BALLUFF

BVS SC-_1280Z00-30-0-0
SMART*CAMERA* Fieldbus

User's manual

English

www.balluff.com

Original user's guide

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1 User instructions

1.1 Introduction

These operating instructions describe the **SMART***CAMERA* product from the Balluff Vision Solution BVS SC product family as well as the data interfaces and the startup for an immediate operation.

The web-based software interface integrated in the **SMART***CAMERA* is described in the separate software manual (BVS Cockpit manual).

Both manuals are available on the Balluff product website via www.balluff.com or via the help system of the BVS Cockpit interface.

The **SMART***CAMERA* was developed to identify objects in automated industrial environments via optical codings (barcode, 2D codes or plain text) and to recognize and verify characteristics of objects such as presence, contours, dimensions, colors and positions. The test results can be processed in a flexible way and forwarded to the higher-level controller. Some outstanding properties are:

- Complete camera control and evaluation integrated in the device
- Simple camera access from the network
- Simple and user-friendly settings, control of camera without additional software
- Easiest, user-supporting operation
- Direct connection to industrial networks (fieldbuses)
- Support of Industry 4.0 through IO-Link
- Separate data channel for larger data volumes
- Integrated, flexible displays of process statistics

These characteristics make it possible to easily create test and identification tasks in automation, to flexibly check the status of the test process, to monitor long-term processes in a clearly arranged way.

Hence, the **SMART***CAMERA* perfectly supports logistics processes and quality assurance in different industries.

These operating instructions apply to the following variants of the **SMART***CAMERA*:

Ordering code	Product name	Description
BVS0029	BVS SC-M1280Z00-30-010	**SMART***CAMERA* Ident monochrome PROFINET / EtherNet/IP + IO-Link
BVS002A	BVS SC-M1280Z00-30-000	**SMART***CAMERA* monochrome PROFINET / EtherNet/IP + IO-Link
BVS002F	BVS SC-C1280Z00-30-000	**SMART***CAMERA* color PROFINET / EtherNet/IP + IO-Link
BVS0033	BVS SC_M1280Z00-30-020	**SMART***CAMERA* HDevelop monochrom PROFINET / EtherNet/IP + IO-Link

Balluff GmbH completes the customer offering with a distinct service and accessories palette.

1.2 Typographical conventions

The following conventions are used in this manual:

Bulleted Lists

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

- Entry 1
- Entry 2

Actions

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

► Action instruction 1
⇒ Action result
► Action instruction 2

1 User instructions

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}).

Parameters:

Parameters are shown in italics (e.g. CRC_*16*).

Directory paths:

Path information for saving data is shown with capital letters (e.g. PROJECT:\DATA TYPES\USER-DEFINED).

ASCII code:

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

Symbols

Note, tip
This symbol indicates general notes.

NOTICE
The signal word NOTICE warns against possible property damage.
► Always observe the described measures for preventing this danger.

CAUTION
The pictogram used with the signal word CAUTION warns of a possible hazardous situation affecting the health of persons. Failure to observe these warning notes may result in injury.
► Always observe the described measures for preventing this danger.

1 User instructions

1.3 Abbreviations

BVS	Balluff Vision Solution
CMOS	Complementary metal-oxide-semiconductor
DCP	Discovery and basic Configuration Protocol
DHCP	Dynamic Host Configuration Protocol
DID	Device ID
I/O port	Digital input and output port
EEPROM	Electrical Erasable and Programmable ROM
EMC	Electromagnetic compatibility
EtherNet/IP	Ethernet Industrial Protocol
FCC	Federal Communications Commission
FE	Function ground
GND	Ground
GSD	General Station Description
GSDML	GSD Markup Language
I/O port	Digital input / output port
ID	Identification
IO	Input / Output
IP	Internet Protocol
IRT	Isochronous Real-time
LAN	Local Area Network
LPS	Limited Power Source
MAC	Media Access Control
n.c.	not connected
PC	Personal Computer
PROFINET	Process Field Network
RT	Real-time
RX	Receiver
SC	**SMART***CAMERA*
SIO	Standard Input/Output
PLC	Programmable Logic Controller
TX	Transmitter
UINT8	unsigned integer, 1 byte long
UINT16	unsigned integer, 2 bytes long
UINT32	unsigned integer, 4 bytes long

1 User instructions

1.4 Copyright

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All information and notes in these operating instructions, particularly the section “Safety”must be observed.

1.5 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 **SMART***CAMERA* uses an embedded Linux/GNU as the operating system. Also used are 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.

1.6 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.

1.7 Trademarks

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2 Safety

2.1 Intended use

The **SMART***CAMERA* BVS SC is a camera with integrated image analysis for contactless acquisition and examination 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”.

2.2 General safety notes

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.

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.

► When connecting the **SMART***CAMERA* to an external controller, observe proper selection and polarity of the connection as well as the power supply (see “Connections and pin assignment” on page 14).

The **SMART***CAMERA* may only be used with an approved power supply (see “Product specification” on page 12).

Conformity

CE	This product was developed and manufactured in accordance with all applicable European Directives. CE conformity has been verified.
c UL us LISTED	This product is approved by UL PROCESS CONTROL EQUIPMENT File No. E227256.

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

– Components are used that are not part of the **SMART***CAMERA* BVS SC.

– Components are used that have not been explicitly approved by Balluff. For a list of the approved components, see chapter “Accessories” on page 86.

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.

Maintenance, inspection, repair

The working principle used in this **SMART***CAMERA* is maintenance- and wear-free. The operator must regularly inspect the SmartCamera for signs of damage or malfunctions in line with the operating conditions and environmental influences. If any damage or wear is found, the **SMART***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 **SMART***CAMERA*'s housing may not be opened or loosened!

► 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.

2.3 Disposal

► Observe the national regulations for disposal.

3 Product description

The Balluff **SMART***CAMERA* BVS SC is a camera for the acquisition and analysis of black-and-white and color images. Application areas are optical identifications of codes and plain text, inspections for quality assurance and the measurement of objects. The camera can also be used in robot environments.

With the fieldbus system interface or via the Gigabit LAN interface, the host system can affect the camera and read out customer-specific result data.

An IO-Link master interface is available as additional interface which enables a direct integration of IO-Link components. This allows the **SMART***CAMERA* to make a valuable contribution for implementing requirements in the environment of Industry 4.0.

Since the complete software is located on the **SMART***CAMERA* itself, no external software is required for the configuration and monitor display. Using standardized web browsers such as Google Chrome, Mozilla Firefox or Internet Explorer, the user can easily connect with the **SMART***CAMERA* and work in the Balluff BVS Cockpit interface developed specifically for camera systems.

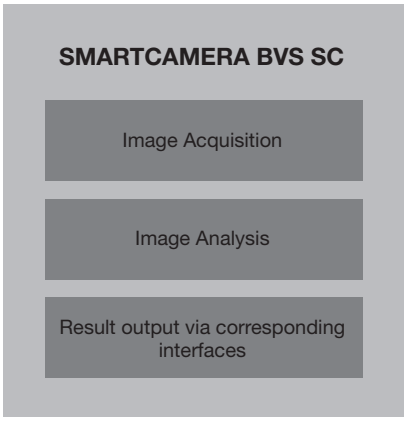


Figure 1: Function blocks of the **SMART***CAMERA*

Figure 2: **SMART***CAMERA* with lens

3.1 Product variants

The **SMART***CAMERA* has been designed in accordance with current, industrial standards:

- Image acquisition: C-mount lenses with corresponding matching filters; 1280 x 1024 pixel monochrome or color sensor
- LAN connection via Gigabit Ethernet M12
- Configuration/monitoring via Google Chrome, Mozilla Firefox or Microsoft Internet Explorer
- Digital input/output channels for NPN and PNP connections
- Fieldbus interface PROFINET IO or EtherNet/IP via M12 plug connectors

The **SMART***CAMERA* product family is available in different designs.

3 Product description

Designation	Sensor	Image processing	LAN	Fieldbus	IO-Link	Digital I/Os
BVS0029 BVS SC-M1280Z00-30-010	Mono-chrome	Identification tools	yes	PROFINET / EtherNet/IP (configurable)	yes	2/8[1)]
BVS002A BVS SC-M1280Z00-30-000	Mono-chrome	All tools	yes	PROFINET / EtherNet/IP (configurable)	yes	2/8[1)]
BVS002F BVS SC-C1280Z00-30-000	Color	All tools	yes	PROFINET / EtherNet/IP (configurable)	yes	2/8[1)]
BVS0033 BVS SC-M1280Z00-30-020	Mono-chrome	All tools plus HDevelop-interface	yes	PROFINET / EtherNet/IP (configurable)	yes	2/8[1)]

[1)] depending on the configuration of the IO-Link port

3.2 Scope of delivery

Included in he scope of delivery:
- **SMART***CAMERA* BVS SC
- 2× cap M12
- Safety Precautions
- Quick Start Guide

A lens protection is available for specific environmental conditions which is screwed directly onto the camera housing, thereby meeting the requirements in accordance with IP67.

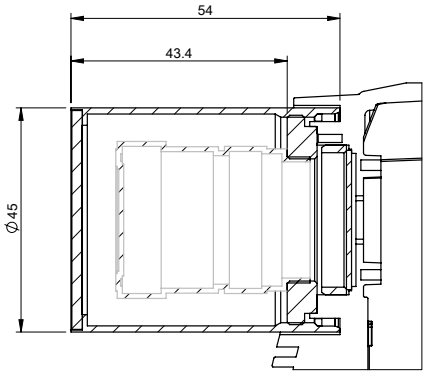


Figure 3: BAM PC-VS-023-1 (BAM02NA)

Please note that only C-mount lenses with a maximum diameter of 42 mm and a length of 40 mm can be used here. For longer lenses up to 69 mm the long tube BAM PC-VS-023-1-01 (BAM02W0) may be used.

The following accessory groups complete the Balluff product range:
- C-mount lenses (BAM LS-VS-004-C2/3-xx14-2)
- Screw-on filter (BAM OF-VS-002-xx-yy)
- Lights (BAE LX)
- Touchpanel PC (BAE-PD-VS-011-01)
- Mounting accessories
- Connection cable
- Power supply units

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

3 Product description

3.3 Assembly

The camera features 12 internal threads for installation at the location of use. Four threads each at the rear, the left and the right. This ensures 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” on page 86).

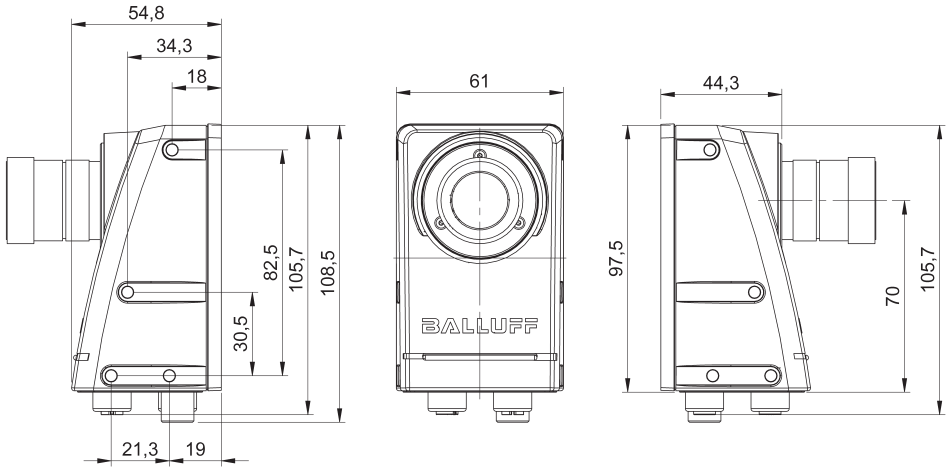


Figure 4: Mechanical connection (dimensions in mm)

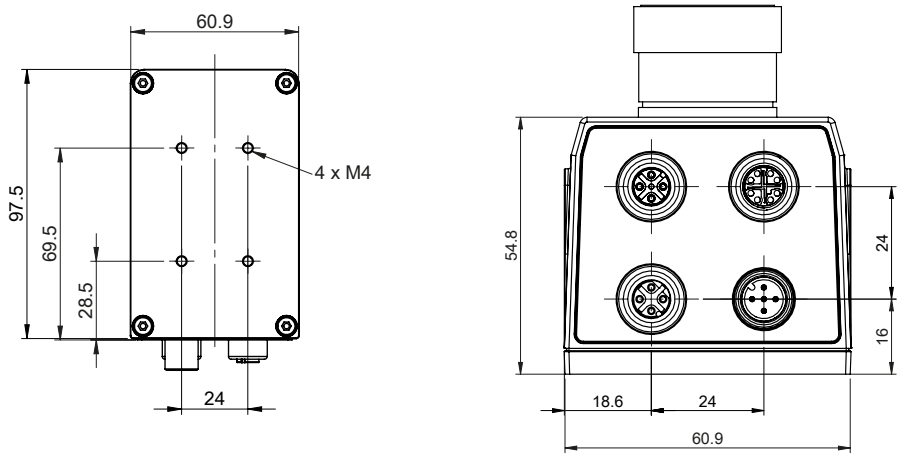


Figure 5: Mechanical connection at rear/bottom (dimensions in mm)

The screw connections at the rear plate have M4 threads. The maximum engagement length is 5 mm. The maximum tightening torque is 2 Nm.

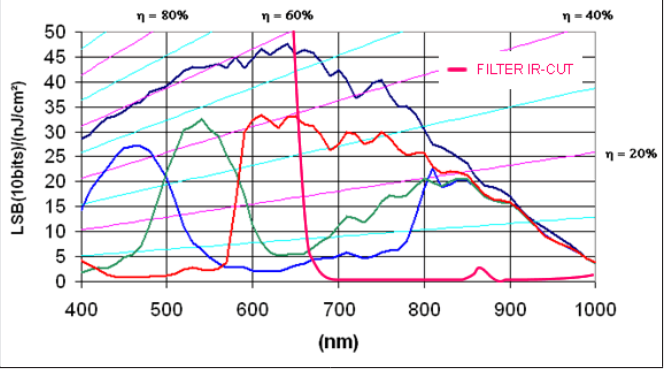
The lateral screw connections have an M5 thread. The maximum engagement length is 5 mm. The maximum tightening torque is 2.6 Nm.

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

3 Product description

3.4 Product specification

Image sensor

Model variant	Monochrome (CMOS)	Color (CMOS)
Resolution	1280 × 1024	
Max. frame rate [Hz]	60	
Shutter type	Global shutter [1]	
Sensor size	1/1.8"	
Pixel size [µm]	5.3 × 5.3	
Spectral sensitivity		

1) 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).

Mechanical data

Housing material	Painted aluminum die-cast box
Degree of protection	IP67 (with connectors and protection tube) [2]
Weight (without lens and accessories)	Approx. 360 g
Dimension (L × W × H, without connector, without lens)	110 × 62 × 55 mm

2) The enclosure rating has not been UL certified.

Electrical data

Supply voltage	⎓ 24 V ± 20%
Residual ripple	≤ 5%
Rated current consumption without external load	300 mA
Max. current consumption	4 A

► The **SMART***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.

3 Product description

Operating conditions

Ambient temperature	0 °C … +55 °C
Storage temperature	–25 °C…+70 °C
EMC	EN 61000-4-2/3/4/5/6 EN 61000-6-2 EN 61000-6-3 EN 55011
Vibration/shock for operation inside	EN 60068 Part 2-6/27
Operation	Internally
Height	up to 2000 m
Relative humidity	maximum 80 % for temperatures up to 31 °C, decreasing linearly to 50 % at 40 °C
Pollution degree	Pollution degree 2

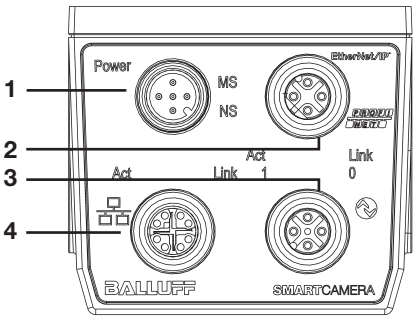
Vibration/shock was verified for the **SMART***CAMERA* – the C-mount lens used and its adjustment rings must be secured accordingly for operation.

3 Product description

3.5 Connections and pin assignment

The product variants differ by the existing interfaces.

Fieldbus versions



1 Power
2 PROFINET / EtherNet/IP
3 IO-Link
4 LAN

Figure 6: Connections and pin assignment of fieldbus variant

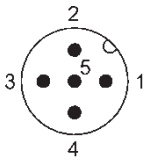
Connection	Function
Power	Voltage supply of **SMART***CAMERA*, two freely configurable I/O signals are also available.
IO-Link	Connects the **SMART***CAMERA* with an IO-Link device or, e.g. an external lighting.
LAN	Integrates the **SMART***CAMERA* in a local network.
PROFINET / EtherNet/IP	Connects the **SMART***CAMERA* with the fieldbus network (PROFINET / EtherNet/IP)

Note
In order to ensure enclosure rating IP67, unused I/O ports must be closed with cover caps.

► The **SMART***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.

Power

5-pin M12 plug, A-coded



Pin	Description	Function
1	+24 V_{DC}	Supply voltage
2	I/O 0	Input/output
3	GND	Ground
4	I/O 1	Input/output
5	Not used	None. Pin may not be used.

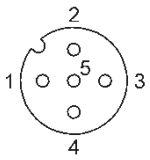
Notes
The digital sensor inputs correspond to the guideline concerning inputs, EN 61131-2,Type 3.

The maximum load on any output is 100 mA. The total current of the module must not exceed 4 A per pin. The load or supply must be limited accordingly.

3 Product description

IO-Link

5-pin M12 female, A-coded



Pin	Description	Function
1	L+	Supply voltage
2	I/Q, I/O 6	Input/output
3	L–	Ground
4	C/Q, I/O 7	IO-Link / input / output
5	Not used	None. Pin may not be used.

Notes

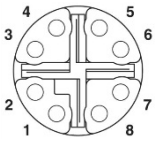
The maximum load on the supply voltage output is 1.2 A.

Every output may be loaded with a maximum current of 2 A.

Unused ports must be provided with cover caps in order to ensure enclosure rating IP67.

LAN (Gigabit Ethernet)

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 +

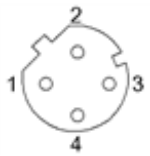
Notes

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.

Fieldbus

Female M12, 4-pin, D-coded



Pin	Description	Function
1	+Tx	Transmit Data +
2	+Rx	Receive Data +
3	–Tx	Transmit Data –
4	–Rx	Receive Data –

Note

The cable must correspond at least to category 5 in accordance with EIA/TIA-568.

3.5.1 Power

The power plug connector supplies the **SMART***CAMERA* with the supply voltage and offers two I/O-24 V switching signals (I/O 0 & I/O 1) for the connection with sensors, actuators or PLC.

These two inputs and outputs feature a push-pull output stage. This allows using the output signal for PNP logic as well as NPN logic. The input stage always features PNP logic.

3 Product description

I/O 0 & I/O 1 (power plug connectors)			
Operation as input			
Voltage	Signal 0	0…5 V	< 2 mA
	Signal 1	11…30 V	2…5 mA
Delay		< 160 µs	

Operation as output			
Voltage	Signal 0	0 V (+V_D)	100 mA max.
	Signal 1	24 V (V_{DC} – V_D)	100 mA max.
Voltage drop V_D		< 2 V	
Delay		< 10 µs	

See also the guideline on digital inputs, EN 61131-2, Type 3.

Below are examples how inputs and outputs must be connected to obtain input and output function.

Input connection

If I/O 0 is configured as input, it is sinking and can be connected directly with the PNP output of a sensor, a PLC. A 1 signal is being detected if the input is connected with the supply voltage. A 0 signal is being detected if the input is set to ground or is not connected.

If an NPN device is to be connected to the input, then an external level converter must be connected upstream.

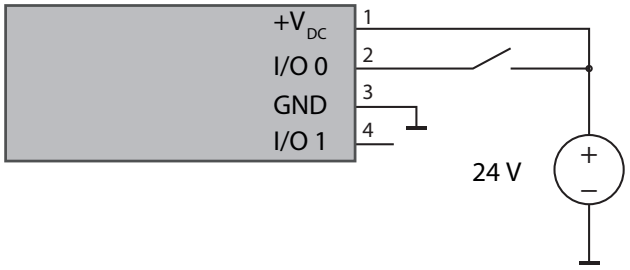


Figure 7: Input connection

3 Product description

Output connection

If I/O 0 is configured as output, the supply voltage is applied at the output and the actuator, PLC input is supplied with it if 1 is being output. The output is connected with GND if 0 is being output. The output current of an I/O may not exceed 100 mA.

If the output is being overloaded, e.g. by a short circuit, it is switched off and periodically checked whether the fault occurrence is still present. If the error was removed, the output is again in normal operating state without a reset.

