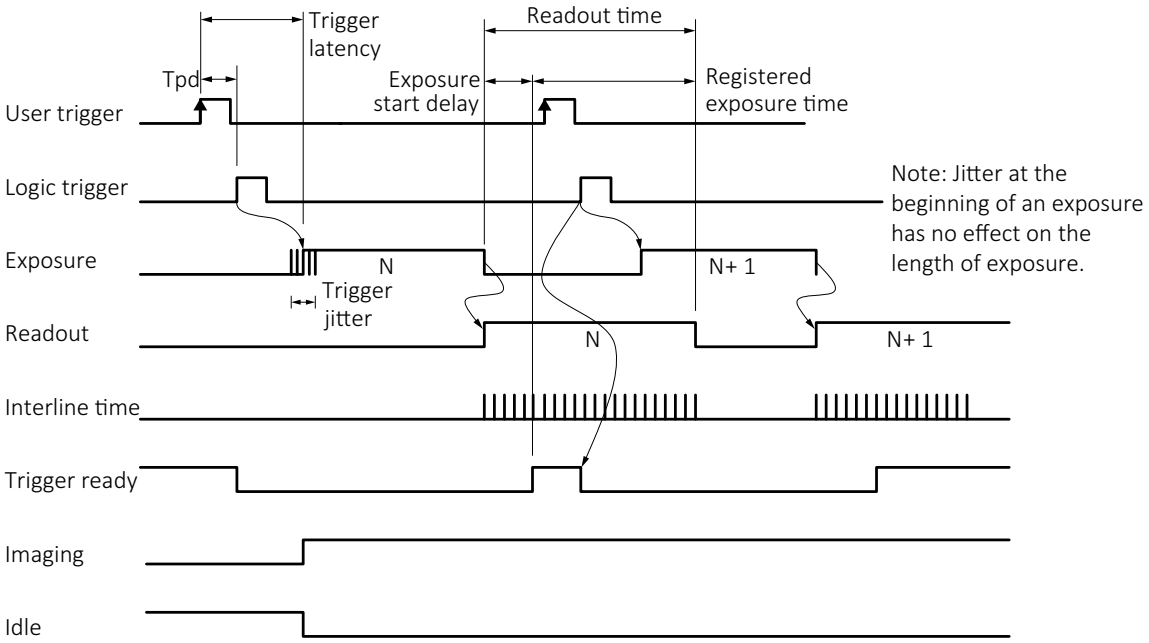


Figure 43: *Trigger timing diagram*

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)
Tpd	Propagation delay between the user trigger and the logic trigger
Exposure	High when the camera image sensor is integrating light
Readout	High when the camera image sensor is reading out data
Trigger latency	Time delay between user trigger and start of exposure
Trigger jitter	Error in the trigger latency time
Trigger ready	Indicates that the camera will accept the next trigger
Registered exposure time	Exposure time value currently stored in the camera memory
Exposure start delay	Registered exposure time subtracted from the Readout time and indicates when the next exposure cycle can begin such that the exposure will end after the current readout
Interline time	Time between sensor row readout cycles
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 36: *Trigger definitions*

Trigger rules

User trigger pulse width

The user trigger pulse width should be at least three times the width of the trigger latency as indicated in *Specifications* on page 17.

- The end of exposure will always trigger the next readout.
- The end of exposure must always end after the current readout.
- The start of exposure must always correspond with the interline time if readout is true.
- Exposure start delay equals the readout time minus the registered exposure time.

Triggering during the idle state

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

Triggering during the readout state

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

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

Image data flow

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

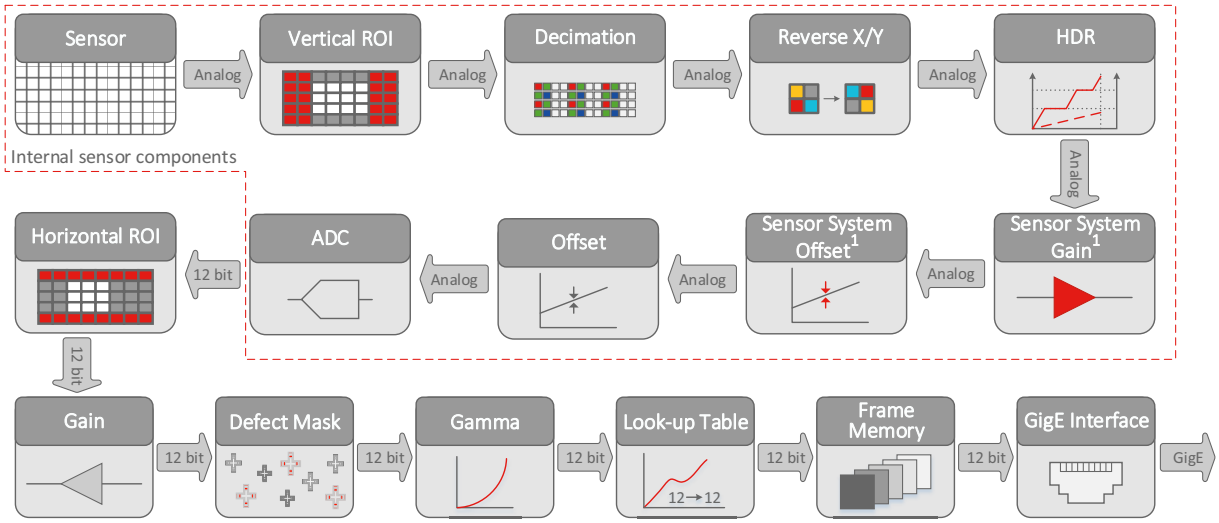
Camera control documents

A complete description of individual blocks can be found online:

