

# Operational Manual

## GigE<sup>PRO</sup>

Gigabit Ethernet CMOS cameras



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## General information

### Scope of the manual

This manual introduces the GigEPRO camera family and covers all common aspects of work with these cameras. Technical specifications and other model-specific data are listed in section [Specifications](#) p.19 .

### Related documents

- SynView Quick Start Guide — SynView SDK package overview, installation instructions and quick start guide.
- SynView Programmers Guide — SynView API tutorial with programming examples
- SynView Reference Guide — SynView API reference guide with class hierarchy
- GigEPRO Open Camera Platform Description — GigEPRO “custom module” integration

## Overview

The NET GigEPRO camera series is designed for advanced digital image processing applications requiring real-time image processing functionality of the camera with compliancy to GigE Vision and GenICam standards. With GigEPRO cameras customers have access to already available NET image processing functions or can apply own image processing functions or even decide for a combination of all in order to achieve efficiency improvements in image processing.

As sophisticated image analysis and processing functions become quite complex and might be impossible to perform on a host PC at reasonable cost, the GigEPRO camera is offered with different FPGA options. GigEPRO customers are free to decide on the optimal software and hardware configuration.

## Image Sensors

GigEPRO cameras are equipped with color, monochrome and infrared CMOS image sensors with resolutions from 0.36 to 10 megapixel. These sensors allow high speed frame rates at full resolution. Its sensors comprise global shutter for fast moving objects and rolling shutter (also with global reset image readout) to capture images with outstanding signal quality.

Table 1: GigEPRO Image Sensors

Camera model	Sensor type	Image sensor	Resolution [px]	Format	Frames per second	Pixel size [μm]	Shutter
GP4136M	monochrome	EV76C560	1280 x 1024	1/1.8"	61	5.3	G, R, GR
GP4136IR	monochrome / NIR	EV76C661	1280 x 1024	1/1.8"	61	5.3	G, R, GR
GP4136C	color	EV76C560	1280 x 1024	1/1.8"	61	5.3	G, R, GR
GP4206M	monochrome	EV76C570	1600 x 1200	1/1.8"	52	4.5	G, R, GR
GP4206C	color	EV76C570	1600 x 1200	1/1.8"	52	4.5	G, R, GR
GP2239M	monochrome	IMX174	1920 x 1200	1/1.2"	50	5.86	G
GP2239C	color	IMX174	1920 x 1200	1/1.2"	50	5.86	G
GP2238M	monochrome	IMX249	1920 x 1200	1/1.2"	38	5.86	G
GP2238C	color	IMX249	1920 x 1200	1/1.2"	38	5.86	G
GP2507M	monochrome	IMX264	2448 x 2048	2/3"	22	3.45	G
GP2507C	color	IMX264	2448 x 2048	2/3"	22	3.45	G
GP2507Z	monochrome	IMX264MZR	2448 x 2048	2/3"	22	3.45	G
GP2646M	monochrome	IMX178	3072 x 2048	1/1.8"	17*	2.4	RGR
GP2646C	color	IMX178	3072 x 2048	1/1.8"	17*	2.4	RGR
GP11004M	monochrome	MT9J003	3840 x 2748	1/2.3"	7	1.67	RGR
GP11004C	color	MT9J003	3840 x 2748	1/2.3"	7	1.67	RGR

## Scope of Delivery

### Content

- GigEPRO is offered as follows:
  - Image Sensor: see [Table 1: GigEPRO Image Sensors](#)
  - FPGA type: XILINX Spartan 6 LX45 / Spartan 7 LX50
  - DDR3 memory size: 1Gbit
- CD-ROM including full SynView installer including:
  - SynView Software Development Kit (SDK) with viewer software (sv.explorer)
  - SynView Filter Driver and Kernel Driver
  - SynView Quick Start Guide
  - SynView Programmers Guide
  - SynView Reference Guide
  - GigEPRO Operational Manual (this document)

### Options

- GigEPRO can be further customized with the following configuration options:
  - FPGA type: XILINX Spartan 6 LX75, LX100
  - DDR3 memory size: 2Gbit, 4Gbit

### Optionally available hardware accessories

The GigEPRO camera product does not include any accessories. Other equipment must be provided separately. System components necessary for using this camera series are listed below:

#### ***GigEPRO camera mounting plate***

The mounting plate can be attached to the bottom of the camera and allows the camera to be mounted on a tripod with a 1/4" screw. The GigEPRO camera mounting plate comes with four 6mm M3 screws.

- CA-Base-Plate-GigEPRO: **Order number 05005800xx (\*1)**

#### ***Auxiliary connection cable***

This cable allows you to connect digital IO and auxiliary power to the camera. The cable is 5m long with a header (JST SHR-08V-S-B) on one side fitting into the GigEPRO auxiliary I/O connector.

- CA-iCube-TRIGGER-5m: standard version **Order number 06087600xx (\*1)**

- ZY-iCube-TRIGGER-TC-5m: trailer chain version **Order number 06091100xx (\*1)**

### **LAN Cable**

This cable is used to connect the camera to host equipment. Ethernet packets (stream and control) are transmitted via this cable. Please use a LAN cable that supports 1000BASE-T (Cat 5e or over). This product is able to connect a LAN cable that is equipped with screw lock mechanism.

- CA-G18-S10-05: trailer chain version **Order number 06077400xx (\*1)**
- CA-G18-S10-10: trailer chain version **Order number 06077401xx (\*1)**

### **Network Interface Card (NIC) (\*2)**

This is the interface card to connect to the camera. Usually this card is installed to a PCIe expansion slot of host PC etc. Please use 1000BASE-T NIC, supporting Jumbo Frame is recommended.

### **PoE Switching HUB / PoE Power Injector etc. (\*2)**

Use this equipment when you supply power to the camera from PoE. Please use 1000BASE-T equipment, supporting Jumbo Frame is recommended.

*\*1: Optional part. Contact your NET sales contact for details of option units.*

*\*2: Commercial items.*

### **C-mount lenses and Illumination**

Contact your NET sales contact for details.

## Optionally available software accessories

- GigEPRO calibration tool

## Optionally available Image Processing (NET IP) library functions

Please ask your NET sales contact for further details

- Geometric Correction (GC) and calibration tool
- Flatfield Correction (FFC) and calibration tool
- Defect Pixel Correction (DPC) and calibration tool
- Bayer Channel Compensation (BCC) and calibration tool
- Canny Edge Detection
- 2D Down Scaling
- High Dynamic Range (HDR) Image Mapping

## Optionally available for “Open Camera” customers

- GigEPRO development and debug cable and programming dongle
- CD-ROM including:
  - GigEPRO XILINX ISE Project including programming templates
  - GigEPRO Open Camera Platform Description

## Standard Conformity

### Legal Notice

The cameras implement the **GigE Vision 1.2** standard and were properly registered as GigE Vision compliant devices with AIA.

The cameras (and supporting libraries) fully implement the **GenICam** standard, including SFNC (Standard Features Naming Convention) and GenTL.

### RoHS

The product fulfills the requirements of the **EU directive RoHS 2015/863/EU** regarding the restrictive use of certain hazardous materials in electric applications within the allowable limits.

## FCC

This equipment has been tested and found to comply with the limits for a **class A** 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 commercial 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 communication.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

## CE

This apparatus has been certified to meet or exceed the standards for CE compliance per Council Directives. Pertinent testing documentation is available for verification. This product following the provision of directive 2014/30/EU.

## Safety Precautions

Before using this product read these safety precautions carefully. Important information is shown in this Operational Manual to protect users from injuries and property damages and to enable them to use the product safely and correctly.

Please be sure to thoroughly understand the meanings of the following signs and symbols before reading the main text that follows, and observe the instructions given herein.

[Definition of Safety Signs]

Safety Signs	Description
 WARNING	Indicates a potentially hazardous situation that may result in death or serious injury (*1) in the event of improper handling.
 CAUTION	Indicates a potentially hazardous situation that may result in light to moderate injuries (*2) or only in property damage (*3) in the event of improper handling.

### Notes

\*1: "Serious injury" refers to cases of loss of eyesight, wounds, burns (high or low temperature), electric shock, broken bones, poisoning, etc., which leave after-effects or which requires hospitalization or a long period of outpatient treatment of cure.

\*2: "Light to moderate injuries" refers to injuries, burns, electric shock etc. that do not require hospitalization or long-term treatment.

\*3: "Property damage" refers to cases of extensive damage involving damage to buildings, equipment, farm animals, pet animals and other belongings.

[Explanation of Safety Symbols]

Safety Symbols	Description
 PROHIBITED	This sign indicates <b>PROHIBITION</b> (Do not). The content of prohibition is shown by a picture or words beside the symbol.
 MANDATORY	This sign indicates <b>MANDATORY ACTION</b> (You are required to do). The content of action is shown by a picture or words beside the symbol.

## General Handling

### WARNING



	<p><b>Stop operation immediately when any abnormality or defect occurs.</b> If abnormal conditions are present, such as smoke, a burning smell, ingress of water or foreign matter, or if the equipment is dropped or malfunctions, fire or electric shock may result. Be always sure to disconnect the power cable from the wall socket at once and contact your dealer.</p>
	<p><b>Do not use the equipment in locations subject to water splashes.</b> Otherwise, fire or electric shock may result.</p>
	<p><b>Do not disassemble, repair, or modify the equipment.</b> Otherwise, fire or electric shock may result. For internal repair, inspection or cleaning, contact your sales representative.</p>
	<p><b>Do not place anything on the equipment.</b> If metallic objects, liquid, or other foreign matter enters the equipment, fire or electric shock may result.</p>
	<p><b>Do not install the equipment in an unstable or inclined location or locations subject to vibration or impact.</b> Otherwise, the equipment may topple over and cause personal injury.</p>
	<p><b>During an electrical storm, do not touch the power cable and the connection cable.</b> Otherwise, an electric shock may result.</p>
	<p><b>Use the specified voltage.</b> Use of an unspecified voltage may result in fire or electric shock.</p>
	<p><b>Do not handle roughly, damaged, fabricated, bent forcefully, pulled, twisted, bundled, placed under heavy objects or heated the power cable and the connection cable.</b> Otherwise, fire or electric shock may result.</p>

CAUTION



	<b>Observe the following when installing the equipment:</b>
Instruction	Do not cover the equipment with a cloth, etc. Do not place the equipment in a narrow location where heat is likely to accumulate. Otherwise, heat will accumulate inside the equipment, possibly resulting in a fire.
	<b>Do not place the equipment in locations subject to high moisture, oil fumes, steam, or dust.</b> Otherwise, fire or electric shock may result.
Avoid	
	<b>Do not install the equipment in locations exposed to direct sunlight or humidity.</b> Otherwise, the internal temperature of the equipment will rise, which may cause a fire.
Avoid	
	<b>Use only specified the power cable and the connection cables.</b> Otherwise, fire or electric shock may result.
Instruction	
	<b>Do not give strong impact against the equipment.</b> It may cause the trouble.
Avoid	
	<b>When performing connection, turn off power.</b> When connecting the power cable and the connection cable, turn off the equipment power. Otherwise, fire or electric shock may result.
Instruction	
	<b>Do not expose the camera head to any intensive light (such as direct sunlight).</b> Otherwise, its inner image pickup device might get damaged.
Avoid	
	<b>Avoid short-circuiting signal output.</b> Otherwise, a malfunction may occur.
Avoid	
	<b>Avoid giving a strong shock against the camera body.</b> It might cause a breakdown or damage. If your camera is used in a system where its camera connector is subjected to strong repetitive shocks, its camera connector is possible to break down. If you intend to use your camera in such a situation, if possible, bundle and fix a camera cable in the place near the camera, and do not transmit a shock to the camera connector.
Avoid	

## Usage Notes

### *Read the documentation*

Read the camera documentation before using the camera.

### *Camera power*

Incorrect input power can damage the camera. Follow guidelines in section [Power Supply](#) p.21. Do not reverse power polarity. Do not connect or disconnect other cables when the camera power is on.

### *Opening the camera*

Do not open the camera. Do not let liquid, dust, flammable or metallic material to get inside the camera.

### *Environmental storage conditions*

Temperature: -20°C ~ 60°C  
Humidity: 90% or less (no condensation)

### *Environmental operating conditions*

Always use the camera in conditions meeting the specification in this chapter. Do not use the product in locations where the ambient temperature or humidity exceeds the specifications. In a thermal challenging environment the customer needs to ensure sufficient heat dissipation with a thermal connection to the bottom of the camera housing and sufficient airflow.

Non adequate thermal connection may increase heat induced noise or degrade image quality in other ways and internal components may be adversely affected up to camera outages due to overheating.

Temperature	Range	Measurement
Environmental	0°C ~ 45°C	close to the camera case
Camera housing	≤ 50°C	at camera case
Camera internal	≤ 65°C	read internal temperature sensor
Humidity	Relative	
Environmental	20 %–90 %	non-condensing

### *Maintenance*

Turn off power to the equipment and wipe it with a dry cloth. If it becomes severely contaminated, gently wipe the affected areas with a soft cloth dampened with diluted neutral detergent. Never use

alcohol, benzene, thinner, or other chemicals because such chemicals may damage or discolor the paint and indications.

### ***Cleaning the sensor window***

Avoid cleaning the sensor window if possible. Keep lens cap closed as long as no lens is attached, avoid touching the sensor. If necessary, clean the sensor window using compressed air. If further cleaning is required, use lint-free, ESD-safe cloth wiper. Avoid cloth that could generate static charge or that could scratch the window. The camera should be cleaned in an ESD-safe area. The person performing cleaning should be earthed.

### ***Connectors***

Take care when handling the camera so that no damage can be done to the connectors. Prevent foreign objects in the connectors.

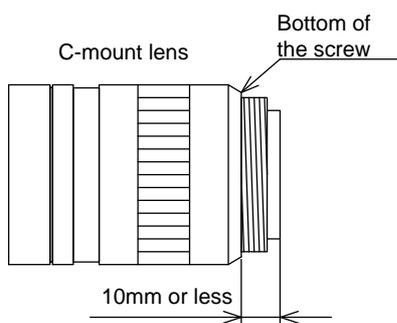
### ***Handle carefully***

Always transport the camera in its original packaging. Do not drop the equipment or allow it to be subject to strong impact or vibration, as such action may cause malfunctions. Do not damage the connection cable, since this may cause wire breakage. If the camera is not in use, attach the lens cap to the camera to protect the image pickup surface. If the equipment is not to be used for a long duration, turn off power to the camera for safety.

### ***Check compatibility of lens***

Depending on lens and lighting an image can be reflected as a ghost into the imaging area. This is not a fault of the camera. Depending on the lens the performance of the camera might not be brought out fully due to deterioration in resolution and brightness in the peripheral area, aberration and other side effects. Be sure to check lens and lightning you plan to use for compatibility with your camera. When installing a lens in the camera make sure that it is not tilted. Use a mounting screw free from defects and dirt. Otherwise the lens might not be removable from the camera.

Install lenses with a protrusion from bottom of the screw equal or less than 10 mm. If a lens does not fulfill this condition it might damage the camera when trying to be installed.



**Figure 1: C-Mount Lens**

### ***Dropping Frames***

Depending on your PC or Gigabit Ethernet interface board configurations, images may not be captured properly (e.g. dropping frames). In this case, change to frame rate setting lower.

### ***Occurrence of moiré***

If you shoot thin stripe patterns, moiré patterns (interference fringes) may appear. This is not a malfunction.

### ***Electromagnetic fields***

Keep the camera away from strong electromagnetic fields. Avoid static charging and handle the camera in ESD protected area. If an intense magnetic or electromagnetic field is generated near the camera or connection cable, noise may be generated on the screen. If this occurs, move the camera or the cable.

#### ***Following information is only for EU-member states:***

The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed correctly, you help to prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about the take-back and recycling of this product, please contact your supplier where you purchased the product.



