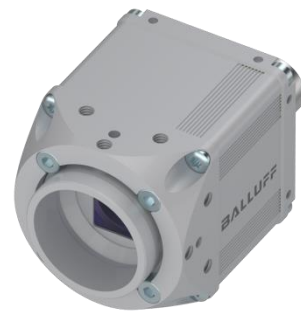


BALLUFF

GigE[®]
VISION



BVS CA - 31

Industrial cameras GigE

User's manual



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2 USER INSTRUCTIONS

2.1 Introduction

These operating instructions describe the GigE Vision compliant Balluff *Camera* BVS CA__31__ from the Balluff Vision Solutions BVS CA and the startup for an immediate operation.

The Balluff *Camera* features an FPGA, which allows to develop logic blocks and execute them directly on the camera. These "Smart Features" can

- simplify and optimize an overall system by eliminating cables, controllers as well as reducing the need of host PC load,
- furthermore they can improve the efficiency of the overall system and increase the flexibility.

All Smart Features are described in the separate functional description ("BVS CA - Smart Features").

Both manuals are available in the product download area on the Balluff product website via www.balluff.com.

The Balluff *Camera* is an image for automated industrial environments. Some outstanding properties are:

- Reduce of the host system's load and functional added value by FPGA based Smart Features
- Reliable image transfer by internal image buffer
- High-bit ADC for images with a higher information density
- Comprehensive support of third-party software by image processing standards GigE Vision and GenICam
- Easy application integration due to Ethernet
- Simple camera access from the network
- Support of Industry 4.0

These characteristics make it possible that the Balluff *Camera* can be used as the eyes for robot control systems, for quality assurance and traceability in different industries.

2 USER INSTRUCTIONS

These operating instructions apply to the following variants of the Balluff *Camera*:

Ordering code	Product name	Description
BVS002H	BVS CA-M1456Z00-31-000	Balluff <i>Camera</i> , mono, 1.6 MPix, Gigabit Ethernet
BVS002J	BVS CA-C1456Z00-31-000	Balluff <i>Camera</i> , color, 1.6 MPix, Gigabit Ethernet
BVS002K	BVS CA-M2064Z00-31-000	Balluff <i>Camera</i> , mono, 3.2 MPix, Gigabit Ethernet
BVS002L	BVS CA-C2064Z00-31-000	Balluff <i>Camera</i> , color, 3.2 MPix, Gigabit Ethernet
BVS002M	BVS CA-M2464Z00-31-000	Balluff <i>Camera</i> , mono, 5.1 MPix, Gigabit Ethernet
BVS002N	BVS CA-C2464Z00-31-000	Balluff <i>Camera</i> , color, 5.1 MPix, Gigabit Ethernet
BVS002P	BVS CA-M4112Z00-31-000	Balluff <i>Camera</i> , mono, 12.1 MPix, Gigabit Ethernet
BVS002R	BVS CA-C4112Z00-31-000	Balluff <i>Camera</i> , color, 12.1 MPix, Gigabit Ethernet

Balluff GmbH completes the customer offering with a distinct service and accessories palette (see [GigE Anhang](#)).

2 USER INSTRUCTIONS

2.2 Typographical conventions

The following conventions are used in this manual:

2.2.1 Bulleted Lists

Enumerations are shown as a list with an en-dash.

- Entry1
- Entry 2

2.2.2 Actions

Action instructions are indicated by a preceding triangle. The result of an action is indicated by an arrow.

1. Action instruction 1
 - a. Action result
2. Action instruction 2

2.2.3 Numbers

- Decimal numbers are shown without additional indicators (e.g. 123).
- Fixed-point numbers are shown with a period (e.g. 0.123).
- Hexadecimal numbers are shown with the additional indicator hex (e.g. 00_{hex}).

2.2.4 Parameters

Parameters are shown in italics (e.g. *CRC_16*).

2.2.5 Directory paths

Path information for saving data is shown with fixed font width (e.g. Projekt:\Data Types\Benutzerdefiniert).

2.2.6 ASCII code

Characters transmitted in ASCII code are set in apostrophes (e.g. 'L').

2.2.7 Symbols

NOTE

A **note** indicates important information that helps you optimize usage of the products.

WARNING

A **warning** indicates how to avoid either potential damage to hardware or loss of data.

ATTENTION

An **attention** indicates a potential for property damage, personal injury, or death.

2 USER INSTRUCTIONS

2.3 Abbreviations

ADC	Analog-to-digital converter
BVS	Balluff Vision Solutions
CA	Balluff <i>Camera</i>
CMOS	Complementary metal-oxide-semiconductor
DHCP	Dynamic Host Configuration Protocol
EEPROM	Electrical Erasable and Programmable ROM
EMC	Electromagnetic compatibility
FCC	Federal Communications Commission
FPGA	Field Programmable Gate Array
GenICam	Generic Interface for Cameras
GigE Vision	Image processing standard for Gigabit Ethernet interfaces
GND	Ground
GUI	Graphic User Interface
I/O-Port	Digital input / output port
IO	Input / Output
IP	Internet Protocol
LAN	Local Area Network
LLA	Logical Link Address
MAC	Media Access Control
MTU	Maximum Transmission Unit (in Bytes)
NC	Not connected
PC	Personal Computer
PLC	Programmable Logic Controller
RGB	Red Green Blue
RX	Receiver
TX	Transmitter

2 USER INSTRUCTIONS

2.4 Copyright

Copyright © Balluff GmbH, Neuhausen a.d.F., Germany, 2018. All rights reserved. In particular: Right to duplication, modification, dissemination and translation into other languages. Please note that all texts, graphics and images contained in these operating instructions are protected by copyright and other protection laws. Commercial duplications, reproductions, modifications and disseminations of any type require the prior written approval of Balluff GmbH. All information and notes in these operating instructions, particularly the chapter Safety Instructions, must be observed.

2.5 Legal requirements

The General Terms and Conditions of Balluff GmbH in their respective current version and the conditions in these operating instructions exclusively apply to all deliveries of products and to all other services of Balluff GmbH (henceforth referred to as “GTC”). The provisioning of the software is exclusively subject to the respective current GTC, the conditions in these operating instructions as well as the regulations of the “Balluff Enduser Licensing Agreement”. You may use the software only in compliance with these provisions. If they should not yet be available, Balluff GmbH will gladly provide the current GTC upon request.

The driver of the Balluff *Camera* uses a variety of freely available tools which were published under various open source licenses. Some licenses require that the source code and modifications be published. These sources are published on the Product homepage.

The license texts for all software products used can be downloaded from the web interface along with the manuals. They are available as ZIP files.

2.6 Updates and upgrades

Balluff GmbH is authorized – but not obligated – to make updates or upgrades of the firmware available via the website of Balluff GmbH or in any other form. In such a case, Balluff GmbH is authorized – but not obligated – to inform you about the updates or upgrades. The use of such upgrades or updates assumes that you accepted the validity of the current GTC as well as the additional conditions in the operating instructions.

2.7 Trademarks

The product, trade, company and technology designations used (e.g. Microsoft®, Windows 7®, Internet Explorer®, Google Chrome®, Mozilla Firefox® and HALCON®) are trademarks of the respective owners.

3 SAFETY

3.1 Intended use

The Balluff *Camera* is a camera for contactless acquisition of objects in industrial environments.

The intended use also includes that you have read these operating instructions in their entirety and follow all the information – particularly the section “Safety”.

3.2 General safety notes

3.2.1 Installation and startup

Installation and startup may only be performed by trained technical personnel. Qualified personnel are people who are familiar with installation and operation of the product and have the necessary qualifications for these tasks.

WARNING

Manufacturer's guarantee, warranty and liability are void for damage caused by unauthorized tampering or unapproved use, installation or handling in violation of the specifications of this user's guide. The operator must ensure that appropriate safety and accident prevention regulations are observed

1. When connecting the Balluff *Camera* to an external controller, observe proper selection and polarity of the connection as well as the power supply (see “Connections and pin assignment”).

The Balluff *Camera* may only be used with an approved power supply (see “Product specification”).

3.2.2 Conformity



This product was developed and manufactured in accordance with all applicable European Directives. CE conformity has been verified.

All approvals and certifications are no longer valid in the following cases:

- Components are used that are not part of the Balluff *Camera*.
- Components are used that have not been explicitly approved by Balluff. For a list of the approved components, see chapter “Accessories”.

3.2.3 Operation

Before commissioning, carefully read the user's guide.