PNP output connection

PNP logic is predominantly used in Europe. The output is sourcing, so that the load between I/O and GND must be switched accordingly. The load is connected with supply voltage if 1 is being output.

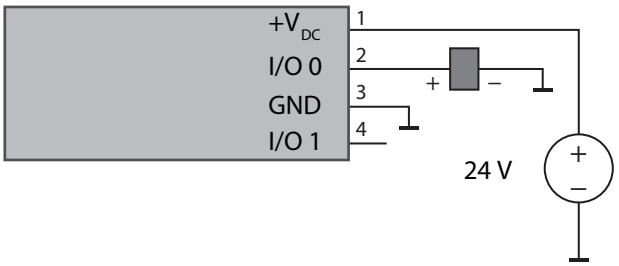


Figure 8: PNP output connection

NPN output connection

NPN logic is predominantly used in Asia. The output is sinking, so that the load between I/O and supply voltage must be switched accordingly. The load is set to GND if 0 is being output.

To obtain a normal switching behavior, the output can be inverted.

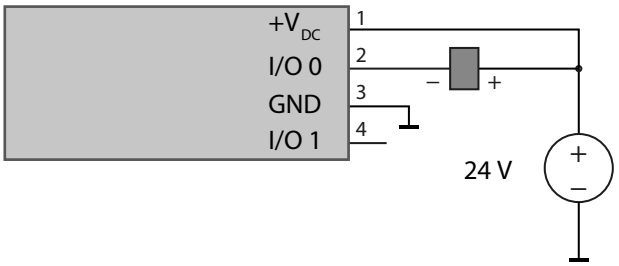


Figure 9: NPN output connection

3.5.2 LAN

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. In addition, a communication channel is available to control the image analysis and to call up the generated result values.

3.5.3 Fieldbus

The fieldbus version of the **SMART***CAMERA* is selectable between the fieldbus systems PROFINET and EtherNet/IP. Both are open bus systems for process and field communication in cell networks with few slaves.

PROFINET enables data communication as per IEC 61158/EN 50173. The **SMART***CAMERA* uses PROFINET IO.

EtherNet/IP™ uses the *Common Industrial Protocol*(CIP) open communication protocol on the application level (in accordance with ISO/OSI reference model). Ethernet/IP is supported by the *Open DeviceNet Vendor Association* (ODVA) network organization.

3 Product description

3.5.4 IO-Link

IO-Link is defined as a standardized point-to-point connection between sensors/actuators and an I/O module. An IO-Link sensor/actuator can send additional communication data (e.g. diagnostics signals) in addition to the binary process signals over the IO-Link interface.

The IO-Link interface is suitable for connecting external lighting (e.g. a ring light).

Compatibility with standard I/O:

- IO-Link sensors/actuators can be connected to existing I/O modules.
- Sensors/actuators that are not IO-Link-capable can be connected to an IO-Link module.
- Standard sensor/actuator cables can be used

Key technical data:

- Serial point-to-point connection
- Communication as an add-on to the standard I/O
- Standard I/O connection technique, unshielded, max. 20 m cable length
- Communication using 24 V pulse modulation, standard UART protocol

Standard IO mode

- IO-Link-capable devices are parameterized via the IO-Link interface and then switched to SIO mode.
- From this point on, the IO-Link port pin acts as simple switching input that furnishes a binary signal.

Note

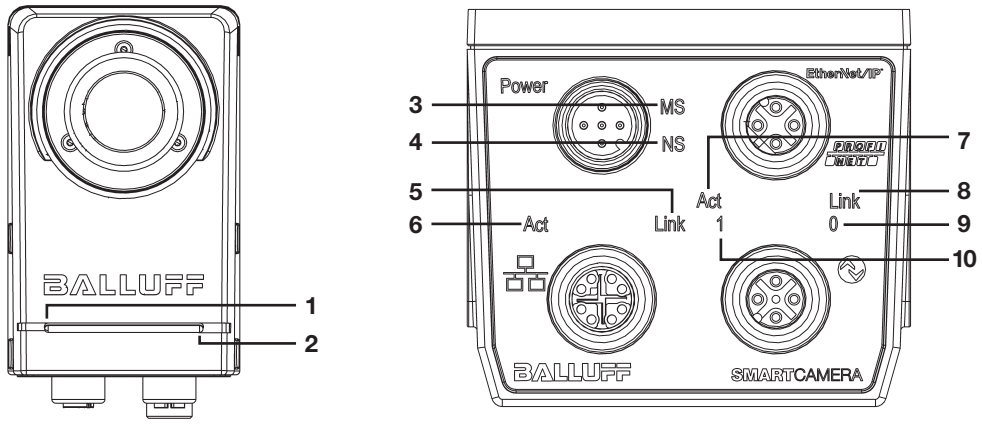
Visit www.balluff.com for more information on available IO-Link devices and accessories.

3 Product description

3.6 Display elements

The operating states of the vision system, the IO-Link master as well as the LAN and fieldbus interface are displayed using LEDs. The display elements are distributed across the front and the underside of the **SMART***CAMERA*.

Displays on the front



1 Power LED
2 Signal LED
3 Fieldbus 1
4 Fieldbus 2
5 LAN Link
6 LAN Act
7 Fieldbus Act
8 Fieldbus Link
9 0: IO-Link C/Q
10 1: IO-Link Pin 2

Figure 10: Display elements on the front and at the plug connectors

Displays on the front

LED	Indicator	Function
Power LED	Off	No supply voltage
	Green on	Inspection is running or waiting for a trigger
	Green, flashing	Inspection stopped or in configuration mode
	Red on	Fault
	Red, flashing	Firmware update active
Signal LED	Off	Signal = 0
	Yellow on	Signal = 1

The signal LED indicates the status of the I/O cable null.

Displays at the plug connectors

Fieldbus

LED	Indicator	Function
Fieldbus Link	Off	No fieldbus connection
	Green on	Fieldbus connection established
Fieldbus Act	Off	No data transfer
	Yellow, flashing	Data transmission

3 Product description

PROFINET

LED	Indicator	Function
Fieldbus 1 MS: Bus Failure	Off	No fault or no voltage
	Red, flashing	No data exchange or no configuration
	Red on	PROFINET IO not configured or not connected
Fieldbus 2 NS: System Failure	Off	No fault or no voltage
	Red on	PROFINET IO not ready
Fieldbus 1 and Fieldbus 2	Both LEDs flashing red	DCP signal service enabled

EtherNet/IP

LED	Indicator	Function
Fieldbus 1 NS: Network Status	Off	No voltage or no IP address
	Green	Connection made
	Green, flashing	No connection made
	Red	Duplicate IP Address
	Red, flashing	Connection timeout
	Red – Green flashing	Self-test after switch-on
Fieldbus 2 MS: Module Status	Off	No voltage
	Green	Device is ready for operation
	Green, flashing	Device not configured
	Red	Severe, fatal error
	Red, flashing	Simple, rectifiable error
	Red – Green flashing	Self-test after switch-on

IO-Link

LED	Indicator	Function
IO-Link C/Q	Off	Status of input or output pin is 0
	Green on	IO-Link communication active
	Flashing green (1 Hz)	No IO-Link communication or wrong IO-Link device
	Flashing green rapidly	IO-Link preoperate during data retention
	Yellow on	Status of input or output pin is 1
	Flashing red rapidly	Validation failed / incorrect configuration of the IO-Link data length / self-test after switch-on
	Red on	IO-Link short circuit / sensor supply short circuit / firmware update
IO-Link pin 2	Off	Status of input or output pin is 0
	Yellow on	Status of input or output pin is 1
	Red on	Short circuit at output

3 Product description

LAN

LED	Indicator	Function
LAN Link	Off	No LAN connection
	Green on	LAN connection established
LAN Act	Off	No data transfer
	Yellow, flashing	Data transmission

3.7 Cleaning

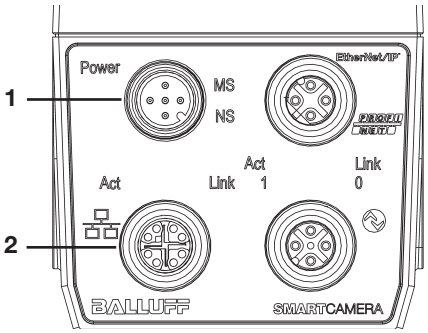
The outside of the camera can be cleaned with a soft cloth. Persistent dirt can be removed with a cloth that is first moistened with a soap solution and wrung out. After wiping off the dirt spots, wipe the camera with a dry cloth.

4 First steps

Three simple steps are required to initially start up and configure the **SMART***CAMERA*. Besides the **SMART***CAMERA*, the following is required:

- Power cable
- 24 V power supply
- LAN cable
- PC with web browser

4.1 Step 1: Establishing a network connection with the SMART*CAMERA*



1 Power
2 LAN

Figure 11: Network connection with the **SMART***CAMERA*

► Connect the **SMART***CAMERA* via the **LAN** port with the network.

Depending on the network topology between computer and **SMART***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	Consequences
SMART*CAMERA* and PC are connected directly via a LAN cable.	IP addresses are set automatically.
SMART*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.
SMART*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 **SMART***CAMERA* must be matched and manually set. Pertinent useful notes are located in the section “Network settings / LAN interface” on page 27.
SMART*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. Since the different subnets, on the other hand, are connected via switches, the communication with the **SMART***CAMERA* is still possible. Pertinent useful notes are located in the section “Network settings / LAN interface” on page 27.

4.2 Step 2: Turn on SMART*CAMERA*

► Now connect the power supply at the **Power** port with the power supply (24 V).

The **SMART***CAMERA* starts up and is operational after approx. 30 seconds.

At the start, the **SMART***CAMERA* opens the most recently opened inspection program and is in the same process state it occupied at switch-off.

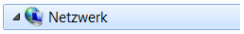
4 First steps

4.3 Step 3: Opening the BVS Cockpit web interface

The camera is being configured via the BVS Cockpit. This web interface is being opened and operated via web browsers.

The following commercially available browser are being supported:

– Google Chrome version 24.0 and higher
– Mozilla Firefox version 15.0 and higher
– Microsoft Internet Explorer version 10 and higher

1. Record the serial number of the **SMART***CAMERA*.
   The serial number is located on the nameplate on the **SMART***CAMERA*.
   If the nameplate is not visible, you can also locate the **SMART***CAMERA* in the network via Windows Explorer (e.g. sc-150800015de).
2. To do so, select the network folder 

to display all the network devices.
   It also lists the connected **SMART***CAMERA* cameras.
3. To open the configuration screen of the **SMART***CAMERA*, perform the following steps:
   a. Open the web browser.
   b. Enter the following URL: http://sc-150800015de (150800015de" must be replaced with the serial number of the **SMART***CAMERA*).
   c. Confirm the entry.

Notes

More information about the configuration interface of the BVS Cockpit can be found in the software manual (BVS Cockpit manual) on the Balluff homepage and on the **SMART***CAMERA*.

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

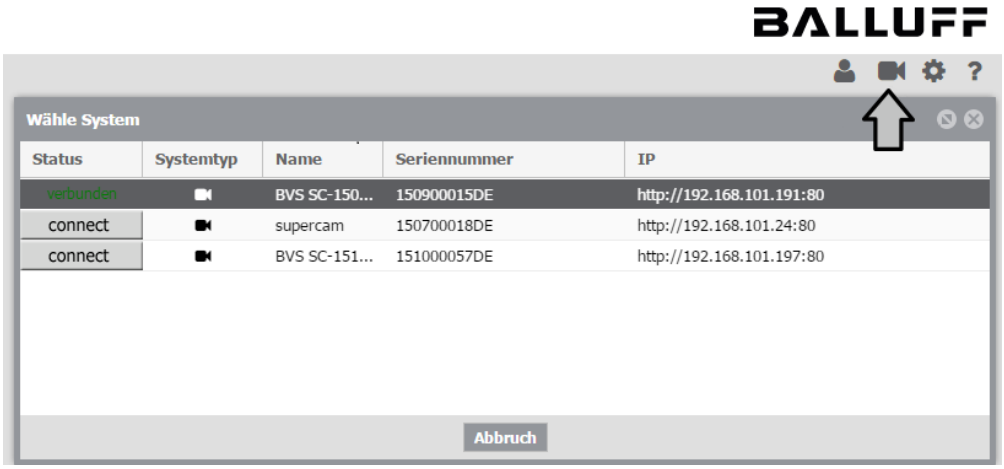


Figure 12: Display of all **SMART***CAMERAs* in the network

5 Startup

5.1 Updating software

The Balluff homepage regularly offers new software updates. These may include error fixes, speed optimizations or added functions.

Notes

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

Notes

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

To update the camera perform the following steps:

1. Download the newest update file from the Balluff homepage (www.balluff.com) and save it on your computer.
2. Unzip the downloaded file. It contains:
   a. A PDF document that describes the new functions, fixed errors and the update procedure.
   b. The file BVS_Cockpit_X.X.X.sh. This contains the new software and must be loaded into the **SMART*CAMERA***. X.X.X indicates the software version.
3. Press the Windows + R keys and enter the address of the update directory of the **SMART*CAMERA*** (e.g. \\sc-151000057de\updates[1)]). Windows Explorer opens up in the update directory of the **SMART*CAMERA***.
4. Copy the update file (BVS_Cockpit_X.X.X.sh) to the updates folder. The **SMART*CAMERA*** will now automatically start the update process. This may take up to 5 minutes. The Power LED on the front side will flash red during the update. The **SMART*CAMERA*** is inaccessible in the network during the update.

► Never disconnect the camera from power during an update. This can result in irreparable damage to the **SMART*CAMERA***.

5. After a few minutes the update will be finished and the Power LED will change to green. The **SMART*CAMERA*** is now ready for use.

1) The name comes from the Web address printed on the part label. In this example the address on the **SMART*CAMERA*** is http://sc-151000057de/. The name in the network is then: \\ sc-151000057de\updates.

5 Startup

5.2 Network topologies

For the startup of the **SMART***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 **SMART***CAMERA* requires that the supply voltage is provided via the power connection in any case.

In the fieldbus 1 topology, both network connections of the **SMART***CAMERA* are being used. The LAN connection is used for the configuration and, if necessary the monitoring during operation. The communication for the controller runs via PROFINET or EtherNet/IP.

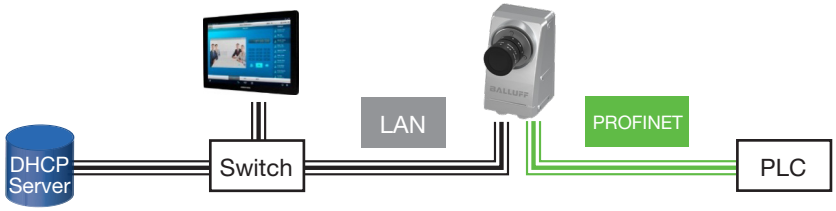


Figure 13: Fieldbus 1 topology

To reduce the wiring effort, the system can also be operated as in fieldbus 2 topology. Only the PROFINET port is used in this case. The real-time communication for the control as well as the configuration via the web interface are possible at the same time via this port. Because of the prioritization of the PROFINET communication and the lower transfer rate, this may lead to performance constraints of the web interface.

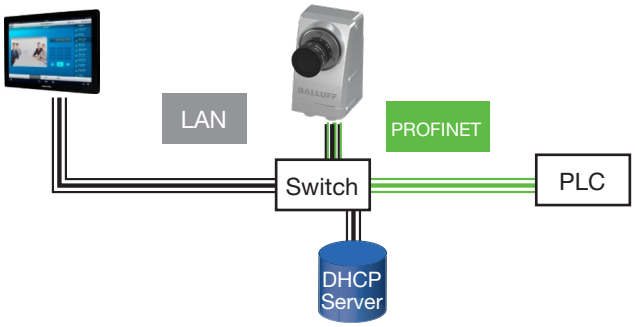


Figure 14: Fieldbus 2 topology

In the representation of the fieldbus 3 topology, all connections of the **SMART***CAMERA* are shown. The IO-Link port allows expanding the **SMART***CAMERA* by additional I/O signals. The example shows a Balluff **SMART***LIGHT* for indicating the system status.

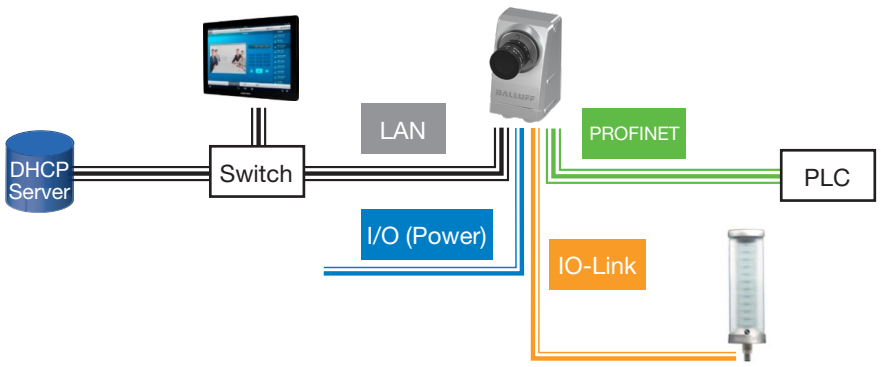


Figure 15: Fieldbus 3 topology

5 Startup

IO-Link can also be combined with the fieldbus 2 topology.

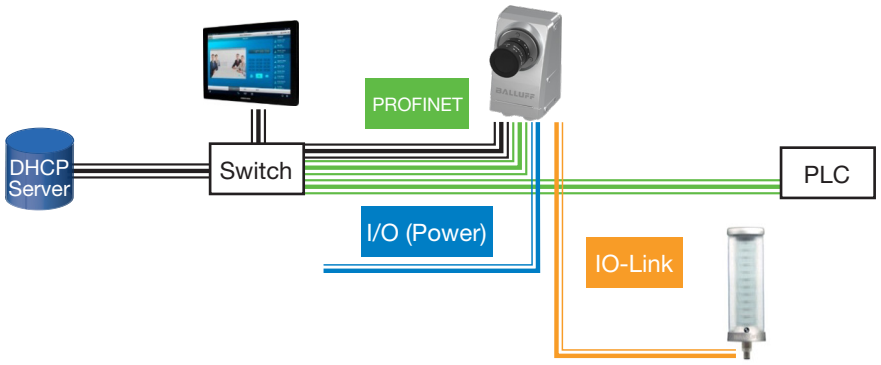


Figure 16: Fieldbus 2 topology in combination with IO-Link

The following sections describe the configuration of the individual interfaces in detail.

5.3 System settings

Below is a description of system settings. They can be reached via the System Settings selection in the system menu.

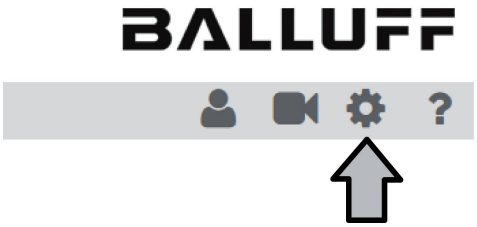


Figure 17: System menu

The system menu is located in the upper section of the user interface. It consists of the following menu items:

Menu item	Meaning
	User login
	Camera selection
	System setting
	Help system

5.4 Selecting the communication interface for the process data

The exchange of the process data (results of image analysis, control of image acquisition, …) can be performed either via fieldbus or LAN interface. The operating principle and communication protocol of the fieldbuses are described under “Communication functions of the device with fieldbus” on page 55.

The data are transferred as TCP or UDP packets via the LAN interface. The pertinent protocol is described under “LAN interface” on page 78.

5 Startup

The communication interface is set in the System settings under Mode on the Communication tab. Available options for the selection are Fieldbus, TCP and UDP. If TCP or UDP is selected, the camera uses port 36701. The controlling system can use any available port.

Interfaces that are not selected are deactivated!