# System Requirements

## SynView – Software Development Kit (SDK)



<b>compliance</b>	GigE Vision, GenTL and GenICam (with XML files)
<b>supported image processing libraries</b>	Halcon Imaging Library, VisionPro, LabView Vision, Matlab (and all GenTL consumer like Matrox MIL)
<b>supported operating systems</b>	Windows XP (32 bit), Windows 7,8,10 (32/64 bit), Linux (32/64 bit)

# Specifications

## Outline Dimensions

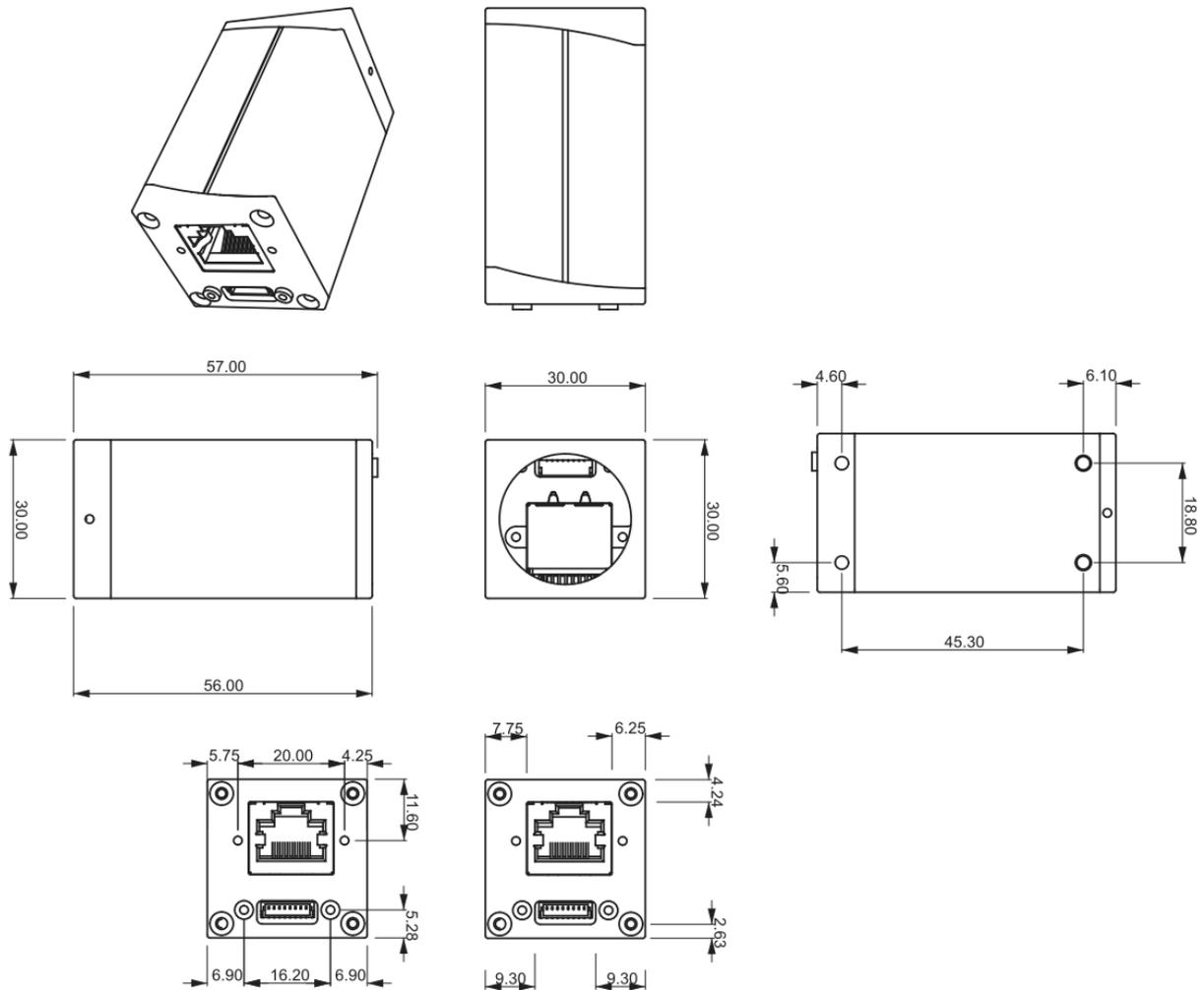


Figure 2: GigEPRO Camera Dimension

Camera body weight: 68g

CAD files on request

## Camera Mount

4 mounting screw holes are available on the camera's bottom side to mount the camera on the GigEPRO camera mounting plate, two close to the front side and two close to the back side of the camera as outlined in [Figure 2: GigEPRO Camera Dimension](#). The holes are M3 and screw length of 3mm is allowed.

## Lens Mount

### ***C-Mount***

All GigEPRO models are equipped in the factory with a C-mount adapter (1-inch thread diameter, 32 threads per inch, 17.526 mm flange back) which is adjusted to precisely fulfill the C-mount flange back distance. Modifications to this adjustment are strongly discouraged since the factory precision is lost.

### ***CS-Mount***

The GigEPRO camera supports CS-Mount with 12.5 mm flange back after removing the C-Mount adapter from the camera head. To remove the C-Mount adapter the two 1mm hex-socket screws on the top and bottom side of the camera's head can be released. After the two screws in the mounting points are loosened the C-mount adapter can be released. The CS-Mount lens can then be installed directly into the camera's head. When finished with adjusting fasten the flange back position of the lens with the two screws again to fix your adjustments.

## Interfaces

Table 2: Overview

<b>standard Ethernet connector</b>	RJ45 with screw locking, GigE Vision Camera Interface Standard for Machine Vision Version 1.2, 1 Gbit/s IEEE802.3ab conformity
<b>conformity LAN cable</b>	twisted pair (category 5e or better)
<b>LAN cable length</b>	up to 100m (for unshielded twist pair (UTP) cable)
<b>auxiliary cable connector</b>	8 pin connector, 9-24 V Auxiliary Power
<b>digital input/output</b>	external trigger input (Line0) = opto coupled (open collector) external strobe output (Line1) = opto coupled (open collector) external strobe output (Line2) = opto coupled (open collector)

### *Power Supply*

The camera supports two ways of supplying power:

- Supply from LAN cable (PoE)
- Supply from auxiliary camera cable

If both PoE and Auxiliary power are connected, power is taken from Auxiliary Power.

Power consumption varies among individual models from 2.5W up to 4W.

#### **Auxiliary DC Power Input**

The camera accepts 9–24 V DC power input on its auxiliary I/O connector.

#### **Power over Ethernet (PoE)**

The GigEPRO cameras are “PoE” compatible cameras according to the Power over Ethernet standard version IEEE 802.3af. They should be used with PoE switches (“endspans”) or power injectors (“midspans”) complying with the IEEE 802.3af specification.

Both PoE modes (A and B) are supported by the camera.

GigEPRO cameras are classified in the power level class 0.

When connecting multiple PoE cameras to a single PoE switch verify how much total power the switch can provide and how it handles cases when the limit is exceeded.

#### Note:

Please control the power supply of the camera to be off when plugging in or pulling out the I/O connector. Always use a LAN cable with a lock screw and secure the camera cable as close as possible to the camera body in order to avoid physical damage to the camera connector and electronics.

## Connector Pin Assignment

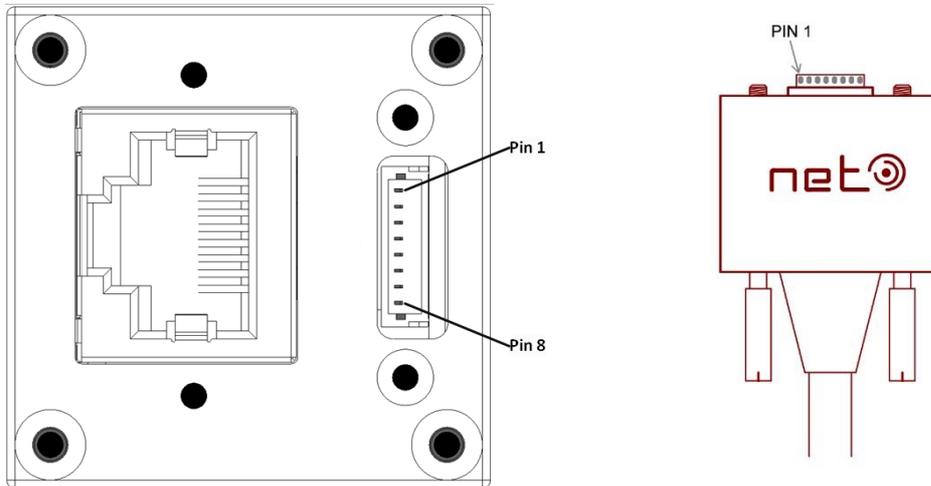


Figure 3: Camera rear view with AUX pin order (left) and trigger cable (right)

## Ethernet Connector

The camera uses the Gigabit Ethernet interface and is fully compatible with the 1000BASE-T standard (also known as IEEE 802.3ab) — Gigabit Ethernet over copper.

The camera does not support Fast Ethernet networks (100BASE-TX).

Table 3: Gigabit Ethernet Interface Connector RJ-45 Jack

Pin No.	I/O	Signal	Function
1	I/O	BI_DA+ / VDC+	Bidirectional Data A (+) / Power (+)
2	I/O	BI_DA- / VDC+	Bidirectional Data A (-) / Power (+)
3	I/O	BI_DB+ / VDC-	Bidirectional Data B (+) / Power (-)
4	I/O	BI_DC+ / VDC+	Bidirectional Data C (+) / Power (+)
5	I/O	BI_DC- / VDC+	Bidirectional Data C (-) / Power (+)
6	I/O	BI_DB- / VDC-	Bidirectional Data B (-) / Power (-)
7	I/O	BI_DD+ / VDC-	Bidirectional Data D (+) / Power (-)
8	I/O	BI_DD- / VDC-	Bidirectional Data D (-) / Power (-)

## Auxiliary I/O Connector

The camera has an 8pin connector to connect digital IO and auxiliary power.

Table 4: Auxiliary I/O Connector pin assignment

Pin No.	I/O	Signal	Function
1	I	LINE 0	Trigger Input
2	I	LINE 0 GND	Trigger Input GND
3	O	LINE 1	Strobe 1 Output
4	O	LINE 1 GND	Strobe 1 Output GND
5	O	LINE 2	Strobe 2 Output
6	O	LINE 2 GND	Strobe 2 Output GND
7	-	POWER	Alternative external Power Supply (9-24V)
8	-	GND	Power GND

## I/O Specification

### Digital IO interfaces

Digital IO's of the GigEPRO camera are electrically decoupled by optocoupler to prevent damage or unwanted interference by ground loops or block voltage spikes. An optocoupler is a device using optical path to transfer an electronic signal between two circuits. It consists of a photodiode converting the input signal to light and a phototransistor converting the light again to electronic signal. GigEPRO cameras provide 1 digital input and 2 digital output that way.

### Digital Data Input

The digital input (Line0) can be used for trigger applications or other synchronization tasks for GigEPRO cameras. An external signal level from 0~0.5V is interpreted as **Low**, a level from 3.3~24V is interpreted as **High**. The input voltage must not exceed the 24 V limit.

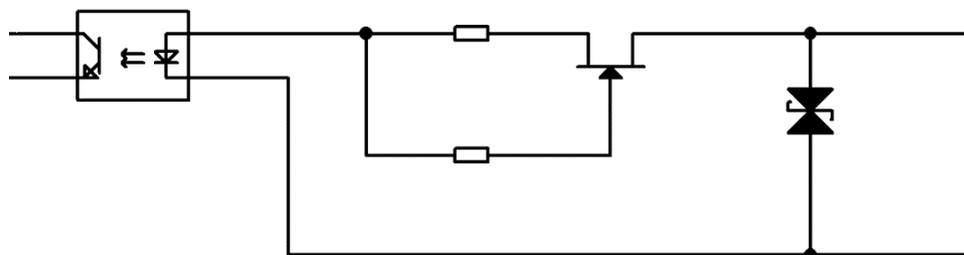


Figure 4: Digital Data Input

Table 5: Digital Input Characteristics

Parameter	Value
Operating voltage	0—24 V
Input current	7.5 mA
External resistor requirement	No
ON voltage level	> 3.3 V
OFF voltage level	< 0.5 V
OFF to ON delay	< 4 us
ON to OFF delay	< 40 us

**Note:**

For external trigger application a rising edge signal is recommended to minimize the time it takes for the optocoupler to change state.

### Debouncing of the Trigger Input

When a trigger signal to the camera is generated by a mechanic switch, the switch contacts might bounce off each other when it opens or closes. This bouncing action can produce transient signals that do not represent a true change of state. In this case it is necessary to filter out transient signals using the debouncing function of the trigger input port.

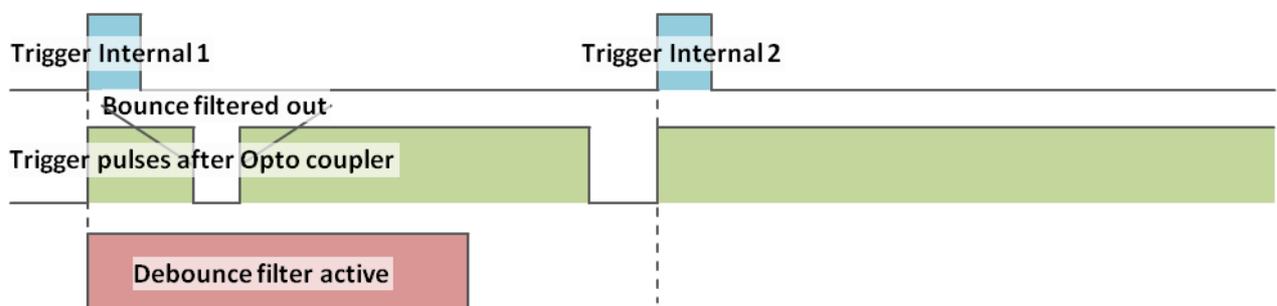


Figure 5: Internal trigger delay with debounce filter

The figure above shows the operation of the debounce circuit. The debounce circuit will filter out signal changes passed through the opto-coupler as long as the debounce filter is active. The debounce filter duration is user-programmable up to 268µs.

## Digital Data Output

The digital outputs (Line1/2) can be used for strobe applications or to control other external devices.

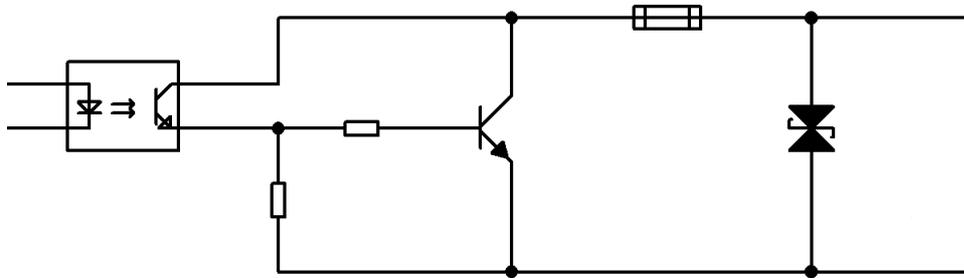


Figure 6: Digital Data Output

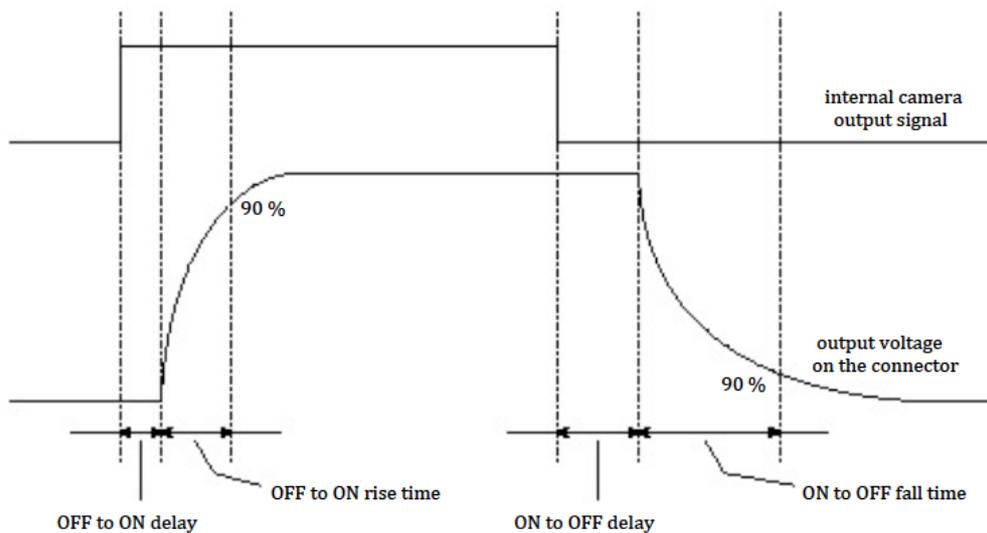


Figure 7: Digital Output Timing Diagram

Table 6: Digital Output Characteristics

Parameter	Value
Operating voltage	3.3—24 V
Output current	100 mA
External resistor requirement	Yes
Slew rate rising	0.2V/us
Slew rate falling	2.0V/us
OFF to ON delay	30 us
ON to OFF delay	3 us

### Note:

An external strobe application should use the falling edge of the camera output signal to minimize the overall strobe delay.