The system must not be used in applications in which the safety of persons is dependent upon proper functioning of the device.

The operator is responsible for ensuring that local safety regulations are observed.

3.2.4 Maintenance, inspection, repair

The working principle used in this Balluff *Camera* is maintenance- and wear-free. The operator must regularly inspect the Balluff *Camera* for signs of damage or malfunctions in line with the operating conditions and environmental influences. If any damage or wear is found, the Balluff *Camera* must be immediately taken out of operation and secured against unauthorized use.

Only service technicians from Balluff GmbH may repair defective devices. Intervention in the product by the operator is not permitted due to safety reasons. The Balluff *Camera's* housing may not be opened or loosened!

3 SAFETY

WARNING

Before maintenance, disconnect the device from the power supply.

NOTE

In the interests of product improvement, Balluff GmbH reserves the right to change the technical data of the product and the content of this manual at any time without notice.

3.3 Disposal

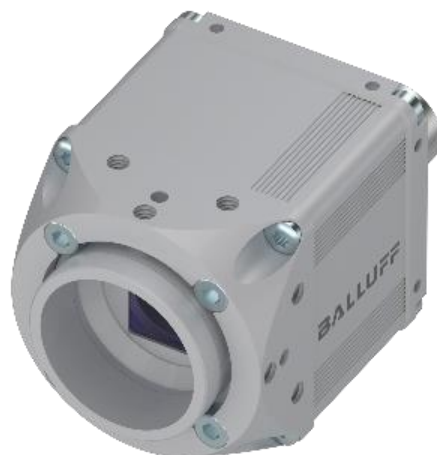
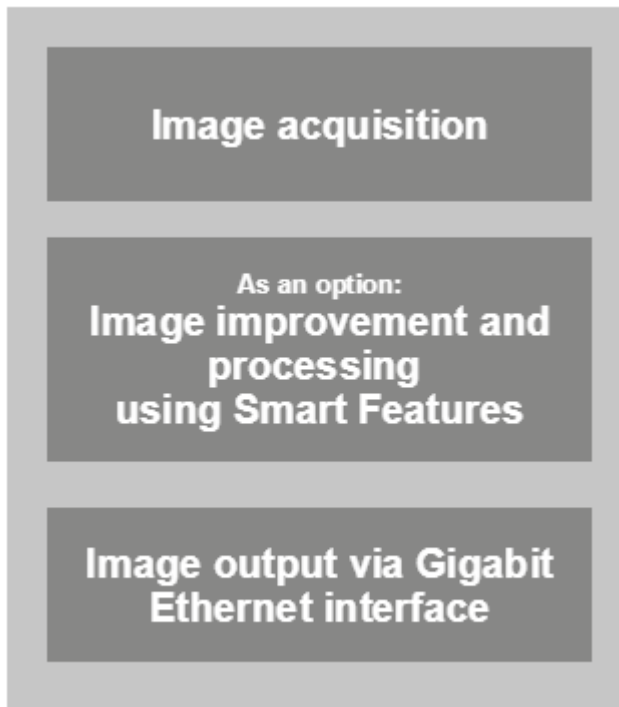
Observe the national regulations for disposal.

4 PRODUCT DESCRIPTION

The Balluff *Camera* BVS CA___31___ is a GigE Vision compliant camera for the acquisition and preprocessing of images. Application areas are optical identifications, inspections for quality assurance, and the measurement of objects. The camera can also be used in robot environments.

With the Gigabit LAN interface, the host industrial system can affect the processes in the camera and receive customer-specific processed image data.

The Balluff *Camera* works with the he Balluff BVS Cockpit interface developed specifically for camera systems, however, it is also possible to configure and use the Balluff *Camera* with third-party software, which is compliant to the image processing standards GigE Vision and GenICam.



4 PRODUCT DESCRIPTION

4.1 Product variants

The Balluff *Camera* has been designed in accordance with current, industrial standards:

- Image acquisition: Individual with C-mount lens with suitable filter; 1456 x 1088 to 4112 x 3008 pixels monochrome and color sensor. Monochrome models are equipped with an unfiltered protection glasses; color models with IR-Cut filters.
- LAN connection via Gigabit Ethernet M12
- Configuration/monitoring via BVS Cockpit
- Digital input/output channels
- 64 MB image memory

The Balluff *Camera* product family is available in different designs.

Designation	Sensor	Smart Features	LAN	Fieldbus	IO-Link	Digital I/Os
BVS CA-M1456Z00-31-000	Monochrome, 1456 x 1088	Yes	Yes	No	No	4/4
BVS CA-C1456Z00-31-000	Color, 1456 x 1088	Yes	Yes	No	No	4/4
BVS CA-M2064Z00-31-000	Monochrome, 2064 x 1544	Yes	Yes	No	No	4/4
BVS CA-C2064Z00-31-000	Color, 2064 x 1544	Yes	Yes	No	No	4/4
BVS CA-M2464Z00-31-000	Monochrome, 2464 x 2056	Yes	Yes	No	No	4/4
BVS CA-C2464Z00-31-000	Color, 2464 x 2056	Yes	Yes	No	No	4/4
BVS CA-M4112Z00-31-000	Monochrome, 4112 x 3008	Yes	Yes	No	No	4/4
BVS CA-C4112Z00-31-000	Color, 4112 x 3008	Yes	Yes	No	No	4/4

4 PRODUCT DESCRIPTION

4.2 Scope of delivery

Included in the scope of delivery

- Balluff *Camera* BVS CA with protective cap on the power I/O connector and lens holder
- Filter (mounted):
 - with monochrome sensor: protection glass
 - with color sensor: IR-Cut
- Quick Start Guide
- General Safety Notes

The following accessory groups complete the Balluff product range:

- C-mount lenses (BAM LS-VS)
- Filters (BAM LS OF)
- Lights (BAE LX)
- SmartVision Controller (BAE PD)
- Mounting accessories
- Connection cable
- Power supply units

NOTE

Visit www.balluff.com for more information on available software and accessories.

4 PRODUCT DESCRIPTION

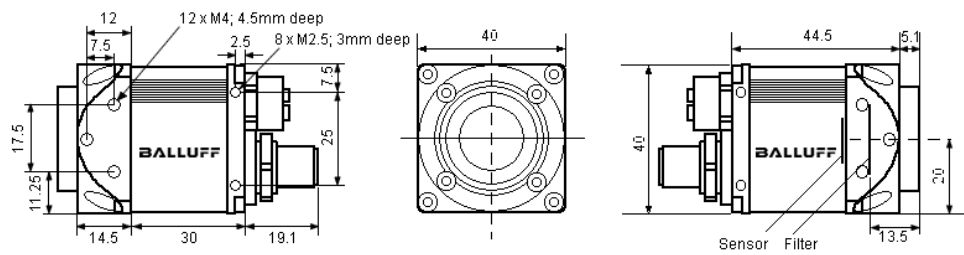
4.3 Assembly

The camera features 20 internal threads for installation at the location of use:

- Three threads at each side of the lens holder
- Two threads at each side at the rear panel.

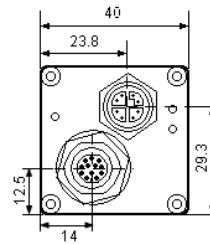
This ensures a secure and reliable mounting.

The following drawings describe the exact position of all mounting holes. Individual threads are also used for fastening optional accessories (see chapter “Accessories”).



The screw connections at the lens holder have M4 threads. The maximum engagement length is 4.5 mm. The maximum tightening torque is 2 Nm.

The screw connections at the rear panel have M2.5 threads. The maximum engagement length is 3 mm. The maximum tightening torque is 0.5 Nm.



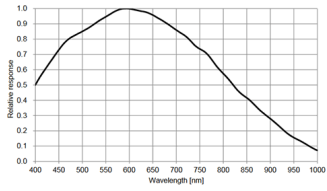
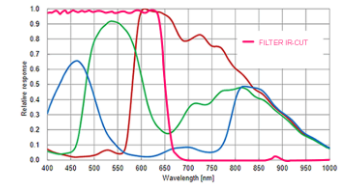
WARNING

The Balluff *Camera* and accessories must be firmly attached. Use only installation materials which are sufficiently dimensioned and ensure secure attachment.

