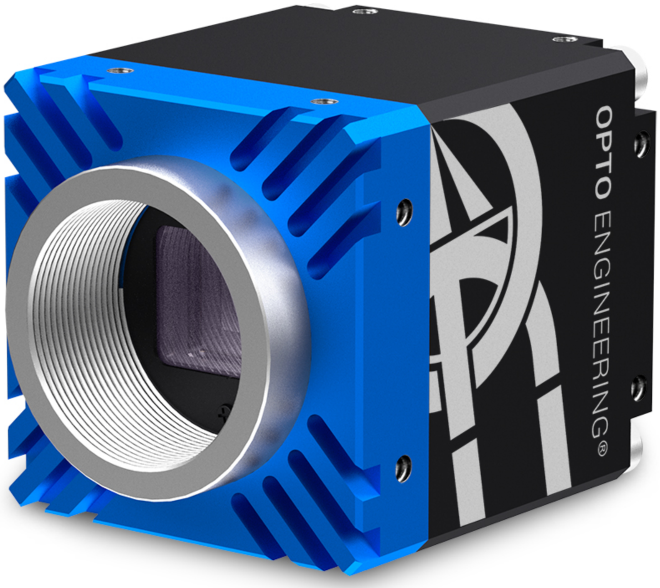


INSTRUCTION MANUAL

ITALA

GigE Vision Cameras

V1.1 - eng

CAMERAS

Contents

1 GENERAL INFORMATION

1.1 Disclaimer

Always use and store Opto Engineering® products in the prescribed conditions in order to ensure they function properly: failing to comply with the following conditions may shorten the product lifetime and/or result in malfunctioning, performance degradation or failure.

Be aware that incorrect functioning of this equipment may cause dangerous situations or significant financial losses. It is essential that the users ensure that the operation of the camera is suitable for their applications.

All trademarks mentioned herein belong to their respective owners.
Except where prohibited by law:

- All hardware, software and documentation are provided on an "as is" basis.
- Opto Engineering® accepts no liability for consequential loss, of any kind.

Upon receiving your Opto Engineering® product, visually examine it for any damage during shipping. If the product is damaged upon receipt, please notify Opto Engineering® immediately.

1.2 Forbidden use

Please read the following notes before using this camera.
Contact your distributor or dealer for any doubts or further advice.

- Do not disassemble, modify or repair the product yourself. It may cause permanent malfunctioning or even fire or electric shock, possibly resulting in serious injury;
- Do not place the product in dusty, humid or hot places or near flames. These conditions may cause malfunctioning and damage or even fire or electric shock, possibly resulting in serious injury;
- Do not spray insecticide or apply other volatile chemicals on or around the product;
- This device must not be used in an application where its failure could cause a hazard to human health or damage to other equipment. Keep in mind that if the device is used in a manner not foreseen by the manufacturer, the protection provided by its circuits and by its enclosure may be impaired;
- This is a low voltage power supplied device. As such, the potential difference between any combination of applied signals must not exceed the supply voltage at any time;
- Higher voltages may cause a fault and can be dangerous to human health;

- This device has limited protection against transients caused by inductive loads. If necessary, use external protection devices like fast diodes or better still, specific transient protectors;
- Do not allow foreign objects to enter the unit or drop into holes, terminals and other openings or gaps. This may cause fire or electric shock, possibly resulting in serious injury;
- Disconnect the power cable before moving the product. Failure to comply with this precaution may damage the power cable, cause fire or electric shock, possibly resulting in serious injury;
- Do not scratch, cut, open or twist the power cables. It may cause malfunctioning, fire or electric shock, possibly resulting in serious injury;
- If the power cable is damaged or cracked, please contact our technical support and do not use the product. Damaged cables may cause malfunctioning, fire or electric shock, possibly resulting in serious injury;
- Do not insert or remove the plug of the power cable with wet hands. It may cause electric shock, possibly resulting in serious injury;
- Do not use the product in presence of inflammable gas. It may cause outbreaks and flames, possibly resulting in serious injury;
- If you notice any abnormality such as smell, smoke or overheating, turn off the power and disconnect the power cables. Continuing to use the product in these conditions may cause fire or electric shock, possibly resulting in serious injury;
- If you have dropped the product or damaged the product case, turn off the power and disconnect the power cables. Continuing to use the product in these conditions may cause fire or electric shock, possibly resulting in serious injury.

1.3 Revisions

In Table 1 are listed all the user manual revisions.
In the column *Description* are listed all the relevant differences between different revisions.

Rev.	Date	Description	FW ver.
1.0	22/09/2021	First manual release	1.0.0 - 1.1.2
1.1	14/06/2022	- Added references to new camera features - Added SDK installation section - Added Driver installation section - Added Itala View quick start section - Added Itala View wizards sections	1.1.3 - 1.1.5

Table 1: Manual revisions

1.4 Ordering code

The camera part number is composed as follow:

ITA000-WX-00Y-ZZ

The ordering code is explained in Table 2.

Code	Description	Options	Value
ITA	Series Name		
000	Sensor resolution	32	3.2 Mpixel
		50	5.0 Mpixel
		89	8.9 Mpixel
		120	12.3 Mpixel
W	Interface	G	Ethernet
X	Mono/Color sensor	M	Monochrome
		C	Color
00	Variant	10	-
Y	Mount	C	C-mount
	Mount	F	F-mount
	Mount	J	J-mount (M42x1 FD 12)
ZZ	Optional features	–	Standard version
		EL	With liquid lens controller

Table 2: Ordering code

2 WARRANTY AND CERTIFICATIONS

2.1 Warranty

The device warranty is 5 years from the effective delivery date with reference to the device serial number.
Warranty covers the replacement or the repair of the defective part (components, device or part of it) with the exclusion of dismantling and shipping costs.
The replacement of one or more components does not renew the warranty period of the entire device.
The electronics and parts subjected to normal use or deterioration due to atmospheric agents and external environment are excluded from the warranty. Also, all failure caused by the lack of, insufficient or incorrect maintenance performed by unskilled or unauthorized personnel or due to unintended use or unauthorized replacements, alterations or repairs is excluded from the warranty.
The general validity of the warranty depends on:

- Maintenance being performed correctly as described in the device manual;
- The intended use of the device as specified in this manual.

2.2 CE Declaration

The Itala camera is conformal to the EMC directive 2014/30/EU and therefore comply with the following standards:

Standard	Date of issue	Description
EN 61000-6-2	2019	Generic standards - Immunity standard for industrial environments
EN 61000-6-4	2007+A1:2011	Generic standards - Emission standard for industrial environments

2.3 Shock and vibrations

Shock and vibration tests will be performed.

2.4 RoHS, REACH and WEEE

Itala cameras are conformal to the following directives and standards:

- RoHS 2011/65/EU
- REACH 1907/2006/EC
- WEEE 2012/19/EU

3 INTRODUCTION

3.1 Manual and conventions

Opto Engineering® SpA, with its registered office in Strada Circonvallazione Sud 15, 46100 Mantova (Mn) - Italy, hereinafter the manufacturer, provides all the necessary information in this installation, use and maintenance manual in a clear and simple way to install, use and service the product Itala.

The recipients of this manual are all those who have the knowledge, experience and capability of understanding the standards, prescriptions and safety measures indicated in this manual. Such people will be later identified as qualified personnel who are authorized to transport, install, use and service the products described in this manual.

This material can only be used by the customer whom this manual has been delivered to, in order to install, use and service the product.

The manufacturer will retain the right to modify or improve the manual and/or the product referred to in this manual without any prior notice.

The following typographical conventions are used in this document:

NOTE: *notes contain important information. Highlighted outside the text to whom they refer*

CAUTION: *these indications highlight procedures that, if not observed in their entirety or in part, can cause damage to the machine or to the appliances*

HAZARD: *these indications highlight procedures that, if not observed in their entirety or in part, can cause injuries or affect the health of the operator*

3.2 Product identification data

Itala cameras are identified with a label placed on the lateral side of the packaging box. A compact version of the label is also placed on the back side of the camera, near the connectors.

This label is used to identify the part number, serial number and MAC address of each device. A label example is shown in Figure 1.

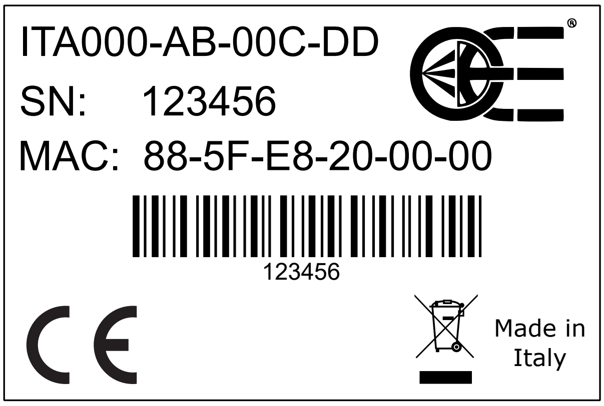


Figure 1: Example of camera label.

3.3 Storage and use conditions

3.3.1 Storage conditions

Storage environment between -10°C and 60°C. Avoid thermal shock by not exposing the product to sudden changes in temperature.
Store the product in a dry place: storage environment with relative humidity (RH) less than 85% (no condensation).

3.3.2 Operating conditions

Operating environment between 0°C and 50°C. Extreme temperatures affect the functionality of the product, especially the electronic components.
Avoid thermal shock by not exposing the product to sudden changes in temperature.
Since the product includes electronic components, it may generate heat when functioning: it's very important to dissipate an appropriate amount of heat (if necessary, operate the device with a forced air cooling system).
Use the product in a dry place: operating environment with relative humidity (RH) less than 85% (no condensation).

In general, avoid to store and use the camera in the following environments:

- Environments with strong electric/magnetic fields.
- Places exposed to direct sunlight, rain or snow.
- Environments exposed to particular gas and dangerous substances.
- In extremely vibrating systems.
- Dusty places.
- Extremely humid places.
- Excessive hot/cold environments.

3.4 Cleaning and maintenance

Even if the camera is equipped with a rugged mechanical case, some measures must be followed in order not to damage the camera itself.
In particular, when cleaning the Itala camera, remember:

- To avoid disassembling the camera.
- To avoid liquids or inappropriate cleaning chemicals like benzene, alcohol, spray-like cleaners.
- To use an appropriate soft cloth or soft brush.

The protection glass or filter placed in front of the sensor can be cleaned using compressed air or a cotton swab soaked with isopropyl alcohol.

4 GETTING STARTED

4.1 Overview

Itala is an industrial **Gigabit Ethernet camera** compliant with the *GigE Vision* and *GenICam* specifications. This camera is capable of transferring image data at high frame rates and over long distances, up to hundreds of meters.
Specifically designed for harsh industrial environments, Itala cameras guarantee reliable operation and top notch performances in their class. The *GigE Vision* and *GenICam* compliance allow easy camera integration and replacement. With flexible powering options, 12-24 Vdc and **Power over Ethernet**, Itala cameras are compatible with most vision systems, allowing simple and flexible wiring configurations.

4.2 Hardware installation

4.2.1 Camera installation

The camera is provided with 4 x M3 threaded holes on each side, allowing for flexible and robust mounting. It is recommended to mount the camera to a metal object using a metal bracket in order to facilitate the heat dissipation. Before installing the camera make sure to align it correctly, as requested by your application. Keep in mind that you can also exploit **ReverseX** and **ReverseY** camera features to flip the image on X and Y axis directly in camera, without performance loss.
Room should be provided to ensure a good cables setting on the back of the camera.

4.2.2 Lens

Cameras which come in **TYPE 1** enclosure are equipped with a standard **C mount** (1 inch diameter, 32 threads per inch), with a flange distance of 17.526 mm.
Cameras which come in **TYPE 2** enclosure are equipped with an **M42x1** threaded mount, with a flange distance of 12 mm.
See section 5.5 for the cameras dimensional drawings.

Before installing the lens, make sure that the lens and the camera protection glass are perfectly clean. Refer to section 3.4 for cleaning instructions.

> ***NOTE****: for heavy lenses, consider to directly mount the lens with an appropriate clamping system instead of relying on the camera mounting holes. If the lens allows you to adjust the phase of the mount, this operation is straightforward. Otherwise, you need to ensure that the camera orientation will be correct after screwing it in final position.*

4.2.3 Ethernet cable

Connect the camera to the host device with a suitable Cat 5e Ethernet cable or better, compliant with *ANSI/TIA-568* standard. A shielded cable can be used to improve the system EMI immunity, especially in harsh industrial environments.

Itala cameras come with 2 x M2 threaded holes for use with screw lock RJ45 connectors.
For moving applications (e.g. camera mounted on a robotic arm) use screw lock connectors and cable strain reliefs to ensure a reliable connection. A high-flexibility cable specifically designed for a high number of bending cycles is also recommended.
See section 5.5 for the cameras dimensional drawings.

If you intend to power the camera with PoE (Power over Ethernet), connect the cable to a suitable PoE injector or NIC (network interface card).

***CAUTION**: always use certified IEEE 802.3af PoE power supplies, injectors and NICs. Failing to do so may result in damaging the camera.*

***HAZARD**: cables should be arranged carefully, avoiding pinching, sharp corners and excessive tension. Failing to do so can lead to short circuits, damage to the appliances or even fire.*

4.2.4 GPIO cable

The camera can also be powered through the GPIO (general purpose input/output) port, using a suitable GPIO cable and power supply. Always use shielded cables for better performance and EMI immunity. See section 5.6 for the GPIO connector pinout and section 5.2 for the complete list of Itala cameras electrical specifications.

Firmly plug in the push-pull connector paying attention to the correct orientation.

***CAUTION**: don't force the connector if you encounter too much resistance. Check the connector orientation and try again.*

For moving applications (e.g. camera mounted on a robotic arm) a high-flexibility cable specifically designed for a high number of bending cycles is recommended.

***HAZARD**: always use suitable cables and power supplies that satisfy all the device specifications. Failing to do so may result in damaging the camera, fire or injury to the operator.*

***HAZARD**: cables should be arranged carefully, avoiding pinching, sharp corners and excessive tension. Failing to do so can lead to short circuits, damage to the appliances or even fire.*

4.2.5 Liquid lens

If the camera comes with the **Liquid Lens Controller** option, use a specific cable to connect the camera GPIO port to an Opto Engineering® electrically tunable lens. A **Y-cable** allows for simultaneous connection of liquid lens, power supply and synchronization devices. See section 6.13.1 for more information about the liquid lens connection and operation.

***CAUTION**: always use the specific cable provided by Opto Engineering® to connect the liquid lens to the camera. Failing to do so may result in damaging the camera or the liquid lens.*

***NOTE**: if the lens allows you to adjust the phase of the mount, choose an orientation that will reduce the strain on the cable.*

The orientation of the lens mounting can affect the image quality. Read the lens specifications before the final installation of the vision system.

4.3 System configuration

4.3.1 System requirements

The Itala SDK can be installed in a system working with one of the following OS:

- Microsoft Windows 7 (32 or 64-bit)
- Microsoft Windows 8 (32 or 64-bit)
- Microsoft Windows 10 (32 or 64-bit)

Proper functioning of the camera has not been tested with other operating systems.

Be careful to use a NIC (network interface card) which supports Gigabit Ethernet communication: in particular, choose a NIC with jumbo frame packets capability.

The Itala camera is a high performance device which streams uncompressed images with high data throughput. In order to guarantee optimal performances, the host system should be sufficiently powerful to handle the large amount of data sent by the camera. Consider choosing a high performance CPU and enough amount of RAM for the image acquisition and processing of your specific application.

4.3.2 Driver installation

To better handle the image streaming high throughput, it's recommended to use the **Itala filter driver**. The filter driver intercepts *GigE Vision* streaming protocol packets, reassembles the whole payload and sends it directly to the application image buffer. This allows to skip the standard network protocol stack that would increase latency and CPU usage on the host machine (Fig.2). The result is a low level packet handling offload which optimizes the host system resources consumption.

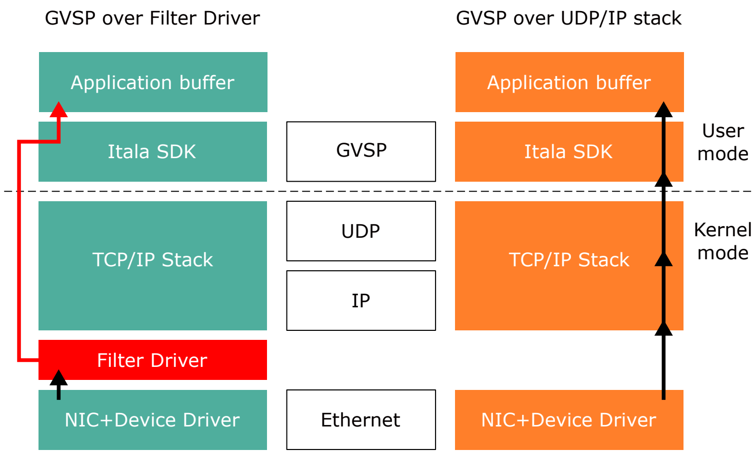


Figure 2: GigEVision Streaming (GVSP) with and without the Filter Driver

The Itala SDK installer takes care of the necessary filter drivers which are **automatically installed** on the host computer.

You can check for successful installation of the filter driver on your Ethernet connection property window. Go to *Control Panel* > *Network and Sharing Center* > *Change adapter settings*, right-click on your Ethernet connection and select *Properties*. In the *Networking* tab you should see the filter driver entry with a selected checkbox, as shown in Fig.3.

> ***NOTE****: in order to avoid conflicts, it's recommended to disable filter drivers from other camera vendors that you may have installed on your system.*

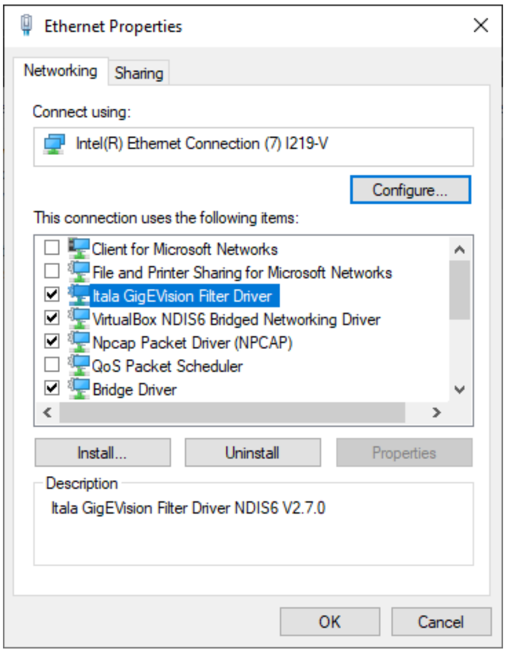


Figure 3: Successfully installed filter driver.

If you need to re-install the drivers after an unwanted removal, follow this procedure:

1. Go to the Itala SDK installation directory.
2. Open the Filterdriver folder.
3. Launch *install_driver_win10.bat* in case of Windows 10 OS. Please be careful to choose the correct batch depending on the operating system.
4. At the end of the installation, the filter driver will appear in the NIC property window (Fig.2).

4.3.3 Network and configuration

The camera is factory configured to automatically obtain an IP address in DHCP / LLA mode. This ensures the highest compatibility with different network configurations. For the first connection, it's recommended to configure your network settings in order to use DHCP.
Go to *Control Panel > Network and Sharing Center > Change adapter settings*, right-click on your Ethernet connection and select *Properties*. In the *Networking* tab select *Internet Protocol Version 4 (TCP/IPv4)* from the list and then click *Properties*.
Select *Obtain an IP address automatically* and click *OK*. Finally, click *OK* on the previous window.

If the camera is not accessible you can **force** it to adopt an **IP configuration** which is compatible with the current NIC settings. To do so, refer to section 4.7.2.

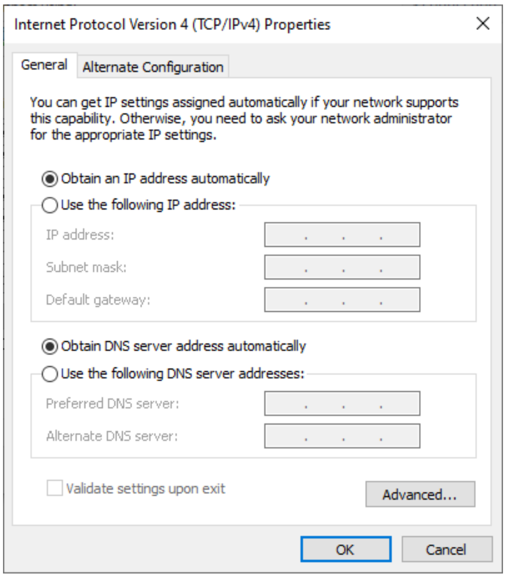


Figure 4: DHCP configuration of the network connection.

After the first connection, it is recommended to set a static IP address for both NIC and device whenever possible. This ensures a faster discovery process and IP negotiation.

It is recommended that the connection is as simple as possible. To achieve best performance use direct connection with the NIC or connect the camera and the host computer to the same Ethernet switch (without any other heavy traffic routed through the same switch).

4.3.4 Bandwidth management

To achieve the best streaming performances, connection reliability and to reduce CPU consumption, it's recommended to configure the NIC (network interface card) to use **Jumbo frames**. Jumbo frames are Ethernet frames which are larger than 1500 bytes and allow to increase the connection efficiency, reducing the amount of protocol overhead. Opto Engineering® recommends to use a NIC which supports Jumbo frames of at least 9000 bytes.

Jumbo frames are usually turned off by default. To enable them, go to *Control Panel* > *Network and Sharing Center* > *Change adapter settings*, right-click on your Ethernet connection and select *Properties*.
In the *Networking* tab click on *Configure*. The NIC settings window will appear.
In the *Advanced* tab locate the *Jumbo frame* or similar entry and enable it (Fig.5). The value to set may differ depending on the specific NIC model and manufcturer.

If you still experience issues with the camera connection you can try:

- Installing the latest NIC drivers.
- Increase the *receive buffer size* of your NIC.

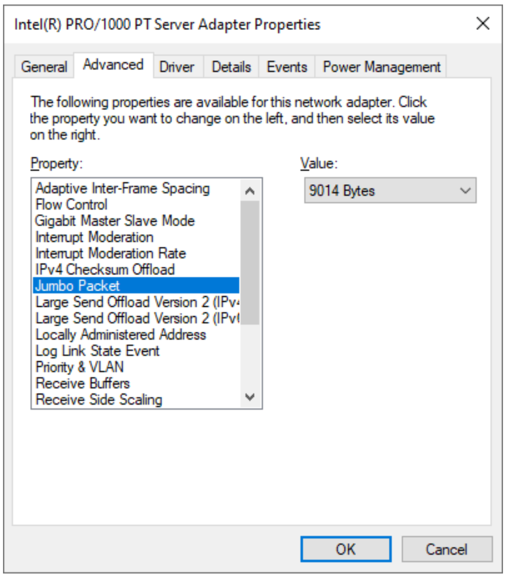


Figure 5: NIC advanced settings with Jumbo frames enabled.