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

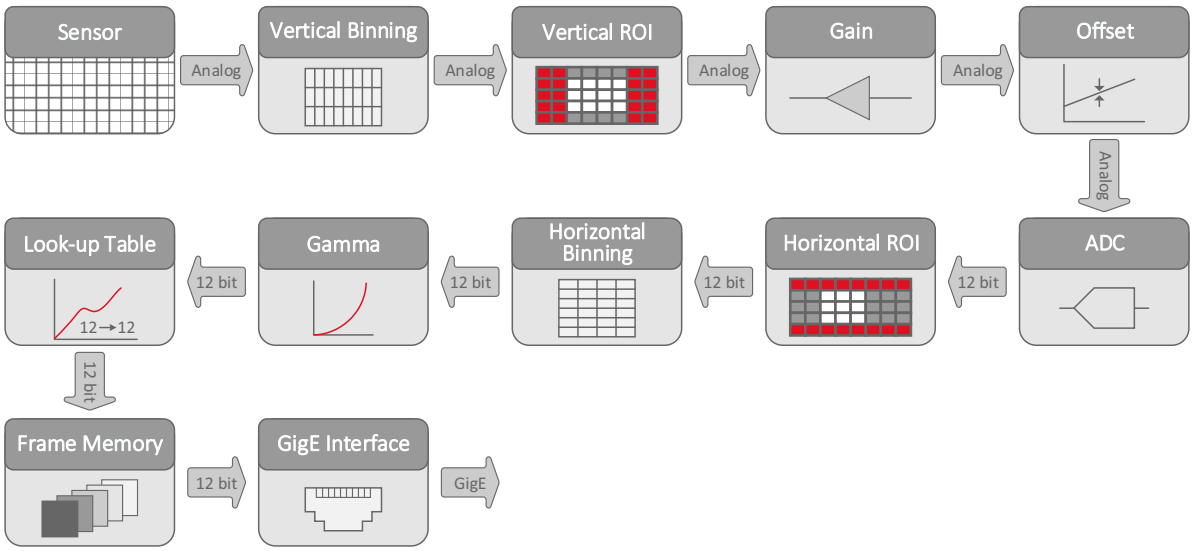
Mako G monochrome cameras

Mako G-030B

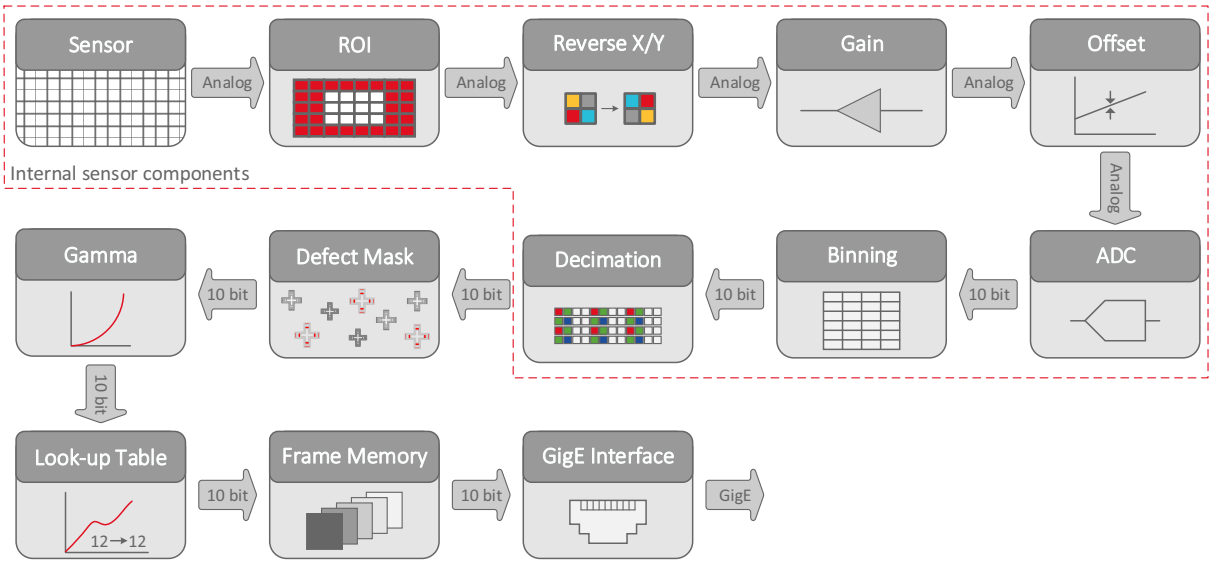


[1] Factory calibrated. Not a user control.