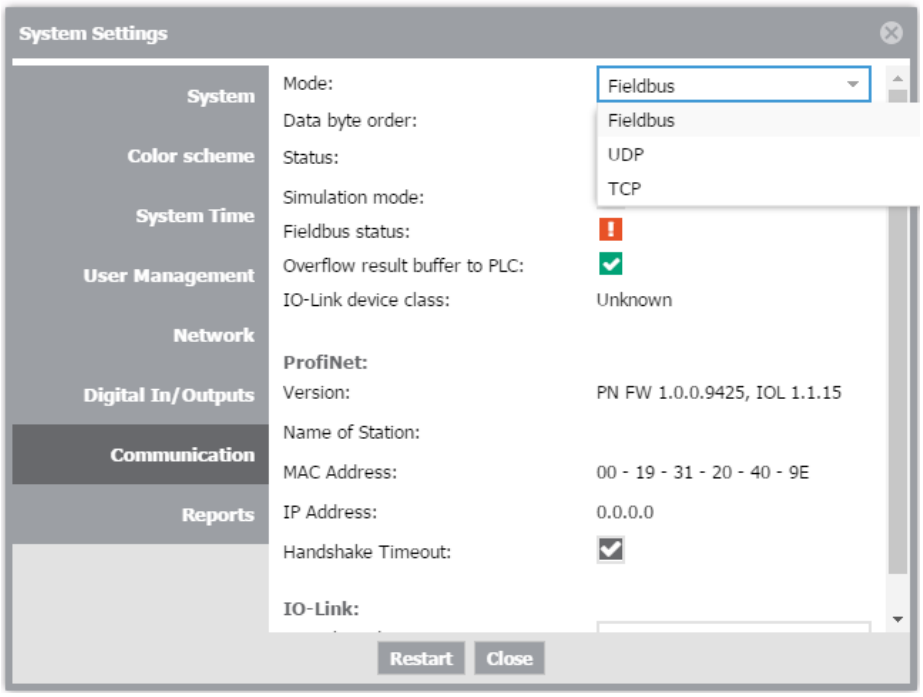


Figure 18: Communication tab in the System settings

5.4.1 Network settings / LAN interface

All variants of the **SMART***CAMERA* feature a 1 Gbit/s LAN interface for configuring and monitoring the image analysis. Chapter “First steps” on page 22 describes how this interface is used to establish the connection between computer and **SMART***CAMERA*. For some network topologies, this simple description is not sufficient. The required steps are described below.

5.4.2 Locating the camera in the network

SMART*CAMERA* **and PC are in different subnets of the network.**

Subnets are explicitly created to be able to subdivide computers in different networks and to structure it in this way. Since the different subnets, on the other hand, are connected via switches, the communication with the **SMART***CAMERA* is still possible. In most networks, it is only necessary to enter the URL http://sc-150800015de with the matching serial number in the address field of the browser. The connection is established automatically. The **SMART***CAMERA* obtains the IP address from the DHCP server and the name service of the network ensures that the URL with the serial number is replaced with the correct IP address.

Without a name service, the URL cannot be resolved! In this case, the IP address must be entered directly. To do so, it is recommended to configure the DHCP server in such a way that the **SMART***CAMERA* is assigned the same address in every case. As an alternative, the IP address can also be assigned manually (see the next section).

Note
To prevent address conflicts, no IP may be used more than once in the network!

No DHCP server available in the network

In this case, the IP address of the LAN port must be set manually. To do so, you have to connect with the **SMART***CAMERA* using a PC that is configured for automatically assigned, private “”IP address (see “First steps” on page 22). The settings dialog for the IP address of the **SMART***CAMERA* is located on the BVS Cockpit web interface under the icon ⚙ (see “Fieldbus parameters in BVS Cockpit” on page 30). This option also allows establishing a connection to the **SMART***CAMERA* if the manually set IP address is not known.

Note
After changing the IP address, the **SMART***CAMERA* may no longer be reachable. In this case, briefly disconnect the network at the PC and reconnect it.

The fieldbus variant of the **SMART***CAMERA* features an additional second network port for the fieldbus communication. This port can also be used to configure the camera using the web interface.

This type of wiring is not recommended if the web interface is used permanently for monitoring the image analysis. The fieldbus interface features a transfer rate of only 100 Mbit/s and the real-time data have priority over the non-time-critical data of the web interface. This may lead to problems, such as delayed response of the web interface, particularly during the transfer of the live image.

5.4.3 Network configuration via BVS Cockpit

The network configuration is done in the System settings on the Network tab.

Setting and Displays	Description
Obtain an IP address automatically	It defines whether the IP address of the camera should be assigned dynamically or via DHCP or statically.
IP	If a static IP address is to be used, it can be entered here.
Gateway	If a static IP address is to be used, the gateway can be entered here. This entry is optional if the same subnet is used exclusively to access the camera.
Port	Which port the Web interface of the **SMART***CAMERA* can be accessed on. Default is Port 80.
Enable second network adapter	Here you can select whether the Web interface for the camera is also accessible via the Ethernet Port fieldbus.“”
Use Avahi/Bonjour	Determines whether the camera reports itself to other cameras via its name in the network (see “Figure 12” on page 23).

5 Startup

5.5 Digital I/O interface

The **SMART***CAMERA* provides eight internal I/O signals. Depending on the variant, they are connected with the signals at the plug connectors. The digital I/O 2 to 5 are not directly connected with physical outputs.

Digital inputs and outputs are configured in the System settings on the Digital inputs/outputs tab.

Setting	Description
Name	A user-defined name that describes this input/output.
Direction	It defines whether it is an input or an output. Inputs can be read out with the *Read inputs* tool. Outputs are set with the *Set outputs* tool.
Inv.	If activated, the input/output is inverted. In the inverted state, the input/output is assumed to be active if no voltage is present.
Pulse length	Defines the pulse length of an output in milliseconds. The value default setting is 0. This means the output remains switched until the *Set outputs* tool is used to manually set a different value. For values greater than 0 the output is switches for this time length and then changed back to inactive mode. The system allows a maximum of two outputs to have a pulse length greater than zero assigned. In this case the remaining fields for entering pulse length are grayed out.

Note

If the pulse length exceeds the throughput time for an inspection this may result in undesired effects.

Note

After switching on and after switching to another inspection program the outputs are set as in the general settings:

- 0 V if Inv. is not active
- 24 V if Inv. is active

The logical signals I/O 0 and I/O 1 are permanently linked with the physical signals of the power connection. I/O 0 to I/O 7, on the other hand, can be output at the IO-Link connection depending on the configuration.

Three options are supported (see “Camera mode” on page 51).

In PLC gateway mode, the interface is controlled via the fieldbus.

In I/O mode, I/O 6 and I/O 7 are linked.

In camera mode, I/O 0 to I/O 7 can be input or output, depending on the device and configuration.

Signal	I/O 0	I/O 1	I/O 2	I/O 3	I/O 4	I/O 5	I/O 6	I/O 7
Power	Pin 2	Pin 4						
I/O-Link (camera mode)	Depends on the device configuration (see “IO-Link interface” on page 51).							
I/O-Link (I/O mode)							Pin 2	Pin 4
I/O-Link (PLC gateway mode)	N.C. (signals depending on the configuration via fieldbus)							

5 Startup

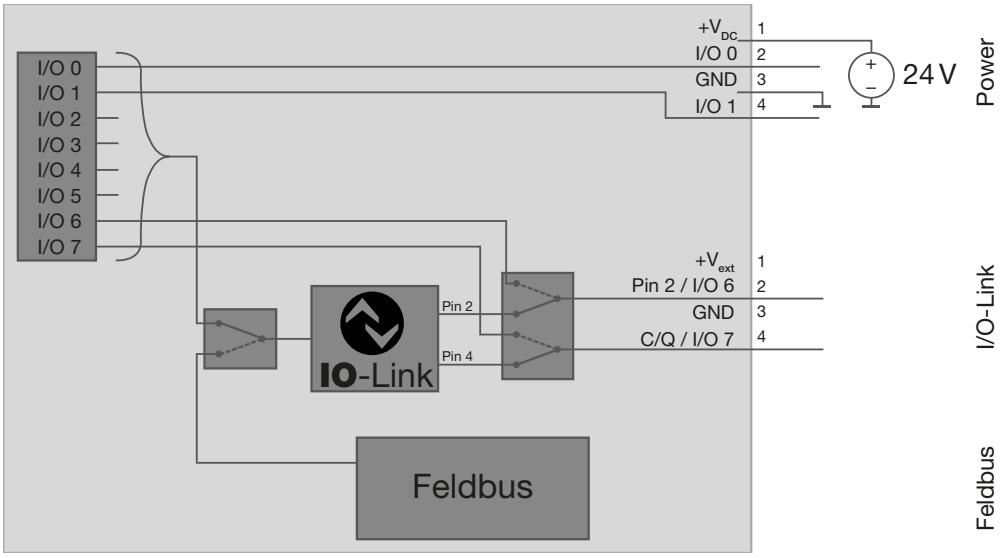


Figure 19: Control plan

The same applies here again – when operating the I/O as output, signals of the same name are switched, and when operating as input, I/O of the same name or logically combined with OR.

5.6 Fieldbus parameters in BVS Cockpit

The fieldbus parameters are set in the System settings on the Communication tab. Here the selection is also made between PROFINET or EtherNet/IP.

PROFINET is preselected by default. The fieldbus can be changed at any time between PROFINET and EtherNet/IP.

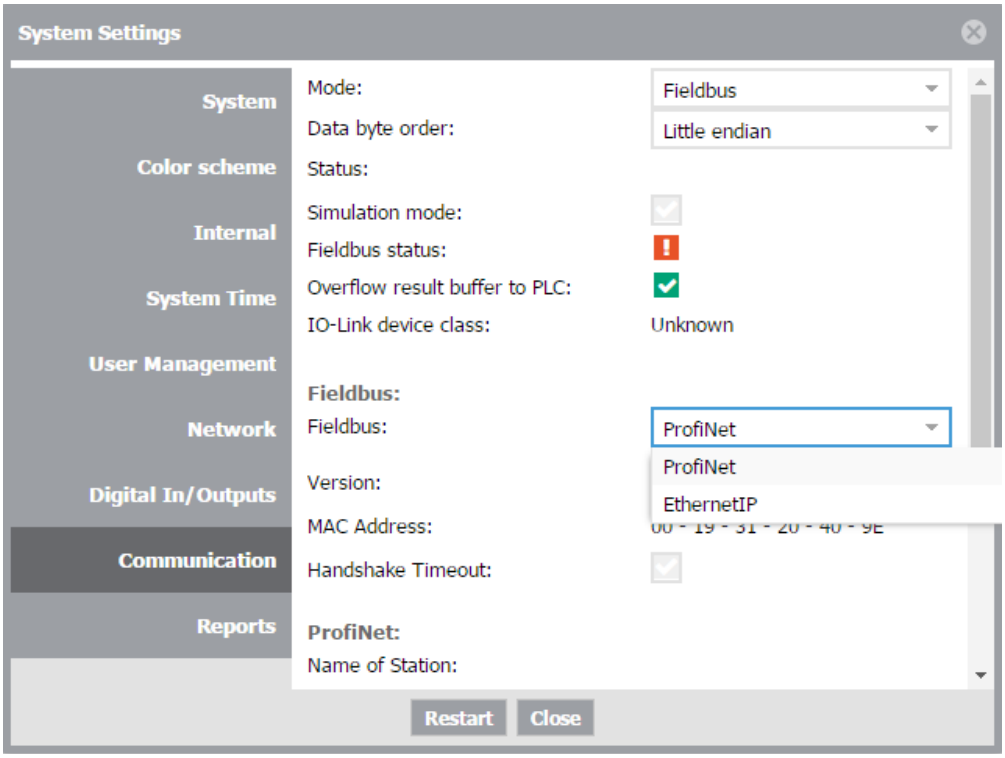


Figure 20: Switching between PROFINET and Ethernet/IP

5 Startup

Note

After switching the fieldbus and after setting a few fieldbus parameters, the fieldbus module of the **SMART***CAMERA* must be restarted. Only then does the change take effect. In this case the Restart fieldbus module button will appear for initiating the restart. Click on the button when you are finished making your settings. The fieldbus module then restarts. After a few seconds the dialog is reopened and the settings are applied.

The Communication tab contains various parameters to choose from depending on the fieldbus selected.

PROFINET settings

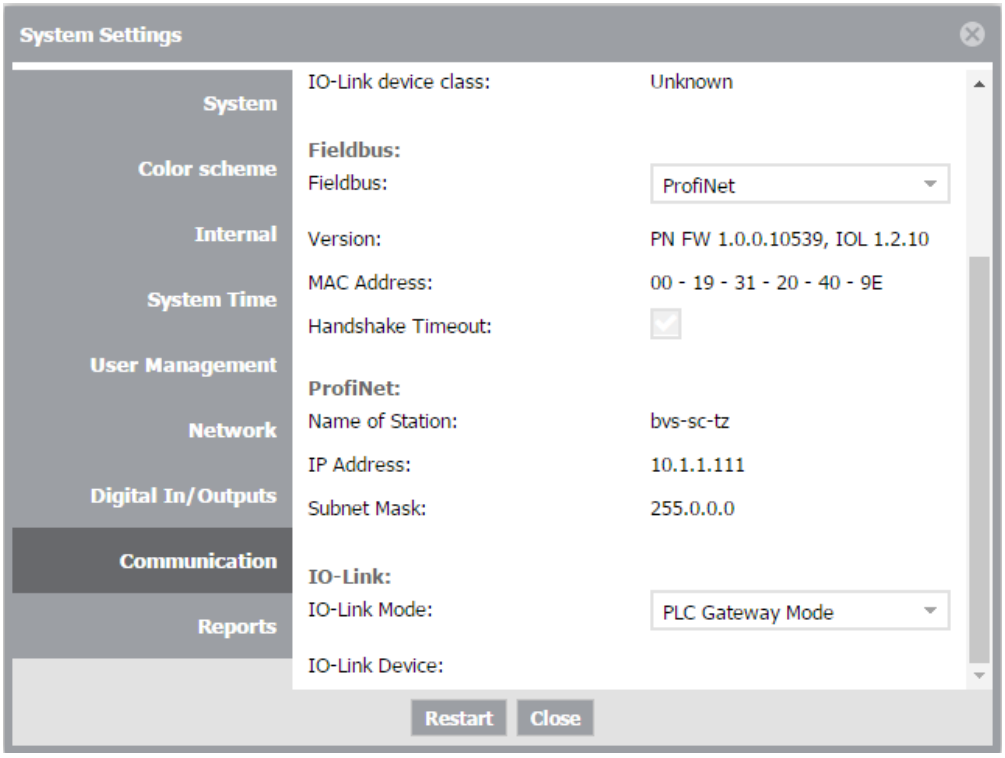


Figure 21: PROFINET parameters in the System Settings (Communication tag)

Setting and Displays	Description
Version	Version of fieldbus firmware (for service purposes only)
MAC address	Basic MAC address of the fieldbus
Handshake timeout	This setting activates a 500-ms timeout for the handshake of the process data
Station name	Name of the fieldbus device
IP address	Fieldbus IP address, assigned by the PLC
Subnet mask	Fieldbus subnet mask, assigned by the PLC
IO-Link mode	Defines how the IO-Link master port is used

5 Startup

EtherNet/IP settings

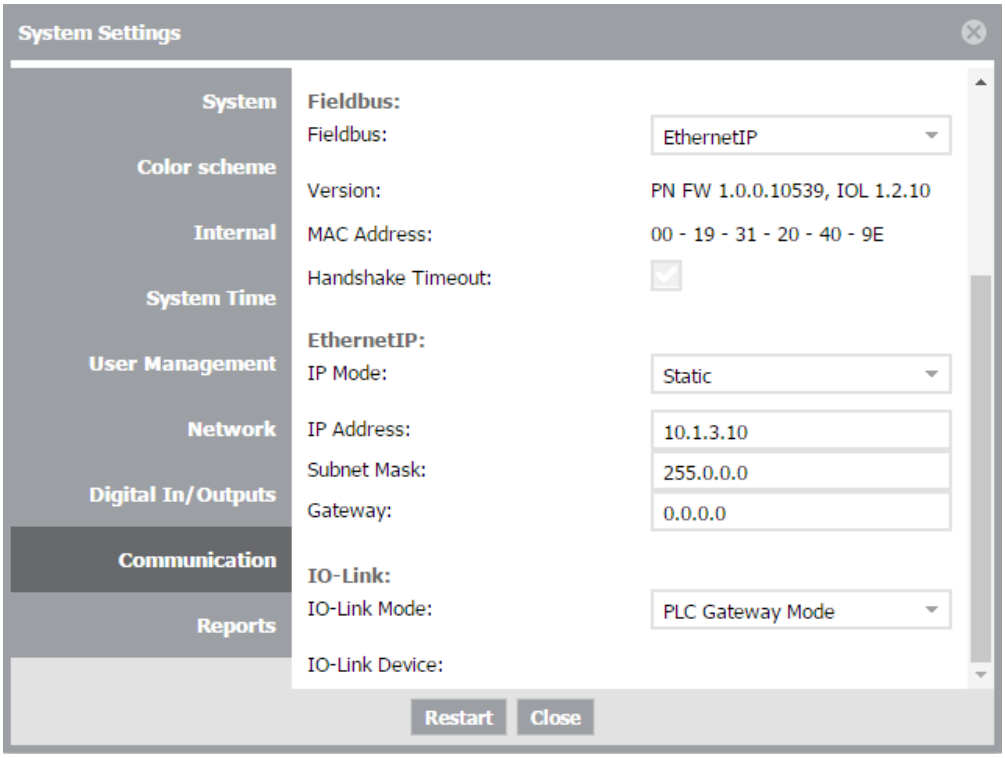


Figure 22: Ethernet/IP parameters in the System Settings (Communication tab)

Setting and Displays	Description
Version	Version of fieldbus firmware (for service purposes only)
MAC address	Basic MAC address of the fieldbus
Handshake timeout	This setting activates a 500-ms timeout for the handshake of the process data
IP mode	IP address, subnet mask and gateway can either be manually set (static) or automatically using DHCP protocol or BOOTP.
IP address	Fieldbus IP Address
Subnet mask	Fieldbus subnet mask
Gateway	Fieldbus default gateway
IO-Link mode	Defines how the IO-Link master port is used
IO-Link device	Name of the connected IO-Link device

5 Startup

5.7 PROFINET fieldbus interface

The communication between the **SMART***CAMERA* and the host system is done via PROFINET IO.

The system PROFINET IO consists of the following components:

– IO controller (e.g. PLC)
– IO device (here the **SMART***CAMERA*)

In a PROFINET network, IO controllers and IO devices are connected to each other using all common network topologies: star, line, ring or tree type topologies are possible.

Device master data

To parameterize the IO controller true to type, the device master data in form of a GSDML file are needed.

The file is located on the Balluff homepage (see www.balluff.com).

Input/output buffer

The data exchange with the host system takes place in the input and output buffer. The size of these buffers must be configured by the master (IO controller).

Note

The possible buffer sizes are stored in the GSDML file. A minimum of 16 and maximum of 1280 bytes can be set in different combinations of input/output buffers.

Device name and IP address

The **SMART***CAMERA* and the host system communicate via the PROFINET protocol. This means an IP address and a unique device name are required. The device name and the IP address can be edited using the respective configuration software used, e.g. *Simatic Manager* and the IO device.

Note

The **SMART***CAMERA* is delivered without a device name. The GSDML file has the prepared device name *BVS-SC*.

5.7.1 Configuration

In configuring PROFINET devices, a device is mapped as a modular system that consists of a *BVS-SC* head module and multiple data modules.

GSDML file

The device data required for configuring is stored in a GSDML file (General Station Description). The data module of the **SMART***CAMERA*, the IO-Link port and any additional modules are represented slot-based in the project planning software. The GSDML file makes the possible data modules (inputs/outputs for the **SMART***CAMERA* and the IO-Link port for various data widths) available. For the configuration of the **SMART***CAMERA*, the matching data modules are assigned to a specific slot.

Slot 0 must always be occupied by the "*BVS-SC*" head module.

Slot 1 may host a data module for the **SMART***CAMERA*. Depending on use, an IO-Link port, a standard I/O, an IO-Link data module or an SIO module can be plugged in at slot 2.

