BALLUFF

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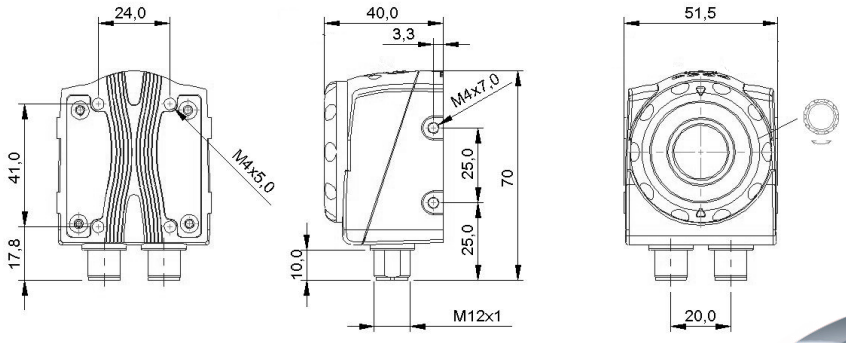
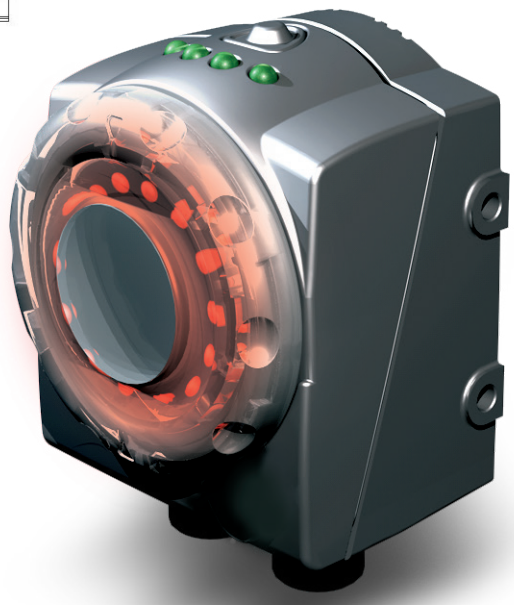
Vision Sensor BVS

Operation Manual





English

www.balluff.com

1 Notes for the user

1.1 About this manual

This manual contains operating instructions and technical documentation for BVS-E Vision Sensors and the BVS Configuration and Visualization software ConVis.
All instructions in this operator's manual, especially the Safety Notes chapter, must be strictly observed.
This operator's manual must be carefully stored so that it is always available.

1.2 Structure of the manual

The Manual is organized so that the sections build on each other.
– General
– Installation of hardware and software
– Creating and applying an inspection
– Locators and Tools
– Interfaces and Outputs
– Inspection changing and Teaching
– References and Advices
– Technical Data
– Annex
For the exact structure refer to the Table of Contens.

1.3 Typographical conventions

This Manual uses the following typographic conventions:

Enumerations

Enumerations are shown in list form with bullets.
– Term 1,
– Term 2.

Actions

Action instructions are indicated by a preceding triangle. The result of an action is indicated by an arrow.
► Action instruction 1.
⇨ Result of the action.
► Action instruction 2.

Orthography

Decimal numbers are shown without additional indicators (e.g. 123),
hexadecimal numbers are shown with the additional indicator "hex" (e.g. 00hex)
Parameters are shown in italics (e.g. *CRC_16*).
References to paths under which data are saved or should be saved are shown in small caps (e.g. Project:\Data Types\User Defined).
Cross-references indicate where additional information on the topic can be found (example: see "Components" on page 9).

1.4 Symbols

Attention!
This symbol indicates a safety instruction which must be followed.

Note
This symbol indicates general notes.

1.5 Abbreviations

ADV	Vision Sensor Typ Advanced
BVS	Balluff Vision Sensor
EMC	Elektromagnetic Compatibility
ID	Vision Sensor Typ Identifikation
OI	Object identification
ROI	Region of Interest",
STD	Vision Sensor Type Standard
TCP/IP	Ethernet protocol
UR	Vision Sensor Type Universal

Note
Other important terms can be found in the glossary.

2 General Information

2.1 Validity

This operating manual is valid for BVS Vision Sensors model numbers (yy = ID or OI or UR)
– BVS yy-3-00x-E,
– BVS yy-3-05x-E,
– BVS yy-3-10x-E , and
– BVS yy-3-15x-E
(x is a number in the range 1 to 7) mit Seriennummer ab 1101001 and B11A00001 resp.
Sensors with other serial numbers are compatible only upto version 1.3.0. Each sensor is identified on the back with a part label. This allows you to determine exactly which model you have. Detailed information can be found in Section "16 Technical Data".

2.2 General description

The functionality described in this Manual refers to sensors having firmware version ST 2.5.0.x and operating software BVS ConVis version 1.5 and higher.

A vision sensor is a comparing or reading sensor for inspection tasks. Vision Sensors are used for reliable production and object monitoring as well as for reading bar and Data Matrix codes.

To inspect a part using a Vision Sensor, you must configure the sensor using the BVS ConVis software, which is available at no charge. The software must be installed on a PC.
As part of the configuration you will create one or more so-called inspections. An "inspection" consists of:
– A learned reference image for each part to be inspected
– The so-called tools, which inspect one or more image regions (hereinafter referred to as "features") in the digital image of the object.
– And the functions assigned to the digital outputs, e.g. Output 1 for the result "Inspection OK" and Output 2 "Inspection NOT OK".
Features may be for example the contrast at a particular location in the image (on the object) or the width of the object.
If all the features meet certain parameters set when the inspection was created, the result of the inspection is OK; otherwise it is NOT OK.
Once you have created an inspection using the BVS ConVis software and sent it to the BVS sensor, you may disconnect the sensor from the PC. The sensor then carries out the inspections autonomously and independent of a PC.

Example

Let us say you want to use a BVS to check whether 4 holes are present at exactly defined positions on a base plate. The surface of the plate appears bright in the image recorded by the BVS, and a hole appears dark. You select the Contrast tool four times and use the software to insert it into the image so that the holes are all in the area inspected by the tool. Then associate Output 1 with the result "Part OK" and Output 2 with "Part NOK". If a plate does not have all 4 holes, this is interpreted by the sensor as "NOK".

Vision Sensors can inspect a variety of part features, including orientation, position, completeness, etc. at a glance.
Using the BVS ConVis software you can also adapt existing inspections or simulate inspections offline (i.e. without having a sensor connected).

2.3 Proper use

The BVS Vision Sensors are image processing sensors for non-contact acquisition and inspection of objects and for reading bar or Data Matrix codes in industrial environments.

BVS sensors are NOT safety components in accordance with the EU Machine Directive!

Use of the sensor is not permitted :
– In explosive atmospheres or explosive environments,
– For medical purposes,
– When the safety of persons or of machinery depends on the device function.

2 General Information

2.4 Safety notes

Carefully read the Operating Guide included with this product as well as this Operating Manual before starting up the device.
Be sure that the product is fully suitable for your application.
Ignoring the Operating Manual and the technical data may result in injury and/or equipment damage.

Attention!

- This sensor is not a safety component according to the EU Machine Directives. It is prohibited to use this sensor in any application where the safety of persons, traffic safety or the safety of machines depends on flawless functioning of the device.
- Observe the accident prevention regulations and all locally prevailing ordinances and safety regulations.
- Installation, wiring and startup are to be performed by trained specialists only.
- The technical data, especially the operating voltage, ripple and protection class must be observed.
- Use only shielded cable such as Balluff BCC M418-0000-1A- 046-PS0825-05. Ensure that the shield is properly grounded. Ensure that loose cable ends are disconnected or insulated before turning on the system. Note correct polarity and installation of the connections.
- The software for the BVS may NOT be installed on PCs or consoles which are used to control the machine!
- The device must be protected from moisture and dirt during hookup, startup and operation.
- The device must be continually protected from mechanical effects such as shock and vibration.
- Place the sensor out of service if non-clearable faults occur.
- Any damage caused by non-allowed manipulation and/or non-permissible use will void the direct manufacturer's warranty.
- The manufacturer assumes no liability for improper use. The manufacturer’s warranty is void if the sensor has been opened.
- Never connect or disconnect the PWR IO cable while power is on. Neither at the sensor side nor on the cabinet side.

Strong artificial radiation as from LEDs, for example, can affect your vision. Our lights are therefore tested by an independent, certified test agency according to the latest applicable standard (IEC 62471).

BVS sensors as well as our lights fall into the “Extempt Group” or (infrared lights only) into “Risk Group 1” and are therefore considered highly safe.
For group classifications and any instructions for use please refer to the manuals which accompany the lights.

LED beam!

- The LED ring in the BVS Sensor is classified in the **Exempt Group** per IEC 62471:2006-07.
- Do not look directly into the light source - there is a risk of glare and irritation!
- Install the sensor so that it is not possible to look directly into the light source.

The definitions of the individual risk groups per IEC 62471 are as follows:

Exempt Group:	No photobiological danger.
Risk Group 1:	Normal restrictions through the behavior of the user mean the light source represents no hazard.
Risk Group 2:	Lamps that may pose photobiological hazards to the eye or skin from even a moderate exposure duration but which first cause an avoidance reaction or thermal discomfort.
Risk Group 3:	Lamps represent a hazard even from momentary or short-time exposure. Use in normal lighting is not permitted.

2.5 New functions in software version 1.5

In the document: BVS-E_Releasenotes_R15_DE contains an overview of new functions or revisions compared with software version 1.4.0. The document can be found on the DVD included with the product or in the Internet.

2 General Information

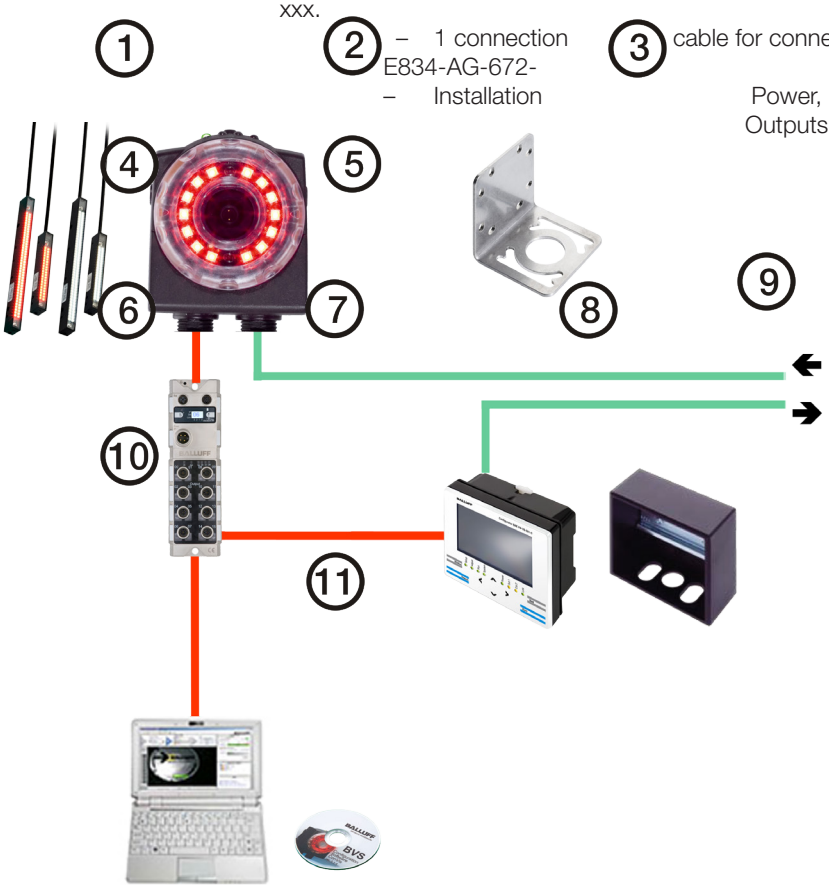
2.6 Revisions to this operating manual

Revisions and any known errors are documented in BVS-E_KnownIssues_R15x_yymm. This document can be found on the DVD included with the product or in the Internet.

2.7 Components

The following components are needed for startup and integration of a BVS-E Vision Sensor:

- 1 Vision Sensor BVS OI-3-xxx-E with integrated light source.
- 1 PC with network connection (Ethernet 10/100 RJ45) under Windows XP SP 3 or
- Windows 7 with BVS ConVis configuration and visualization software installed.
- 1 connection cable for power supply and inputs/outputs: e.g. BCC M418-0000-1A-046-PS0825-xxx.



– 1 connection cable for connecting the sensor to the PC e.g. BCC M415-E834-AG-672-ES64N8-050.
– Installation accessories (see section on “Installation”).
Power, Outputs

Legend:

1. Lights (optional accessory)
2. Vision Sensor BVS-E
3. Mounting bracket and installation accessories (optional)
4. Adaptor + connection cable BCC M454-M454-5D-RM002-000 (adaptor)
   BCC M414-M414-6D-331-PS54T2-200 (cable)
5. Connection cable for BVS-E, e.g.: BCC M418-0000-1A-046-PS0825-050
6. Ethernet-switch BNI EIP-950-000-Z009
7. Connection cable
   Monitor - Switch : as 4.
   Monitor directly to sensor: BCC M415-M415-5D-687-ES64N8-050
8. BVS-E Monitor (housing BAM PC-AE-002-1: optional accessory)
9. Connection cable BVS-E Monitor, e.g.: BCC M418-0000-1A-046-PS0825-050
   Connection cable PC -Switch: BCC M414-E834-8G-668-PS54T2-020
   Connection cable PC- Monitor: BCC M415-E834-AG-672-ES64N8-050
10. PC with installed BVS ConVis-software

Fig. 2-1: BVS-E system overview

A list of the available models for the BVS-E Vision Sensor can be found in the section "16 Technical Data".

2.8 Repair

No changes or modifications to the devices are permitted unless described in this manual.

Repairs are to be performed only by the manufacturer.
If repair should be required, return the sensor in the original packing if possible.
Include a detailed description of the problem.

2.9 Storage and transport

BVS sensors and accessories must be packed so that they are protected from shock and moisture. The permissible ambient conditions specified in the Technical Data must always be observed.

Please retain the original packing materials for storage or for returning the unit.

3 Installation – Connection – Network communication

3.1 Overview of the sensor

Fig. 3-1: Overview of the BVS-E sensor

The initial startup sequence is described in the following diagram. Each bubble represents one of the following sub-chapters:

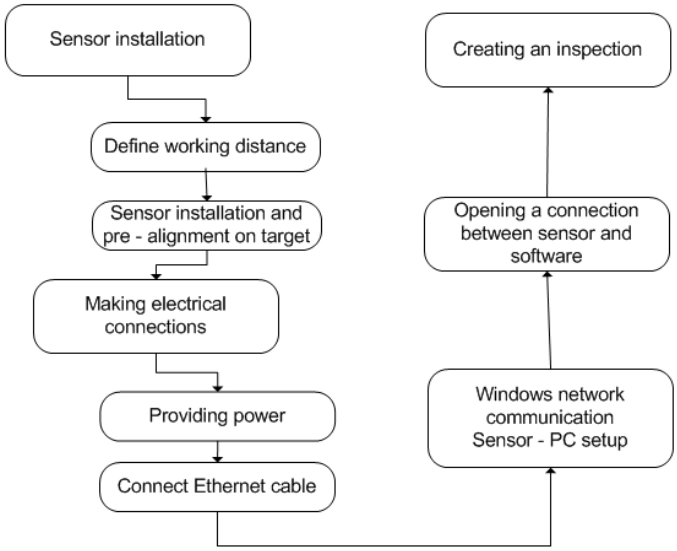


Fig. 3-2: Initial startup sequence

Note
Before first starting up a BVS-E sensor, the current configuration software BVS ConVis version 1.5 must be installed on your PC. For additional information see Section 4.

3 Installation – Connection – Network communication

3.2 Installing the sensor (mounting)

Please note the following factors when mounting the sensor so that reliable sensor function can be assured.
These are:
– Working distance between sensor and the part to be inspected,
– the necessary lighting intensity on the part,
– avoidance of ambient light such as sunlight or room lighting,
– ambient effects such as dust and moisture.

Definitions

Working distance is the distance between the optical face of the sensor and the object.

The **field of view** is the image area which is visible to a sensor at a given working distance. The size of the field of view:
– Is dependent on the focal length of the internal lens,
– Increases with the working distance.

Relationships

Optical resolution
The optical resolution is the ability to distinguish two adjacent details from each other in the image.
The optical resolution depends on:
– The pixel count of the imaging sensor (BVS-E is always 640x480 pixels),
– The focal length of the internal lens,
– The working distance between sensor and object.
This means that if you need a larger field of view, you must increase the distance between the sensor and the part to be inspected. Optical resolution decreases with increasing field of view size. This has consequences for the maximum attainable accuracy. This would include for example if you want to inspect the width of the part.
On our homepage you can find a distance calculator for the BVS. This allows you to quickly and simply determine the field of view at a given working distance and the possible resolution in the X- and Y-direction.

Light intensity on the inspection object
The sensors feature internal lighting. The light intensity on the object decreases AS THE SQUARE of the working distance. This means that farther objects appear darker than objects which are closer.

Example: A bright object needs to be inspected once at a distance of 10 cm and once at a distance of 100 cm.
The brightness of the objects at 10 cm distance is 100x greater than the object when it is at 100 cm distance.

This means the effect of ambient light (e.g. daylight, incandescent lamps) is greater on the inspection result the greater the distance between sensor and object.
The built-in light is generally sufficient for working distances of up to 300 mm. At greater distances we recommend using an additional external light.

Ambient effects
If the sensor optics become contaminated by dust, oil, liquids or other materials or the lens is scratched, the sensor can no longer function reliably. Therefore you should select the mounting location such that contamination of any kind can be prevented, or you must clean the sensor regularly.
The specified ambient conditions must be maintained!

Ambient light
To achieve good and reliable results when using a Vision Sensor it is very important that the light intensity on the object remain as constant as possible after setting up the sensor. The most frequent cause of variations in the light intensity is ambient light, e.g. daylight or other external sources such as room lighting which is turned on and off.

To reduce the effect of variations in the light intensity, the lighting intensity on the part to be inspected should be as great as possible. This also means the exposure time selected for the inspection during sensor configuration can be very short; this tends to overcome the effect of ambient fluctuations.
If the built-in light is not sufficient, you may use an external light in your application. .

3 Installation – Connection – Network communication

Note
All BVS infrared sensors have an integrated infrared pass filter.
This filter allows only infrared light to pass through, whereas visible light is strongly attenuated.
We recommend the use of infrared sensors when ambient light may be present in the application.

Caution!
The sun also radiates infrared light. Strong sunlight may cause problems in the application in spite of the integrated filter!

Sensor installation

To make it easier to install the sensor we offer a wide range of accessories.
The following illustration shows the mechanical attachment of the sensor using these mounting accessories
.

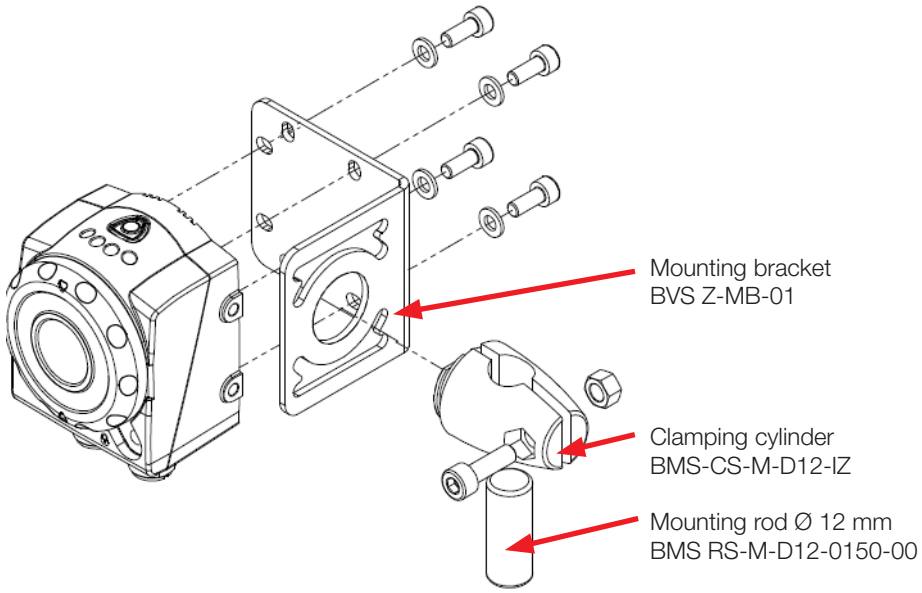


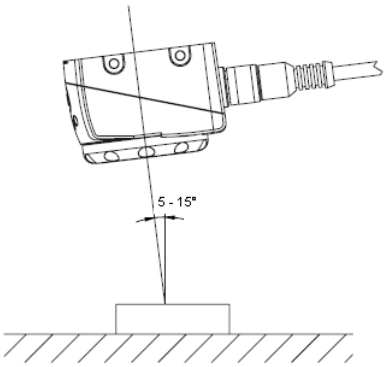
Fig. 3-3: Sensor attachment using mounting accessories

Select the mounting location of the sensor so that the inspection object is not subjected to direct sunlight or strong ambient light (room lighting, optical sensors, lasers) while it is in the sensor field of view.

Install the sensor so that is always protected from mechanical effects such as bumps and vibration.

Install the sensor so that contamination can be precluded. To configure the sensor using the associated operating software the sensor connections should be easily accessible.

3 Installation – Connection – Network communication



If you want to inspect an object having reflecting surfaces, we recommend installing the BVS at an angle of 5 to 15 degrees to the vertical axis to prevent unwanted reflections.

Fig. 3-4: Mounting and aligning the sensor

Clean the sensor lens after installation using a clean, soft cloth. If necessary, dampen the cloth with a mild, non-abrasive cleaning solution. Be sure not to leave any streaks!

Attention!
Aggressive cleaning agents such as acetone or thinners should NEVER be used for cleaning. This can leave the sensor lens cloudy!

To attach the sensor, use 4 M4 x 8 mm screws, which are included with the sensor.

Roughly align the sensor with the inspection object.

Note
At working distances of greater than 300 mm we recommend use of an additional external light to reduce the effect of ambient light.

More information on the topic of lights can be found in Section "6 Lights".

Setting focus / focusing ring

Turn the focus ring on the sensor to set the focus. Turning the ring clockwise brings farther objects into focus.
Turning the ring counter-clockwise brings closer objects into focus.

Fig. 3-5: Setting the focus

3.3 Making the electrical connection

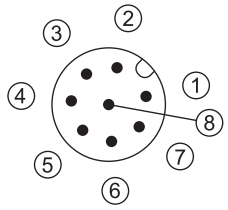
The BVS E sensors are connected using two differently coded M12 connectors. This ensures that the connections are always proper.
In the following we refer to the 8-pin, A-coded connector as PWR IO, and the 4-pin D-coded as TO PC (Ethernet).

3 Installation – Connection – Network communication

To attach the connectors Balluff offers pre-assembled cables.
There are various pin configurations for the different BVS models.In Chapter 3.3.1 you will find notes concerning connection of the Standard (STD) and Advanced (ADV) models, and Chapter 3.3.2 contains corresponding information for the Ident (ID) and Universal (UR) models.

3.3.1 Providing supply voltage STD and ADV

Pin contact connector, 8-pin, A-coded (Connector PWR IO)



Pin	Wire colors BCC M418-0000	Function
1	White	Input Select
2	Brown	24 V DC
3	Green	Trigger output – External light (see explanation in Section 16.2.4) **or** (serial number 0943xxx or higher only) Output 4
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	Output 3
7	Blue	Ground 0 V
8	Red	Trigger input

Supply voltage

Please connect PIN 2 of the PWR IO connector using an 8-conductor, shielded cable (Recommendation: BCC M418-0000-1A-046-PS0825- xxx) to 24 V DC; PIN 7 to 0 V.

Attention!
Never connect or disconnect the PWR IO cable while power is on. Neither at the sensor side nor on the cabinet side. .

Connecting the in- and outputs

Note
If you simply want to perform a test run with the sensor, you do not have to connect the in- and outputs. In this case we recommend insulating the single wires of the in- and outputs before startup.

Function	Type	Description
PIN 1 SELECT	Input	Used for external inspection switching. If you want to use the inspection switch function, connect this pin to a digital output, e.g. on a PLC.
PIN 3 Trigger Ext. lighting / Output 4	Output	To synchronize an external light with the sensor, connect PIN 3 of the sensor to the trigger input of the light. The light must in any case be supplied with power. If you are not connecting an external light, you may also use this PIN (hardware version > 2.0) as Output 4. More information about this can be found in the section "10.1 Setting outputs". **Note:** The hardware version of the sensors can be verified by software by clicking on INFO in the Help menu.
PIN 4 -6 Outputs 1-3	Output	The function depends on the configuration. Connect the outputs to the digital inputs of a PLC for example. Please note the maximum output current if you connect the output directly to a load.
PIN 8 Trigger input	Input	Connect this input for example to the switching output of a sensor used as a “trigger” for the Vision Sensor. We recommend use of an external trigger when inspecting moving parts. More information about use of a trigger signal can be found in Section “5.3.6 Trigger settings”.

3 Installation – Connection – Network communication

Attention!
Ensure that the electrical reference potential (GND) of the switching output of an external trigger sensor or a PLC agrees with that of the BVS sensor when you are connecting the switching output to the trigger input of the sensor!
If there is a different reference potential between trigger sensor and BVS the external triggering may malfunction (BVS does not perform an inspection even though it is externally triggered).

Grounding

Connect the cable shield at the open cable end to ground potential!

Wiring diagram

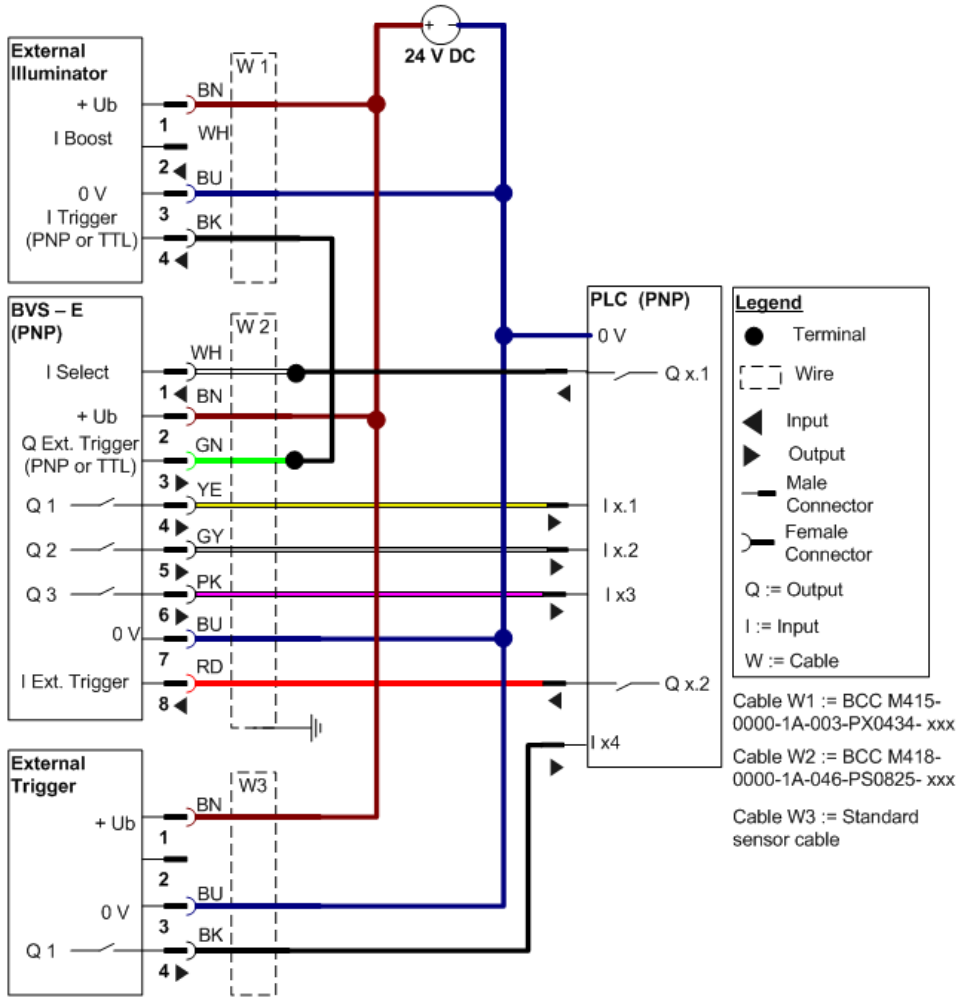


Fig. 3-6: Wiring diagram of the BVS-E sensor

Sensor ready

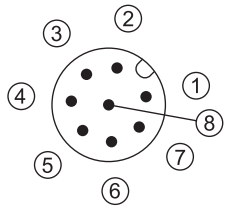
After turning on power the sensor loads its current configuration from the internal memory.

The sensor is UNABLE to perform an inspection during the first 10 seconds after being turned on, NOR may the PLC be allowed to change the inspection type during this time.

3 Installation – Connection – Network communication

3.3.2 Providing supply voltage: ID and UR

Pin contact connector, 8-pin, A-coded (Connector PWR IO)



Pin	Wire colors BCC M418-0000	Function
1	White	RS 232 RxD
2	Brown	24 V DC
3	Green	Trigger output – External light **or** Output 4
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	RS 232 TxD
7	Blue	Ground 0 V
8	Red	Trigger input

Note
The cable for the BVS ID/UR should never be plugged in when power is on!!