## Image Sensors

Table 7: Image Sensors SXGA

	GP4136C	GP4136M	GP4136IR
<b>resolution (H*V) [pixel]</b>	1280 x 1024 SXGA	1280 x 1024 SXGA	1280 x 1024 SXGA
<b>sensor</b>	CMOS	CMOS	CMOS
<b>image sensor</b>	EV76C560	EV76C560	EV76C661
<b>sensor size</b>	1/1.8"	1/1.8"	1/1.8"
<b>pixel size [μm]</b>	5.3 x 5.3	5.3 x 5.3	5.3 x 5.3
<b>aspect ratio</b>	5 : 4	5 : 4	5 : 4
<b>frame rate [fps]</b>	61	61	61
<b>shutter</b>	global; rolling; global reset	global; rolling; global reset	global; rolling; global reset
<b>shutter speed</b>	10 us - 1 s	10 us - 1 s	10 us - 1 s
<b>data path</b>	10 bit	10 bit	10 bit
<b>binning</b>	2 x 2	2 x 2	2 x 2
<b>partial scan</b>	ROI, linescan	ROI, linescan	ROI, linescan
<b>pixel clock frequency</b>	120MHz	120MHz	120MHz
<b>responsivity</b>	6600 LSB10/lux/s	6600 LSB10/lux/s	13000 LSB10/lux/s

Table 8: Image Sensors UXGA

	GP4206C	GP4206M
<b>resolution (H*V) [pixel]</b>	1600 x 1200 UXGA	1600 x 1200 UXGA
<b>sensor</b>	CMOS	CMOS
<b>image sensor</b>	EV76C570	EV76C570
<b>sensor size</b>	1/1.8"	1/1.8"
<b>pixel size [μm]</b>	4.5 x 4.5	4.5 x 4.5
<b>aspect ratio</b>	4 : 3	4 : 3
<b>frame rate [fps]</b>	52	52
<b>shutter</b>	global; rolling; global reset	global; rolling; global reset
<b>shutter speed</b>	10 us - 1 s	10 us - 1 s
<b>data path</b>	10 bit	10 bit
<b>binning</b>	2 x 2	2 x 2
<b>partial scan</b>	ROI, linescan	ROI, linescan
<b>pixel clock frequency</b>	120MHz	120MHz
<b>responsivity</b>	7400 LSB10/lux/s	7400 LSB10/lux/s

Table 9: Image Sensors WQUXGA

	<b>GP11004C</b>	<b>GP11004M</b>
<b>resolution (H*V) [pixel]</b>	3840 x 2748 WQUXGA	3840 x 2748 WQUXGA
<b>sensor</b>	CMOS	CMOS
<b>image sensor</b>	MT9J003	MT9J003
<b>sensor size</b>	1/2.3"	1/2.3"
<b>pixel size [μm]</b>	1.67 x 1.67	1.67 x 1.67
<b>aspect ratio</b>	4 : 3	4 : 3
<b>frame rate [fps]</b>	7	7
<b>shutter</b>	rolling with global reset	rolling with global reset
<b>shutter speed</b>	10 us - 3 s	10 us - 3 s
<b>data path</b>	12 bit	12 bit
<b>binning</b>	2 x 2, 4 x 4	2 x 2, 4 x 4
<b>partial scan</b>	ROI	ROI
<b>pixel clock frequency</b>	80MHz	80MHz
<b>responsivity</b>	0.31 V/lux/s	0.31 V/lux/s

Table 10: Image Sensors WUXGA

	<b>GP2239C</b>	<b>GP2239M</b>	<b>GP2238C</b>	<b>GP2238M</b>
<b>resolution (H*V) [pixel]</b>	1920 x 1200 WUXGA	1920 x 1200 WUXGA	1920 x 1200 WUXGA	1920 x 1200 WUXGA
<b>sensor</b>	CMOS	CMOS	CMOS	CMOS
<b>image sensor</b>	IMX174	IMX174	IMX249	IMX249
<b>sensor size</b>	1/1.2"	1/1.2"	1/1.2"	1/1.2"
<b>pixel size [μm]</b>	5.86 x 5.86	5.86 x 5.86	5.86 x 5.86	5.86 x 5.86
<b>aspect ratio</b>	16 : 10	16 : 10	16 : 10	16 : 10
<b>frame rate [fps]</b>	50	50	38	38
<b>shutter</b>	global	global	global	global
<b>shutter speed</b>	30.3 us - 34 s	30.3 us - 34 s	39 us - 34 s	39 us - 34 s
<b>data path</b>	12 bit	12 bit	12 bit	12 bit
<b>binning</b>	-	-	-	-
<b>partial scan</b>	ROI	ROI		
<b>pixel clock frequency</b>	120MHz	120MHz	120MHz	120MHz
<b>responsivity</b>	4503 LSB12/lux/s	3656 LSB12/lux/s	4503 LSB12/lux/s	3656 LSB12/lux/s

Table 11: Image Sensors 5 MP

	GP2507C	GP2507M	GP2507Z
resolution (H*V) [pixel]	2448 x 2048	2448 x 2048	2448 x 2048
sensor	CMOS	CMOS	CMOS
image sensor	IMX264	IMX264	IMX264MZR
sensor size	2/3"	2/3"	2/3"
pixel size [μm]	3.45 x 3.45	3.45 x 3.45	3.45 x 3.45
aspect ratio	6 : 5	6 : 5	6 : 5
frame rate [fps]	22	22	22
shutter	global	global	global
shutter speed	34 us – 1.8 s	34 us – 1.8 s	n.n.
data path	12 bit	12 bit	12 bit
binning	-	-	n.n.
partial scan	ROI	ROI	n.n.
pixel clock frequency	74.25MHz	74.25MHz	74.25MHz
responsivity	4687 LSB12/lux/s	3742 LSB12/lux/s	1399 LSB12/lux/s

Table 12: Image Sensors 6 MP

	GP2646C	GP2646M
resolution (H*V) [pixel]	3072 x 2048	3072 x 2048
sensor	CMOS	CMOS
image sensor	IMX178	IMX178
sensor size	1/1.8"	1/1.8"
pixel size [μm]	2.4 x 2.4	2.4 x 2.4
aspect ratio	3 : 2	3 : 2
frame rate [fps]	17 preliminary	17 preliminary
shutter	Rolling with global reset	Rolling with global reset
shutter speed	n.n.	n.n.
data path	n.n.	n.n.
binning	n.n.	n.n.
partial scan	n.n.	n.n.
pixel clock frequency	n.n.	n.n.
responsivity	1751 LSB12/lux/s	1566 LSB12/lux/s

## IR-cut or AR filter

All camera models have by default either an IR-cut filter (color camera) or an AR (anti-reflective) filter (BW/IR camera) mounted on top of the sensor.

Taverage	≥ 92%	420nm	620nm
Tmin	≥ 88%	420nm	620nm
T	= 50%	650nm	± 10nm
Taverage	≤ 5%	690nm	1100nm

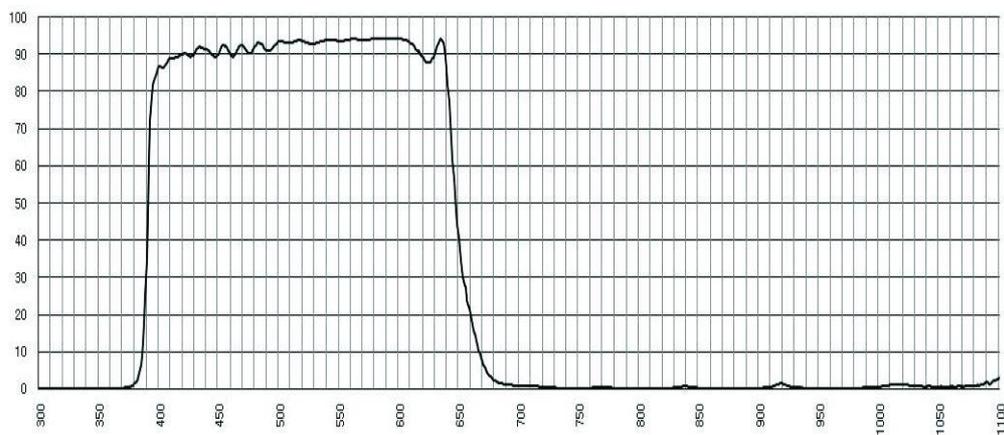


Figure 8: IR cut filter characteristics for color cameras

Tave.	≥ 97%	420nm	680nm
Tabsn	≥ 92%	420nm	680nm

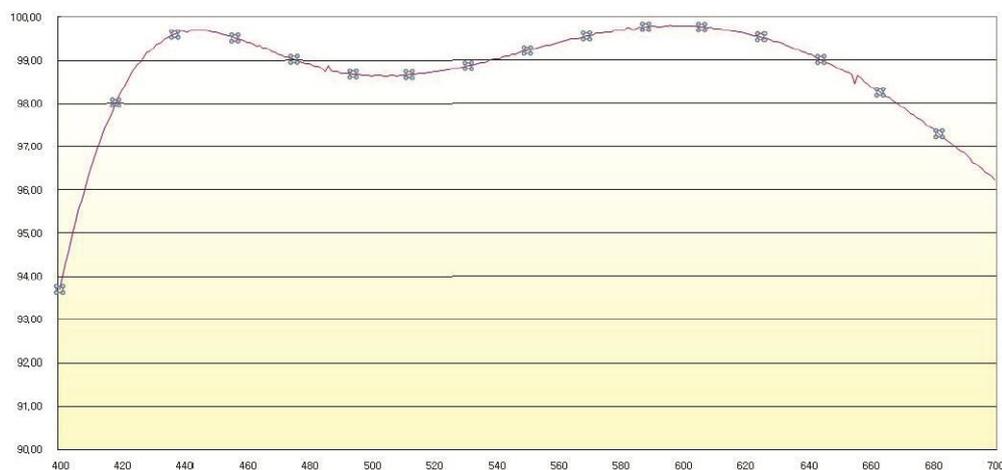


Figure 9: AR filter characteristics for BW/IR cameras

### Removing the filter

The C-mount flange distance from the sensor is adjusted for the use of either filter. Removing the filter will decrease the length of the optical path and changed the optical properties. This will make a readjustment necessary and in some cases it might become impossible to focus properly.

### Typical Spectral Response

Excerpt from sensor datasheets.

Note that lens and illumination characteristics are not reflected with this data.