When connecting **multiple cameras** to a single computer, it is recommended to connect all devices directly using multiple gigabit NICs. If you're connecting the camera through an Ethernet switch, make sure it also supports jumbo frames. Keep in mind that if multiple devices are connected to the same Ethernet switch, they will share the available bandwidth.
For more information about bandwidth management and multi-camera system configuration, refer to section 6.1.1.

4.4 Itala SDK

Itala cameras comes with a complete Software Development Kit, Itala SDK, which takes full advantage of the latest standards and technologies in machine vision industry.
The SDK includes:

- Itala API
- Itala View
- GenTL producer (.cti)
- Filter driver
- Documentation with code examples

In order to install the Itala SDK correctly, do the following steps:

1. Download the Itala SDK from Opto Engineering website and run the installer.
2. The Itala SDK setup window is displayed: make sure to follow the instructions listed (Fig.6).

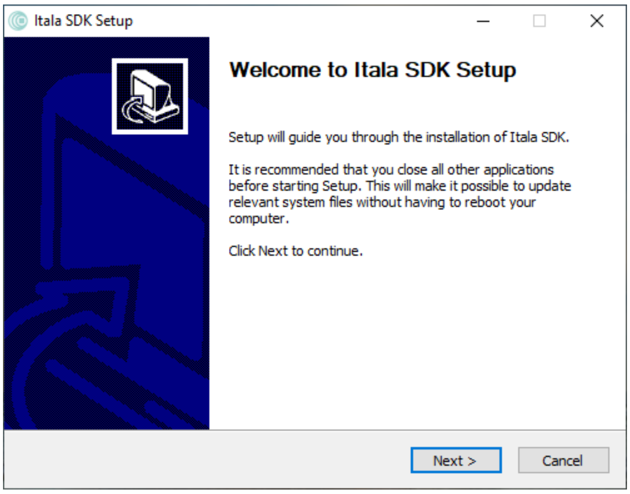


Figure 6: Itala SDK setup window.

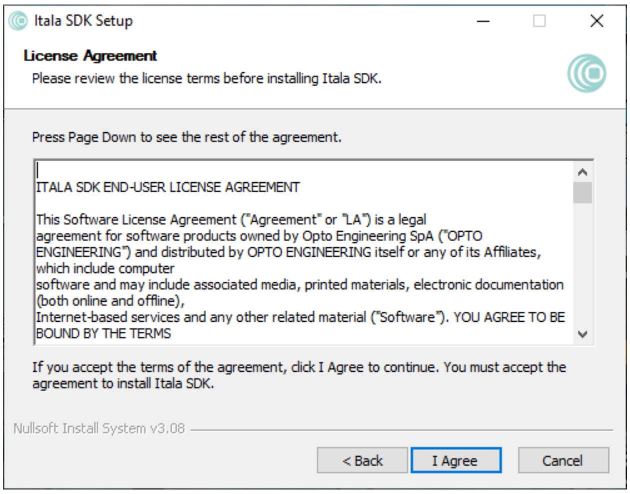


Figure 7: Itala SDK licence agreement window.

3. Check the licence terms before installing Itala SDK (Fig.7).
4. Choose the destination folder (Fig.8).
5. Select the components which need to be installed (Fig.9). In case of installation of the filter driver only, step 6 can be skipped.
6. (Optional) In case the .NET runtime needs to be installed, click *Install* in the .NET runtime installation window (Fig.10). In case of successful installation, the windows shown in Fig.11 will appear.
7. The Itala SDK installation will be performed automatically. The progress bar can be monitored to check the installation status. At the end of the installation, a confirmation window will be displayed (Fig.12).

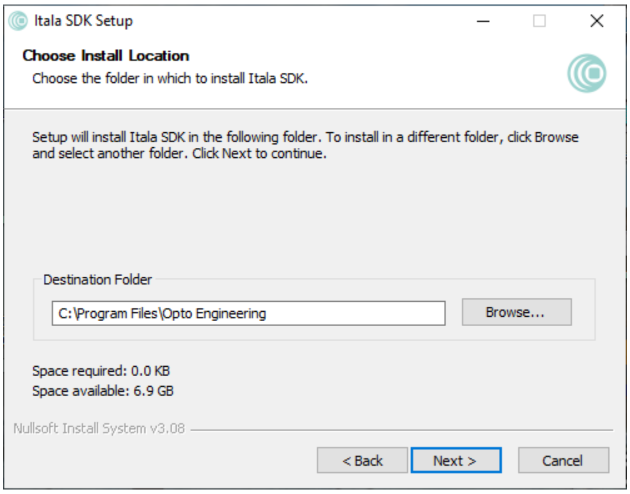


Figure 8: Itala SDK destination folder window.

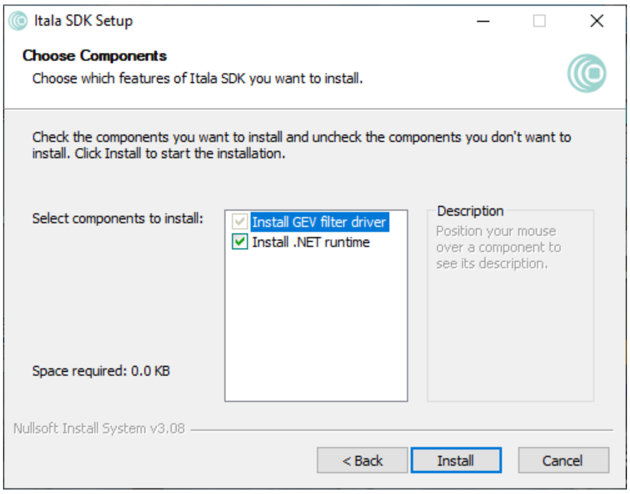


Figure 9: Components selection window.

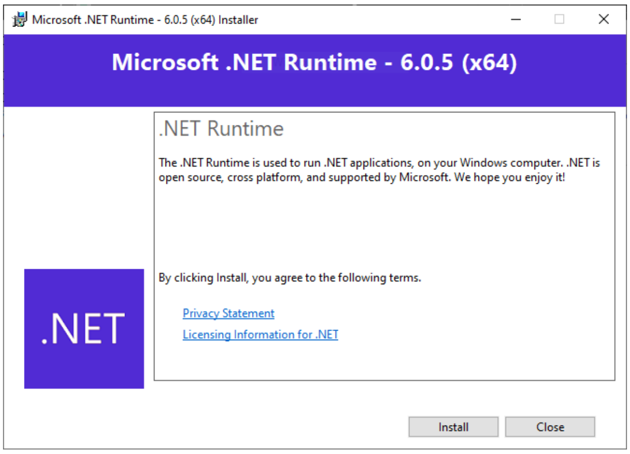


Figure 10: .NET runtime installation window.

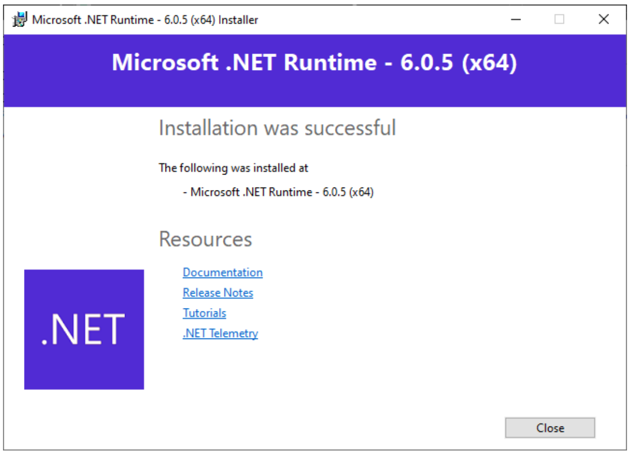


Figure 11: .NET runtime successful installation window.

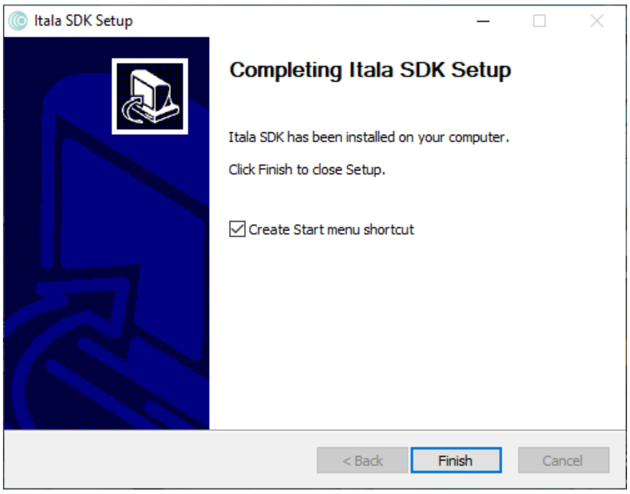


Figure 12: Itala SDK installation finished successfully.

4.5 Using the camera with Itala API

With Itala API it's easy to integrate Itala devices in custom applications, thanks to an extensive set of examples and complete documentation. For more information about the use of the library, refer to Itala API documentation in the SDK installation folder.

4.6 Using the camera with third party software

Itala cameras are compliant to **GigEVision** and **GenICam** standards, allowing easy integration with third party vision software. In addition, the SDK includes a **GenTL producer** (.cti file) compliant with the GenTL specifications hosted by EMVA. This further enhances the interoperability with other compliant devices and software.

4.7 Using the camera with Itala View

Itala View is a GUI tool which allows the evaluation, configuration and troubleshooting of Itala cameras. With a comprehensive set of utilities and wizards, Itala View speeds up the evaluation and deployment of a vision system built around Itala cameras.
To facilitate the first use of the application, a brief overview is given in the following sections.

4.7.1 Tabs and panels

With reference to Fig.13, the main window of Itala View can be divided in different functional areas:

1. Menu bar
2. Device discovery
3. Device information and control
4. Video streaming
5. Image data analysis and logging
6. GenICam feature tree

The **menu bar** gives you access to the settings, tools and wizards of the application.

The **device discovery** panel lists the NICs of your computer and the cameras connected to them. A refresh button on the top allows you to perform a discovery and enumeration of the GigEVision devices connected to your network.
Each device has a status icon which signals if it's reachable or not. An unreachable device can be symptom of a wrong IP configuration or that the same device is currently in use by another client application.
Next to each device there's a connect/disconnect button used to gain access to it.

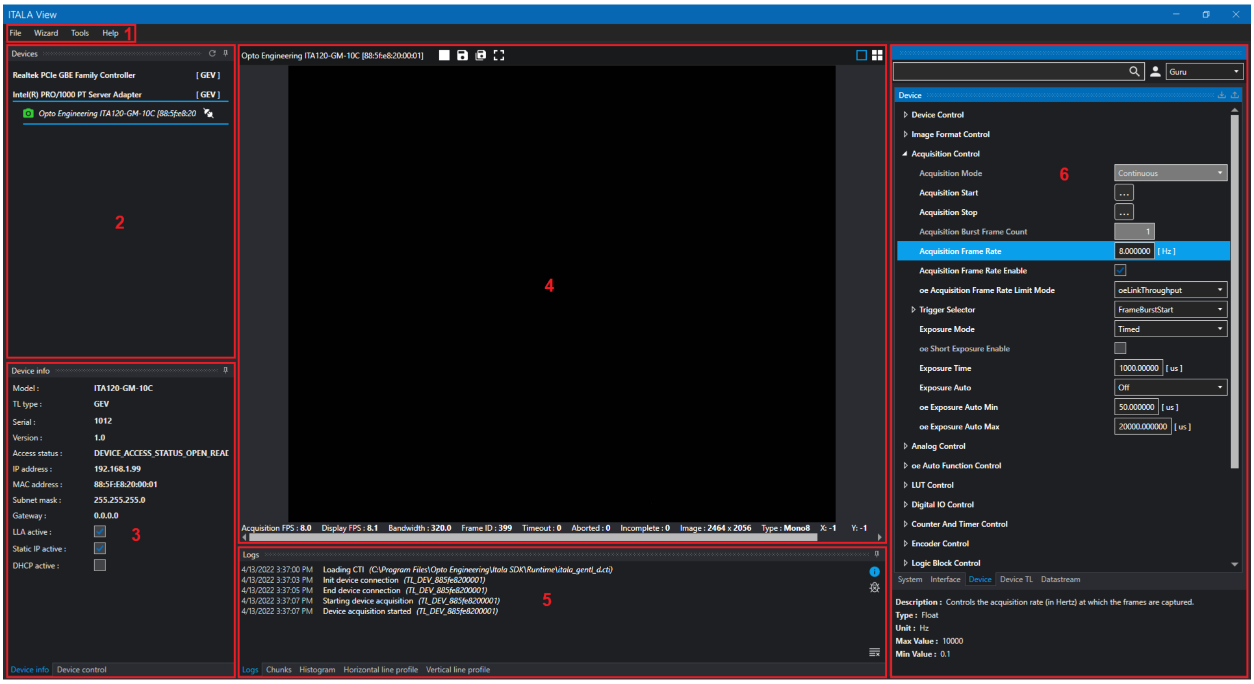


Figure 13: Viewer main window.

In the **device info** tab is shown some essential information about the device currently selected in the discovery panel. This includes the device model, serial number, MAC address and current IP address.
In the **device control** tab you can select the desired access mode and the number of buffers you want to allocate for image grabbing.

The **video streaming** view allows you to control the acquisition process and see the actual images grabbed by the camera.
On the top of the panel there are some quick access buttons to start/stop the acquisition, save images and toggle the full-screen mode.
On the bottom there's a status bar with statistics about the acquisition and useful information about the current image.

Using the **image data analysis and logging** tabs you can see the application log, current image chunk data and perform different types of analysis on the acquired image.

Through the **GenICam feature tree** you can access the camera parameters. The features are grouped by functions in a hierarchical manner and allow to configure the camera peripherals and/or read their status. These include basic functions, like the exposure time, gain or trigger settings and more advanced ones, like the encoder or the liquid lens controller.
You can use the tabs below the tree view to switch between the node maps of both GenTL modules and the connected device (selected by default).

4.7.2 IP configurator

From the *Tools* menu you can access the *IP Configurator* utility. The IP configurator has been designed to efficiently address network configuration issues of Itala cameras, including but not restricted to:

- Camera and NIC set with persistent IPs but different subnets
- Camera and NIC set with persistent IPs but different subnet masks
- Camera set in DHCP mode and NIC set with a persistent IP
- Camera set with a persistent IP and NIC set in DHCP mode

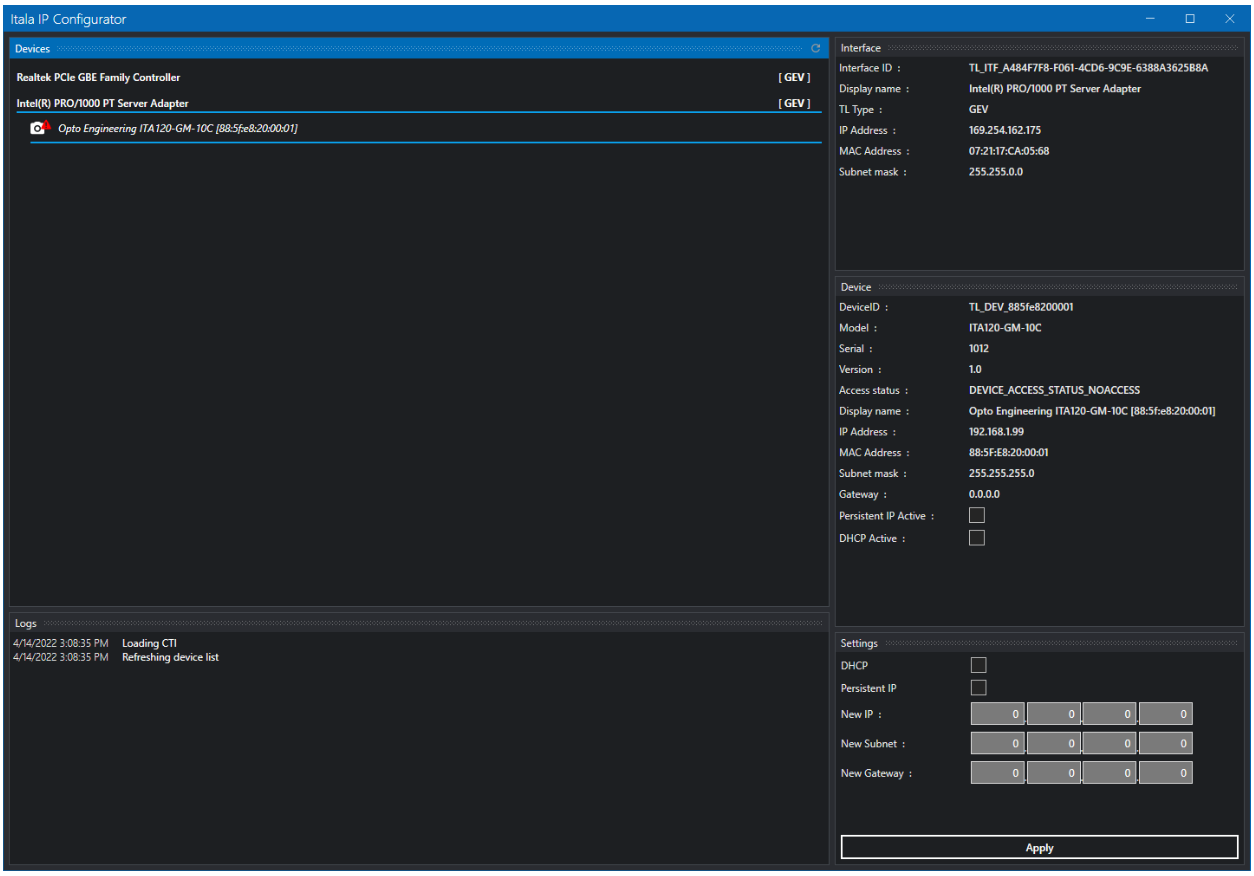


Figure 14: IP configurator window.

As can be seen in Fig.14, the IP configurator presents a panel for device discovery and enumeration similar to the one of the viewer main window. On the right relevant NIC and camera information related to the currently selected device in the aforementioned discovery panel can be seen.
IP configuration issues can be solved from the **settings** panel in the lower right corner. For example camera can be forces to adopt a persistent IP coherent with the current NIC IP settings. Just input the correct data and click the *Apply* button. In the log panel the configuration progress and check that the settings has been correctly applied can be seen.

As in the viewer main window, the icon next to each enumerated device show potential issues with a red warning sign.
For more information about the IP configuration of the camera refer to section 4.3.3.

4.7.3 Firmware update

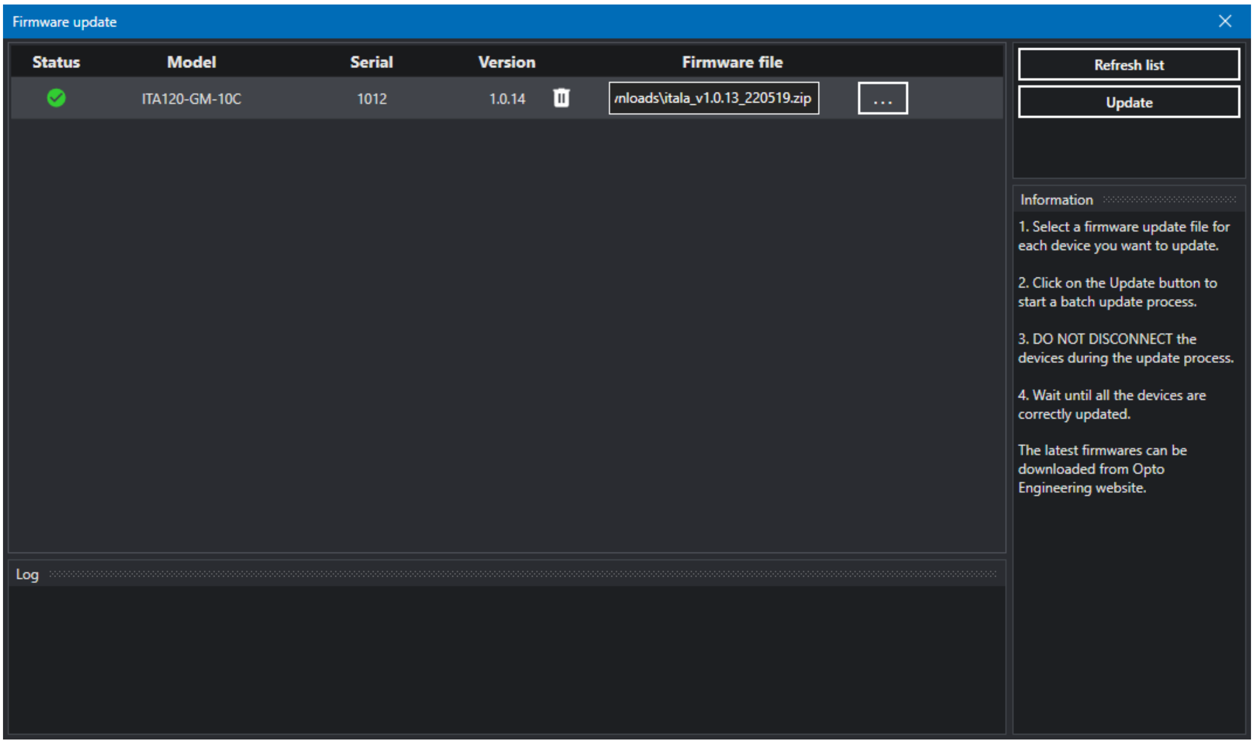


Figure 15: FW updater window.

From the *Tools* menu you can access to the *Firmware Update* utility (Fig.15). You can now select a firmware file for each device that has been enumerated. The latest firmware for Itala cameras can be downloaded from Opto Engineering website.
Follow this steps to update one or more devices:

1. Select a firmware update file for each device you want to update.
2. Click on the *Update* button to start a batch update process.
3. **Do not disconnect or power down** the devices during the update process (Fig.16).
4. Wait until all the devices are correctly updated.