Supply voltage

Please connect PIN 2 of the PWR IO connector using an 8-conductor, shielded cable (Recommendation: BCC M418-0000-1A-046-PS0825- xxx) to 24 V DC; PIN 7 to 0 V.

Note
If you simply want to perform a test run with the sensor, you do not have to connect the in- and outputs. In this case we recommend insulating the single wires of the in- and outputs before startup.

Connecting the in- and outputs

Function	Type	Description
PIN 1 RS232 RxD	RS232	Receive Data line for the RS 232 interface
PIN 3 Trigger Ext. lighting / Output 4	Output	To synchronize an external light with the sensor, connect PIN 3 of the sensor to the trigger input of the light. The light must in any case be supplied with power. If you are not connecting an external light, you may also use this PIN as Output 4. More information about this can be found in the section "10.1 Setting outputs".
PIN 4 -5 Outputs 1-3	Output	The function depends on the configuration. Connect the outputs to the digital inputs of a PLC for example. Please note the maximum output current if you connect the output directly to a load.
PIN 6 RS232 TxD	RS232	Transmit Data line for the RS 232 interface
PIN 8 Trigger input	Input	Connect this input for example to the switching output of a sensor used as a “trigger” for the Vision Sensor. We recommend use of an external trigger when inspecting moving parts. More information about use of a trigger signal can be found in Section “5.3.6 Trigger settings”.

Attention!
Ensure that the electrical reference potential (GND) of the switching output of an external trigger sensor or a PLC agrees with that of the BVS sensor when you are connecting the switching output to the trigger input of the sensor!
If there is a different reference potential between trigger sensor and BVS the external triggering may malfunction (BVS does not perform an inspection even though it is externally triggered).

3 Installation – Connection – Network communication

Grounding

Connect the cable shield at the open cable end to ground potential!

Wiring diagram

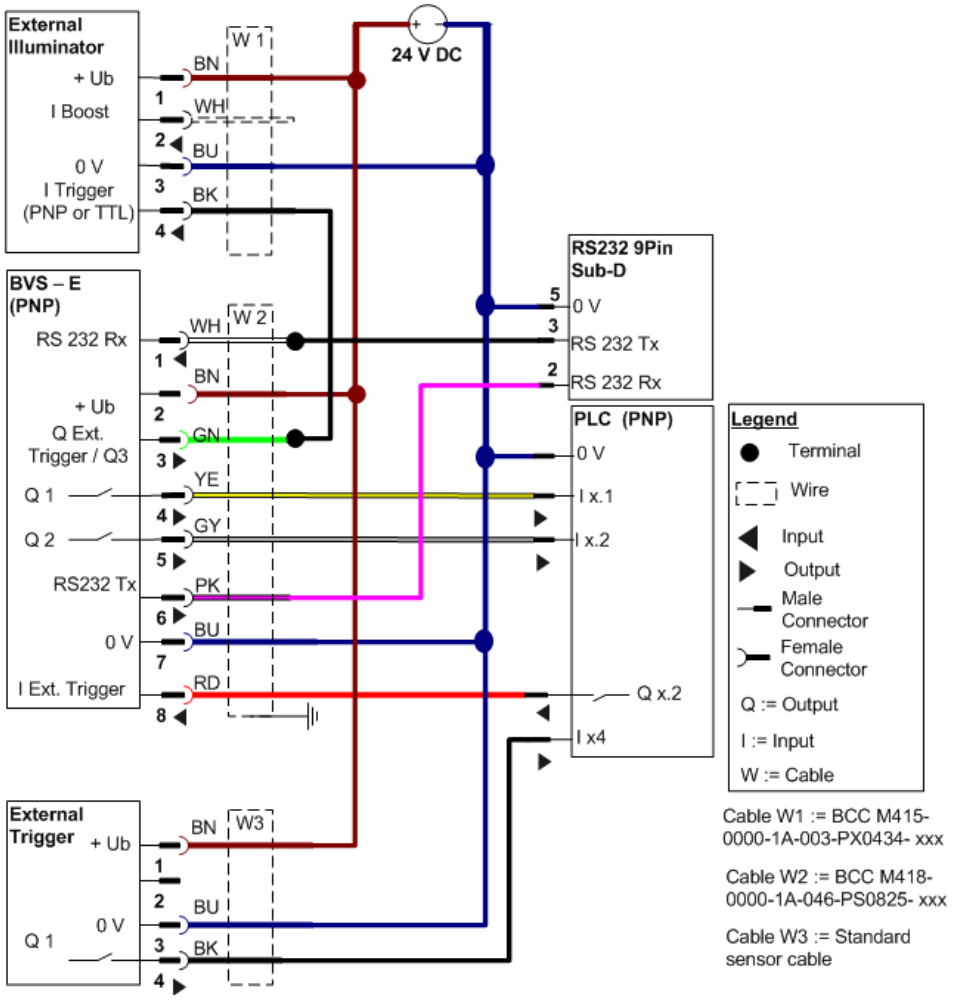


Fig. 3-7: Wiring diagram of the BVS-E sensor ID and UR

RS232 Electrical Connection:

- ► Connect PIN 1 (RS232 Rx) to Pin RS232 Tx on the opposite side (e.g. the PC or PLC) ,
- ► Connect PIN 6 (RS232 Tx) to Pin RS232 Rx on the opposite side.
- ► Connect sensor ground to the ground on the opposite side (same potential).

Sensor ready

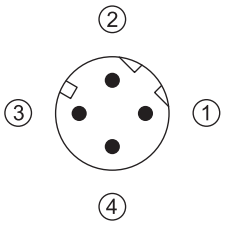
After turning on power the sensor loads its current configuration from the internal memory.

The sensor is UNABLE to perform an inspection during the first 10 seconds after being turned on, NOR may the PLC be allowed to change the inspection type during this time.

3 Installation – Connection – Network communication

3.3.3 Connector TO PC: Ethernet

Pin contact connector, 4-pin, D-coded



Pin	Function
1	Rx+
2	Tx+
3	Rx-
4	Tx-

When first starting up the sensor, connect it directly to the PC:

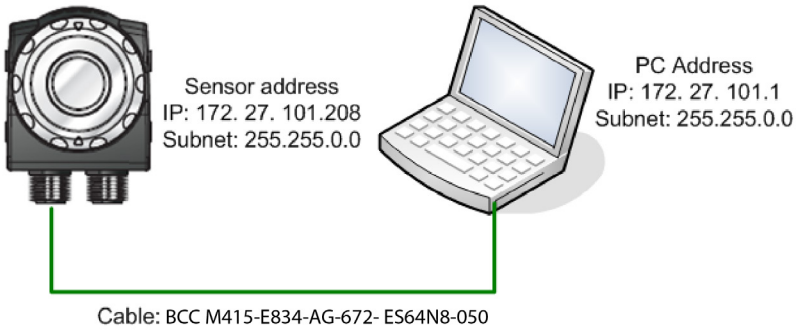


Fig. 3-8: Direct connection of the sensor

First unplug all existing Ethernet cables from your PC.

The sensor plug TO PC must be connected to an Ethernet 10/100 terminal on the PC using a "crossed" Ethernet cable. We recommend using the BCC M415-E834-AG-672- ES64N8-050 cable.

Please check the network setting on the PC as described in the next section.

3.4 Windows network communication Connect sensor ↔ PC

When first starting up a BVS-E sensor, you must check the network settings on your PC. This should be done **before** installing the BVS ConVis configuration software.

Note
To be able to follow the next instructions, you must as the user have Administrator rights. Please contact your IT representative if you do not have these rights.

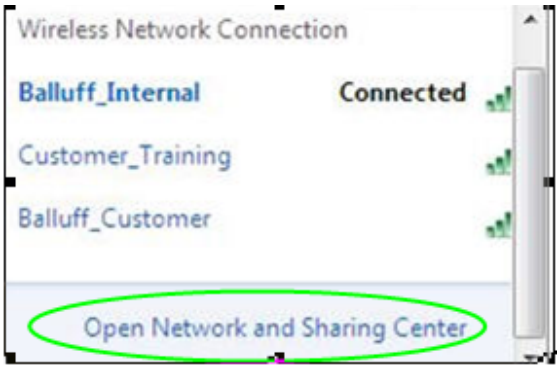
Settings Windows 7

Windows 7:
The following information and details are provided as a guide for a quick change to the Ethernet IP address in a Windows 7 operating system.

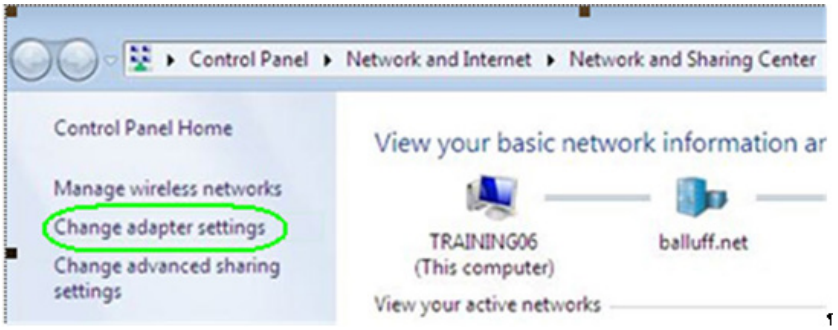
► In the lower right corner of Windows 7 click on the antenna strength Icon or Monitor Icon (all icons or buttons to press are shown highlighted by a green ellipse or circle throughout this chapter)

► Now click on “Open Network and Sharing Center” on the bottom of the pop up dialog.

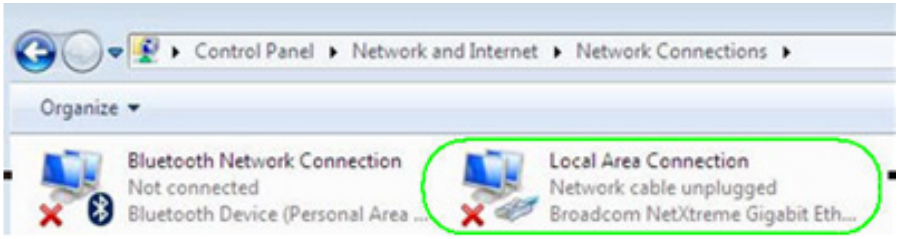
3 Installation – Connection – Network communication



Windows show this window:

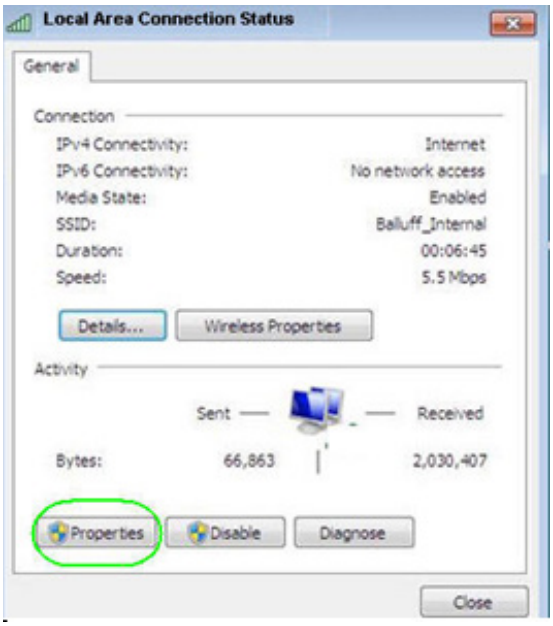


- ► Now click on the left column “Change adapter settings”
- ► Then double click on “Local Area Connection” in the new window:

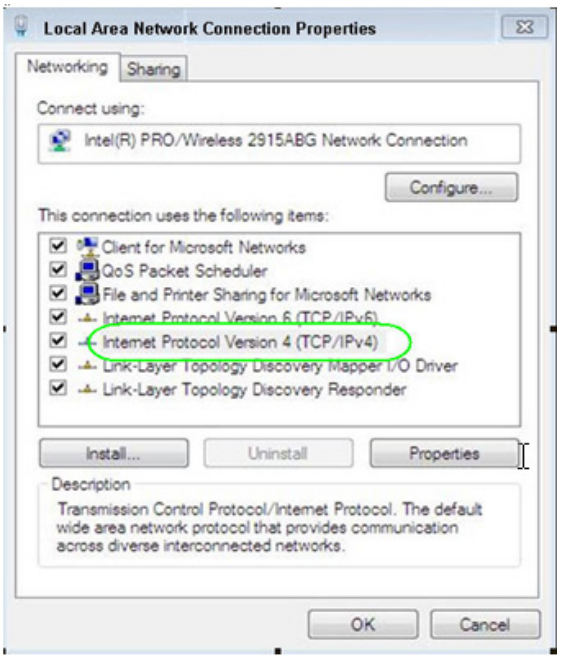


- ► Now click on “Properties”

3 Installation – Connection – Network communication



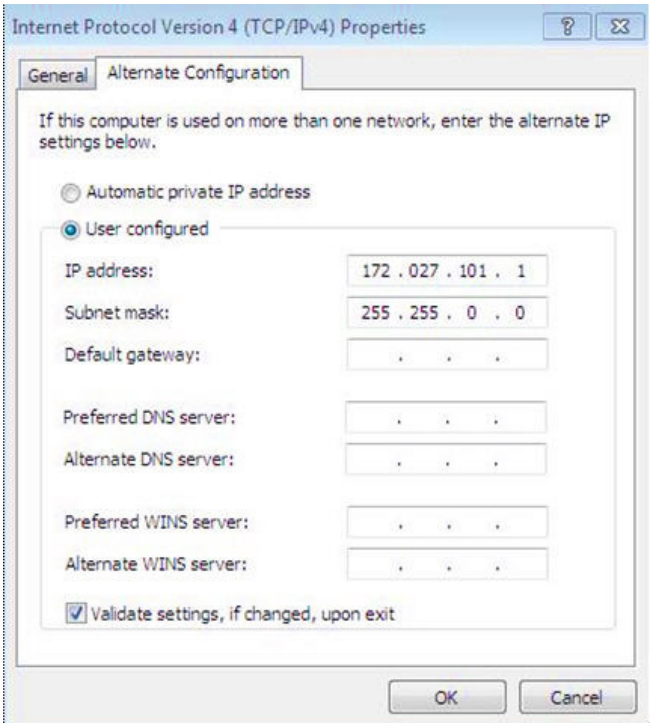
► Then Double click on “Internet Protocol Version 4 (TCP/IPv4)”



Keep the setting: OBTAIN IP Adress automatically.

► Now click on the tab: “Alternate IP Address”

3 Installation – Connection – Network communication



► Enter the following IP address and subnet mask:
IP address: **172.27.101.1**
Subnet mask: **255.255.0.0**

Note
For “Standard gateway” or “Use this DNS server address” no entries are required.
REMOTE MAINTENANCE of the sensor through a GATEWAY is not possible.

Nach dem Abschluss der Einstellungen sucht Ihr PC automatisch nach einem Netzwerk an dieser Verbindung.
Je nach Einstellung Ihres PCs wird der aktuelle Zustand der Netzwerkverbindung in der Windows Taskleiste (rechts unten) angezeigt.

4 BVS ConVis - Installation

4.1 First installation of BVS ConVis

In order to configure the sensor, you must have the supplied (or available via download from the Balluff homepage) BVS ConVis software installed on your PC.
Have you already installed the software?
Continue in the section "Connect sensor and software" to link the sensor with the software.

4.1.1 Minimum system requirements

The PC/laptop must meet the following requirements in order to run the software:

Components	Recommended	Compatible
Processor(s)	Pentium 4 or better performance	Pentium 4
Operating system	Windows 7	Windows XP, Windows 8
Clock frequency	≥ 2 GHz	≥ 1 GHz
RAM	2 GB	1 GB
Available hard disk space	150 MB	100 MB
Screen	1024 x 768 pixels	1024 x 768 pixels
Rights Windows XP	Full access for any files in C:\Documents and Settings\All Users\Anwendungsdaten\Balluff\BVS ConVis 1.5. Possibly you have to ask to your administrator to adjust the user rights for your account after installation.	Full access for any files in C:\Documents and Settings\All Users\Anwendungsdaten\Balluff\BVS ConVis 1.5. Possibly you have to ask to your administrator to adjust the user rights for your account after installation.
Rights Windows 7	Full access for any files in C:\Program Data\Balluff\BVS ConVis 1.5 . Possibly you have to ask to your administrator to adjust the user rights for your account after installation.	Full access for any files in C:\Program Data\Balluff\BVS ConVis 1.5 . Possibly you have to ask to your administrator to adjust the user rights for your account after installation.
	Attention: As Windows 7 default Program Data is normally a hidden folder!	

– DVD-ROM drive.
– Installed Ethernet network card and installed driver.
– An available 10/100 Mbps Ethernet connection on the PC.
– BVS configuration software "ConVis" from Balluff (supplied with the sensor).

Besides the configuration software, the following software packages from Microsoft must be installed:
1. Microsoft .NET Framework 4.0 SP1
2. Microsoft Visual C++ 2008 Redistributable

Program packages 1 and 2 are included on the DVD supplied with the BVS-E.

4.1.2 First installation

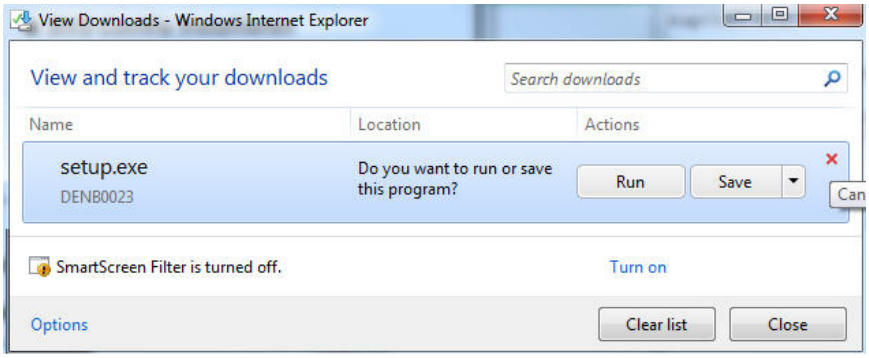
Note
The following instructions apply initial installation of the BVS ConVis software. First please perform the steps described in the section "Updating the software" if version 1.2 or older of the BVS ConVis software is already installed on your PC.

We recommend closing all running programs.
► Insert the DVD with the ConVis BVS configuration software in a DVD drive of the local PC. The DVD will start automatically.
► Select **Install BVS** from the displayed menu.

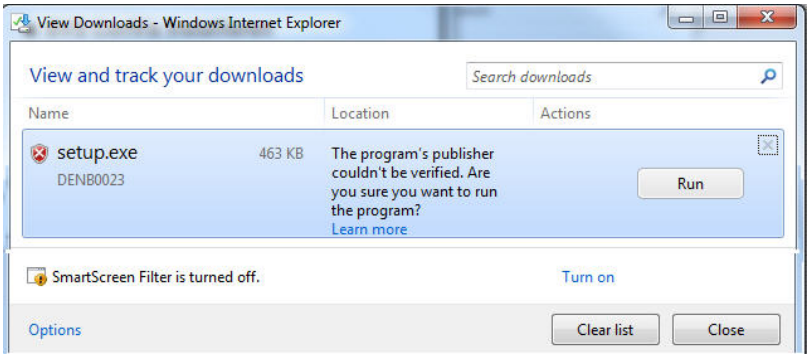
Note
To be able to follow the next instructions, you must as the user have Administrator rights. Please contact your IT representative if you do not have these rights.

4 BVS ConVis - Installation

⇨ Depending on your Windows Security settings Windows will start the Internet Explorer or another browser and display a dialogue like this:



► Please click "**Run**".
In the case now this or something similar is shown:



► press "**Run**" again.
⇨ This will start the installation.
If the DVD does not start automatically, you can find the **setup.exe** file in the directory: **User_Interface_EN** on your DVD drive.
► Start the installation by double clicking on the file "**setup.exe**".
The program is installed. After installation is complete, click on “Close”.

Note
The installation program checks whether the necessary program packages listed in Section 4.1.1 are already installed on your PC. These programs are **absolutely essential**. Please allow these programs to be installed when prompted.
The programs are subject to software terms and conditions of Microsoft Corporation. You must agree to these conditions separately from the conditions which apply to the Balluff ConVis software.

4.1.3 Firewall settings

After installation of the BVS ConVis software check the settings of your firewall. The software uses UDP protocol on ports 5090 and 5091 to locate sensors.
The software uses TCP/IP protocol on port 5423 for communication.
Please check whether your firewall allows these ports and if necessary enable the program BLayout.exe (see installation directory).

4.2 Updating the software

Each sensor is shipped with the newest available BVS ConVis software. Currently this is 1.5.1. Balluff provides updates with improved and new functions for this software on their Web site. If you are using older ConVis software and want to update it, please simply follow these steps:
► If you are currently running a version of BVS ConVis, please exit it first.
► Download the current software from the Balluff Web site if you have not already done so.
► Open the folder containing the download and double-click on “setup.exe”.
► Install version 1.5 as described in Section 4.1.2.

4 BVS ConVis - Installation

Older versions must be UNINSTALLED. To do this:

- Are you using version 1.1.4 or older? Then first save the “Projects” folder in the installation directory of the program (e.g. C:\Programs\Balluff\BVS ConVis\Projects) if it contains important inspections already completed.
- Uninstall the software using the Microsoft Windows software function.
- Click on the Windows "Start" button, select "Control Panel → System → Software".
- Select “BVS ConVis” from the list of installed programs and click on the “Delete” button on the right side of the screen.
- Copy the saved inspections to the installation directory of the updated BVS-ConVis Version (XP: C:\Documents and Settings\All Users\Application Data\Balluff\BVS ConVis 1.5; Win7: C:\Program Data\Balluff\BVS ConVis 1.5)

4.3 Updating the firmware

Each BVS sensor is shipped with the most current firmware. The firmware version in the sensor works reliably only with the BVS-ConVis version contained on the accompanying DVD.

Whether the sensor firmware is compatible with the respective BVS-ConVis software is checked by the software when opening a connection to the sensor. If the software is older than the firmware in the sensor, you receive the following message:
“Unknown firmware, a connection could not be opened to the sensor."
If the firmware is older than the software, then the following message appears:
“Please update the sensor firmware. Otherwise correct sensor function cannot be guaranteed!”
In this case proceed as follows:

- Use the following table to check whether you can perform an update with Version 1.5:

Firmware in sensor	Current firmware
	ST2.4.0.XX
ST2.2.1.XX	Can not be updated Please contact our Service department.
ST2.3.0.XX	The sensor can only be updated if the serial number is higher than 1101001 or B11A0001 e.g. 1139042 or B11C00034. 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor needs to be restarted after the update.
ST2.4.0.XX	The sensor should only be updated if the inspection in the PC is NEWER than the version on the sensor. The following actions are carried out: 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor needs to be restarted after the update. **4. BVS Ident and BVS Advanced Sensors:** In the new version the image saving conditions of each inspection can be set via the logic conditions. It is important to setup the right saving conditions for all inspections after updating the sensor to Firmware ST 2.4.x.y as the old Conditions like ALL; ONLY GOOD; ONLY BAD are not maintained anymore. **5. BVS Ident only:** Be sure to check the RS232 Communication mode setting (Synchronous, Asynchronous) in the Sensor Settings Menu after the update as there is only one setting for the whole sensor anymore.
ST2.5.0.XX	The sensor should only be updated if the inspection in the PC is NEWER than the version on the sensor,or if you need new functions or a bugfix provided with this version. The following actions are carried out: 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor automatically restarts after the update!

4 BVS ConVis - Installation

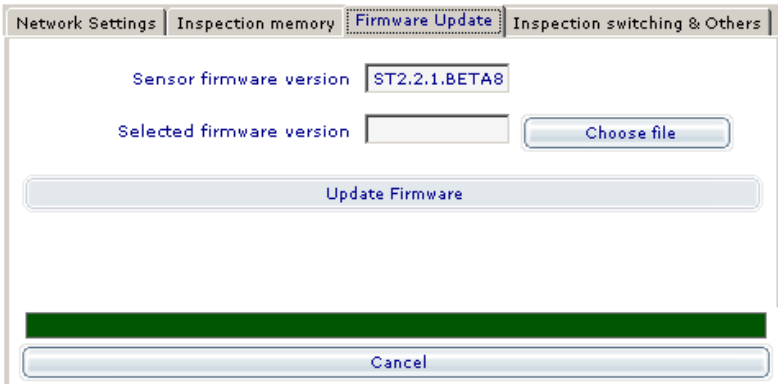
4.3.1 General update sequence

Close the dialog with the message that the sensor firmware is out of date.

- ► Select the “Settings” entry from the Sensor menu.
  - ⇨ The Sensor Settings dialog box opens.
- ► Click on the “Update firmware” tab.
  - ⇨ The firmware version currently available on the sensor is shown in the field: “Sensor firmware version”.
- ► Now click on the “Select firmware” button.
  - ⇨ The software opens a file dialog box and shows you the folder with firmware files (file extension .sfw2).
- ► Select the file having the highest version number.

Example: Assuming these two files are available: ST_2.5.1.01.sfw2 and ST_2.5.2.03.sfw2. In this case select ST_2.5.2.03.sfw2.

- ► Now click on the “Update firmware” button.



The BVS ConVis software now updates the sensor and displays the progress; after successful updating of the firmware a message appears.

4.3.2 Converting inspections

To convert an old inspection (file extension .bvs , .bvs2 or .bvs3) to an inspection compatible with Version 1.5 (file extension .bvs5) proceed as follows:

- ► Click on “Open from PC” in the “File” menu.
- ► Then select “File type” “.bvs” , “.bvs2” or ".bvs3" to display files for the previous inspection type.
- ► Then select the file you want to convert and click on OK.
  - ⇨ The software now opens the selected file in the previous version.
- ► Click on “Save on PC” from the “File” menu and select .bvs5 as the “File type”. Click on OK.
  - ⇨ The software now saves the file in the new version – all new functions are now available.

Important!
After conversion test to be sure your inspection still works reliably. Please refer here to the instructions in the Release Notes!

4 BVS ConVis - Installation

4.4 Overall view

The following illustration shows an overview of the BVS user interface directly after starting the software.

Fig. 4-1: BVS user interface - Overall view

Each area is explained separately in detail in its own section. Go to these sections using the following links:

- Menu bar
- Toolbar
- Setup field
- Control panel
- Frame buffer
- Image display / Work area
- Inspection Explorer
- Help field
- Status bar

4.5 Opening a connection between the sensor and the software

Note
Up to and including firmware version ST 2.4.0.xx it was necessary to restart the sensor after changing the IP address or other sensor settings. From firmware 2.5.0.xx the sensor will automatically restart when the change was made. For sensors with an older firmware version, the procedure is here described yet.

Definition
Throughout this manual the term "Restart the sensor" describes the following procedure::

1. Close (if open) connection between software and sensor.
2. Power down the sensor (do not disconnect the cable)
3. Power up the sensor

4 BVS ConVis - Installation

4.5.1 PC-Sensor direct connection

Prerequisite
BVS ConVis installed on the PC.
Directly connect PC to sensor (see Fig. 4-2)
Windows network connection established (see Section 3.4) .

To make a connection between the sensor and the BVS ConVis software, please follow these instructions:

- ► Connect sensor to power (connector PWR IO Pin 2: 24 V DC; Pin 7: 0 V).
- ► Unplug all existing Ethernet cables from your PC.
- ► Plug the TO PC connector into the Ethernet 10/100 terminal on your PC using a crossed Ethernet cable.

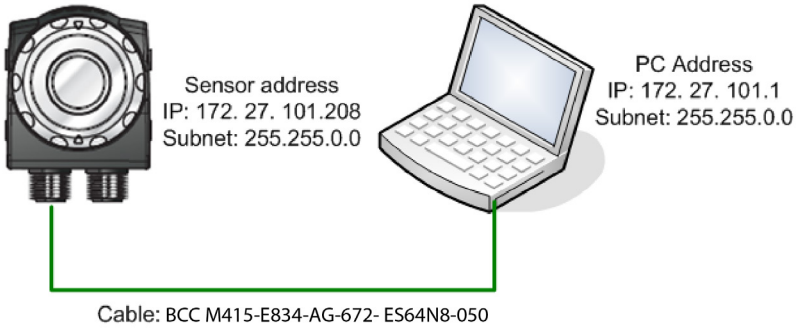


Fig. 4-2: Direct connection of the sensor

- ► Start the BVS ConVis software.
- ► To configure the sensor using the software, you must click on “Find sensors” in the “Select connection mode” window. After a short wait time the software will display the found sensors in the so-called control panel (upper right).
- ► Click on the “Connect” button. The software reports "Connected to BVS”.

4.5.2 Sensor in a network with DHCP server Definition

You have successfully established communication and may now configure the sensor. Continue in Section “5 Creating an inspection”. If “Find sensor” does not locate a sensor, or the found sensor is highlighted in RED, then refer to Section “12.7.2 Fault elimination”.

Dynamic Host Configuration Protocol (DHCP) allows you to assign a network configuration to network devices from a server. DHCP allows network devices which are connected to an existing network to be automatically configured.