4 PRODUCT DESCRIPTION

Product specification

4.3.1 Image sensors

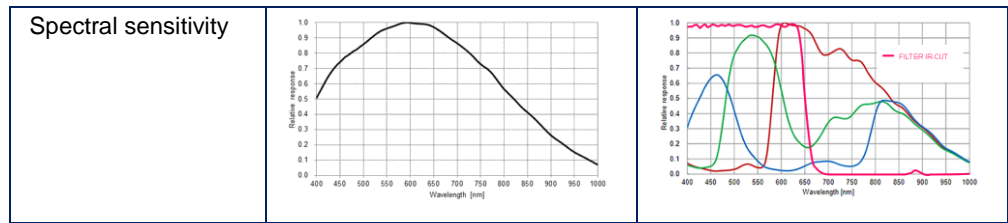
	BVS CA-M1456Z00-31-000	BVS CA-C1456Z00-31-000
Sensor	Sony IMX273	Sony IMX273
Model variant	Monochrome (CMOS)	Color (CMOS)
Resolution	1456 x 1088	1456 x 1088
Max. frame rate [Hz]	126.3 / 75 ¹	126.3 / 75 ¹
Shutter type	Global shutter ²	Global shutter ²
Sensor size	1/2.9"	1/2.9"
Pixel size [µm]	3.45 x 3.45	3.45 x 3.45
Spectral sensitivity		

¹ Burst mode / streaming

² A global shutter sensor is not read line by line or column by column, but in one access. This rules out distortions with moving motifs (rolling shutter effect).

	BVS CA-M2064Z00-31-000	BVS CA-C2064Z00-31-000
Sensor	Sony IMX265	Sony IMX265
Model variant	Monochrome (CMOS)	Color (CMOS)
Resolution	2064 x 1544	2064 x 1544
Max. frame rate [Hz]	55.4 / 37 ¹	55.4 / 37 ¹
Shutter type	Global shutter ²	Global shutter ²
Sensor size	1/1.8"	1/1.8"
Pixel size [µm]	3.45 x 3.45	3.45 x 3.45

4 PRODUCT DESCRIPTION



¹ Burst mode / streaming

² A global shutter sensor is not read line by line or column by column, but in one access. This rules out distortions with moving motifs (rolling shutter effect).

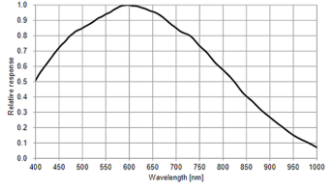
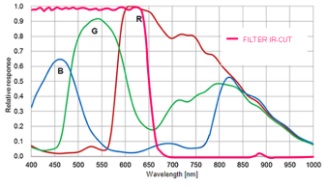
	BVS CA-M2464Z00-31-000	BVS CA-C2464Z00-31-000
Sensor	Sony IMX264	Sony IMX264
Model variant	Monochrome (CMOS)	Color (CMOS)
Resolution	2464 x 2056	2464 x 2056
Max. frame rate [Hz]	35.6 / 23.5 ¹	35.6 / 23.5 ¹
Shutter type	Global shutter ²	Global shutter ²
Sensor size	2/3"	2/3"
Pixel size [µm]	3.45 x 3.45	3.45 x 3.45
Spectral sensitivity		

¹ Burst mode / streaming

² A global shutter sensor is not read line by line or column by column, but in one access. This rules out distortions with moving motifs (rolling shutter effect).

	BVS CA-M4112Z00-31-000	BVS CA-C4112Z00-31-000
Sensor	Sony IMX304	Sony IMX304
Model variant	Monochrome (CMOS)	Color (CMOS)
Resolution	4112 x 3008	4096 x 3008
Max. frame rate [Hz]	15.0 / 9.6 ¹	15.0 / 9.6 ¹
Shutter type	Global shutter ²	Global shutter ²

4 PRODUCT DESCRIPTION

Sensor size	1.1"	1.1"
Pixel size [µm]	3.45 x 3.45	3.45 x 3.45
Spectral sensitivity		

¹ Burst mode / streaming

² A global shutter sensor is not read line by line or column by column, but in one access. This rules out distortions with moving motifs (rolling shutter effect).

4.3.2 Mechanical data

Housing material	Aluminum, lacquered
Degree of protection	IP40
Weight (without lens and accessories)	140 g
Dimensions (L x W x H, without lens)	68.7 x 40 x 40 mm

4.3.3 Electrical data

Supply voltage	11V to 25V DC
Residual ripple	≤ 5 %
Max. current consumption without external load	500mA
Power over Ethernet	Class 2 < 6.49W

WARNING

The Balluff *Camera* and accessories shall be supplied by limited energy in accordance to UL 61010-1 Third Edition, Sub. Clauses 9.4 or LPS in accordance to UL 60950-1 or Class 2 in accordance to UL 1310 or UL 1585.

4.3.4 Operating conditions

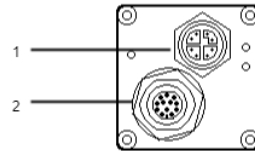
Ambient temperature	0 .. 45 °C / 30 .. 80 % relative humidity
Storage temperature	-20 .. 60 °C / 20 .. 90 % relative humidity
EMC	EN 61000-6-4 / 2007 + A1 / 2011 EN 61000-6-2 / 2005
Operation	Internally

4 PRODUCT DESCRIPTION

Height	Up to 2000 m
Pollution degree	Pollution degree 2

4.4 Connections and pin assignment

1 LAN
2 12 pin power, I/O



Connection	Function
LAN	Integrates the Balluff <i>Camera</i> in a local network.
Power I/O	Voltage supply of Balluff <i>Camera</i> additional four digital inputs and four digital outputs.

WARNING

The Balluff *Camera* and accessories shall be supplied by limited energy in accordance to UL 61010-1 Third Edition, Sub. Clauses 9.4 or LPS in accordance to UL 60950-1 or Class 2 in accordance to UL 1310 or UL 1585.

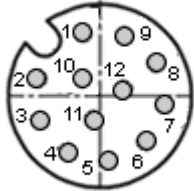
4 PRODUCT DESCRIPTION

4.4.1 Power I/O

The Balluff *Camera* is powered via the Power I/O plug which additionally provides digital I/Os:

- Four PLC compliant inputs as optocoupler with current limiter (11V .. 24V)
- Four outputs as high-side-switches (10V .. 24V and 700 mA) with direct drive output for high power flash, relays, or actuators

12-pin M12 socket, A-coded

	Pin	Description	Function
	1	PWR_IN+ ¹	12 .. 24V power supply
	2	PWR_IN-/GND	Ground
	3	DigOut3	Output
	4	Opto DigIn0	Optocoupler input
	5	DigOut2	Output
	6	DigOut0	Output
	7	Opto GND	Ground for optocoupler
	8	Opto DigIn2	Optocoupler input
	9	Opto DigIn3	Optocoupler input
	10	+24V_HSD	24V supply for the high side outputs
	11	Opto DigIn1	Optocoupler input
	12	DigOut1	Output

¹ Using POE and an external power supply at the same time, the external power supply will be treated prioritized.

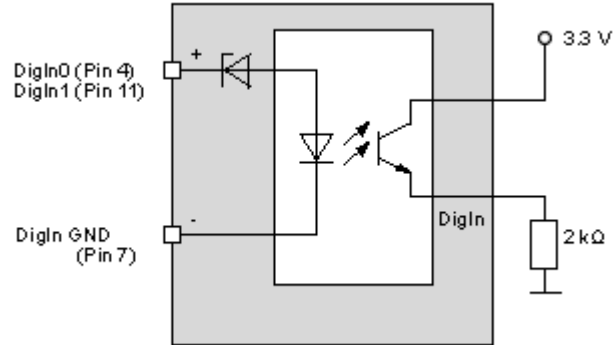
NOTE

The digital sensor inputs correspond to the guideline concerning inputs. EN 61131-2, Type 3.

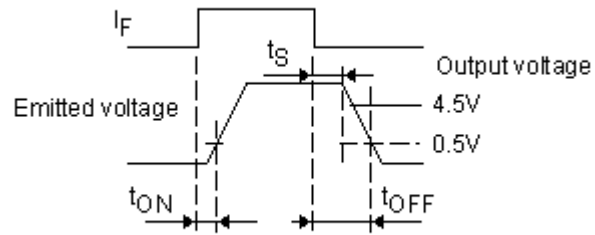
The maximum load on any output is 700 mA. The load or supply must be limited accordingly.