> ***NOTE*: *do not disconnect or power down*** *the device during the update process. Failing to do so could lead to a condition where the device is no longer bootable and it should be returned to Opto Engineering for a factory reset.*

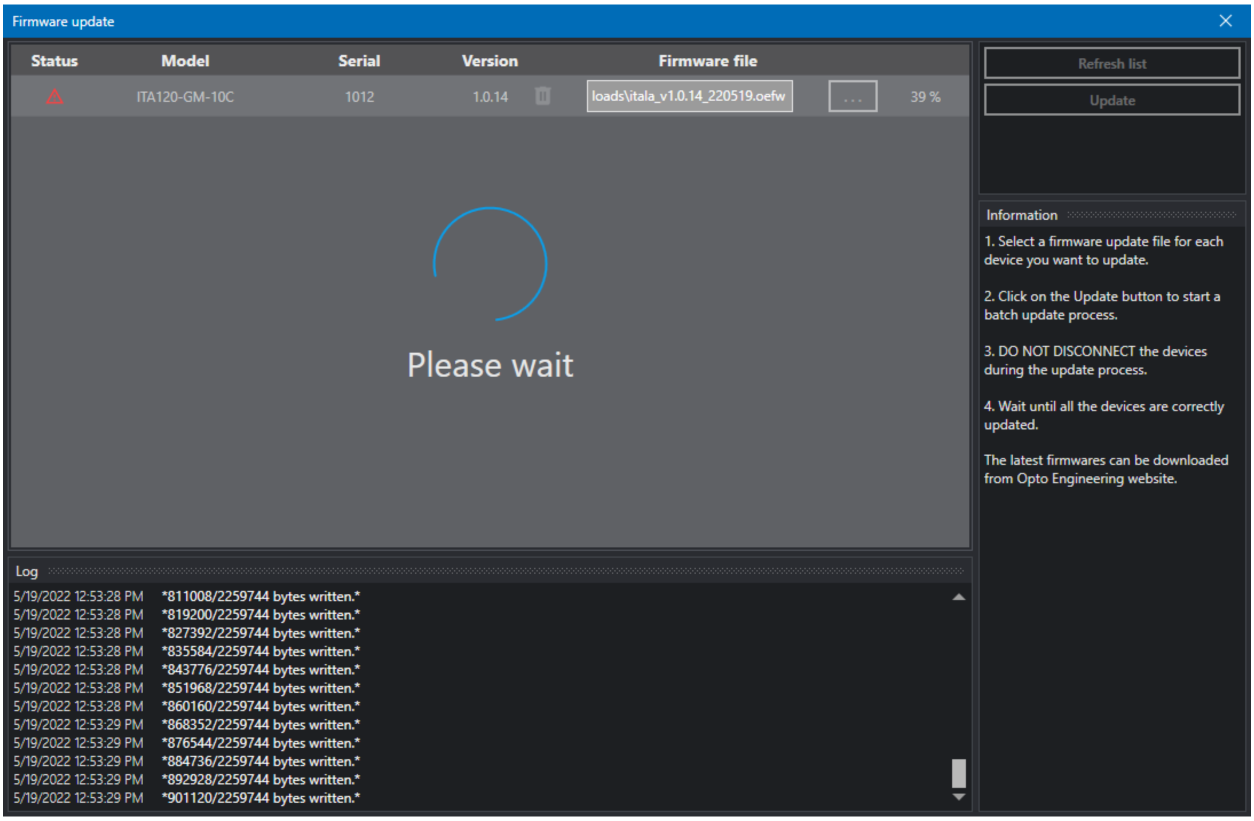


Figure 16: FW update in progress.

4.7.4 LUT wizard

From the *Wizard* menu you can access to the *LUT* wizard. This allows to view and edit the LUT of the selected camera.
Click on *Import from camera* to read the LUT from the camera registers and display it in the *Chart* tab (Fig.17). You can now edit each value the LUT in the *Table* tab (Fig.18). A better way to set a specific LUT is to load a CSV file previously generated with a spreadsheet editor or similar software. You can also write the current LUT on a CSV file, edit it and then read it back.
When you're satisfied with the resulting LUT, click on *Apply* to save it in the camera memory. For more information about the LUT feature refer to section 6.6.1.

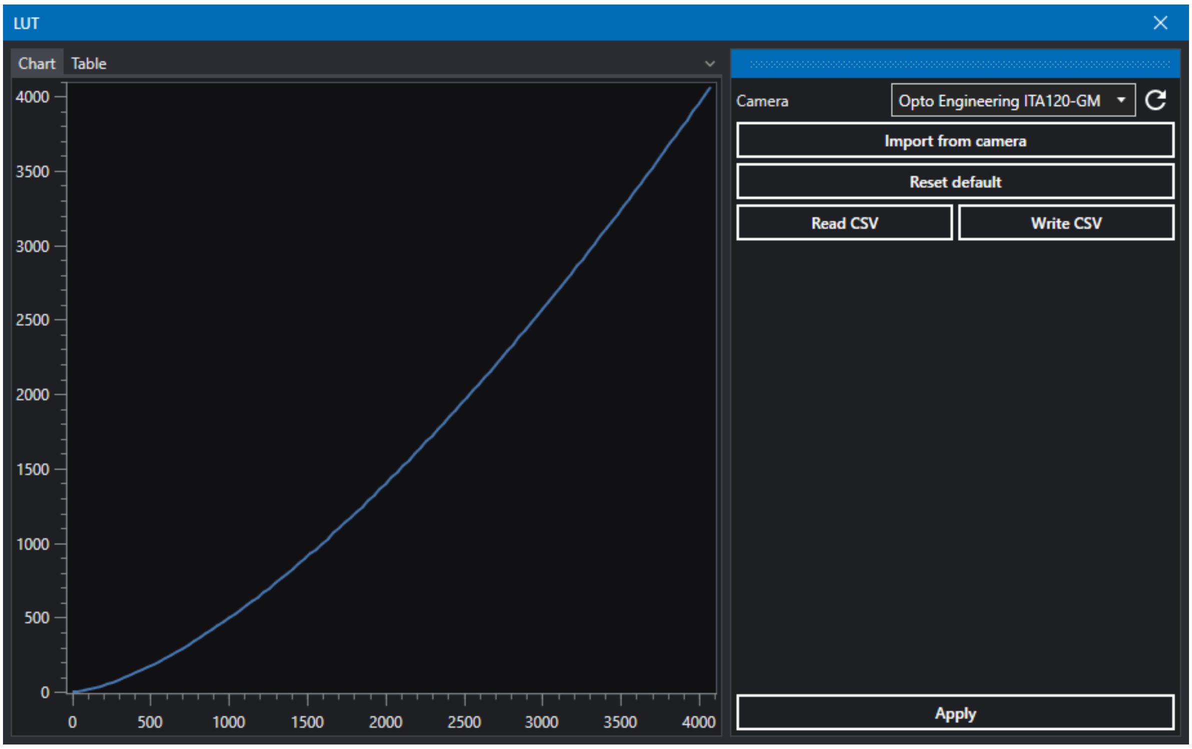


Figure 17: LUT wizard.

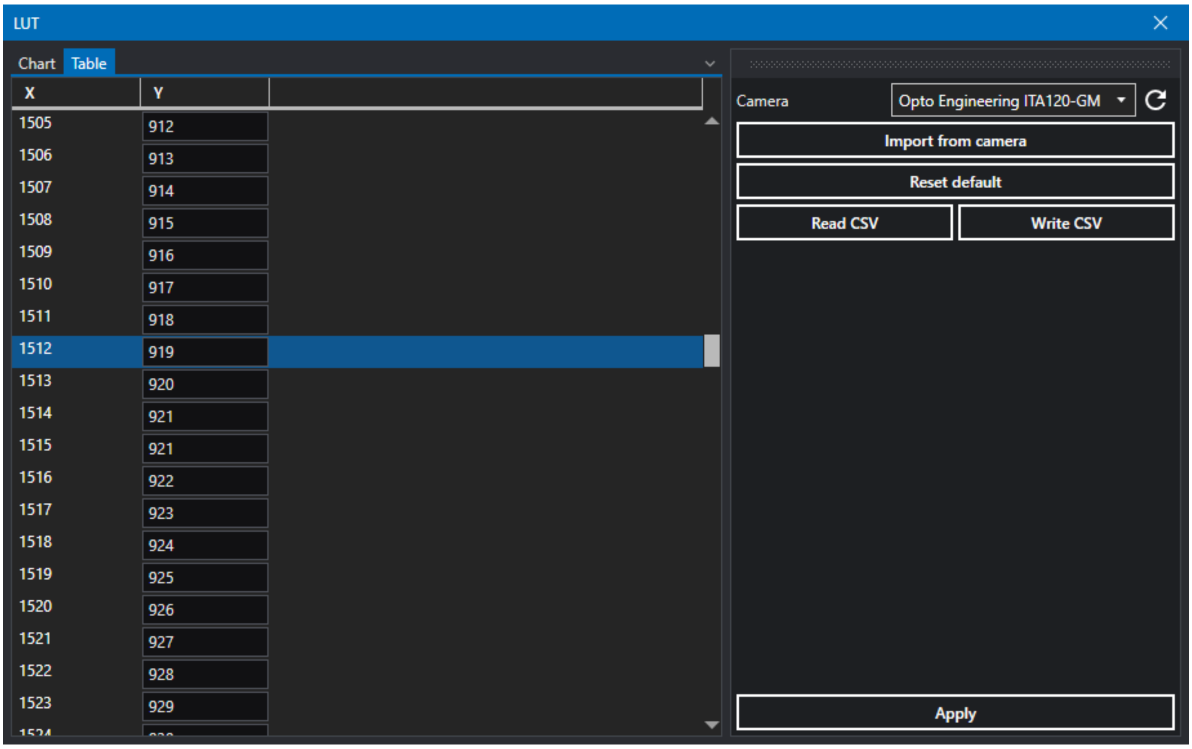


Figure 18: LUT wizard.

4.7.5 Defective pixels correction wizard

The image sensor defective pixels are mapped during Itala cameras production and testing procedures, since most of them are related to the sensor silicon production process. Their values are then corrected real-time in the camera acquisition pipeline. For more information about the defective pixel correction refer to section 6.14.
Anyway, there are other environmental factors which can increase the amount of defective pixels during the camera life. For this reason, Itala cameras enable the user to perform a custom pixel correction that takes into account these defects.
In order to enable the user defined defective pixel correction, the result of this operation must be saved in one of the available user set. The default user set, in fact, will correct only the defective pixels detected in factory.

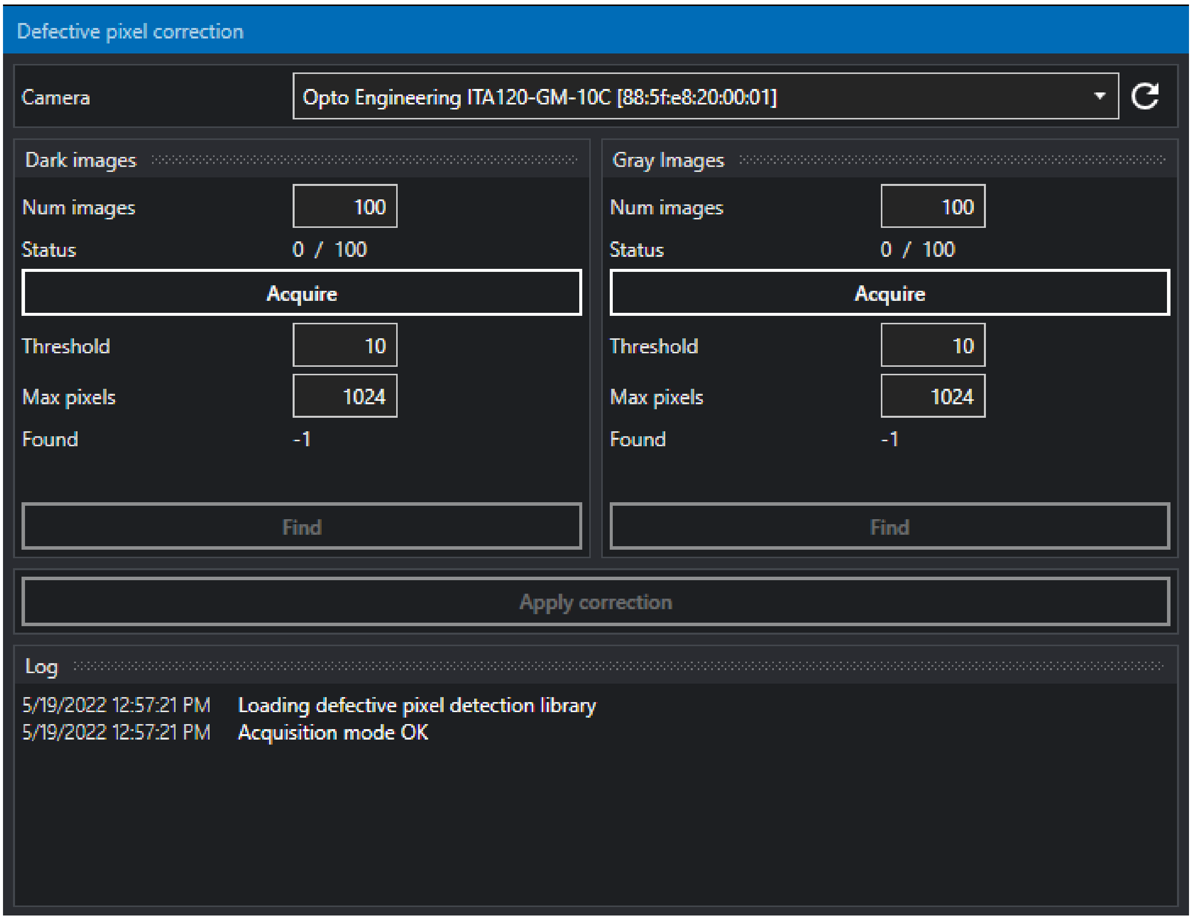


Figure 19: Defective pixels correction wizard.

From the *Wizard* menu you can access the *Defective Pixel Correction* wizard (Fig.19).

1. Put the camera in freerun acquisition or make sure there is a continuous stream of incoming trigger pulses.

2. For best results, consider using a raw pixel format with a bit depth of 12 bits, for example

Mono12p or *BayerRG12*.

3. Start the image acquisition.
4. Cover the camera sensor.
5. Click on the *Acquire* button in the *Dark images* panel to acquire a first batch of dark images.
6. Click on the *Find* button on the same panel to detect the *leaky* pixels.
7. Expose the sensor to a uniform light source (suggested uniformity: >97%) in order to obtain an image with an average brightness of 50% of the maximum saturation level. You can adjust the exposure time to reach the desired level. **Keep in mind that the same exposure time should be used to acquire the dark images**.
8. Click on the *Acquire* button in the *Gray images* panel to acquire a second batch of gray images.
9. Click on the *Find* button on the same panel to detect the *hot* and *cold* pixels.
10. Click on *Apply correction* to upload the data to the camera.

In order to make this change permanent, you should save the current user set. Loading the default user set will restore the factory defective pixel correction.

4.7.6 Color correction wizard

From the *Wizard* menu you can access the *Color correction* wizard (Fig.20). With a reference color checker (Fig.21) is possible to calibrate the camera in specific light conditions and obtain an optimal color rendering. For more information about the color correction matrix refer to section 6.7.1. Follow these steps to achieve a correct calibration:

1. Select the desired device.
2. Start the image acquisition.
3. Open the Color Correction Wizard (*Wizard* > *Color correction*) (Fig.22).
4. Point the camera to a reference color checker (Macbeth chart) such that its orientation match the one visible in overlay.
5. The color checker should fill the frame as much as possible (Fig.23).
6. Click and drag the 2 corners of the overlay matrix in order to center each overlay color target to the tiles of the color checker.
7. Select X and Y ratio in order to consider only the center part of each color tile. Keep the overlay color targets distant from the tiles edges.
8. Click the Correct button to start the color calibration.
9. Wait until the end of the process.

In order to make this change permanent, you should save the current user set. Loading the default user set will restore the factory color correction matrix.

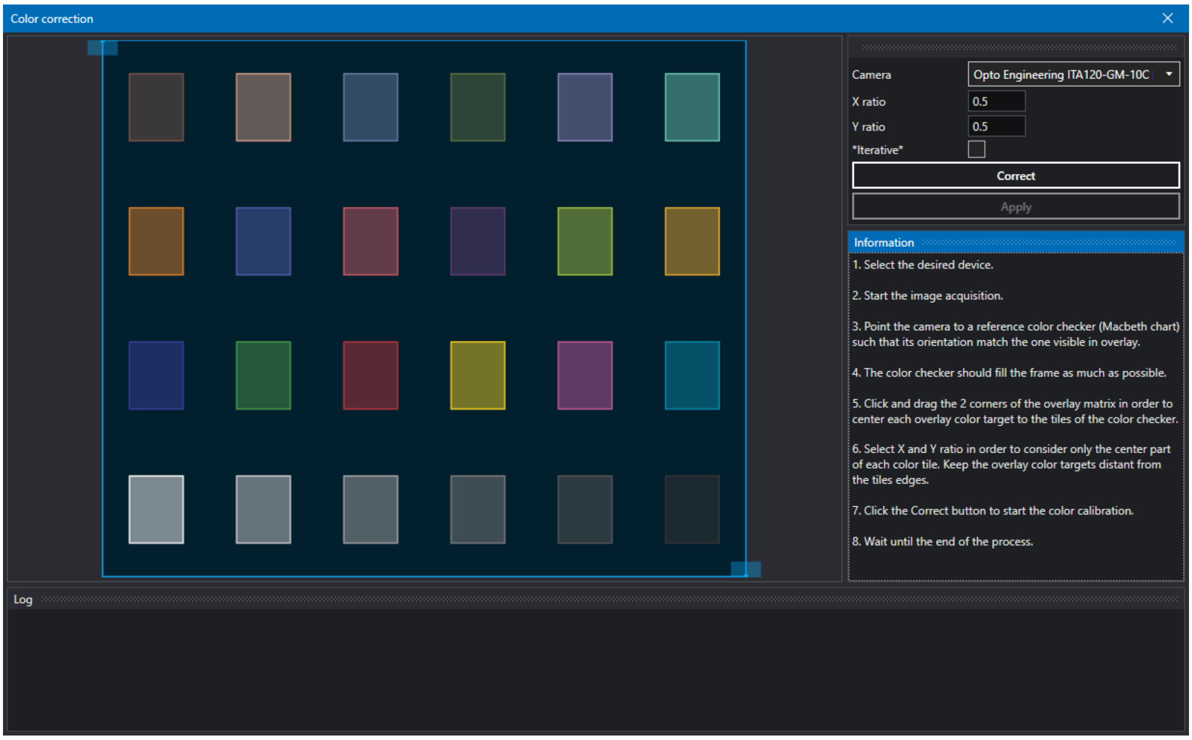


Figure 20: Color correction wizard.

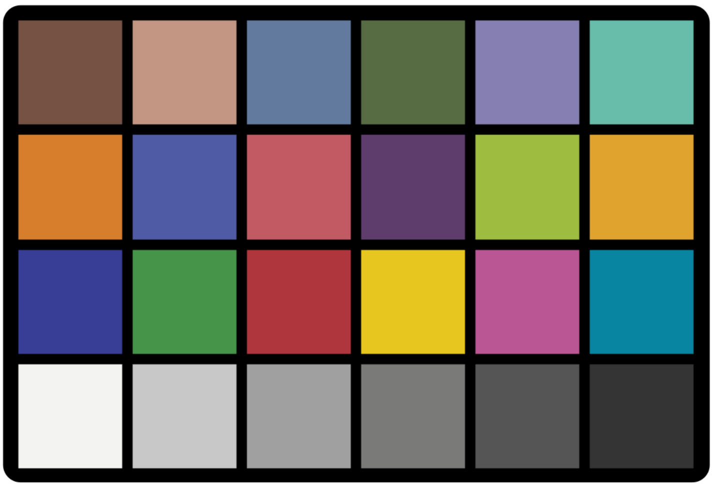


Figure 21: Reference color checker.

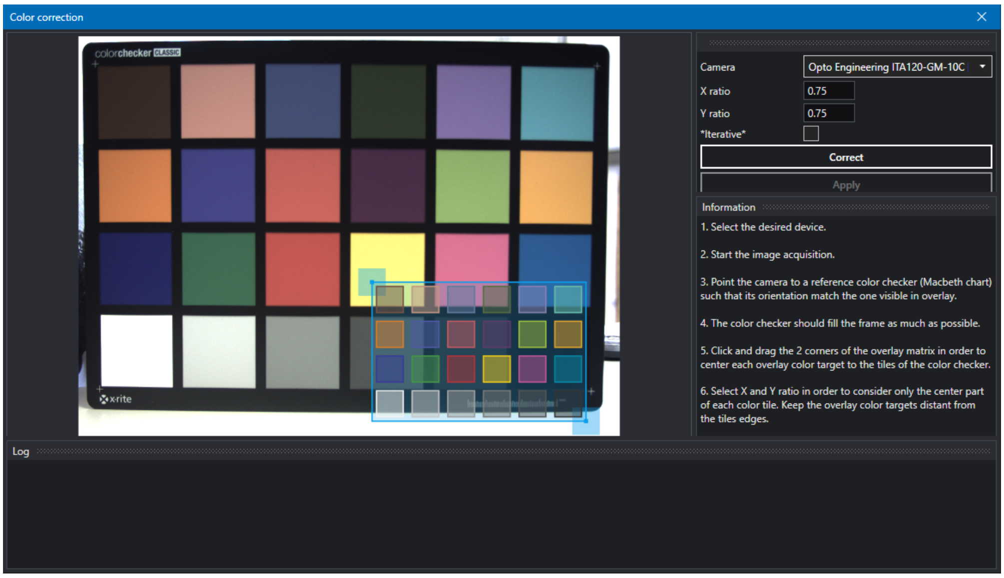


Figure 22: Window of the color correction wizard.

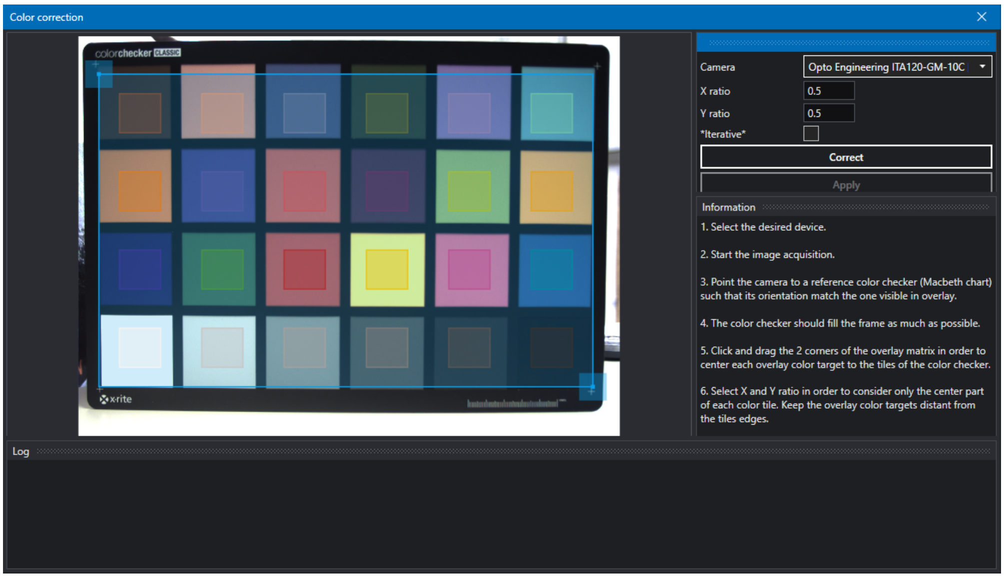


Figure 23: For optimal results, make sure to align the wizard color mask to the Macbeth color chart tiles.