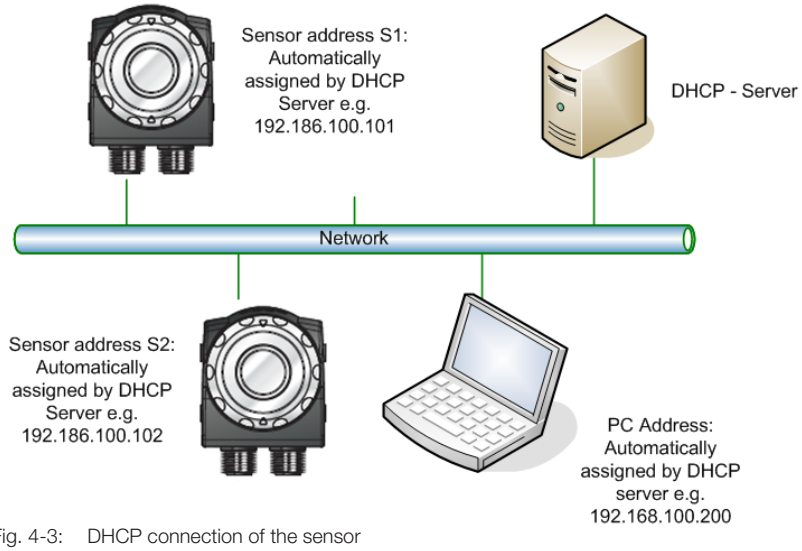
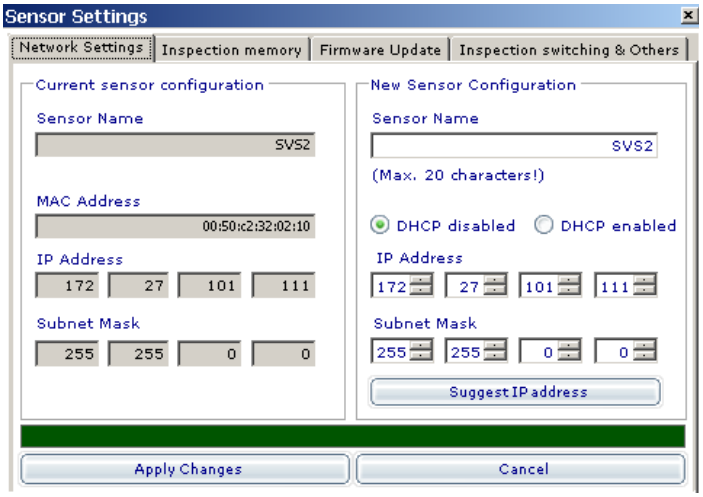


Fig. 4-3: DHCP connection of the sensor

4 BVS ConVis - Installation

To incorporate multiple sensors into a network with DHCP protocol, initial startup for each sensor must be carried out as described in Section 3 and “DHCP protocol” must be enabled in the sensor settings.
To do this proceed as follows:

► After you have made a connection between software and sensor, click on menu item "Sensor" and then select "Settings".



► Then select “Enable DHCP” and close the window.
► Now click on offline.
► Disconnect the network plug from the PC.
► Now connect the TO PC connector to an RJ-45 network terminal of the network with DHCP Server (e.g. using the BCC M415-E834-AG-672- ES64N8-050 cable).
► Restart the sensor (reapply power).

After (connection to the network OR restart) the sensor waits for 3 minutes for instructions to configure using the DHCP server (LED2 flashes). As soon as a network address has been assigned, LED2 turns off. If after 30 seconds no network address has been assigned, the sensor uses the preset IP address (Default: 172.27.101.208).

► Connect your PC to the DHCP network. As soon as a connection is opened, you can use “Find sensor” to make a connection between sensor and software.

5 Creating an inspection

Definitions
1. Inspection

What we refer to as an “Inspection” is a configuration file which is created using the BVS ConVis software and can be stored on the sensor (or PC).
An “inspection” consists of:
– A ‘taught’ reference image,
– The so-called tools, which inspect one or more image regions (hereinafter referred to as “features”) in the digital image of the object.
– And the functions assigned to the 3 (optional 4) digital outputs, e.g. Output 1 for the result “Inspection OK” and Output 2 “Busy-Ready”.

2. Part feature and ROI

A parts inspection using the Vision Sensor is not done on the entire part (image), but rather only on certain part features specified during configuration which occupy the particular regions of interest.
Example:
You want to check whether holes have been drilled in a plate at certain locations. The surface of the plate appears bright in the image and a hole appears dark.
During configuration you must select which tool you want to use for inspecting this part feature AND where this part is in the image.
For example to check the presence of the hole, we select the Contrast tool and insert it into the image so that the hole is in the area which is inspected by the tool.
The number is based on the available memory and is managed by the system.

3. Tools

Tools are predetermined evaluation functions which can inspect various “part features", such as part position or width or the presence of an imprint (Pattern detect). When configuring the sensor you must select the appropriate tools for your task, position and parameterize them.
The result of a tool is either OK or NOT OK.

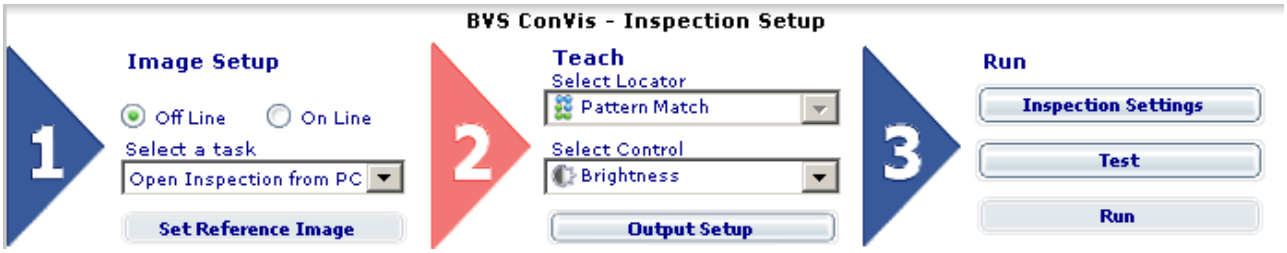
4. Inspection result

If all the features meet the parameters set when the inspection was created, the result of the inspection is OK, otherwise it is NOT OK.

Software BVS ConVis

The BVS ConVis software allows you to display images recorded by the sensor, to parameterize the sensor, create new inspections or adjust already existing inspections. The software guides you through setup of an inspection in 3 steps:
Step 1: Connect
Step 2: Parameterize tools and outputs
Step 3: Test and apply
Each step is indicated by a number; the currently active step is highlighted in LIGHT RED, inactive steps are shown in **BLUE** or **GRAY**. For example to return from Step 2 to Step 1, click on the triangle with the corresponding number. The selected step is then highlighted in **LIGHT RED**.

After successful parameterization of the sensor, you may disconnect the sensor from the software and PC. The sensor can run autonomously.



Note
If you have already opened a connection between the sensor and the PC, please read the following “Basic Considerations” and then continue from “5.2.1 Creating a new sensor inspection”.

5 Creating an inspection

5.1 Basic considerations

The following considerations apply both for each individual feature and for the entire part to be inspected.
Only in very few cases does a “good” feature (part) agree 100% with the feature (part) you have “inspected” when the inspection was created. Position shifts, variations in ambient light or the always present feature variation (parts variation) can all affect agreement.
Each “bad” feature should therefore be as different as possible from a “good” feature.

Good image quality and good contrast are the basis for successful inspection.
The following instructions should therefore always be observed:

- ► Determine which part feature you wish to monitor.
- ► Set the focus as sharp as possible. In general, sharp and clear contours in the image are better than out-of-focus contours.
- ► Be sure that the feature in question is fully in the field of view.
- ► Provide even illumination for the inspection features.
- ► Ensure that the difference between “good” and “bad” for the product feature is as great as possible.
- ► Align the light (or sensor) so that the difference between a good feature and a bad feature is as clear (contrasty) in the image as possible. The ideal is a change from white to black or black to white between a good and bad feature.
  Example: You want to check whether holes have been drilled in a plate at certain locations. The surface of the plate appears bright in the image and a hole appears dark. If holes are missing, then the image area where the hole should be will be brighter than normal.
- ► Minimize the effects of ambient light on the features, for example by using external lights or shading the features from ambient light sources, for example using a mechanical screen.
- ► Select the tools for the inspection using the tool descriptions ("8.1 Inspection tools").
- ► Create parameters and tolerances for the tools so that process-reliable detection is possible even under changing ambient conditions.

We recommend using multiple good parts and multiple bad parts when testing your application. Also take into account possible changes in the lighting conditions as well as the location when you select the desired value which represents the "border" between a good and bad part. More information on the topic of lights can be found in Section “6 Lights”.

5.2 Considerations for reading codes (Ident and Universal only)

The following considerations apply generally for reading codes using Vision Sensors.

Only in very few cases does every code agree 100% with the code which you have “inspected” when creating the inspection. Position shifts, fluctuations in the ambient light or the always present variation in the printing or in the part surface may cause greater or lesser differences.

Good image quality, contrast and correct resolution are necessary in order to successfully implement your application. The following instructions should therefore always be observed:

- – Select the working distance between the sensor and the code based on the reading field diagrams in the Appendix of this document. The “module size,” i.e. the width of the narrowest bar (for barcodes) or the side length of the square (for Data Matrix codes) must be known. If the working distance **selected is too great**, then reading will be difficult or impossible.
- – The values given in the reading field diagrams are **maximum values** for a particular module size. This means: For a particular module size the working distance must be **less than or equal** to the specified distance!
- – Place the test card included with the sensor in the field of view, if needed on the or closely in front of the object, so that the working distance and focus can be properly set.
- – Select the code from the test card which is closest in size to the bars or “squares” (hereinafter called modules).
- – Set the working distance and focus so that the bars / modules in the unenlarged image can be easily distinguished from each other. If the bars/modules blend together, reliable reading will not be possible.
- – The image must be sharply focused on the code.
- – Remove the card and now set your code. You may have to refocus.
- – Be sure that the code you wish to read is fully in the field of view.

5 Creating an inspection

- Set the lighting so that the contrast between the dark and light bars/modules is as great as possible.
- Ensure that the code is evenly illuminated - uneven code lighting may result in incorrect readings.
- Minimize the effects of ambient light on the features, for example by using external lights or shading the “read station” from ambient light sources, for example using a mechanical screen over the read station. (More information on the topic of lights can be found in Section “6 Lights”.)
- Select the correct tool based on the code type – note the quality parameters when making your setting. The overall quality of the target code should be as high as possible.
- Test the settings and ensure that your settings enable process-reliable reading. We recommend trying out different codes when testing your application. Also take into account possible changes in the lighting conditions as well as the location in the test.

For a one-dimensional barcode a module is the narrowest element (bar or gap) in a code.

Thinnest bar = module width

Barcodes used to be exclusively printed. Depending on the selected “**print resolution**” (DPI) different module widths in mm were the result.

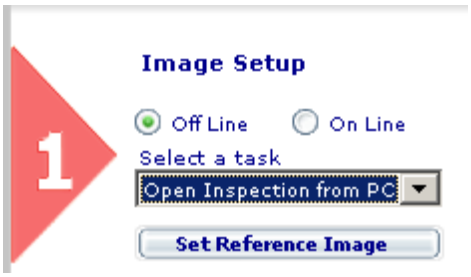
For Data Matrix codes a **module** is considered to be one **bit** (black or white). The module size (also module width) is the edge length of a bit in **millimeters** or **micrometers**. Data Matrix codes are scalable, i.e. the module size can be adapted to the application.
In this way a module in medical technology may for example as small as 30 **micrometers**, whereas a module in a code for pallet identification may be several **centimeters** in size.

		Increasing module size from LEFT to RIGHT The module shape may also be different. For example, square and round modules are often encountered.

Using a high-quality printer **module sizes** of 0.2 mm can be printed. A DMC code with 12 x 12 bits has then an area requirement (including L- and Alternating Pattern) of 2.8 x 2.8 mm.
In Britain and America the so-called density is often given in **MIL**.
A **MIL** is a **milli-inch** = 1/1000 inch = 0.0254 mm.

5.3 Step 1: Connect

Step 1 Connect contains:
- Selecting the operating mode for the BVS ConVis: Online or Offline (simulation mode).
- Creating a new inspection or modifying an existing one.
- Basic settings for the Vision Sensor in Online mode.
- Selecting the reference image to use for setting up your inspection.



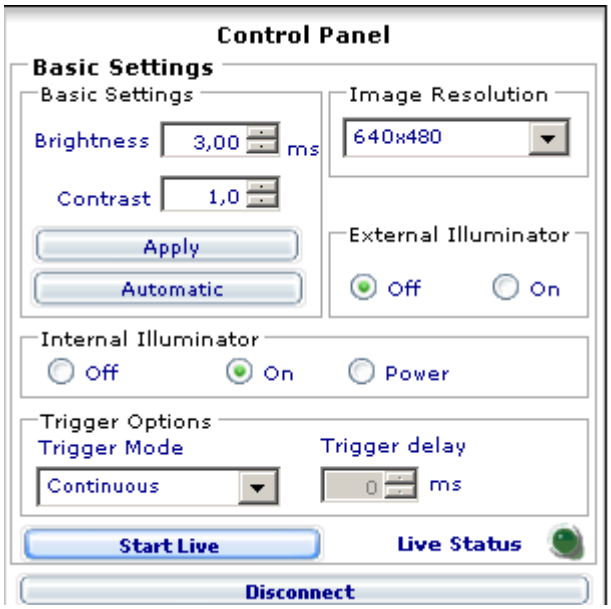
5 Creating an inspection

5.3.1 Creating a new inspection

Note
Once you have successfully followed all the instructions in the section “Communicating with the sensor”, you will be in the middle of “Step 1: Connect”. Please do not continue with the following instructions until you have completely followed those instructions.

- ► Click on ▼ beneath the text “Please select" and select "New inspection".
  - ⇨ The ConVis software now shows the basic settings on the right side of the screen in the control panel.
- ► Click on the “Start Live mode” button.
  - ⇨ The screen begins to show the live images of the object which the BVS is recording.
- ► Now click on the “Automatic” button. The sensor sets the image brightness accordingly.
- ► Turn the focus ring on the sensor to set the focus. Turning the ring clockwise brings farther objects into focus. Turning the ring counter-clockwise brings closer objects into focus.

Fig. 5-1: Setting the focus



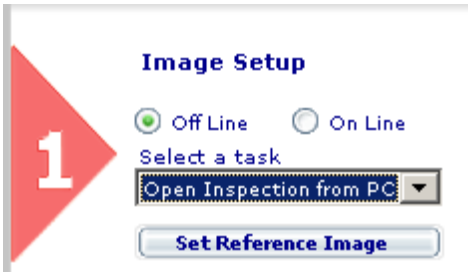
- ► Now change brightness and contrast until the inspection features are contrasty. If needed, also change the sensor position, distance and tilt angle to achieve the optimal result.
- ► Click on Trigger mode and change it to “External rising edge” or “External falling edge” if your part moves and you are using a through-beam sensor for example to “trigger” the sensor (see also “5.3.6 Trigger settings”)
- ► Click on “Stop Live mode” and then on “Set reference image”.

5 Creating an inspection

The following sections contain detailed information such as:
– Online and Offline modes
– Creating a new inspection
– Basic sensor settings.
Read on in Section 5.4 to learn how to further configure your sensor.

5.3.2 Modes

As mentioned above, BVS ConVis offers two different modes:
1. *Online* mode with active sensor connection;
2. *Offline* mode: no active sensor connection, the inspection is simulated using images stored in the PC. The PC handles processing of the tools. The advantage: You can test your inspection without having the sensor installed. The limited number of images makes it easier to select the tools for solving your applications.

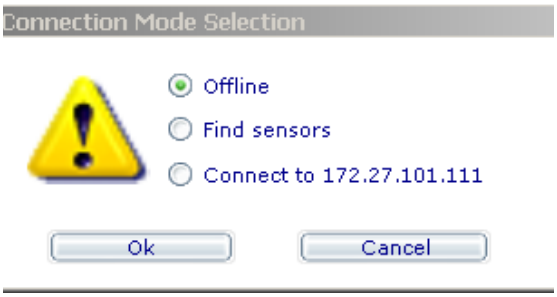


To select the desired mode, please click on the corresponding button.

Note
In the next sections the different sequences for Online and Offline mode are described.

5.3.3 Opening a connection to the sensor - Online mode only

After starting the software this window is shown:

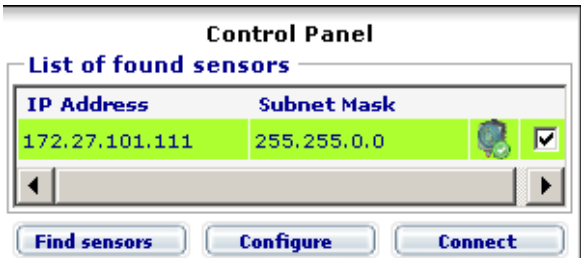


Parameter	Description
Offline	BVS--ConVis works offline, with no connection to a sensor.
Find sensors	ConVis is searching for any connected sensors and displays them in a list in the control panel.
Connecting to …	ConVis is opening a direct connection to the sensor with this IP number.

Control panel “Find sensors”

After selecting “Find sensors” the software first shows a window with a progress bar. If it finds at least one sensor, it shows the list with the found sensors in the control panel on the right side of the screen:

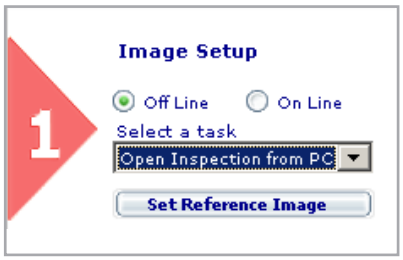
5 Creating an inspection



The control panel shows all the sensors found using the “Find sensors” function. The following information is displayed for each sensor:
– IP address of this sensor
– Subnet mask of this sensor
– A control box.
Sensors to which a connection can be opened are highlighted in GREEN; if no connection can be opened, the sensor information is highlighted in RED. (for troubleshooting see "12.3.4 Fault elimination)
If the list contains multiple sensors, you can use the control box in the last column to select the sensor you want to open a connection to.

5.3.4 Creating or opening an inspection

You can use the operating field to configure the static IP address for the selected connection (click on "Configure" and proceed as described in Section "12.3.3 Changing the static sensor IP address").
Both in Online and Offline mode you must now either create a new inspection or load an existing one.
Please click below on ▼, to select from between the following possibilities:



Parameter	Description
New inspection	Creates a new inspection After selecting “New inspection” the software opens a dialog box: Select the sensor model with these options: **BVS-E Standard:** An inspection with the tools from the standard model is created. **BVS-E Advanced:** An inspection with the tools from the advanced model is created. **BVS-E Identification:** An inspection using the Identification and Code Reading tools is created. **BVS_Universal:** An inspection with all available tools is created. **Note:** If the software is connected to a particular sensor model (e.g. Standard) when the inspection is created, you can create an inspection using the tools from the other model and test it, but you can not load it onto the sensor and use it.
Open from PC	Loads an existing inspection from the PC.
Open from sensor	ONLINE MODE ONLY Loads an existing inspection including any existing defect images from the sensor to ConVis. The defect images, if any, are displayed in the frame buffer bar. You can analyze the defect images in Step 3 “Test and apply”. (see “5.5 Testing and applying the inspection”)

5 Creating an inspection

More information about the differences between the Standard, Advanced, Ident and Universal models can be found in Section 16.1 .

Creating a new inspection in Offline mode

If you select “New inspection” in Offline mode, ConVis opens a file dialog box. This makes it possible to load images into your inspection.

Note
The images must be saved as BITMAP (.bmp) and must be 640x480 pixels with a bit depth of 8 bits.
Are you unsure whether your image meets the requirements? Then open Windows Explorer, locate the folder containing your image, right-click on it and select Properties. In the opened Properties window click on File Information and compare.

You may load multiple images. After loading, thumbnails appear for the images in the frame buffer. You can select the current image by simply clicking on the thumbnail.
Once you have selected your reference image, confirm by clicking on the "Set reference image" button.

Opening an inspection from the PC

The software opens a file dialog box after clicking on “Open from PC”.
Inspection files of type *.bvs5 (software version 1.5.0) or (after changing the file type) inspection files of type ".bvs3”, ".bvs2” and “.bvs” (software versions 1.4 or older) can be opened.

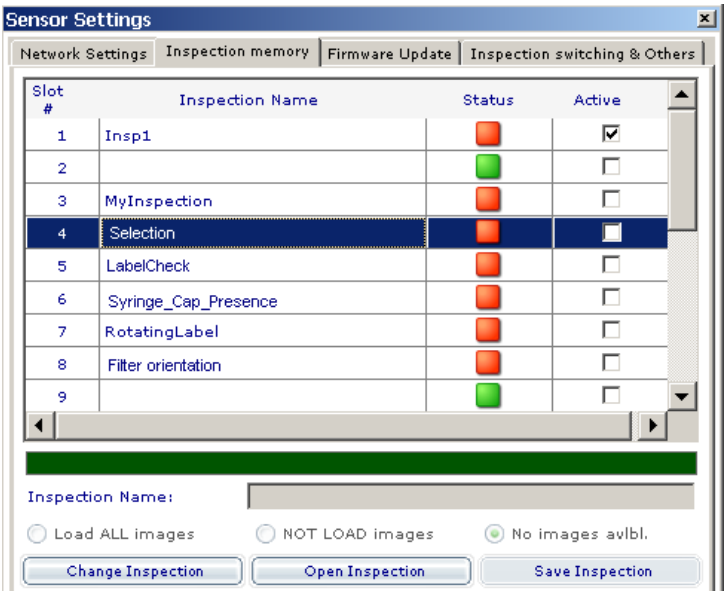
After selecting the file you wish to open, click on OK. BVS ConVis loads the file and then automatically jumps to STEP 2 – Parameterization. You can then test the loaded inspection offline for example or connect to a sensor to save the inspection on the sensor and run it.

Note
Inspection files of type .bvs , .bvs2 or .bvs3 must be converted to type .bvs5 before saving them on the sensor. To do this, click on “Save to PC” and save the inspection (type .bvs5 is automatically pre-selected). The conversion is automatically performed.

Important!
After conversion test to be sure your inspection still works reliably. Please note the instructions for the tools “Contrast Check” and "Pattern Detect" in Section “8.1 Inspection tools”.

Opening an inspection from the sensor

After selecting “Open from sensor" the BVS ConVis software opens a dialog box displaying the inspections stored in the sensor. Select one of them.



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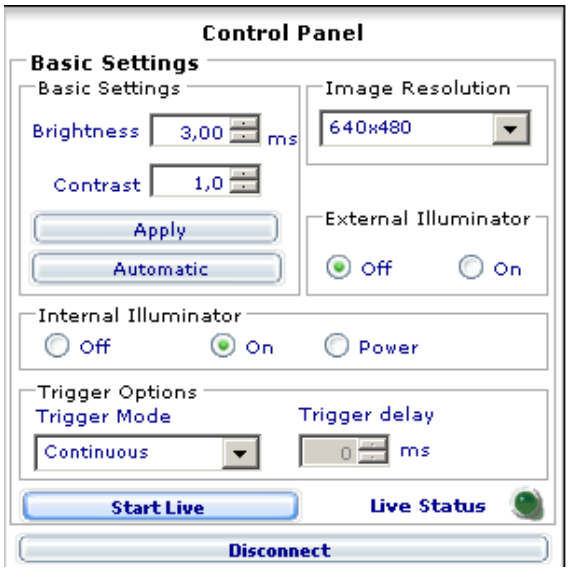
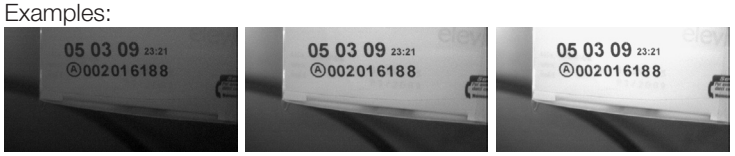
5.3.5 Basic settings – Online mode only

After selecting “New inspection” in Online mode, you are now shown the “Basic settings” for the new inspection in the operating field.:



Note
The changes made in the basic settings only become immediately visible if the sensor is recording images. Image recording can be started and stopped using the “Live Mode” key.

Parameter	Description
Brightness	Changing the value for brightness determines how bright or dark the image is. The higher the value you set, the brighter the visible image. Minimum value: 0.1; Maximum value: 100. Default: 3.00. **Note:** The value corresponds to the exposure time in milliseconds. The larger the value you select, the longer the sensor requires to record an image. Please set the brightness such that the features are contrasty against the background.
Contrast	By changing the Contrast value you change the image contrast. The higher the value, the greater the contrast between black and white; gray tones are reduced, and the image appears harder. Minimum: 1.0; Maximum: 3.0; default 1.0 Examples:  Low contrast Medium contrast High contrast
Automatic	After clicking on Automatic the sensor determines ONE value once for image brightness. Use this function for quickly viewing an image. You should still set brightness manually to achieve optimal results.
Resolution	**Note:** Setting image resolution is possible only with BVS-E Advanced and Universal models. By changing the image resolution the number of pixels per image line and column is changed. Advantage: At less resolution the average run time of an inspection is reduced, but the detail accuracy of the images is also less. You can select the following resolutions:

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Parameter	Description
	Resolution / Description 640x480 — Maximum Resolution. Attainable inspection rate: approx. 40 Hz 160x120 — Minimum Resolution. Attainable inspection rate: approx. 80 Hz **Note:** Tools such as “Check position” and “Width” generally require the highest image resolution.
External light	– On: An external light connected to the Trigger output (Pin 3 on the PWR IO connector) is triggered as soon as a new part is to be inspected. – Off: The external light is not triggered.
Internal light	– Off: The internal light is turned off. – On: The internal light is activated and is turned on as soon as a new part is to be inspected, e.g. after a trigger signal. – Power: The internal light is activated as for ON, but the light intensity is approx. 30% greater
Trigger mode	see “5.3.6 Trigger settings”
Trigger delay	see “5.3.6 Trigger settings”
Start Live mode / Stop Live mode	Starts or stops Live mode. In Live mode the sensor records images and sends them to the BVS ConVis screen..
Live-Status	Indicates whether Live mode is active (light green) or not (dark green).
Disconnect	Closes the connection between sensor and BVS ConVis software. You can then continue in offline mode..

Please take your time making the right setting for brightness and contrast. Change the angle between sensor and object if there are strong reflections from the object.

5.3.6. Trigger settings

The Trigger signal starts an event. It triggers image recording and processing in the BVS. You can set trigger mode and the trigger delay in the Basic Settings operating fiel.

Note
An external trigger is absolutely essential when the sensor is used to inspect movable objects. When inspecting movable objects, ensure that the object is inside the field of view at the moment the sensor records the image.

The BVS distinguishes different types of triggers:

- **Continuous:** Default trigger. The sensor records images at the fastest possible frequency. A new image is recorded as soon as the last one has been processed. The time interval between processing may vary.
- **External rising edge:** Uses an external trigger signal. A new image is recorded as soon as a rising edge is present on Pin 8 (from 0 V to 24 V).
- **External falling edge:** Uses an external trigger signal. A new image is recorded as soon as a falling edge is present on Pin 8 (from 24 V to 0 V).
- **Ethernet- RS232:** A new image is recorded as soon as a corresponding command is received by the sensor **(not available for BVS-Standard)**. As a alternative you can push the Button "Softrigger" in ConVis to trigger the sensor.

Trigger delay

By changing the trigger delay parameter you can delay the start of image recording and processing by up to 1000 ms after an external trigger edge is received. Use this parameter for example to ensure that the image is recorded when the object is actually in the field of view. In Continous mode or Ethernet - RS232 the triger delay is ignored.

Note
The BUSY-READY signal depends on the time point of the trigger, i.e. depending on what trigger type is set, it only starts with a FALLING edge.

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5.3.7. Creating a reference image

Finally you still need to “Set reference image”. Clicking on “Set reference image” specifies the currently displayed image as the reference image. Some tools, such as “Pattern detect”, “Contour check” compare the currently found patterns or contours with the patterns and contours selected in the reference image. The reference image also serves as a reference for the setting of the other tools such as Contrast.

5.4 Step 2: Parameterizing the inspection

After specifying the reference image, the software activates STEP 2. This step includes:
- Inserting a so-called “Tool for locating” into your inspection if needed.
- Inserting tools for checking features.
- Configuring outputs.

5.4.1 Selecting and positioning a tool

Use the “Select tool” pull-down menu to select one of the following tools and insert it into your inspection:

Tool symbol	Name	Description	BVS-E Stand.	BVS-E Advan.	BVS-Ident	BVS Univ.
	Check brightness	Compares the average brightness value in the ROI with the set minimum and maximum value.	X	X		X
	Compare contrast	Compares the maximum contrast value in the ROI with the set minimum and maximum value.	X	X		X
	Check contour	Checks whether the contour (shape) of the current part (feature) agrees with the contour from the reference image.	X	X		
	Count edges	Counts the edges in the ROI (along a line) and checks whether the number lies between the permissible minimum and maximum.	X	X		X
	Compare width	Compares the width in pixels between two edges and checks whether it lies between the permissible minimum or maximum.	X	X		X
	Pattern detect	Calculates the similarity of a pattern (feature) with the corresponding pattern from the reference image and counts how often the pattern is found in the search area.	X	X		X
	Check position	Finds the position of the first edge in the ROI and checks whether it lies between the permissible minimum and maximum.	X	X		X
	360° Defect finder	Compares a contour in the ROI with a desired contour and calculates their similarity with each other. Deviations between the actual and desired contour are detected with high precision. The contours to be checked can be selected during parameterization..				X
	360° Count Contours	Finds and counts all contours whose similarity with the desired contour is greater than the set value. The position in the image and its rotation angle are output for each contour..				X

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Tool symbol	Name	Description	BVS-E Stand.	BVS-E Advan.	BVS-Ident	BVS Univ.
	Optical character verification (OCV)	Checks presence and correctness of the learned lettering.			X	X
	Read barcode	Reads the following barcodes: Interleaved 2-of-5, Code 39, Code 128, Pharmacode, Codabar, EAN 8, EAN 13, UPC-A, UPC-E.			X	X
	Read Data matrix code	Reads Data Matrix ECC 200 codes.			X	X
	Read QR Code	Read and verifies QR and Micro-QR Codes			X	X

After you have selected your tool, you must position it in the reference image and adjust the size and rotation angle if needed. The tool parameters can be set in the “Operating field” at upper right.
Some things you can set with the tool parameters:
– When the tool returns OK or NOT OK,
– What the tool should take into account in the evaluation.