#### GP4136IR

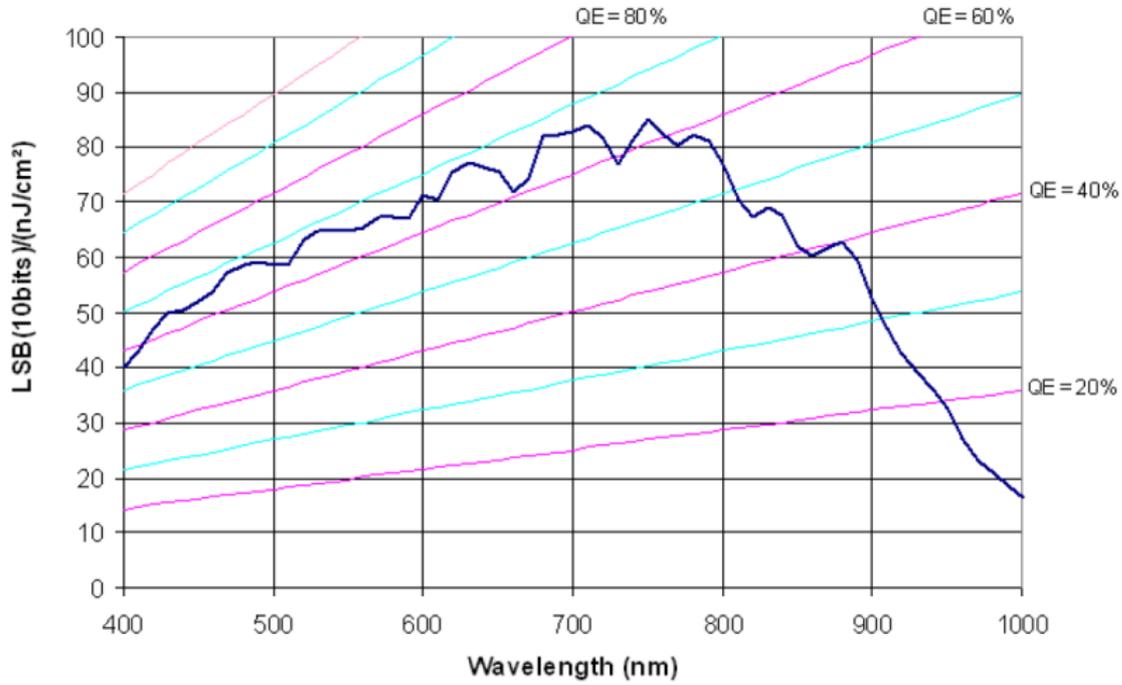


Figure 10: EV76C661 NIR

#### GP4206M/C

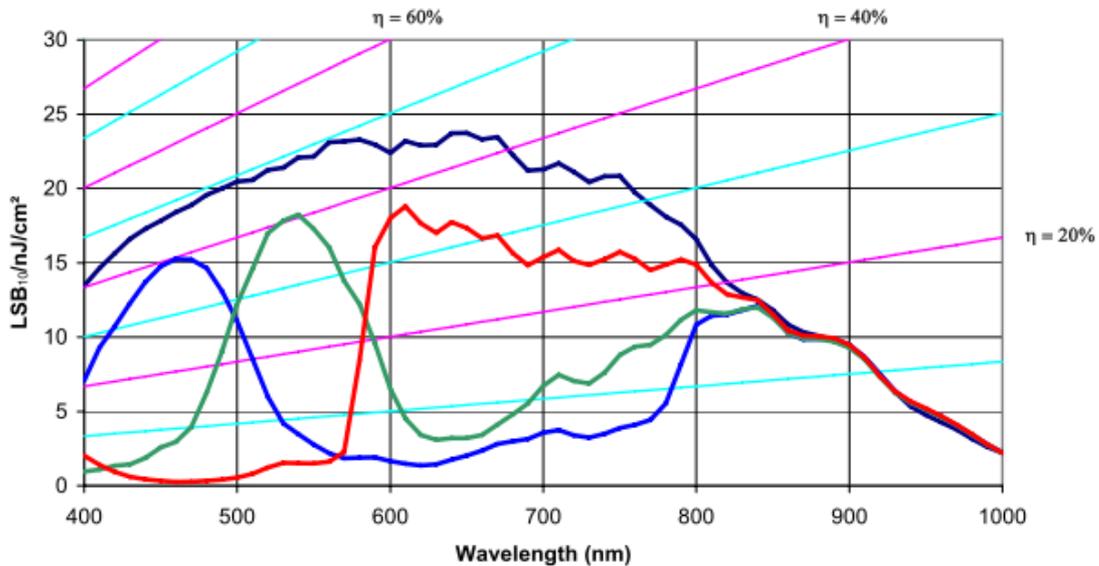


Figure 11: EV76C570 Color + BW

**GP4136M**

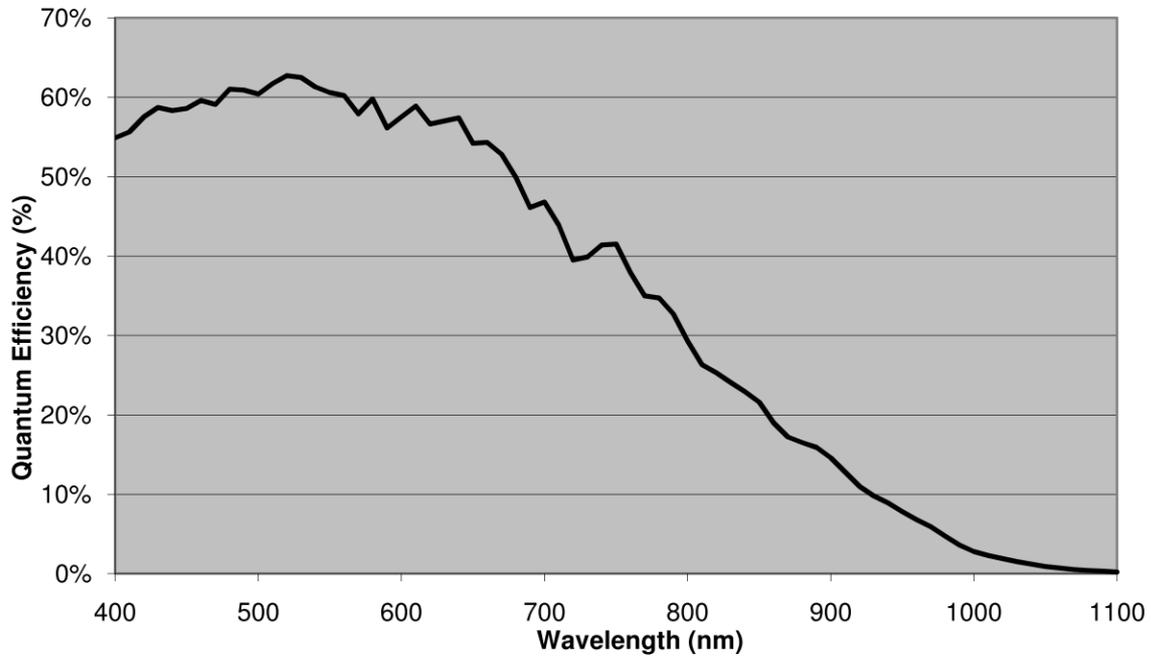


Figure 12: EV76C560 BW

**GP4136C**

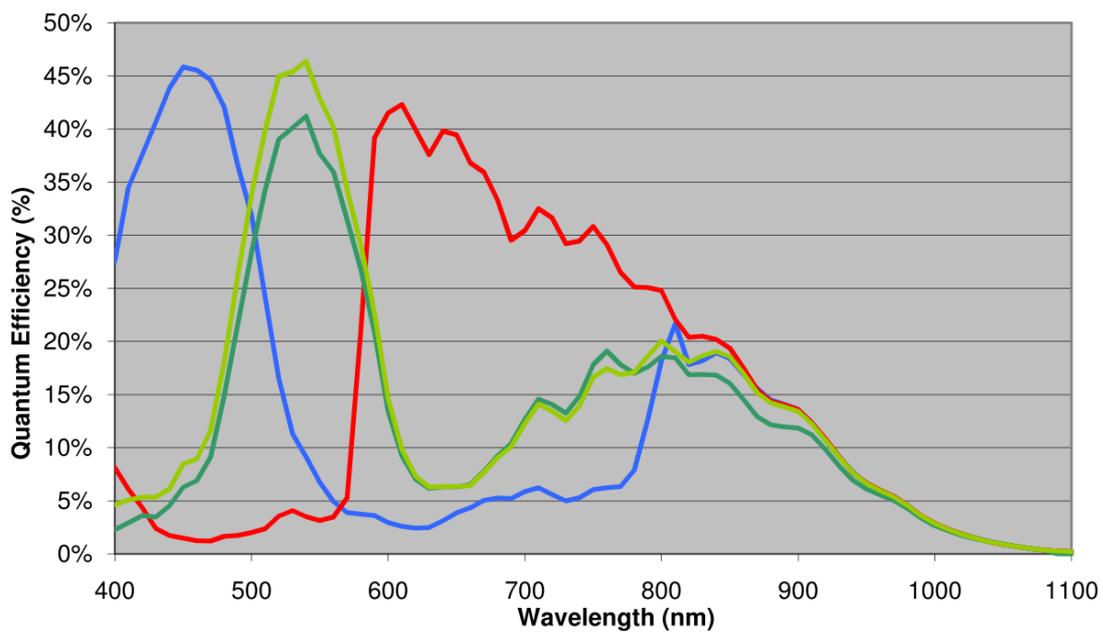


Figure 13: EV76C560 Color

**GP2239M**

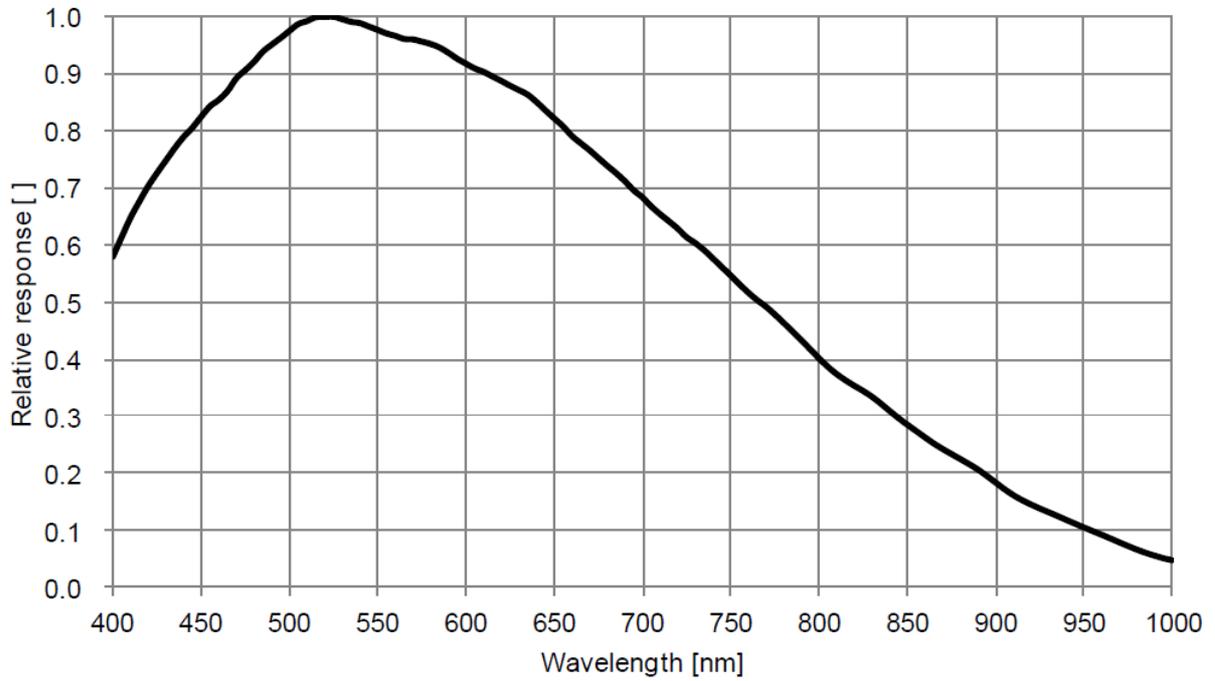


Figure 14: IMX174 BW

**GP2239C**

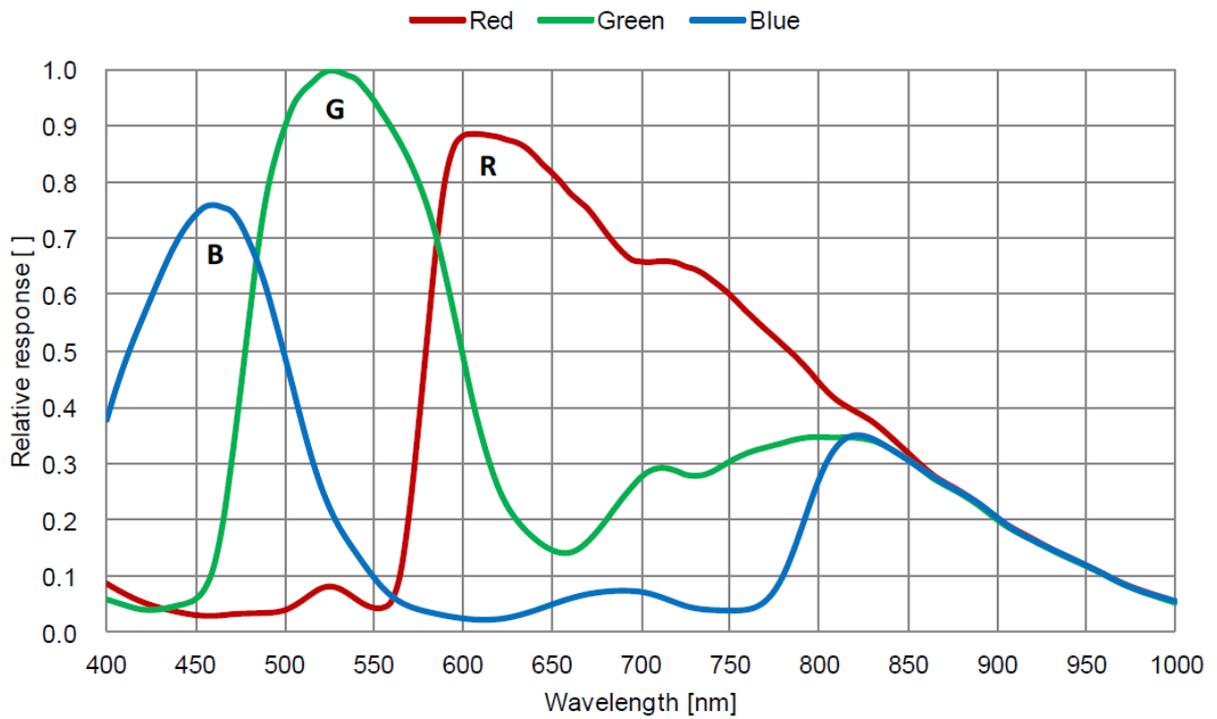


Figure 15: IMX174 Color

**GP2238C**

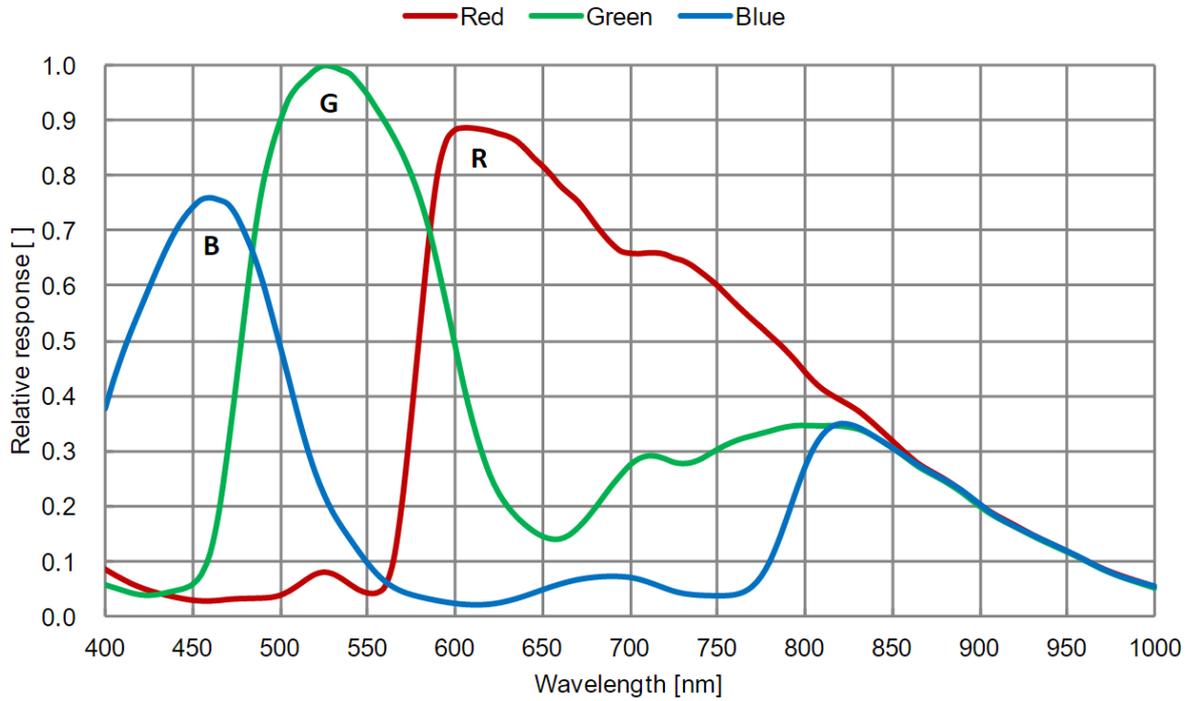


Figure 16: MT9V032 BW

**GP2238M**

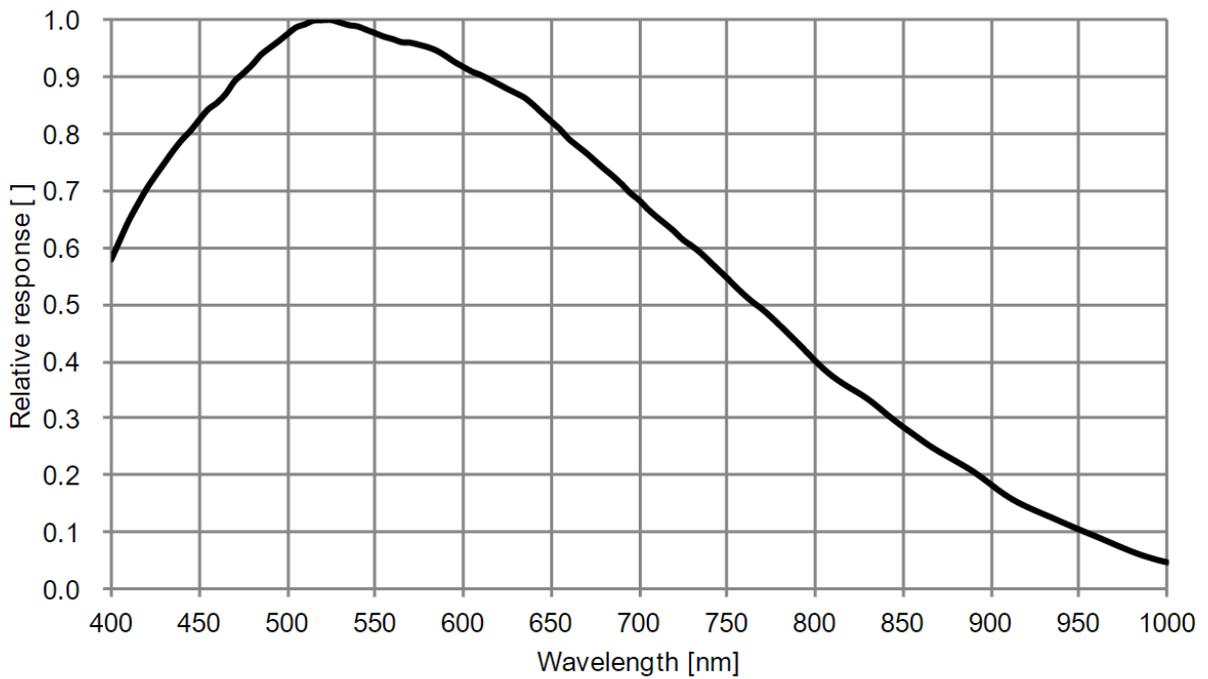


Figure 17: MT9V032 Mono

**GP2507C**

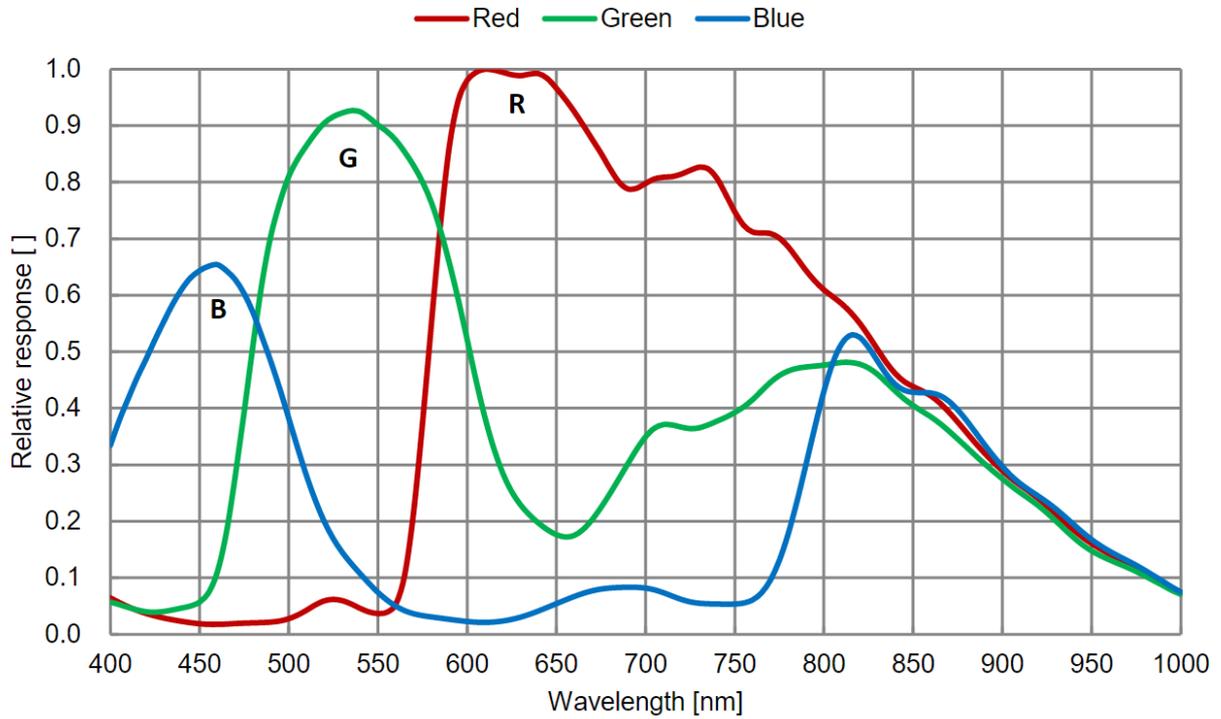


Figure 18: IMX264 Color

**GP2507M**

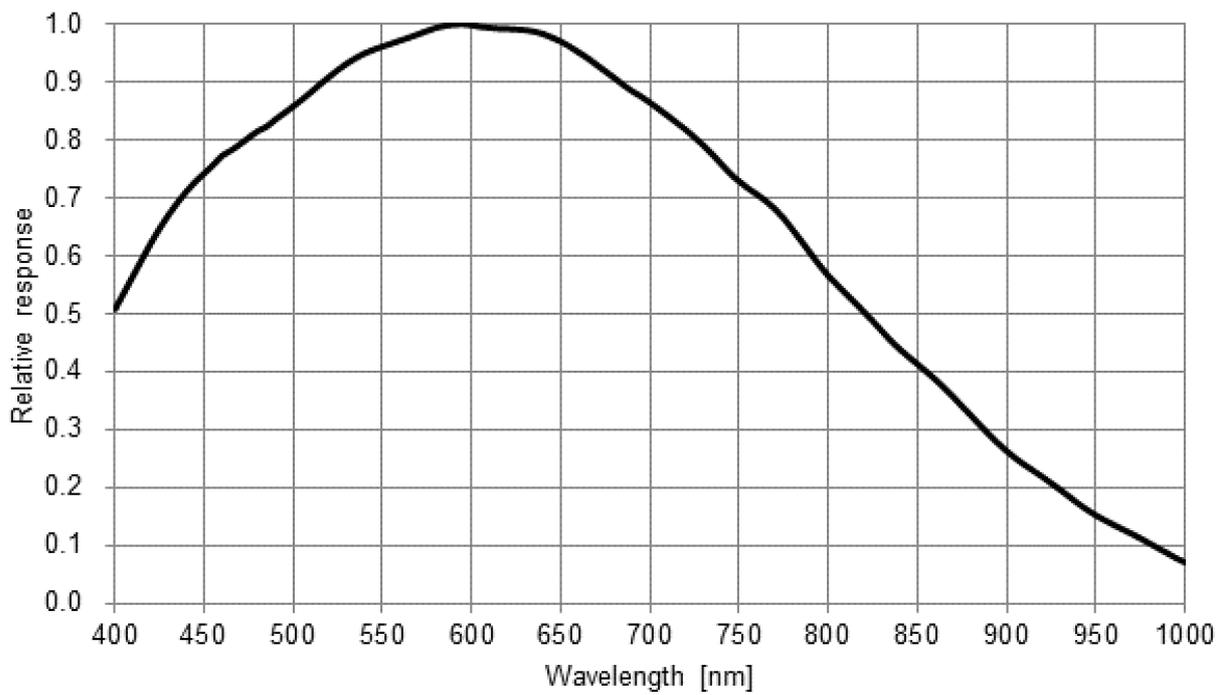