5 TECHNICAL SPECIFICATIONS

5.1 Technical specifications

In Table 5.1 are summarized the main camera features.
Further explanations will be given in the following chapters.

Features	Standard version	Liquid Lens version	Ref. page
IMAGE FEATURES			
ADC resolution	8/12bit [1]	8/12bit [1]	-
Image buffer size	~ 400MB	~ 400MB	-
Image mirror (X/Y)	✓	✓	p.51
ROI mode	✓	✓	p.49
Decimation/binning	✓	✓	p.49
Pixel format	Mono8, Mono10Packed, Mono10p, Mono12Packed, Mono12p, RGB8, YUV422, BayerRG8, BayerRG10p, BayerRG10Packed, BayerRG12p, BayerRG12Packed [2]	Mono8, Mono10Packed, Mono10p, Mono12Packed, Mono12p, RGB8, YUV422, BayerRG8, BayerRG10p, BayerRG10Packed, BayerRG12p, BayerRG12Packed [2]	-
LUT/Gamma correction	✓	✓	p.59
Test pattern	✓	✓	p.52
Gain	✓	✓	p.56
Black level	✓	✓	p.60
Autoexposure	✓	✓	p.61
Autogain	✓	✓	p.61
Defective pixel correction	✓	✓	p.75
Debayering	✓[3]	✓[3]	-
White balance	✓[3]	✓[3]	p.57
Color correction matrix	✓[3]	✓[3]	p.65
Chunk data	✓	✓	p.77
CAMERA FEATURES			-
Status LED indicator	✓	✓	p.44
OS compatibility	Windows 7, 8, 10	Windows 7, 8, 10	p.16

PoE (Power over Ethernet)	✓	✓	-
Gigabit ethernet	✓	✓	-
Packet resend option	✓	✓	-
Static IP/DHCP	✓	✓	-
IEEE 1588 (PTP)	✓	✓	-
Opto-isolated inputs	2	2	p.42
Opto-isolated outputs	4	1	p.42
Temperature sensor	Image sensor, FPGA	Image sensor, FPGA	-
User sets	Factory + 2 user sets	Factory + 2 user sets	-
Remote FW update	✓	✓	p.27
Burst acquisition	✓	✓	-
Trigger hardware	✓	✓	-
Trigger software	✓	✓	-
Timers	2	2	p.68
Counters	4	4	p.68
Encoder control	1 [4]	1 [4]	p.69
Logic blocks	4	4	p.71
Logic functions	OR, AND, LUT	OR, AND, LUT	p.71
Serial communication	RS232/485		p.72
Liquid Lens controller		✓	p.74
CERTIFICATIONS AND COMPLIANCES			
GigEVision compliance	✓	✓	-
GenICam compliance	✓	✓	-
CE certificate	✓	✓	p.9
Shock and Vibrations	✓	✓	p.9
RoHS	✓	✓	p.9
REACH	✓	✓	p.9
WEEE	✓	✓	p.9
ENVIRONMENTAL			
Storage temperature	-10°C - 60°C	-10°C - 60°C	p.12
Storage Humidity	RH < 85%	RH < 85%	p.12
Operating temperature	0°C - 50°C	0°C - 50°C	p.12
Operating Humidity	RH < 85%	RH < 85%	p.12

[1] Sensor specific data.
[2] With BayerRG pixel format, also BayerGR, BayerGB, BayerBG are included in the available pixel formats.
[3] Not available for monochrome sensors.
[4] Refer to paragraph 6.10 for the compatible encoder interfaces.

5.2 Electrical specifications

Table 5 summarizes all the electrical specifications of the camera.
Further explanations about the I/O digital pins can be found in the paragraph 5.7 (pag.42).

Parameter	MIN	TYP	MAX	UNIT
GENERAL				
Supply Voltage	12	-	24	[V]
Power consumption	-	-	5	[W]
DIGITAL INPUT				
Input voltage	0	-	30	[V]
Input HIGH voltage threshold	2.4	-	-	[V]
Input LOW voltage threshold	-	-	2.0	[V]
DIGITAL OUTPUT				
Output voltage	0	-	+Vcc [1]	[V]

1 External power supply connected to the digital output + pin.

Table 5: Electrical specifications

In Table 6 are shown the results of the minimum/maximum input delays when Itala camera is triggered by an external device: the column *Input voltage* defines the triggering-signal voltage level while the columns *MIN Input delay* and *MAX Input delay* show the relative dalays for the signal to be detected by the internal logic.

Input voltage (V)	MAX Input delay (us)
TRIGGERING DEVICE (ACTIVE-HIGH LOGIC)	
3.3	4.27
5	3.38
12	3.31
24	3.39
TRIGGERING DEVICE (ACTIVE-LOW LOGIC)	
3.3	26.6
5	30.6
12	31.0
24	31.2

Table 6: Maximum input delays when Itala cameras are triggered by an external device

> ***NOTE***: *As it can be seen in Table 6, rising edge triggers are preferable for high speed and low latency applications.*

In Table 7 are shown the results of the minimum/maximum output delays when Itala camera triggers external devices: the column *Supply Voltage* refers to the voltage connected to the *OPTO REF V+* pin while the columns *Load Resistance* indicates the load connected to the opto-isolated output port.

Supply Voltage (V)	Load Res (ohm)	MAX Output delay (us)	Meas Output Voltage (V)	Meas Output Current (mA)
ITALA STROBE SIGNAL (ACTIVE-HIGH LOGIC)				
3.3	150	3.5	2.1	14.0
	330	3.5	3.0	8.8
	560	3.4	3.2	5.6
	1000	3.3	3.2	3.2
5	330	3.5	4	12.1
	560	3.5	4.5	8.0
	1000	3.5	4.7	4.7
	2200	3.4	4.8	2.2
12	330	3.8	8.5	25.6
	560	3.8	10.2	18.2
	1000	3.7	11.4	11.3
	2200	3.6	12.0	5.4
24	560	4.0	16.5	29.5
	1000	4.0	21.0	21.0
	2200	3.9	23.2	10.6
	4700	3.8	23.7	5.1
ITALA STROBE SIGNAL (ACTIVE-LOW LOGIC)				
3.3	150	6.6	2.1	14.2
	330	17.3	3.0	9.1
	560	27.3	3.1	5.6
	1000	34.8	3.2	3.2
5	330	9.6	4.0	12.2
	560	20.6	4.6	8.2
	1000	30.7	4.7	4.7
	2200	42.2	4.8	2.2
12	330	1.8	8.4	25.6

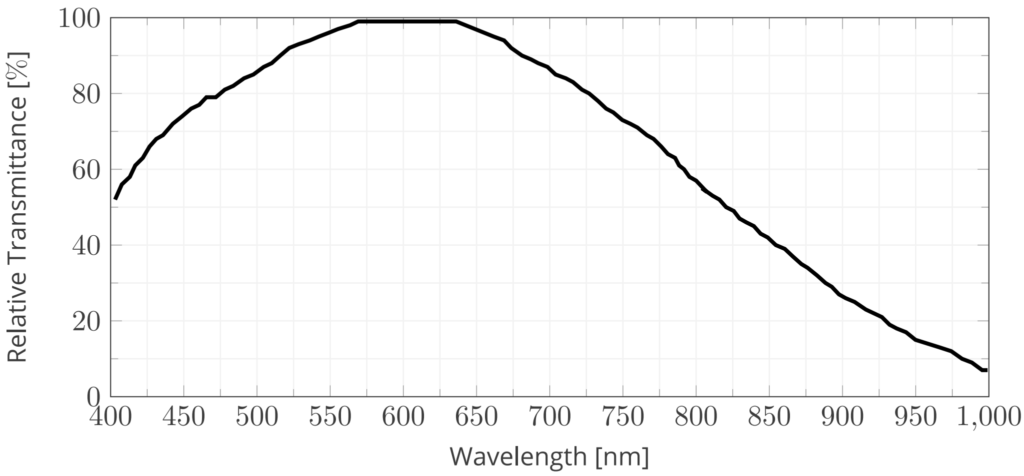
	560	4.7	10.2	18.2
	1000	12.0	11.4	11.4
	2200	31.3	12.0	5.4
24	560	1.5	17.0	30.3
	1000	4.0	21.2	21.2
	2200	15.8	23.3	10.6
	4700	36.9	23.8	5.1

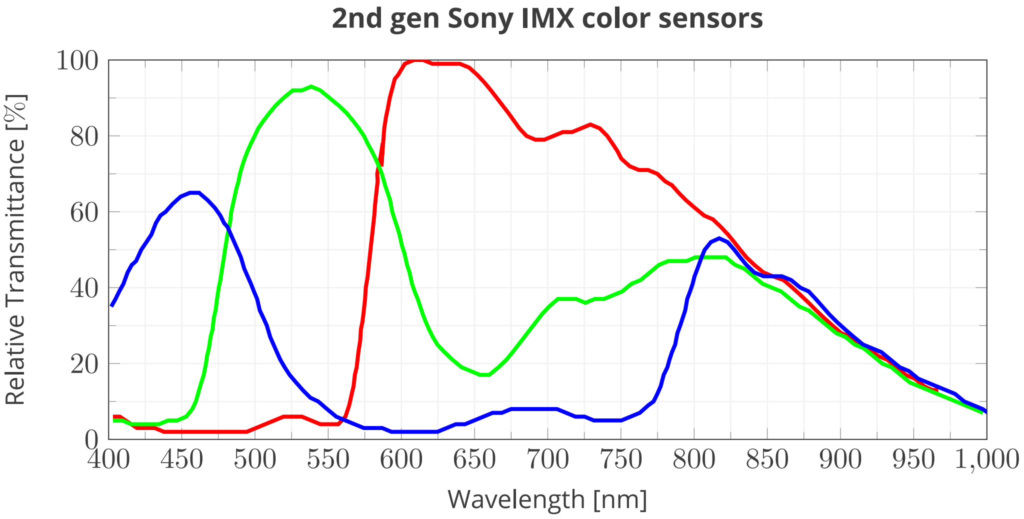
Table 7: Maximum output delays and electrical measurements for Itala cameras strobe signals

5.3 Sensor optical response

All the 2nd generation Sony IMX sensors exhibit the same optical response.
The relative transmittance for mono and color sensors is shown in the following graphs.

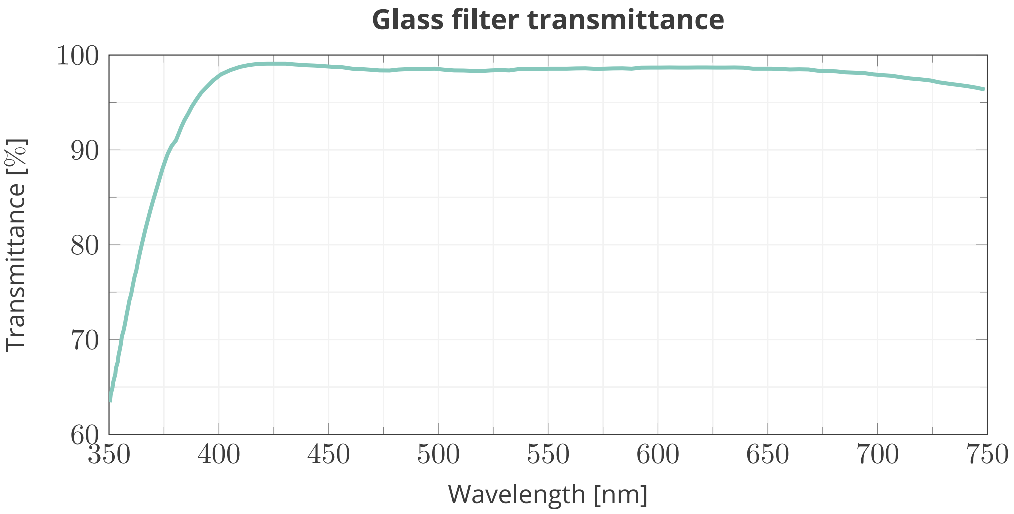
2nd gen Sony IMX monochrome sensors

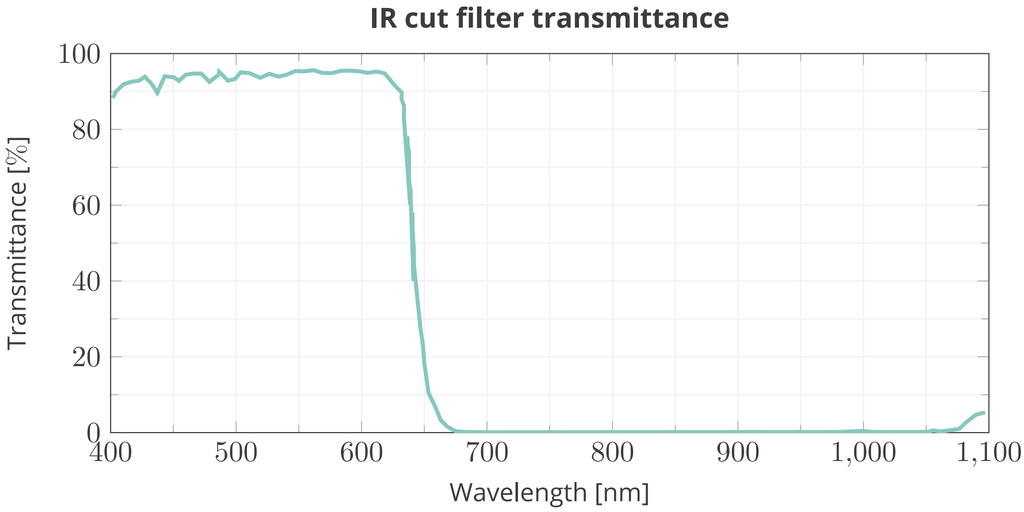




5.4 Optical filters

The following figures show the transmittance characteristics of the available optical filters for the Itala camera series.





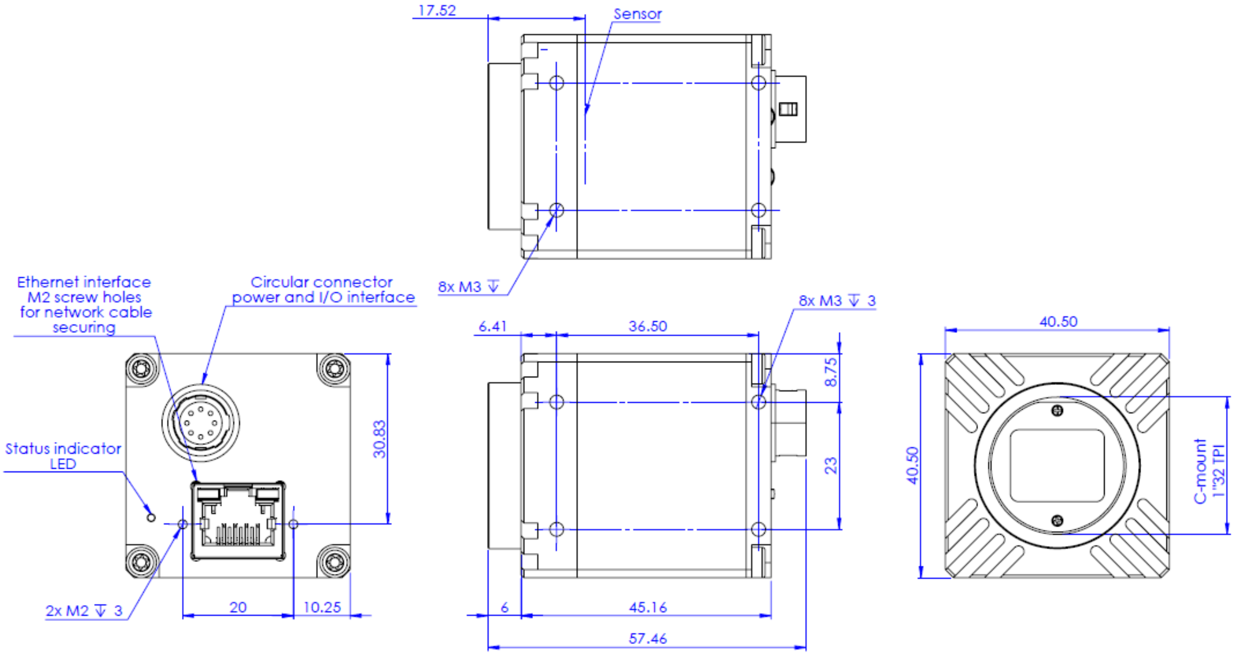
5.5 Mechanical specifications

Here are shown the dimensional drawings for all the camera models.

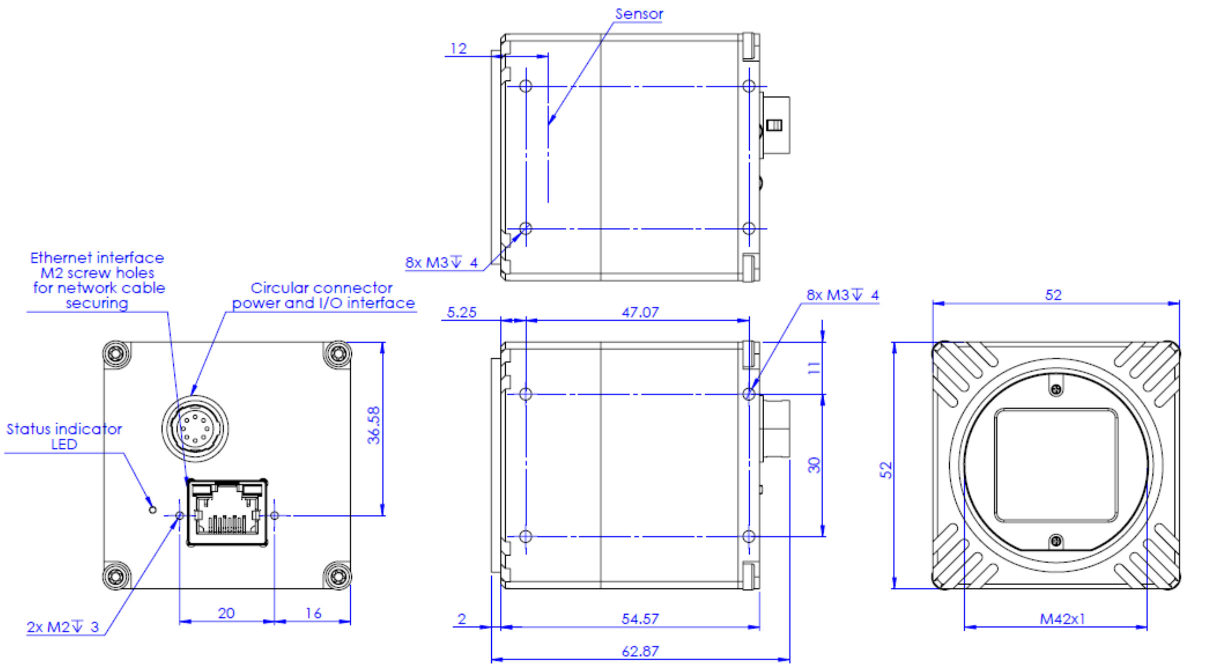
The **TYPE 1** refers to all the cameras up to the 12Mp image sensor. These are equipped with a standard **C mount** (1 inch diameter, 32 threads per inch), with a flange distance of **17.526 mm**.

The **TYPE 2** drawings refers to all the cameras from 16Mp to 31Mp image sensor. These are equipped with an **M42x1** threaded mount, with a flange distance of **12 mm**.

TYPE 1 dimensional drawings



TYPE 2 dimensional drawings



5.6 Connectors and pinout

The camera has two connectors:

- **Standard RJ45 connector with screw locks**
  Connection for image streaming and (optionally) for camera powering via PoE.

- **12-pin circular connector (P/N: HR10G-10R-12PB(71))**
  This connector has multi-purpose pins: power supply, trigger, synchronism, serial communication, liquid lens driver. The pinout is not fixed and depends on the camera model (standard or with liquid lens controller). Refer to Table 8 to see the pinout for both the camera models.

PIN	Standard	Liquid lens
1	GND	GND
2	+VIN	+VIN
3	Opto OUT 3	Lens -
4	Opto IN 0	Opto IN 0
5	Opto OUT 2	Lens +
6	Opto OUT 0	Opto OUT 0
7	Opto REF GND	Opto REF GND
8	RS232 RX	Lens SCL
9	RS232 TX	Lens SDA
10	Opto REF V+	Opto REF V+
11	Opto IN 1	Opto IN 1
12	Opto OUT 1	Lens +3.3V

Table 8: Itala pinout for both standard and liquid lens controller version.

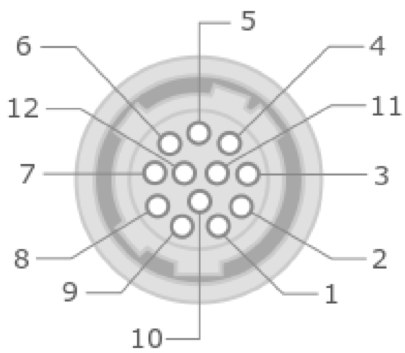


Figure 24: 12 pin circular connector pinout (camera front view)

> ***NOTE**: If a CBGPIO001 cable is used, check Opto Engineering® website to get the "color vs function" association.*

5.7 I/O circuitry

All input and output pins of the I/O connector are galvanically isolated.
All the electrical specifications and the maximum voltage/current ratings are listed in Table 5 (pag.36).

5.7.1 Opto Isolated Input

The opto-isolated input topology is schematically shown in Figure 25.