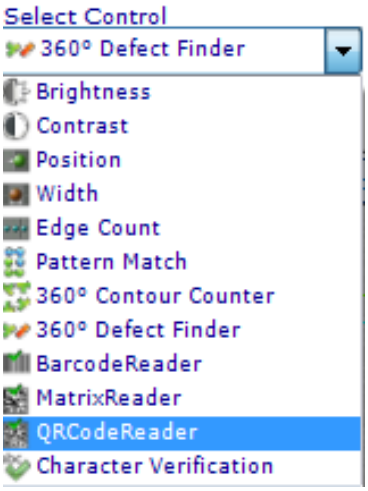
Note
The operating field of the tool is also shown when you click on the ROI of a tool.

If you require more than one tool in your inspection, please insert them one after the other. A maximum of 255 tools is possible.

Attention!
Please use only as many tools in an inspection as you ABSOLUTELY need.
The number of possible tools in an inspection is limited by the memory in the sensor needed for executing the tool. If you are using too many tools with a high memory requirement (e.g. Detect Pattern and Check Contour), ConVis will issue a warning.
In this case you must delete one or more tools, since the permissible memory for an inspection could otherwise be exceeded.

Inserting a tool

Carry out the following instructions to insert a tool into the inspection and position it:
► Click on ▼ beneath the text “Select tool” and select the tool corresponding to the desired inspection from the list shown.



► Drag the mouse pointer, which now takes the shape of the corresponding tool symbol, to the location in the image where you want to insert the tool.

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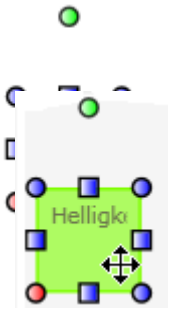
► Then **left-click**.
⇨ The BVS ConVis software shows a green or red frame in the image.
This frame designates the position and area of the ROI which will be checked by the tool.



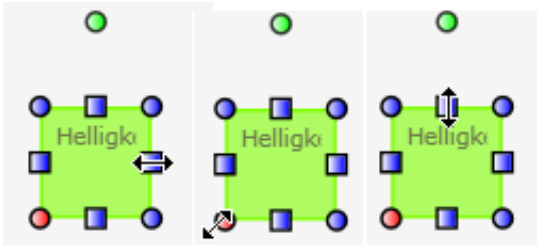
If you move the mouse pointer over the frame of the ROI, the pointer appears as a cross with 4 arrows.

Positioning

Changing the position of the ROI:
► Position the mouse pointer on one of the corner points of the ROI until the pointer is shown as a cross with 4 arrows.
► Then left-click on the frame and drag it while holding the button down to the desired location in the image

Changing image area size

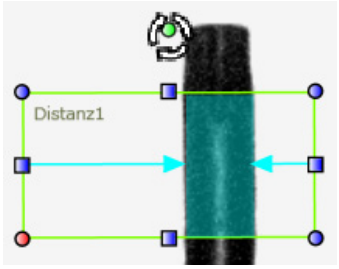
Changing the size of the ROI:
► Position the mouse pointer on one of the corner points of the ROI until the pointer is shown as a double arrow:



► Now LEFT click and change the size of the ROI by moving the mouse with the button held down.

Changing the rotation angle of the ROI

Changing the rotation angle of the ROI:
► Position the mouse pointer on the green POINT above the ROI.
⇨ The mouse pointer symbol changes as follows:



► Now LEFT click and ROTATE the ROI in the desired direction. The RED corner point of the ROI always shows you the starting point. For example to check a position from UP to DOWN, you must rotate the ROI by 90° degree - and the red point from one corner to the other.

Enlarging / reducing the ROI

To enlarge the ROE, click in the toolbar on this symbol:  You can also zoom in on the image multiple times. Using the slider control on the edge of the image you can conveniently select the image section you want to display.

To reduce the displayed region of interest, click on this symbol: 

Note
The selected zoom level is also retained in Test mode.

Deleting a tool

To delete a tool from the inspection, either click on the ROI of the tool in the “Image display” or on the name of the tool in the Inspection Explorer. Then click on the “Delete” key in the tool operating field.

The border color of the ROIs changes from green to red and back depending on the result. This means as follows:
Tools which return an OK result are shown with green borders; tools which return a NOT OK result are shown with red borders.

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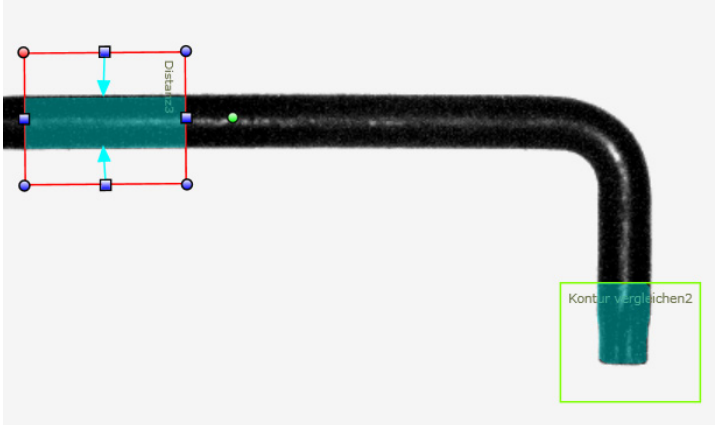

Key combinations for using tools

BVS ConVis offers the following key combinations for copying, inserting and fine positioning the tools:

Key combination	Description
DEL	Delete selected tool
CRTL + C	Copy tool incl. all parameters
CRTL + V	Paste copied tool into inspection
CRTL + ↑	Move ROI up by one pixel
CRTL + ↓	Move ROI down by one pixel
CRTL + ←	Move ROI left by one pixel
CRTL + →	Move ROI right by one pixel
CRTL + ⇧ + →	Rotate ROI right by one degree
CRTL + ⇧ + ←	Rotate ROI left by one degree

5.4.2 Selecting a Locator tool

What is a Locator tool?
A Locator tool can be used to compensate for changing part locations from image to image as long as the part does not leave the sensor field of view. The Locator tool " tracks" the part position within the field of view and aligns all other tools according to the current part location. More information on the topic of the Locator can be found in Section "7.1 Locator tools".

5.4.3 Setting tool parameters

BVS ConVis always shows you when you have inserted a new tool or, when you click on the ROI of a tool in the upper right corner, the operating field for this tool.
By adjusting the parameters you can change among other things:
– When the tool returns OK or NOT OK,
– What the tool should take into account in the evaluation.

Recommendations for using the tools can be found here: "Selecting the right tools".
Details about the tools and their parameters can be found starting here: Section 8.2ff.

► If you would like to add additional tools, you must begin over again with "Select tool" (see above).
► To copy a tool (with all the settings you have made), click on the ROI of the tool. Now press Ctrl+C and then Ctrl+V. Then drag the tool to the desired location.

5.4.4 Setting outputs

► After all the tools have been created and set up, please click on the "Set outputs" button. Depending on the sensor model only the setting for "Set outputs" (BVS Standard) is displayed or additionally the view for
► "Logical operations" (all others)
⇨ The ConVis software now displays the settings for "Set outputs".

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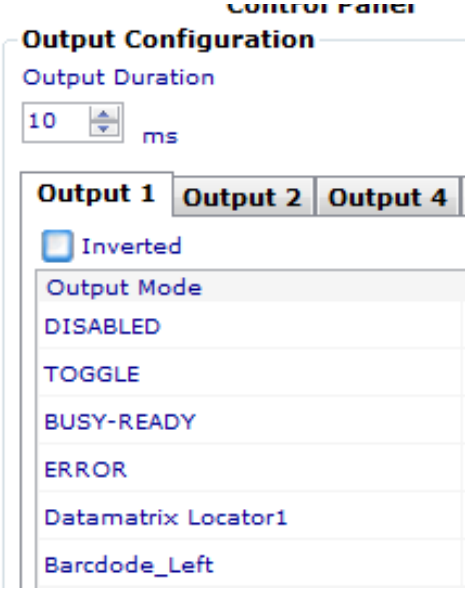

- ► Click on the tab with the corresponding output name to configure the output.
- ► Click on “Save images” to specify the settings for saving images on the sensor and (if connected to a PC) on the computer.
- ► Above the tab you can set the parameters “Output duration” for all the outputs.

More information on the available output functions, the pulse duration and switching delay parameters can be found in Section “10.1 Setting outputs”.

Save images

With “Save images" you specify whether
- – the sensor for example should save defect images when running the current inspection (in Run mode or autonomous operation),
- – and whether the defect images in Run mode should be saved by ConVis to a separate director.

This setting does not apply to all inspections, but rather only to the current one.

The settings for separators and RS232 are only relevant for BVS Identification and Universal sensors. The default setting is “Deactivated”, i.e. no images are saved on the sensor or PC. If you select “Activated,” you can use the selection list to determine under which circumstances an image will be saved. The condition under which an image can be saved can be determined for all sensor models except for BVS Standard using the logical operations.

Parameter	Description
All	Sensor or PC saves each image regardless of the inspection result.
When part OK	The sensor or PC only saves an image if all the tools have returned OK.
If part defective	The sensor or PC only saves an image if at least ONE tool has returned NOT OK
Logical Operation	Advanced and Universal only: You can use Logical Operations to specify under which conditions an image should be saved in the sensor and (if connected) on the PC.

Note
A maximum of 10 images can be saved on the sensor, or a maximum of up to 10 000 images on the PC. As soon as an additional image needs to be saved, the first stored image is overwritten.

The directory where the images are stored on the PC can be set using the Options menu. The stored images can be loaded into an inspection in Test mode. To do this click on the “Load images” icon in the taskbar and then select the directory having the corresponding images.

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The images saved on the sensor are displayed on the screen if you select “Open from sensor” and then the option “Load images.” This option is only selectable if there are actually images on the sensor.

5.5 Step 3: Testing and applying the inspection

After you have set the output functions, exit Step 2 and click on the “Inspection settings” button to continue with “Step 3: Testing and applying”.
After specifying the reference image, the software activates STEP 3. This step includes:
– Adjusting the inspection settings.
– Testing the inspection - offline or online.
– Applying the inspection on the sensor.

5.5.1 Monitor settings

With these settings you can specify which tools and their parameters can be changed with the BVS-E Monitor and which not.
The panel shows you a list of all tools and parameters for the current inspection.

All selected parameters (☑) can be modified later, all deselected parameters (☐) are NOT modifiable with the Monitor.
The parameters can be selected or deselected individually or by tool. Whether a parameter is selected or deselected has NO effect on the correct function in the sensor.
For example, the image brightness can be reset or settings for tools optimized during production.
Descriptions for the tool parameters can be found in the manual for the Monitor.

5.5.2 Testing the inspection

Click on the “Test” button to test the inspection on the PC.
In “Online” test mode the sensor only records images and sends them to the PC, which then processes them. All the outputs on the sensor are deactivated during the test.
Click on “Start” to start the test, click on “Stop” to stop the test.
In the “Image display” you are shown the current image and tool results during the test. The “Output status” as well as the reference image are displayed in the operating field.
You can use the “Inspection Explorer” to monitor the settings and current tool parameters.
If you have stopped the test or no sensor is connected to the software, you can also test “Offline.” If images are present in the frame buffer, you can test them by clicking on an individual image.

If there are no images in the frame buffer, click on the “Load images” button and select the images you want to use for testing your inspection. After loading you can test an image by clicking on it in the frame buffer. The PC then calculates the results and updates the tool results in the “Working area” (frame color) and in the Inspection Explorer.

Note
The test images must be BITMAP (.bmp) images with 640x480 pixels and a bit depth of 8 bits.
Are you unsure whether your image meets the requirements? Then open Windows Explorer, locate the folder containing your image, right-click on it and select Properties. In the opened Properties window click on File Information and compare.

“Test” operating field

In testing, the operating field displays this information:
– The simulated status of each output: Yellow for ON; gray for OFF.
– The currently used test mode (either Offline or Online test).
– The reference image used for this inspection.

Note
All the outputs on the sensor are deactivated in Test mode. The images are processed by the personal computer. The sensor only records images; it does not process them.

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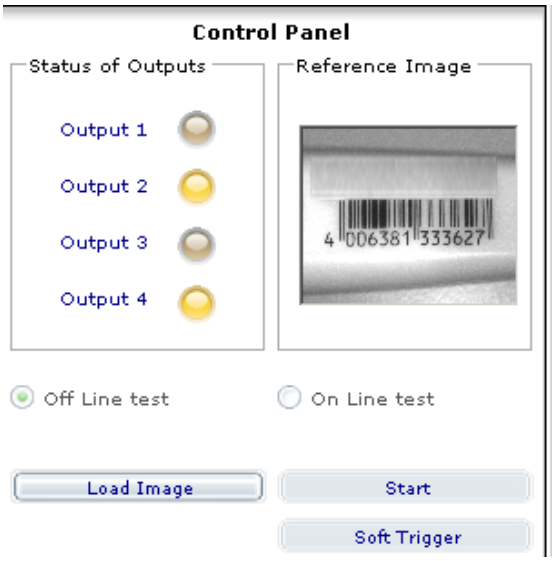


Buttons	Description
Load image	Offline mode only. Loads additional images into the frame buffer. These can then also be tested.
Start / Stop	Online mode only. Sensor begins to record images; the PC does the calculation; the results are updated.
Soft trigger	The Soft trigger field is only active in Trigger mode "Ethernet-RS232". Clicking on the field triggers the sensor once.

5.5.3 Applying an inspection

To store and apply the inspection on the sensor, click in Step 3 on the “Apply” button (under the “Test” button). The operating field at upper right in the software shows you the status of the inputs, symbolized by LEDs, and the taught reference image.
The following buttons and parameters are displayed:

Parameter	Description
Show images	The sensor sends the current images and the evaluations to the PC. The PC displays them in the “Image display” area.
Statistics and timing	The sensor does not send images to the PC. The PC shows: a) The run results for each tool b) The run time for each tool c) A statistic on how many “parts” total were tested and how many of these were good and bad.
Start / Stop	Starts and stops application of the inspection.
Soft trigger	The Soft trigger field is only active in Trigger mode "Ethernet-RS232". Clicking on the field triggers the sensor once.

Note
After Start the software prompts you to save the inspection on the sensor. You can assign a name to each inspection.

After starting in “Apply” mode, the sensor records images and sends them and the calculated tool results to the PC, assuming you have selected “Show images”. The PC then shows them in the “Image display”. With Stop the application of the inspection will be stopped.

Note
In “Show images” mode the sensor power is reduced. At a high parts rate it may therefore happen that not every image is displayed.

5 Creating an inspection

“Statistics & Timing”

If you have selected “Statistics and timing”, the “Statistics” field shows an overview, e.g. the processing times for each tool and the maximum processing time for the inspection. More information on what times need to be taken into consideration can be found in Section “15.1 Inspection times”.
No fixed switching frequencies can be given for Vision Sensors as with other sensors. Different computing times are required for evaluating the various tools in the inspection. The typical detection rate is a guideline as to how often a part can be inspected per second. The actual achievable detection rates may be greater or smaller - this depends mainly on what task you are performing. You can use the “STATISTICS” display in Step 3 to estimate the possible detection rates for your task.

The inspection times can be determined using the BVS ConVis software:
In Step 3 - Select Apply, then “Statistics & Timing.” After saving on the sensor and clicking “Start” a table is displayed with the times:

Show: (•) Data ( ) Graphs [Reset Statistics]

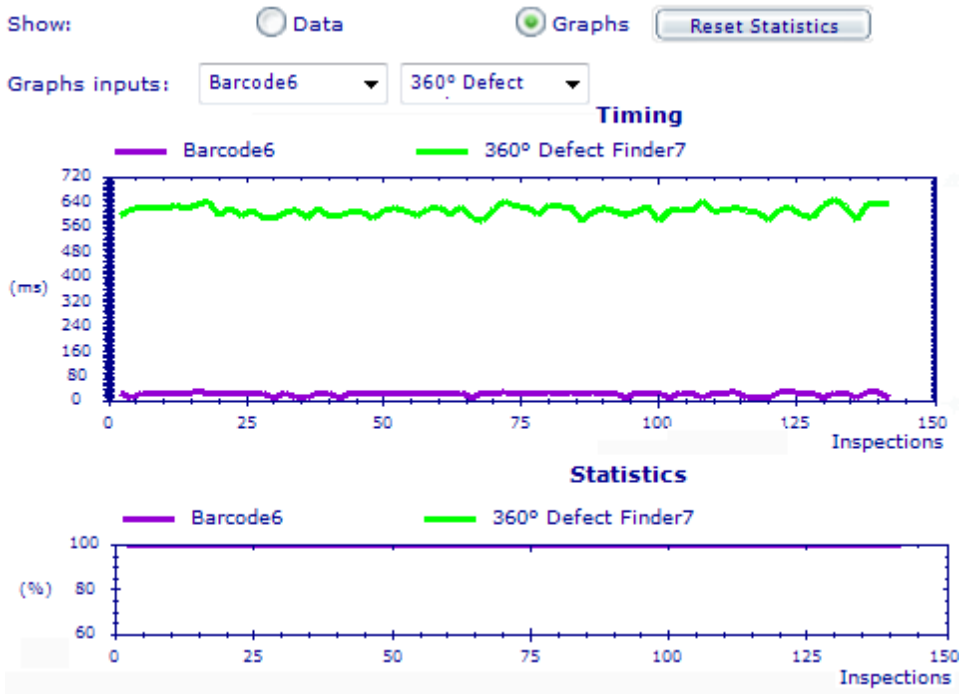
Graphs inputs: NONE | NONE | NONE | NONE | NONE

Control	Percentage	Total PASSED	Total FAILED	Executed
Exp. Time + Img. Acquisition time	14,24 ms			
Barcode6	11,68 ms	68 (100%)	0 (0%)	68
360° Defect Finder7	598,73 ms	67 (99%)	1 (1%)	68
And9	0,00 ms	67 (99%)	1 (1%)	68
Not8	0,00 ms	1 (1%)	67 (99%)	68
Output delay time:	0,00 ms			
Output duration time:	10,00 ms			
Total execution time	634,70 ms	67 (99%)	1 (1%)	68
Maximum execution time	710,25 ms			
Insp. per second				1,58 Insp./sec

From the above example the actual overall execution time is 27,34 ms, but the maximum execution time was 27,39 ms.
The “Tool cycle time” is in “Processing time".

Additionally this table shows which tool and how often a tool had an error. This information will allwo improving your process, if necessary.The statistics display also provides a second mode - the Graphical Display.Within this mode you can select the tools and/or the inspection data as source for the graph.
At each execution the result of the sources will be added to the display which results in a graphic representation of your inspection, which allow to easier track the execution times and the total results.

5 Creating an inspection



If you notice in the test and during "Apply" that you have to adjust your tools and/or tool parameters, then stop "Test" and "Apply" and click back to Step 2.

Disconnecting the sensor from the PC

If the inspection works as desired, you can disconnect the sensor from the ConVis software: Click on “Offline”. The sensor now runs autonomously. You can unplug the cable from the TO PC plug. We recommend closing off the TO PC plug with the provided cap to protect it from exposure to dust, dirt and liquids. If you need a metal cover cap, we recommend the BKS 12-CS-01.

6 Lights

Basic considerations

The right lighting is the key to handling your application successfully.
Success or failure when using Vision Sensors often depends on selecting the right light. Only the correct lighting ensures that the evaluation tools function optimally.

The lighting at the inspection location must be carefully selected, set and be kept as constant as possible for all inspections of an object.

Notes on correct use of lights

The purpose of this section is to briefly describe a few important considerations related to lighting conditions which can be easily applied to many tasks in the area of machine vision.

Note
All BVS infrared sensors have an integrated infrared pass filter.
This filter allows only infrared light to pass through, whereas visible light is strongly attenuated.
We recommend the use of infrared sensors when ambient light may be present in the application.

Caution!
The sun also radiates infrared light. Strong sunlight may cause problems in the application in spite of the integrated filter!

– **Keep the lighting of the field of view and the object (the “scene”) constant.**
The brightness must be kept as even as possible. Avoid brightness fluctuations caused by ambient light, sunlight or other external light sources, since these variations are the most frequent cause of errors. By suppressing external light effects you can prevent such errors. It can happen that the internal light on the sensor is not sufficiently effective, and you need to consider use of an external light. Alternate solutions include diaphragms or any type of physical shield for deflecting light from the inspection area.

– **Keep the lighting of the scene as even as possible.**
Be sure that the entire scene is evenly illuminated to prevent very bright spots or shadows. Also be sure that the target objects have features that are sufficiently contrasty and stand out against the background.

– **Place the light source in the right location.**
Select the best distances between the light source, the sensor and the target object. Be sure that the light source has the right brightness to prevent saturation in parts of the scene.

– **Illuminating reflective surfaces**
Tests have shown that when inspecting highly reflective surfaces the camera needs to be very carefully located and an external light may need to be installed at an appropriate angle to maximize contrast between the object and the background. The reflected light results in saturation in parts of the scene. In such cases we recommend use of an external diffuse LED light.

Good and reliable results in machine vision require that the light intensity be kept as constant as possible. The most frequent cause of variations in the light intensity is ambient light, e.g. daylight or other external light sources.
We strongly recommend keeping the exposure times as short as possible to reduce the effect of external light sources.
In our experience, you normally need additional light sources if the working distance is greater than 300 mm or parts need to be inspected using background lighting.

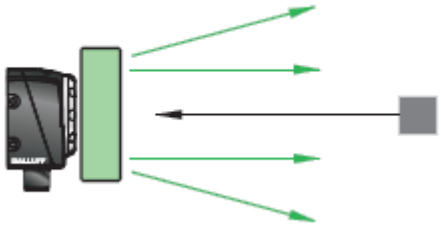
In the following you will find an overview of the available types of lights:

6 Lights

Light types

– **Ring light**

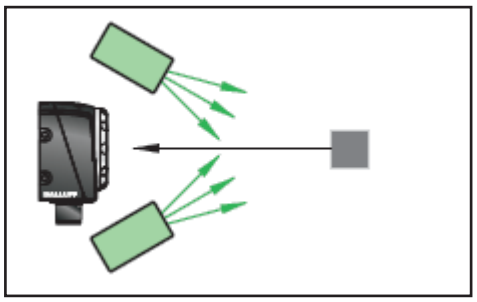
A ring light can be located near the sensor, so that the sensor looks through the light as shown in the illustration. Ring lights ensure virtually shadow-free lighting with high intensity.



Advantages: A ring light can create the right lighting for a variety of applications. They provide very intense light and can therefore also be used at a greater working distance. The light is centered in the image.
Disadvantages: If a right light is used for large objects, the corners of the image may be darker. With highly reflective objects the image may show a “halo” of reflected light.

– **Incident light**

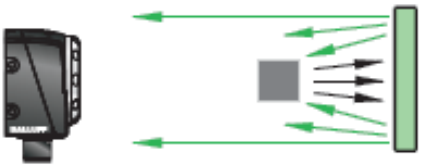
This type provides even lighting in a concentrated area. The light (usually a spotlight or light bar) is positioned behind the sensor and makes it possible to emphasize desired parts on the object and causes other areas to disappear in the dark.



Advantages: Since a spotlight can be attached separately from the sensor, it makes it possible to emphasize certain areas on the object, e.g. by creating shadows.
Disadvantages: It is difficult to illuminate an object evenly over the entire area.

– **Background light**

The light is located behind the target object and directed back towards the sensor. The resulting silhouette can be checked for dimensions and shape. If background light can be used in your application, then it should be preferred over the other light types.



Advantages: Background lighting allows suppression of variations in surface qualities, since only the shape is inspected. Facilitates diameter checking of round objects. Shows the presence or absence of holes.
Disadvantages: Sometimes it is difficult to locate the light behind the object. The illuminated area must always be larger than the inspection area.

Typical applications include sorting of objects by shape and dimensions, measuring distances between chip connection pins, checking objects for holes or cracks.

All of our available lights can be found in our "Industrial Identifcation" catalogue on our website!

7 Locators

7.1 Locator tools

Locator tools are special tools which search for a particular feature (e.g. an edge or a pattern) inside your ROI or search region.
If a corresponding feature is found, its location in the image is determined - all other tools in the inspection are then aligned based on the “found” location.

Locator with changing part and feature location

If the “searched” feature on the part you are inspecting is always in the same location, a locator can be used to compensate changing part locations from image to image. This requires however that the feature not leave the sensor field of view or the ROI or search region.

If the “searched” feature is present on your part in various locations, you can use a locator to compensate for the feature location and thereby track the feature.

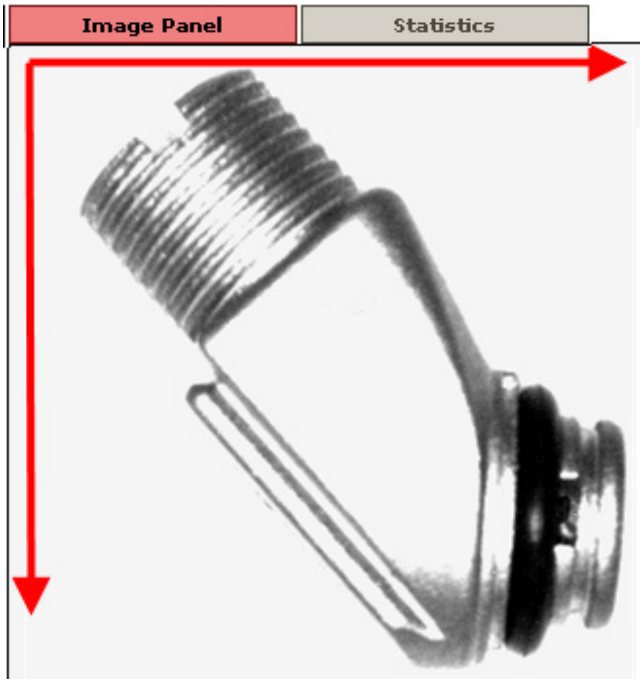
Notes
- There can be only **ONE** locator tool in an inspection
- If the locator returns a NOK, then none of the other tools in the inspection are checked. Then only the ROI of the locator is shown in RED in the current image or reference image. The ROIs for all the other tools are not displayed.

7.2 Using the Locator

Locator tools are inserted, positioned and enlarged in the inspection like normal tools. More information on using tools can be found in Section “5.4.1 Selecting and positioning a tool”.

No Locator: Fixed ROI

If there is no locator in an inspection, then all the tools use the upper left corner of the image as the absolute, fixed origin for their ROIs.



This means that if the part in the current image is displaced compared with the part in the reference image, the position of the tool ROIs does not follow the part. As a consequence the part may not be correctly inspected.

7 Locators

Example

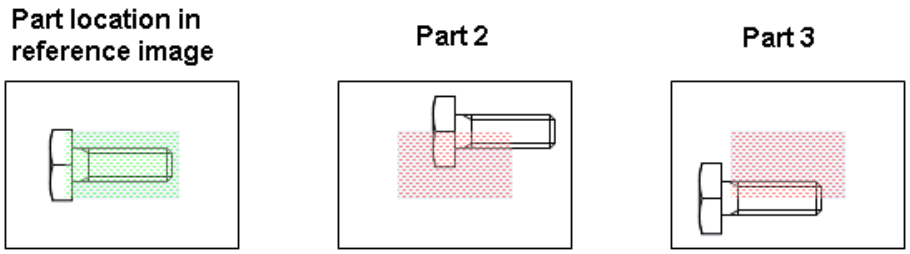


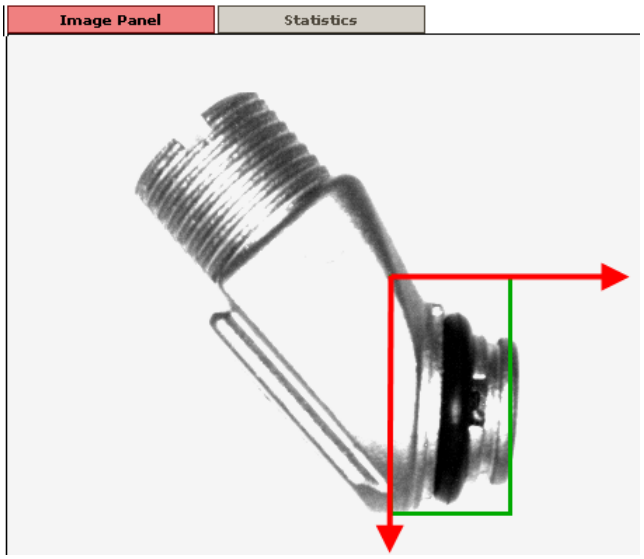
Fig.7-1: Changing part location without Locator

The first image at left shows the part location in the reference image, with the tool (green hatching) inspecting the screw length.
In Image 2 the part is shifted to the upper right - the inspection fails (red hatching), likewise in Image 3.