Slot	Module	Function
0	Header module of **SMART***CAMERA*	Parameter configuration, no process data
1	**SMART***CAMERA*	Process data
2	IO-Link port	IO-Link data modules of various data widths or configurable as a standard I/O port; IO-Link parameterization
3	IO-Link station diagnostics or IO-Link extended diagnostics	Slots for optional IO-Link additional modules
4	Input pin 4	
5	Output pin 4	
6	Restart pin 4	
7	Input pin 2	
8	Output pin 2	
9	Restart pin 2	

Coding IO-Link data modules (slot 2)

Data modules for standard I/O ports

Data module	Data width
Standard I/O	0 byte; (see “Additional modules (slot 3 to 9)” on page 35)

Data modules for IO-Link inputs

Data module	Data width
IOL_I_1byte	1 byte
IOL_I_2byte	2 bytes
IOL_I_4byte	4 bytes
IOL_I_6byte	6 bytes
IOL_I_8byte	8 bytes
IOL_I_10byte	10 bytes
IOL_I_16byte	16 bytes
IOL_I_24byte	24 bytes
IOL_I_32byte	32 bytes

Data modules for IO-Link outputs

Data module	Data width
IOL_O_1byte	1 byte
IOL_O_2byte	2 bytes
IOL_O_4byte	4 bytes
IOL_O_6byte	6 bytes
IOL_O_8byte	8 bytes
IOL_O_10byte	10 bytes
IOL_O_16byte	16 bytes
IOL_O_24byte	24 bytes
IOL_O_32byte	32 bytes

5 Startup

Data modules for IO-Link inputs and outputs

Data module	Data width	
	Input	Output
OL_I/O_1/_1byte	1 byte	1 byte
IOL_I/O_2/_2byte	2 bytes	2 bytes
IOL_I/O_2/_4byte	2 bytes	4 bytes
IOL_I/O_4/_4byte	4 bytes	4 bytes
IOL_I/O_4/_2byte	4 bytes	2 bytes
IOL_I/O_2/_8byte	2 bytes	8 bytes
IOL_I/O_4/_8byte	4 bytes	8 bytes
IOL_I/O_8/_2byte	8 bytes	2 bytes
IOL_I/O_8/_4byte	8 bytes	4 bytes
IOL_I/O_8/_8byte	8 bytes	8 bytes
IOL_I/O_10/_10byte	10 bytes	10 bytes
IOL_I/O_4/_32byte	4 bytes	32 bytes
IOL_I/O_32/_4byte	32 bytes	4 bytes
IOL_I/O_16/_16byte	16 bytes	16 bytes
IOL_I/O_24/_24byte	24 bytes	24 bytes
IOL_I/O_32/_32byte	32 bytes	32 bytes

Note
Project planning software of various providers mostly offers graphical assistance during configuration; the configuration string is automatically created.

Additional modules (slot 3 to 9)

Slot	Subslot	Input	Output	Contents
3	1	1 byte	–	IO-Link station diagnostics
3	1	1 byte	–	IO-Link extended diagnostics
4	1	1 byte	–	Input pin 4
5	1	–	1 byte	Output pin 4
6	1	–	1 byte	Restart pin 4 *
7	1	1 byte	–	Input pin 2
8	1	–	1 byte	Output pin 2
9	1	–	1 byte	Restart pin 2 *

* If the modules Restart pin 4/2 are inserted, no automatic restart of the pin is performed after an actuator short circuit. A restart is performed only after the respective restart module is set to the value 01_{hex}.

Byte allocation of diagnostic modules

Slot 3 can host one of two diagnostic modules. Both modules have input data of length 1 byte and no output data.

IO-Link station diagnostics

Bit	Meaning
0…3	–
4	Supply voltage short circuit (pin 3) (IO-Link mode)
5	Overload warning pin 2 or pin 4
6	Actuator warning pin 2 or pin 4
7	Supply voltage short circuit (pin 3) (IO mode)

IO-Link extended diagnostics

Bit	Meaning
0	IO-Link device connected
1	–
2	–
3	Supply voltage short circuit (pin 3)
4	Overload warning pin 4
5	Overload warning pin 2
6	Actuator warning pin 4
7	Actuator warning pin 2

Modules for use as digital I/O port

All of these modules feature the same design:

– Input pin 4
– Output pin 4
– Restart pin 4
– Input pin 2
– Output pin 2
– Restart pin 2

Only one bit is used in each case

Bit	Meaning
0	Input, output or restart information
1…7	–
5	Overload warning pin 2 or pin 4
6	Actuator warning pin 2 or pin 4
7	Supply voltage short circuit (pin 3) (IO mode)

5.7.2 Parameter configuration

Device parameter

Slot 0, Subslot 1

Index	Byte	Bit	Length	Contents	Values	Default
1	0	0	1 bit	IO-Link diagnostics	0/1	0
2	1	0	1 byte	IO-Link port function pin 4	0/1/3/4/5/6	0
	2	0	1 byte	IO-Link port function pin 2	0/1/2/3	0
3	3	0	1 byte	IO-Link safe state pin 4	0/1/2	0
	4	0	1 byte	IO-Link safe state pin 2	0/1/2	0

IO-Link port parameter

Slot 2, Subslot 1

Index	Byte	Bit	Length	Contents	Values	Default
1	0	0	6 bits	Cycle time	0…63	0
	0	6	2 bits	Cycle time base	0/1/2	0
2	0	0	1 byte	Data window offset	0…31	0
	1	0	1 byte	Max. data input length	0…32	0
3	0	0	2 bits	Validation type	0/1/2	0
	1	0	1 byte	Vendor ID Byte 0	0.255	0
	2	0	1 byte	Vendor ID Byte 1	0.255	0
	3	0	1 byte	Vendor ID Byte 2	0.255	0
	4	0	1 byte	Device ID Byte 0	0.255	0
	5	0	1 byte	Device ID Byte 1	0.255	0
	6	0	16 bytes	Serial Number	String	Empty string
4	0	0	1 bit	Parameter server upload	0/1	0
	0	1	1 bit	Parameter server download	0/1	0
	0	6	2 bits	Parameter server enable	0/1/2	0
5	0	0	1 byte	Process data length input	0…32	Fixed per module
	1	0	1 byte	Process data length output	0…32	Fixed per module

Description of individual parameters

IO-Link diagnostics

This function can be used to permit / suppress all of the IO-Link module's diagnostics messages (visual diagnostics signals are unaffected).

IO-Link port function pin 4

Here the function of the IO-Link port can be defined:

Normally open	=	Input as normally open contact
Normally closed	=	Input as normally closed contact
Output	=	Output function
IO-Link	=	IO-Link function
Normally open after parameter configuration	=	SIO mode; an IO-Link device can be configured via IO-Link and afterward switched over to an SIO mode in which the IO-Link port pin functions as a simple normally open switch input
Normally closed after parameter configuration	=	SIO mode, as with normally open after configuration, but as normally closed switch input

IO-Link port function pin 2

Here the function of the IO-Link port can be defined:

Normally open	=	Input as normally open contact
Normally closed	=	Input as normally closed contact
Output	=	Output function
Diagnostics input	=	Cable break detection

5 Startup

IO-Link safe state pin 4/2

This function is an extension of the IO-Link port starting configuration. A safe state that the port is to take on in the case of a loss of bus communication can be predefined for the respective port.

Cycle time

The cycle time controls the timing for triggering the IO-Link device. The factory default setting is 0 (Auto). It is recommended that this value be retained. The cycle time is stored in the IO-Link device (slave) and is detected automatically. Only times that are slower than the automatically selected times can be set manually.

Offset data window and Length data window

The offset (offset data window) can be used by the start byte with length (length data window) to define the end byte of the process data. This setting is only for the input data, has no influence on the actual process data length and is for visual purposes only.

Validation type

Whether a connected IO-Link device receives access to the IO-Link master can be controlled using validation.

Configuration options:

0 No validation
1 Allows communication to the IO-Link master only for devices whose vendor ID (VID) and device ID (DID) correspond to the configured values.
2 Identical to **1**, in addition the serial number of the IO-Link device is checked.

Vendor ID, VID

Vendor ID for the IO-Link device (refer to the manual for the device)

Device ID, DID

Device ID for the IO-Link device (refer to the manual for the device)

Serial number (SerNum), optional

Serial number for the IO-Link device (if available; refer to the IO-Link device's type plate)

Parameter server, optional

Automatic upload (IO-Link slave → IO-Link master) or download (IO-Link master → IO-Link slave) can be switched on using this parameter.

For automatic upload, the parameter configuration is read when an IO-Link device is plugged in. For automatic download, the parameter configuration is transmitted to the device when an IO-Link device is plugged in.

Background:

The automatic upload makes it possible to read in the parameter configuration of a correctly configured device when plugging one in. If an IO-Link device has to be replaced, the previously read in parameter configuration from the old device is transferred to the new device when it is plugged in. The *Upload* option can be disabled by having a valid parameter set read.

Configuration options:

– Turning on
– Turning on the upload
– Turning on the download

5 Startup

5.7.3 Integration into project planning software

The connection of a **SMART***CAMERA* to a Siemens S7 controller is shown with the *SIMATIC Manager*. The exact procedure depends on the configuration software used.

Installing the GSDML file

To perform project planning on the PC, the GSDML file for the module must be installed:

1. Open a new project.
2. Open hardware configurator.
3. Select the *Tools* | *Install new GS* menu command.
   ⇒ The *Install new GSD file* dialog opens.
4. Select directory and GSDML file.
   ⇒ The [Install] button becomes active only if a GSDML file is selected.
5. Click on [Install].
   ⇒ The GSDML file is being installed.
   ⇒ A message appears once the process has finished.
6. Confirm the message and close the window.
7. Select *Tools* | *Update catalog*.
   ⇒ The devices are displayed in the product tree.

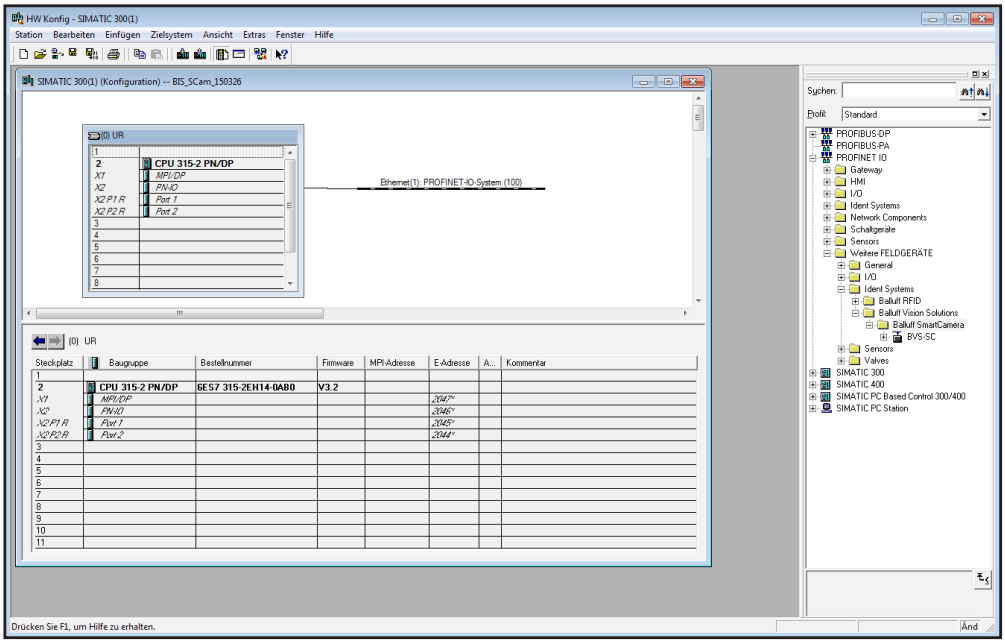


Figure 23: Installing the GSDML file

5 Startup

Adding a PROFINET device

The devices are located in the hardware catalog under > *More field devices* > *Identsystems* > *Balluff Vision Solutions* > *Balluff* **SMART***CAMERA*. The module is added as PROFINET IO.

► Select the PROFINET rail.

► Double-clicking adds the device as a PROFINET IO.

⇒ The slots are assigned the default settings.

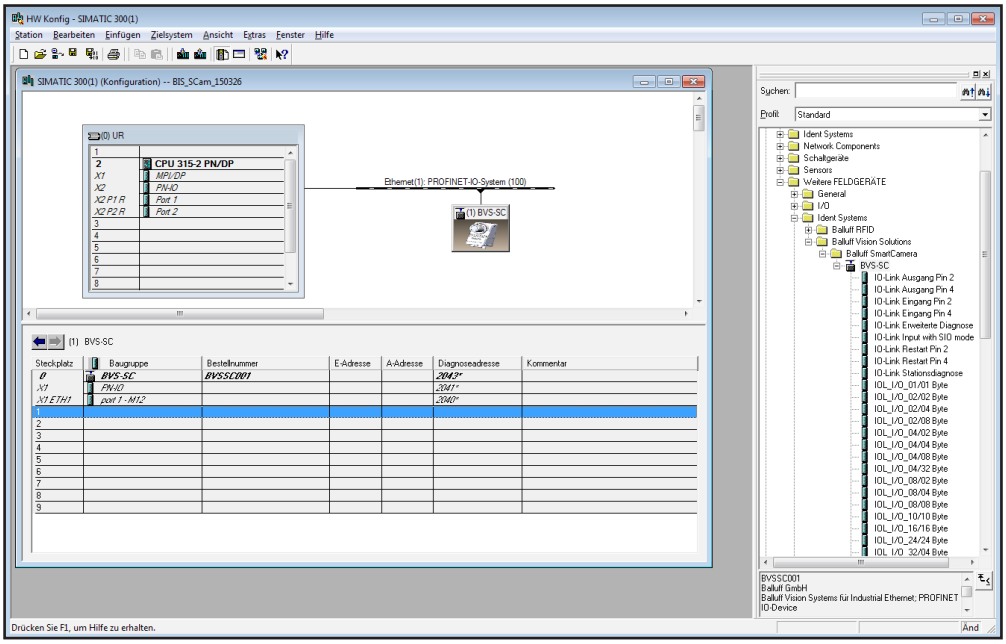


Figure 24: Adding a PROFINET device

Determining the station name

► Define the PROFINET station name of the device.

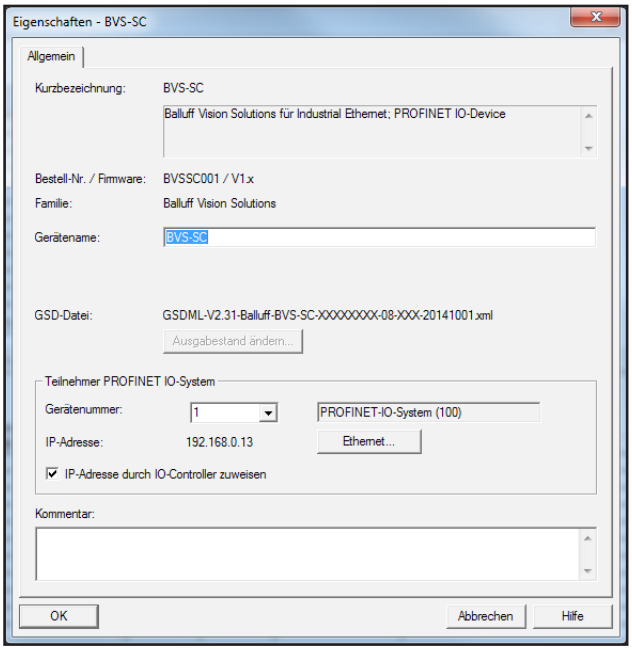


Figure 25: Determining the station name

5 Startup

Changing the device's IP address

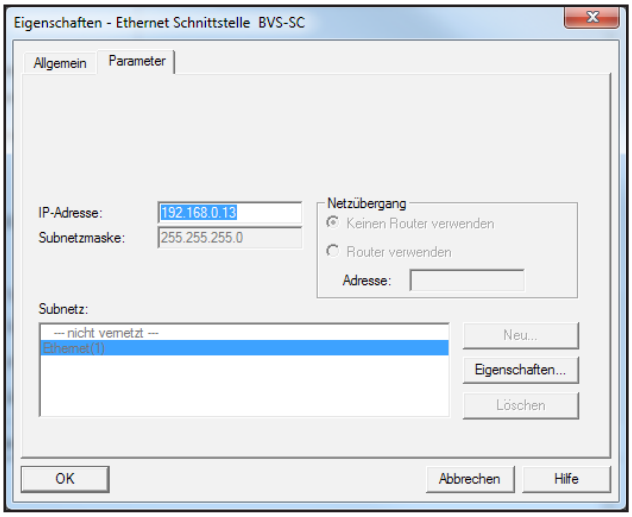


Figure 26: Changing the device's IP address

Configuring **SMART***CAMERA* data

The number of process data (buffer size) of the **SMART***CAMERA* can be selected by deleting or inserting a corresponding module (min. 16 bytes, max. 1280 bytes). When a module is not plugged in, no process data are configured. The optimal size depends on the size of the results container used and the input data.

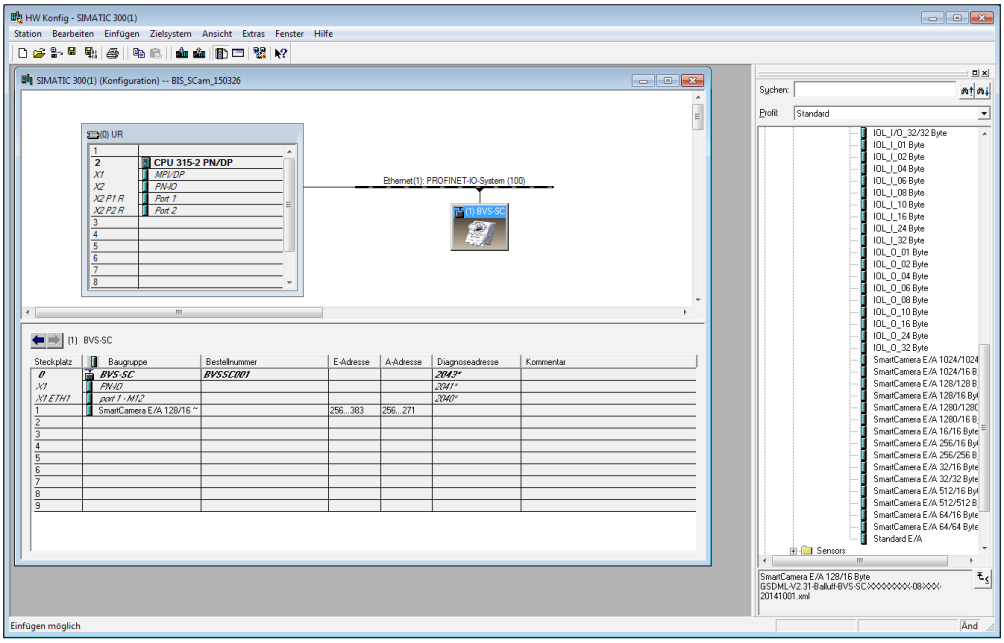


Figure 27: Configuring **SMART***CAMERA* data

5 Startup

Configuring the IO-Link module

If an IO-Link module is to be configured, it must be dragged to slot two. It may be necessary to delete the default IO module first.

► Drag the selected module to slot 2 (slots 3...9 are reserved for optional additional modules for IO-Link).

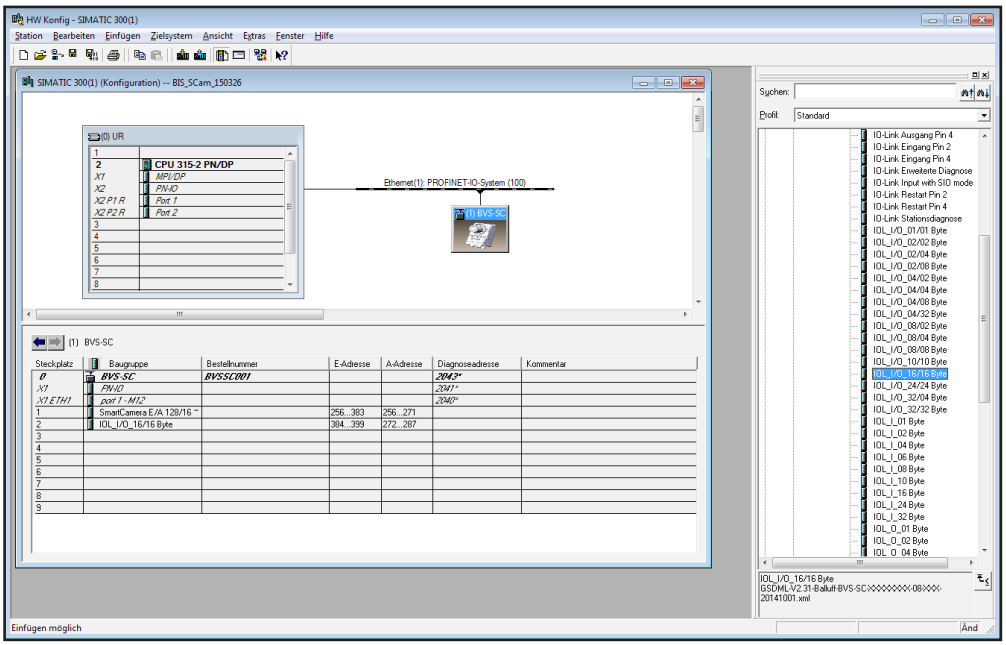


Figure 28: Configuring the IO-Link module

► If the IO-Link port is to be used with standard I/O, slot 2 must host the *Standard I/O* module and slots 3 to 9 must host the corresponding modules (input or output pin 4 and pin 2).