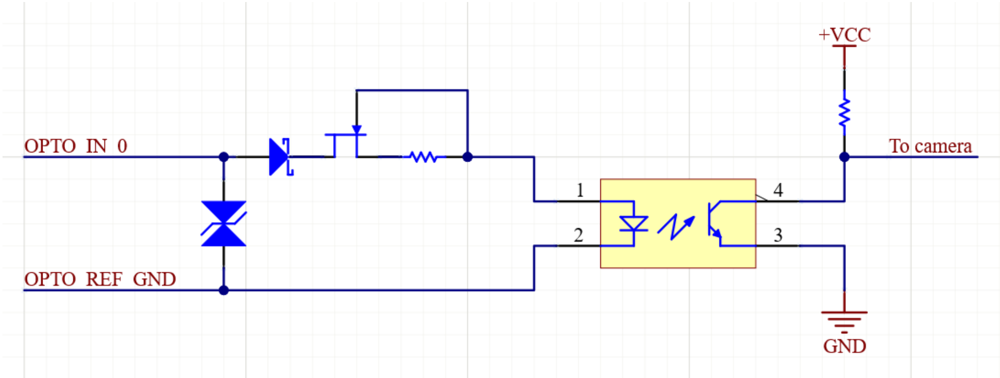


Figure 25: Opto isolated input topology.

A TVS diode is used as countermeasure against high voltage spikes, while a series diode prevents input polarity inversion. In addition, a current limiter circuit is also included in order to automatically adjust the input current.

> ***NOTE**: Be careful that any damage to opto-isolated input circuitry makes it not usable anymore.*

Some wiring diagram examples (both for opto-isolated and not-isolated systems) are shown in the Troubleshooting chapter of this manual.

5.7.2 Opto Isolated Output

The opto-isolated output topology is schematically shown in Figure 26.

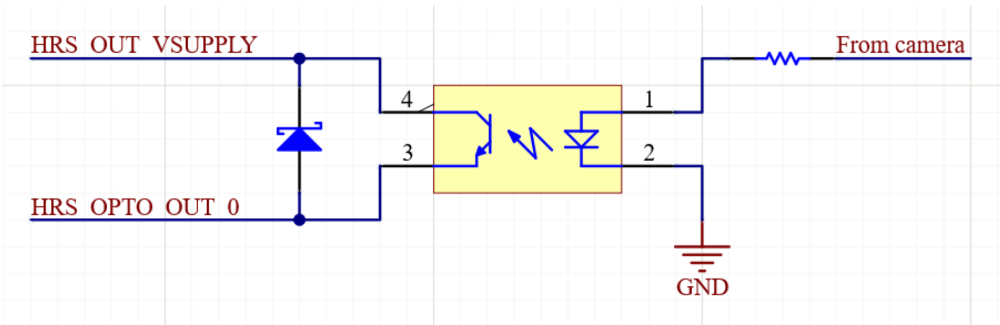


Figure 26: Opto isolated output topology.

The reference voltage for the opto-isolated output pins can be different from the power supply voltage, however the maximum specifications listed in Table 5 must not be exceeded.

5.8 LED and indicators

Itala is equipped with a LED indicator on the back side of the camera, next to the connectors.
This indicator shows the current status of the camera.
The color codes are listed in Table 9.

Color		Camera status
○	White	-
●	Blue	Camera is configuring (after a FW update)
●	Purple	Camera in boot mode
●	Yellow	Camera ready
●	Green	Camera is triggered
●	Red	Error

Table 9: LED colors vs status of the camera

6 CAMERA FEATURES

This chapter provides a summary of the standard and custom features of the Itala camera series. Features are defined following the *Standard Feature Naming Convention (SFNC)* and *GenICam* nomenclature. The following sections provide more detailed explanation of each feature.

6.1 Device Control

This section contains the features related to the control and information of the device.
This is mainly used to identify the device during the enumeration process and to obtain information about the device itself.
In Table 10 are listed all the Device Control parameters.

Feature	Description	Interface	Access
DeviceType	Returns the device type	IEnumeration	R
DeviceScanType	Scan type of the sensor of the device.	IEnumeration	R
DeviceVendorName	Name of the manufacturer of the device	IString	R
DeviceModelName	Model of the device	IString	R
DeviceManufacturerInfo	Manufacturer information about the device	IString	R
DeviceVersion	Version of the device	IString	R
DeviceFirmwareVersion	Version of the firmware in the device	IString	R
DeviceSerialNumber	Device serial number.	IString	R
DeviceUserID	User-programmable device identifier	IString	RW
DeviceTLType	Transport Layer type of the device	IEnumeration	R
DeviceTLVersionMajor	Major version of the Transport Layer of the device	IInteger	R
DeviceTLVersionMinor	Minor version of the Transport Layer of the device	IInteger	R
DeviceLinkSelector	Selects which Link of the device to control	IInteger	RW
DeviceLinkSpeed	Indicates the speed of transmission negotiated on the specified Link	IInteger	R

DeviceLinkThroughputLimitMode	Controls if the DeviceLinkThroughputLimit is active	IEnumeration	RW
DeviceLinkThroughputLimit	Limits the maximum bandwidth of the data that will be streamed out by the device on the selected Link	IInteger	RW
DeviceLinkHeartbeatMode	Activate or deactivate the Link's heartbeat	IEnumeration	RW
DeviceLinkHeartbeatTimeout	Controls the current heartbeat timeout of the specific Link	IFloat	R
DeviceLinkCommandTimeout	Indicates the command timeout of the specified Link. This corresponds to the maximum response time of the device for a command sent on that link	IFloat	RW
DeviceReset	Indicates the speed of transmission negotiated on the specified Link	ICommand	W
DeviceFeaturePersistenceStart	Indicate to the device and GenICam XML to get ready for persisting of all streamable features	ICommand	W
DeviceFeaturePersistenceEnd	Indicate to the device the end of feature persistence	ICommand	W
DeviceRegistersStreamingStart	Prepare the device for registers streaming without checking for consistency	ICommand	W
DeviceRegistersStreamingEnd	Announce the end of registers streaming	ICommand	W
DeviceTemperatureSelector	Selects the location within the device, where the temperature will be measured	IEnumeration	RW
DeviceTemperature	Device temperature in degrees Celsius (°C)	IInteger	R

Table 10: Device Control features

6.1.1 Bandwidth limit

The **DeviceLinkThroughputLimit** feature allows to limit the bandwidth available for the camera data streaming. Delays will be uniformly inserted between transport layer packets in order to control the peak bandwidth. This is equivalent to directly set the inter-packet delay value through the **GevSCPD** feature in the **Transport Layer Control** section. A suitable delay in data transfer will prevent the camera from "overrunning" the transfer interface limit.

The bandwidth limit is especially useful when setting up a multi-camera system with an installed bandwidth lower than the sum of the bandwidth of the single devices. Setting a proper limit on each device ensures the lowest amount of collisions on the network, maximizing performances and improving overall stability.

The relationship between the inter-packet delay and the resulting bandwidth is the following:

$$BW[Mbps] = BW_{MAX}[Mbps]\frac{(PS + 18)}{(PS + 18) + SCPD \cdot 1.25} \quad (1)$$

where BW_{MAX} is the maximum bandwidth of the device link (**DeviceLinkSpeed**), PS is the negotiated packet size (**GevSCPSPacketSize**) and SCPD is the inter-packet delay (**GevSCPD**).

6.2 Image Format Control

The Image Format Control section describes how to configure image size and format.

Feature	Description	Interface	Access
SensorWidth	Effective width of the sensor in pixels	IInteger	R
SensorHeight	Effective height of the sensor in pixels	IInteger	R
SensorPixelWidth	Physical size (pitch) in the x direction of a photo sensitive pixel unit	IFloat	R
SensorPixelHeight	Physical size (pitch) in the y direction of a photo sensitive pixel unit	IFloat	R
SensorName	Product name of the imaging Sensor	IString	R
WidthMax	Maximum width of the image (in pixels)	IInteger	R
HeightMax	Maximum height of the image (in pixels)	IInteger	R
Width	Width of the image provided by the device (in pixels)	IInteger	RW
Height	Height of the image provided by the device (in pixels)	IInteger	RW

OffsetX	Horizontal offset from the origin to the region of interest (in pixels)	IInteger	RW
OffsetY	Vertical offset from the origin to the region of interest (in pixels)	IInteger	RW
BinningHorizontalMode	Sets the mode to use to combine horizontal photo-sensitive cells together when BinningHorizontal is used	IEnumeration	RW
BinningHorizontal	Number of horizontal photo-sensitive cells to combine together	IInteger	RW
BinningVerticalMode	Sets the mode to use to combine vertical photo-sensitive cells together when BinningVertical is used	IEnumeration	RW
BinningVertical	Number of vertical photo-sensitive cells to combine together	IInteger	RW
DecimationHorizontalMode	Sets the mode used to reduce the horizontal resolution when DecimationHorizontal is used	IEnumeration	RW
DecimationHorizontal	Horizontal sub-sampling of the image	IInteger	RW
DecimationVerticalMode	Sets the mode used to reduce the vertical resolution when DecimationVertical is used	IEnumeration	RW
DecimationVertical	Vertical sub-sampling of the image	IInteger	RW
ReverseX	Flip horizontally the image sent by the device	IBoolean	RW
ReverseY	Flip vertically the image sent by the device	IBoolean	RW
PixelFormat	Format of the pixels provided by the device	IEnumeration	RW
TestPattern	Selects the type of test pattern that is generated by the device as image source	IEnumeration	RW

Table 11: Image control features

6.2.1 Image ROI

The **Width**, **Height**, **OffsetX**, **OffsetY** parameters are used to change the image format and to stream only a part of the full resolution image: in particular, the offsets set the displacement of the ROI (region of interest), while the width and height parameters set the effective dimensions of the image.
The sum of **OffsetX** and **Width** cannot exceed the **WidthMax** value and the sum of **OffsetY** and **Height** cannot exceed the **HeightMax**.
WidthMax and **HeightMax** are sensor specific and cannot be set by the user.
In Fig.27 is shown a graphical explanation of these parameters.

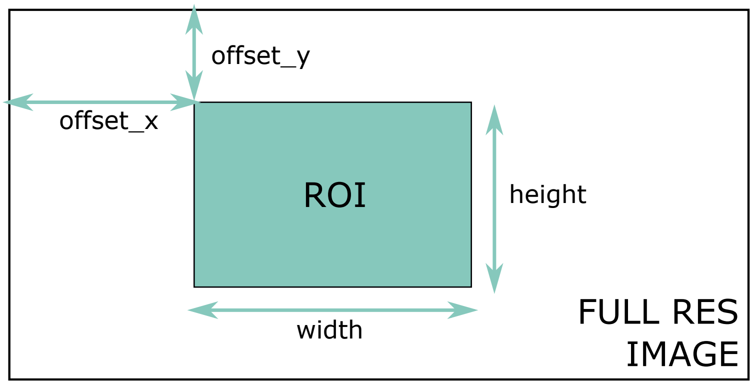


Figure 27: Image ROI paramenters.

6.2.2 Binning

Binning mode is used to increase camera sensitivity by summing the values of adiacent pixels, with the drawback of a lower effective resolution.
As depicted in Fig.28, a **2x1 binning** halves the image resolution along the x-axis, but the overall image brightness is doubled (since two adiacent pixels have been combined). If a **2x2 binning** is performed, the image resolution is one quarter of the initial one, but the brightness is four time the initial brightness.

In case of color sensors, Bayer filter must be taken into account: since adiacent pixels have different chroma information, binning is performed on alternate pixels, as depicted in Fig.29. In this way, chroma information is not affected by algorithm artifacts.

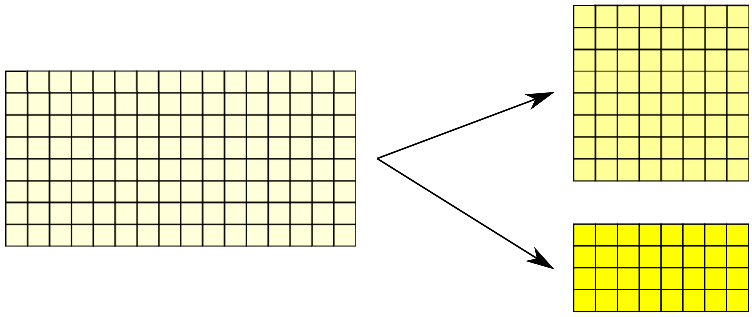


Figure 28: Examples of binning: in the figure above a 2x1 binning is performed, while in the figure below a 2x2 binning is applied.

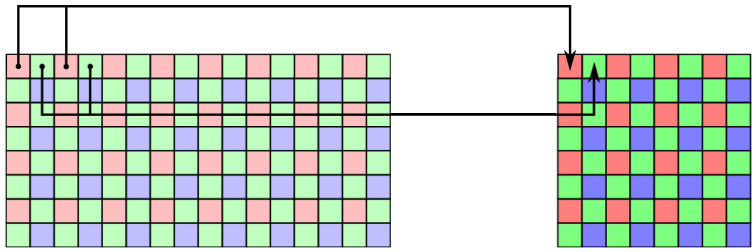


Figure 29: Examples of binning for color sensors: in the figure above a 2x1 binning is performed.

6.2.3 Decimation

Decimation mode is used to discard pixels in order to obtain a sub-sampled image.
Decimation mode has some advantages, e.g. the increasing of the frame rate of the camera.
In Fig.30 are shown two examples of decimation: in the figure above a **2x1 decimation** is performed: only one pixel over two is considered, thus the resulting image has half of the initial horizontal resolution; in the figure below a **4x1 decimation** has been applied, so only one pixel over four is acquired. Also in this case the resulting horizontal resolution has been reduced (by a factor 4).

In case of color sensors, Bayer filter must be taken into account: since adiacent pixels have different chroma information, decimation is performed grouping pixels with alternate colors, as depicted in Fig.31. In this way, chroma information is not affected by algorithm artifacts.

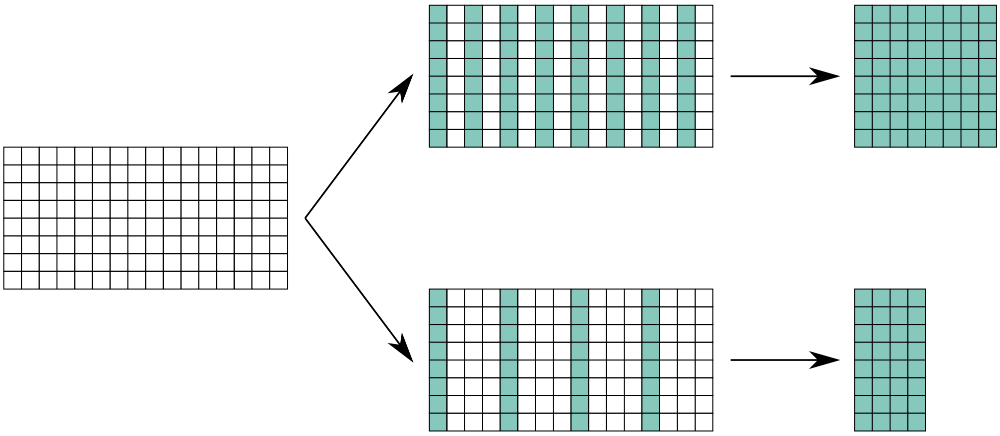


Figure 30: Examples of decimation: in the figure above a 2x1 decimation is performed, while in the figure below a 4x1 decimation is applied.

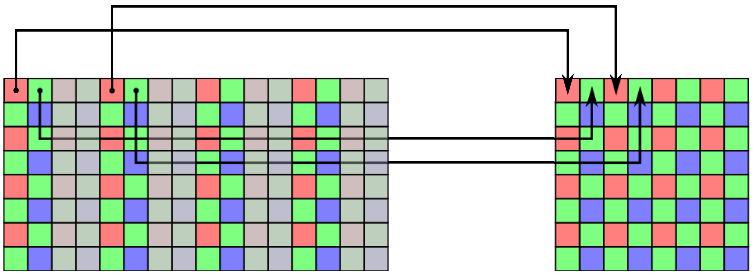


Figure 31: Examples of decimation for color sensors: in the figure above a 2x1 decimation is performed.

6.2.4 Readout direction

The camera supports image mirroring in both horizontal and vertical directions in order to make the integration of the camera insestitive to the mounting position.
In Fig.32 is shown an example of the **ReverseX** and **ReverseY** features.

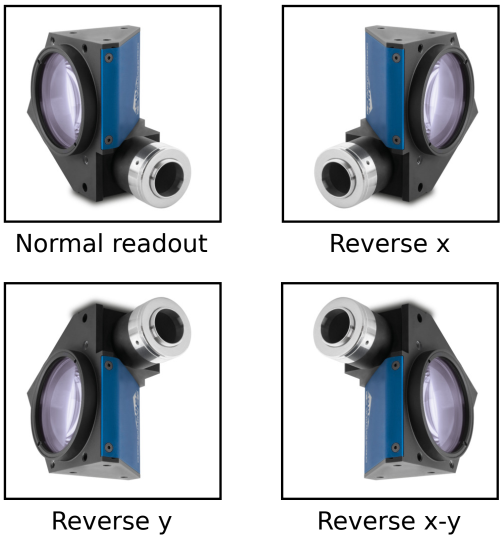


Figure 32: Representation of all the four possible readout modes.

6.2.5 Test pattern

Itala cameras support two different test patterns, one monochrome and one color.
The two different test patterns are represented in Fig. 33 and 34.

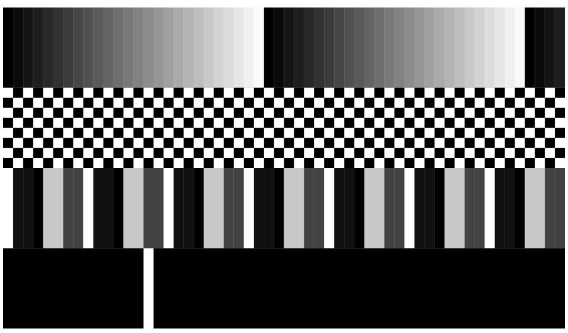


Figure 33: Monochrome test pattern

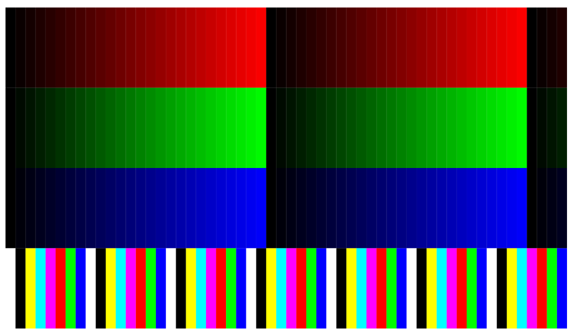


Figure 34: Color test pattern

The **monochrome pattern** is characterized by 4 different section:

- a fixed gradient pattern, from black to white;
- a fixed chess pattern;
- a fixed asymmetrical bars pattern (values: 0xFF, 0x10, 0x10, 0x00, 0xC8, 0xC8, 0x42, 0x42);
- a white moving line on a black background.

The **color pattern** is characterized by 4 different section:

- a fixed red gradient pattern, from black to red;
- a fixed green gradient pattern, from black to green;

- a fixed blue gradient pattern, from black to blue;
- a fixed color bars pattern (all the possible combinations of R, G and B coordinates).

6.3 Acquisition Control

The Acquisition Control section describes all features related to image acquisition, including the trigger and exposure control. It describes the basic model for acquisition and the typical behavior of the device.

Feature	Description	Interface	Access
AcquisitionMode	Sets the acquisition mode of the device. It defines mainly the number of frames to capture during an acquisition and the way the acquisition stops	IEnumeration	RW
AcquisitionStart	Starts the Acquisition of the device	ICommand	RW
AcquisitionStop	Stops the Acquisition of the device at the end of the current Frame	ICommand	RW
AcquisitionBurstFrameCount	Number of frames to acquire for each FrameBurstStart trigger	IInteger	RW
AcquisitionFrameRate	Controls the acquisition rate (in Hertz) at which the frames are captured	IFloat	RW
AcquisitionFrameRateEnable	Controls if the AcquisitionFrameRate feature is writable and used to control the acquisition rate. Otherwise, the acquisition rate is implicitly controlled by the combination of other features like ExposureTime, etc..	IBoolean	RW
oeAcquisitionFrameRateLimitMode	Select what limits the acquisition frame rate	IEnumeration	RW
oeResultingFrameRate	Shows the resulting acquisition frame rate	IFloat	RO
TriggerSelector	Selects the type of trigger to configure	IEnumeration	RW

TriggerMode	Controls if the selected trigger is active	IEnumeration	RW
TriggerSoftware	Generates an internal trigger	ICommand	RW
TriggerSource	Specifies the internal signal or physical input Line to use as the trigger source	IEnumeration	RW
TriggerOverlap	Specifies the type trigger overlap permitted with the previous frame or line. This defines when a valid trigger will be accepted (or latched) for a new frame or a new line	IEnumeration	RW
ExposureMode	Sets the operation mode of the Exposure	IEnumeration	RW
oeShortExposureEnable	Enable the short exposure mode	IBoolean	RW
ExposureTime	Sets the Exposure time when ExposureMode is Timed and ExposureAuto is Off	IFloat	RW
ExposureAuto	Sets the automatic exposure mode when ExposureMode is Timed	IEnumeration	RW
oeExposureAutoMin	Set the lower limit for the auto exposure algorithm	IFloat	RW
oeExposureAutoMax	Set the upper limit for the auto exposure algorithm	IFloat	RW

Table 12: Acquisition Control Features

6.3.1 Trigger overlap

By default, the feature **TriggerOverlap** is set to OFF: in this case, as shown in Fig.35, the following exposure time period is not allowed until the end of the current frame transfer, i.e. exposure time and frame transfer cannot be overlapped. In this configuration, however, the latency between exposure time and frame transfer is highly repeatable.
In conclusion, a higher level of determinism can be achieved at the cost of a lower effective camera frame rate.
When **TriggerOverlap** is set to ON, the latency between exposure time and frame transfer is affected by a higher uncertainty, but the following exposure can happen during the actual transfer between sensor and memory buffer. As shown in Fig.36, the only limitation in this mode is the overlapping of two following transfer periods.
In conclusion, a higher camera frame rate can be achieved (in accordance with the ethernet bandwidth limitation) at the cost of a lower frame transfer determinism.

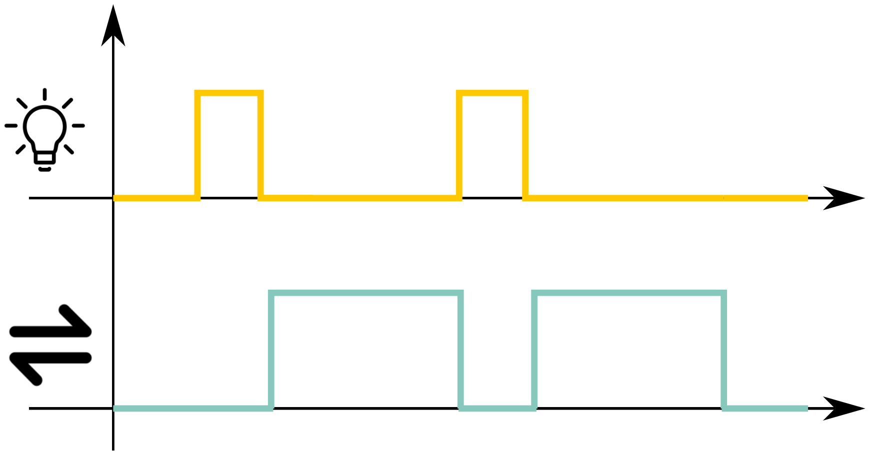


Figure 35: When TriggerOverlap is set to OFF, the latency is highly repeatable, but the following exposure time cannot be accepted until the current frame has been transfered to the internal memory.