Figure 19: IMX264 Mono

GP2507Z

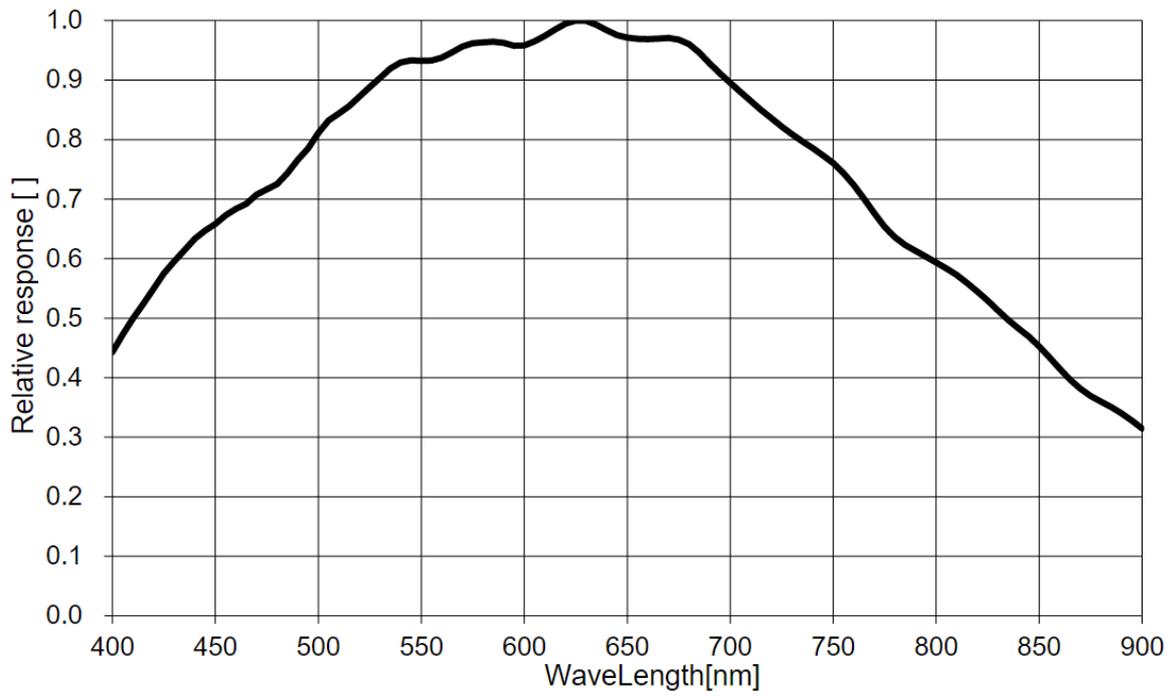


Figure 20: IMX264MZR Mono

GP2646M

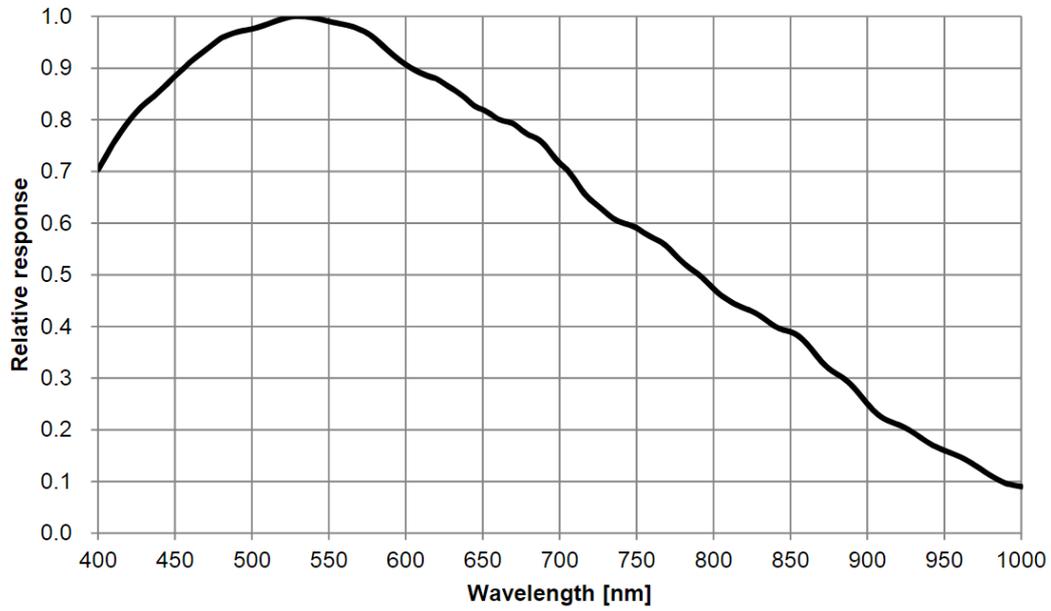


Figure 21: IMX178 Mono

GP2646C

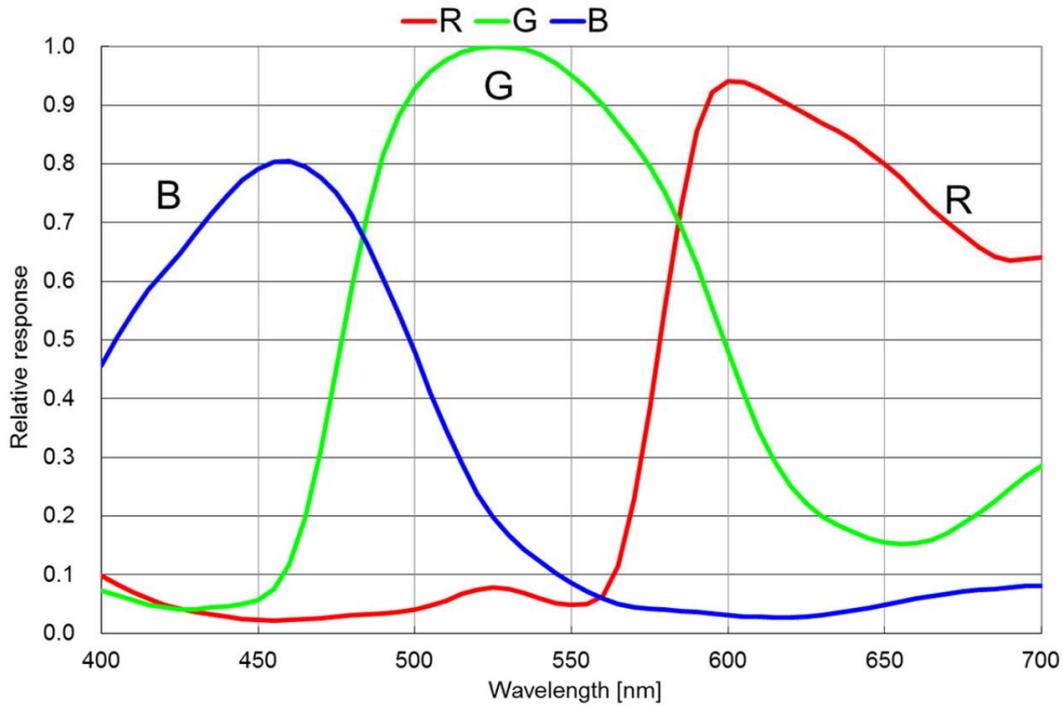


Figure 22: IMX178 Color

**GP11004M**

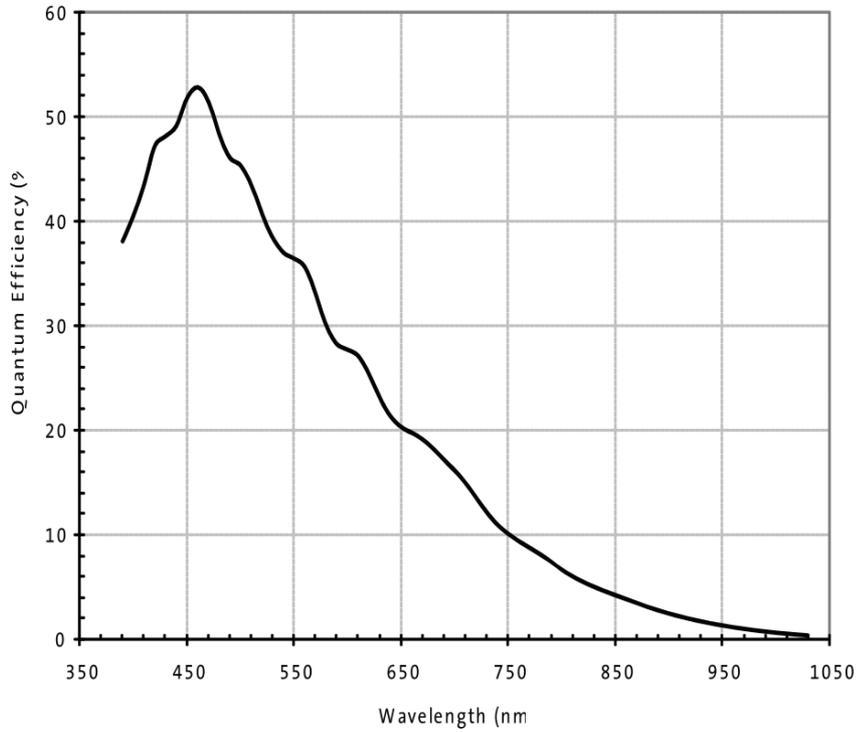


Figure 23: MT9J003 BW

**GP11004C**

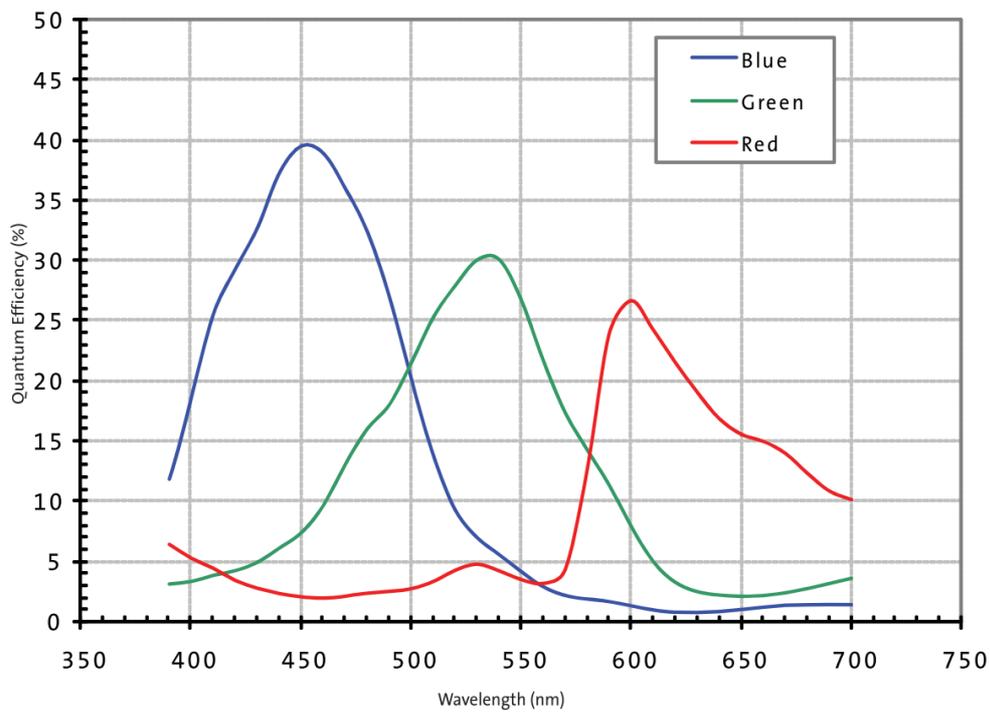


Figure 24: MT9J003 Color

# Standard Camera Functions

## Overview

This section introduces standard functions of the GigEPRO cameras. All GigEPRO cameras provide a GenICam XML file compatible with GenApiSchema version 1.1. This XML file includes all standard and extended camera features available in the camera and follows the “Standard Feature Naming Convention (SFNC)” version 2.0 whenever possible.