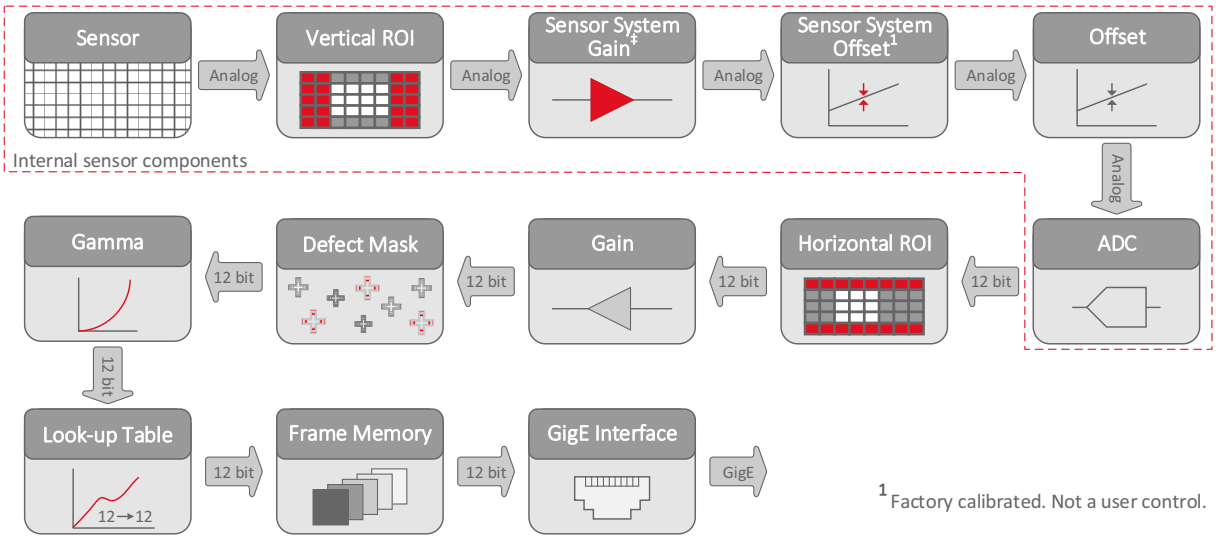
Mako G-032B, G-125B



Mako G-131B, G-192B

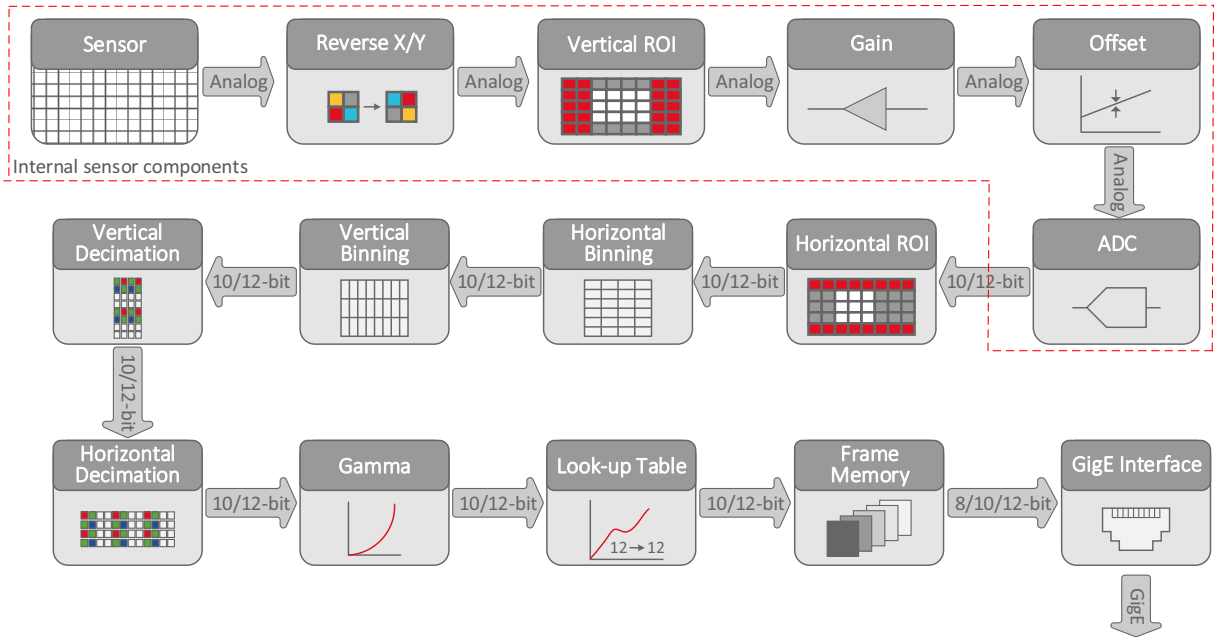


Mako G-223B, G-223B NIR, G-419B, G-419B NIR



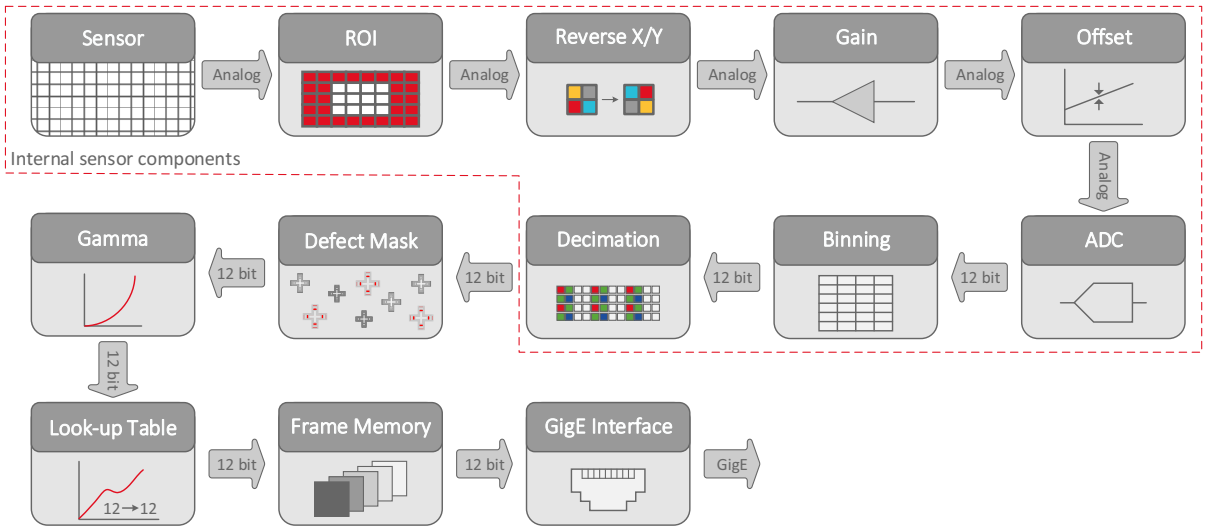
[1] Factory calibrated. Not a user control.