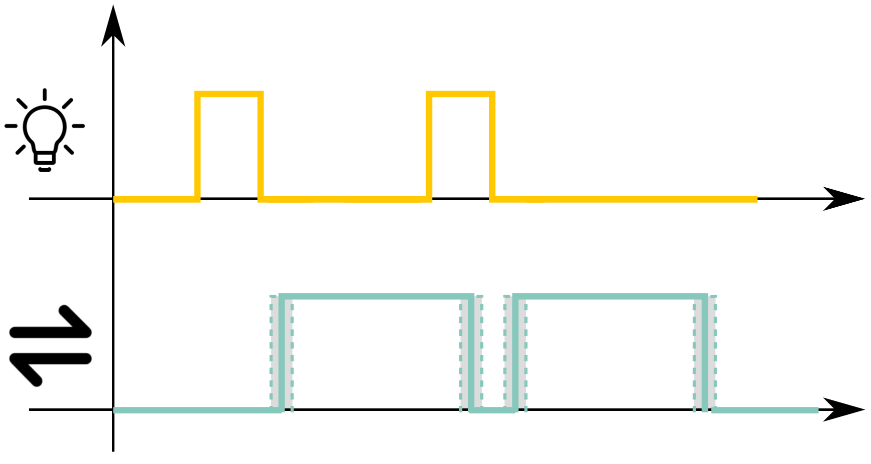


Figure 36: When TriggerOverlap is set to ON, the latency is affected by a higher uncertainty, but the following exposure time can be accepted when the current frame is transferring to the internal memory.

6.4 Analog Control

This sections describes how to influence the analog features of an image, such as gain, black level and gamma.

Feature	Description	Interface	Access
Gain	Controls the selected gain as an absolute physical value	IFloat	RW
GainAuto	Sets the automatic gain control (AGC) mode	IEnumeration	RW
oeGainAutoMin	Set the lower limit for the auto gain algorithm	IFloat	RW
oeGainAutoMax	Set the upper limit for the auto gain algorithm	IFloat	RW
BlackLevel	Controls the analog black level as an absolute physical value	IFloat	RW
BalanceRatioSelector	Selects the balance ratio to control	IEnumeration	RW
BalanceRatio	Controls the ratio of the selected color component	IFloat	RW
BalanceWhiteAuto	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted	IEnumeration	RW
oeGammaEnable	Enable the gamma correction. The LUT functions will be disabled	IBoolean	RW
Gamma	Controls the gamma correction of pixel intensity	IFloat	RW

Table 13: Analog Control Features

6.4.1 Gain

Gain is a multiplying factor applied to pixel values in order to increase the image brightness also in low-light conditions.
Sensor gain, however, affects indiscriminately useful signal and undesired noise: as can be seen in Fig.37, image brightness increases proportionally to the gain, however image quality can decrease in case of high gain values due to excessive noise.

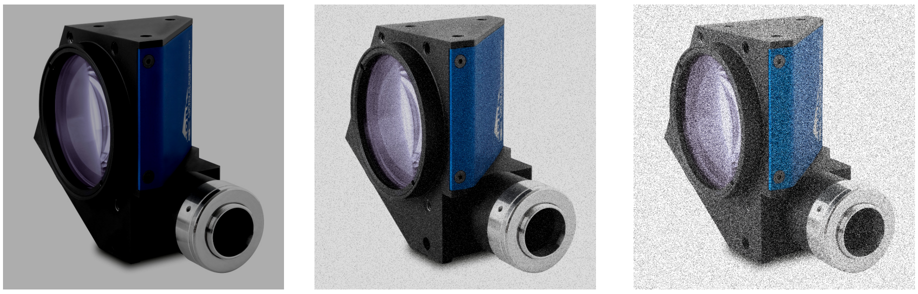


Figure 37: Different gain images

6.4.2 White balance

The **white balance** feature allows the adjustment of the response of the three color channels (R, G, B) of color cameras.
Typically color sensors have different sensitivities for the three color coordinates: this is mainly due to the different response of the Bayer filter present on top of the image sensor.
In Fig.38 (left figure) is shown a typical characteristic of a color sensor: even in case of perfectly uniform external light (i.e. flat spectrum), the pixel responses are not uniform (different mean values of grey levels), therefore green pixels will result brighter than red and blue ones.

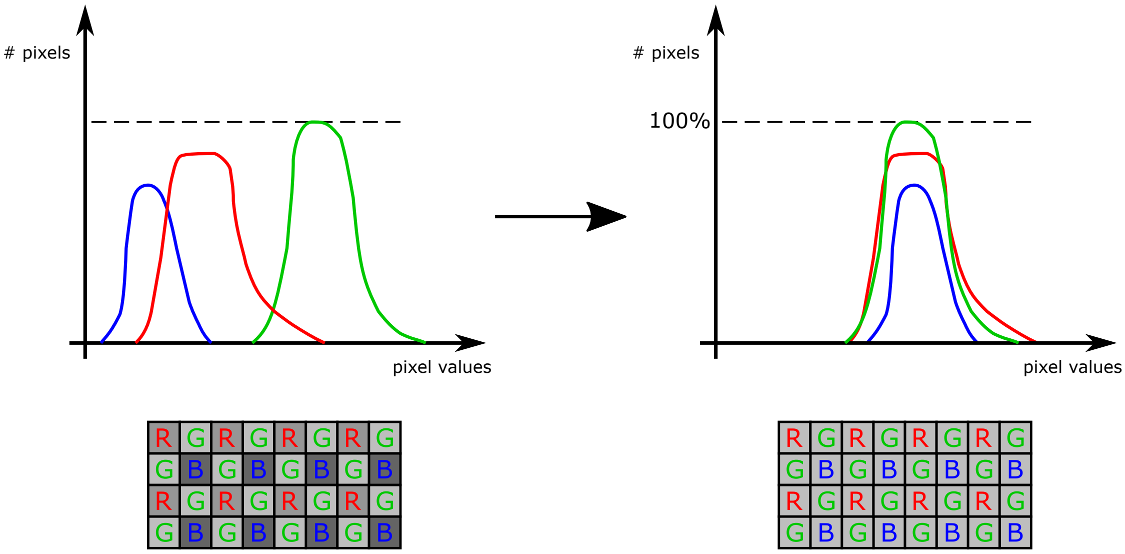


Figure 38: On the left, the histogram of a typical spectral sensitivity of a color sensor. On the right the histogram of a white balanced camera.

To solve this inhomogeneity a scaling factor can be applied to the three color channels:

$$R_{out} = K_{red} * R_{in} \tag{2}$$

$$G_{out} = K_{green} * G_{in} \tag{3}$$

$$B_{out} = K_{blue} * B_{in} \tag{4}$$

To further simplify this operation a color channel may be kept constant (typically the green one, since it's the dominant Bayer tile color). The white balance coefficient for the red and blue channels can be therefore written as:

$$R_{out} = K_{red} * R_{in} \tag{5}$$

$$G_{out} = G_{in} \tag{6}$$

$$B_{out} = K_{blue} * B_{in} \tag{7}$$

where:

$$K_{red} = G_{in}/R_{in} \tag{8}$$

$$K_{blue} = G_{in}/B_{in} \tag{9}$$

Like in the last equations, **BalanceRatio** allows to set K_{red} and K_{blue} coefficients while K_{green} is fixed to 1.
The effect of the white balance procedure is depicted in Fig.38 (right figure): the three channels are equalized and show the same mean grey level.

Itala camaras offer the possibility to automatically balance the three color coordinates: in order to do this, the **BalanceWhiteAuto** feature must be enabled.
The BalanceWhiteAuto algorithms relies on the *grey world approximation*: the premise behind this assumption is that in a well balanced color image the average of all the color present is a neutral grey.
Consequently, in order to obtain a perfect white balance, perform the following steps:

- Start a free-run acquisition;
- Make sure to insert a uniform sample (for example a white neutral background) which cover all the ROI (region of interest) of the image;
- Enable the BalanceWhiteAuto (*Continuous mode* or *Once mode*);
- In case of *Continuous mode* auto white balance, after the correction is performed, disable the BalanceWhiteAuto;
- Remove the uniform neutral background;
- The camera is now balanced and ready to be used.

An example of auto white balance procedure is shown in Fig.39: on the left side an uncorrected image is displayed; on the right side a white balance corrected picture is shown.

Figure 39: On the left side an uncorrected image is displayed; on the right side a white balance corrected picture is shown.

6.4.3 Gamma correction

Gamma correction is a non-linear operation which follows the formula 10:

$$V_{out} = V_{in}^{\gamma} \tag{10}$$

where V_{out} is the grey level of the pixel *n* after the gamma correction, V_{in} is the grey level of the pixel *n* and γ is the coefficient used for the non-linear transformation, set with the **Gamma** feature.

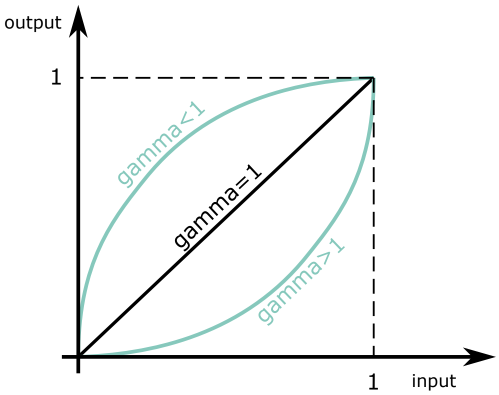


Figure 40: Gamma correction curves for $\gamma = 1$, $\gamma < 1$ and $\gamma > 1$. X-axis and Y-axis are normalized.

This operation is clearly shown in Fig.40: while "black" and "white" pixels remain the same after the correction, the different grey pixels are re-mapped on a non-linear curve, which enhances dark or bright features, depending on γ value.

In Fig.41 is shown an example of application of gamma correction.
A $\gamma < 1$ expands the range of values of dark regions and compresses the bright ones, so it's useful when looking at features in dark parts of the image. Viceversa, a $\gamma > 1$ compresses the range of values of the dark regions and expands the bright ones, so it's useful when looking at features in bright parts of the image.

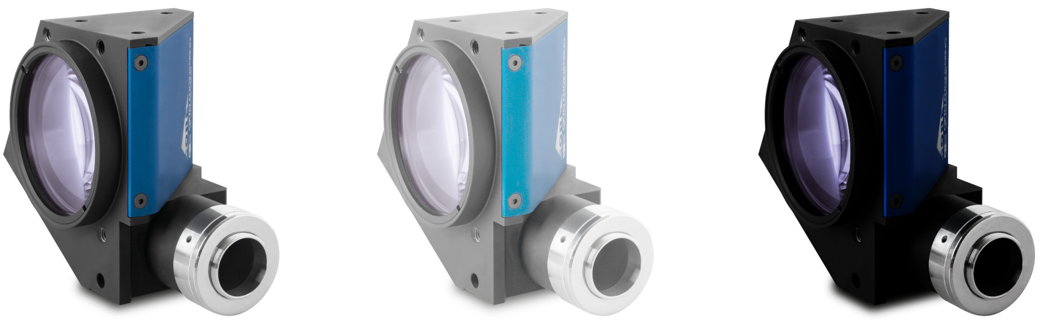


Figure 41: Images taken with different γ values: on the left $\gamma = 1$, in the center $\gamma < 1$ and on the right $\gamma > 1$

Please note that the Gamma correction can't be used if the LUT feature is enabled (see section 6.6.1).

6.4.4 Black level

The **BlackLevel** is an offset value, expressed in grey levels, that can be added to all the pixels of the image.
The effect of adding a black level value to an image is to move the pixels histogram towards the saturation level (as depicted in Fig.42).

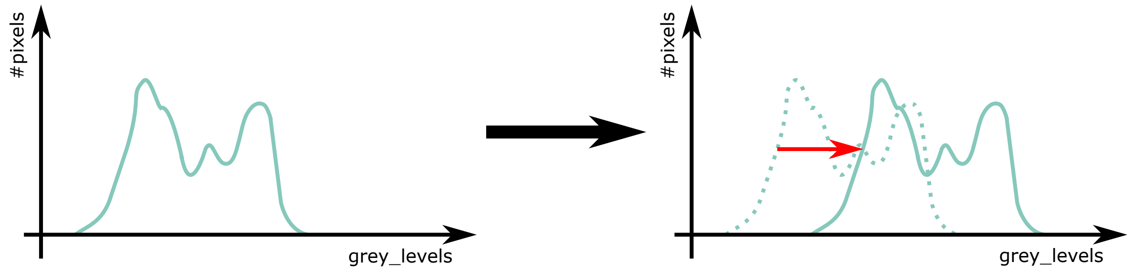


Figure 42: The black level moves the pixel histogram towards higher pixel values.

6.5 OE Auto Functions Control

This sections includes all the features related to auto exposure and auto gain control.

Feature	Description	Interface	Access
oeAutoTargetBrightness	Desired brightness level (in %) of the image used by auto gain and auto exposure functions	IInteger	RW
oeAutoDampingFactor	Control value (in %) used by auto gain and auto exposure features to reduce algorithm oscillations	IInteger	RW
oeAutoConfidence	Hysteresis around the target value used by auto gain and auto exposure features. Larger values improve image stability but increase the brightness error	IInteger	RW
oeAutoAOIWidth	Width of the area used for auto functions calculations (in pixels)	IInteger	RW
oeAutoAOIHeight	Height of the area used for auto functions calculations (in pixels)	IInteger	RW
oeAutoAOIOffsetX	Horizontal offset from the origin to the area used for auto functions calculations (in pixels)	IInteger	RW
oeAutoAOIOffsetY	Vertical offset from the origin to the area used for auto functions calculations (in pixels)	IInteger	RW

Table 14: OE Auto Functions Control Features

6.5.1 OE Autoexposure/Autogain

When the correct amount of exposure time needed to have a sufficient level of brightness is not known a priori, or when the illumination of the target changes during time, the **autoexposure** and **autogain** features can be used to obtain a stable brightness level even if the external light conditions are not constant.

For example, consider Fig.43: at the beginning of the acquisition (i.e. the first capture), the resulting average grey level value of the image is equal to 50. Usually, a good exposure is centered at half of the full scale range (about 127 in case of 8-bit image), so an average grey level value of 50% of the full dynamic can be set in the **oeAutoTargetBrightness** feature. Thus, as it can be seen in Fig.43, the average grey level value automatically adjusts in order to achieve the desired brightness of 127.

In order to avoid the continuously adjustment of the exposure time, a certain threshold can be set with the **oeAutoConfidence** feature: in this way the algorithm becomes more insensitive to little external light fluctuations and becomes active only in case of a consistent grey level variations (see Fig.44).

The behaviour of the autogain/autoexposure algorithm can be tuned through the **oeAutoDamp-**

Figure 43: Evolution of the average grey level value over time when autoexposure is active.

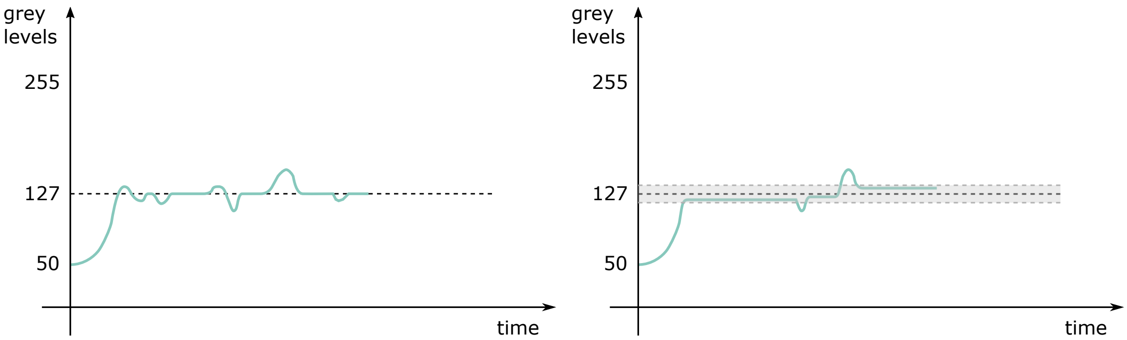


Figure 44: The continuous adjustment of the exposure time due to variations of the external light (figure on the left) can be slowed down by adding a confidence value around the target brightness (figure on the right).

ingFactor node: low values of this parameter give higher stability but slower response; on the contrary, high values can speed up the algorithm but can lead to unstable behaviours (see Fig.45). If the light conditions are poor, a long exposure time is needed to achieved the desired brightness level: in some cases, this situation can lead to an undesired reduction of the camera frame rate. In order to avoid this condition, it's possible to set a minimum and maximum exposure time which can clamp and limit the exposure time computed by the autoexposure algorithm (i.e. **oeExposureAutoMin** and **oeExposureAutoMax** respectively): for example, as shown in Fig.46, in case the exposure time needed for having the desired brightness is greater than the oeExposureAutoMax value, the target grey level cannot be reached but the resulting frame rate won't be affected by an excessively long exposure time.

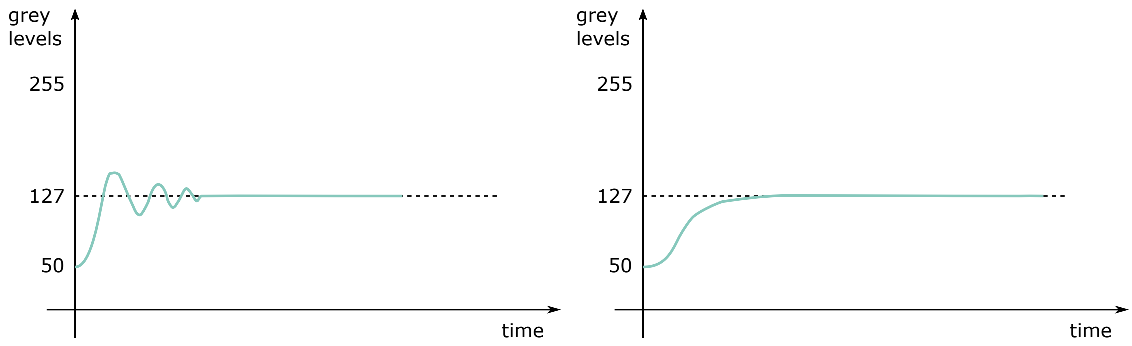


Figure 45: In case of low damping factor (figure on the left) the algorithm has a fast response but oscillations may rise; in case of high damping factor(figure on the right) the algorithm is stable but it can require long time to converge.

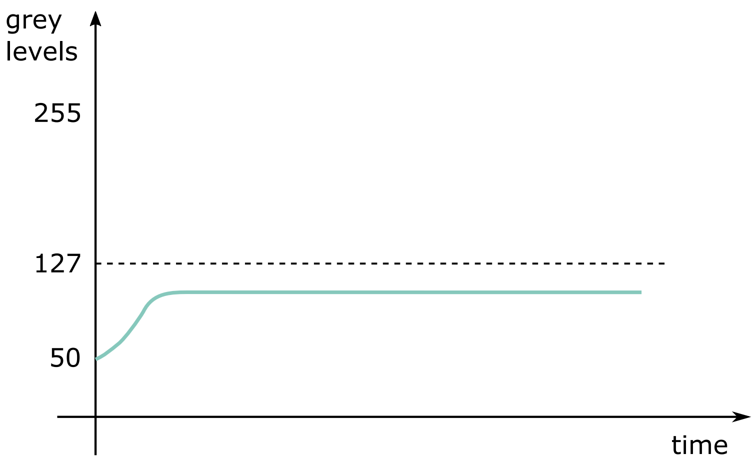


Figure 46: When an oeExposureAutoMax is set, the target brightness may not be achieved, but long exposures are avoided, thus preventing the reduction of the camera frame rate.

6.6 LUT Control

Features in this chapter describe the Look-up table (LUT) related features.

Feature	Description	Interface	Access
LUTSelector	Selects which LUT to control	IEnumeration	RW
LUTEnable	Activates the selected LUT	IInteger	RW
LUTIndex	Control the index (offset) of the coefficient to access in the selected LUT	IInteger	RW

LUTValue	Returns the Value at entry LUTIndex of the LUT selected by LUTSelector	IInteger	RW

Table 15: LUT Control Features

6.6.1 LUT

The **LUT** (Look-up-table) feature allows the user to set a transformation at pixel level: a specific grey level at the input of the LUT can be replaced by a new grey level value. All the pixels with the same grey level value are processed in the same way.

Consider the graphs shown in Fig.47: in the first graph no LUT is applied, so the output grey level is equal to the input one (e.g. grey level 127 remains 127 at the output of the LUT); in the second graph, a binary thresholding is applied: all pixels with grey level values below 127 (in case of 8-bit image) are set equal to 0 (black), the others are set to 255 (white).

In Fig.48 are shown the results of the two previous transformations.

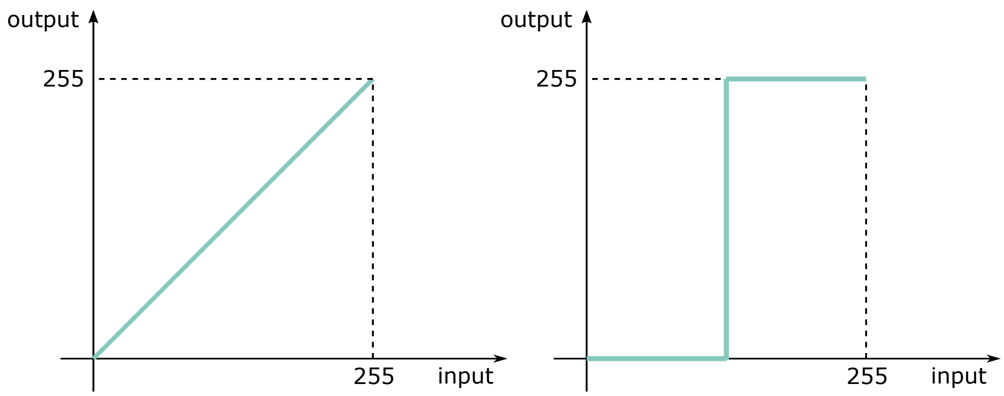


Figure 47: Two typical in-to-out transfer function: on the left no LUT is applied, on the right a binary thresholding is adopted.