4 PRODUCT DESCRIPTION

Digital input



Delay

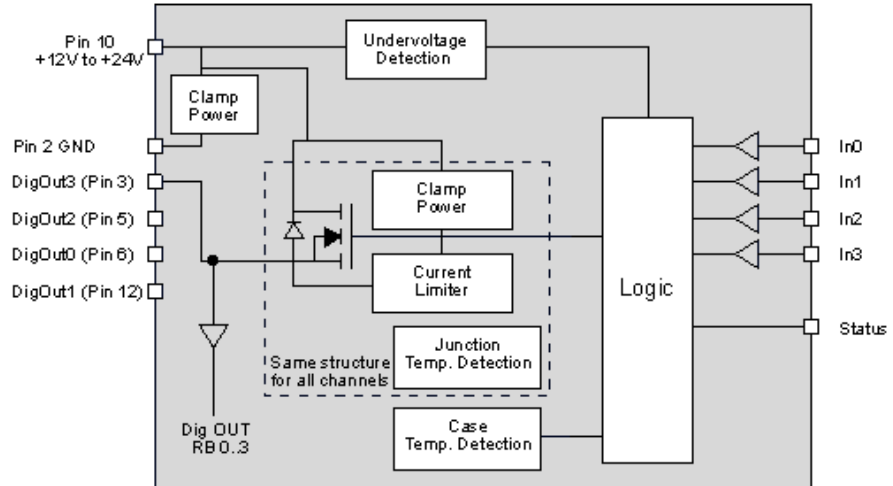


Characteristic	Symbol	Test conditions	Typical value	Unit
Minimum trigger pulse width			5	μs
Turn-On time	t _{ON}	R = 2 kOhm, internal output voltage 5V, I _F = 16mA	2	
Storage time	t _s		44	
Turn-Off time	t _{OFF}		95	

Characteristic	Typical value	Unit
High Level	+11 to +24	V
Low Level	0 to +8	V
Threshold (Low → High High → Low)	10 ± 1	V
I _{max}	16	mA

4 PRODUCT DESCRIPTION

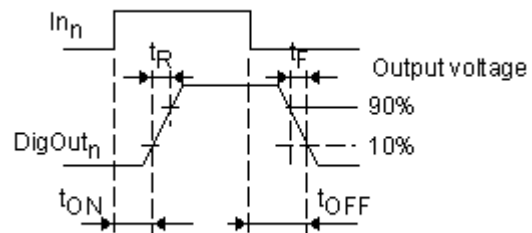
Digital output



NOTE

Each output has a short circuit protection between 1 A and 1.7 A (generally 1.3 A). So if you combine two outputs with one load, the short circuit protection can have an effect.

Delay



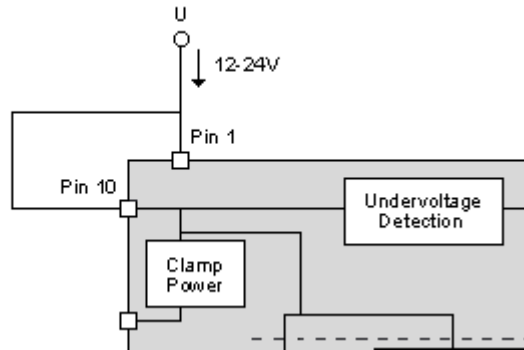
Characteristic	Symbol	Typical value	Unit
Turn-On time	t_{ON}	20	μs
Rise time	t_R	10	
Fall time	t_F	8	
Turn-Off time	t_{OFF}	30	

4 PRODUCT DESCRIPTION

Characteristic	Typical value	Unit
High Level	+12 to +24	V
Low Level	max. +1	V
I_{out} (4x)	0.7 (max. short circuit)	A

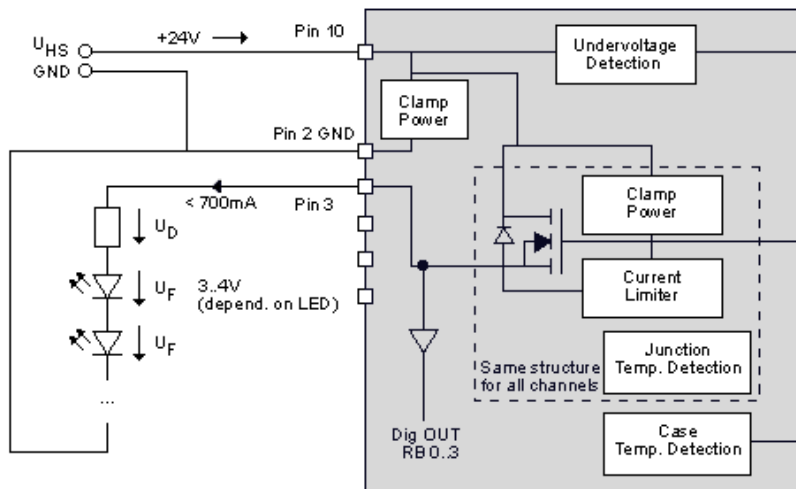
Example circuit 1: High-side-switch uses power supply of the camera

In this case you have to bridge pin 2 (external power supply) with pin 10 (the supply of the outputs):



Example circuit 2: High-side-switch uses external (higher) power supply

Following figure shows, how to connect, for example, high power flash LEDs in series at the direct drive output at pin 3:



A 24V power supply is connected at Pin 10. To protect the LEDs a series resistor is needed, which can be calculated in this way:

Voltage

$$U_{HS} - (n * U_F) = U_D$$

4 PRODUCT DESCRIPTION

Series resistor

$$R = U_D / 0,7A$$

Power

$$P = \text{duty cycle} * U_D * I$$

The duty cycle is a coefficient < 1 , which defines the power of the resistor. It is the ratio of the time period while current flows compared to the total time. If the current always flows, " $P = U * I$ " will be the determining factor. If the current only flows a hundredth of time (duty cycle 1%), a resistor with a hundredth of power will be enough.

NOTE

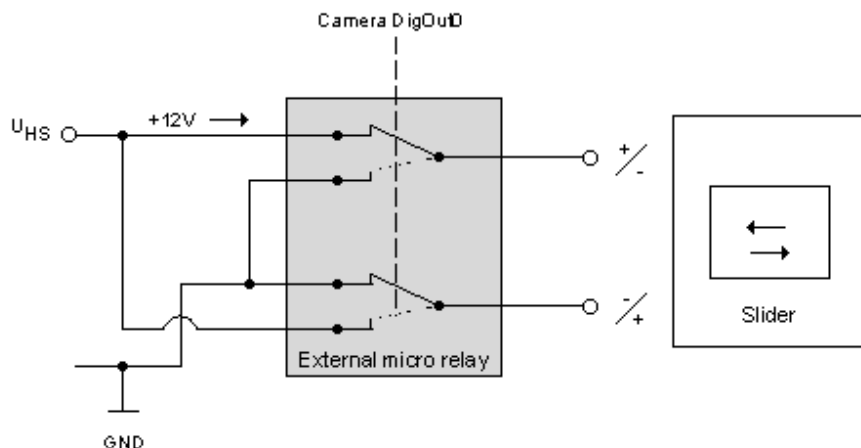
For the connected LEDs and the ground of the external power supply, you have to use the ground of the camera at pin 2.

WARNING

The series resistor has to handle the power, which depends on the duty cycle and the frequency.

Example circuit 3: Controlling a motorized lens

It is possible to control a motorized lens. However, an external micro relay is necessary which changes the polarity of the lens slider when triggered by the camera's digital output. The following figure shows an example circuit:



4 PRODUCT DESCRIPTION

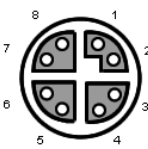
4.4.2 LAN (Gigabit Ethernet)

The LAN interface meets the Ethernet standard in accordance with IEEE 802.3-2008 (up to 1 Gigabit). This network connection is used to call up the web interface BVS Cockpit for the configuration and to send the image data.

NOTE

The LAN signals are galvanically isolated from the camera electronics and camera housing.

8-pin M12 socket, X-coded

	Pin	Description	Function
	1	BI_DA +	Bidirectional data, Pair A +
	2	BI_DA –	Bidirectional data, Pair A –
	3	BI_DB +	Bidirectional data, Pair B +
	4	BI_DB –	Bidirectional data, Pair B +
	5	BI_DD +	Bidirectional data, Pair D +
	6	BI_DD –	Bidirectional data, Pair D –
	7	BI_DC –	Bidirectional data, Pair C –
	8	BI_DC +	Bidirectional data, Pair C +

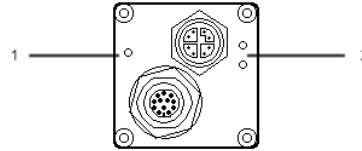
NOTE

The cable must correspond at least to category 5e in accordance with EIA/TIA-568. Transfer in accordance with 1000BASE-T/100BASE-TX/10BASE-T is being supported.