You should not work without the locator unless you can ensure that the part or feature is always positioned in the same location at the time the image is recorded.
This means: The part/feature should not be displaced either horizontally or vertically or rotated with respect to the reference part.

WITH Locator: ROI positions depending on "Position" of the Locator

If there is a locator in an inspection, then all the "normal" tools use the position determined by the locator as their origin.



The figure above illustrates this using the example of the "Pattern detect" locator.
If the locator finds the taught feature in the reference image, it changes the position of its ROI in the image, and the determined position is then the upper left corner of the ROI.
All other tools are oriented by this POSITION.

Example

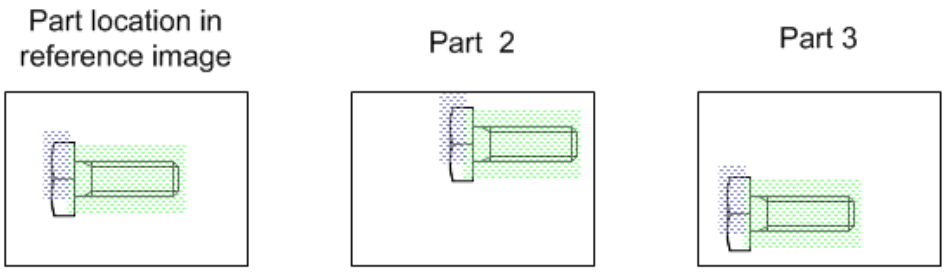


Fig.7-2: Changing part location with locator

7 Locators

The first image at left shows the part location in the reference image; the “Pattern detect” locator (blue hatching) detects the screw head, the tool (green hatching) inspects the screw length.
In Image 2 the part is shifted to the upper right - the inspection is successful, since the screw head is detected by the locator, likewise in Image 3.

7.3 Brief description of the Locator tools

To insert a “Locator” into the inspection, click on “Select locator”.
Depending on the model (Standard or Advanced) you can select from the following locator tools:

Symbol	Name	Description
	Check position	Searches for the first “edge” in the image region in a particular direction. The direction (e.g. left to right, up to down) to search in can be determined by changing the rotation angle of the ROI; default is LEFT to RIGHT. **Note:** With this tool ONLY a position change in the set direction can be located.
	Pattern detect	Searches within the search region (outside border) for the pattern that was learned in the reference image. Location changes from right to left (horizontal) or from up to down (vertical) can THEN be located if the searched for pattern has features in BOTH directions. **Note:** With this tool ONLY a location change in the X- and Y-direction can be located. Changes in the rotation angle can (depending on the desired value setting) only be located up to a deviation of from 5 to 10 degrees.
	360° Pattern detect	**Note:** 360° pattern detect is only available with BVS-E Advanced models. Searches within the search region (outside border) for the pattern that best matches the pattern learned in the reference image AND whose rotation angle lies between the permissible minimum and maximum angles. Position changes can be located with this tool horizontally, vertically and in the rotation angle. **Note:** With this tool a rotation angle can be located ONLY if the pattern is asymmetrical (e.g. a square or a circle).
All 3 of the following Locator tools are only available with the BVS_E Universal.		
	360° Contour Match	Searches within the ROI (outer frame) for the contour that best matches the contour (form and length) learned in the reference image AND whose rotational position lies between the permissible minimum and maximum rotation angle. Location changes can be located in the horizontal, vertical and rotation position using this tool. The tool can also compensate for slight tilts and changes in the lighting, although then the maximum locating accuracy cannot be achieved. **Note:** This tool can be used to locate a rotation position ONLY if the contour is not symmetrical (e.g. a square or a circle). The contour can also be located with the part is partially covered. The tool is NOT suited for precise contour inspection. Maximum accuracy: ± 1 pixel in X and Y direction and ± 1 degree in the direction of rotation under ideal conditions and consistent contour (orientation to sensor, homogenous lighting).

7 Locators

 DataMatrix	Searches within the ROI (outer border) for a readable DataMatrix code and passes the position of the code to other tools. The main point of the code is determined. This may vary depending on the content of the code. Location changes can be located in the horizontal, vertical and rotation position using this tool. The tool can also compensate for slight tilts and changes in the lighting, although then the maximum locating accuracy cannot be achieved. A DataMatrix code can also be read and located even if the code is partially covered. Maximum accuracy: ± 1 pixels in the X und Y direction and ± 1 degree in the rotation direction under ideal conditions and consistent code contents. (Code quality, orientation to sensor, homogenous lighting)
 QR Code	Searches within the ROI (outer border) for a readable QR code and passes the position of the code to other tools. The main point of the code is determined. This may vary depending on the content of the code.
 Barcode	Searches within the ROI (outer border) for a readable barcode of a certain type and passes the position of the code main point to other tools. The minimum quality of the code and whether there is a particular code contents. Position changes can be located using this tool in the horizontal, vertical and rotation angle (except for Pharamcode, IMB and Mailcode). The tool can also compensate for slight tilts and changes in the lighting, although then the maximum locating accuracy cannot be achieved. Maximum accuracy: ± 1 pixels in the X und Y direction and ± 1 degree in the rotation direction under ideal conditions and consistent code contents. (Code quality, orientation to sensor, homogenous lighting).

Note
There can be only ONE locator tool in an inspection!
If you want to want to select another locator after a first test of your inspection, then you first need to delete the existing "Locator".

Note
The result of the locator can be connected to an output. More information about this can be found in the section "10.1 Setting outputs".

After you have added a locator to the current inspection, the operating field shows its current parameters.

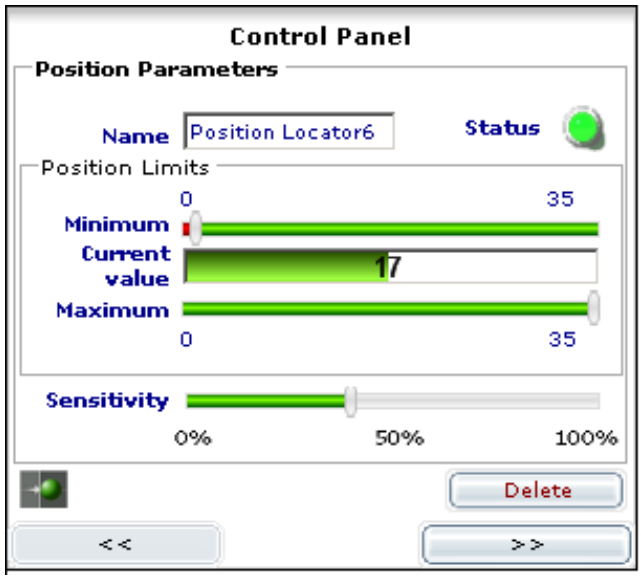
Note (Ident only)
If you want to define the code you want to read as a pattern for the Locator, then the locating only functions if every part you want to inspect has the same code – the code information does not change. If the code information changes, then the combination of bars or modules changes also – the pattern you are seeking is then no longer present and can not be detected.
Please note that the tools "Read Barcode", "Read Datamatrix" and "Read QR Code " are able to compensate for location changes of the target code.
Additional information can be found in the descriptions for the corresponding tools.

7 Locators

7.4 Locator – "Check position"

The tool searches for the position (in pixels) of the first edge inside the ROI in a particular direction. If the found position lies within the set limits, then the tool returns: OK, otherwise: NOK.
An "edge" is a defined border between a bright area and a dark area in the image; e.g. a dark rectangle on a white background has 4 edges from bright to dark.
The direction (e.g. left to right, up to down) to search in can be determined by changing the rotation angle of the ROI; default is LEFT to RIGHT. By rotating the ROI by 90 degrees for example the first edge from up to down can be searched for.
Not every difference between a bright and dark area is supposed to be considered by the tool as an edge. For this reason the "Sensitivity" parameter allows you to set the definition of the edge.

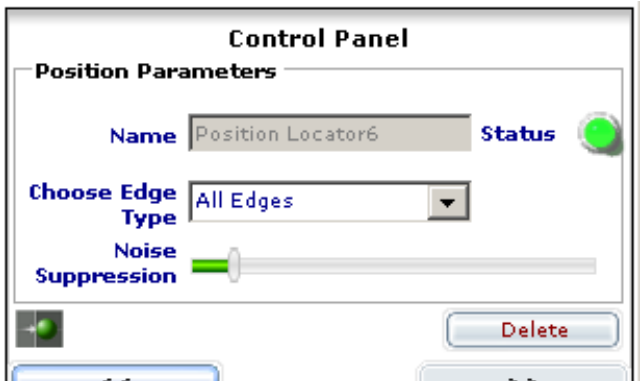
Note
With this tool ONLY one position change in the set direction can be located.



Parameter	Description
Name	Name of the tool max. length 256 characters.
Status	Green: OK. Found edge lies within the "Position Limits". Red: NOK. Locator found no edge or the found edge does not lie within the limits..
Minimum / Maximum	The result is OK if the current position lies within MINIMUM and MAXIMUM. If the current position is less than the set minimum or greater than the set maximum, then the result of the tool is: NOK. By default the tool uses a minimum of 1 pixel; the maximum is the actual WIDTH of the ROI. – Actual value ≥ Minimum AND actual value ≤ Maximum = OK – Actual value < Minimum OR actual value > Maximum = NOK
Actual value	The actual value in pixels is the determined position of the edge from the left border or the image region. The lower left corner of the ROI is marked by a RED point.
Sensitivity	The GREATER the sensitivity, the LESS the brightness difference between a bright and a dark area needs to be for an edge to be detected.

Note
"Minimum" and "Maximum" always refer to the ROI. The zero point lies on the side of the ROI indicated by a RED corner point.

7 Locators

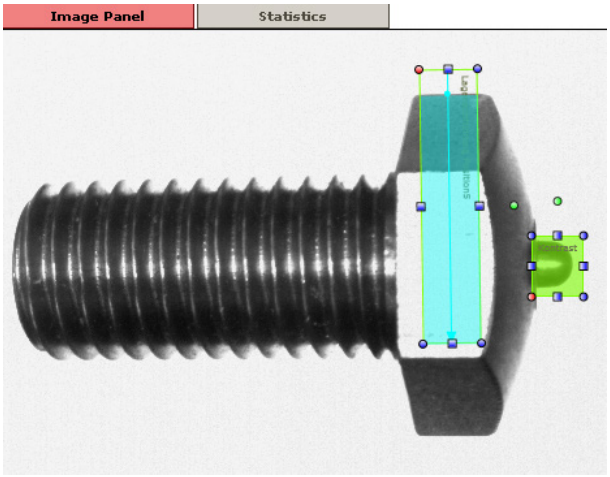


Parameter	Description
Edge type	Determines an edge type to search for in the image. The selection possibilities are: Select all edges to detect transitions from bright to dark and dark to bright. Select only dark-bright edges to find only transitions from dark to bright. Select only bright-dark edges to find only transitions from bright to dark. If you select Automatic, the strongest transitions are selected both from bright to dark and dark to bright.
Noise suppression	Noise suppression allows you to filter out slight brightness changes when searching for edges. The strong you set the noise suppression, the greater the brightness change necessary to locate an edge.
Delete	Deletes the Locator from the inspection.

Note
If an edge is not correctly detected in the image, adjust the parameters “Edge type”, “Sensitivity” or “Noise suppression”.

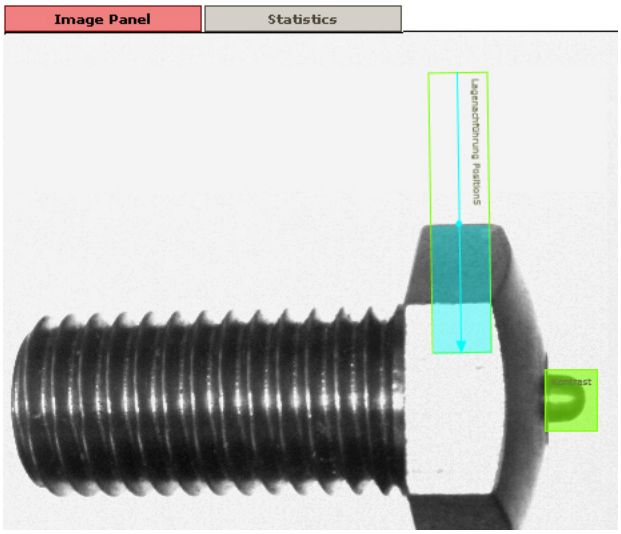
Example

You want to locate the position of a screw in the vertical direction (i.e. from down to up and the reverse). You also want to check whether the part on the screw head is present or not (e.g. using a contrast tool).
To do this, insert the “Check position” locator into the inspection.
Then ROTATE the ROI of the tool using the mouse until the red marked corner of the tool stops at upper left (see illustration).



Now enlarge the ROI of the tool - the position change of the part must always take place within the ROI, otherwise the position cannot be located. Now adjust the permissible Maximum to your application.
As the position of the part changes as in the following illustration, the "edge" of the head is found and the tool is located.

7 Locators

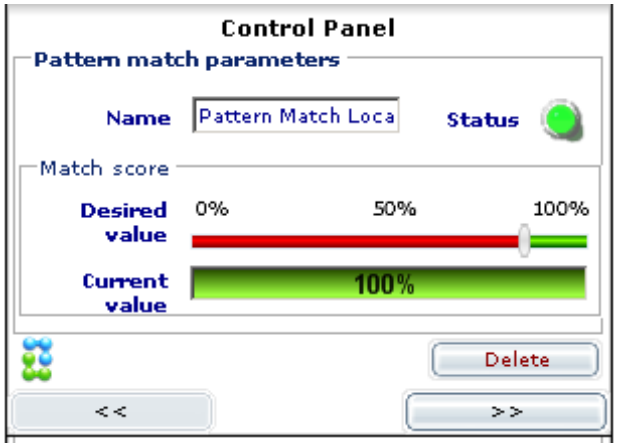


7.5 Locator – “Pattern detect”

The “Pattern detect” locator searches within the search region (outer frame) for the pattern whose agreement (actual value) is the greatest with the learned pattern and passes this position to the other tools.

The result of the Locator tool is OK if at least one pattern was found whose actual value is greater than the set desired value, otherwise it returns NOK.

After inserting the tool into the inspection the following operating field is displayed:

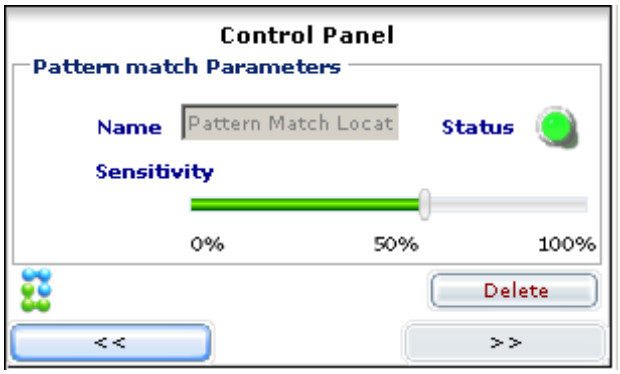


Parameter	Description
Name	Name of the tool max. length 256 characters
Status	Green: OK. The similarity of the pattern found within the search region with the parameterized pattern is greater than the set desired value. Red: NOK. No pattern found whose similarity is greater than or equal to the set desired value..

7 Locators

Parameter	Description
Desired value	The desired value defines the minimum similarity which a pattern found in the search region must have in order to be considered as detected. Only patterns which have a similarity greater than the set desired value are displayed by the software and counted by the tool. 100% = Identical pattern, 0% = No similarity. The default value is 85%; for most inspections we recommend a value of 66%.
Actual value	The actual value is the similarity of the pattern with the reference pattern in percent. – Actual value 100%: Pattern identical to reference pattern – Actual value 50%: Pattern agrees with reference pattern by only 50%.

By clicking on the >> button you can go to the “page” with the expanded parameters:



Parameter	Description
Sensitivity	By changing the sensitivity you can affect how strongly differences between the reference pattern and the found pattern affect the actual value. The sensitivity is set to 60 percent by default. – Sensitivity 100%: Differences have a strong effect on the actual value – Sensitivity 50%: Differences have a medium effect on the actual value – Sensitivity 0%: Differences have a low effect on the actual value **Note:** The less the sensitivity, the faster the pattern detection can be executed.

Example

You want to check the orientation of chip cards.
OK is terminals at upper right; NOK is any other location.

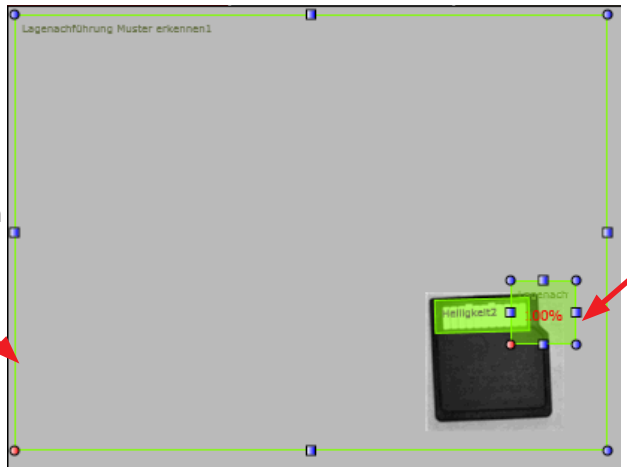
Since the chip cards can be found anywhere in the field of view but only in 2 different positions (terminal up or terminal down), we are using here the "Pattern detect" locator.
After insertion we see two frames, with one lying inside the other. The outer frame marks the so-called search region, the inner ROI of the tool. The search region can be adjusted in size and position using the mouse just like the ROI.
Please note: The pattern is searched for only INSIDE the search area - if the pattern lies outside the search area (but still within the image area of the sensor), the pattern will not be found.

Note
The cycle time for the “Pattern detect” tool depends greatly on the size of the ROI and search area. The larger the area, the more time is required. Therefore we recommend setting the ROI and search area as small as possible but as large as necessary.

In the following figure the ROI and search region have already been adjusted:

7 Locators

Outer frame: Search region – the pattern defined with the ROI is only searched for in this area.



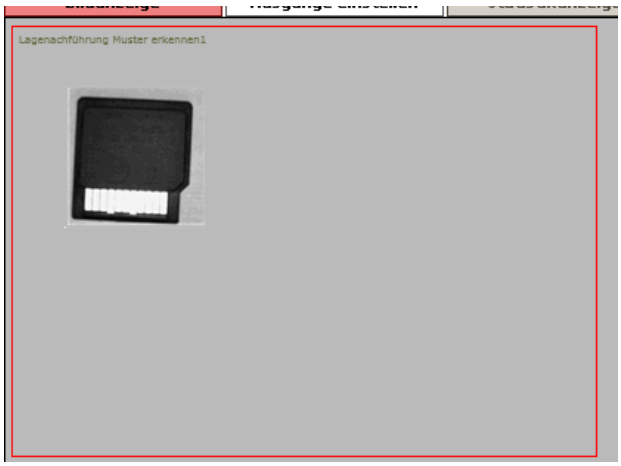
Inner frame: ROI – you use the ROI to define the reference pattern to search for.

We have selected the “Coding corner” for two reasons:

1. The corner is different from the 3 other corners and is therefore UNIQUE – only in this way can we create a reference to the orientation of the card.
2. Since the chip card can shift in the X- and Y-direction, the pattern must also have “features” in the X- and Y-direction for us to locate it.

In the following illustration the card is shifted up and to the left - the pattern of the "coding corner" is reliably found.

But if the card orientation is wrong, as in this illustration …



... then the card is not found - the inspection in this case is NOK.

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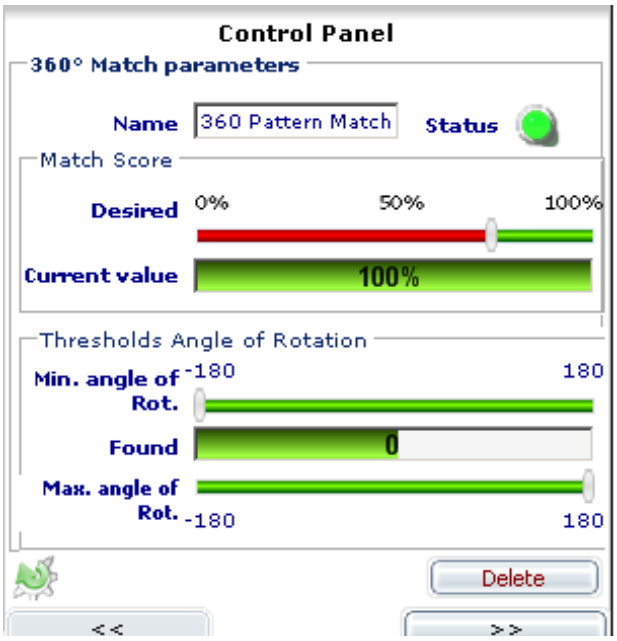
7.6 Locator “360° pattern detect”

Note
The locator "360° pattern detect" is only available with the BVS Advanced or Universal models. If you are using a Standard model, the locator can be tested but not run on the sensor.

The “360 degree pattern detect” locator searches within the search region for the pattern that best matches the one specified in the reference image. The result of the tool is OK if a pattern was found whose actual value is greater than the set desired value AND whose rotation angle lies within the limits.
If you insert “360 degree pattern detect” into an inspection, the software will show you two rectangles: The search region - and the ROI. The pattern searched for by the tool is defined by the “feature points” in the ROI of the reference image and their location with respect to each other.
The software shows you all the feature points found in the search region as **LIGHT BLUE** dots.
Please note that the pattern searched for should be defined by at least 5 feature points.
The tool uses the following control panel:



Parameter	Description
Name	Name of the tool max. length 256 characters.
Status	Green: OK. The found pattern has an actual value greater than or equal to the set desired value. The rotation angle of the pattern lies within the limits Min. rotation angle and Max. rotation angle. Red: NOK. Either no pattern with an actual value greater than or equal to the set desired value was found OR the rotation angle of the pattern lies outside the set limits.
Desired value	Threshold value in percent. This specifies how great the similarity (agreement) between the pattern found in the search area and the reference pattern must be for the tool to return OK. For most inspections we recommend a value of 85%.
Actual value	The actual value is the similarity of the found pattern with the reference pattern in percent. Actual value 100% means the pattern is identical with the reference pattern.

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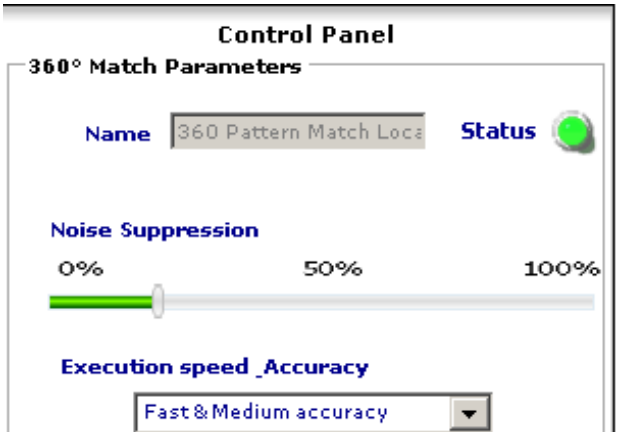
Parameter	Description
Min. rotation angle, max. rotation angle	The pattern is OK if the rotation angle lies within the area defined by the minimum and maximum rotation angle AND its actual value is greater than the set desired value. The zero point always lies on the VERTICAL AXIS! Rotation angle ≥ Min. rotation angle AND ≤ Max. rotation angle = OK Rotation angle < Min. rotation angle OR > Max. rotation angle = NOK The default for the minimum rotation angle is -180 degrees, and the default for the maximum rotation angle is +180 degrees.

Note
For technical reasons the detected rotation angle may vary from image to image by approx. ± 3 degrees when the part location is unchanged.
If the part has a rotation angle of 180 degrees, then the rotation angle detected by the tool can change from image to image between +180 degrees and -180 degrees.

After clicking the >> key the second “page” of the control panel is displayed:



Parameter	Description
Noise suppression	By changing the noise suppression you can affect which points are detected by the tool. The lower the value for noise suppression the less contrast and sharpness are required for a point to be detected. Default setting: 20 percent. We recommend changing the sensitivity only if your inspection does not work using the default setting..
Execution speed - Accuracy	– Slow & High - Choose this setting if your pattern consists of only a few corner points. The acquisition time increases and the accuracy of the calculated rotation angle rises. – Fast & Medium - Default setting. Use this setting if your pattern consists of many corner points.

Note
When updating from software version 1.2.0 or higher to version 1.3.0:
The Locator 360 pattern detect tool has significantly MORE feature points in version 1.3 than in the earlier version. After updating we recommend testing your inspections using the ConVis software. If your inspection does not function as desired you must adjust the Noise Suppression parameter.

To ensure definitive locating the following must be taken into account when selecting the pattern:

1. The part to detect must not be symmetrical, otherwise the rotation angle cannot be UNAMBIGUOUSLY detected.
   Example: You want to detect a square feature. Since the square is axis-symmetrical, the rotation angle may change from image to image by 90 degrees, even though the location and position have not changed.

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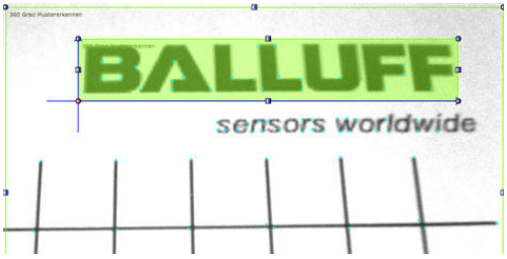
2. The sensor is installed so that the ROI shows the least possible perspective distortion. **Example:** A sensor was tilted by approx. 30 degrees to the vertical in order to prevent undesirable reflections.

IIn the image a grid with parallel lines is placed, and above this grid there is a logo that needs to be checked. By tilting towards the vertical the grid lines seem to form a vanishing point, but the logo as well appears to be wider at the bottom than the top.



If this feature is rotated 90° clockwise, for example, then the alignment of the logo changes also. There is no longer agreement between the reference pattern and the detected pattern.

Example

You want to inspect the printing of warning labels having a lightning bolt symbol. The labels are transported on a belt and may at the point of inspection lie anywhere in the field of view and may be turned at any angle.
To locate the rotational direction we need to use the “Detect 360 degree pattern” tool:

The target pattern is the lightning bolt - defined by the ROI. Also displayed is the orientation of the pattern - represented by the dark blue coordinate system. The zero point always lies on the VERTICAL AXIS!
In the following illustration a rotated label positioned differently is found and its rotation direction determined - here approx. 17° clockwise.

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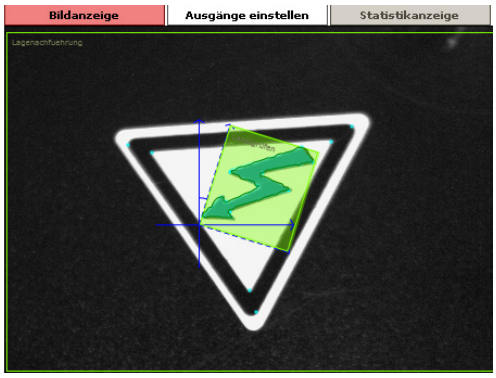
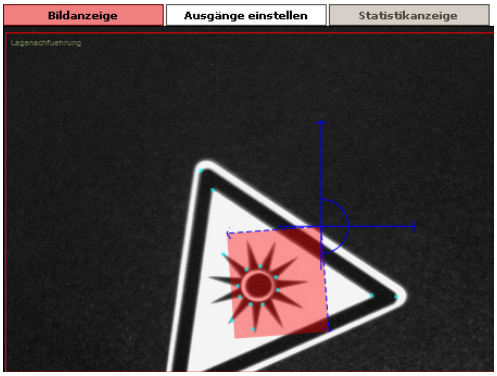


An incorrectly printed label is found, but its actual value is significantly lower (here approx. 65% compared with 90% otherwise) and is therefore detected as NOK.



Note
The acquisition time for a tool depends on the size of the ROI and the search region. Therefore you should select a search region and ROI only as large as absolutely necessary!

7.7 360° Contours – General function and parameterization

All "360° Contour tools" search within the ROI (outer border) for contours which most closely match (actual value) the learned contour template in strength, length and shape. The position, rotation angle and agreement with the detected contour(s) is sent over the Ethernet interface and passed to the other tools (Locator), which then use these positions as a reference point.

7.7.1 General parameter setting instructions

Select only clearly visible contours having good contrast and clear delineation against the background as your reference.

Small, irrelevant contour points can be removed from the reference using the Noise Suppression parameter. Larger contours which are not relevant to the inspection are removed by clicking on them.

Note
If the image region is moved at all, the found contours will be recalculated. All changes (selected/deselected contours) are then cancelled.

Example

Selecting suitable contours with a metal screw.

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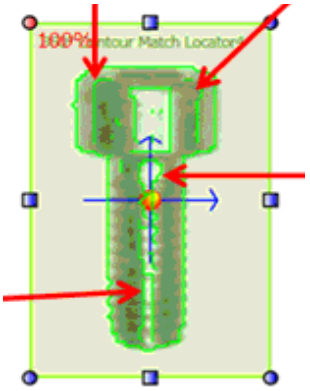
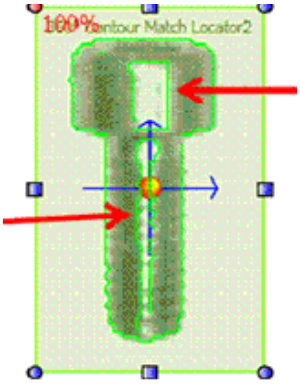
1.) Contour reference directly after selecting the ROI - the red arrows point to contours that are not relevant to the inspection.