Please note that the LUT can’t be used if the Gamma feature is enabled (see section 6.4.3).
For more information about the LUT wizard of Itala Viewrefer to section 4.7.4.

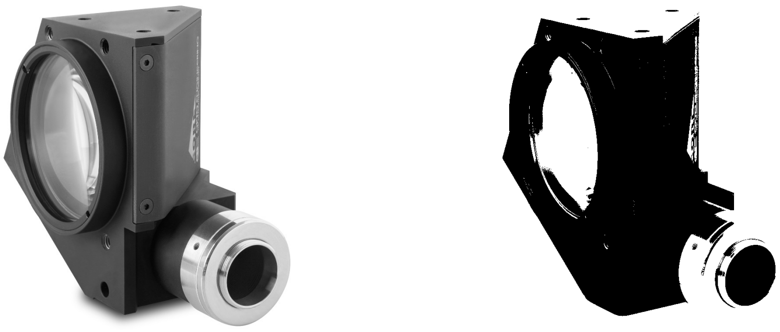


Figure 48: On the left no LUT is applied, on the right a binary thresholding is adopted.

6.7 Color transformation control

The Color Transformation section describes all features related to color transformations in the device.

Feature	Description	Interface	Access
ColorTransformationSelector	Selects which Color Transformation module is controlled by the various Color Transformation features	IEnumeration	RW
ColorTransformationEnable	Activates the selected Color Transformation module	IBoolean	RW
ColorTransformationValueSelector	Selects the Gain factor or Offset of the Transformation matrix to access in the selected Color Transformation module	IEnumeration	RW
ColorTransformationValue	Represents the value of the selected Gain factor or Offset inside the Transformation matrix	IFloat	RW

Table 16: Color Transformation Control Features

6.7.1 Color Correction Matrix (CCM)

Obtaining a good color fidelity can be challanging, this because the colors of an image depend on the camera color filter and, above all, on illumination.
Since illumination is application specific, sometimes colors need to be corrected in order to obtain a suitable color fidelity.
The **Color Correction Matrix (CCM)** allows the adjustment of the output colors of an image by

acting on gains/offset as follow:

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} Gain00 & Gain01 & Gain02 \\ Gain10 & Gain11 & Gain12 \\ Gain20 & Gain21 & Gain22 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} Offset_0 \\ Offset_1 \\ Offset_2 \end{bmatrix}$$

where *R'*, *G'* and *B'* are the corrected color coordinates, while *R*, *G* and *B* are the uncorrected ones. Gains and Offsets can be freely edited by the user but, in order to obtain an excellent calibration, a wizard has been already developed and available in Itala Viewer. Please refer to Paragraph 4.7.6 to see the steps of this calibration procedure.

The color correction matrix is also use to make conversions between color spaces: for example, if a YUV pixel format is selected, the camera automatically load the right coefficients to switch from RGB to YUV color space:

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.147 & -0.289 & 0.436 \\ 0.615 & -0.515 & -0.100 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 0 \\ 128 \\ 128 \end{bmatrix}$$

For the proper adjustment of the CCM coefficients refer to section 4.7.6.

6.8 Digital I/O Control

The Digital I/O chapter covers the features required to control the general Input and Output signals of the device. These include input and output control signals for triggering timers, counters and also static signals such as user configurable input or output bits.

Feature	Description	Interface	Access
LineSelector	Selects the physical line (or pin) of the external device connector or the virtual line of the Transport Layer to configure	IEnumeration	RW
LineMode	Controls if the physical Line is used to Input or Output a signal	IEnumeration	RW
LineInverter	Controls the inversion of the signal of the selected input or output Line	IBoolean	RW
LineStatus	Returns the current status of the selected input or output Line	IBoolean	R
LineStatusAll	Returns the current status of all available Line signals at time of polling in a single bitfield	IInteger	R

LineSource	Selects which internal acquisition or I/O source signal to output on the selected Line	IEnumeration	RW
oeDebounceAmount	Amount of time for which the input signal need to stay constant in order to be recognized as a valid input	IFloat	RW
oePulseGeneratorEnable	Override the output signal with a pulse generated at the rising edge of the signal specified by LineSource	IBoolean	RW
oePulseGeneratorPeriod	Sets the duration of the output signal pulse	IFloat	RW
UserOutputSelector	Selects which bit of the User Output register will be set by UserOutputValue	IEnumeration	RW
UserOutputValue	Sets the value of the bit selected by UserOutputSelector	IBoolean	R
UserOutputValueAll	Sets the value of all the bits of the User Output register	IInteger	RW
UserOutputValueAllMask	Sets the write mask to apply to the value specified by UserOutputValueAll before writing it in the User Output register	IInteger	RW

Table 17: Digital I/O Control Features

6.8.1 I/O stage

The digital I/O block includes an onboard processing stage for input trigger signals and synchronization outputs.
The **LineInverter** feature must be activated when the input trigger works with an *active-low* logic, i.e. when a falling edge must be detected. This feature applies also for synchronization outputs.

External triggers may be characterized by spurious and unwanted pulses or spikes known as *bounces*. For this reason a debounce stage has been included in the processing chain.
The **oeDebounceAmount** feature sets a threshold level: signals whose duration is lower than oeDebounceAmount are considered spurious pulses and therefore are discarded, while the other ones are considered useful signal.
Obviously, the debounce stage bring intrinsically a delay in the input trigger processing, since a period of oeDebounceAmount must pass before choosing if the input signal is spurious or not.

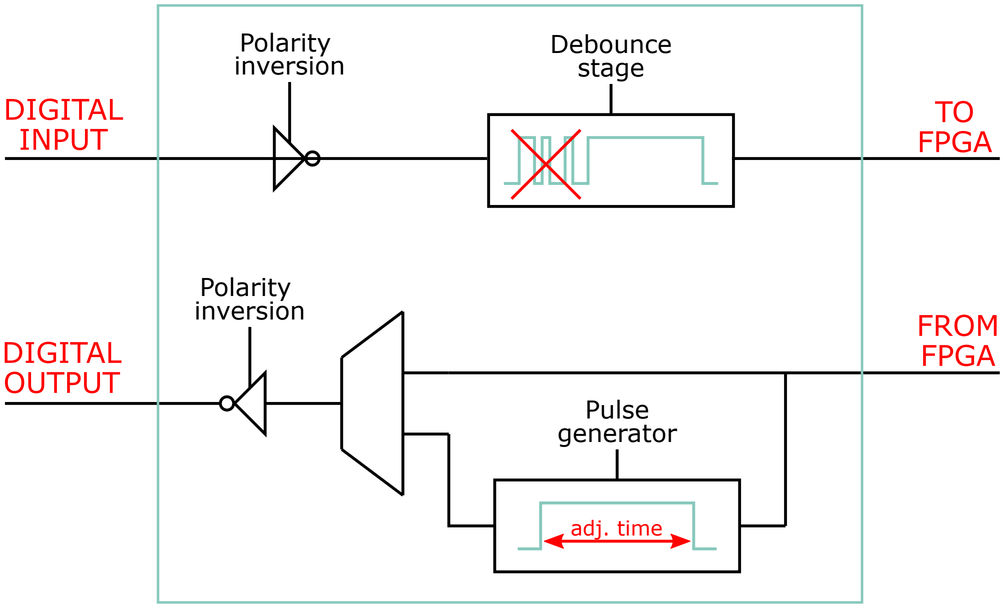


Figure 49: Digital I/O stage representation.

The output synchronization signal can be chosen between an internally generated pulse which asserts when conditions are met (e.g. TimerEnd, CounterEnd, EncoderOut, ...) and a dedicated pulse generator: the advantage of using the second approach relies in the possibility of choosing the duration of the pulse, while in the first case the generated signals may last only one clock period and may be too fast to be detected by the slave device.
The **oePulseGeneratorEnable** feature allows the triggering of the pulse generator when **LineSource** condition is met, while the **oePulseGeneratorPeriod** feature sets its on-time.

6.9 Counter and Timer Control

This section lists all features related to control and monitor Counters and Timers.

Feature	Description	Interface	Access
CounterSelector	Selects which Counter to configure	IEnumeration	RW
CounterEventSource	Select the events that will be the source to increment the Counter	IEnumeration	RW
CounterResetSource	Selects the signals that will be the source to reset the Counter	IEnumeration	RW
CounterDuration	Sets the duration (or number of events) before the CounterEnd event is generated	IInteger	RW

CounterValue	Reads or writes the current value of the selected Counter	IInteger	RW
CounterReset	Does a software reset of the selected Counter and starts it	ICommand	RW
TimerSelector	Selects which Timer to configure	IEnumeration	RW
TimerTriggerSource	Selects the source of the trigger to start the Timer	IEnumeration	RW
TimerDuration	Sets the duration (in microseconds) of the Timer pulse	IFloat	RW
TimerValue	Reads or writes the current value (in microseconds) of the selected Timer	IFloat	RW
TimerReset	Does a software reset of the selected timer and starts it	ICommand	RW

Table 18: Counter and Timer Control Features

6.10 Encoder Control

This section lists all features for the control and the monitoring of quadrature encoders. Quadrature encoders are also known as incremental, rotary and shaft encoders.

Feature	Description	Interface	Access
EncoderSelector	Selects which Encoder to configure	IEnumeration	RW
EncoderSourceA	Selects the signal which will be the source of the A input of the Encoder	IEnumeration	RW
EncoderSourceB	Selects the signal which will be the source of the B input of the Encoder	IEnumeration	RW
EncoderMode	Selects if the count of encoder uses FourPhase mode with jitter filtering or the HighResolution mode without jitter filtering	IEnumeration	RW
EncoderDivider	Sets how many Encoder increment/decrements are needed to generate an Encoder output pulse signal	IInteger	RW

EncoderOutputMode	Selects the conditions for the Encoder interface to generate a valid Encoder output signal	IEnumeration	RW
EncoderValue	Reads or writes the current value of the position counter of the selected Encoder	IInteger	RW
EncoderResetSource	Selects the signals that will be the source to reset the Encoder	IEnumeration	RW
EncoderReset	Does a software reset of the selected Encoder and starts it	ICommand	RW

Table 19: Encoder Control Features

6.10.1 Encoder output mode

The **encoder output mode** feature includes two main ways of functioning (see Fig.50):

- **position mode**: when the moving direction changes, the encoder counter stops incrementing, maintaining the actual value until the moving direction changes again;
- **direction mode**: when the moving direction changes, the encoder counter stops incrementing and starts decrementing until the moving direction changes again;

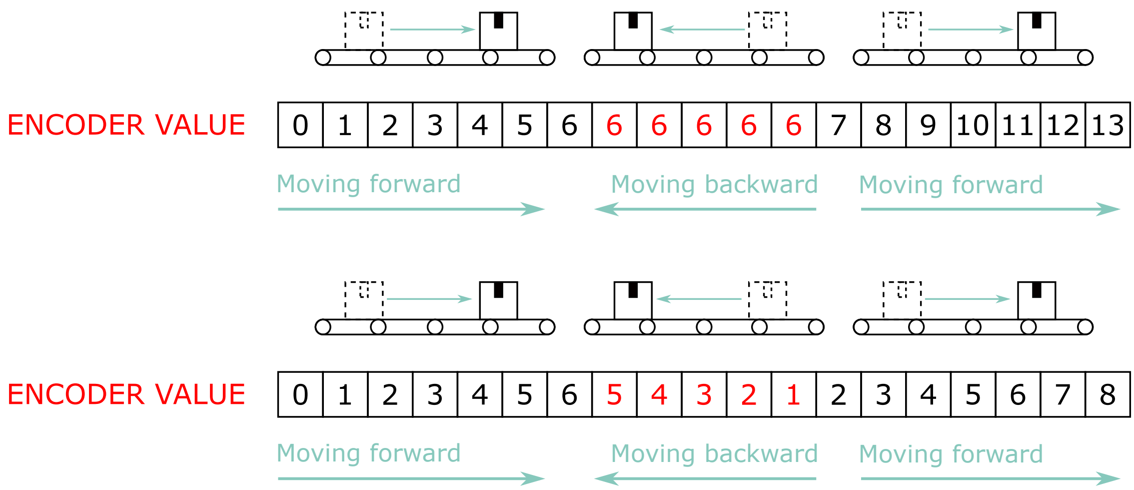


Figure 50: The two different ways of functioning of the encoder block: in **position** mode (figure above), any change of direction is not considered and the encoder counter value doesn't change. In **direction** mode (figure below), if the direction changes, the encoder counter changes accordingly.

6.11 Logic Block Control

The Logic Block Control section describes the model and features related to the control and the generation of signals by Logic Block elements.

Feature	Description	Interface	Access
LogicBlockSelector	Specifies the Logic Block to configure	IEnumeration	RW
LogicBlockFunction	Selects the combinational logic Function of the Logic Block to configure	IEnumeration	RW
LogicBlockInputNumber	Specifies the number of active signal inputs of the Logic Block	IInteger	R
LogicBlockInputSelector	Selects the Logic Block's input to configure	IInteger	RW
LogicBlockInputSource	Selects the source signal for the input into the Logic Block	IEnumeration	RW
LogicBlockInputInverter	Selects if the selected Logic Block Input source signal is inverted	IBoolean	W
LogicBlockLUTIndex	Controls the index of the truth table to access in the selected LUT	IInteger	RW
LogicBlockLUTValue	Read or Write the Value associated with the entry at index LogicBlockLUTIndex of the selected LUT	IBoolean	RW
LogicBlockLUTValueAll	Sets the values of all the output bits of the selected LUT in one access ignoring LogicBlockLUTIndex	IInteger	RW

Table 20: Logic Block Control Features

6.11.1 Logic block module

The **logic block module** is mainly used to generate an output signal depending on two input conditions.
This block is characterized by three different logic functions (see Fig.51):

- **AND**: the output of logic block is HIGH if both the inputs are HIGH;
- **OR**: the output of logic block is HIGH if at least one the inputs is HIGH;
- **LUT**: the user can freely compile the truth table of the lut:

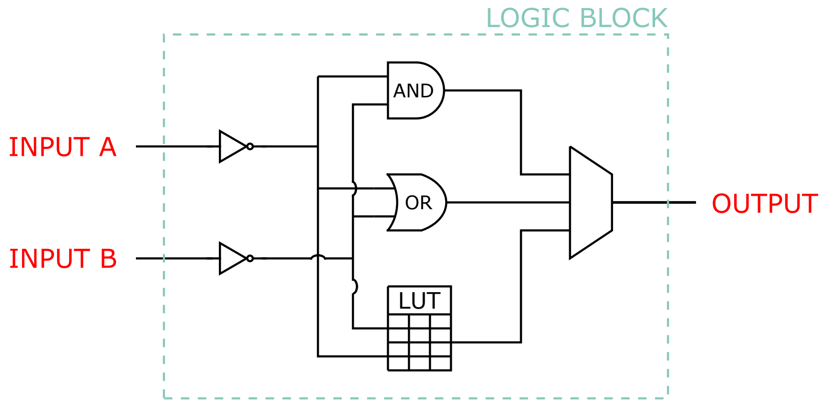


Figure 51: Simplified scheme of the logic block cell.

LogicBlockLUTIndex	Input A	Input B	LogicBlockLUTValue
0	0	0	LogicBlockLUTValue[0]
1	0	1	LogicBlockLUTValue[1]
2	1	0	LogicBlockLUTValue[2]
3	1	1	LogicBlockLUTValue[3]

Table 21: Example of LUT compilation.

In order to have the maximum flexibility, also an **inverting stage** has been included at the input of this block.

6.12 OE Serial Interface Control

This section deals with the serial communication features.

Feature	Description	Interface	Access
oeSerialEnable	Enable the serial interface	IBoolean	RW
oeSerialBaudRate	Select the serial interface baud rate	IEnumeration	RW
oeSerialMode	Select the serial interface mode of operation	IEnumeration	RW
oeSerialProtocol	Select the protocol to use on the serial interface	IEnumeration	RW
oeSerialSlewRate	Select the slew rate of the serial interface data	IEnumeration	RW
oeSerialWriteBuffer	Character write buffer of the serial interfce	IString	RW

oeSerialWrite	Start a write operation on the serial interface	ICommand	RW
oeSerialReadCount	Number of bytes to read from serial input buffer	IInteger	RW
oeSerialReadBuffer	Character read buffer of the serial interfce	IString	R
oeSerialRead	Read the serial input buffer	ICommand	RW

Table 22: OE Serial Interface Control Features

6.12.1 Serial interface

The **serial interface** allows to communicate with an external device through a serial connection. This is a dual-protocol peripheral which can be configured as a **RS232** or **RS485** transceiver via the **oeSerialMode** feature, as shown in Fig.52. Select the appropriate mode of operation according to the external device you want to connect to the camera. The communication channel in RS232 mode is full-duplex while in RS485 mode is half-duplex.

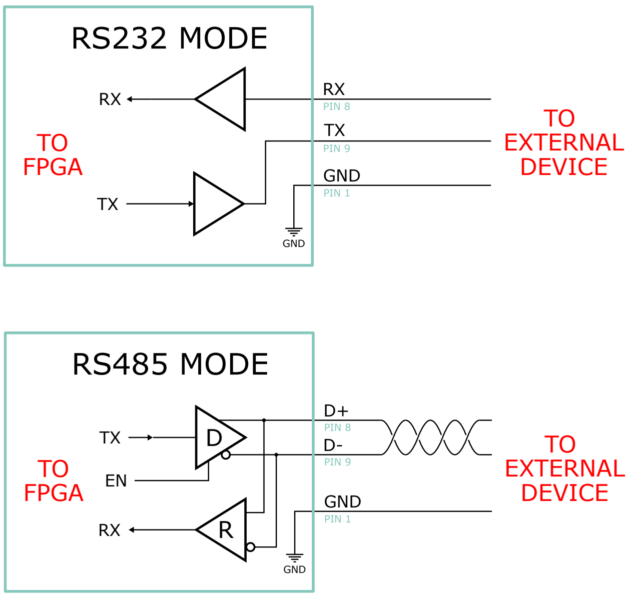


Figure 52: Equivalent circuit of the serial interface in RS232 and RS485 mode of operation.

> ***CAUTION**: always check the external device specification **before** connecting it to the camera and set the serial protocol accordingly. Failing to do so may result in damaging the camera or the external device.*

The **slew rate** control affect the shape of the output signal waveform. The **slow** setting yields smooth transitions and may reduce EMI radiation. The **fast** setting yields steep transitions, enabling the use of the highest baud rates. This feature is only available for **RS485** mode.

WRITE DATA: Enter the desired string in **oeSerialWriteBuffer** and send a **oeSerialWrite** command.

READ DATA: Enter the number of characters to read in **oeSerialReadCount** and send a **oeSerialRead** command. Received data can be accessed through **oeSerialReadBuffer**.

6.13 OE Liquid Lens Control

This section describes all the features related to the liquid lens control.

Feature	Description	Interface	Access
oeLiquidLensEnable	Enable the liquid lens controller	IBoolean	RW
oeLiquidLensConfigurationData	Get the configuration for the liquid lens	IEnumeration	R
oeLiquidLensSerialNumber	Liquid lens serial number. This string is a unique identifier of the liquid lens	IString	R
oeLiquidLensTemperature	Temperature read by the sensor integrated in the liquid lens (available on specific models only)	IFloat	R
oeLiquidLensMode	Select the lens control mode	IEnumeration	RW
oeLiquidLensMaxPositiveCurrent	Maximum positive current which can be applied to the lens	IFloat	RW
oeLiquidLensMaxNegativeCurrent	Maximum negative current which can be applied to the lens	IFloat	RW
oeLiquidLensCurrent	Set the liquid lens coil current	IFloat	RW
oeLiquidLensPower	Set the liquid lens focal power	IFloat	RW
oeLiquidLensResultingCurrent	Resulting liquid lens coil current	IFloat	R
oeLiquidLensResultingPower	Resulting liquid lens focal power	IFloat	R

Table 23: OE Liquid Lens Control Features

6.13.1 Liquid Lens interface

The **liquid lens interface** allows to control an Opto Engineering® product with liquid lens technology directly from the camera device. This ensure maximum integration with the camera SDK and compatibility with third party software thanks to *GigE Vision* and *GenTL* standards.

The interface can operate in two different modes:

- EEPROM mode;
- manual mode;

In **EEPROM mode** the camera automatically detects the connected lens and read the calibration data from the embedded EEPROM. Through the *GenICam* feature tree is possible to read the lens attributes and directly set the lens focal power. The EEPROM also includes a temperature sensor used by the controller for thermal compensation of the lens current. This ensures a costant focal power across a wide range of operating temperature. It's also possible to directly control the lens current and check for the actual resulting focal power, which depends on the lens temperature. This mode is automatically selected when a compatible lens is connected.

In **manual mode** is possible to control a lens without an embedded EEPROM, directly setting the current of the actuation coil. In this case the user is responsible to set the correct values and to not exceed the limits reported in the lens specifications.

oeLiquidLensConfigurationData shows if the lens is equipped with a calibration EEPROM or if the peripheral is running in manual mode.

***CAUTION**: always check the lens specification before connecting it to the camera. If the lens is not equipped with a calbration EEPROM, check and set current limits **before** connecting the lens. Failing to do so may result in damaging the camera or the liquid lens.*

6.14 OE Defective Pixel Correction Control

This section describes all the features related to the correction of the defective pixels.

Feature	Description	Interface	Access
oeDefectivePixelCount	Shows the number of the defective pixels	IInteger	RW
oeDefectivePixelSelector	Represents the index of the defective pixel inside the defective pixel map	IInteger	RW
oeDefectivePixelXCoordinate	Represents the horizontal coordinate of the actual defective pixel	IInteger	RW
oeDefectivePixelYCoordinate	Represents the vertical coordinate of the actual defective pixel	IInteger	RW

oeDefectivePixelWriteMap	Write the defective pixel map in the camera non-volatile memory	ICommand	RW

Table 24: OE Defective Pixel Correction Control Features

6.14.1 Defective Pixel Correction

Image sensors can be affected of pixel degradation for multiple causes (temperature, aging, cosmic rays, ionizing radiation and so on..).
A possible way to overcome these effects is to adopt a defective pixel correction strategy. This consists in replacing the defective pixel value with the one of a near good pixel. This algorithm is executed real-time in the camera acquisition pipeline and rely on a defective pixel coordinates table.

> ***NOTE**: The automatic procedure for the pixels defects detection and correction is explained in section 4.7.5. Here there is the explanation of the single defective pixel correction only.*

oeDefectivePixelCount is the indicator of the actual defective pixels corrected in camera.
The defective pixels coordinates can be displayed on the nodes **oeDefectivePixelXCoordinate** and **oeDefectivePixelYCoordinate** after selecting the pixel index (**oeDefectivePixelSelector**).