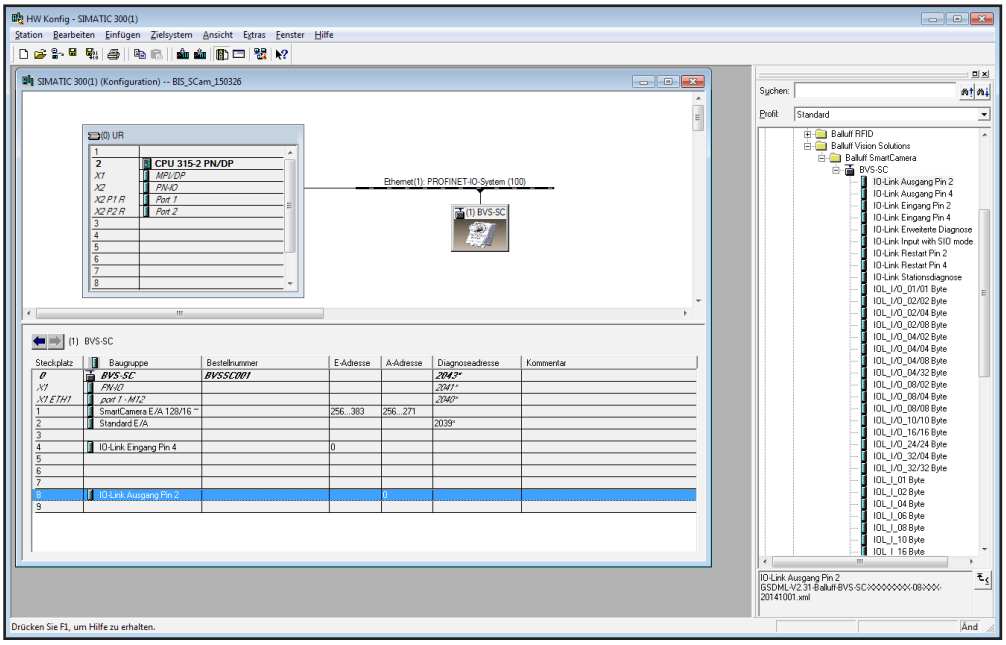


Figure 29: Using IO-Link port with standard I/O

5 Startup

5.8 EtherNet/IP fieldbus interface

Device master data

To parameterize the correct **SMART***CAMERA* model in an EtherNet/IP network, device database information in the form of an EDS file is required.

The file is located on the Balluff homepage (see www.balluff.com).

5.8.1 Process data structure

The following values describe the data sizes of the input, output and configuration data. These must be entered in the host system.

Assembly	Instance ID	Data length in bytes
INPUT	100	176
OUTPUT	101	162
CONFIG	102	26

Input Assembly (input data, camera to PLC)

Start byte	Length	Description
0	128	Camera process data. The process data protocol is described in section 6 starting on page 55.
128	1	Digital inputs: Bit 0: Pin 4 input data Bit 1: Pin 2 input data
129	1	IO-Link Device Status: Bit 0: Port in IO-Link mode Bit 1: Device is connected Bit 2: Validation failed Bit 3: Short circuit between pins 1 and 3 Bit 4: Pin 4 overload Bit 5: Pin 2 overload
130	32	IO-Link process data
162	2	IO-Link vendor ID
164	3	IO-Link device ID
167	9	IO-Link 3 events, each 1 byte error code and 2 bytes additio-nal Co

Output Assembly (output data, PLC to camera)

Start byte	Length	Description
0	128	Camera process data. The process data protocol is described in section 6 starting on page 55.
128	1	Digital outputs: Bit 0: Pin 4 output data Bit 1: Pin 2 output data
129	1	Restart after short circuit: Bit 0: Pin 4 Bit 1: Pin 2
130	32	IO-Link process data

5 Startup

Config assembly

All camera functions are set via the Web interface. The configuration data include only IO-Link functions.

Start byte	Length	Description
0	2	IO-Link port function 0: Standard-I/O, 1: IO-Link
2	1	Cycle time Bit 0-5: Multiplier Bit 6-7: Time base
3	1	Validation Type 0: no validation, 1: compatible (VID, DID), 2: identical (VID, DID, serial number)
4	2	Vendor ID
6	3	Device ID
9	16	Serial Number
25	1	Parameter Server Bit 0: Enable upload Bit 1: Enable download Bit 6: Delete Bit 7: Enable parameter server

IO-Link port function

This parameter determines whether pin 4 works in IO-Link mode (1) or whether it is used as a digital in-/output (0). Pin 2 is always a digital in-/output.

There is no setting that specifies whether a pin is an input or output. A digital I/O pin is always both. If a pin is to be used as an input, the output must output a zero (byte 128 in the output assembly). The output stage is a “highside switch”, and if it outputs a zero, the pin is high-impedence and can be used as an input. The input data (byte 128 in the input assembly) always represent the logical value of the corresponding pin, even if it is controlled as an output.

Cycle time

This parameter can be used to influence the IO-Link communication speed. The time for an IO-Link process data cycle results from the time base and the multiplier.

Since the multiplier takes up 6 bits, it can have values from 0 to 63.

The time base is 2 bits which are coded as follows.

Binary coding	Base time	Calculation	Time range
00	0.1 ms	Multiplier x base time	0.4[1)]…6.3 ms
01	0.4 ms	6.4 ms + multiplier x base time	6.4…31.6 ms
10	1.6 ms	32 ms + multiplier x base time	32…132.8 ms

1) 0.4 ms is the shortest possible cycle time. It can also not be fallen below using a smaller multiplier.

5 Startup

Validation type

Whether a connected IO-Link device receives access to the IO-Link master can be controlled using validation.

Configuration options:

	Description
0	No validation
1	Allows communication to the IO-Link master only for devices whose vendor ID (VID) and device ID (DID) correspond to the configured values.
2	Identical to **1**, in addition the serial number of the IO-Link device is checked.
Vendor ID, VID	Vendor ID for the IO-Link device (refer to the manual for the device)
Device ID, DID	Device ID for the IO-Link device (refer to the manual for the device)
Serial number (SerNum), optional	Serial number for the IO-Link device (if available; refer to the IO-Link device's type plate)

Parameter Server

	Description
Switched on	Data management functions enabled, parameter data and identification data of the IO-Link device are stored permanently.
Switched off	Data management functions disabled, stored parameter data and identification data of the IO-Link device remain stored.
Delete	Data management functions disabled, stored parameter data and identification data of the IO-Link device remain stored.
Enable upload	If only the upload is enabled, the master always starts an upload of the parameter data. In this case, the upload is independent of the upload flag of the IO-Link device. If there are no data stored in the master port, an upload also takes place (e.g. after deleting the data or before the first data upload).
Enable download	If only the download is enabled, the master always starts a download of the parameter data. In this case, the download is likewise independent of the upload flag of the IO-Link device. If there are no data stored in the master port, first an upload takes place (e.g. after deleting the data or before the first data upload).
Enable upload and download	If upload and download are enabled, different parameter sets are distinguished depending on the upload flag of the IO-Link device. If there are no parameter data stored in the IO-Link master port, a first upload also takes place (e.g. after deleting the data or before the first data upload). If the upload flag is set on the IO-Link device, an upload of the parameter data takes place. If no upload flag is set and parameter data has already been stored, a download of the parameter data always takes place.

Note

After the upload of the parameter data, the vendor ID and device ID of the connected IO-Link device are also still saved until the data records are deleted.

When the connected IO-Link device is started, a validation takes place. Thus, only an IO-Link device of the same type can be used for the data management. If an IO-Link device of a different type is to be used, the contents of the parameter server must be deleted.

Data storage is supported only by IO-Link devices with IO-Link Revision 1.1. The upload flag on the IO-Link device is needed to overwrite already saved data in the parameter server with new parameter data of the same IO-Link device.

To enable the upload flag of an IO-Link device the data value 5 must be entered in Index 2, Subindex 0.

5.8.2 Configuration via explicit messages

Fault State

The *Fault State* function can be used to specify which value the digital in-/outputs assume when the bus connection is lost. This always affects pin 2. It affects pin 4 if it is configured as a digital I/O line.

Standard services 14 (Get Attribute Single) and 16 (Set Attribute Single) are used for the fault state. Values can be read (Get Attribute Single) and written (Set Attribute Single).

Attribute 6 enables or disables the *Fault State* function:

Class	Instance	Attribute	Value
9	1	6	0: Fault State disabled 1: Fault State enabled

When the Fault State function is enabled Attribute 5 is used to specify how the line should respond in case of a bus interruption. It can either enable the output (Output on) or hold the last set value (Hold last state).

Class	Instance	Attribute	Value
9	1	5	0: Output on 1: Hold last state

If the *Fault State* function is not enabled, IOs are high-impedance if the bus connection fails, and behave then like an input.

Note

The fault state settings are stored only temporarily in the **SMART***CAMERA*. They are deleted after a restart.

To ensure a long-term fault state configuration, the configuration has to be programmed via the host system so that the settings are transferred to the module again whenever the system is restarted.

5 Startup

Configuration of IO-Link devices

The parameters of an IO-Link device are addressed by Index and Subindex.

Reading a parameter

Service	Class	Instance	Attribute	Value
50	150	1	3 (Read Parameter)	**Byte** / **Meaning** 0 / Index, lowest byte 1 / Index, highest byte 2 / Subindex

The response contains the addressed data. There must be sufficient storage space on the host system..

Writing a parameter

Service	Class	Instance	Attribute	Value
50	150	1	2 (Write Parameter)	**Byte** / **Meaning** 0 / Index, lowest byte 1 / Index, highest byte 2 / Subindex 3…n / Data for writing

5 Startup

5.8.3 SMART*CAMERA* integration in Rockwell Studio 5000

This example shows how the **SMART***CAMERA* is connected to a CompactLogix or ControlLogix PLC.

1. Start EDS Hardware Installation Tool in the Logix Designer and register EDS file.

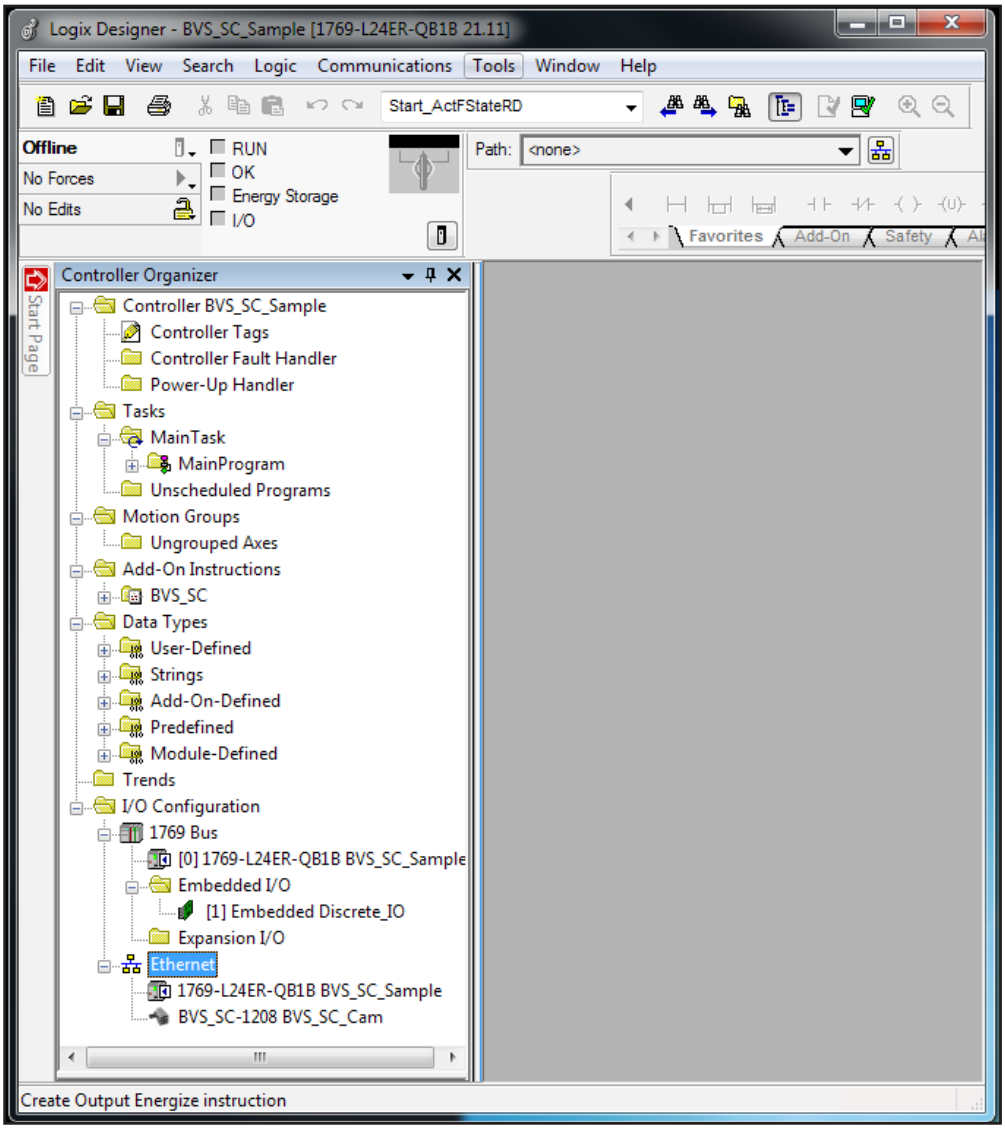


Figure 30: Register EDS File

5 Startup

2. Right-click Ethernet on the corresponding scanner card. Select a new module. Note: The function is not available in online mode!

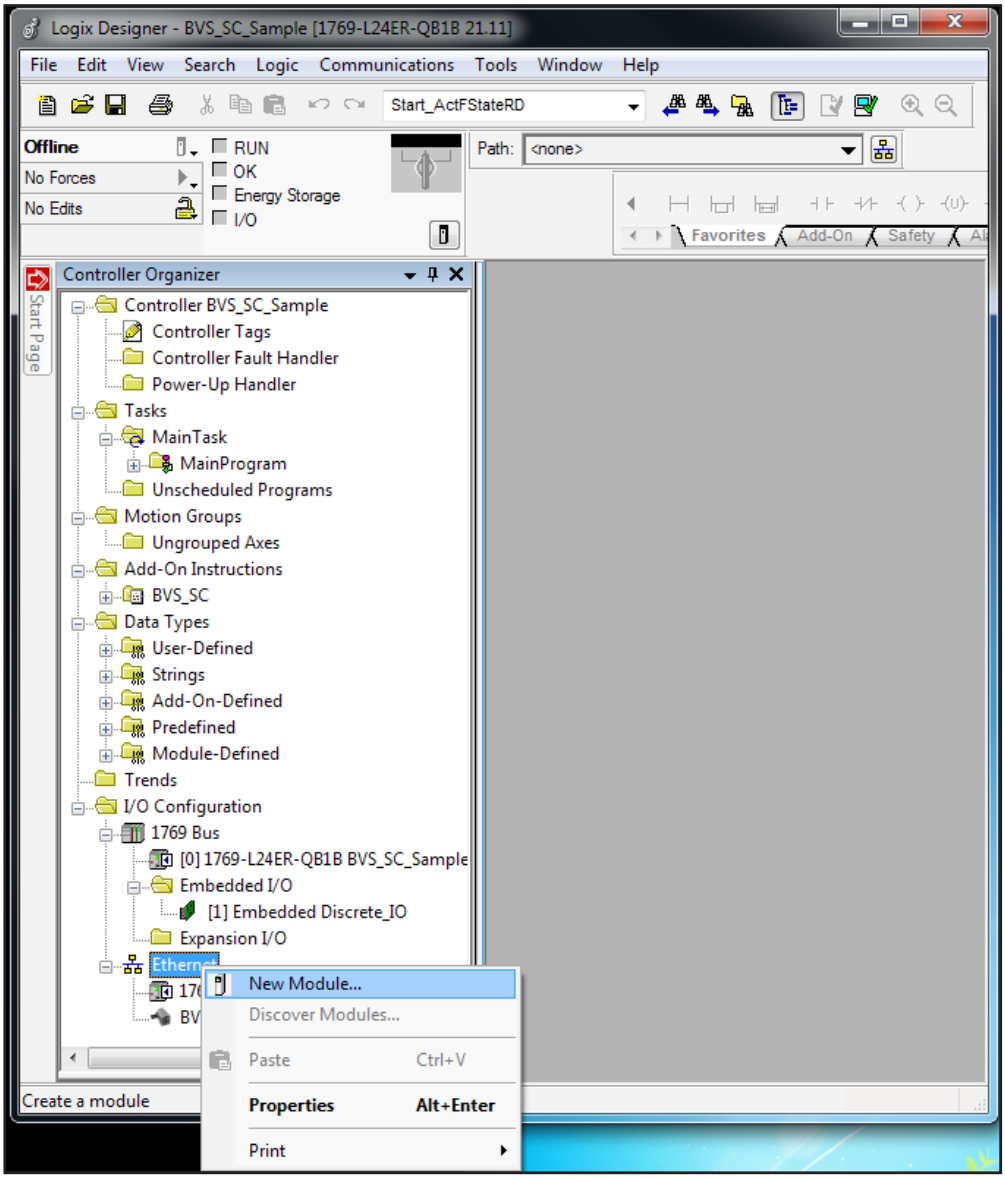


Figure 31: Add module

3. Select **SMART***CAMERA* Module BVS_SC-1280 and apply to the configuration.

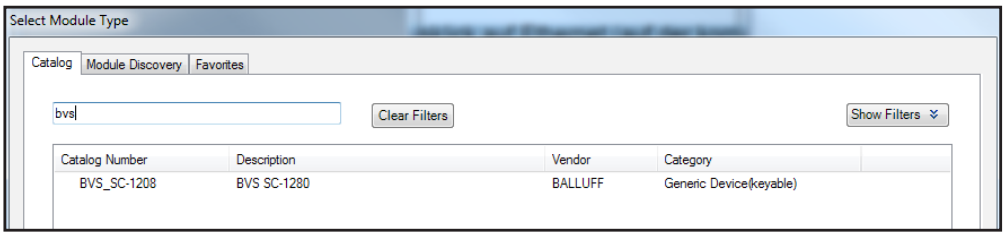


Figure 32: Select camera

5 Startup

4. The input, output and configuration tags are automatically created in the controller tags.

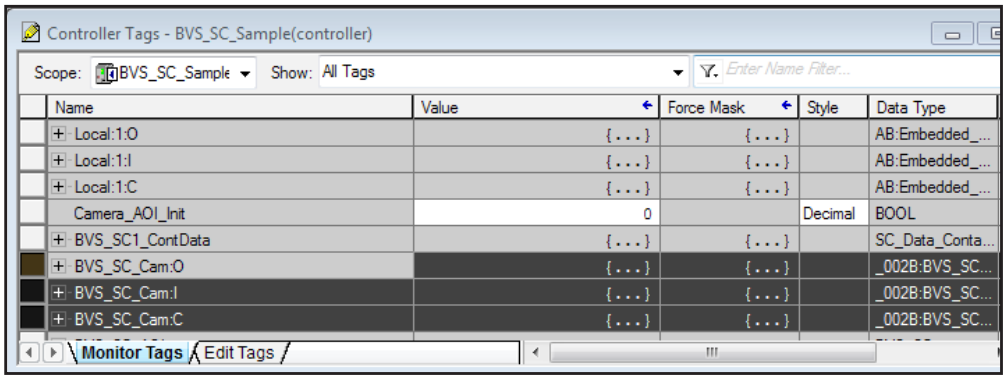


Figure 33: Camera controller tags

5. Set the desired IP address and connection parameters for the **SMART***CAMERA* under Module Properties

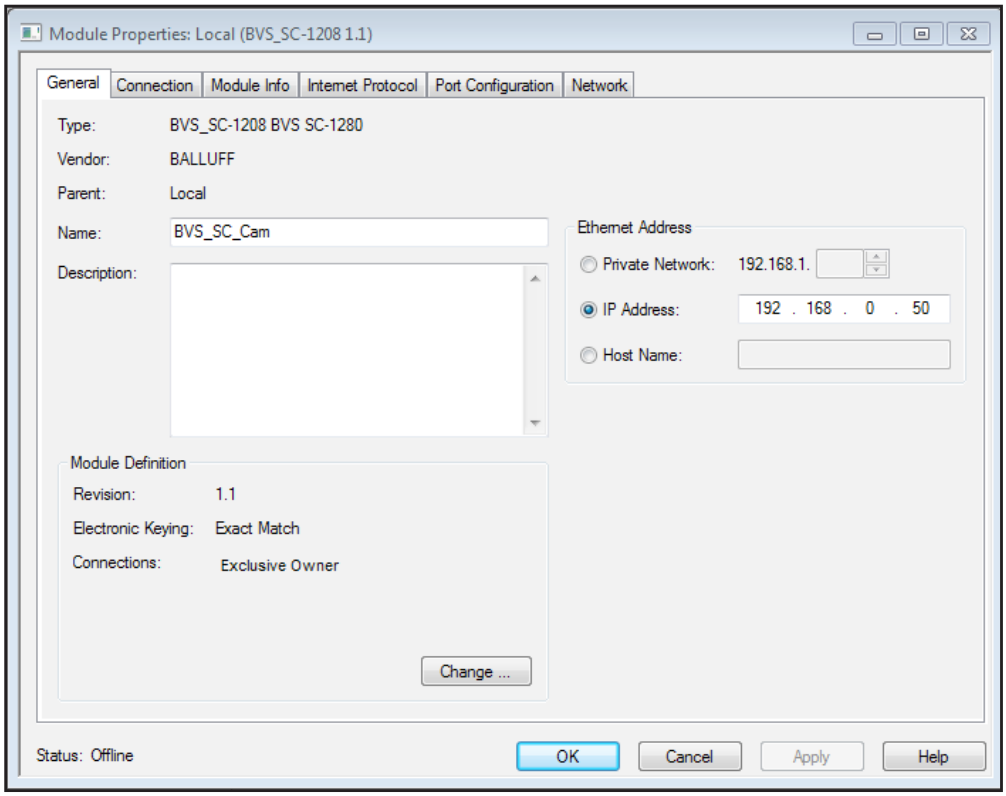


Figure 34: Set connection parameters

5 Startup

5.9 IO-Link interface

The IO-Link interface of the **SMART*CAMERA*** can be operated in three different modes:

– PLC mode for controlling IO-Link standard devices by a PLC
– Camera mode for direct control of special IO-Link devices
– IO mode for direct control of two I/O signals

The parameterization of the different modes is done via the Communication tab in the System Settings.