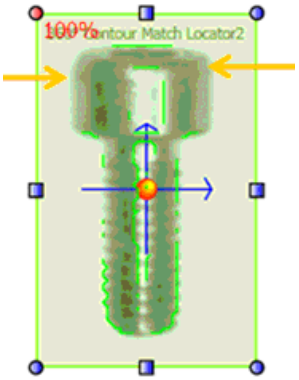
2.) Removing weak reflection contours using the Noise Suppression parameter. Contours with weak contrast or short length are removed by adjusting the Noise Suppression parameter.

In the following illustration you can see that the week contours on the screw head were definitively removed. Contours with strong contrast are not filtered out if moderate settings are used.



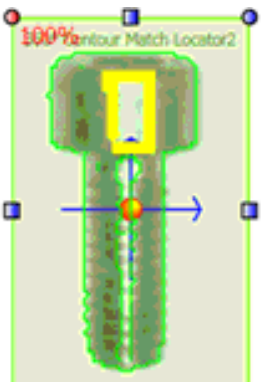
Be sure when changing the Noise Suppression parameter you do not remove any contours important for the inspection, e.g. on the screw head.

Reference contour with Noise Suppression set too high.



3.) Use the mouse to remove other unimportant contours. Placing the mouse pointer over a selected or deselected contour will show it in yellow.

Example: Contour at upper middle is beneath the pointer.
Then left-click – the contour is removed from the reference and shown as a red line.



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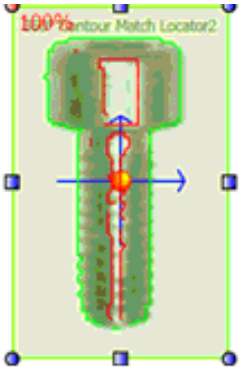
Example: Inner contours deselected with the mouse



You can also remove ALL contours by clicking on the corresponding button in the field. Then you can use the mouse to add individual contours by left-clicking on the red lines.

Contours which have been removed can be restored to the reference by selecting them again with the mouse.

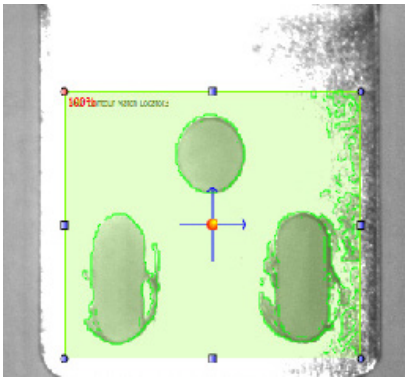
Tip
Before manually selecting the contours use ZOOM IN and ZOOM OUT in the task list.

Note
ConVis gives you a warning when your reference contour does not have sufficiently good contours (contrast strength, length). In this case add contours again or change the image selection.

Here are two more examples for poor contours

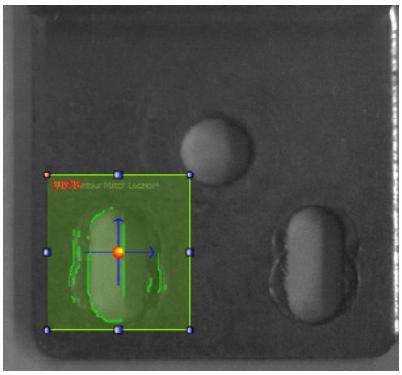
The strong reflections and non-homogenous lighting on the metallic surface result in over-exposure. This in turn results in weak contour contrasts which can vary from part to part since the surfaces will differ from part to part.

In this case we recommend setting the brightness and contrast (Step 1) differently and if possible changing the alignment of the sensor to the part. Also, the use of external lighting may provide dramatic improvement.



In the next example the image brightness is too low and the contour repeats itself on the part.

On one hand this means the contours may not be correctly identified, which can result in greater error frequency, and on the other hand there may be false positionings if the part is not introduced in the proper orientation.



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7.7.2 Parameterizing the origin point for all 360 Degree tools

The position coordinates which are output by the tool over the interface refer to the coordinate origin (Position = 0; Y-Position = 0), which lies in the upper left corner of the image.

Green dot = Origin of the coordinate system
X = 0, Y = 0;;
Orange dot = Furthest removed point in the coordinate system: X = 640; Y = 480

The determined position normally refers to the center of the ROI, indicated by the red center point of the coordinate crosshair:

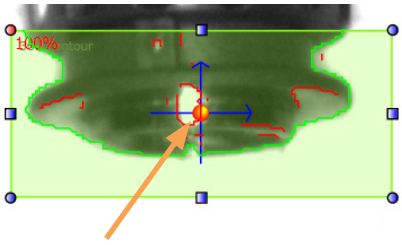
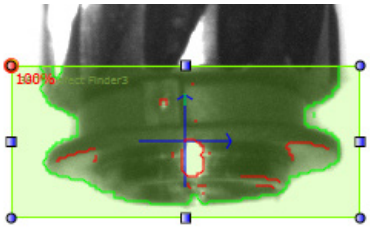
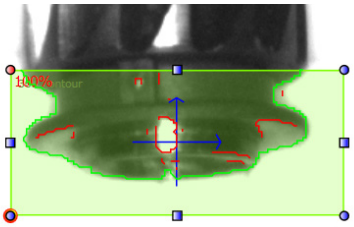


Fig 7-3: Coordinate crosshair, center point in red

You can however transfer this coordinate point into a point which is better suited to your application. Click on the center point of the coordinate cross and while holding the mouse button down move the point to any other desired location in the image.
After moving the point, the position coordinates of the original point as well as the moved point are sent over the interface.



Center point left side high

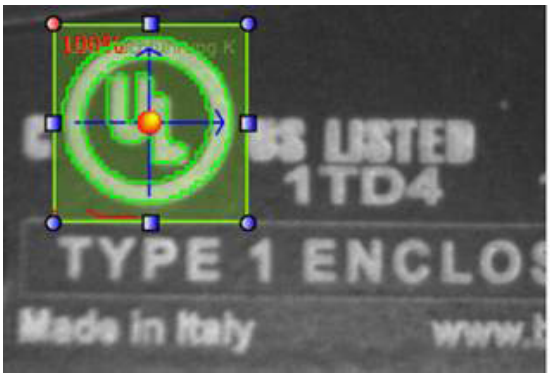


Center point left side low

Fig 7-4: center point shifted

7.7.3 Detected Position vs. Position of Contour

Die vom von den Konturwerkzeug "erkannte" Position, die als Ergebnis ausgegeben wird, bezieht sich immer auf den Mittelpunkt des „Schablonenfensters“. Dieser kann, muss aber nicht, mit der Mitte der erkannten oder gesuchten Kontur übereinstimmen, wie folgendes Beispiel verdeutlicht:
Hier: Der Mittelpunkt des Schablonenfensters (Grüner Rahmen) stimmt mit dem Konturmittelpunkt des UL Zeichens sehr gut überein.
Die Position hier ist X:= 255 Y:= 350



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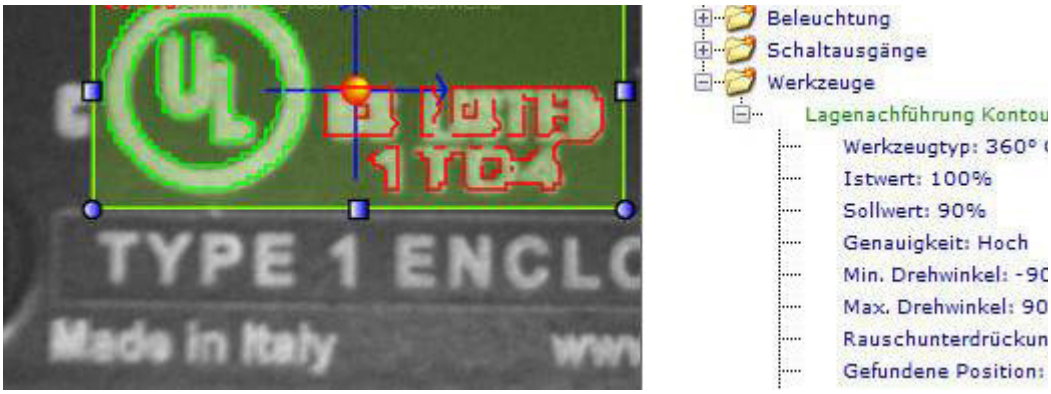
Im zweiten Bild ist das Schablonenfenster deutlich länger, die Kontur aber an gleicher Stelle, irrelevante Konturteile wurden ausgeblendet.
Der Mittelpunkt des Fensters ist hier gegen die Position der Kontur verschoben.
In diesem Fall wir diese Position ausgegeben: X:= 304; Y:= 349



Soll die erkannte Position verwendet werden um z.B. einen Greifer zu steuern, dann sollte dieser Offset mittels einer "Referenzfahrt" während der Inbetriebnahme ausgeglichen werden. Nachpositionierungen mit hohen Anforderungen an die Genauigkeiten können wegen dieses Offsets im Allgemeinen nicht gelöst werden

7.8 360° Contour Match Locator

The locator tool "360° Contour Match " searches within the search area (outer border) for the contours whose agreement (actual value) with the learned reference contour is greatest in contrast strength, length and shape. The position of the recognized contour is shared with the other tools.

The result of the locator tool is OK if at least one contour was found whose actual value is greater than the set desired value, otherwise it returns NOK.
After inserting the tool into the inspection the following control panel is displayed:

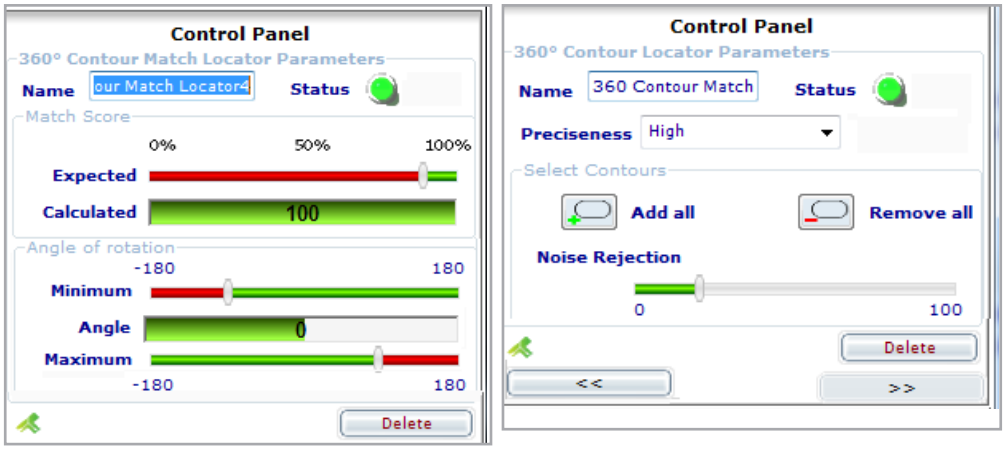


Fig 7-5: Control panel 360° Contour Match Locator, page 1 and 2

Parameter	Description
Name	Name of the tool. Maximum length is 256 characters.
Status	GREEN The found contour is better than the required one (set desired value) and is therefore OK. Red: NOK. The found contour deviates too strongly from the reference contour, the set desired value is not achieved. It is therefore NOK.

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Parameter	Description
Desired value	The desired value defines the minimal agreement which a contour must have in order to be declared OK. The location deviation of the contour pixels from the learned contour is evaluated. 100% = Identical contours, 0% = No similarities. The prescribed value is 75%: for most inspections we recommend a value of 90%.
Actual value	The actual value is the similarity of the found contour with the reference contour in percent.
Minimum / Maximum rotation anglel	The contour is OK if the rotation angle lies within the range defined by minimum and maximum rotation angle AND its actual value is greater than the set desired value. The zero point always lies on the VERTICAL AXIS! Rotation angle ≥ Min. rotation angle AND ≤ Max. rotation angle = OK Rotation angle < Min. rotation angle OR > Max. rotation angle= NOK The standard for the minimum rotation angle -90 degrees, the standard for the maximum rotation angle + 90 degrees.
Accuracy	**High:** Achieves a high locator accuracy at high execution time. **Low**: Faster execution time with low accuracy. Use HIGH for non-homogenous background or when you need a precise inspection.
Noise Suppression	Use this parameter to remove undesired, interfering contours from the reference contour, especially if you have to inspect a poorly contrasting part.
Select all	All contours within the ROI which are not suppressed by the noise suppression are added to the reference contour.
Delete all	All contours are removed from the reference contour.

Application notes

1. The reference image must be sharp and should have as much contrast as possible. Use the setting options in STEP 1 (brightness and contrast) and / or use external lighting.
2. Be sure that the contours belong to the target part and not to the background (belt, other part, etc.). The contours should not differ greatly from part to part, and the part colors should differ only slightly.
3. The target part must lie fully within the ROI. If part of it lies outside, the result will be NOK.
4. Partial covering, distortion in perspective or a change in contrast are all tolerated by the tool, but the accuracy of the locator may suffer.
5. The LARGER the reference contour, the LESS execution time will be required for the search.
6. This tool is not suited for precise contour inspection of a part. For this purpose you should use the 360° Defect finder tool.
7. Even textures (surface structures) on the part and the background may result in errors in the Locator or even incorrectly identified parts.
8. A 360° rotation angle can only be located if the contour is not symmetrical (e.g. a square or a circle). In case that the part is symmetrical, the X & Y position can still reliably detected, if you limit the min. and max. angle. The rule is that the min. & max. angle of rotation has to be chosen so, that it is always smaller than the angle of the symmetry. **Example:** A square has a symmetry every 90 degrees - so the permitted angle is to 89 or -45 to +44. **Example Circle:** Her we have a point symmetry - Permitted angle 0.
9. The contour can also be located when the part is partially covered. The degree of possible covering is greater the smaller the desired value is.
10. Maximum accuracy: ± 2 pixel in X and Y direction and ± 2 degree in rotation direction assuming ideal conditions and consistent contour (orientation to sensor, homogenous lighting).
11. The execution time may be over 3 seconds if the settings are not ideal! Use the following setting options to accelerate the execution time:

► Reduce the ROI of the tool to the actual needed area, e.g. if the inspected contour is always found at the same place in the image
► Enlarge the reference contour. The larger the reference contour the fewer steps are necessary in

7 Locators

order to find the same location in the image.
- ► Set the allowed area for Rotation angle as small a possible for your application.
- ► Change Accuracy to Low
- ► Increase the contrast of the contours

7.9 Datamatrix and QR Code Locator

The Datamatrix Locator tool has the same operating parameters as the Read DataMatrix tool and the Read QR Code. Instructions for use can be found in the chapter "8.13 Read Data Matrix Codes" and "8.14 Read QR-Code" resp..

Instructions for Use:

1. The prerequisite for stable and repeatable reading results are the greatest possible contrast between the code and the image background as well as even lighting.
2. Ambient light (e.g. sunlight, room and machine lighting) can have a strong effect on the reading result. If ambient light problems are anticipated, we recommend using a BVS with infrared light source. In addition, shading (sunshades) and/or short exposure times and use of external lighting can all minimize the effect of ambient light.
3. The tool can read multiple DMC or QR-Codes at the same time. The processing time the tool requires for reading multiple codes is correspondingly greater than for reading just one code.
4. The tool can, depending on the settings, code quality and number of codes in the field of view, require up to several seconds. If a read has to take place within a fixed time window, you must then verify the processing times using the statistics in Step 3.
5. Location changes can be located in the horizontal, vertical and rotation position using this tool. The tool can also compensate for slight tilts and changes in the lighting, although then the maximum locating accuracy cannot be achieved.
6. A DataMatrix code or QR-Code can also be read and located even if it is partially covered. Maximum accuracy: ± 1 pixel in the X und Y direction and ± 1 degree in the rotation direction under ideal conditions and consistent code size as well as number of bits. (Code quality, orientation to sensor, homogenous lighting)

The detected location may vary if the ROI for the Locator tool is selected too small in relation to the code size, or if parts of the code lie outside of the ROI.

7.10 Barcode Locator

The Locator has the same operating parameters as the tool of the same name. Instructions for use can be found in the chapter "8.12 Read Barcode".

Instructions for Use:

1. The prerequisite for stable and repeatable reading results are the greatest possible contrast between the code and the image background as well as even lighting.
2. Ambient light (e.g. sunlight, room and machine lighting) can have a strong effect on the reading result. If ambient light problems are anticipated, we recommend using a BVS with infrared light source. In addition, shading (sunshades) and/or short exposure times and use of external lighting can all minimize the effect of ambient light.
3. The tool “reads” ONLY THE code type which was set in parameterization (auto or manual).
4. Location changes can be located in the horizontal, vertical and rotation position using this tool. The tool can also compensate for slight tilts and changes in the lighting, although then the maximum locating accuracy cannot be achieved.
5. Maximum accuracy: ± 1 pixel in the X und Y direction and ± 1 degree in the rotation direction under ideal conditions and consistent code size as well as number of bits. (Code quality, orientation to sensor, homogenous lighting).

The detected location may vary if the ROI for the Locator tool is selected too small in relation to the code size, or if parts of the code lie outside of the ROI.

8 Inspection tools

8.1 Inspection tools

The tools play the main role in the inspection process: They are used to check certain features in the image. The selection and setup of the tools is one of the most important steps in creating an inspection.
All tools are positioned graphically in the working area by using the mouse. When you insert a tool, the control panel displays its parameters, and a new entry for this tool is added to the Inspection Explorer.
A tool can return the following results:
OK if the feature corresponds to the set parameters, or
NOK: If the feature does not correspond to the set parameters.
More precise definitions of OK and NOK can be found in the descriptions for the tools.

8.1.1 Selecting the right tools

Following is a brief set of instructions for using all the available tools:

"Check brightness" tool

"Check brightness" allows you to check the brightness in the ROI of the tool. The tool calculates the average brightness of the pixels in percent. A value of 0% corresponds to black; a value of 100% corresponds to white.

With the "Check brightness" tool you can check the presence or absence of a particular part feature in the ROI.

Note
"Check brightness" cannot compensate for a position shift.

Use

- Checking presence of a bright label on a dark part.
- Checking presence of a packing slip in a package
- Checking the switching status of indicator lamps

"Compare contrast" tool

With "Compare contrast" you can check the presence or absence of a particular contrast in the ROI. If there are mainly white and black surfaces in the ROI, then the contrast is high; a gray image on the other hand has a low contrast value. The tool calculates the average difference between light and dark pixels in the ROI in percent.
If there is no contrast (e.g. only white pixels in the ROI), then the actual value is 0%; if half the pixels in the ROI are white, and the other half black, then the contrast is 100%.

Use

You can use "Compare contrast" for example
- to check the presence or absence of an O-ring on a metal part,
- or check the presence of an imprint on a label,
- or the level in a bottle.

Example

You want to check whether there is an imprint on the cap insert. The printing is green (appears dark gray to black when illuminated with red light, and the insert itself appears white). If the printing is present, the contrast is high; if the printing is missing, the contrast is low.
Fig. 8-1a shows a good part with printing, Fig. 8-1b a bad part without printing

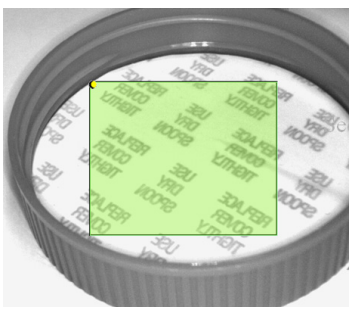


Fig. 8-1a Inspection for the correct printing OK

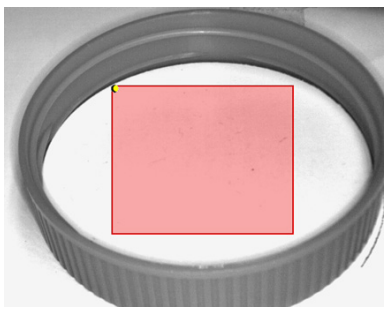


Fig. 8-1b Inspection for the correct printing NOK

8 Inspection tools

"Check contour" tool

The "Contour Match" tool determines the outline (contour or form) of a feature (part) within the ROI. The determined contour is compared with the learned contour template and the degree of similarity is displayed as the actual value in percent. The result of the tool is OK if the actual value is greater than or equal to the set desired value.
The contour check is able to identify both internal and external contours.
Each found contour in the ROI of the tool is highlighted in **LIGHT BLUE**.
The tool can only find ONE contour in the ROI.

Use

Use "Check contour" to
- Check the shape of an injection molded part - tabs or burrs can be detected
- Differentiate parts based on the contour - such as the size of small packages
- Check whether a retaining ring is present in the corresponding position.

"Compare width" tool

This tool allows to measure the distance between two points.
This tool can be used whenever you want to measure the distance in pixels between two edges of an object or part. Minimum and Maximum width thresholds can be established to accept or reject the inspection.

Note
This tool can also be used to measure a height!

Use

- Control the correct size of parts e.g. width steel bands
- Cap mounting control;
- Control diameter of screws, O-Rings etc.

Example

The size of O-Rings need to be checked to ensure that only correct rings are used in the customer process.
In Fig.8-2a shows an O-Ring of correct size whereas Fig. 8-2b shows an O-Ring with a smaller inner diameter, resulting in a failed inspection..

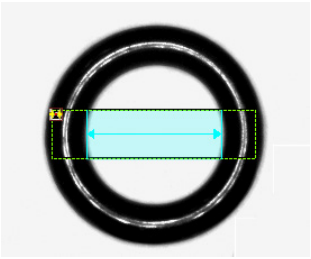


Fig.8-2a: O-Ring with correct size

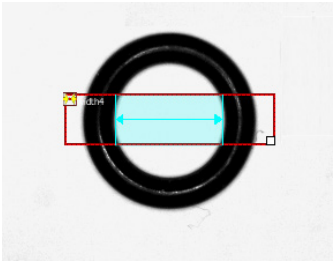


Fig.8-2b: O-Ring too small!

"Count edges" tool

"Count edges" counts the number of transitions having a high brightness difference (so-called edges) within the ROI. The result is OK if the determined number of edges lies within MINIMUM and MAXIMUM.
By changing the rotation angle of the ROI you can determine in which direction the edges are counted. The default direction is from LEFT to RIGHT.

Use

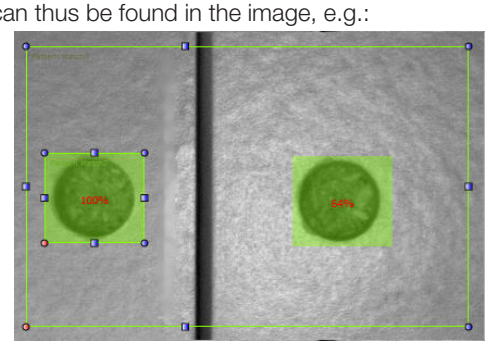
Use the edge count tool for example to:
- Check the presence of holes, threads or teeth in or on a part
- Check the presence of scratches on surfaces
- Check the part orientation (e.g. slot left or right)

"Pattern detect" tool

"Pattern detect" searches within the search region for the pattern which are similar to the learned reference pattern. For each found pattern the degree of similarity (= actual value) to the reference pattern is determined. If the actual value of a pattern is greater than the set desired value, this is indicated by a colored frame in the image and the number of found patterns is incremented by 1.

8 Inspection tools

More than one pattern can thus be found in the image, e.g.:



The pattern defined by the ROI of the reference image is learned as the pattern.

Note
Please be sure to illuminate the search area as homogenously as possible!

Use

Use “Pattern detect” for example for the following applications:
- Checking whether a part is oriented up or down (if the pattern is present on one side only).
- Checking whether a seal is fully closed.
- Checking whether a label was fully printed.
- Check whether all pills are present in a pill box.
- Check rivet integrity.
- Check for the correct number of ordered “units” in the packaging..

Example

Here the orientation of a shampoo bottle needs to be checked.
The orientation of the bottle is OK if the seal is oriented towards the front.
The pattern detected is the one that results from the shape of the indentation beneath the seal.
Fig. 8-3a shows a successful inspection, and Fig. 8-2b a bad part.

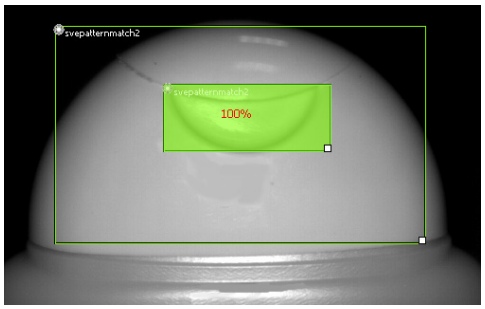


Fig. 8-3a Pattern detection of a shampoo bottle seal: OK

Fig. 8-3b Pattern detection of a shampoo bottle seal: NOK

“Check position” tool

Use

The “Check position” tool searches for the position (in pixels) of the first edge within the selected ROI. If this position lies within the set limits, then the tool returns: OK, otherwise: NOK.

Use the “Check position” tool you want to inspect the position of a feature (part) with respect to the image border or (together with a Locator) with respect to another feature. “Check position” is useful among other things for the following applications:

- Checking the level of a container. As long as the level is not less than a certain minimum or maximum, the result is OK.
- Checking correct part location - see example below.
- Checking whether a seal is fully closed.

Example

Correct attachment of a spout on a bottle needs to be checked. We insert the “Check position” locator into the image. Then we change the value for Maximum so that an incorrectly placed spout

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results in a value greater than the permissible Maximum. If the actual value is greater than the maximum value, the position of the spout is NOK.
Fig. 8-4a shows a correctly placed spout; in contrast, Fig. 8-4b shows an incorrectly placed spout.

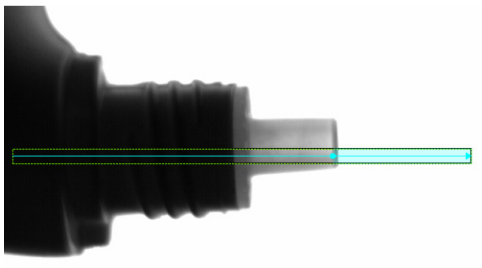

Fig. 8-4a Position checking of the spout of a dish liquid bottle: OK

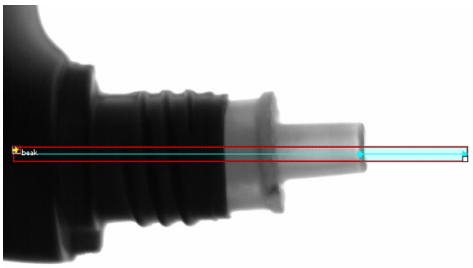

Fig. 8-4b Position checking of the spout of a dish liquid bottle: NOK

"360° Defect finder" tool

The 360° Defect finder tool allows contours on workpieces and parts to be inspected for deviations with very high accuracy.
The result is OK if the actual contours have a similarity equal to or greater than the set desired value of the reference contour and the angle of rotation is within the approbriate thresholds. The reference contour can be selected during parameter setting.
The tool reliably checks:

- Whether there are location deviations between the outline of the actual contours compared with the outline of the contours in the reference contour.
- Whether contours present in the reference contour are missing in the inspection object.
- Whether additional contours are present which are not present in the reference.

The tool can also check the contours if the part is rotated up to 360 degrees from the reference or there is a shift in the X- and Y-direction.
The minimum detectable difference in the contour is ± 10 pixels. Smaller deviations cannot be detected. Please note the instructions for use in the tool description!

Use

- Finding deviations from the desired part – e.g. scratches, paint spray defects, manufacturing defects.
- inspection for correct assembly – if a contour change results from incorrect assembly.

"360° Contour counter" tool

The 360° Contour counter tool finds and counts all contours whose similarity with the reference contour is greater than the set desired value and the angle of rotation is within the approbriate thresholds. For each detected contour the X- and Y-position as well as the rotation and the similarity is determined and output over the interface. The result is OK if the number of contours found in the ROI is greater than the set minimum value and also less than the set maximum value.

The tool can also count the contours if they are rotated up to 360 degrees from the reference or there is a shift in the X- and Y-direction.

Use

- Inspecting for completeness before packaging.
- Inspecting for correct number and positioning.
- Inspecting for correct assembly, e.g. threaded joints, riveting, etc.

"Optical Character Verification" tool

Using the OCV tool (Optical Character Verification) you can check whether an imprint on an object is identical with the previously read one.
It is NOT used to actually read the printed text - it simply checks whether the detected character string is identical with the reference example!

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Note
The OCV tool uses a reference image as the inspection basis. You can specify a new reference image by clicking on TEACH in the SETUP menu. Please note that after any change in position or size of the ROI the system automatically records a reference image.

Use

- Presence or absence of an imprint
- Check lot code
- Check printed EAN number below the barcodes
- Ensure that only parts with the correct type codes are used

Example

Here we are using the OCV tool to check the type code on a label. The type code for the current parts must be 53231560 – all parts with different or illegible type codes are sorted out by the OCV tool.