Table 13: Standard camera function control

Category	Function	Description
Device Control	Device Name	Report model name
	Device Firmware Version	Report model version
	Device Temperature	Report device temperature
Image Format Control	Sensor Width and Height	Report sensor size
	Region Selector	Control region of interest
	Binning/Decimation/Flip	Select scaling option
	Pixel Format	Select pixel format
Acquisition Control	Test Pattern Selector	Select test pattern
	Acquisition	Control acquisition mode
	Trigger	Control trigger operation
	Strobe1	Control strobe1 operation
	Strobe2	Control strobe2 operation
Digital I/O Control	Exposure	Control exposure mode
	Line Selector	Control I/O configuration
Analog Control	User Output Selector	Control output signals
	Black Level	Control black level
	Gain Selector	Control gain settings
	Balance White Auto	Control auto white balance
LUT Control	Gamma	Set gamma correction
	LUT Selector	Control LUT programming
Transport Layer Control	LUT Enable	Activate LUT
	Network Interface	Configure network interface
	Timestamp	Report timestamp
	Control Channel	Configure control channel
	Message Channel	Configure message channel
User Set Control	Stream Channel	Configure stream channel
	User Set Selector	Load / Save user setting
Color Transformation Control	User Set Default	Select default user setting
	Color Transformation Selector	Control color matrix
Event Control	Event Selector	Control event channel

## Device Control

Registers of this category provide information about the camera. And you can set the free user ID to the camera.

### **Registers**

Register	Visibility	Access	Description
Device Type	Guru	R	Returns the device type: Transmitter
Device Scan Type	Expert	R	Returns the scan type: Areascan
	Expert	R/W	Selects the scan type: Areascan, Linescan *
Device Sensor Clock	Expert	R/W	Selects the sensor reference clock in MHz
Device Vendor Name	Beginner	R	Returns the vendor name: NET GmbH
Device Model Name	Beginner	R	Returns the model name: e.g. GP4136C
Device Manufacturer Info	Beginner	R	Returns the manufacturer information
Device Version	Beginner	R	Returns the device version: GigEPRO
Device Firmware Version	Beginner	R	Returns the firmware version: e.g. 1.12.007
Device Serial Number	Expert	R	Returns the serial number: e.g. 15111704001
Device User ID	Beginner	R/W	User-programmable device identifier
Device SFNC Version Major	Beginner	R	Returns the Standard Features Naming Convention version of GenICam XML that was used to create the device's XML.
Device SFNC Version Minor	Beginner	R	
Device SFNC Version Sub Minor	Beginner	R	
Device Max Throughput	Expert	R	Returns maximum bandwidth of the stream channel
Device Link Speed	Expert	R	Indicates the speed of transmission negotiated on the specified Link.
Device Reset	Guru	W	Resets the device to its power up state.
Device Temperature Selector	Expert	R/W	Selects the location within the device, where the temperature will be measured.
Device Temperature	Expert	R	Device temperature in degrees Celsius (C). It is measured at the location selected by DeviceTemperatureSelector.
Device Initial Delay	Expert	R/W	Specifies the delay in timestamp ticks to apply after the reception of a frame before sending out data.

\*(models GP4136 and GP4206 only)

## Image Format Control

Registers of this category provide control of the image format delivered by the camera.

### Registers

Register	Visibility	Access	Description
Sensor Width	Expert	R	Effective width of the sensor in pixels.
Sensor Height	Expert	R	Effective height of the sensor in pixels.
Width Max	Expert	R	Maximum width of the image (in pixels). The dimension is calculated after horizontal binning, decimation or any other function changing the horizontal dimension of the image.
Height Max	Expert	R	Maximum height of the image (in pixels). This dimension is calculated after vertical binning, decimation or any other function changing the vertical dimension of the image.
Region Number	Beginner	R/W	Sequence of exposures. *
Region Selector	Beginner	R/W	Selects the Region of interest to control. *
Line Pitch	Expert	R	Total number of bytes between 2 successive lines.
Width	Beginner	R/W	Width of the image provided by the device (in pixels).
Height	Beginner	R/W	Height of the image provided by the device (in pixels).
Offset X	Beginner	R/W	Horizontal offset from the origin to the region of interest (in pixels).
Offset Y	Beginner	R/W	Vertical offset from the origin to the region of interest (in pixels).
Width Band2	Expert	R/W	Width of 2nd SIMR vertical band (in pixels). WidthBand2=0 turns off 2nd vertical band.
Height Band2	Expert	R/W	Height of 2nd SIMR horizontal band (in pixels). HeightBand2=0 turns off 2nd horizontal band.
Gap X Band2	Expert	R/W	Horizontal gap between 1st and 2nd SIMR vertical band (in pixels).
Gap Y Band2	Expert	R/W	Vertical gap between 1st and 2nd SIMR horizontal band (in pixels).
ManRegExposure	Expert	R/W	Exposure for this region in manual mode. *
Binning Horizontal	Expert	R/W	Number of horizontal photo-sensitive cells to combine together. This increases the intensity (or signal to noise ratio) of the pixels and reduces the horizontal resolution of the image.
Binning Vertical	Expert	R/W	Number of vertical photo-sensitive cells to combine together. This increases the intensity (or signal to noise ratio) of the pixels and reduces the vertical resolution of the image.
Decimation Horizontal	Expert	R/W	Horizontal sub-sampling of the image. This reduces the horizontal resolution (width) of the image by the specified horizontal decimation factor.
Decimation Vertical	Expert	R/W	Vertical sub-sampling of the image. This reduces the vertical resolution (height) of the image by the specified vertical decimation factor.

Reverse X	Expert	R/W	Flip horizontally the image sent by the device. The Region of interest is applied after the flipping.
Reverse Y	Expert	R/W	Flip vertically the image sent by the device. The Region of interest is applied after the flipping.
Pixel Format	Beginner	R/W	Format of the pixel provided by the device.
Raw Bayer Bypass	Expert	R/W	Selects bayer bypass mode to deliver raw sensor data
Test Pattern Generator Selector	Beginner	R/W	Selects which test pattern generator is controlled by the TestPattern feature.
Test Pattern	Beginner	R/W	Selects the type of test pattern that is generated by the device as image source.

\*(models GP4136 and GP4206 only)

### Pixel Formats in GigEPRO Cameras

The GigEPRO cameras deliver the following pixel formats.

Table 14: Supported pixel formats

Setting value	PixelFormat	PixelSize	Occupied Bits
Mono 8	Mono 8 bit	8 bits per pixel	8
Mono 10	Mono 10 bit	10 bits per pixel	16
Mono 12	Mono 12 bit	12 bits per pixel	16
Bayer GR 8	BAYER 8 bit	8 bits per pixel	8
Bayer GR 10	BAYER 10 bit	10 bits per pixel	16
Bayer GR 12	BAYER 12 bit	12 bits per pixel	16
Bayer GR 10 packed	BAYER 10 bit packed	10 bits per pixel	12
Bayer GR 12 packed	BAYER 12 bit packed	12 bits per pixel	12
RGB 8	RGB 8 bit	8 bits per pixel	24

### Test Image Selector

The GigEPRO cameras support the following test pattern as data output. These test patterns are generated in the camera and are in addition to the sensor patterns which are supported by each specific sensor type.

## Setting

Register	Visibility	Access	Description
Test Pattern Generator Selector	Beginner	R/W	FPGA
Test Pattern	Beginner	R/W	0..16
TPG Rate	Expert	R/W	TPG pixel rate (1024 = 100%)
TPG Ramp Step	Expert	R/W	Selects the ramp increment of the test pattern generator.

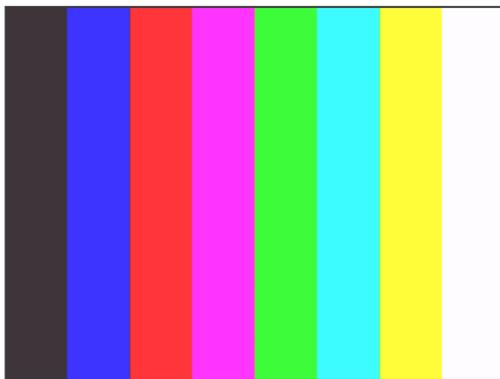


Figure 25: Testpattern=1: Color Bar

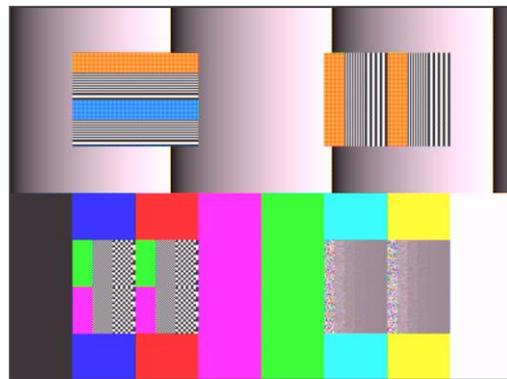


Figure 26: Testpattern=2: Ramp + Color

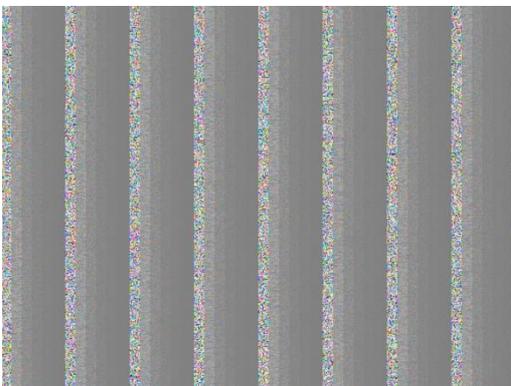


Figure 27: Testpattern=3: Noise Ramp

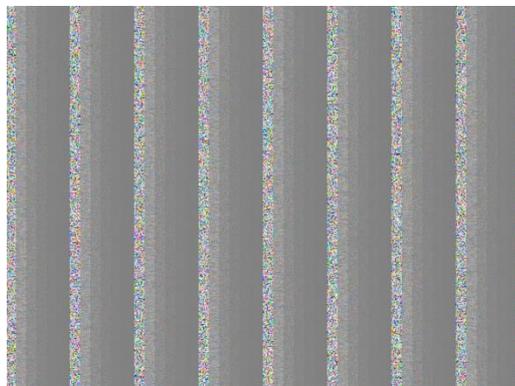


Figure 28: Testpattern=4: Dynamic Noise Ramp

## Acquisition Control

Make a setting of image stream and control image stream output. Camera starts image stream output by receiving AcquisitionStart command. There are some registers that require camera to stop image stream output to change values. The acquisition frame rate is variable. The maximum acquisition frame rate depends on the camera operation mode (ROI, binning, link speed, etc.)

### **Registers**

Register	Visibility	Access	Description
Acquisition Mode	Beginner	R/W	Sets the acquisition mode of the device.
Acquisition Frame Rate	Beginner	R/W	Controls the acquisition rate (in Hertz) at which the frames are captured. AcquisitionFrameRate=0-->as fast as possible

### **Setting**

- Sets frame rate

Set the following value to “AcquisitionFrameRate” register. Setting value is Float type.  
The range of register setting depends on camera model, and camera operation mode.

setting value	FrameRate
Minimum	0 [Hz]
Maximum (*)	Depend on register setting of "Height" and "Binning" or link speed of interface.

\* initial factory setting

#### Note:

Changing “AcquisitionFrameRate” register value is invalid during image stream data output.

When exposure time setting is longer than frame rate setting, camera operation gives priority to exposure time setting.

Depending on your PC or Gigabit Ethernet interface board configurations, images may not be captured normally (e.g. frame drops may occur). In this case, reduce the frame rate.

## TriggerControl

This section describes trigger control of AcquisitionControl category for the GigEPRO cameras. This camera series provides two kinds of exposure synchronization.

- Normal Shutter mode : Free run operation (internal synchronization)
- Random Trigger Shutter mode : Synchronized with external trigger input

In Random Trigger Shutter mode, two kinds of trigger input are available.

- Trigger signal via the I/O connector (HardwareTrigger)
- Trigger command via the Gigabit Ethernet interface (SoftwareTrigger)

The following table shows the combination of operation mode of this camera series.

Trigger Mode	Synchronization	Exposure Control
Normal Shutter mode	Free run	“ExposureTime” register control
		AutoExposure control
Random Trigger Shutter mode	HardwareTrigger	“ExposureTime” register control
	SoftwareTrigger	Trigger pulse width control

*\* The camera operation not mentioned above is not guaranteed.*

Operation point of HardwareTrigger is at the edge of trigger signal, and active edge polarity is able to change by register setting. And you can add delay time from trigger edge to exposure start by register setting.

## **Registers**

Register	Visibility	Access	Description
Trigger Selector	Beginner	R/W	Selects the type of trigger to configure.
Trigger Mode	Beginner	R/W	Controls if the selected trigger is active.
Trigger Software	Beginner	W	Generates an internal trigger. TriggerSource must be set to Software.
Trigger Source	Beginner	R/W	Specifies the internal signal or physical input Line to use as the trigger source.
Trigger Activation	Beginner	R/W	Specifies the activation mode of the trigger.
Trigger Delay	Expert	R/W	Specifies the delay in microseconds (us) to apply after the trigger reception before activating it.

## Setting

- Selects trigger mode

Set the following value to “TriggerMode” register. Setting value is Enumeration type.

setting value	Operation Mode
Off (*)	Normal Shutter Mode
On	Random Trigger Shutter mode

*\* initial factory setting*

- Select trigger source

Set the following value to “TriggerSource” register. Setting value is Enumeration type.

setting value	Trigger source
Line1	Hardware trigger
Timer	Acquisition Frame Rate Timer
Software (*)	Software trigger

*\* initial factory setting*

- Grabs image stream by software trigger

When executes “TriggerSoftware” register command, software trigger command is generated. And the camera starts exposure by receiving software trigger command in software trigger mode

- Change trigger activation (HardwareTrigger operation only)

Set the following value to “TriggerActivation” register. Setting value is Enumeration type.

setting value	Activation
FallingEdge (*)	Trigger on falling edge
RisingEdge	Trigger on rising edge
Any Edge	Trigger on both edges
Level High	Trigger if High
Level Low	Trigger if Low

*\* initial factory setting*

- Sets trigger delay

Set the following value to “TriggerDelay” register. Setting value is Float type.

Adds delay time from trigger edge to exposure start.

setting value	TriggerDelay[ $\mu$ s]
Minimum (*)	0.00[ $\mu$ s]
Maximum	4095.00[ $\mu$ s]

\* initial factory setting

**Note:**

Changing “TriggerMode”, “TriggerSource”, “TriggerActivation” registers value is invalid during image stream data output. When SoftwareTrigger operation, the period from execution of “TriggerSoftware” to grab image is indefinite.

## ExposureControl

GigEPRO cameras are able to adjust exposure time by using electric shutter control.

This camera series provides two kinds of exposure time control mode.

- MANUAL mode: The exposure time is determined by “ExposureTime” register setting value.
- AE mode: The exposure time is adjusted automatically by the photometry of the image.

When HardwareTrigger operation, you are able to control the exposure time by pulse width of external trigger input signal.

### Registers

Register	Visibility	Access	Description
ExposureMode	Beginner	R/W	Sets the operation mode of the Exposure (or shutter).
ExposureTime	Beginner	R/W	Sets the Exposure time when ExposureAuto is Off.
ExposureAuto	Beginner	R/W	Sets the automatic exposure mode when ExposureMode is Timed.
AETarget	Expert	R/W	Target average image level for auto exposure.
AEMinTime	Expert	R/W	Exposure time min for auto exposure.
AEMaxTime	Expert	R/W	Exposure time max for auto exposure.
AEspeed	Expert	R/W	Auto exposure speed.
AEWindow	Expert	R/W	Sets the measurement window for automatic exposure mode.

### Setting

- Selects exposure mode

Set the following value to “ExposureMode” register. Setting value is Enumeration type.

setting value	Manual exposure mode
Timed (*)	“ExposureTime” register control

*\* initial factory setting*

- Sets exposure time (timed mode only)

Set the following value to “ExposureTime” register. Setting value is Float type.