Mako G-234B



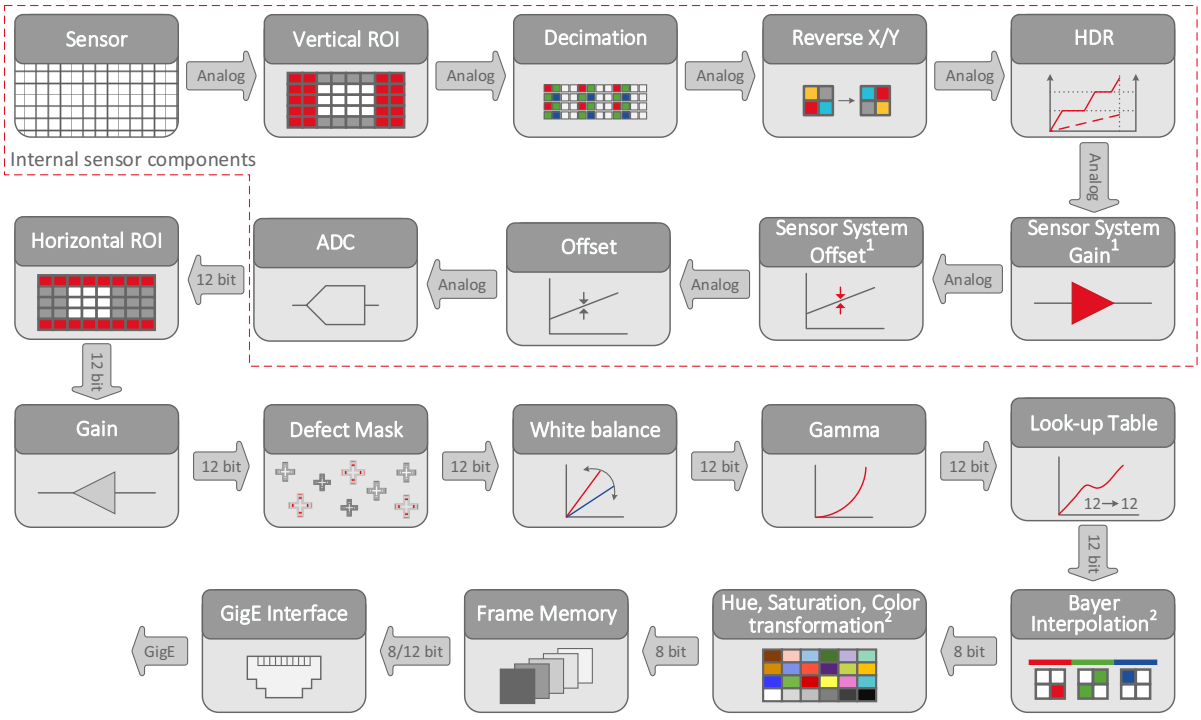
Pixel Format	Data Path in use
Mono12Packed, BayerRG12Packed	12-bit
Mono12, BayerRG12	12-bit
Mono8, BayerRG8	10-bit
YUV411	10-bit
YUV422	10-bit
YUV444, RGB8Packed, BGR8Packed	10-bit

Mako G-503B


Sensor
Analog
ROI
Analog
Reverse X/Y
Analog
Gain
Analog
Offset
Analog
Internal sensor components
ADC
12 bit
Binning
12 bit
Decimation
12 bit
Defect Mask
12 bit
Gamma
12 bit
Look-up Table
12→12
12 bit
Frame Memory
12 bit
GigE Interface
GigE