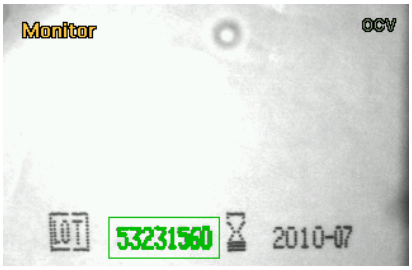

Fig. 8-5a Part marked with the correct type code

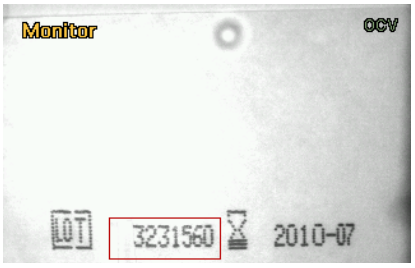

Fig. 8-5b Type code on the part is damaged or incomplete!

"Read Barcode" tool

The Read barcode tool finds and reads all commonly used barcodes in the selected ROI.

The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.
The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:

- The bar code and a surrounding quiet zone are located fully within the ROI, and
- the light conditions in the ROI are homogenous.

Modul sizes:
The barcode reader tool can read barcodes with a minimum module size of 1.75 pixel at good contrast up to a maximum of 16 pixels / module. In any case you have to check the reading diagrams in chapter 16.3. for details.

"Read QR Codes

The "Read QR codes" tool finds and reads QR and Micro QR Codes in the selected ROI.

The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.
The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:

- The QR code and a surrounding quiet zone are located fully within the ROI, and
- the light conditions in the ROI are homogenous

Any QR/Micro QR code will be decoded as ASCII signs. Reading QR Codes with only numeric signs or Kanji signs is not feasible.
Maximum Skew in X- or Y- direction:
The QR code reader can read QR/Micro codes up to a maximum skew of ±30 in X- or Y-direction. Skewing the codes in both direction at once will reduce the possible maximum skews in each direction.

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Modul sizes:
The QR Code reader tool can read QR Codes with a minimum module size of 3 pixel at good contrast up to a maximum of 20 pixels / module. In any case you have to check the reading diagrams in chapter 16.3. for details.
The modules must have 1:1 ratio.
In any application the read realiablity must be tested. Those values given here are reference values.

“Read Data Matrix codes" tool

The Read Data Matrix codes tool finds and reads Data Matrix codes (ECC200) in the selected ROI.

The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.
The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:
– The DMC code and a surrounding quiet zone are located fully within the ROI, and
– the light conditions in the ROI are homogenous.

The Datamatrix reader can read the following codes:
– "Quadratic" Codes (Number of modules at horizontal axis is equal to number of moduls in vertical axis) with the following module numbers:
10x10,12x12,14x14,16x16,18x18, 20x20, 22x22, 24x24, 26x26, 32x32, 36x36, 40x40, 44x44, 48x48, 52x52, 64x64, 72x72, 80x80, 88x88, 96x96,104x104,120x120,132x132,144x144
– "Rectanqular" Codes (Number of modules at horizontal axis not equal with number of modules in vertical axis) with the following module numbers:
8x18,12x26,8x32,12x36, 16x36,16x48

Maximum Skew in X- or Y- direction:
The DM code reader can read DMC codes up to a maximum skew of ±35 in X- or Y-direction.

Modul sizes:
The datamatrix reader tool can read DM Codes with a minimum module size of 3 pixel at good contrast up to a maximum of 20 pixels / module. In any case you have to check the reading diagrams in chapter 16.3. for details.
The modules must have 1:1 ratio.
In any application the read realiablity must be tested. Those values given here are reference values.

Note
The data of the read codes (DMC or QR or any of the barcodes) can be send out via the sensors RS232 or Ethernet interface.
More information you can find in the Chapter 9 Interface

8.1.2 Multiple tools in an inspectiton

Simple inspections often consist of just one tool. If this tool returns NOK, then the entire inspection is considered to have failed; if the result is OK, then the entire inspection is OK. If you add more than one tool to an inspection then in the case of the BVS-E Standard the inspection (part) will be OK if all tools are OK. If a tool is NOK, this will apply to the inspection as well.
For all other models you can use logical operations to specify the states of the outputs and when an image should be saved

Note
The acquisition time (cycle time) for the inspection increases with the number of tools. Depending on the tool, the acquisition time may vary considerably.

The acquisition of an inspection is always as follows:
– The acquisition starts with a trigger event (either internally or from an external sensor).
– The sensor records an image.
– The Locator tool (if used) is evaluated and provides a result (either OK or NOK).
– If the Locator tool is OK: The ROI of the tools are evaluated one after the other and return a result (either OK or. NOK).
– As soon as all events have been calculated, an image is saved in the sensor as long as the conditions for saving are met, the outputs are set accordingly and held for the pulse duration.

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– The sensor is ready for another inspection cycle.

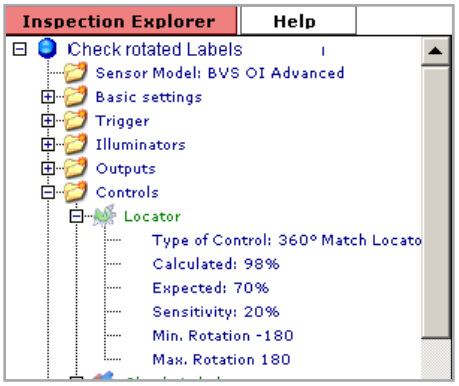
More information inspection timing can be found in Section “10.1 Setting outputs" and "15.1 Inspection times".
No fixed switching frequencies can be given for Vision Sensors as with other sensors. This is because different computing times are required for evaluating the various tools in the inspection. The typical detection rate is a guideline as to how often a part can be inspected per second.
The actual achievable detection rates may be greater or smaller – this depends mainly on what task you are performing.
.
During sensor configuration you can use the “STATISTICS” display in Step 3 to estimate the possible detection rates for your task.

8.1.3 Selection and positioning

More information on selecting and positioning tools can be found in Section “5.4.1 Selecting and positioning tools”.

8.1.4 Tools in the Inspection Explorer

Each tool added to an inspection generates an entry in the Inspection Explorer. This entry consists of
– Name
– The current parameters of the tool
To expand a display level, click on the symbol next to the name.



The following sections contain detailed descriptions of each tool.

8.2 Check brightness

The following illustrations show the two sides of the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

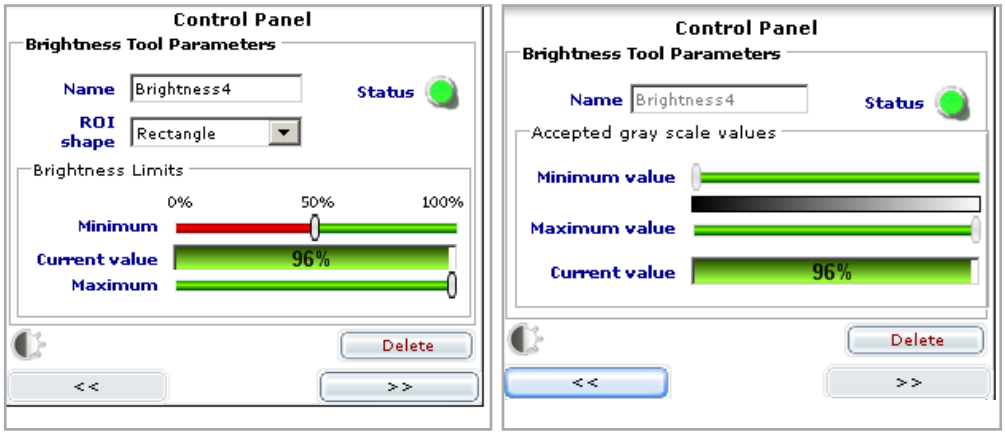


Fig.8-6: Control panel for Brightness, page 1 and page 1

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Parameter	Description
Name	Name of the tool. Max. length 256 characters
Status	Green: OK. The brightness in the ROI lies within the set limits. Red: NOK. The brightness lies OUTSIDE the set limits.
Shape	Changes the shape of the ROI. Available are: **Rectangle:** The ROI of the tool is rectangular. **Ellipse:** The ROI of the tool is circular or elliptical.
Minimum & Maximum	The result is OK as long as the actual value lies between Minimum and Maximum. The result is NOK if the actual value is less than the minimum value or greater than the maximum value. The default value for the Minimum is 50%; the default value for Maximum is 100%. – Actual value ≥ Minimum AND actual value ≤ Maximum = OK – Actual value < Minimum OR actual value > Maximum = NOK
Actual value	The actual value is the average brightness of the ROI in the current image in percent. – A value of 100% means: Area is completely white. – A value of 0% means: Area is completely black.
Minimum and Maximum gray value	If the minimum gray value is 0 and the maximum gray value 255, then the average brightness of all pixels in the ROI is calculated. You can use the minimum gray value for example to remove dark pixels and dark areas from the evaluation by increasing the value. You can use the maximum gray value for example to remove bright pixels and bright areas from the evaluation by decreasing the value. **Example:** You want to check the brightness of a part feature. This feature appears in the image as a light gray – but at this location there is a strong reflection (bright white). The calculated brightness is still too high. If you sent the “Maximum gray value” parameter so that all the bright white pixels are removed from the calculation, you will get the correct results.

Notes on using:

1. “Check brightness” evaluates the brightness of the feature in the ROI. The brightness depends significantly on the material surface as well as on the amount of light reflected by the feature. Please note that ambient light can have a strong influence on the evaluation. We recommend shading the feature you are inspecting from ambient light when using “Check brightness”!
2. “Check brightness” cannot compensate for a position shift. If the position of the feature can shift within the sensor field, you must use a Locator tool.

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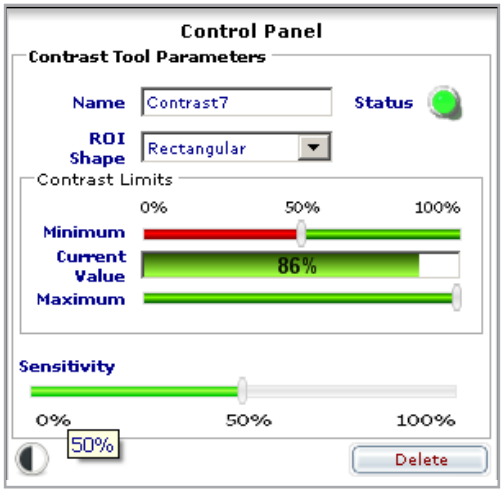
8.3 Compare contrast

The following illustrations show the control panel of the tool. A detailed description of the tool parameters can be found in the table below. A description of the tool can be found in Section “8.1.1 Selecting the right tools”.



Parameter	Description
Name	Name of the tool. Max. length 256 characters
Status	Green: OK. The contrast in the ROI lies within the set limits. Red: NOK. The contrast lies OUTSIDE the set limits.
Form	Changes the shape of the ROI. Available are: **Rectangle:** The ROI of the tool is rectangular. **Ellipse:** The ROI of the tool is circular or elliptical.
Minimum & Maximum	The result is OK as long as the actual value lies between Minimum and Maximum. The result is NOK if the actual value is less than the minimum value or greater than the maximum value. The default value for the Minimum is 50%; the default value for Maximum is 100%. – Actual value ≥ Minimum AND actual value ≤ Maximum = OK – Actual value < Minimum OR actual value > Maximum = NOK
Actual value	The actual value is the contrast within the ROI in the current image in percent. – The contrast is 100% if only black and white pixels are present in the ROI. – The contrast is 0% if all pixels have the same gray value, e.g. white.
Sensitivity	Sensitivity is used to set how strong a contrast is determined. **Sensitivity 100%:** The maximum contrast in the ROI is calculated. **Sensitivity 50%:** The average contrast in the ROI is calculated. **Sensitivity 0%**: The minimum contrast in the ROI is calculated

Notes on using:
“Compare contrast” cannot compensate for a position shift. If the position of the feature can shift within the sensor field, you must use a Locator tool.

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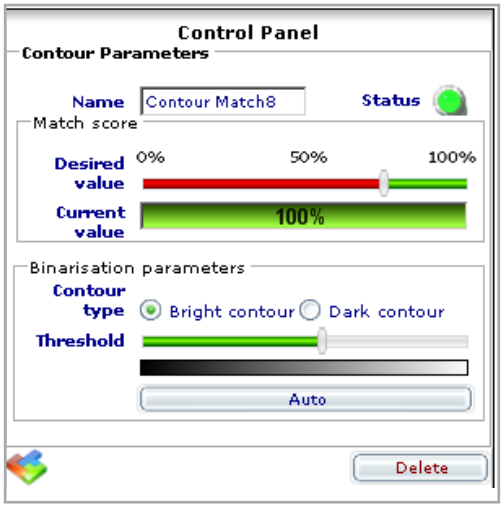
8.4 Check contour

The following illustration shows the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.



Parameter	Description
Name	Name of the tool. Max. length 256 characters
Status	Green: OK. A contour similar to the desired reference contour was found. Red: NOK. No contour was found or the similarity of the found contour lies below the specified desired value.
Desired value	The desired value represents the threshold value for similarity (actual value) of the current contour to the reference contour. If the actual value exceeds the desired value, the tool returns OK. 100% = reference contour is identical with the current contour, 0% = No similarity. The default value is 85%; for most inspections we recommend a value of 66%
Actual value	The actual value represents the similarity of the current contour in the ROI to the contour of the reference image in percent. No similarity = 0%; contour identical = 100%
Contour type	Specifies which contour shall be checked: Bright contour: Bright contour on dark background Dark contour: Dark contour on bright background
Threshold value	Gray scale threshold value. By changing this threshold value you influence which points are parts of the contour and which are not. We recommend setting the threshold to a gray value close to the average gray value of the background.
Automatic	After clicking, the best threshold value for the ROI is determined once. A new threshold will also be determined whenever the ROI will be changed (either be changing the size, moving the ROI or rotating it).

Notes on using:

1. “Check contour” looks only for a closed contour (shape) in the ROI. A contour is considered closed if its outline lies completely within the area and it has no beginning and no end.
   Example: A circle or square which lies fully within the ROI meets both requirements.
2. The prerequisite for stable and repeatable detection in contour evaluation is high contrast between the contour and the background in the ROI as well as even illumination of the feature.
3. “Check contour” cannot compensate for a position shift OUTSIDE its ROI. If the position of the feature can shift within the sensor field of view, you must use a Locator tool. If the feature remains within the ROI of the tool, position and rotation angle changes can be located!

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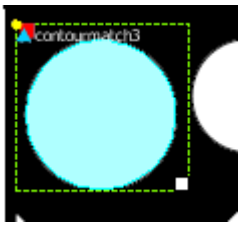
Example

The bright circle in the illustration below in an example for the contour type: Bright contour. The bright contour is highlighted in light blue. The Threshold parameter is set to nearly black.



Note
If a contour is NOT enclosed within the ROI, then the tool "closes" the contour using the frame of the ROI. We recommend using the tool in this way ONLY in applications illuminated by background lighting!

8.5 Count edges

The following illustrations show the control panel of the tool. A detailed description of the tool parameters can be found in the table below. A description of the tool can be found in Section "8.1.1 Selecting the right tools".

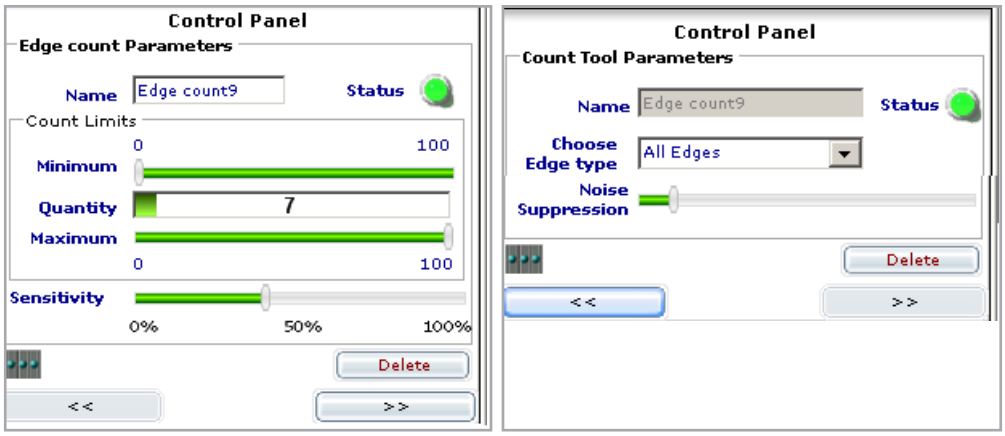


Fig.8-7: Control panel for "Count edges" page 1 and page 2

Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The number of found edges lies within the limits. Red: NOK. The number of found edges lies outside the limits (is therefore less than the set minimum or greater than the set maximum).
Minimum / Maximum	The result is OK if the current number of edges lies within MINIMUM and MAXIMUM. If no edges are found or the current value lies outside the defined limits, the result is NOK. – Number ≥ Minimum AND number ≤ Maximum = OK – Number < Minimum OR number > Maximum = NOK By default the tool uses a minimum of 1; the maximum is 100
Number	"Number" is the sum of the edges found in the ROI which meet the current settings. The arrow shown in the illustration indicates the direction of the edge search.
Sensitivity	The higher the sensitivity, the smaller the differences between bright and dark areas are detected as edges. Normally, when sensitivity is high, even edges with weaker contrasts are detected, which can alter the number of detected edges.

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Parameter	Description
Edge type	Only in “Expanded functions” mode. Determines an edge type to search for in the image. The selection possibilities are: – Select **all edges** to detect transitions from bright to dark and dark to bright. – Select **only dark-bright edges** to find ONLY transitions from dark to bright. – Select **only bright to dark edges** to detect transitions from bright to dark. – Select **Automatic** to find and count the STRONGEST transitions.
Noise suppression	The noise suppression parameter allows you to exclude noise pixels for clean edge detection. Please note: The higher the value, the “stronger” the edge must be.

Notes on using:

1. The “Count edges” tool cannot compensate for a position shift of the feature. If the position of the feature can shift within the sensor field of view, you must use a Locator tool.
2. If for example when testing surfaces a number of ZERO (0) is detected as OK, then you must set the minimum to 0!

8.6 Width

The following illustrations show the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

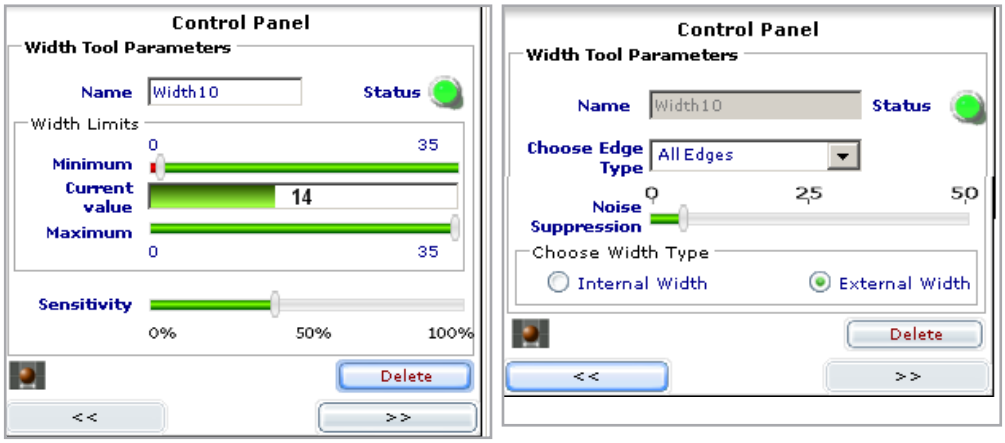

Fig.8-8: Control panel for Width, page 1 and page 2

Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The determined width lies within the limits. Red: NOK. The determined width lies outside the limits (is therefore less than the set minimum or greater than the set maximum.
Minimum & Maximum	The result is OK if the current actual value lies within MINIMUM and MAXIMUM. If no edges are found or the current value lies outside the defined limits, the result is NOK . – Actual value ≥ Minimum AND actual value ≤ Maximum = OK – Actual value < Minimum OR actual value > Maximum = NOK By default the tool uses a minimum of 1; the maximum is the actual WIDTH of the ROI.
Actual value	The actual value in pixels is the determined distance between the edges in the current image.
Sensitivity	The higher the sensitivity, the smaller the differences between bright and dark areas are detected as edges. Normally, when sensitivity is high, even edges with weaker contrasts are detected, which can alter the determined width.

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Parameter	Description
Edge type	Determines an edge type to search for in the image. The selection possibilities are: – Select **all edges** to detect transitions from bright to dark and dark to bright. – Select **only dark-bright edges** to find ONLY transitions from dark to bright. – Select **only bright to dark edges** to detect transitions from bright to dark. – Select **Automatic** to find the STRONGEST transition.
Noise suppression	The noise suppression parameter allows you to exclude noise pixels for clean edge detection. Please note: The higher the value, the “stronger” the edge must be to be detected as an edge.
Width type	– Select **Inner Width** to determine for example the inner width of a hole or O-ring. The tool searches from the center point of the ROI to the borders. – Select **Outer Width** to determine for example the outside width of a tube. The tool searches from the outer borders of the ROI to the center point.

Note
The tool may not be used as a measuring instrument!

Notes on using:

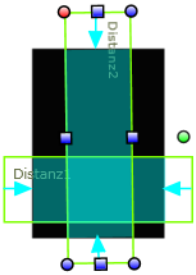
1. The “Width” tool cannot compensate for a position shift of the feature. If the position of the feature can shift within the sensor field of view, you must use a Locator tool.
2. Since two edges need to be found in order to determine a width, the minimum error is at least ± 2 pixels!

Example

Let us assume we want to check the length and width of a dark object on a light background

- ► Insert two width tools into the inspection.
- ► Rotate one width tool to the right by 90 degrees using the mouse.
- ► Adjust the size and position of the ROI to your object:

The found actual width is indicated by the light blue lines inside the ROIs. By using the Minimum and Maximum parameters you can set how far the actual width is allowed to deviate from the width found in the reference image in order to be still considered acceptable.



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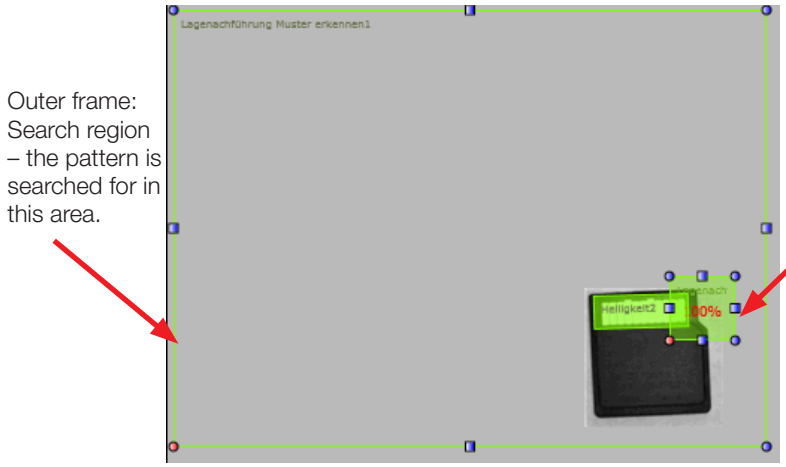
8.7 Pattern detect

If you have inserted a “Pattern detect” tool into your inspection, you will see two rectangles, one of which lies inside the other:



The ROI may always lie only within the search region. While the inspection is being carried out the pattern is also looked for only in the search region.
The following illustrations show the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

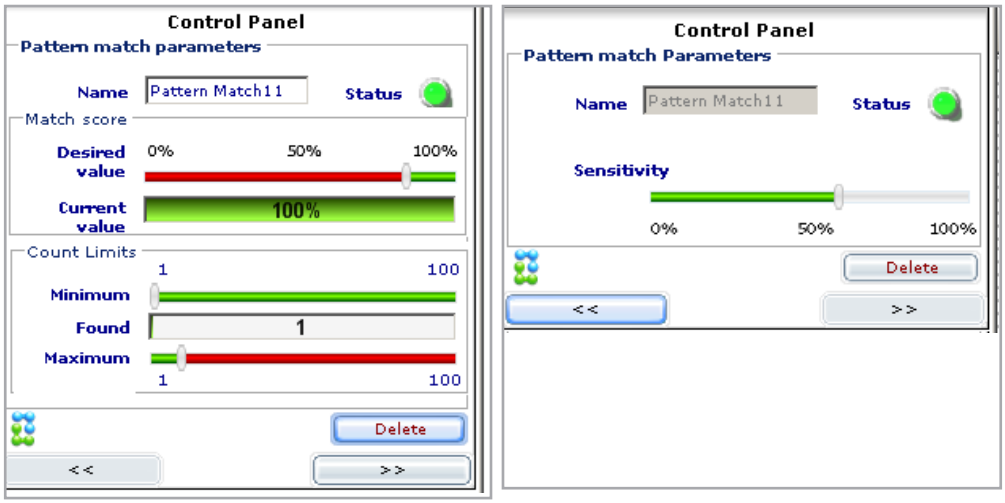


Fig.8-9: Control panel for “Pattern detect”, page 1 and page 2

Parameter	Description
Name	Name of the tool. Max. length 256 characters.
Status	Green: OK. The similarity of the pattern found within the search region with the reference pattern is greater than the set desired value AND the number of found patterns lies within the set limits. Red: NOK. No pattern found whose similarity is greater than or equal to the set desired value or the number of found patterns is less than or greater than the set limits.
Desired value	The desired value defines the minimum similarity which a pattern found in the search region must have in order to be considered as detected. Only patterns which have a similarity greater than the set desired value are displayed by the software and counted by the tool. 100% = Identical pattern, 0% = No similarity. The default value is 85%; for most inspections we recommend a value of 66%.

8 Inspection tools

Parameter	Description
Actual value	The actual value is the similarity of the pattern with the reference pattern in percent. – Actual value 100%: Pattern identical to reference pattern. – Actual value 50%: Pattern is only 50% similar to the reference pattern .
Minimum & Maximum	The result is OK if the number of found patterns lies between the Minimum and Maximum. If no patterns are found or the current value lies outside the defined limits, the result is NOK. – Number ≥ Minimum AND number ≤ Maximum = OK – Number < Minimum OR number > Maximum = NOK By default the tool uses a minimum of 1; the maximum is 100.
Sensitivity	By changing the sensitivity you can affect how strongly differences between the reference pattern and the found pattern affect the actual value. The sensitivity is set by default at 60 percent. – Sensitivity 100%: Differences have a strong effect on the actual value. – Sensitivity 50%: Differences have a medium effect on the actual value. – Sensitivity 0%: Differences have a low effect on the actual value.

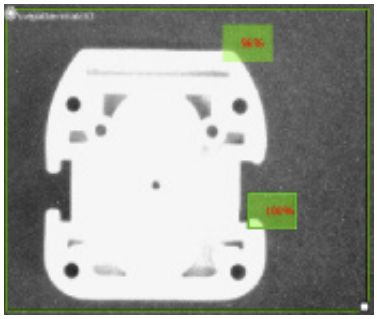
Notes on using:

1. The pattern is searched for only INSIDE the search area - if the pattern lies outside the search area (but still within the image area of the sensor), the pattern will not be found.
2. The acquisition time for the “Pattern detect” tool depends greatly on the size of the ROI and search area. The larger the area, the more time is required. Therefore we recommend setting the ROI and search area as small as possible but as large as necessary.
3. In order to rotate “Pattern detect” you must reduce the search region so that all the sides lie within the image. The green grab point for rotating the tool is found ABOVE the search region.

Example

We are looking for the pattern of the rounded edge and find it twice in the image:

The upper pattern was found with a similarity of 96%; the lower pattern agrees perfectly.



8 Inspection tools

8.8 Check position

The following illustrations show the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

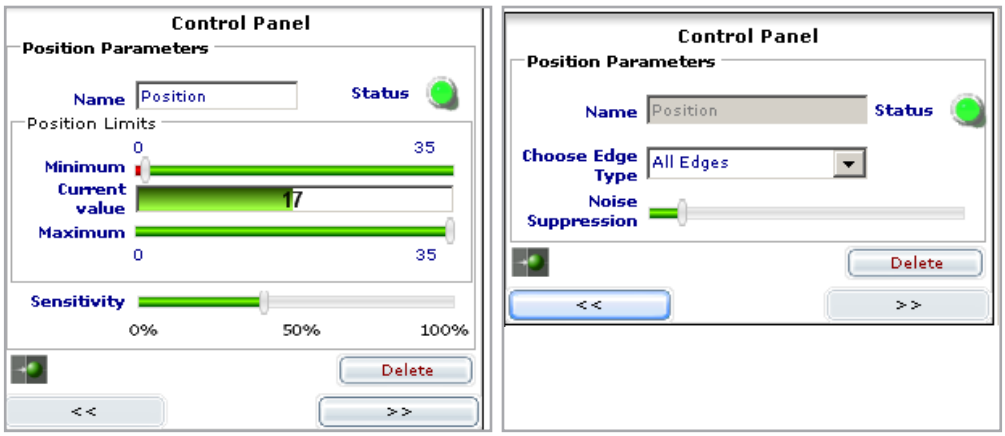


Fig.8-10: Control panel for “Check Position”, page 1 and page 2

Parameter	Description
Name	Name of the tool. Max. length 256 characters.
Status	Green: OK. Found edge lies within the "Position” limits. Red: NOK. No edge found or the found edge does not lie within the limits.
Minimum & Maximum	The result is OK if the current position lies within MINIMUM and MAXIMUM. If the current position is less than the set minimum or greater than the set maximum, then the result of the tool is: NOK. By default the tool uses a minimum of 1 pixel; the maximum is the actual WIDTH of the ROI. – Actual value ≥ Minimum AND actual value ≤ Maximum = OK – Actual value < Minimum OR actual value > Maximum = NOK.
Actual value	The actual value in pixels is the determined position of the edge from the left border or the ROI. The lower left corner of the ROI is marked by a RED POINT.
Sensitivity	The GREATER the sensitivity, the LESS the brightness difference between a bright and a dark area needs to be for an edge to be detected.
Edge type	Determines an edge type to search for in the image. The selection possibilities are: – Select **all edges** to detect transitions from bright to dark and dark to bright. – Select **only dark-bright edges** to find only transitions from dark to bright. – Select **only bright-dark edges** to find only transitions from bright to dark. – If you select **Automatic**, the strongest transitions are selected both from bright to dark and dark to bright.
Noise suppression	Noise suppression allows you to filter out slight brightness changes when searching for edges. The strong you set the noise suppression, the greater the brightness change necessary to locate an edge.