4 PRODUCT DESCRIPTION

4.5 Display elements

1 Status LED
2 LAN LED



Status LED	The RGB signal LED indicates the different status of the Balluff <i>Camera</i> .
LAN LED	The LEDs indicate the connection and the activity of the LAN interface.

4.5.1 Status LED

Start sequences

NOTE

If there is no DHCP server available, the host system will negotiate a local IP address with the Balluff *Camera* from the IP range 169.254.x.y.

Status	LED color			
	LLA		DHCP	
FPGA loaded	White on			
Self-test running	Green on			
Waiting for LAN connection	White blink			
	LLA (Auto IP)	Green blink	DHCP request	Blue blink
	LLA got	Green on	DHCP got	Bright blue
Waiting for client	Blue on			

General behavior

Status	LED color
Connected, streaming off	Yellow on
Streaming on	Green on
Error	Red on

4 PRODUCT DESCRIPTION

4.5.2 LAN-LED

Status	LED color
No LAN connection	Off
LAN connection	Green on
No data transfer	Off
Data transfer	Yellow blink

4.6 Cleaning

The outside of the Balluff *Camera* can be cleaned with a soft cloth. Persistent dirt can be removed with a cloth that is first moistened with a soap solution and wrung out.

→ After wiping off the dirt spots, wipe the camera with a dry cloth.

5 FIRST STEPS

Four simple steps are required to initially start up and configure the Balluff *Camera*. Besides the Balluff *Camera*, the following is required:

- Latest Balluff *Camera* driver
- Power I/O cable
- 12 .. 24V power supply
- LAN cable
- PC with BVS Cockpit

5.1 Step 1: Installing the latest Balluff Camera driver

Download the latest driver from the product download section, unzip it and execute the setup program for 32 bit (**x86**) or 64 bit (**x86_64**) Windows systems.

Beside the Balluff *Camera* driver, four additional tools will be installed:

- **wxPropView** - an interactive GUI tool to acquire images, to configure the device and to display and modify the Balluff *Camera* properties
- **mvDeviceConfigure** - an interactive GUI tool to configure the Balluff *Camera*. It is possible e.g.
 - to check, if the camera is accessible and
 - to update firmware.
- **mvGigEConfigure** - an interactive GUI tool to install the GigE capture filter which adds a service to your Gigabit Ethernet interface
- **mvIPConfigure** - an interactive GUI tool to configure the network behavior of the Balluff *Camera*. It is possible e.g.
 - to assign a user defined name,
 - to change the IP address behavior, and
 - to find and fix misconfigured (e.g. wrong IP address) Balluff *Cameras*.

The user can select, if the device should

- use a persistent IP address or
- use DHCP to obtain an IP address.

5 FIRST STEPS

5.2 Step 2: Establishing a network connection with the Balluff Camera

Connect the Balluff Camera via the LAN port with the network.

Depending on the network topology between computer and Balluff Camera, different network settings must be made on the computer. In general, the network configuration of your computer is set to *Obtain an IP address automatically*. For the firewall setting, port 80 should be enabled.

The following network structures are possible:

Structure	Follow
Balluff Camera and PC are connected directly via a LAN cable.	IP addresses are set automatically.
Balluff Camera and PC are in the same subnet of a local network and a DHCP server is available for automatic IP assignment.	IP addresses are set automatically.
Balluff Camera and PC are in the same subnet of a local network and no DHCP server is available for automatic IP assignment.	In this case, the IP addresses of PC and Balluff Camera must be matched and manually set. Pertinent useful notes are located in the section "Network settings / LAN interface".
Balluff Camera and PC are in different subnets of a local network.	Subnets are explicitly created to be able to subdivide computers in different networks and to structure it in this way. A Balluff Camera in another subnet cannot neither be found nor set.

5.2.1 Adapting the network controller

If you have interplay problems between the Balluff Camera and a network controller please check following settings in the driver settings:

NOTE

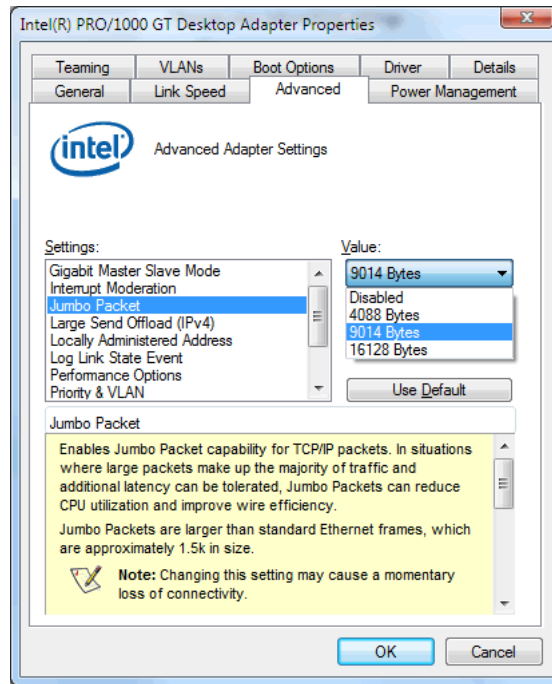
There is no need to set the transfer packet size manually. Whenever the device is initialised, the driver will determine the maximum possible packet size for the current network settings automatically.

The screenshots below are examples for how a dialog for a feature described here might look like. Not every network controller driver will support every feature discussed here and different drivers might use different names for the features presented. The hints are just meant to give an idea for what to look for.

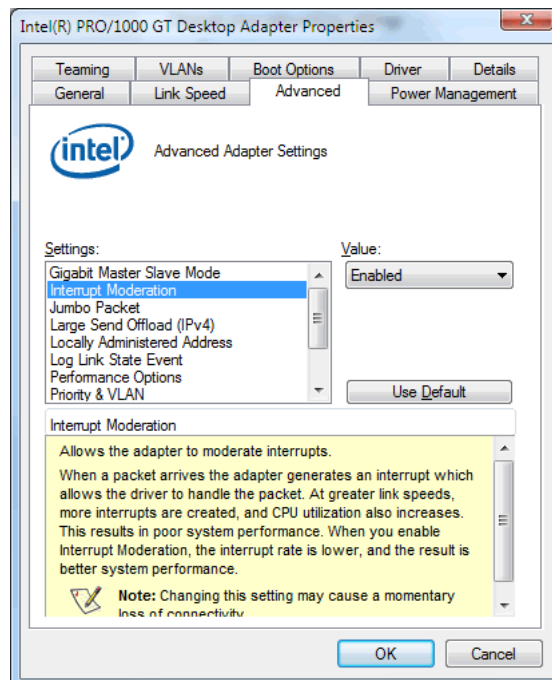
1. Is the network controller a "**1000MBit Full Duplex Controller**" and is this mode activated (via properties of network settings)?
2. Is the driver of the network controller up-to-date?
Some manufacturers have optimized their drivers referring to higher data throughput.
3. Is the "**GigE Vision Capture driver**" installed from Balluff?

5 FIRST STEPS

- Does the MTU of the network controller correspond the setting of the Balluff Camera? Using a peer-to-peer connection leads to a better performance and normally you can use values higher than 1,500. Here, values between 4,000 and 12,000 make sense, whereas some network controllers only allow maximum of 9,000 which is enough for sensors up to 4 megapixels.

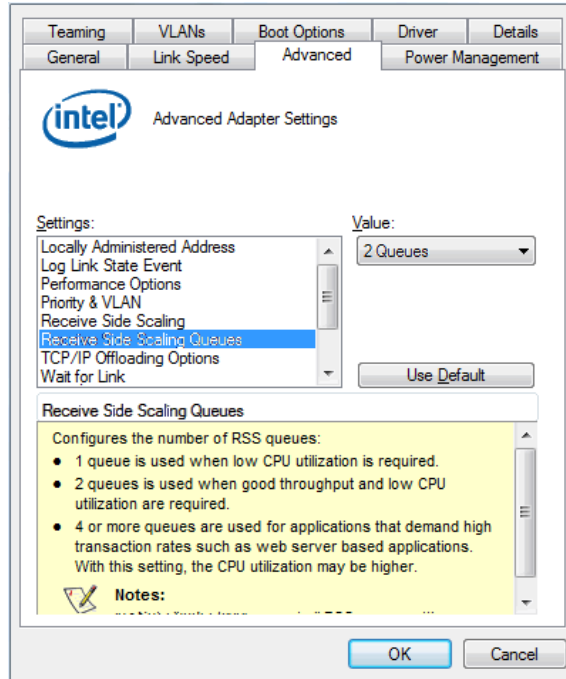


- Is the network controller parameter "Interrupt Moderation" switched on?