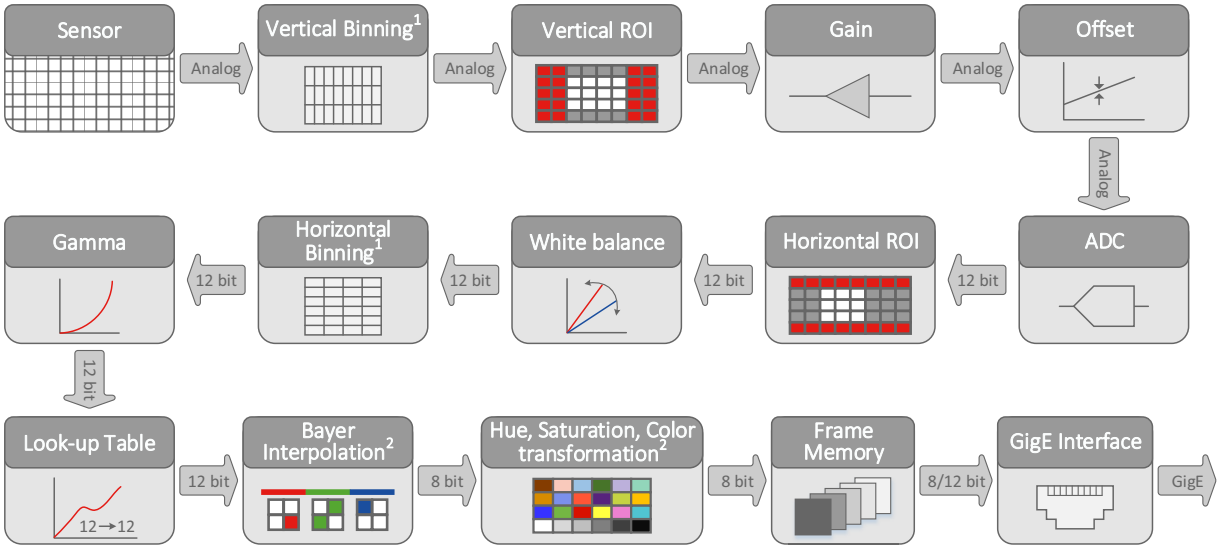
Mako G color cameras

Mako G-030C



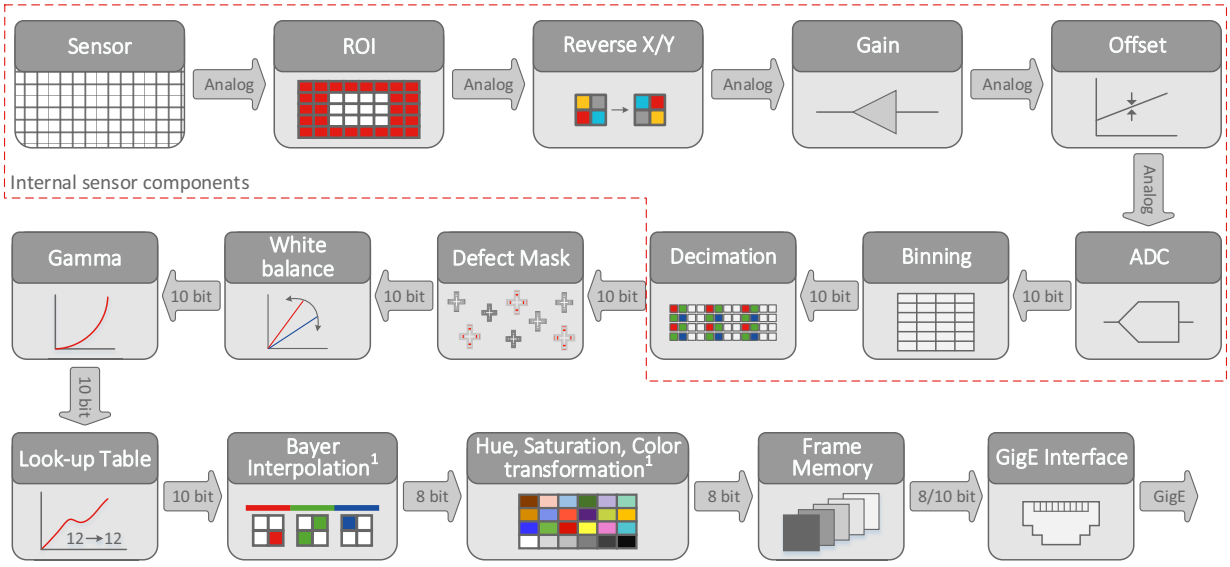
[1] Factory calibrated. Not a user control.
[2] For on-camera interpolated *PixelFormats* only (8-bit output). Raw un-interpolated *PixelFormats* skip this block (8/12 bit output) depending upon the bit depth of *PixelFormat* used.

Mako G-032C, G-125C



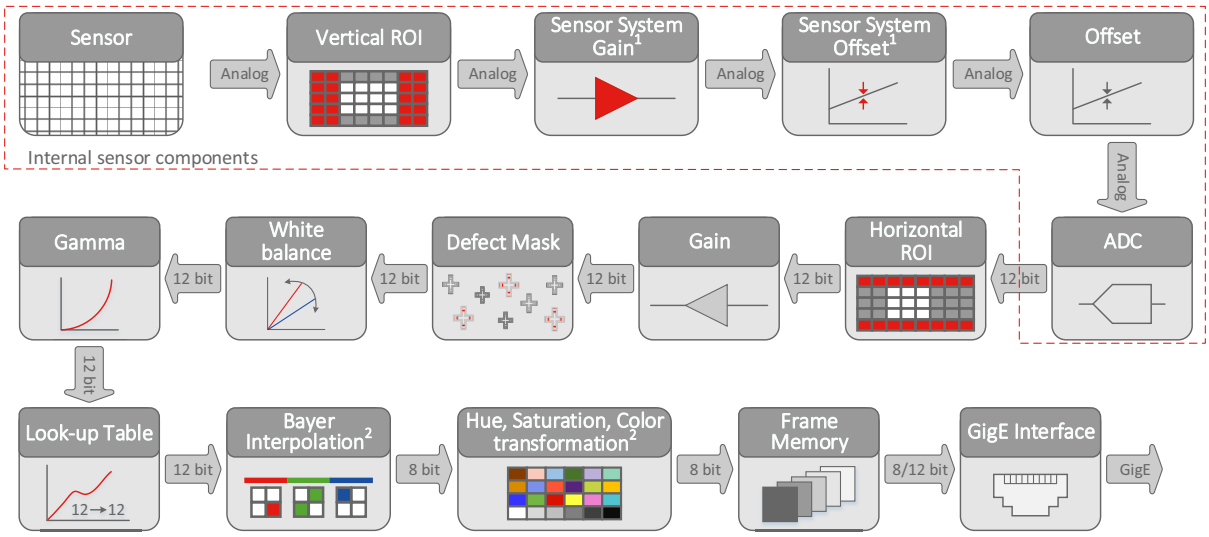
[1] Color information is lost while binning is active
[2] For on-camera interpolated *PixelFormats* only (8-bit output). Raw un-interpolated *PixelFormats* skip this block (8/12 bit output) depending upon the bit depth of *PixelFormat* used.