5.9.1 PLC gateway mode

In this mode, the interface is controlled by the controller (e.g. PLC). The parameterization is done via the fieldbus, diagnostics are forwarded via the fieldbus to the controller.

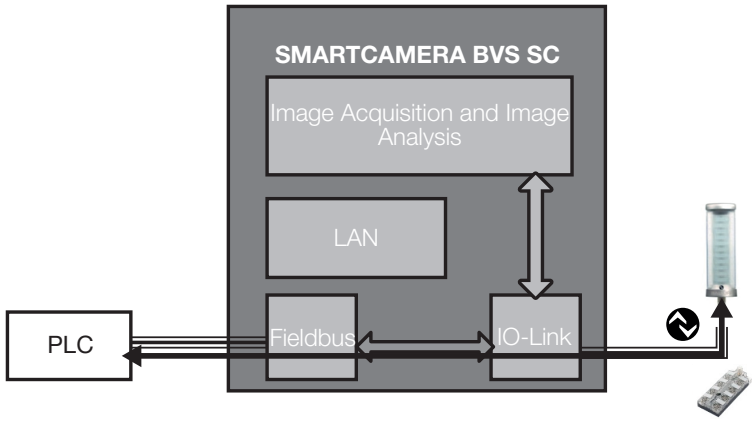


Figure 35: PLC gateway mode

5.9.2 Camera mode

This mode allows controlling some special IO-Link devices by the **SMART*CAMERA***. In this case, the control is done via the 8 IO channels of the camera.

IO-Link parameters of the controller are not taken into account, no data or diagnostics are exchanged with the controller.

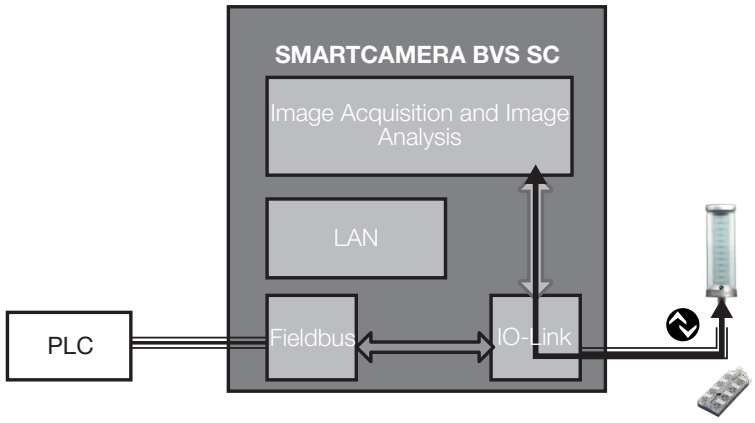


Figure 36: Camera mode

Pin 2 is also controlled automatically depending on the device class.

5 Startup

Device class 1: IO-Link I/O modules

The 8 I/O channels are linked with pin 4 of the ports of the I/O modules (or with the first 8 I/O lines). The function of the individual pins depends on the configuration of the I/O channels (input or output).

	SMART*CAMERA*							
	I/O 0	**I/O 1**	**I/O 2**	**I/O 3**	**I/O 4**	**I/O 5**	**I/O 6**	**I/O 7**
BNI005U BNI IOL-302-000-K006 	Port 0,4 [1]	Port 1,4	Port 2,4	Port 3,4	Port 4,4	Port 5,4	Port 6,4	Port 7,4
BNI004L BNI IOL-310-000-K025 	IO1	IO2	IO3	IO4	IO5	IO6	IO7	IO8
BNI004K BNI IOL-309-000-K024 	IO1	IO2	IO3	IO4	IO5	IO6	IO7	IO8
BNI005M BNI IOL-771-000-K027 	IO1	IO2	IO3	IO4	IO5	IO6	IO7	IO8
BNI0035 BNI IOL-302-000-Z013 	Port 0,4	Port 1,4	Port 2,4	Port 3,4	Port 4,4	Port 5,4	Port 6,4	Port 7,4

1) The representation 0,4 means port 0, pin 4.

Some of these I/O modules require a voltage supply for actuators at pin 2 of the IO-Link connection. For details, see the manual of the respective device. The **SMART***CAMERA* provides the actuator supply. The connection must be made with a 4-conductor cable.

5 Startup

Device class 2: SMART*LIGHT*

– BNI007T BNI IOL-800-000-Z036 (1-stage)

The 1-stage **SMART***LIGHT* is controlled with the IO channels I/O5, I/O 6 and I/O 7.

I/O 5	I/O 6	I/O 7	Description
0	0	0	Off
1	0	0	Red
0	1	0	Yellow
1	1	0	Green
0	0	1	Off
1	0	1	Red, flashing
0	1	1	Yellow, flashing
1	1	1	Green, flashing

– BNI0088 BNI IOL-801-102-Z036 (3-stage)

Then IO channels I/O 5, I/O 6 and I/O 7 are used to control the segments of the **SMART***LIGHT*.

I/O 5	I/O 6	I/O 7	Description
0	0	0	Off
1	0	0	red / off / off
0	1	0	off / yellow / off
1	1	0	off / off / green
0	0	1	flashing red / off / off
1	0	1	off / flashing yellow / off
0	1	1	off / off / flashing green
1	1	1	red / yellow / green

Note

The IO channels I/O 5, I/O 6 and I/O 7 must have been configured as output in the BVS Cockpit.

5 Startup

5.9.3 IO mode

In this mode, the interface is controlled by the **SMART***CAMERA*. Pin 2 and pin 4 can each be configured as an input or output. I/O 6 of the **SMART***CAMERA* is linked with pin 2 and I/O 7 with pin 4.

An external lighting can be controlled here, for example.

IO-Link parameters of the controller are not taken into account, no data or diagnostics are exchanged with the controller.

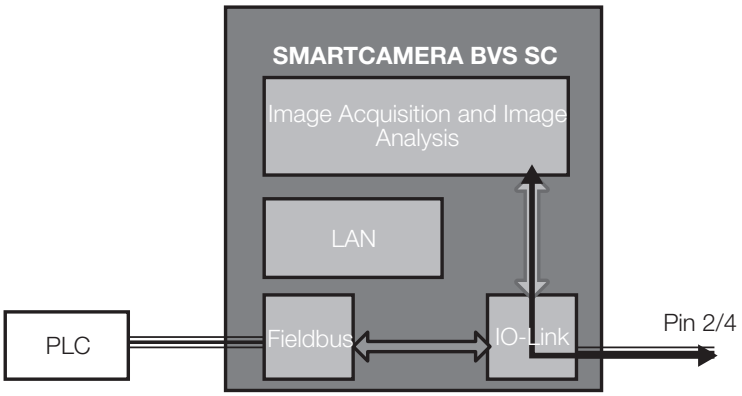


Figure 37: IO mode

6 Communication functions of the device with fieldbus

6.1 Fieldbus interface

6.1.1 Fieldbus protocol of SMART*CAMERA*

Data exchange operating principle

Two buffers are needed to exchange data and commands between the **SMART***CAMERA* and the controller (input buffer and output buffer). The buffer contents are exchanged using cyclical polling. When writing to the buffer, the transmitted data from the previous cycle is overwritten. If some bytes are not being used in a cycle, then they retain the last value.

Example for PROFINET:

Total buffer size 96 bytes (64 bytes **SMART***CAMERA*, 32 bytes IO-Link)

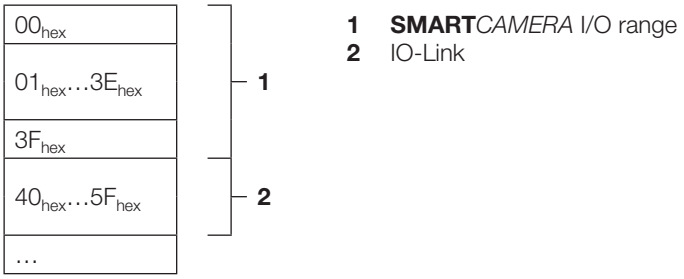


Figure 38: Example for total buffer size 96 bytes (64 bytes **SMART***CAMERA*, 32 bytes IO-Link)

Next, potential additional ranges for IO-Link

The process data buffer is divided into multiple ranges:

– Range 1 = **SMART***CAMERA* communication
– Range 2 = IO-Link
– Potential additional ranges for IO-Link

IO-Link

The size of these ranges can be configured for PROFINET IO using the GSDML file.

In the IO-Link PLC gateway mode, IO-Link data are transferred unchanged from the controller via the camera to the IO-Link devices. IO-Link buffer: 0…32 bytes (max.).

In the IO-Link camera mode (or IO mode via the camera), no IO-Link data are exchanged between IO-Link devices and the fieldbus.

Most of the commands are executed as command-response pair via a handshake mechanism. The controller *sends* a command to the camera and the camera *replies* with the result. This process is synchronized with two bits in the cyclical memory and referred to as handshake. The handshake bits are called strobe and acknowledge bits.

6.1.2 Handshake mechanism

Basic sequence

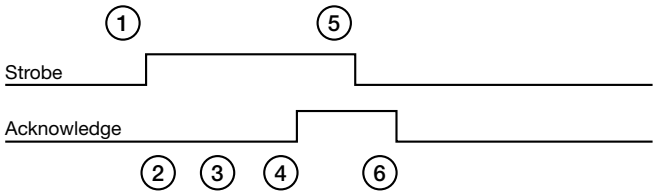


Figure 39: Handshake mechanism

1. The controller sets command ID, data length and data in the output buffer and then the strobe bit.
2. The strobe bit tells the camera that a job is being transferred and the data to be transmitted are valid.
3. The camera accepts the command and executes it.
4. The camera correctly executed the command and sets command status, data length and data in the input buffer and then the acknowledge bit.

5. The controller sees the acknowledge bit, reads the data from the camera and then resets the strobe bit.
6. The camera sees the reset strobe bit and resets the acknowledge bit. The camera is ready for the next command.

6.1.3 Toggle mechanism

If more data is to be transferred with a command or with a response than the cyclical memory area can hold, a toggle mechanism within the handshake is used. For this purpose, two additional bits (Toggle-In and Toggle-Out) are used in the cyclical memory.

Process

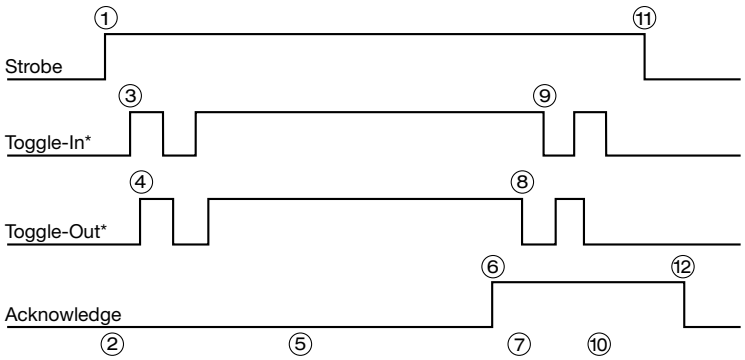


Figure 40: Toggle-In

* In the example, Toggle-In/Out start at 0, the actual start value does not matter.

1. The controller sets command ID, data length and the first part of the data in the output buffer. The data length is the length of the entire data to be transferred. Afterwards, the controller sets the strobe bit.
2. The camera reads the strobe bit and then command ID, data length and (partial) data. Based on the data length and size of the cyclical buffer, the camera recognizes that additional data still have to be transferred.
3. The camera inverts the Toggle-In bit and waits for the inverted Toggle-Out bit.
4. The controller reads the inverted Toggle-In bit, places the next partial data in the output buffer and then inverts the Toggle-Out bit.
5. The camera reads the inverted Toggle-Out bit and accepts the next partial data. If additional partial data must be transferred, continue with 3., otherwise with 6.
6. The camera accepts the command and executes it and sets command status, data length and (partial) data in the input buffer and then the acknowledge bit.
7. The controller reads the acknowledge bit and then command status, data length and (partial) data. Based on the data length and size of the cyclical buffer, the controller recognizes that additional data still have to be transferred.
8. The controller inverts the Toggle-Out bit and waits for the inverted Toggle-In bit.
9. The camera reads the inverted Toggle-Out bit, places the next partial data in the input buffer and inverts the Toggle-In bit.
10. The controller reads the inverted Toggle-In bit and accepts the next partial data. If additional partial data must be transferred, continue with 8., otherwise with 11.
11. The controller resets the strobe bit.
12. The camera reads the reset strobe bit, withdraws the acknowledge bit and is ready for the next command.

6 Communication functions of the device with fieldbus

Note

Camera waits have a deselectable timeout of 500 milliseconds (see “Toggle mechanism” on page 56, step 4 (3), 9, and 12). If there is no response within this timeout, the camera cancels the handshake and resumes the initial state.
The controller should also monitor a corresponding timeout.

Handshake flow chart:

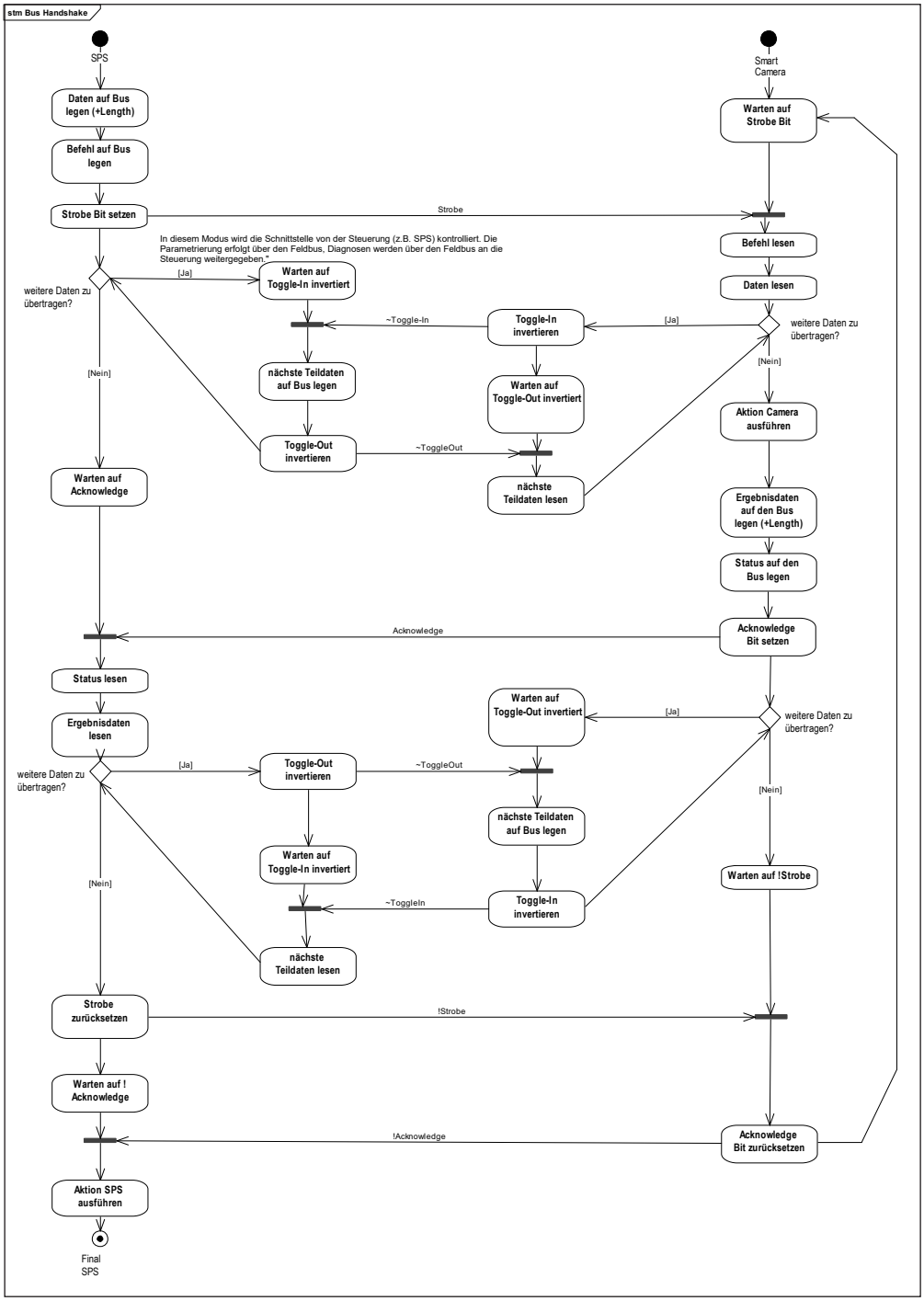


Figure 41: Handshake flow chart

6 Communication functions of the device with fieldbus

6.1.4 Process data buffer

Double bit string

To ensure the complete transmission of all the data in the data buffer, the bytes are transferred with the control bits (bit strings) at the start and end of the data buffer for the process data of the **SMART***CAMERA* and compared. If both bit strings are the same, then the data between these bytes were updated completely and can be taken over. This means that the data for each R/W head is only valid if both bit headers are the same. The host control system must also compare the bits in the bit headers.

Endianness

Endianness refers to the memory organization for simple numeric values, primarily the storage of integers in the working memory.

– For *big-endian* the highest value byte is stored first, i.e. at the lowest memory address.
– For *lilttle-endian* the lowest value byte is stored at the start address.

For the values transmitted by the **SMART***CAMERA* via fieldbus interface, the endianness can be set in the BVS Cockpit.

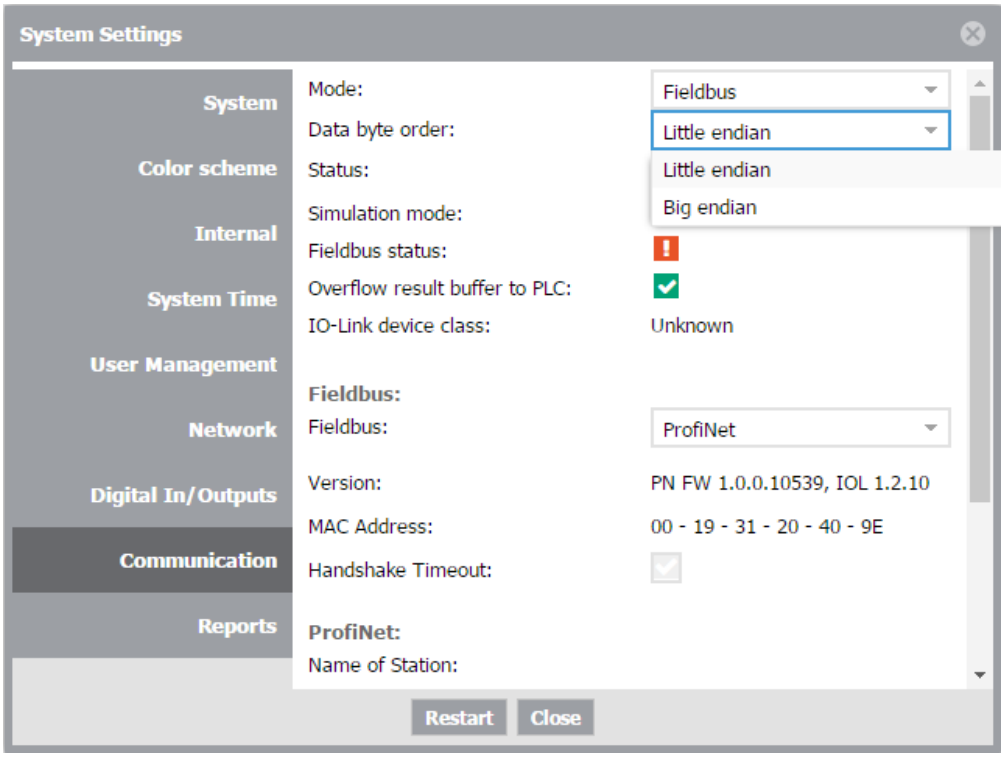


Figure 42: Little endian system settings

6 Communication functions of the device with fieldbus

Output buffer

The control commands are transferred to the **SMART***CAMERA* via the output buffer.