5 FIRST STEPS

- Some multi-port network cards might also offer to configure the number of "RSS (Receive Side Scaling) Queues". When dealing with high data rates, increasing the number of queues might also improve the overall stability of the system in terms of the possibility of packet losses etc.



- Is the amount of the "Receive Descriptors" (RxDesc) of the network controller set to the maximum (generally 2048)? This amount depends on the MTU. You can get a feeling about values with following formula (per camera and per network port):

$$\text{RxDesc} \geq \frac{1.1 * \text{PixelPerImg} * \text{BytesPerPixel}}{\text{MTU}}$$

Example 1: 1500 with 1.6 megapixels

$$\begin{aligned} \text{RxDesc} &\geq 1.1 * 1.6\text{M} * 1 \\ &\quad \quad \quad 1500 \\ &\geq 1170 \end{aligned}$$

5 FIRST STEPS

Example 2: 8192 with 1.6 megapixels

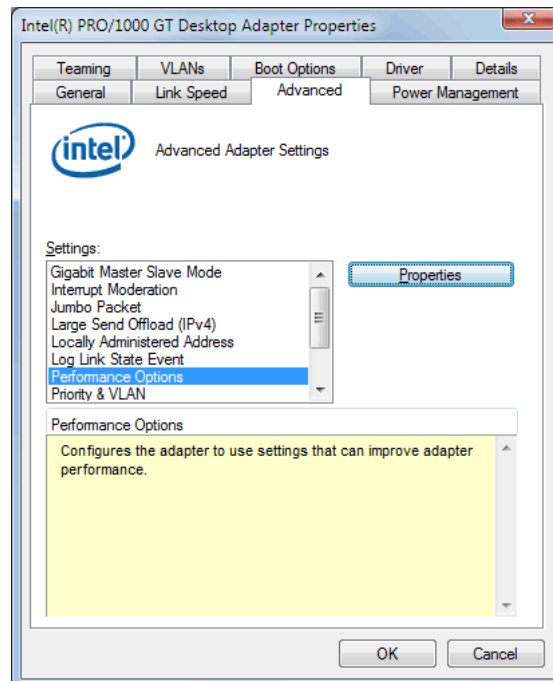
```
RxDesc >= 1.1 * 1.6M * 1
          -----
          8192
          >= 214
```

NOTE

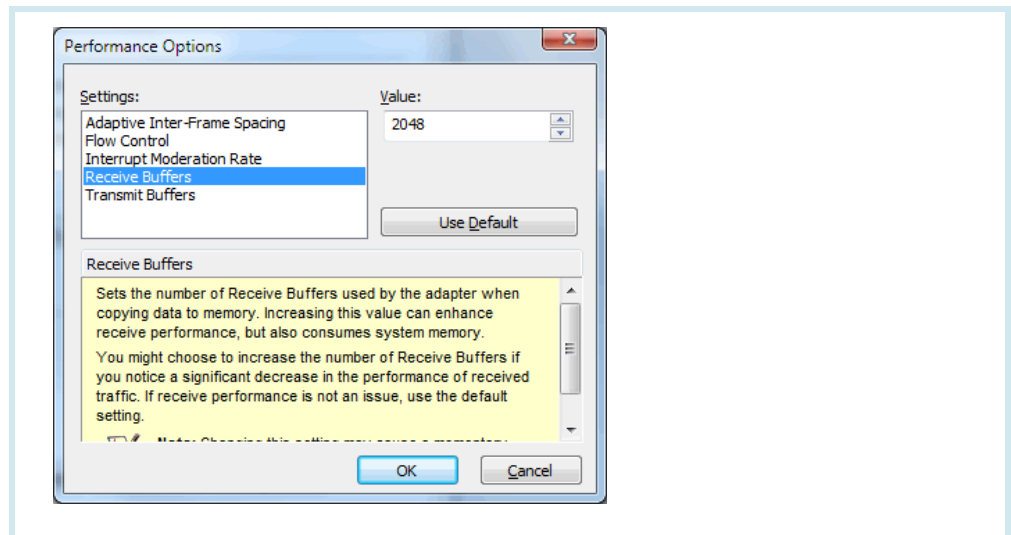
Both examples are showing the RxDesc values based on packages per image per second. Now, if you increase the images per second you will see that you reach the amount of "Receive Descriptors" very soon. Usually, the default values of the system are between 64 and 256 and as a general rule too low. Also each use of a "Receive Descriptor" will result in a certain amount of CPU time needed, which is why larger packets result in a better overall performance.

If you are using small MTU values or if there is only a small value of "Receive Descriptors" possible, you have to enable "Interrupt Throttling". Interrupt throttling enables the network controller to combine packets thus lowering the amount of interrupts.

The "Receive Descriptors" a.k.a. "Receive Buffers" (Intel PRO/1000 network interface) can be found under "Performance Options":



5 FIRST STEPS



5.3 Step 3: Switching on the Balluff Camera

Now connect the power supply at the power port with the power supply. The Balluff *Camera* starts up and is operational after approx. 30 seconds. At the start, the Balluff *Camera* starts with the same settings it occupied at switch-off.

5.4 Step 4: Opening a GigE Vision compliant software

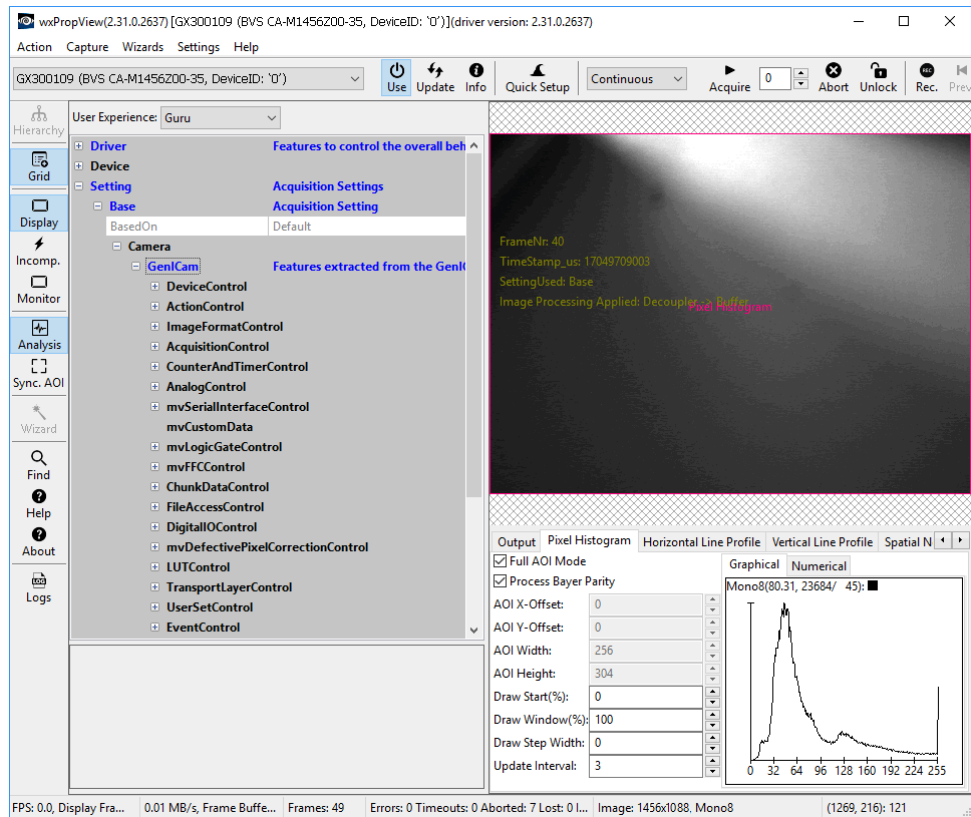
With **wxPropView** you can configure the Balluff *Camera*. After starting the tool, the **Quick Setup Wizard** will open. This wizard is used to optimize the image quality automatically and to set the most important parameters, which affect the image quality. After accepting the changes you have the possibility

- to open the Balluff *Camera*,
- to configure the Balluff *Camera*, and
- to display a live image.