Model	GP1041x	GP4136x	GP4206x	GP1305C	GP1503x	GP11004x	GP2239x
ExposureTime (*)	1000 us						
ExposureTimeMin	10 us	10 us	10 us	10 us	45 us	10 us	30 us
ExposureTimeMax	10 s						34 s

*\* initial factory setting*

- Set auto exposure

Set the following value to “ExposureAuto” register. Setting value is Enumeration type.

setting value	function
Off (*)	Manual exposure control
Once	Single automatic exposure control
Continuous	Continuous automatic exposure control

*\* initial factory setting*

## Digital I/O Control

The cameras provide GPIO input/output selected by the register setting. The polarity of the signal is able to switch by the register setting. The following chart shows the specifications of the selectable signals.

### Registers

Register	Visibility	Access	Description
Line Selector	Expert	R/W	Selects the physical line of the external device connector to configure.
Line Mode	Expert	R	Controls if the physical Line is used to Input or Output a signal.
Line Inverter	Expert	R/W	Controls the inversion of the signal of the selected input or output Line.
Line Status	Expert	R	Returns the current status of the selected input or output Line.
Line Source	Expert	R/W	Selects which internal acquisition or I/O source signal to output on the selected Line. LineMode must be Output.
Line Format	Expert	R	Controls the current electrical format of the selected physical input or output Line.
User Output Selector	Expert	R/W	Selects which bit of the User Output register will be set by UserOutputValue.
User Output Value	Expert	R/W	Sets the value of the bit selected by UserOutputSelector.

### Setting

- Select the Line of the I/O connector

Set the following value to “LineSelector” register. The setting value is Enumeration type.

LineSelector	I/O connector pin assignment	LineMode	LineFormat
Line1 (*)	1 pin: External Trigger Input	Input	OptoCoupled: OpenCollector
Line3	3 pin: GPIO0 Output	Output	OptoCoupled: OpenCollector
Line4	4 pin: GPIO1 Output	Output	OptoCoupled: OpenCollector

- Select the source of GPIO output signal

Set the following value to “LineSource” register. Setting value is Enumeration type.

LineSource	Signal description
Off (*)	No output.
AcquisitionActive	Device is currently doing an acquisition of one or many Frames.
FrameActive	Device is currently doing the capture of a Frame.
ExposureActive	Device is doing the exposure of a Frame (or Line).
TimerActive	The chosen Timer is in active state.
UserOutputActive	The chosen User Output state as defined by its current UserOutputValue.

\* initial factory setting

## Analog Control

### Gain

This section describes Gain control of AnalogControl category for the GigEPRO cameras. This control adjusts the gain of the image.

#### **Registers**

Register	Visibility	Access	Description
GainSelector	Beginner	R/W	Selects which Gain is controlled by the various Gain features.
Gain	Beginner	R/W	Sets the absolute Gain.

#### **Setting**

- Set Gain

Set the following value to “Gain” register. Setting value is Float type.

setting value	Gain
Minimum	0.00
Default (*)	1.00
Maximum	8.00

*\* initial factory setting*

#### Notes on gain setting:

Setting the gain value too high increases noise. When you adjust the brightness of the image, check final image quality with your environment.

## BlackLevel

This section describes BlackLevel control of AnalogControl category for the GigEPRO cameras. This control adjusts the black level of the image

### Registers

Register	Visibility	Access	Description
BlackLevel	Beginner	R/W	Sets the absolute Black Level.

### Setting

- Set Black Level

Set the following value to “BlackLevel” register. Setting value is Float type.

BlackLevel	setting value
Minimum	-1.0
Default (*)	0.0
Maximum	+1.0

\* initial factory setting

## Balance White Auto

This section describes BalanceWhite control of AnalogControl category for the GigEPRO cameras.

### Registers

Register	Visibility	Access	Description
BalanceWhiteAuto	Expert	R/W	Selects the auto white balance mode
BalanceRatioSelector	Expert	R/W	Selects which Balance ratio to control.
BalanceRatio	Expert	R/W	Controls ratio of the selected color component to a reference color component. It is used for white balancing.

### Setting

- Set Balance White Auto

Set the following value to “BalanceWhiteAuto” register. Setting value is Enumeration type.

BalanceWhiteAuto	Setting value
Off (*)	White balancing is manually controlled using BalanceRatioSelector and BalanceRatio.
Once	White balancing is automatically adjusted once by the device. Once it has converged, it automatically returns to the Off state.
Reset	Reset white balancing values.

### Setting

- Set Balance Ratio Selector

Set the following value to “BalanceRatioSelector” register. Setting value is Enumeration type.

BalanceRatioSelector	Setting value
Red (*)	Balance Ratio will be applied to the red channel.
Green	Balance Ratio will be applied to the green channel.
Blue	Balance Ratio will be applied to the blue channel.

### Setting

- Set Balance Ratio

Set the following value to “BalanceRatio” register. Setting value is Float type.

BalanceRatio	setting value
Minimum	0.1
Default (*)	1.0
Maximum	4.0

\* initial factory setting

## Gamma

This section describes Gamma correction of AnalogControl category for the GigEPRO cameras. This function allows you to apply a gamma correction to the output images.

### Registers

Register	Visibility	Access	Description
Gamma	Beginner	R/W	Sets the Gamma correction.

### Setting

- Set Gamma correction

Set the following value to “Gamma” register. Setting value is Float type. Setting this value overwrites the LUT.

Gamma	setting value
Minimum	0.1
Default (*)	1.0
Maximum	10

\* initial factory setting

## LUTControl

This function allows you to program the LUT(input: 12bit, output: 10bit).

### Registers

Register	Visibility	Access	Description
LUTSelector	Expert	R/W	Selects which LUT to control.
LUTEnable	Expert	R/W	Activates selected LUT. Gamma is not available while LUT is enabled.
LUTIndex	Guru	R/W	Controls the index (offset) of the coefficient to access in the selected LUT.
LUTValue	Guru	R/W	Controls the value at entry LUTIndex of the LUT selected by LUTSelector.
LUTSave	Guru	W	Save the LUT to the non-volatile memory of the device.
LUTLoad	Guru	W	Load the LUT from the non-volatile memory of the device.

### Setting

- Set the activation of LUT

Set the following value to “LUTEnable” register. The setting value is Boolean type.

setting value	function
FALSE (*)	Inactivation
TRUE	Activation

*\* initial factory setting*

- Set the input/output value of LUT

Set the following value to “LUTIndex”, “LUTValue” registers. These setting values are Integer type.

“LUTIndex” register value is input level of LUT process, and “LUTValue” register value is output level of LUT process.

LUTIndex / LUTValue	setting value
Minimum	0
Maximum	1023

## TransportLayerControl

This camera series conforms to GigE vision 1.2.

### Registers

Register	Visibility	Access	Description
PayloadSize	Expert	R	Returns the payload size of the image data.
GevVersionMajor	Beginner	R	Returns the version of the GigE Vision protocol.
GevVersionMinor	Beginner	R	
GevDeviceModelsBigEndian	Guru	R	Returns the Endianess of the device registers.
GevDeviceModeCharacterSet	Guru	R	Returns the character set of the string register.
GevMACAddress	Beginner	R	Returns MAC address of the network interface.
GevSupportedIPConfigurationLLA	Beginner	R	LLA bootstrap information.
GevSupportedIPConfigurationDHCP	Beginner	R	DHCP bootstrap information..
GevSupportedIPConfigurationPersistentIP	Beginner	R	Persistent IP bootstrap information.
GevCurrentIPConfigurationLLA	Beginner	R	Returns LLA IP Configuration.
GevCurrentIPConfigurationDHCP	Beginner	R/W	Controls the DHCP IP Configuration.
GevCurrentIPConfigurationPersistentIP	Beginner	R/W	Controls the Persistent IP Configuration.
GevCurrentIPAddress	Beginner	R	Returns Current IP Address.
GevCurrentSubnetMask	Beginner	R	Returns Current IP Subnet Mask.
GevCurrentDefaultGateway	Beginner	R	Returns Current IP Default Gateway.
GevPersistentIPAddress	Beginner	R/W	Sets Persistent IP Address.
GevPersistentSubnetMask	Beginner	R/W	Sets Persistent IP Subnet Mask.
GevPersistentDefaultGateway	Beginner	R/W	Sets Persistent IP Default Gateway.
GevFirstURL	Guru	R	Indicates the first URL to the XML device description file.
GevSecondURL	Guru	R	Indicates the second URL to the XML device description file.
GevSupportedOptionSelector	Expert	R/W	Selects the GEV option to interrogate for existing support.
GevSupportedOption	Expert	R	Returns if the selected GEV option is supported.
GevHeartbeatTimeout	Guru	R/W	Controls the current heartbeat timeout in ms.
GevTimestampTickFrequency	Beginner	R	Indicates the number of timestamp ticks in 1 second
GevTimestampControlLatch	Expert	W	Latches the current timestamp counter into GevTimestampValue.
GevTimestampControlReset	Expert	W	Resets the timestamp counter to 0.
GevTimestampValue	Expert	R	Returns the latched 64-bit value of the timestamp counter.
GevTimestampTime	Expert	R	Returns the latched time value of the timestamp counter in ms.

GevCCP	Guru	R/W	Controls the device access privilege of an application.
GevMessageChannelCount	Expert	R	Indicates the number of message channels supported by this device.
GevMCPHostPort	Guru	R/W	Controls the port to which the device must send messages.
GevMCDA	Guru	R/W	Controls the destination IP address for the message channel.
GevMCTT	Guru	R/W	Controls the transmission timeout value in milliseconds.
GevMCRC	Guru	R/W	Controls the number of retransmissions allowed when a message channel message times out.
GevMCSP	Guru	R/W	Controls the source port for the message channel.
GevStreamChannelCount	Expert	R	Returns the number of stream channels supported.
GevSCPIInterfaceIndex	Expert	R/W	Returns Index of network interface of the stream channel.
GevSCPHostPort	Expert	R/W	Sets the port of the stream channel.
GevSCPSFireTestPacket	Expert	R/W	Sends a test packet. When this feature is set, the device will fire one test packet.
GevSCPSDoNotFragment	Expert	R/W	Sets the "do not fragment" bit in the IP header of each stream packet.
GevSCPSBigEndian	Expert	R	Returns Endianess of multi-byte pixel data for this stream.
GevSCPSPacketSize	Expert	R/W	Sets the stream packet size [byte/packet].
GevSCPD	Expert	R/W	Sets the delay (in timestamp ticks) to insert between each packet for the stream channel.
GevSCDA	Expert	R/W	Sets the destination IP address of the stream channel.

## Setting

- Set the IP Configuration

Set the following value to “GevCurrentIPConfigurationLLA”, “GevCurrentIPConfigurationDHCP”, “GevCurrentIPConfigurationPersistentIP” registers. These setting values are Boolean type.

Set these registers in conformity with your system.

setting value	IPConfiguration
FALSE	Inactive
TRUE	Active

- Set the camera access privilege of an application.

Set the following value to “GevCCP” register. The setting value is Enumeration type.

You can configure multi host system by using this function.

setting value	Access Right
OpenAccess	Secondary access that can only monitor the image and read the register. (MonitorAccess)
ExclusiveAccess (*)	Primary access that can monitor the image and control the register. Other host can not access the camera.
ControlAccess	Primary access that can monitor the image and control the register. Other host can have privilege of Secondary access only.

\* initial factory setting

- Set the Packet Size of the stream channel

Set the following value to “GevSCPSPacketSize” register. The setting value is Integer type. Set the register in conformity with your system (NIC, Switching HUB and the network condition). If the register setting is not in conformity with your system, your host cannot grab the image properly.

PacketSize	setting value
Minimum	576[byte/packet]
Maximum	8192[byte/packet]

\* initial factory setting = 1500[byte/packet]

**Notes on packet size setting:**

When the packet size setting is less than 1500[byte/packet], image may not be captured properly (e.g. dropping frames). In this case, change the packet size more than 1500[byte/packet]. And we recommend you to use network equipment (NIC, Switching HUB, etc. ) supporting Jumbo Frame.

## UserSetControl

The camera can save its actual setup to the non-volatile memory. There are three memory banks available to store user settings. User settings allow to restored a configured setup at the time of next start-up. The following table is the list of registers applied by “UserSetLoad”/“UserSetSave”.

Table 15: The register list applied by “UserSetLoad”/“UserSetSave”

Category	Register
Device Control	DeviceScanType
	DeviceSensorClock
	DeviceInitialDelay
Image Format Control	RegionNumber
	Width
	Height
	OffsetX
	OffsetY
	WidthBand 2,3,4
	HeightBand 2,3,4
	GapXBand 2,3,4
	GapYBand 2,3,4
	ManRegExposure
	ReverseX
	ReverseY
	BinningHorizontal
	BinningVertical
	DecimationHorizontal
	DecimationVertical
	PixelFormat
RawBayerBypass	
TestPattern	
Acquisition Control	AcquisitionMode
	AcquisitionFrameRate
	FrameBufferEnable
	ShutterMode
	TriggerMode
	TriggerSource
	TriggerActivation
	TriggerDelay
	TriggerLength
	TriggerDivider
	StrobeSource 1,2
	StrobeOutput 1,2
	StrobeInvert 1,2
	StrobeDelay 1,2

	StrobeLength 1,2
	ExposureMode
	ExposureTime
	ExposureAuto
	AETarget
	AEMinTime
	AEMaxTime
	AEspeed
	AEWindow
Digital IO Control	LineInverter
	LineSource
	UserOutputValue
Analog Control	Gain
	BalanceRatio
	BlackLevel
	Gamma
LUT Control	LUTEnable
User Set Control	UserSetDefault
Color Transformation Control	ColorTransformationEnable
	ColorTransformationValue
Event Control	EventNotification

## Registers

Register	Visibility	Access	Description
UserSetSelector	Beginner	R/W	Selects a bank of user setting.
UserSetLoad	Beginner	W	Executes to load the user setting.
UserSetSave	Beginner	W	Executes to save the user setting.
UserSetDefault	Beginner	R/W	Selects a bank of user setting when camera powers up.

## Setting

- Select a bank of the user setting

Set the following value to “UserSetSelector” register. The setting value is Enumeration type.

Select the bank of user setting for “UserSetLoad” and “UserSetSave”.

setting value	Description	Save	Load
Default (*)	Memory bank to read initial factory setting data.	×	○
UserSet1	Memory bank 1 for user setting.	○	○
UserSet2	Memory bank 2 for user setting.	○	○

\* *initial factory setting*

“Default” bank is only able to load data. If you want to restore a camera setting to the initial factory setting, please load “Default” bank.

- Load/Save a user setting

When execute “UserSetLoad”, the camera loads the user setting of bank that is selected in “UserSetSelector” register and applies them. When execute “UserSetSave”, the camera saves a user setting that was applied to the bank that is selected in “UserSetSelector” register.

- Load the user setting at the time of start-up

Set the following value to “UserSetDefaultSelector” register. The setting value is Enumeration type. When select “UserSetDefaultSelector” register and save it, the camera loads the user setting of bank that is selected in “UserSetDefaultSelector” register and applies them at the time of next start-up.

**Note:**

Changing “UserSetLoad” register value is invalid during image stream data output.

## Color Transformation Control

All GigEPRO cameras with a color sensor inside provide color transformation feature.

### Registers

Register	Visibility	Access	Description
ColorTransformationSelector	Expert	R/W	Selects which Color Transformation module is controlled by the various Color Transformation features.
ColorTransformationEnable	Expert	R/W	Activates the selected Color Transformation module.
ColorTransformationValueSelector	Expert	R/W	Selects the Gain factor or Offset of the Transformation matrix to access in the selected Color Transformation module.
ColorTransformationValue	Expert	R/W	Represents the value of the selected Gain factor or Offset inside the Transformation matrix.

### Setting

- Select the color transformation matrix

Set the following value to “ColorTransformationSelector” register. Setting value is Enumeration type.

setting value	Matrix
RGB to RGB	RGB to RGB color transformation.
RGB to YUV	RGB to YUV color transformation.