Mako G-131C, G-192C



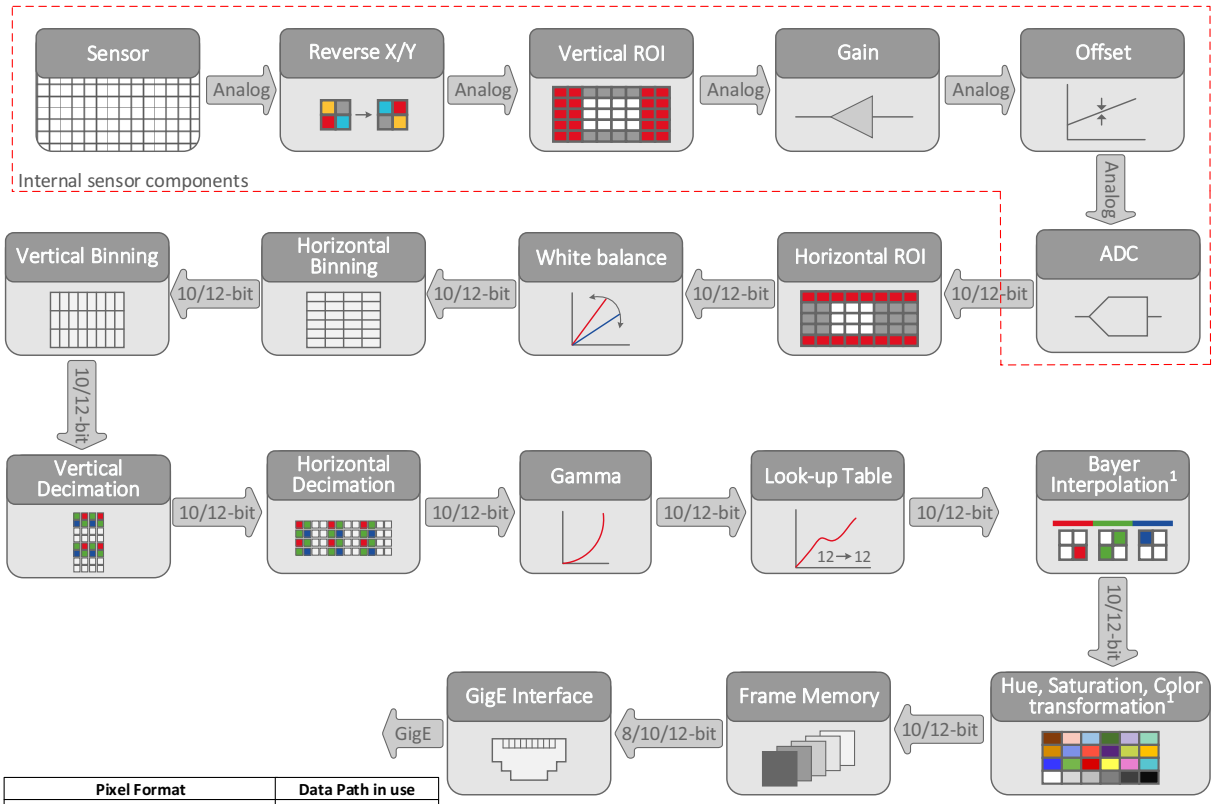
[1] For on-camera interpolated *PixelFormats* only (8-bit output). Raw un-interpolated *PixelFormats* skip this block (8/10 bit output) depending upon the bit depth of *PixelFormat* used.

Mako G-223C, G-419C



[1] Factory calibrated. Not a user control.
[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.