For this, select the Balluff *Camera* and click on the button "**Use**". The properties tree will open afterwards. Via the tree, you can adapt the properties.

You can also display live images from the Balluff *Camera*. For this click on "**Acquire**":

5 FIRST STEPS



The Balluff *Camera* can also be configured via the **BVS Cockpit**. This web interface is being opened and operated via web browsers.

The following commercially available web browser are being supported:

- Google Chrome version 32.0 and above
- Mozilla Firefox version 24.0 and above
- Microsoft Internet Explorer version 11 and above
- Microsoft Edge version 40 and above

NOTE

JavaScript must be enabled in the web browser.

To configure the Balluff *Camera*, start BVS Cockpit and select in the action menu "**Configuration**" the "**Set up camera**" tool or choose the "**Digital In/Outputs**" menu item in the system settings to set the digital inputs and outputs.

NOTE

More information about the configuration interface and firmware update possibilities of the BVS Cockpit can be found in the software manual (BVS Cockpit manual) on the Balluff website.

If there is already another Balluff *Camera* in the network, you can also connect with this Balluff *Camera* and change to any other Balluff *Camera* in the local network using this interface.

6 STARTUP

6.1 Updating software

The Balluff website regularly offers new software updates for Windows operating systems. These may include error fixes, speed optimizations or added functions.

NOTE

To get the maximum benefit from the Balluff *Camera* it is recommended to regularly update the Balluff *Camera* with software updates.

NOTE

This section describes the software update for the Balluff *Camera* with a Windows PC. The process will need to be adapted for other systems.

To update the software, please follow these steps:

6.1.1 Step 1: Installing Balluff Camera driver

First, download the latest driver from the product download section, unzip it and execute the setup program for 32 bit (**x86**) or 64 bit (**x86_64**) Windows systems.

6.1.2 Step 2: Updating the firmware via mvDeviceConfigure or BVS Cockpit

Open **mvDeviceConfigure**. The tool shows all found Balluff *Cameras* and marks the cameras, for which a firmware update is available:

State	Firmware Version	Kernel Driver	Device ID	Allocated DMA Buffer(KB)
Present	2.23.928.0(UPDATE AVAILABLE(Version 2.27.1231.0))	unsupported	0	unsupported
Present	666			
Present	666			
Present	666			
Present	666			
Present	666			

The update will start, as soon as you right-click on the Balluff *Camera* and then on "**Update Firmware**".

WARNING

Do not turn of the Balluff *Camera* during the update process. All current camera settings will be lost when updating the firmware. Network configuration settings will not be affected.

Alternatively, you can update the firmware via **BVS Cockpit**. Select in the action menu "**Configuration**" the tool "**Set up camera**". Select "**Device Control** → **Show**" and you will see the information about the camera including the firmware version.

6 STARTUP

Parameter

Use for inspection processing:

Active camera: GX315332

Device Control: Show

Camera list: Refresh

Image section

startX: 0 - +

startY: 0 - +

Width: 1280 - +

Height: 960 - +

Additionally, there will also be a button "Update". Click the button and the firmware update will start.

Device Control	
Device ID	GX315332
Device Model	BVS CA-M1456Z0031
Device Serial	GX315332
Device Version	2.10
Device User ID	
Device Vendor Name	Balluff GmbH
Device Manufacturer	FW=2.13.460.0
Device Color Mode	BayerMosaic
Device IP Address	192.168.200.158
Device Subnet Mask	255.255.255.0
Device Gateway	192.168.200.1
Device Firmware Version	2.13.460.0
Device Firmware Build	Sep 21 2016 18:39:36
Device Firmware Source	ProgramSection
Device Firmware FPGA	4.0.7.20

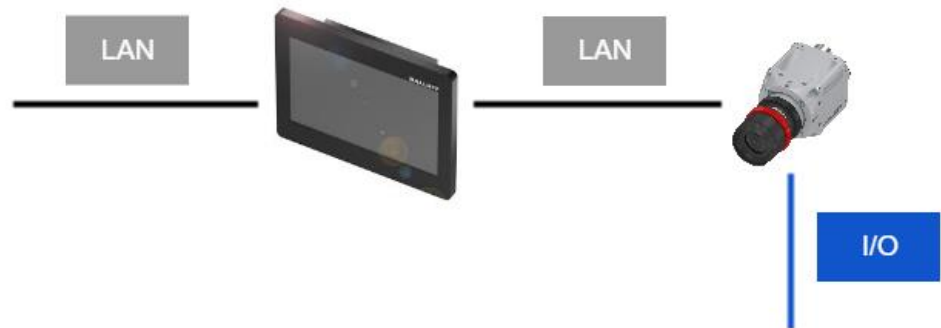
Update Close

6 STARTUP

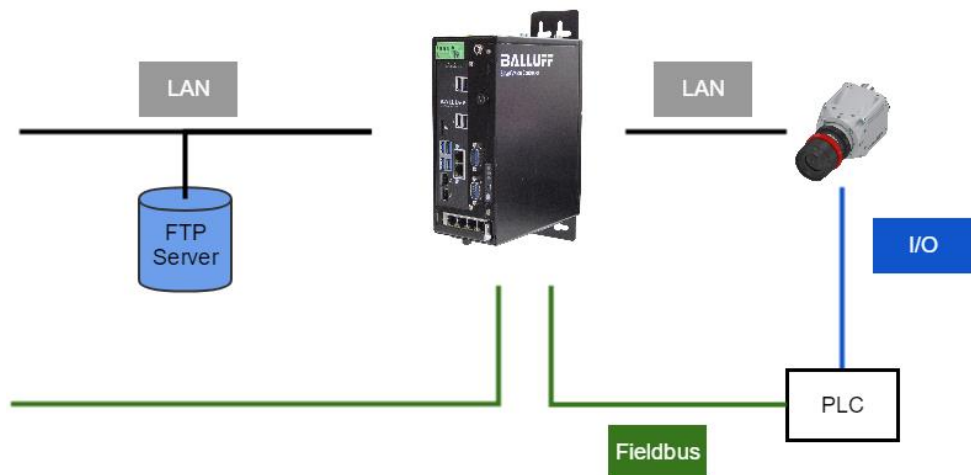
6.2 Network topologies

For the startup of the Balluff *Camera*, it is first integrated in the network environment. The different options are described in the following examples. This covers a large part of the application cases. To operate the Balluff *Camera* requires that the supply voltage is provided via the power connection in any case.

The IO1 topology shows a simply design with an operating panel for the configuration of the Balluff *Camera*. The interaction with the system is done exclusively via the digital I/Os in this example.



In the IO2 example, the I/O signals of the Balluff *Camera* are being analyzed by a controller. In addition, the Balluff *Camera* is controlled via the LAN connection. This allows the controller, e.g. to initiate the trigger or query the status of the Balluff *Camera*.



6.2.1 Network settings / LAN interface

All variants of the Balluff *Camera* feature a 1 Gbit/s LAN interface for configuring and transferring the image data. Chapter "First steps" describes how this interface is used to establish the connection between computer and Balluff *Camera*.

6 STARTUP

6.2.2 Locating the camera in the network

If the Balluff Camera and the PC are located in the same subnet, the Balluff Camera will be detected without any problems. It doesn't matter whether the Balluff Camera got the IP address from a DHCP server or negotiated it with the connected PC directly using the IP range 169.254.x.y.

To adapt the network behavior you can either use **BVS Cockpit** or **mvIPConfigure**.

Via **mvIPConfigure** select the Balluff Camera and click on the button "**Configure**". In the "IP Configuration" section adapt the settings to your needs and "**Apply Changes**".