- Select the color transformation coefficient

Set the following value to “ColorTransformationValueSelector” register. Setting value is Enumeration type.

setting value	Coefficient
Gain00	Selects the gain 00 (RR, red-red) entry of the color transformation matrix.
Gain01	Selects the gain 01 (RG, red-green) entry of the color transformation matrix.
Gain02	Selects the gain 02 (RB, red-blue) entry of the color transformation matrix.
Gain10	Selects the gain 10 (GR, green-red) entry of the color transformation matrix.
Gain11	Selects the gain 11 (GG, green-green) entry of the color transformation matrix.
Gain12	Selects the gain 12 (GB, green-blue) entry of the color transformation matrix.
Gain20	Selects the gain 20 (BR, blue-red) entry of the color transformation matrix.
Gain21	Selects the gain 21 (BG, blue-green) entry of the color transformation matrix.
Gain22	Selects the gain 22 (BB, blue-blue) entry of the color transformation matrix.
Offset0	Selects the offset 0 (R, Red) entry of the color transformation matrix.
Offset1	Selects the offset 1 (G, Green) entry of the color transformation matrix.

Offset2 | Selects the offset 2 (B, Blue) entry of the color transformation matrix.

- Set gain or offset value

Set the following value to “ColorTransformationValue” register. Setting value is Float type.

setting value	Gain
Minimum	-4
Default *	+1
Maximum	+4

\* initial factory setting

### Calibration

The **Color Calibration** application uses a Macbeth standard color checker to evaluate the predefined color spots and calculate the correction values for the RGB color matrix in the camera.



Figure 29: Macbeth standard color checker

## Event Control

This section describes the EventControl category for the GigEPRO cameras.  
 This function allows you to select events delivered by the camera.

### **Registers**

Register	Visibility	Access	Description
EventSelector	Expert	R/W	Selects which event can be enabled by EventNotification.
EventNotification	Expert	R/W	Enables notification to the host application.

### **Setting**

- Select the event notification

Set the following value to “EventSelector” register. Setting value is Enumeration type.

setting value	event
AcquisitionStart	Device started the Acquisition of one or many Frames
AcquisitionEnd	Device completed the Acquisition of one or many Frames
FrameTrigger	Device received a trigger for the capture of one Frame
Line1RisingEdge	Device detected rising edge on the Line 1
Line2RisingEdge	Device detected rising edge on the Line 2
Line1FallingEdge	Device detected falling edge on the Line 1
Line2FallingEdge	Device detected falling edge on the Line 2
Ping	Device was pinged
Error	Device detected an error during the active Acquisition

## Extended Camera Functions

### Overview

Beside the standard image processing GigEPRO cameras deliver great benefit to industrial applications by adding realtime image processing functionality. GigEPRO cameras realize improvements of image processing performance in any industrial application which uses the GigE Vision standard. The NET IP library offers a set of image processing functions which can be fully controlled through the GenICam compliant XML description file inside the camera. Additional specific image processing tasks for custom applications are available on request. The detail of each function is explained in the NET IP Lib data-sheet and is not part of this document.

The standard color GigEPRO camera already contains Color Calibration, De-Bayering and Frame Transfer Request. Other NET IP LIB functions are optionally available. NET offers a PC based calibration tool for some of these functions including a color calibration to calculate the coefficients for the RGB color matrix.

Table 16: NET IP LIB image processing capabilities

NET IP LIB function	Spartan 6 LX45 Spartan 7 LX50		Spartan 6 LX75		Spartan 6 LX100	
	Color	BW	Color	BW	Color	BW
Color Calibration	X		X		X	
5x5 De-Bayering	X		X		X	
Frame Transfer Request	X	X	X	X	X	X
Geometry Correction (GC)			X	X	X	X
Flat Field Correction (FFC)			X	X	X	X
Defect Pixel Correction (DPC)			X	X	X	X
Bayer Channel Compensation (BCC)		X		X		X
Canny Edge Detection			X	X	X	X
2D Down Scaling			X	X	X	X
High Dynamic Range (HDR) --- only on GP2239C/M ---			X	X	X	X
Polarized Sensor						X

This section introduces extended functions of the GigEPRO camera.

Table 17: Extended camera function control

Category	Function	Description
NET IP Control	GC Control	Control geometry correction
	FFC Control	Control flat field correction
	DPC Control	Control defect pixel correction
	BCC Control	Control bayer channel compensation
	Canny Control	Control canny edge detector

## Geometry Correction Control

### Registers

Register	Visibility	Access	Description
GCEnable	Beginner	R/W	Activates the Geometry Correction.
GCMAPIndex	Guru	R/W	Control the index (offset) of the coefficient to access in the Geometry Correction MAP.
GCMAPAddress	Guru	R	Show the physical address of the Geometry Correction MAP entry.
GCMAPValue	Guru	R/W	Control the value at entry GCMAPIndex of the Geometry Correction MAP.
GCMAPSave	Guru	W	Save the Geometry Correction MAP to the non-volatile memory of the device.
GCMAPLoad	Guru	W	Load the Geometry Correction MAP from the non-volatile memory of the device.

### Calibration

The **Geometry Calibration** application uses a calibration target with a regular point grid to calibrate the system. It delivers a geometry correction map which is stored in the non-volatile memory of the camera device.

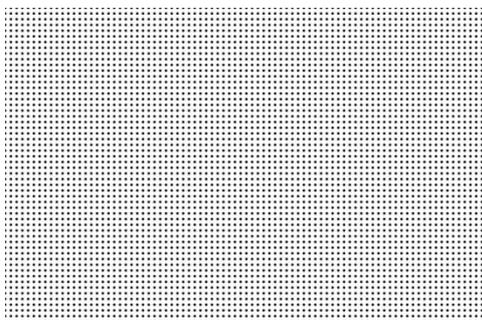


Figure 30: Geometry calibration target

## Flat Field Correction Control

### Registers

Register	Visibility	Access	Description
FFCEnable	Beginner	R/W	Activates the Flat Field Correction.
FFCAutoMap	Guru	R/W	Auto calculation of the Flat Field Correction MAP.
FFCShowMap	Guru	R/W	Shows the Flat Field Correction MAP.
FFCMAPIndex	Guru	R/W	Control the index (offset) to access the Flat Field Correction MAP.
FFCMAPAddress	Guru	R	Show the physical address of the Flat Field Correction MAP entry.
FFCMAPValue	Guru	R/W	Control the Value at entry MAPIndex of the Flat Field Correction MAP.
FFCMAPSave	Guru	W	Save the Flat Field Correction MAP to the non-volatile memory of the device.
FFCMAPLoad	Guru	W	Load the Flat Field Correction MAP from the non-volatile memory of the device.

### Calibration

The **Flat Field Correction** application compensates non-uniform illumination. It delivers a brightness correction map which is stored in the non-volatile memory of the camera device.

## Defect Pixel Correction Control

### Registers

Register	Visibility	Access	Description
DPCEnable	Beginner	R/W	Activates the Defect Pixel Correction.
DPCMAPIndex	Guru	R/W	Control the index (offset) to access the Defect Pixel Correction MAP.
DPCMAPAddress	Guru	R	Show the physical address of the Defect Pixel Correction MAP entry.
DPCMAPValue	Guru	R/W	Control the Value at entry MAPIndex of the Defect Pixel Correction MAP.
DPCMAPSave	Guru	W	Save the Defect Pixel Correction MAP to the non-volatile memory of the device.
DPCMAPLoad	Guru	W	Load the Defect Pixel Correction MAP from the non-volatile memory of the device.

### Calibration

The **Defect Pixel Correction** application compensates pixel defects of the sensor. It delivers a set of x-y pixel coordinates which is stored in the non-volatile memory of the camera device.

## Bayer Channel Compensation Control

### *Registers*

Register	Visibility	Access	Description
BCCEnable	Beginner	R/W	Activates the Bayer Channel Compensation.
BCCNumEntries	Beginner	R	Number of compensated analog gain sets.

### *Calibration*

The **Bayer Channel Compensation** application compensates non-uniform analog gain of the sensor subpixel. It delivers a set of analog gain values which are stored in the non-volatile memory of the camera device.

## Canny Control

### *Registers*

Register	Visibility	Access	Description
CannyEnable	Beginner	R/W	Activates the Canny Filter.
CannyThresh	Expert	R/W	Sets the threshold value.
CannyGaussX	Expert	R/W	Activates the horizontal gauss filter.
CannyGaussY	Expert	R/W	Activates the vertical gauss filter.
CannySobel	Expert	R/W	Activates the sobel filter.
CannyEdge	Expert	R/W	Activates the edge filter.
CannyGaussSizeX	Expert	R/W	Selects the size of the horizontal gauss filter.
CannyGaussSizeY	Expert	R/W	Selects the size of the vertical gauss filter.
CannyEdgeMode	Expert	R/W	Selects the edge filter mode.

# The "Open Camera" Concept

## Overview

GigEPRO features the concept of an "Open Camera". This allows experienced customers and system integrators to customize the camera with proprietary in-house algorithms and the development of products targeted for niche machine vision applications.

In the advanced version the GigEPRO camera offers a customer programmable FPGA (XILINX Spartan6 LX75/LX100) to allow image processing functions in real-time with a low deterministic processing delay. The FPGA is best capable of processing point and neighborhood operators of a typical image pre-processing task (and even simple interpretative tasks like feature extraction).

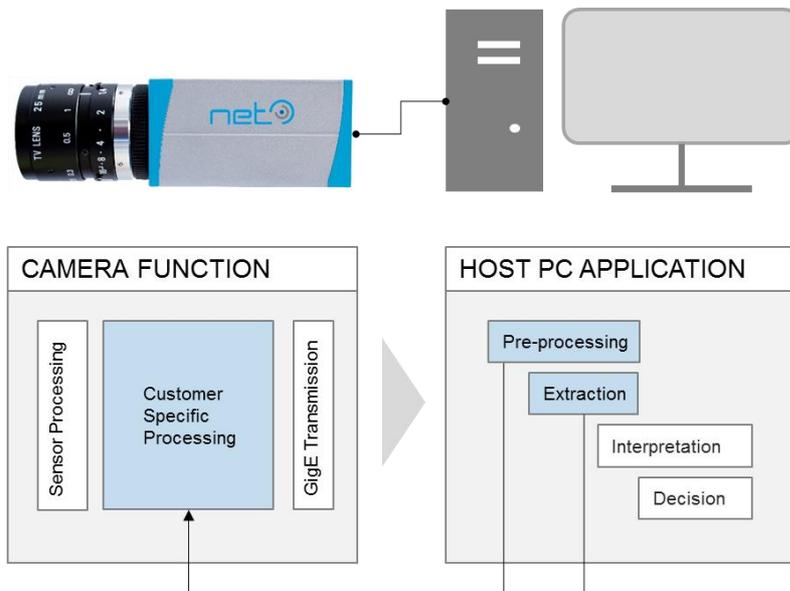


Figure 31: Partitioning of image processing tasks between camera and host

## Processing Capabilities

In most cases the hardware characteristics of an FPGA applied in a camera limit the application possibilities of the camera. To address this issue NET offers three size and performance options of the GigEPRO internal FPGA (Xilinx Spartan6 LX45, LX75, LX100) and three size options of the GigEPRO internal DDR3 memory (1GBit, 2GBit and 4GBit). This rises the image processing capabilities of the camera to a new level in the field of industrial camera computing.

The base design for the GigE-Vision functionality occupies only a fraction of the FPGA. The remaining resources are available for customized image processing tasks. The table below lists the available resources on a LX75 FPGA type available for customer image processing.

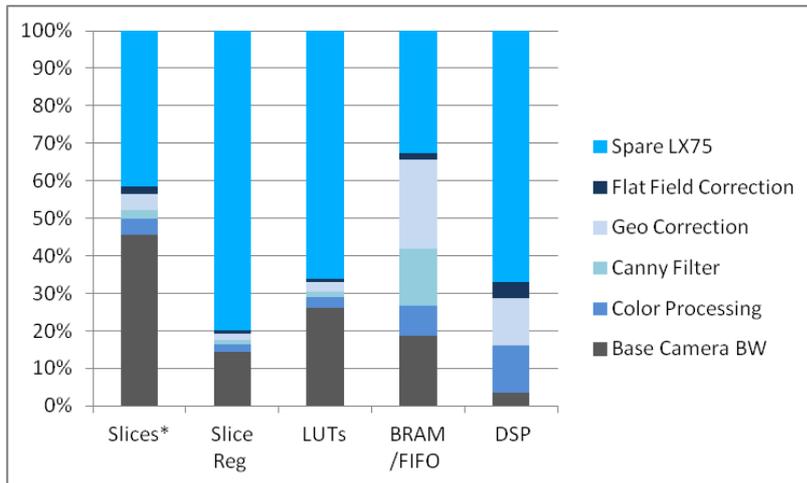


Figure 32: Image processing capability of GigEPRO internal FPGA

## Frame Buffer Options

Each GigEPRO camera collects frames from the image sensor in an internal frame buffer before sending the data via Gigabit Ethernet to the host PC. Frames are send either immediately after being completely captured or the delivery to the host is based on internal camera events or SW control.

While capturing data without automatically sending them to the host the internal memory will be used as a ring-buffer storing all captured frames until the ring-buffer is completely filled. After this the oldest frames will be overwritten. This allows the camera to capture data and not occupying bandwidth on the Gigabit Ethernet line. To support this functionality GigEPRO cameras offer 3 different hardware options with different sizes of the frame buffer memory (1Gbit, 2Gbit and 4Gbit). With the largest memory up to 1400 frames can be captured in the camera.

Table 18: Frame Buffer Options

Model	#pixel	Resolution (HxV) [px]	MByte /frame	#frames @1Gbit	#frames @2Gbit	#frames @4Gbit
GP1041	0.36MP	752 x 480	0,36	332	687	1396
GP4136	1.3MP	1280 x 1024	1,31	92	189	385
GP4206	2MP	1600 x 1200	1,92	63	129	263
GP2238/39	2.3MP	1920 x 1200	2,30	54	112	229
GP1305	3.2MP	2048 x 1536	3,15	38	79	160
GP1503	5.0MP	2592 x 1944	5,04	24	49	100
GP11014	10.0MP	3664 x 2748	10,07	12	25	50

## Open Camera data flow

### ***Methodology - Adding IP to GigEPRO***

First, a “Custom Module” has to be developed according to the following three steps for being able to add customer image processing functionality to GigEPRO.

1. Programming of the image processing function for the FPGA in HDL (i.e. Verilog or VHDL) and providing i.e. the data access, the algorithm, the parameter access and the delivery of processed data back to the FPGA base system.
2. Editing of XML description file (GenApiSchema Version1.1) with the description of the image processing function as developed in step 1.
3. Programming of the host software application by using the customized camera functions as described in the XML file developed in step 2.

### ***FPGA Programming Tools***

#### **Hardware:**

In order to develop a GigEPRO “Open Camera”, the use of a “programming dongle” is mandatory. It allows camera developers to download a bitstream file into the FPGA of the camera via the “XILINX Platform Cable USB II” JTAG interface and the reception of debug messages of the internal micro-controller via a TTY console (using FTDI USB serial adapter).

#### **Software:**

NET supplies an “Open Camera Development Kit” including some example image processing applications together with the GigEPRO FPGA base processing to the customer. The required tool chain (XILINX ISE EDK) for the selected FPGA hardware option has to be available to use the “Open Camera Development Kit”.

### ***XML Camera Description File***

Customers have to add their image processing features to the XML description file in order to make the new added features available to the host application. The XML description must be compliant to the GenApiSchema Version 1.1.

## Related documents

For a more detailed insight into the “Open Camera” concept, please refer to the **GigEPRO Open Camera Platform Description**.

## Technical Support

NET ensures the conformity of its product to be reliable and free from defects during manufacturing by testing all the cameras before release. However, unexpected problems and technical issues may come up due to the complexity of the product.

In case you require technical support, contact the agent near you or contact NET directly at the following locations:

### Websites

Europe	<a href="http://www.net-gmbh.com">www.net-gmbh.com</a>
Italy	<a href="http://www.tkhvision-italy.com">www.tkhvision-italy.com</a>
USA	<a href="http://www.net-usa-inc.com">www.net-usa-inc.com</a>
Asia	<a href="http://www.net-japan.com">www.net-japan.com</a>

### Email

Europe	<a href="mailto:info@net-gmbh.com">info@net-gmbh.com</a>
Italy	<a href="mailto:info@tkhvision-italy.com">info@tkhvision-italy.com</a>
USA	<a href="mailto:info@net-usa-inc.com">info@net-usa-inc.com</a>
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In case of an RMA, you must first contact NET and obtain an RMA Number before sending the product to us. We are not responsible for any problems caused by not following the RMA procedure.

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