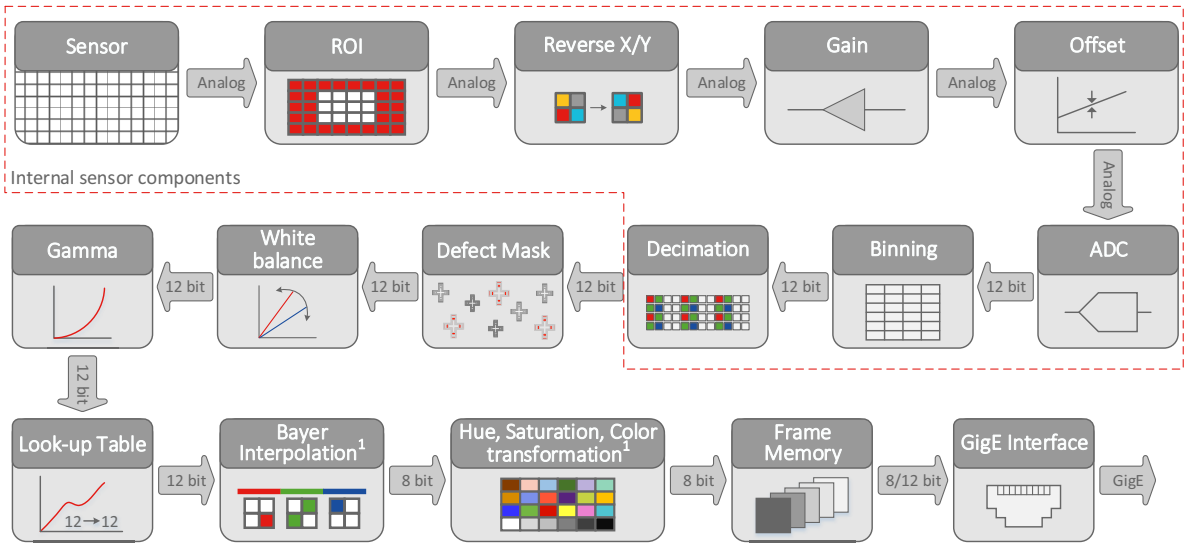
Mako G-234C



Pixel Format	Data Path in use
Mono12Packed, BayerRG12Packed	12-bit
Mono12, BayerRG12	12-bit
Mono8, BayerRG8	10-bit
YUV411	10-bit
YUV422	10-bit
YUV444, RGB8Packed, BGR8Packed	10-bit

[1] 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-503C



[1] 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.

Cleaning optical components

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

Important instructions to be read first

Please read these instructions before you contact Allied Vision or your Allied Vision camera distributor for assistance.

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

Warranty

Warranty information available online

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

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

Warranty precautions

To ensure your warranty remains in effect:

- Do not open the camera housing.
- Follow instructions described below.
- Use only optical quality tissue/cloth if you must clean a lens or 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.

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

Keep optical components clean

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

When screwing/unscrewing the camera lens or dust cap, hold the camera with the C-Mount / 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 44: *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, filter/protection glass, or on the sensor protection glass. Every Mako G camera is cleaned prior to sealing and shipment; however, impurities may develop due to handling or unclean environments.

As shown in figure 45, 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.

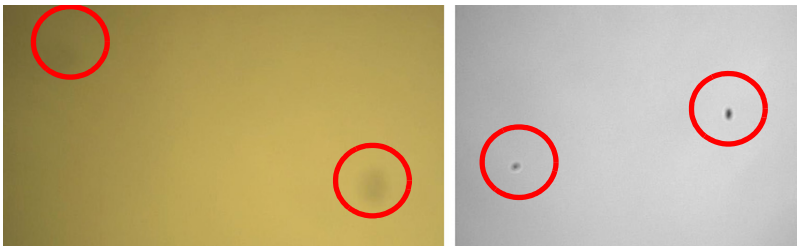


Figure 45: *Image with tiny dust on the filter (left) and dust on the sensor (right)*

Locating impurities

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

1. Start acquiring a uniform image (e.g. a white sheet of paper) with the camera.
2. To identify the affected surface, move the suspected optical component and see if the contamination follows this movement.

a. If you move only the lens (not the camera) and the impurity moves as well, the impurity is on the lens.

b. If you move the IR cut filter/protection glass window and the impurity moves as well, the impurity is on the filter/protection glass. Carefully remove the filter/protection glass 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 IR cut filter/protection glass, it is probably on the sensor.

Removing IR cut filter/protection glass

To remove the IR cut filter/protection glass use the special tool (Allied Vision part number E9020001 for 16mm filter and part number 3851 for 22 mm filter).

Materials for cleaning optical components

Use only these cleaning materials for optical components

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

Never use these cleaning materials for optical components

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

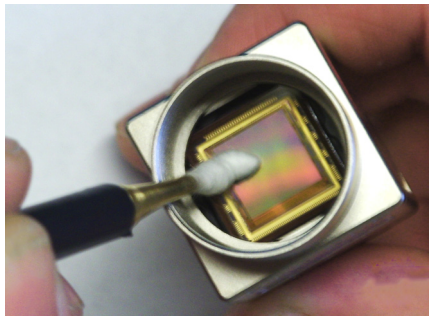
Cleaning Instructions

Workplace conditions

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

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

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



4. Wipe the glass surface with a spiral motion from the center to the rim. Normally, several spiral wipes are recommended. Wipe only on glass avoiding contact to metal surfaces, because microscopic dirt could be released and could cause scratches on the glass.

5. When you have finished cleaning, examine the surface in a strong light. Take an out-of-focus picture of a flat, illuminated surface to see if any dirt or dust remains.
6. If dust spots remain, repeat this procedure using new clean lens tissue (as described above).