Control commands are triggered either as individual bit or via handshake. The camera responds to commands transferred via handshake with a status and possibly result data.

Subaddress	
00_{hex}	Control bits
01_{hex}	Control bits (bit string)
02_{hex}	Command byte - command code
03_{hex}	Data length byte 0 [1]
04_{hex}	Data length byte 1 [1]
05_{hex}	Data byte 0
…	Data byte n
Last byte (corresponds to the byte at address 01_{hex}).	Control bits (bit string)

1) Byte 0 and byte 1 of the data length are processed as a whole-number 16-bit value.

Structure byte 0 – control bits

The camera responds to 0/1 transitions of the individual command bits. The bits should be set until the corresponding acknowledgment arrives.

Subaddress	Bit number	Name	Function description
00_{hex}	0	Trigger bit	Initiates a trigger in the camera. It is acknowledged by the camera resetting the WaitingForTrigger bit.
	4	Reset warning bit	Resets warning messages (warning bits). Is cleared by resetting the corresponding warning bit as long as the indicated status is no longer active.
	5	Reset bit	Triggers a reset of the camera module. The camera is active again after approx. 30 seconds. It is acknowledged by resetting the Camera Ready bit.
	6	Start run mode bit	It activates the Run mode of the camera [1]. It is acknowledged by setting the Running bit.
	7	Stop run mode bit	It deactivates the Run mode of the camera [1]. It is acknowledged by resetting the Running bit.

1) If the Start and Stop run modus bits are set from 0 to 1 at the same time, then the status of the Run mode in the camera is not defined (random).

Structure byte 1 – control bits

Subaddress	Bit number	Name	Function description
01_{hex}	0	Handshake strobe bit	The controller uses this bit to signal that a command is to be transferred and that valid data are in the command byte, data length bytes and data bytes.
	1	Toggle-Out bit	The controller uses this bit to signal that additional data can be read or written.

6 Communication functions of the device with fieldbus

Commands

The controller writes command codes in byte 2. The following codes are allowed:

Name	Command code	Meaning
Switch Application	01_{hex}	Switches the application
Get Application ID	02_{hex}	Gets the ID of the currently active application
Get Results	03_{hex}	Gets the result container
Set Inputs	04_{hex}	Sets the input data
Get Camera Info	05_{hex}	Gets the camera information
Get Date Time	06_{hex}	Get the time stamp
Set Date Time	07_{hex}	Sets the time stamp
Set Sequence Number	08_{hex}	Sets the sequence number

Input buffer

The input buffer is used to transfer responses (status information and results) from the camera to the controller.

Subaddress	
00_{hex}	Status Bits
01_{hex}	Warn Bits
02_{hex}	Control bits (bit string)
03_{hex}	Command status byte
04_{hex}	Data length byte 0 [1)]
05_{hex}	Data length byte 1[1)]
06_{hex}	Data byte 0
…	Data byte n
Last byte = byte 2	Control bits (bit string)

1) Byte 0 and byte 1 of the data length are processed as a whole-number 16-bit value.

Structure byte 0 – control bits

Subaddress	Bit number	Name	Function description
	0	Waiting for Trigger	This bit signals that the camera is waiting for a trigger signal.
	1	Result Ready	This bit signals that a result is ready to be picked up.
	2	–	
	3	–	
	4	–	
	5	Busy	This bit signals that the camera is currently busy. The bit is set while the application is switched over. Some commands are rejected in this condition with the status NOK Busy.
	6	Running	This bit signals that the camera is operating in Run mode.
	7	Camera Ready	This bit is active after a restart only if the internal camera module has been completely started.

Structure of byte 1 – information bits

Subaddress	Bit number	Name	Function description
	0	Overtriggered [1]	A trigger was rejected by the camera
	1	Buffer Bit	This bit becomes active as soon as a result container was not picked up by the controller and overwritten by a new result.
	2	Report	This bit becomes active as soon as a report file could not be transferred and got lost.
	3	–	
	4	Input Container [1]	It is set for input container overflow (more input containers than inspections, so that one input container was discarded) or input container underflow (more inspections than input containers, so that one input container was used multiple times).
	5	–	
	6	Overheat [1]	The camera exceeded the permissible temperature. This could lead to a drop in quality of the inspections. – Check ambient temperature – Check installation conditions
	7	System Error [1]	Fatal system error. At least one reset is required, a part of the camera could be defective.

1) These bits remain set even if the status is no longer present. They can be reset using the Reset Warning control bit.

Structure byte 2 – control bits

Subaddress	Bit number	Name	Function description
02_{hex}	0	Handshake Acknowledge	The camera uses this bit to signal that an incoming command was read and processed and valid result data are present.
	1	Toggle-In	The camera uses this bit to signal that additional data can be read or written.
	7	Error	An error occurred during the handshake or the execution of a command. The command status byte (byte 3) describes the error. The Error bit is reset with a reset of the Strobe bit.

6 Communication functions of the device with fieldbus

Structure of byte 3: Responses to commands / status

Name	Status code	Meaning
OK	00_{hex}	Command was successfully executed
OK Application ID	02_{hex}	Response to the command Get Application ID; transfer of application ID
OK Results	03_{hex}	Response to the command Get Results; transfer of results
OK Camera Information	05_{hex}	Response to the command Get Camera Information; transfer of camera information
OK Date Time	06_{hex}	Response to the command Get Date Time; transfer of time stamp
NOK Error	10_{hex}	An error occurred during the last transfer of a command.
NOK Communication Abort	11_{hex}	Communication was canceled by the controller by resetting the Strobe bit.
NOK Communication Error	12_{hex}	A communication error occurred (e.g. handshake timeout violation)
NOK Invalid Command	13_{hex}	An invalid command code was transferred
NOK Invalid Application ID	14_{hex}	At the last command an invalid Application ID was transmitted or the camera was not ready to switch applications because an application was still running.
NOK Results	15_{hex}	Response to the command Get Results; no results available
NOK Busy	16_{hex}	Command could not be executed since the camera is still processing another command or is not yet ready after a restart.

6 Communication functions of the device with fieldbus

6.1.5 Commands and responses

The following responses are possible for all commands:

- **NOK Error:** General error (e.g. command format error, error in internal communication, …)
- **NOK Communication Error:** Communication error (e.g. handshake timeout violation, toggle bit timeout violation …)
- **NOK Communication Abort:** Strobe bit was prematurely withdrawn (controller cancels)

When setting an invalid command code, the camera responds with *NOK Invalid Command*.

Command	Responses	Meaning
Switch Application	OK	Switching application successful
	NOK Invalid Application ID	Invalid application ID requested
	NOK Busy	Camera not ready, command currently not possible
Get Application ID	OK Application ID	Response with the currently selected application ID
	NOK Busy	Camera not ready, command currently not possible
Get Results	OK Results	Response with the last calculated result data
	NOK Results	No result data available
	NOK Busy	Camera not ready, command currently not possible
Set Inputs	OK	Setting the input data was successful
	NOK Busy	Camera not ready, command currently not possible
Get Camera Information	OK Camera Information	Response with the camera information
Get Date Time	OK Date Time	Response with the current time stamp of the camera
	NOK Busy	Camera not ready, command currently not possible.
Set Date Time	OK	Setting the time stamp was successful
	NOK Busy	Camera not ready, command currently not possible
Set Sequence Number	OK	Setting the sequence number was successful
	NOK Busy	Camera not ready, command currently not possible

6.1.6 Command structure

Byte 00_{hex} contains the command bits and is meaningless for commands that are transferred via handshake.

Note

All values are represented with the *little-endian*setting.

6 Communication functions of the device with fieldbus

Switching the application – Switch Application

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	01_{hex}: Switch Application
03_{hex}	Data length byte 0	01_{hex}: Length 1 byte
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	Application ID
06_{hex}	Data byte 1	No meaning
…	…	…
Last byte	= Byte at address 01_{hex}	

The Application ID Null is not allowed since multiple applications can be given this ID.

Getting the application ID – Get Application ID

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	02_{hex}: Get Application ID
03_{hex}	Data length byte 0	00_{hex}
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 01_{hex}	

Getting the results – Get Results

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	03_{hex}: Get Results
03_{hex}	Data length byte 0	00_{hex}
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 01_{hex}	

Getting the time stamp – Get Date Time

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	06_{hex}: Get Date Time
03_{hex}	Data length byte 0	00_{hex}
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 01_{hex}	

Setting the time stamp – Set Date Time

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	07_{hex}: Get Date Time
03_{hex}	Data length byte 0	07_{hex} Long time stamp
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	Decades
06_{hex}	Data byte 1	Years
07_{hex}	Data byte 2	Months
08_{hex}	Data byte 3	Days
09_{hex}	Data byte 4	Hours
$0A_{hex}$	Data byte 5	Minutes
$0B_{hex}$	Data byte 6	Seconds
…	…	No meaning
Last byte	= Byte at address 01_{hex}	

All elements of the time stamp are binary coded (e.g. month: $0B_{hex}$ = 11 = November). Example: August 31, 2015 12:34:56 = 14_{hex} $0F_{hex}$ 08_{hex} $1F_{hex}$ $0C_{hex}$ 22_{hex} 38_{hex}

Note

If an NTP server is specified in the BVS Cockpit, the camera automatically obtains the time from the server. Use of the *Set time stamp* message is then not necessary. The manually set time is overwritten by that of the NTP server.

Setting the sequence number – Set Sequence Number

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	08_{hex}: Set Sequence Number
03_{hex}	Data length byte 0	04_{hex}: Length 4 bytes
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	Sequence number byte 0
06_{hex}	Data byte 1	Sequence number byte 1
07_{hex}	Data byte 2	Sequence number byte 2
08_{hex}	Data byte 3	Sequence number byte 3
…	…	No meaning
Last byte	= Byte at address 01_{hex}	

Every inspection result features a sequence number which is being incremented with every new result. After sending this command, the numbering starts with the number transferred here. The sequence number is coded as UINT32.

Setting input data – Set Inputs

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	04_{hex}: Set Inputs
03_{hex}	Data length byte 0	Length input data byte 0
04_{hex}	Data length byte 1	Length input data byte 1
05_{hex}	Data byte 0	Input data byte 0
…	…	…
###	Data byte n	Input data byte n
…	…	…
Last byte	= Byte at address 01_{hex}	

Content and format of the input data are configured in the BVS Cockpit (see the BVS Cockpit manual).

Getting camera information – Get Camera Info

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}	Control bits	
02_{hex}	Command code	05_{hex}: Get Camera Info
03_{hex}	Data length byte 0	00_{hex}
04_{hex}	Data length byte 1	00_{hex}
05_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 01_{hex}	

6 Communication functions of the device with fieldbus

6.1.7 Structure of responses

Bytes 00_{hex} and 01_{hex} contain warning and error bits and have no direct meaning for the handshake.

Note
All values are represented with the *little-endian*setting.

Command successful – OK

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	00_{hex}: OK
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

Application ID – OK Application ID

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	02_{hex}: OK Application ID
04_{hex}	Data length byte 0	01_{hex}: Length 1 byte
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	Application ID
07_{hex}	Data byte 1	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

Result data – OK Results

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	03_{hex}: OK
04_{hex}	Data length byte 0	Length of the following data byte 0
05_{hex}	Data length byte 1	Length of the following data byte 1
06_{hex}	Data byte 0	Application ID
07_{hex}	Data byte 1	Result data byte 0
…	…	…
###	Data byte n	Result data byte m
…	…	…
Last byte	= Byte at address 02_{hex}	

6 Communication functions of the device with fieldbus

Content and format of the result data are configured in the BVS Cockpit (see the BVS Cockpit manual). Consequently, different result data can also define formats for different applications. While the result data are being picked up, a maximum of one additional result data record of the next analysis is buffered in the background. If the bus communication or the **SMART***CAMERA* restarts, the result data are discarded.

Camera information – OK Camera Information

Subaddress	Meaning	Content / functional description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	05_{hex}: OK Camera Information
04_{hex}	Data length byte 0	$0E_{hex}$: Length 14 bytes
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	Camera data byte 0
…	…	…
13_{hex}	Data byte 13	Camera data byte 13
…	…	…
Last byte	= Byte at address 02_{hex}	

The data are coded as follows:

1 byte: validity (0 = not valid / 1 = valid)

4 byte: Firmware version of camera module
2 byte UINT16 major version
2 byte UINT16 minor version

1 byte: Camera type (0 = monochrome; 1 = color)

4 byte: X-resolution of camera (UINT32)

4 byte: Y-resolution of camera (UINT32)

Time stamp – OK Date Time

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command code	06_{hex}: OK Date Time
04_{hex}	Data length byte 0	07_{hex}: Time Stamp Length
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	Decades
07_{hex}	Data byte 1	Years
08_{hex}	Data byte 2	Months
09_{hex}	Data byte 3	Days
$0A_{hex}$	Data byte 4	Hours
$0B_{hex}$	Data byte 5	Minutes
$0C_{hex}$	Data byte 6	Seconds
…	…	No meaning
Last byte	= Byte at address 02_{hex}	

6 Communication functions of the device with fieldbus

All elements of the time stamp are binary coded (see “Set time stamp” on page 82).

General error – NOK Error

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	10_{hex}: NOK Error
04_{hex}	Data length byte 0	04_{hex}: Length 4 bytes
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	Error code byte 0
07_{hex}	Data byte 1	Error code byte 1
08_{hex}	Data byte 2	Error code byte 2
09_{hex}	Data byte 3	Error code byte 3
$0A_{hex}$	Data byte 4	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

The error code is coded as UINT32.
For error codes and their meaning (see “Error Codes” on page 71).

Communication abort – NOK Communication Abort

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	11_{hex}: NOK Communication Abort
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

6 Communication functions of the device with fieldbus

Communication error – NOK Communication Error

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	12_{hex}: NOK Communication Error
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

Invalid command code – NOK Invalid Command

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	13_{hex}: NOK Invalid Command
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

Invalid application ID – NOK Invalid Application ID

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	14_{hex}: NOK Invalid Application ID
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

No results – NOK Results

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	15_{hex}: NOK Results
04_{hex}	Data length byte 0	00_{hex}

Subaddress	Meaning	Function description
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

Not ready - NOK Busy

Subaddress	Meaning	Function description
00_{hex}		
01_{hex}		
02_{hex}	Status/Control bits	
03_{hex}	Command status byte	16_{hex}: NOK Busy
04_{hex}	Data length byte 0	00_{hex}
05_{hex}	Data length byte 1	00_{hex}
06_{hex}	Data byte 0	No meaning
…	…	…
Last byte	= Byte at address 02_{hex}	

6.1.8 Error Codes

Code		Description	Handling recommendation
00000000_{hex}	None	No error occurred	None
00000005_{hex}	COMMAND_BUFFER_ OVERFLOW	Overflow internal command buffer	Internal error, camera overload. Try command again.
00000006_{hex}	COMMAND_ENCODE_ ERROR	Error coding output data	Structure of commands for checking camera.
00000007_{hex}	COMMAND_TIMEOUT	Timeout violation while executing a command	Have program run faster (timeout 500 ms) or disable timeout ion BVS-Cockpit.
00000009_{hex}	FORMAT_ ERROR	Invalid format of data for a command. (incl. wrong data length)	Structure of commands for checking camera.
$0000000A_{hex}$	INCONSISTENT_DATA_ TIMEOUT	After beginning of a handshake both bit strings were different for too long	Check consistency of both bit strings. You may have forgotten to set the second bit string.
$0000000B_{hex}$	COMMAND_EXECUTE_ FAILED	Executing a command failed. (e.g. no response from camera module)	Serious error. Restart camera.
$FFFFFFFF_{hex}$	UNKNOWN_ERROR	An unknown error occurred	None

6.1.9 Function module

To simplify communication between **SMART***CAMERA* and the host system Balluff GmbH provides function blocks:

– For Siemens controllers there is a PROFINET function block.
– For Rockwell controllers there is an EtherNet/IP function block.

Both can be downloaded from the Balluff homepage (www.balluff.com).

6 Communication functions of the device with fieldbus

6.2 Examples of fieldbus communication

– 16 bytes output buffer; 16 bytes input buffer
– Representation for the setting *little-endian* (lowest value byte first)

Notation	Meaning	Logic combination
|##$_{hex}$	Set bits	Value = value OR ##$_{hex}$
~##$_{hex}$	Reset bits	Value = value AND (NOT(##$_{hex}$))
^##$_{hex}$	Invert bits	Value = value XOR ##$_{hex}$

6.2.1 Switch application (application 51 = 33_{hex})

Controller

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	01_{hex}
03_{hex}	Data length byte 0:	01_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Application ID:	33_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

3. Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

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2. Process input buffer (observe sequence):

03_{hex}	Command status: (command executed successfully)	00_{hex}
04_{hex}	Data length byte 0:	00_{hex}
05_{hex}	Data length byte 1:	00_{hex}
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|01_{hex}

4. Process input buffer

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit	~01_{hex}

6.2.2 Switch application, problem: invalid application ID (FF_{hex})

Controller

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	01_{hex}
03_{hex}	Data length byte 0:	01_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Application ID:	FF_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

3. Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

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2. Process input buffer (observe sequence):

03_{hex}	Command status: (NOK Invalid Application ID)	14_{hex}
04_{hex}	Data length byte 0:	00_{hex}
05_{hex}	Data length byte 1:	00_{hex}
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|81_{hex}

4. Process input buffer

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit and error bit	~81_{hex}

6 Communication functions of the device with fieldbus

6.2.3 Switch application, problem: camera not yet ready

Controller **SMART*CAMERA***

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	01_{hex}
03_{hex}	Data length byte 0:	01_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Application ID:	33_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

2. Process input buffer (observe sequence):

03_{hex}	Command status: (NOK Busy)	16_{hex}
04_{hex}	Data length byte 0:	00_{hex}
05_{hex}	Data length byte 1:	00_{hex}
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|81_{hex}

3. Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

4. Process input buffer

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit and error bit	~81_{hex}

6.2.4 Switch application, problem: internal camera problem

Controller **SMART*CAMERA***

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	01_{hex}
03_{hex}	Data length byte 0:	01_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Application ID:	33_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

2. Process input buffer (observe sequence):

03_{hex}	Command status: (NOK Error)	10_{hex}
04_{hex}	Data length byte 0:	04_{hex}
05_{hex}	Data length byte 1:	00_{hex}
06_{hex}	Data byte 0: Error code byte 0	11_{hex}
07_{hex}	Data byte 1: Error code byte 1	00_{hex}
08_{hex}	Data byte 2: Error code byte 2	00_{hex}
09_{hex}	Data byte 3: Error code byte 3	00_{hex}
02_{hex}/ $0F_{hex}$	Set Acknowledge bit and error bit	|81_{hex}

3. Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

4. Process input buffer

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit and error bit	~81_{hex}

6.2.5 Get result container (without toggling) (4 byte result container)

Controller

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	03_{hex}
03_{hex}	Data length byte 0:	00_{hex}
04_{hex}	Data length byte 1:	00_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

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2. Process input buffer (observe sequence):

03_{hex}	Command status: (OK Results)	03_{hex}
04_{hex}	Data length byte 0:	05_{hex}
05_{hex}	Data length byte 1:	00_{hex}
06_{hex}	Application ID	
07_{hex}	Data byte 0: Result byte 0	
08_{hex}	Data byte 1: Result byte 1	
09_{hex}	Data byte 2: Result byte	
$0A_{hex}$	Data byte 3: Result byte 3	
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|01_{hex}

3. Read output buffer:

07_{hex}…$0A_{hex}$	Copy result bytes

Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

4. Process input buffer

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit	~01_{hex}

6.2.6 Get result container (without toggling)

(20 byte result container)

Controller | **SMART***CAMERA*

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	03_{hex}
03_{hex}	Data length byte 0:	00_{hex}
04_{hex}	Data length byte 1:	00_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

2. Process input buffer (observe sequence):

03_{hex}	Command status: (OK Results)	03_{hex}
04_{hex}	Data length byte 0:	15_{hex}
05_{hex}	Data length byte 1:	00_{hex}
06_{hex}	Application ID	
07_{hex}	Result byte 0	
…	…	
$0D_{hex}$	Result byte 6	
$0E_{hex}$	Result byte 7	
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|01_{hex}