The following example shows how to manually add a new defective pixel to the defective pixels list. Let's consider a defective pixel at coordinates (4,2) (see Fig.53). To correct this pixel:

1. Increase by 1 the number of **oeDefectivePixelCount**;
2. Select the first available index in **oeDefectivePixelSelector** node: the correct index is the one with the un-initialized **oeDefectivePixelXCoordinate** and **oeDefectivePixelYCoordinate** values (be aware that pixel enumeration starts from 0);
3. Insert the coordinates of the defective pixel in the **oeDefectivePixelXCoordinate** and **oeDefectivePixelYCoordinate** fields;
4. Save the new map in the onboard-memory with **oeDefectivePixelWriteMap** command;

In case of color cameras, the color correction algorithm takes into account that the adiacent pixel has a different chroma information, therefore the correction is performed with the following pixel value, ad depicted in Fig.54.

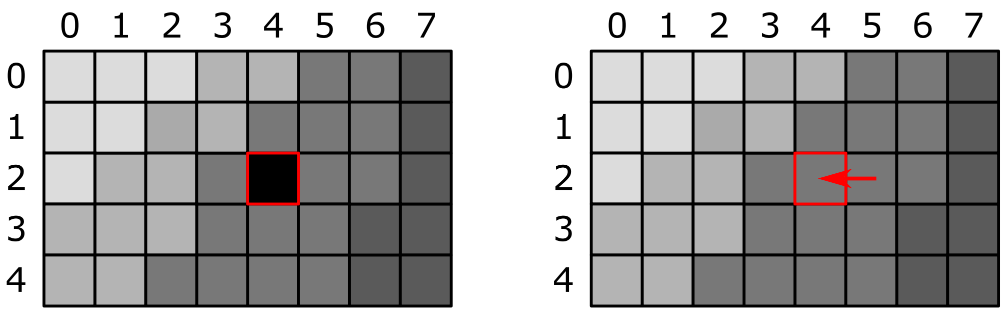


Figure 53: (On the left) Presence of a dead pixel at coordinates (4,2). (On the right) Error correction through the nearest neighbor algorithm.

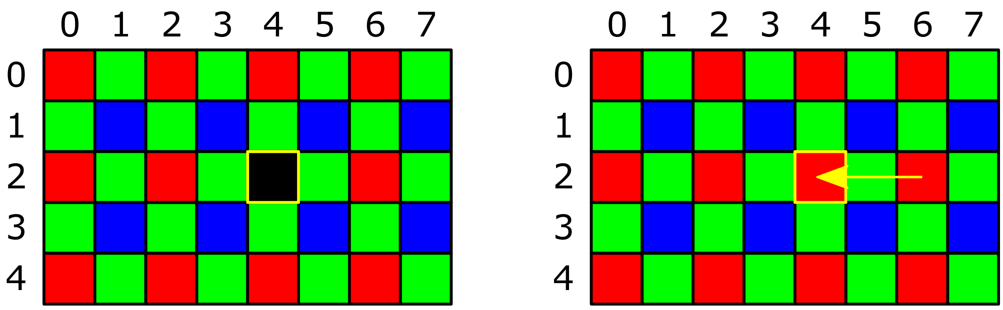


Figure 54: (On the left) Presence of a dead pixel at coordinates (4,2). (On the right) Error correction through the nearest neighbor (but with the same chroma info) algorithm.

6.15 Chunk mode Control

This section describes all the features related to the chunk data.

Feature	Description	Interface	Access
ChunkModeActive	Activates the inclusion of Chunk data in the payload of the image	IBoolean	RW
ChunkSelector	Selects which Chunk to enable or control	IEnumeration	RW
ChunkEnable	Enables the inclusion of the selected Chunk data in the payload of the image	IBoolean	RW
ChunkWidth	Returns the Width of the image included in the payload	IInteger	R
ChunkHeight	Returns the Height of the image included in the payload	IInteger	R
ChunkOffsetX	Returns the OffsetX of the image included in the payload	IInteger	R

ChunkOffsetY	Returns the OffsetY of the image included in the payload	IInteger	R
ChunkPixelFormat	Returns the PixelFormat of the image included in the payload	IEnumeration	R
ChunkExposureTime	Returns the exposure time used to capture the image	IFloat	R
ChunkGain	Returns the gain used to capture the image	IFloat	R
ChunkBlackLevel	Returns the black level used to capture the image included in the payload	IFloat	R
ChunkTimestamp	Returns the Timestamp of the image included in the payload at the time of the FrameStart internal event	IInteger	R
ChunkFrameID	Returns the unique Identifier of the frame (or image) included in the payload	IInteger	R

Table 25: Chunk mode Control Features

6.16 Event Control

This section describes how to control the generation of events to the host application. An Event is a message that is sent to the host application to notify it of the occurrence of an internal event. Events are typically used to synchronize the host application with some Events happening in the device.

Feature	Description	Interface	Access
EventSelector	Selects which Event to signal to the host application	IEnumeration	RW
EventNotification	Activate or deactivate the notification to the host application of the occurrence of the selected Event	IEnumeration	RW
EventExposureEndData	Category which contains all the attibutes related to the ExposureEnd event	-	-
EventFrameTriggerMissedData	Category which contains all the attibutes related to the ExposureEnd event	-	-

EventLine0RisingEdgeData	Category which contains all the attibutes related to the ExposureEnd event	-	-
EventLine1RisingEdgeData	Category which contains all the attibutes related to the ExposureEnd event	-	-

Table 26: Event Control Features

Feature	Description	Interface	Access
EventExposureEnd	Returns the unique Identifier of the Exposure End type of Event	IInteger	R
EventExposureEndTimestamp	Returns the Timestamp of the Exposure End Event	IInteger	R
EventExposureEndFrameID	Returns the unique Identifier of the Frame (or image) that generated the Exposure End Event	IInteger	R

Table 27: Event Exposure End Data features

Feature	Description	Interface	Access
EventFrameTriggerMissed	Returns the unique Identifier of the Frame Trigger Missed type of Event	IInteger	R
EventFrameTriggerMissedTimes-tamp	Returns the Timestamp of the Frame Trigger Missed Event	IInteger	R
EventFrameTriggerMissed-FrameID	Returns the unique Identifier of the Frame (or image) that generated the Frame Trigger Missed Event	IInteger	R

Table 28: Event Frame Trigger Missed Data features

Feature	Description	Interface	Access
EventLine0RisingEdge	Returns the unique Identifier of the Line 0 Rising Edge type of Event	IInteger	R

EventLine0RisingEdgeTimestamp	Returns the Timestamp of the Line 0 Rising Edge Event	IInteger	R
EventLine0RisingEdgeFrameID	Returns the unique Identifier of the Frame (or image) that generated the Line 0 Rising Edge Event	IInteger	R

Table 29: Event Line 0 Rising Edge Data features

Feature	Description	Interface	Access
EventLine1RisingEdge	Returns the unique Identifier of the Line 1 Rising Edge type of Event	IInteger	R
EventLine1RisingEdgeTimestamp	Returns the Timestamp of the Line 1 Rising Edge Event	IInteger	R
EventLine1RisingEdgeFrameID	Returns the unique Identifier of the Frame (or image) that generated the Line 1 Rising Edge Event	IInteger	R

Table 30: Event Line 1 Rising Edge Data features

6.17 Transport Layer Control

This section provides the Transport Layer control features.

Feature	Description	Interface	Access
PayloadSize	Provides the number of bytes transferred for each image or chunk on the stream channel	IInteger	R
GevSupportedOptionSelector	Selects the GEV option to interrogate for existing support	IEnumeration	RW
GevSupportedOption	Returns if the selected GEV option is supported	IBoolean	R
GevInterfaceSelector	Selects which logical link to control	IInteger	RW
GevMACAddress	MAC address of the logical link	IInteger	R

GevCurrentIPConfigurationLLA	Controls whether the Link Local Address IP configuration scheme is activated on the given logical link	IBoolean	RW
GevCurrentIPConfigurationDHCP	Controls whether the DHCP IP configuration scheme is activated on the given logical link	IBoolean	RW
GevCurrentIPConfigurationPer-sistentIP	Controls whether the PersistentIP configuration scheme is activated on the given logical link	IBoolean	RW
GevCurrentIPAddress	Reports the IP address for the given logical link	IInteger	R
GevCurrentSubnetMask	Reports the subnet mask of the given logical link	IInteger	R
GevCurrentDefaultGateway	Reports the default gateway IP address of the given logical link	IInteger	R
GevPersistentIPAddress	Controls the Persistent IP address for this logical link	IInteger	RW
GevPersistentSubnetMask	Controls the Persistent subnet mask associated with the Persistent IP address on this logical link	IInteger	RW
GevPersistentDefaultGateway	Controls the persistent default gateway for this logical link	IInteger	RW
GevDiscoveryAckDelay	Indicates the maximum randomized delay the device will wait to acknowledge a discovery command	IInteger	RW
GevMCPHostPort	Controls the port to which the device must send messages	IInteger	RW
GevMCDA	Controls the destination IP address for the message channel	IInteger	RW
GevMCTT	Provides the transmission timeout value in milliseconds	IInteger	RW
GevMCRC	Controls the number of retransmissions allowed when a message channel message times out	IInteger	R
GevMCSP	This feature indicates the source port for the message channel	IInteger	RW

GevStreamChannelSelector	Selects the stream channel to control	IInteger	RW
GevSCPInterfaceIndex	Index of the logical link to use	IInteger	RW
GevSCPHostPort	Controls the port of the selected channel to which a GVSP transmitter must send data stream or the port from which a GVSP receiver may receive data stream	IInteger	RW
GevSCPSFireTestPacket	Sends a test packet. When this feature is set, the device will fire one test packet	IBoolean	RW
GevSCPSDoNotFragment	The state of this feature is copied into the "do not fragment" bit of IP header of each stream packet. It can be used by the application to prevent IP fragmentation of packets on the stream channel	IBoolean	RW
GevSCPSPacketSize	This GigE Vision specific feature corresponds to DeviceStreamChannelPacketSize and should be kept in sync with it	IInteger	RW
GevSCPD	Controls the delay (in GEV timestamp counter unit) to insert between each packet for this stream channel	IInteger	RW
GevSCDA	Controls the destination IP address of the selected stream channel to which a GVSP transmitter must send data stream or the destination IP address from which a GVSP receiver may receive data stream	IInteger	RW
GevSCSP	Indicates the source port of the stream channel	IInteger	R

Table 31: Transport Layer Control Features

6.18 User Set Control

This section describes the features for global control of the device settings. It allows loading or saving factory or user-defined settings.

Loading the factory default User Set guarantees a state where a continuous acquisition can be started using only the mandatory features.

Feature	Description	Interface	Access
UserSetSelector	Selects the feature User Set to load, save or configure	IInteger	RW
UserSetLoad	Loads the User Set specified by UserSetSelector to the device and makes it active	ICommand	RW
UserSetSave	Save the User Set specified by UserSetSelector to the non-volatile memory of the device	ICommand	RW
UserSetDefault	Selects the feature User Set to load and make active by default when the device is reset	IEnumeration	RW

Table 32: User Set Control Features

7 USE CASES

7.1 Wiring connection examples

7.1.1 Triggering the camera by an external device

To trigger Itala cameras in a machine vision system, suitable connections must be performed. Considering the circuitry of the opto-isolated input pin (Section 5.7), possible connections are the depicted in Figure 55.

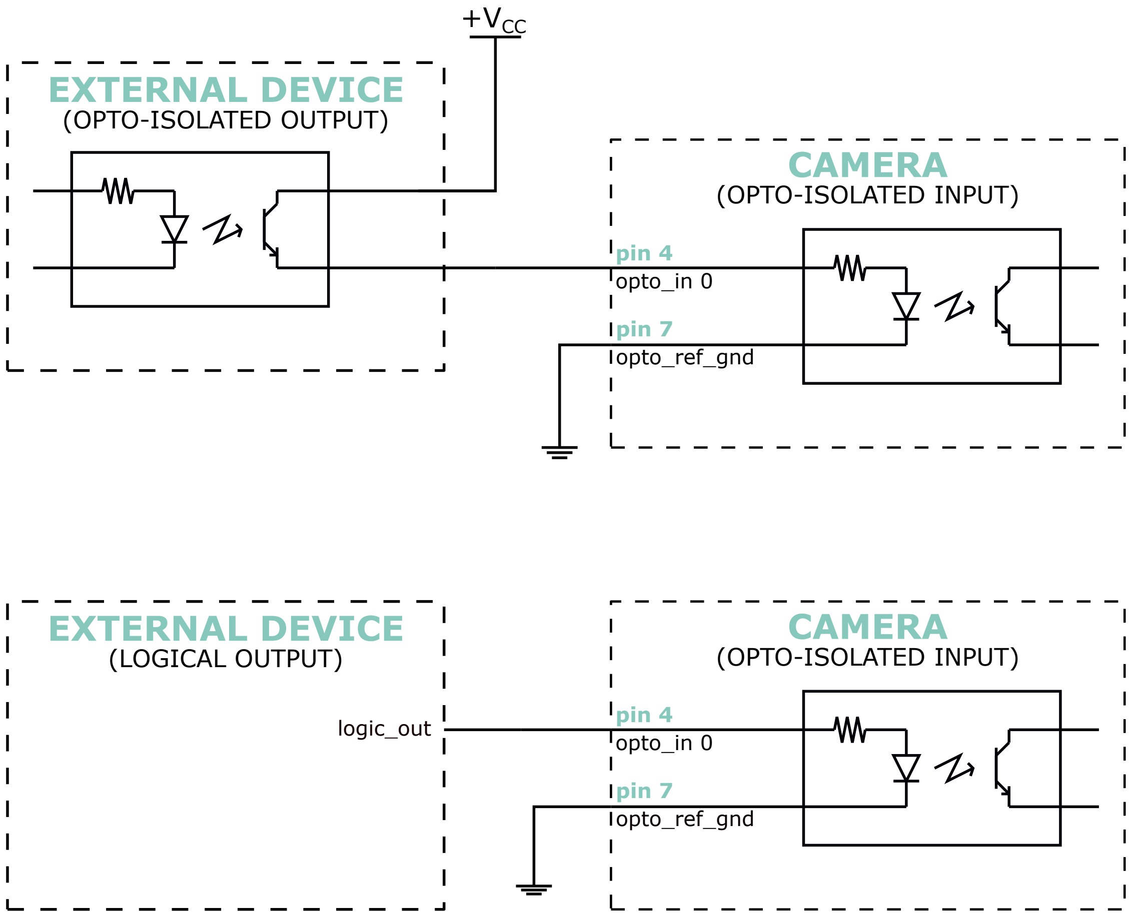


Figure 55: Figure above: camera is triggered by an opto-isolated external device. Figure below: camera is triggered by a logic output pin.

When Itala camera is triggered by an external **opto-isolated** device, the input pin of the camera can be directly wired to the source output pin of the triggering device.
In this case the triggering output stage acts as a switch: when the synchronization signal is generated, the switch closes and the external power supply ($+V_{CC}$) is delivered to the camera input pin, toggling the actual state and therefore triggering the camera.

> ***CAUTION**: Please be careful not to exceed the maximum voltage specification of the opto-isolated input pins.*
> *As mentioned in Section 5.2, $+V_{CC}$ must not exceed 30V.*

When Itala camera is triggered by an external **logic** pin (e.g. TTL), the output pin can still be wired to the opto-isolated input pin of the camera: in this case the logic output pin must be capable of triggering the opto-isolated input stage, i.e. the high logic level must be greater than the threshold voltage of the opto-coupler (see Section 5.2).
Morevoer, the output pin must have a suitable drive strenght in order to toggle the opto-isolated input stage.

7.1.2 Synchronizing an external device with Itala cameras

When Itala camera is used to trigger external devices, suitable connections must be performed. Considering the circuitry of the opto-isolated output pin (Section 5.7), possible connections are the depicted in Figure 56.
When Itala camera triggers an external **opto-isolated** device, the output pin of the camera can be directly wired to the input pin of the triggered device.
In this case the output stage acts as a switch: when the synchronization signal is generated, the switch closes and the external power supply ($+V_{CC}$) is delivered to the external device, toggling the actual state and therefore triggering the device.

> ***CAUTION**: Please be careful not to exceed the maximum voltage specification of the opto-isolated input pins.*
> *As mentioned in Section 5.2, $+V_{CC}$ must not exceed 30V.*

On the opposite, when Itala camera triggers an external **logic** pin (e.g. TTL), the output pin can still be wired to the opto-isolated input pin of the camera with some cautions: an external resistor is required in order to tie the input pin to ground when the opto-isolated output is not active.

> ***CAUTION**: Please be careful not to exceed the maximum voltage specification of the opto-isolated input pins.*
> *As mentioned in Section 5.2, $+V_{CC}$ must not exceed 30V.*

> ***CAUTION**: Always check the compatibility between $+V_{CC}$ and the logic pin maximum voltage ratings.*

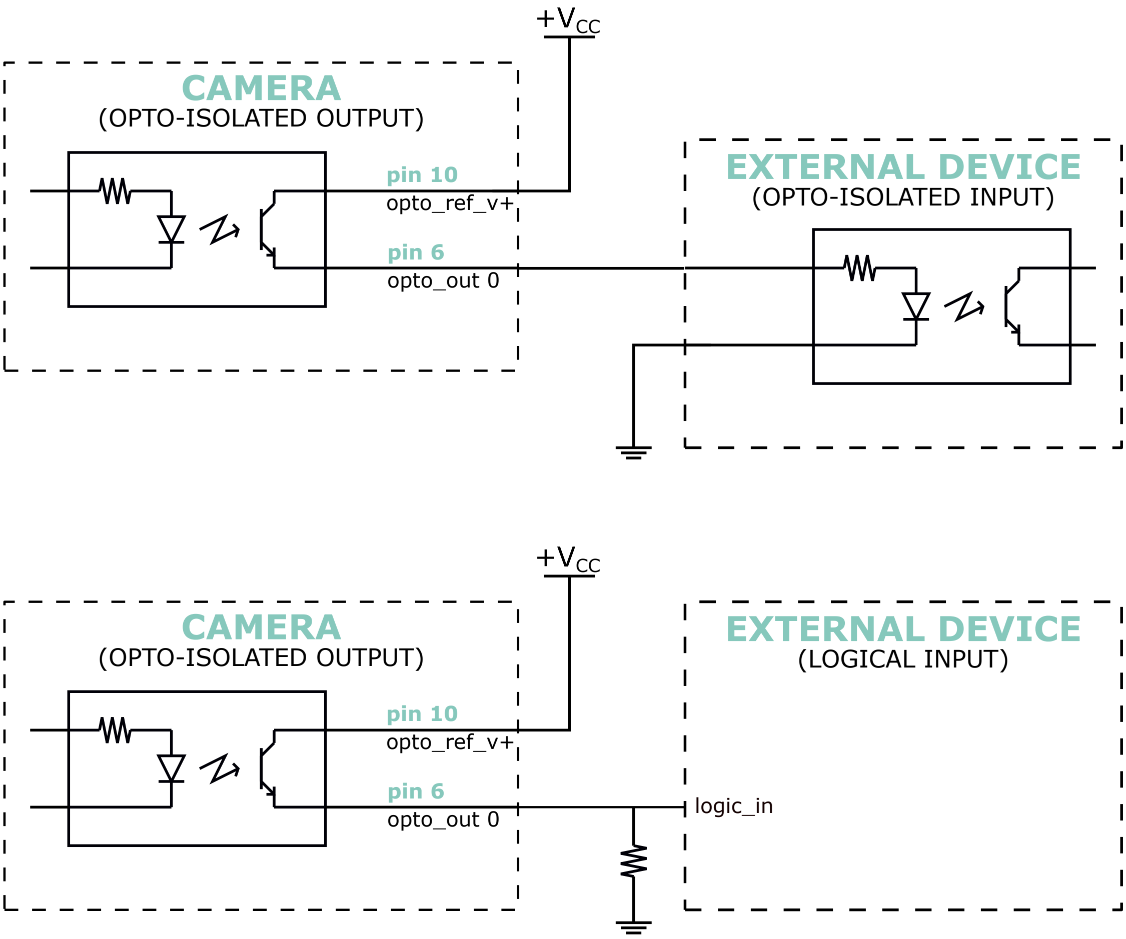


Figure 56: Figure above: camera triggers an opto-isolated external device. Figure below: camera triggers a logic input pin.

8 TROUBLESHOOTING

8.1 The camera cannot be found in the available device list

When the camera is not detected and it's not available in the device list, check the following steps:

1. Check that the camera is correctly powered. When the camera is turned on, the status LED becomes yellow after few seconds.
2. Check if a firewall is currently blocking the communication between the host and the device.
3. Check the configuration of the NIC (network interface controller).
   By default, the camera is configured to have an IP address assigned by a DHCP server.
   The user, however, can assign a static IP address to the camera: in this case check that the interface card has a suited IP address, compatible to the camera one.
   As alternative, use the *IP Configurator tool* to properly configure the IP of the camera.
4. Check that network card's drivers are correctly installed (and updated to the last version).
5. If the camera is currently used by another application, the camera results unavailable for the actual process. In this case, disconnect the camera from the other application and connect the camera to the desired application again.
6. Check that the cable is not damaged.

8.2 Why some features are not present in the GenICam tree of the camera viewer?

When some feature are missing check the following points:

1. Check that the feature is actually available for the selected camera model.
   For example, typical color features (like RGB pixel formats) are not available for monochrome cameras.
2. Check the visibility mode of the viewer.
   Some features are not visible in *Beginner mode*, but can be displayed only in *Expert mode* or *Guru mode*.
3. Some new features may be added in following firmware releases: check that the camera FW is always up to date.

8.3 Why does the camera give frame losses?

When the camera and/or the network card are not properly configured, some frames may be lost. When this is happening, check the following potential causes:

1. Check the the GigE Vision capture driver is correctly installed.
2. Check the network interface drivers are currently up to date.
3. Check that the *jumbo packet* option of the network interface card is enabled.
   Jumbo packets support frames larger than 1500 bytes and give optimal performance on high-bandwidth cameras.
4. Check that the network interface card receive buffer is correctly dimensioned. In case of frame losses, try to increase the receive buffer size.
5. Check that the PC is not in *power saving mode*. In this working regime, CPU performances are strongly reduced and may cause frame losses.
6. Check that the bandwidth doesn't exceed the supported rate of 1 Gigabit.
   As a rule of thumb, BW can be approximated quite well by the equation 11:

   $$BW[Mbps] = Resolution[Mpixel] * BitPerPixel[bit/pixel] * FrameRate[fps] \tag{11}$$

   Along with this check, the *DeviceLinkThroughputLimit* feature may be used to control the amount of bandwidth used by the camera. The maximum available frame rate may decrease when this value is lowered since less bandwidth is available for transmission.

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