Figure 1 mvIPConfigure

The screenshot displays the mvIPConfigure web interface with the following sections:

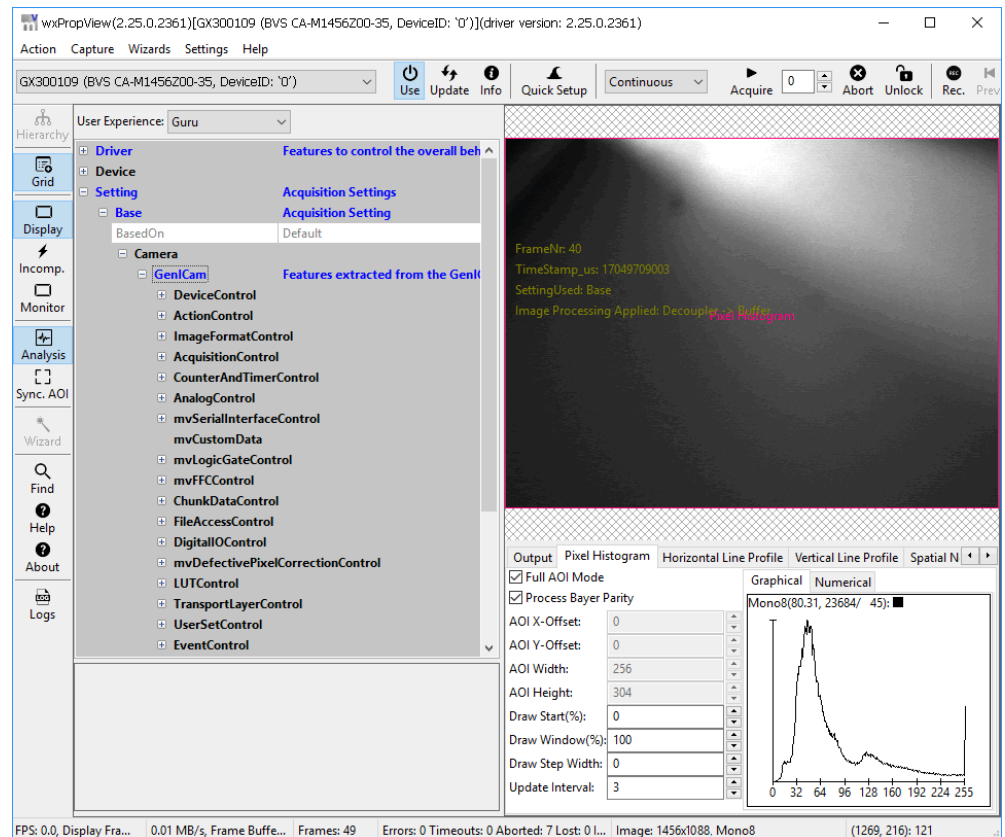
- Device Information:**
 - Manufacturer: [Redacted]
 - Serial Number: [Redacted]
 - User Defined Name (DeviceUserID): [Text Input Field]
 - Interface Count: 1
- Interface Configuration:**
 - Selected Interface: 0
 - Current Interface Parameter:**
 - IPv4 Address: 192.168.1.241
 - Subnet Mask: 255.255.255.0
 - Default Gateway: 192.168.1.15
 - MAC Address: 00:0c:8d:60:4a:43
 - Connected To IPv4 Address: 192.168.1.128
 - Connected Adapter Netmask: 255.255.255.0
 - Connected Adapter MTU(Bytes): 1500
 - Connected Adapter Link Speed(MBps): 1000
 - More Information: [IPv4](#), [MTU](#)
- Persistent IPv4 Address:**
 - IPv4 Address: 0.0.0.0
 - Subnet Mask: 0.0.0.0
 - Default Gateway: 0.0.0.0
- IP Configuration:**
 - Use Persistent IP
 - Use DHCP
 - Use LLA (Link-local address a.k.a auto-IP or zero config)
 - More Information: [DHCP](#), [LLA](#)

Buttons for "Configure" and "Apply Changes" are located at the top right of the interface.

6 STARTUP

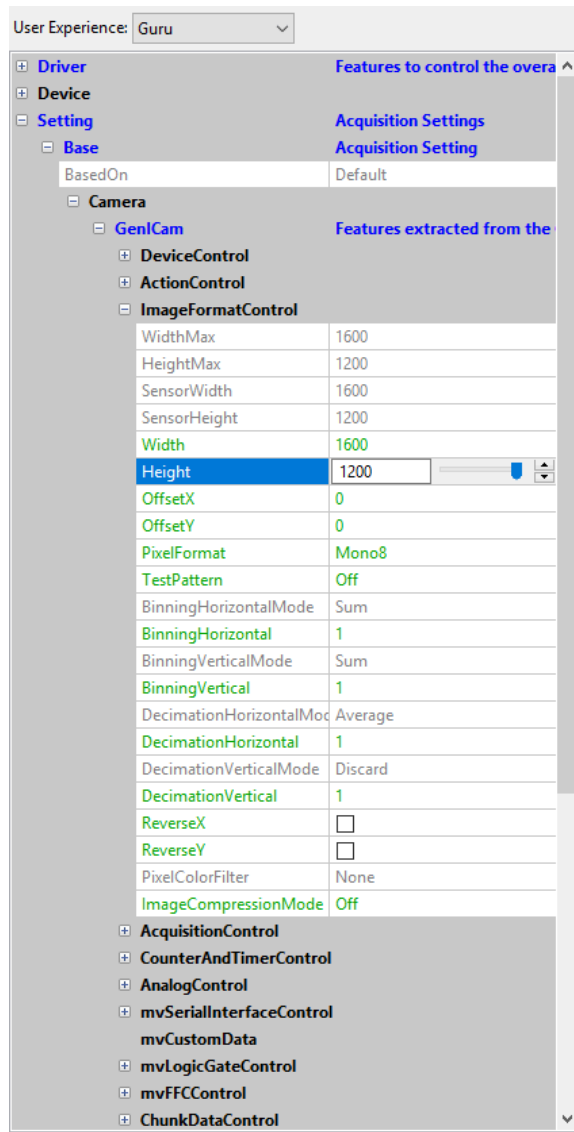
6.3 Setting camera properties

You can set camera properties with **wxPropView**. As soon as you have selected the Balluff Camera and opened it with the button "Use", the properties tree will open afterwards:



Properties of a GigE Vision compliant camera are specified in the SNFC (Standard Features Naming Convention) and are categorized as so-called *Controls*. For example, *ImageFormatControl* contains features related the format of the transmitted image, while *AcquisitionControl* contains features related to the image acquisition. The behavior of the digital inputs and outputs are set in the *DigitalIOControl*, and so on. There are more details about the *Controls* in the manual "**Smart Features functional description**".

To change properties, open the relevant tree, select the relevant property and change it:



BVS Cockpit offers different tools to set properties. In the action menu "Configuration", "Set up camera", "Get Inputs", "Set Outputs" are tools associated with camera properties and the control of the image acquisition. In the system settings you can find the digital In/outputs settings. You can reach them via the system menu:



You can find more details about the BVS Cockpit in the **BVS Cockpit** manual.

7 APPENDIX

7.1 Type code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
B	V	S		C	A	-	M	1	4	5	6	Z	0	0	-	3	1	-	0	0	0

1-3	BVS	Balluff Vision Solutions
5-6	CA	Camera
8	Function type	M = Monochrome sensor C = Color sensor
9-12	Resolution	1456 = 1456x1088 1936 = 1936x1216 2064 = 2064x1544 2464 = 2464x2056 4112 = 4112x3008
13	Lights	Z: No integrated lighting
14-15	Optics	00: C-mount lenses
17-18	Interface	31 = GigE Vision 35 = USB3 Vision
20-22	Variants	000: Full standard functionality

7 APPENDIX

7.2 Accessories

(optional, not included in the scope of delivery)

C-mount lenses		
BAM0364	BAM LS-VS-006-C2/3-0814-5	KOWA lens 1.6 - 5.1 Mpix, 8mm
BAM0365	BAM LS-VS-006-C2/3-1214-5	KOWA lens 1.6 - 5.1 Mpix, 12mm
BAM0366	BAM LS-VS-006-C2/3-1614-5	KOWA lens 1.6 - 5.1 Mpix, 16mm
BAM0367	BAM LS-VS-006-C2/3-2514-5	KOWA lens 1.6 - 5.1 Mpix, 25mm
BAM0368	BAM LS-VS-006-C2/3-3514-5	KOWA lens 1.6 - 5.1 Mpix, 35mm
BAM0369	BAM LS-VS-006-C2/3-5014-5	KOWA lens 1.6 - 5.1 Mpix, 50mm
BAM035R	BAM LS-VS-007-C1/1-0818-C	TAMRON lens 12.4 Mpix, 8mm
BAM035T	BAM LS-VS-007-C1/1-1618-C	TAMRON lens 12.4 Mpix, 16mm
BAM035U	BAM LS-VS-007-C1/1-2518-C	TAMRON lens 12.4 Mpix, 25mm
BAM035W	BAM LS-VS-007-C1/1-5018-C	TAMRON lens 12.4 Mpix, 50mm

NOTE

Other accessories for the BVS SC-... such as lenses, filters, lights or cables can be found at www.balluff.com.

 **www.balluff.com**

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