3. Read input buffer:

06_{hex}…$0E_{hex}$	Copy first 8 result bytes

Process output buffer:

01_{hex}/ $0F_{hex}$	Invert Toggle-Out	~02_{hex}

4. Process input buffer

06_{hex}	Result byte 8	
07_{hex}	Result byte 9	
…	…	
$0D_{hex}$	Result byte 15	
$0E_{hex}$	Result byte 16	
02_{hex}/ $0F_{hex}$	Invert Toggle-In	^02_{hex}

5. Read input buffer:

06_{hex}…$0E_{hex}$	Copy second 9 result bytes

Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~02_{hex}

6. Process input buffer:

06_{hex}	Result byte 17	
07_{hex}	Result byte 18	
08_{hex}	Result byte 19	
02_{hex}/ $0F_{hex}$	Invert Toggle-In	^02_{hex}

7. Read input buffer:

06_{hex}…07_{hex}	Copy last three result bytes

Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

8. Process input buffer:

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit	~01_{hex}

Result data:

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6.2.7 Set input data (with toggling) (22 byte input data)

Controller

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	04_{hex}
03_{hex}	Data length byte 0:	16_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Input byte 0	
06_{hex}	Input byte 1	
…	…	
$0D_{hex}$	Input byte 8	
$0E_{hex}$	Input byte 9	
01_{hex}/ $0F_{hex}$	Set Strobe bit	|01_{hex}

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2. Read output buffer

06_{hex}…$0E_{hex}$	Copy first 10 input bytes

Process input buffer (observe sequence):

02_{hex}/ $0F_{hex}$	Invert Toggle-In	^02_{hex}

Controller

3. Process output buffer:

05_{hex}	Input byte 10	
06_{hex}		
…	…	
$0D_{hex}$	Input byte 18	
$0E_{hex}$	Input byte 19	
01_{hex}/ $0F_{hex}$	Invert Toggle-Out	~02_{hex}

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4. Read output buffer

06_{hex}…$0E_{hex}$	Copy second 10 input bytes

Process input buffer

02_{hex}/ $0F_{hex}$	Invert Toggle-In	^02_{hex}

Controller

5. Process output buffer:

05_{hex}	Input byte 20	
06_{hex}	Input byte 21	
01_{hex}/ $0F_{hex}$	Invert Toggle-Out	~02_{hex}

SMART*CAMERA*

6. Read output buffer:

06_{hex}…$0E_{hex}$	Copy last two input bytes

Process input buffer:

03_{hex}	Command status: OK	00_{hex}
04_{hex}	Data length byte 0:	00_{hex}
05_{hex}	Data length byte 1:	00_{hex}
02_{hex}/ $0F_{hex}$	Set Acknowledge bit	|01_{hex}

Controller

7. Process output buffer:

01_{hex}/ $0F_{hex}$	Reset Strobe bit	~01_{hex}

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8. Process input buffer:

02_{hex}/ $0F_{hex}$	Reset Acknowledge bit	~01_{hex}

Input data:

6 Communication functions of the device with fieldbus

6.2.8 Switch application, problem: controller sets invalid length

Controller

1. Process output buffer (observe sequence):

02_{hex}	Command identifier:	01_{hex}
03_{hex}	Data length byte 0:	FF_{hex}
04_{hex}	Data length byte 1:	00_{hex}
05_{hex}	Application ID:	33_{hex}
01_{hex}/ $0F_{hex}$	Set Strobe bit	$\|01_{hex}$

Timeout while waiting for Acknowledge bit
⇒ Cancel handshake

4. Process output buffer

01_{hex}/ $0F_{hex}$	Reset Strobe bit	$\sim01_{hex}$

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2. Process input buffer (observe sequence):

02_{hex}/ $0F_{hex}$	Invert Toggle-In	$\^02_{hex}$

Timeout while waiting on inverted Toggle-Out
⇒ Cancel handshake

3. Process input buffer

03_{hex}	Command status: (NOK Communication Error)	30_{hex}
04_{hex}	Data length byte 0:	00_{hex}
05_{hex}	Data length byte 1:	00_{hex}
02_{hex}/ $0F_{hex}$	Set error bit	$\|80_{hex}$

5. Process input buffer

02_{hex}/ $0F_{hex}$	Reset error bit	$\sim80_{hex}$

- Controller sets wrong data length (FF = 255), but wants to transfer only one application ID byte.
- **SMART***CAMERA* expects additional data after the start of the handshake and starts toggle process.
- While waiting for the next partial data, a timeout occurs in the camera → the camera cancels the process and writes the command status *NOK Communication Error* to the input buffer and sets the error bit.
- While waiting for the end of the handshake (waiting for Acknowledge bit), the controller runs into a timeout → the controller also cancels the process and resets the Strobe bit.
- By reading out the error bit and the value *NOK Communication Error* in the command status, the controller recognizes that the camera canceled the handshake.
- After canceling the handshake on both sides, the controller and **SMART***CAMERA* are back in the initial state and ready for new commands.

7 Device communication via the LAN interface

7.1 LAN interface

The TCP and UDP sockets provide a similar functionality as that provided via the fieldbus interface. The camera always uses port 36701. The controlling system can use any available port.

7.2 General information

TCP and UDP sockets are essentially different. With a TCP socket first a connection between camera and controlling system is opened. With a UDP socket this is not necessary, since individual packets are simply sent. In both cases the camera expects a Connect message, then it starts to send out status updates and result data. If the controlling system of a UDP socket does not want any more updates, it sends Disconnect. Likewise a Disconnect should be sent for a TCP socket before the socket is closed.

The camera responds to a Connect message with a Connect response; in addition, the camera then sends a status message to the client so that the client is informed about the current status of the camera.

The camera supports only one active client. In case of an existing TCP connection any further connection attempts are rejected. If on the other hand a UDP connection exists, it is closed as soon as a new request is placed by another client.

If transmission security is of great importance, use of TCP sockets is recommended.

Invalid messages are ignored by the camera.

7.2.1 Structure of the messages

The message elements consist of unsigned 32-bit numbers (UINT32) and byte strings. They are transferred using the little endian format. The lowest value byte is transferred first in this case.

There are three different categories of messages:

1. Messages from the camera to the client
   a. Status
   b. Result containers
2. Messages from the client to the camera without a response
   a. Disconnect
   b. Set time stamp
   c. Set input data
   d. Set sequence number
   e. Trigger application
   f. Start application
   g. Stop application
   h. Trigger reset
3. Messages from the client to the camera, which then sends a response after the action is complete.
   a. Connect
   b. Switch application
   c. Query application
   d. Get the time stamp

All messages have the same structure.

Length in bytes	Structure	Designation
4	UINT32	Magic Number: 42565350_{hex}
4	UINT32	User data length in bytes
4	UINT32	Message ID
4	UINT8[]	User data

Messages that do not meet the specified format (wrong *Magic Number*, wrong length, unknown message ID), are ignored by the camera. The "*Magic Number*" is used to avoid inadvertent transfers. It is recommended to watch for a correct "*Magic Number*" at the receiving point when programming the client software.

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Every message has a unique ID:

ID	Message
01_{hex}	Connect
02_{hex}	Disconnect
12_{hex}	Status
20_{hex}	Result containers
30_{hex}	Query application
31_{hex}	Switch application
32_{hex}	Get time stamp
33_{hex}	Set time stamp
34_{hex}	Set input data
35_{hex}	Set sequence number
40_{hex}	Trigger application
41_{hex}	Start application
42_{hex}	Stop application
43_{hex}	Trigger reset

7.2.2 The individual messages

Connect

At the beginning of the connection of a client with the camera, the client has to send a Connect message.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	01_{hex}	Message ID

The camera responds to it with its Connect message.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	04_{hex}	User data length in bytes
4	UINT32	01_{hex}	Message ID
4	UINT32	01_{hex}	Protocol version

If the LAN protocol should be expanded, the protocol version is counted up. This allows a client to see which protocol the camera is using.

After the Connect message, the camera sends a Status message to the client.

Disconnect

The client uses the Disconnect message to exit the connection. Afterwards, he no longer receives any result data and also no status messages.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	02_{hex}	Message ID

Status

After every status change, the camera sends the new status to the client.

Length in bytes	Struc - ture	Value	Designation
4	UINT32	42565350 $_{hex}$	Magic Number
4	UINT32	08_{hex}	User data length in bytes
4	UINT32	12_{hex}	Message ID
4	UINT32		Status word. A set bit indicates that the status is active (see the following table). In contrast to the fieldbus interface, the status bits do not have to be reset actively. If a status is no longer active, the camera simply sends out a new status message.

Value	Bit	Name	Function description
1	0	Overheat	The camera exceeded the permissible temperature. This could lead to a drop in quality of the inspections. – Check ambient temperature – Check installation conditions
2	1	System Error	Fatal system error. At least one reset is required, a part of the camera could be defective.
4	2	Input Container	It is set for input container overflow (more input containers than inspections, so that one input container was discarded) or underflow (more inspections than input containers, so that one input container was used multiple times).
16	4	Busy	This bit signals that the camera is currently busy. The bit is set while the application is switched over.
32	5	Report	This bit becomes active as soon as a report file could not be transferred and got lost.
128	7	Running	This bit signals that the camera is operating in Run mode.
256	8	Overtriggered	A trigger was rejected by the camera.
512	9	Waiting for Trigger	This bit signals that the camera is waiting for a trigger signal.

4	UINT32		It defines the endian format of the result container and the input data: 0: Little endian

Result containers

After the conclusion of an inspection, the result is send from the camera to the client with this message.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350 $_{hex}$	Magic Number
4	UINT32		User data length in bytes
4	UINT32	20_{hex}	Message ID
4	UINT32		Application ID. The BVS Cockpit can manage several applications, each of which has its own ID. This field shows the application that gene - rated the result container.
x	UINT8[]		Result data as defined in the BVS Cockpit.

7 Device communication via the LAN interface

Query application

The client can use this message to query the application ID of the active application.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	30_{hex}	Message ID

The camera is waiting for:

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	04_{hex}	User data length in bytes
4	UINT32	30_{hex}	Message ID
4	UINT32		Active application ID

Switch application

The client can use this message to switch over the active application on the camera.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	04_{hex}	User data length in bytes
4	UINT32	31_{hex}	Message ID
4	UINT32		ID of the desired application

An application ID allows only values under which an application is actually stored in the BVS Cockpit.

The Application ID Null is not allowed since multiple applications can be given this ID. The application can only be changed if it is stopped (see message “Stop application”).

Following this message, the camera returns an acknowledgment to the client.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	08_{hex}	User data length in bytes
4	UINT32	31_{hex}	Message ID
4	UINT32		Status: 0: Application was successfully set 1: Application ID is invalid
4	UINT32		Active application ID

The message is not sent until after the application has been switched over, which may take several 100 milliseconds.

Get the time stamp

The client uses this message to query the real-time clock of the camera.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	32_{hex}	Message ID

The camera responds to it with the current values:

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	18_{hex}	User data length in bytes
4	UINT32	32_{hex}	Message ID
4	UINT32		Year (e.g. 2016)
4	UINT32		Month (1...12)
4	UINT32		Day (1...31)
4	UINT32		Hour (0…23)
4	UINT32		Minute (0…59)
4	UINT32		Second (0…59)

Set time stamp

The client uses this message to set the current time at the camera. After every voltage ramp-up, the time stamp must be set anew.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	18_{hex}	User data length in bytes
4	UINT32	33_{hex}	Message ID
4	UINT32		Year (e.g. 2016)
4	UINT32		Month (1...12)
4	UINT32		Day (1...31)
4	UINT32		Hour (0…23)
4	UINT32		Minute (0…59)
4	UINT32		Second (0…59)

The camera does not send a response to this message. Invalid values are rounded to the next valid value.

Note

If an NTP server is specified in the BVS Cockpit, the camera automatically obtains the time from the server. Use of the *Set time stamp* message is then not necessary. The manually set time is overwritten by that of the NTP server.

Setting input data

Some applications require input data (e.g. comparison code or traceability data). This message transfers them from the client to the camera.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32		User data length in bytes
4	UINT32	34_{hex}	Message ID
x	UINT8[]		Input data for the application as defined in the BVS Cockpit.

7 Device communication via the LAN interface

Set sequence number

Every application pass generates a result that contains a unique sequence number. This sequence number is displayed in the BVS Cockpit. The result container can also be configured in such a way that it contains the sequence number. After the restart, the sequence number starts with zero. This message allows the client to set the sequence number to a defined value. The next application pass will then receive this sequence number. With every additional application pass, the sequence number is being incremented.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	04_{hex}	User data length in bytes
4	UINT32	35_{hex}	Message ID
	UINT32		New sequence number

Trigger application

It is sent from the client to the camera to start an application pass. The behavior of the camera depends on the setting in the BVS Cockpit. If an application is untriggered, this message is being ignored.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	40_{hex}	Message ID

Start application

It is sent from the client to the camera to set the camera to the Run mode. The behavior of the camera depends on the setting in the BVS Cockpit. An untriggered application starts immediately after this message and continuously furnishes results. A triggered application is ready after this message to receive a trigger.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	41_{hex}	Message ID

Stop application

It is sent from the client to the camera to exit the Run mode of the camera. An untriggered application stops after this message and furnishes no more results. A triggered application ignores additional triggers after this message.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	42_{hex}	Message ID

Trigger reset

Restarts the camera. After this message, the network connection is being lost and must be re-established after the restart. The restart takes approx. 30 seconds.

Length in bytes	Structure	Value	Designation
4	UINT32	42565350_{hex}	Magic Number
4	UINT32	00_{hex}	User data length in bytes
4	UINT32	43_{hex}	Message ID

7.2.3 Examples

Examples for Ethernet communication

The following examples show how the messages are structured and how they are sent.

Connect

Most message elements are of type UINT32 and consist of 4 bytes. But over Ethernet one byte after the other is sent. Be sure therefore that the data are sent in little-endian format. This means the lowest value byte is transferred first.

Each message begins with the Magic Number 42565350_{hex}.
Transmission begins with the lowest value byte: 50_{hex} 53_{hex} 56_{hex} 42_{hex}

Then the user data follow. The Connect message has no user data and so the length is Null. As UINT32 in little-endian: 00_{hex} 00_{hex} 00_{hex} 00_{hex}

The messages ID for Connect is 01_{hex}, as UINT32, little-endian: 01_{hex} 00_{hex} 00_{hex} 00_{hex}

There are no user data, the message is now complete.

The entire Connect command is thus:

50_{hex}	53_{hex}	56_{hex}	42_{hex}
00_{hex}	00_{hex}	00_{hex}	00_{hex}
01_{hex}	00_{hex}	00_{hex}	00_{hex}

The message is coded in C language:

```
unsigned char[] connect =
{
0x50, 0x53, 0x56, 0x42,
0x00, 0x00, 0x00, 0x00,
0x01, 0x00, 0x00, 0x00
};
```

Result containers

After each completed inspection the camera sends a results container to the controlling system. The structure of the user data depends on the configuration in the BVS Cockpit. In this example it is assumed that an inspection was configured which provides a string of 20 bytes (= 14_{hex}. The camera read the text “Hallo Welt!” and sends it to the controlling system.

The coding of the text is in ASCII format. The text that is read (11 bytes long) is shorter therefore than the area provided in the message (20 bytes). The camera therefore fills the remaining bytes with zeros. One byte chain is simply sent after the other. Little-endian has no meaning here since these are individual bytes.

7 Device communication via the LAN interface

The entire command is thus:

50_{hex}	53_{hex}	56_{hex}	42_{hex} (Magic number)
14_{hex}	00_{hex}	00_{hex}	00_{hex} (user data length)
20_{hex}	00_{hex}	00_{hex}	00_{hex} (Message-ID)

Reply from **SMART***CAMERA*:

48_{hex} 61_{hex} $6C_{hex}$ $6C_{hex}$ $6F_{hex}$ 20_{hex} 57_{hex} 65_{hex} $6C_{hex}$ 74_{hex}
21_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex} 00_{hex}
(ASCII: 'H', 'a', 'l', 'l' 'o', space, 'W', 'e', 'l', ‚t‘, '!', 9× fill-bytes)

Other examples (values always in hex):

- Start application: 50535642 00000000 41000000
- Trigger application: 50535642 00000000 40000000
- Stop application: 50535642 00000000 42000000
- Trigger reset: 50535642 00000000 43000000
- Disconnect: 50535642 00000000 02000000
- Set input data (10 x a, b, c, d, e, f, g, h, i, j – (= ASCII 41, … 50):
  50535642 0A000000 34000000 41424344454647484950
- Query application ID: 50535642 00000000 30000000
- Change application to xx($_{hex}$) ID-Number: 50535642 04000000 30000000 xx000000
- Get time stamp: 50535642 00000000 32000000

8 Appendix

8.1 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		S	C	-		1	2	8	0	Z	0	0	-			-			

1–3	BVS	Balluff Vision Solutions
5–6	SC	**SMART***CAMERA*
8	Function type	M: Monochrome sensor C: Color sensor
9–12	Resolution	1280: 1280 × 1024 pixel
13	Lights	Z: No integrated lighting
14–15	Optics	00: C-mount lenses
17–18	Interface	07: IO variant (no fieldbus) 30: PROFINET IO / EtherNet/IP plus IO-Link
20–22	Variants	000: Full standard functionality 010: Ident variant (code and OCR reading)

8.2 Accessories

(optional, not included in the scope of delivery)

Protection tube		
BAM02NA	BAM PC-VS-023-1	Protection tube for lenses up to a length of 40 mm.
BAM02W0	BAM PC-VS-023-1-01	Protection tube for lenses up to a length of 69 mm.
C-mount lenses		
BAM029R	BAM LS-VS-004-C2/3-0614-2	C-mount lens 6 mm focal length
BAM02FA	BAM LS-VS-004-C2/3-0814-2	C-mount lens 8 mm focal length
BAM02FC	BAM LS-VS-004-C2/3-1214-2	C-mount lens 12 mm focal length
BAM02FE	BAM LS-VS-004-C2/3-1614-2	C-mount lens 16 mm focal length
BAM02FF	BAM LS-VS-004-C2/3-2514-2	C-mount lens 25 mm focal length
BAM02FH	BAM LS-VS-004-C2/3-3514-2	C-mount lens 35 mm focal length
BAM02FJ	BAM LS-VS-004-C2/3-5014-2	C-mount lens 50 mm focal length
BAM02Y3	BAM LS-VS-004-C2/3-7532-2	C-mount lens 75 mm focal length
Filters		
BAM02FK	BAM OF-VS-002-PL-27	Lens filter 27 mm polarized
BAM02FL	BAM OF-VS-002-UV-27	Lens filter 27 mm UV
BAM02MN	BAM OF-VS-002-IR-27	Lens filter 27 mm IR
BAM02FM	BAM OF-VS-002-RD-27	Lens filter 27 mm red
BAM02FN	BAM OF-VS-002-YE-27	Lens filter 27 mm yellow
BAM02FP	BAM OF-VS-002-GN-27	Lens filter 27 mm green
BAM02FR	BAM OF-VS-002-BU-27	Lens filter 27 mm blue

8 Appendix

Spacer rings		
BAM02MT	BAM SP-XO-002-0,5-40/31-A	C-Mount spacer rings (0.5/1/5/10/20/40 mm)
Touchpanel PC		
BAE00WC	BAE PD-VS-011-01	Touchpanel PC 12"
Mounting accessories		
BAM00ZW	BAM MB-MS-038-B19-1	Mounting bracket **SMART***CAMERA*
BAM01YT	BMS CUJ-M-S25-D045-00	3D holder system
BAM01YP	BMS CS-M-S25-DX15-00	Removable disk for 3D fastener system
BAM02ZU	BMS CU-M-S25-D030-01	Attachment for interchangeable plate
BAM02P7	BAM MB-VS-026-B14-1	Ring light mounting bracket – **SMART***CAMERA*

Connection cable		
BCC0HZK	BCC M418-E818-8X0-723-PS58N9-020	GigE cable RJ45, M12, 2 m
BCC06K7	BCC M418-0000-2A-044-VX8825-020	IO interface, M12, open, 2 m
BCC0JF0	BCC M414-E834-8G-668-PS54N2-020	PROFINET, M12, M12, 2 m
BCC0E90	BCC M414-E894-8G-672-ES64N9-020	EtherNet/IP M12, M12, 2 m
BCC032F	BCC M415-0000-1A-003-PX0434-020	Power, M12, open, 2 m
BCC031N	BCC M414-0000-2A-003-PX0434-020	IO-Link, M12, open, 2 m
BCC09FR	BCC M415-M415-3A-312-PX0534-020	IO-Link, M12, M12, 2 m

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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