Cleaning issues

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

Cleaning with compressed air

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

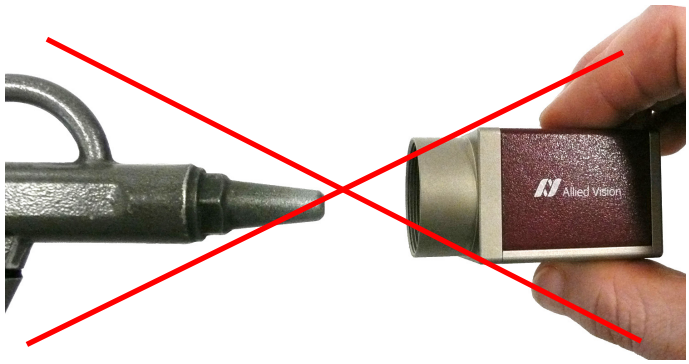


Figure 46: *Do not use compressed air*

Possible material damage

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

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

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

Compressed air pressure and operating distance

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

Firmware update

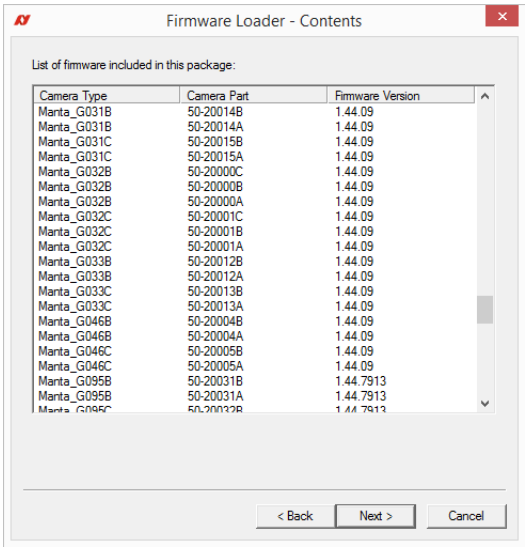
This chapter includes:

- How to update the firmware on your Allied Vision Mako G camera.

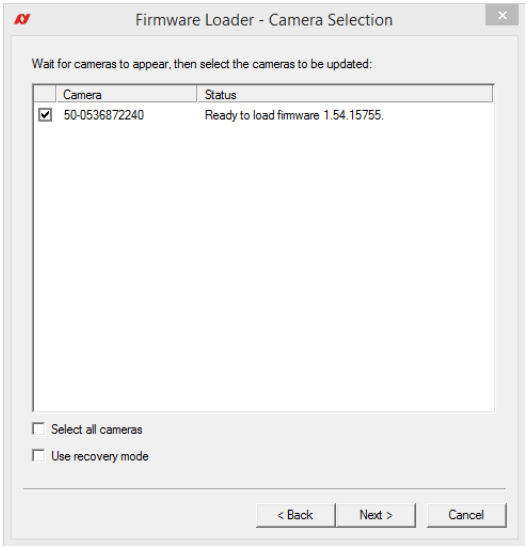
To update the firmware on your Allied Vision GigE camera

1. Launch the Allied Vision Firmware Loader.

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



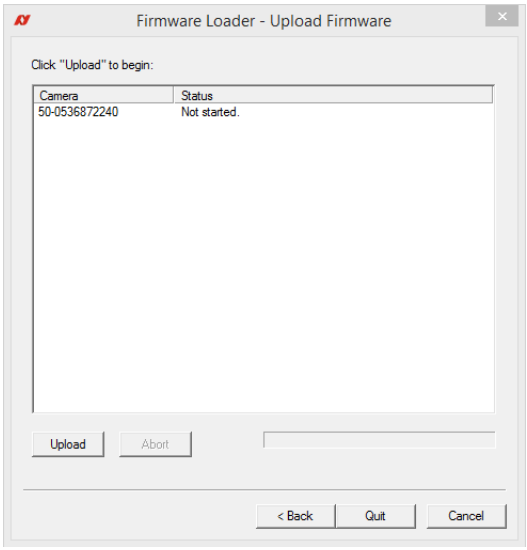
3. Click **Next**. You can select your camera model on this page.



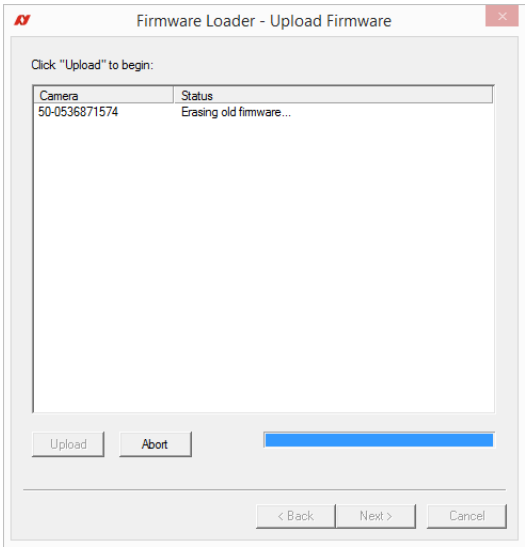
Recovery Mode

Select the **Use recovery mode** checkbox if the connected GigE camera is not found by the firmware loaded, or if the GigE camera is listed as unavailable.

4. Click **Next**.



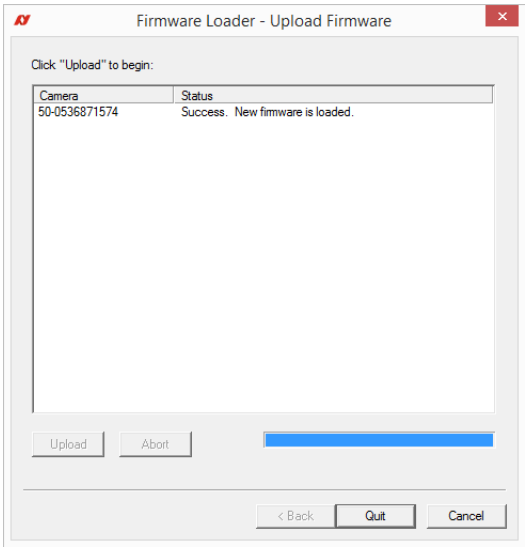
5. Click **Upload** to start the update. The existing firmware will be erased and the new firmware will be updated to the camera.



Possible material damage

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

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



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