Notes on using:

1. The “Check position” tool cannot compensate for a position shift of the feature. If the position of the feature can shift within the sensor field of view, you must use a Locator tool!
2. If a position of ZERO (0) should be detected as GOOD, then you must set the minimum to 0!
3. "Minimum" and "Maximum" always refer to the ROI. The zero point lies on the side of the ROI indicated by a RED corner point.
4. If an edge is not correctly detected in the image, adjust the parameters “Edge type”, “Sensitivity” or “Noise suppression”.

8 Inspection tools

8.9 360° Defect finder tool

After inserting the tool into the inspection the following control panel is displayed:

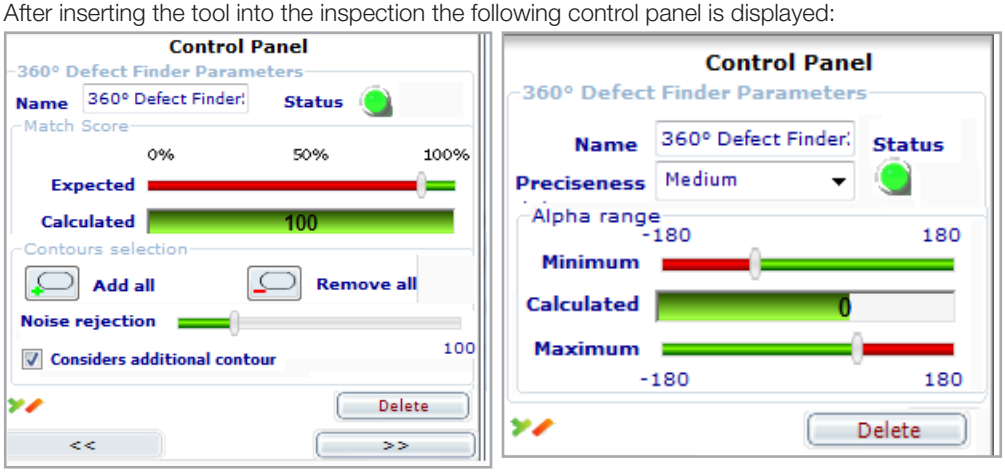


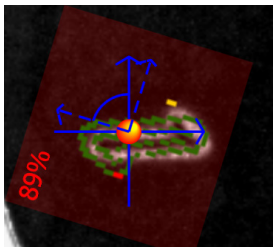
Fig 8-11: Control panel 360° Defect finder, page 1 and 2

Parameter	Description
Name	Name of the tool. Maximum length is 256 characters.
Status	GREEN: The found contour is better than the required one (set desired value) and therefore OK. Red: NOK. The found contour deviates too much from the reference contour, the set desired value is not reached. It is therefore NOK.
Desired value	The desired value defines the minimum agreement a contour must have in order to be classified as OK. The location deviation between the found contour and the reference contour and any missing or additional pixels present are evaluated. 100% = Identical contours, 0% = No similarities. The default value is 90%.
Actual value	The actual value is the similarity of the found contour with the reference contour in percent.
Minimum / Maximum rotation anglel	The contour is OK if the rotation angle lies within the area defined by the minimum and maximum rotation angle AND its actual value is greater than the set desired value. The zero point always lies on the VERTICAL AXIS! Rotation angle ≥ Min. rotation angle AND ≤ Max. rotation angle = OK Rotation angle < Min. rotation angle OR > Max. rotation angle = NOK The standard for the minimum rotation angle -90 degrees, the standard for the maximum rotation angle + 90 degrees.
Include additional contours	**On / Off** If this option is selected the tool also includes contours which are additionally present in the currently inspected part but which are not present in the reference contour. Deselect this option if for example interfering reflections could occur on the part and you do not want these to be included in the inspection.
Accuracy	**High:** Achieves a high locator accuracy with high execution time **Low:** Faster execution time with low accuracy Use **HIGH** for non-homogenous background or when you need a precise inspection.
Noise Suppression	Use this parameter to remove undesired, interfering contours from the reference contour, especially if you have to inspect a poorly contrasting part.
Select all	All contours within the ROI which are not suppressed by the noise suppression are added to the reference contour.
Delete all	All contours are removed from the reference contour.

8 Inspection tools

Application notes

1. The reference image must be sharp and should have as much contrast as possible. Use the setting options in STEP 1 (brightness and contrast) and / or use external lighting.
2. Be sure that the contours belong to the target part and not to the background (belt, other part, etc.). The contours should not differ greatly from part to part, and the part colors should differ only slightly.
3. The target part must lie fully within the ROI. If part of it lies outside, the result will be NOK.
4. The tool is optimized to find even small deviations in the contour. Coverings, distortion in the perspective or additional contours will always change the result of the inspection.
   In Test and Run MISSING contours or pixels with RED lines are shown, and ADDITIONAL CONTOURS or PIXELS are yellow.



RED: Missing contour pixels;
yellow: Additional contour pixels found

5. The LARGER the reference contour, the LESS execution time will be required for the search.
6. Same textures (surface structures) on the part and on the background may result in errors or even in erroneously detected parts.
7. A rotation direction can be only located in 360 degrees if the contour is not symmetrical (e.g. a square or a circle). .
   In case that the part is symmetrical, the X & Y position can still reliably detected, if you limit the min. and max. angle. The rule isthat the min. & max. angle of rotation has to be chosen so, that it is always smaller than the angle of the symmetry. **Example:** A square has a symmetry every 90 degrees - so the permitted angle is to 89 or -45 to +44 . **Example Circle:** Her we have a point symmetry - Permitted angle Grade 0.
8. Partial covering, distortion in perspective or a change in contrast are all tolerated by the tool. The degree of possible covering is greater the smaller the desired value is.
9. Minimum difference: The minimum contour difference is ± 10 pixels. Smaller deviations cannot be detected.
10. The execution time may be over 3 seconds under unfavorable circumstances. Use the following methods to accelerate the execution time:

- ► Reduce the ROI of the tool to just what is absolutely needed, e.g. if the inspected contour is always in the same location in the image.
- ► Enlarge the reference contour. The larger the reference contour the fewer steps are necessary in order to search the entire ROI.
- ► Change the Accuracy to Low.
- ► Set the allowed area for Rotation angle as small a possible for your application.
- ► Increase the contrast of the contours.

8 Inspection tools

8.10 360° Count Contours

After inserting the tool into the inspection the following control panel is displayed:

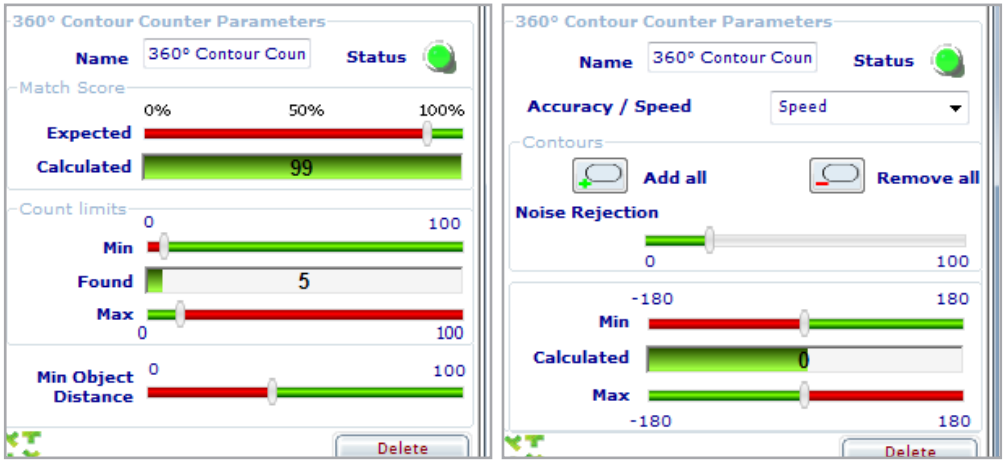


Fig 8-12: Control panel for "360° Contour counter", page 1 and 2

Parameter	Description
Name	Name of the tool. The maximum length is 256 characters.
Status	GREEN The found contour is better than the required one (set desired value) and is therefore OK. Red: NOK. The found contour deviates too strongly from the reference contour, the set desired value is not achieved. It is therefore NOK.
Desired value	The desired value defines the minimal agreement which a contour must have in order to be declared OK. The location deviation of the contour pixels from the learned contour is evaluated. 100% = Identical contours, 0% = No similarities. The prescribed value is 90%. .
Actual value	The actual value is the similarity of the found contour with the reference contour in percent.
Minimum / Maximum	The result is OK if the number of found contours lies between the minimum and maximum. If no contours are found or the actual number lies outside the defined limits, the result is NOT OK.
Minimum distance	This parameter determines the minimum distance (the SMALLEST distance) in percent of the template size between the centers of two found contours. This parameter can help avoiding double detection of the same contour in particular on symetric parts. On those parts it can happen that the tool found different contours nearly in the same place but with different angle of rotation. If two contours are found whose distance is less than the defined minimum distance, both contours are removed from the count.
Accuracy	**High:** Achieves a high locator accuracy at high execution time **Low:** Faster execution time with low accuracy. Use HIGH for non-homogenous background or when you need a precise inspection.
Noise Suppression	Use this parameter to remove undesired, interfering contours from the reference contour, especially if you have to inspect a poorly contrasting part..
Minimum / Maximum rotation angle	The contour is OK if the rotation angle lies within the range defined by minimum and maximum rotation angle AND its actual value is greater than the set desired value. The zero point always lies on the VERTICAL AXIS! Rotation angle ≥ Min. rotation angle AND ≤ Max. rotation angle = OK Rotation angle < Min. rotation angle OR > Max. rotation angle = NOK The standard for the minimum rotation angle -90 degrees, the standard for the maximum rotation angle + 90 degrees.
Select all	All contours within the ROI which are not suppressed by the noise suppression are added to the reference contour.
Delete all	All contours are removed from the reference contour.

8 Inspection tools

Application notes

1. The reference image must be sharp and should have as much contrast as possible. Use the setting options in STEP 1 (brightness and contrast) and / or use external lighting.
2. Be sure that the contours belong to the target part and not to the background (belt, other part, etc.). The contours should not differ greatly from part to part, and the part colors should differ only slightly.
3. The target part must lie fully within the ROI. If part of it lies outside, the result will be NOK.
4. Partial covering, distortion in perspective or a change in contrast are all tolerated by the tool, but the accuracy of the position detection may suffer.
5. The LARGER the reference contour, the LESS execution time will be required for the search.
6. This tool is not suited for precise contour inspection of a part. For this purpose you should use the 360° Check Contour tool.
7. Even textures (surface structures) on the part and the background may result in errors in the Locator or even incorrectly identified parts.
8. A 360° rotation angle can only be located if the contour is not symmetrical (e.g. a square or a circle)..
   In case that the part is symmetrical, the X & Y position can still reliably detected, if you limit the min. and max. angle.
   The rule is that the min. & max. angle of rotation has to be chosen so, that it is always smaller than the angle of the symmetry. **Example**: A square has a symmetry every 90 degrees - so the permitted angle is to 89 or -45 to +44 . **Example Circle:** Her we have a point symmetry - Permitted angle Grade 0.
9. The contour can also be located when the part is partially covered. The degree of possible covering is greater the smaller the desired value is.
10. Maximum accuracy: ± 2 pixel in the X and Y direction and ± 2 degree in the rotation direction under ideal conditions and assuming even contour (alignment with sensor, homogenous lighting).
11. To reduce the execution time and memory requirements, follow these tips:

- ► Reduce the ROI of the tool to the actual needed area, e.g. if the inspected contour is always found at the same place in the image.
- ► Enlarge the reference contour. The larger the reference contour the fewer steps are necessary in order to find the same location in the image.
- ► Change Accuracy to Low.
- ► Increase the miniumum distance as much as possible. Set the allowed area for Rotation angle as small a possible for your application.
- ► Increase the contrast of the contours.

8.11 Optical Character Verification

Using the OCV tool (Optical Character Verification) you can check whether an imprint on an object is identical with the previously read one.
It is NOT used to actually read the printed text — it simply checks whether the detected character string is identical with the reference example!

Note
The OCV tool uses a reference image as the inspection basis.

The following illustration shows the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

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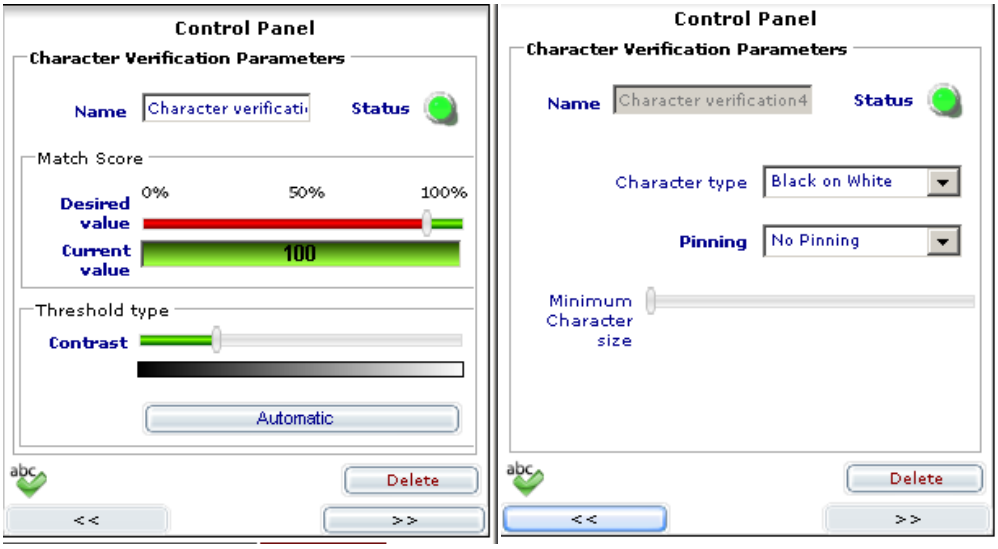
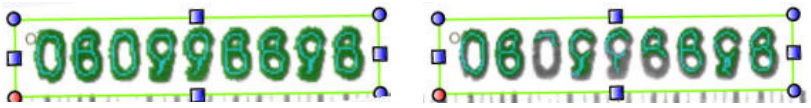
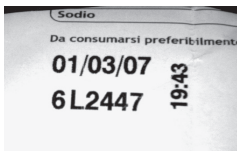
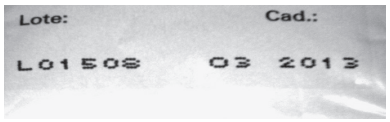
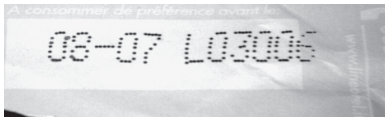


Fig 8.13: Control panel “Optical character verification” Page 1 and Page 2

The OCV tool includes the following parameters:

Parameter	Description
Desired value	This parameter defines the threshold value for the result evaluation in percent. If the actual result in the character verification is lower than the specified desired value, the result is NOK, otherwise it is OK
Threshold value	For character recognition the tool uses the technique of so-called binarization. The tool converts the gray values of all pixels in the ROI for character detection into either black or white. Pixels which are darker than the “binarization threshold” are “black”, all other pixels are “white.” By changing this parameter you can influence which pixels are considered part of the character and which are considered background. Use the slide controller to select any desired value between 0 (black) and 255 (white). We recommend setting the threshold value so that the character contours (shown in green) are completely captured. Example:  Correct setting Incorrect setting **Note:** The threshold setting should be carefully tested in case the light conditions change around the inspected parts (due for example to ambient light). **Important:** The threshold value of the tool is automatically adjusted when the ROI of the tool is shifted in the image or changes in size
Character type	Using the Character Type parameter you can set whether you wish to detect DARK type on a LIGHT background or LIGHT type on a DARK background. – Dark-Light: Default setting. Recommended for dark print on a light background. – Light-Dark: Setting for checking light print on dark background.

8 Inspection tools

Parameter	Description
Dot matrix	With the correct setting of the dot matrix parameter you can also check dot-pinned character sequences such as created on ink jet or dot matrix printers. The following settings can be selected: – None: Default setting. For non-stippled printing such as:  – Light: Use this setting for lightly dotted character sequences such as here:  – Strong: Use this setting for strongly dot-pinned character sequences such as here: 
Noise suppression	The Noise Suppression parameter allows you to suppress noise pixels when detecting characters. Please note: The higher the set value the “stronger” the more pixels are filtered. If you set noise suppression to strong even some full characters might be filtered.

Notes on using

- The tool compares the character sequence in the image with the character sequence in the reference image. Any change to the reference image will significantly affect the tool result.
- OCV can compensate for location changes in the X- and Y-direction if the character sequence you are inspecting remains fully in the ROI and the light conditions are constant.
- OCV is relatively sensitive to change in the light conditions. We recommend shielding the inspection feature/part from ambient light.
- The labeling should be visible in the image as large as possible. Reliable distinguishing of some characters, such as Z and 2, is not possible when the font height is too small.
- The tool OCV also displays the actual value of NOK character sequences. This makes it easier to find the correct settings and enables targeted readjustment.
- There is no font, size, or defined character that can be reliably guaranteed. We recommend viewing the characters in the field of view as large as possible..

Defects that can be detected

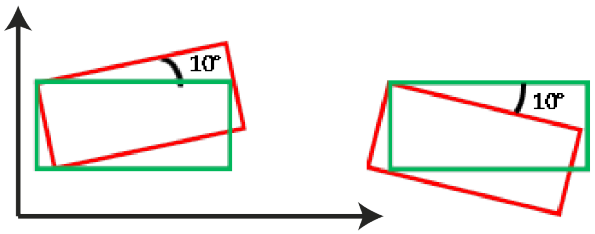
The OCV tool can detect the presence of a wrong character (i.e 3 instead of 8) and also a partial or missing character. Please note that result of the tool is not a sum of the results for each character, but for the number of pixels of this character. Thus each character can add a different value to the overall result.

The more characters that are present in the string to check, the lower the result percentage each character adds to the overall result.

It is strongly recommended to test your OCV application.

Teaching OCV tool

The OCV tool can securely check strings which are ± 10°degrees to the horizontal at the time of teaching the tool. (green rectangle shall be the tool ROI)



8 Inspection tools

In case the string is not horizontal on your part you should
1. Align the teach part so, that the string is horizontal during teach phase.
2. Use a proper locator (e.g. Any of the 360 degree match tools) to align the part during the process.

In case this can't be done it is suggested to test the OCV application before using it in production, as a correct functionality cannot be guaranteed in general. It depends on the size and the contrast of the characters if the application will work as intended.

Checking one line per OCV ROI only
The OCV tool can check one string, with one line of text, in one ROI tool as per the example below:

```
BVS OI-3-151-E
```

It is not recommended to draw one ROI around two lines of text
like the example below.

```
BVS OI-3-151-E
BVS0013
```

8.12 Read Barcode

The Read Barcode tool finds and reads all commonly used barcodes in the selected ROI.

The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.
The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:
– The bar code and a surrounding quiet zone are located fully within the ROI, and
– the light conditions in the ROI are homogenous.
The following illustrations show the control panel of the tool. A detailed description of the tool parameters can be found in the table below. A description of the tool can be found in Section "8.1.1 Selecting the right tools".

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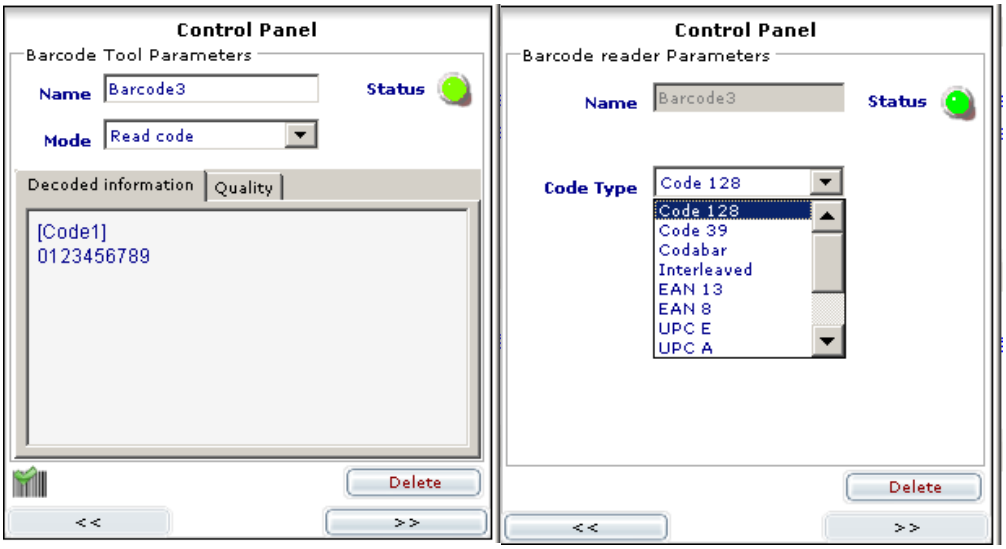

Fig 8-14: Control panel for Read Barcode, page 1 and page 2

Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The code was read and successfully "compared" and the quality of the code is greater than the preset desired value. Red: NOK. The code could not be read or the information contained in the code does not correspond to the reference information or the code quality is less than the preset desired value
Mode	The tool works in different ways depending on which mode is set. – Read code: The code is read. The content and quality can be output. – Compare code: The code is read and checked to see whether the content agrees with the reference content. – Count codes: The number of codes in the ROI is counted and read. If the number lies within the defined limits, the result is OK.
Code content	When a code is read, the “decoded” content is displayed here. The field shows nothing if the code could not be read or the code quality is less or equal to the preset quality desired value
Quality	The Quality field shows the determined code quality. You set the desired value to specify what overall quality must be identified for the code to be evaluated as OK. If the determined overall quality lies below the preset desired value, the result is NOK, even if the code was able to be read. The default value for the desired value is 0. An explanation of the individual code parameters can be found under Code Quality Parameters for Barcodes. **Note:** For PDF 417, Pharmacode, IMB and Postnet no quality data is provided!
Count	Count is only visible if “Count codes” mode is selected. The result of the tool in this mode is OK if the number of codes read lies within the MINIMUM and MAXIMUM. If the code number is less than or greater than the defined limits, the result is NOK. – Number of codes ≥ Minimum AND number of codes ≤ Maximum = OK – Number of codes < Minimum OR number of codes > Maximum = NOK By default the tool uses a minimum of 1; the maximum is 100.

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Parameter	Description
Compare	Compare is only visible if “Compare code” mode is selected. In this field you enter the character string which you want to compare with the content of the actual barcode. The result of the tool is: OK if the code was able to be read AND the code quality ≥ desired quality AND the character string that was read AGREES with the preset character string! Otherwise the result is NOK. By pressing AUTO button the the character string of the code read in the reference image is directly applied as compare code. The compare tool allows using those signs as wildcards: "*" := works as wild card for one character or for a whole string "?":= works as wild card for one character only. The tool always always compares the complete string with the content of the read code. **Example:** Preset character string: BALLUFF?BVS* OK: BALLUFF_BVS-C; BALLUFF-BVS-E NOK: BALUFF BVS or BVS BALLUFF
Code type	When inserting the tool into the inspection, when moving and enlarging or reducing the tool automatically determines the code type. You can also set the code type manually. The following code types can be set: – Code 39 – Code 128 – Codabar – Interleaved 2 of 5 – UPC-A + E, EAN 8 + 13 – PDF 417 – Pharmacode
Character limit	The parameter character limit defines the minimum/maximum number of characters a read code has to have for a OK result. With this parameter you can ensure that only codes with the correct lenght of characters are accepted.

Notes on using

1. During operation the tool “reads” ONLY the code type which was set when your parameters were configured (automatically or manually). NOT all decodable code types are automatically “read” when they enter the ROI.
2. The prerequisite for stable and repeatable read results are high contrast between the code you are reading and the image background, as well as even illumination.

Examples:

High contrast

Low contrast

Low contrast

3. Ambient light (e.g. sunshine, room and machine lighting) can have a strong influence on the read results. We recommend minimizing the effect of ambient light by, for example, using a shade and/or short exposure times and the use of an external auxiliary light.
4. The tool reads all codes having the same code type found in its ROI. The processing time the tool requires for reading multiple codes is correspondingly higher than for reading only one code.
5. **Pharmacode, Postnetcode and IMB Code:**
   These code types are not always automatically detected. Please select the code type manually.
   Please note: to read a Pharmacode or Postnet you must provide a relatively large ROI.
   Example for Pharmacode:

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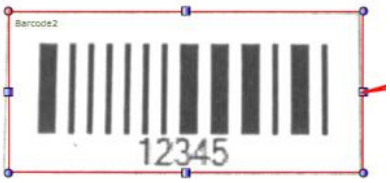
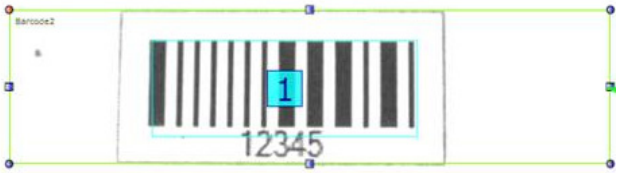
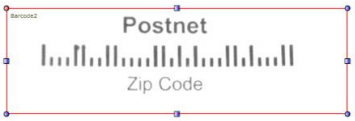


ROI is too narrow for reliable reading

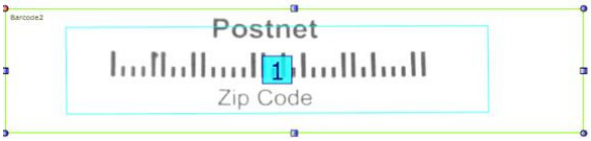


ROI width OK – code will be reliably detected.

Example for Postnet:



ROI too narrow for reliable reading

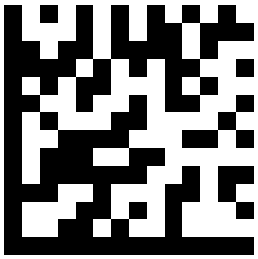


ROI width OK – code will be reliably detected.

Codetyp Interleaved 2 of 5:
Beim Codetyp Interleaved 2 of 5 werden erst Codes mit mehr als 5 codierten Zeichen gelesen. Kürzere Codes werden nicht gelesen, da sich bei diesem Codetyp sonst die Gefahr von Fehllesungen erhöht.

8.13 Read Data Matrix codes

The Read Data Matrix code tool finds and reads Data Matrix codes (ECC200) in the selected ROI.



The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.
The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:
– The DMC code and a surrounding quiet zone are located fully within the ROI, and
– the light conditions in the ROI are homogenous.
The following illustration shows the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

8 Inspection tools

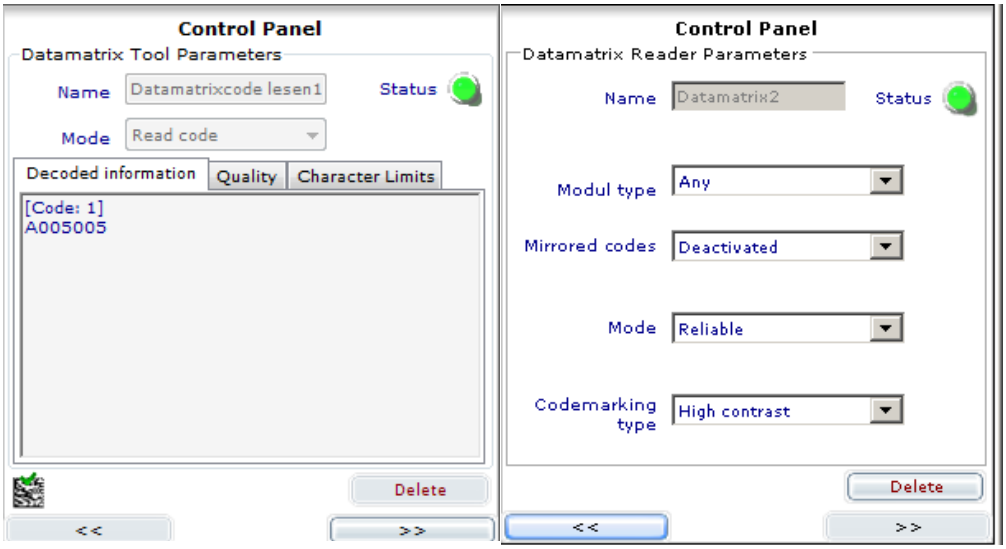


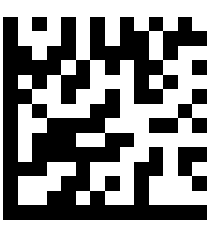
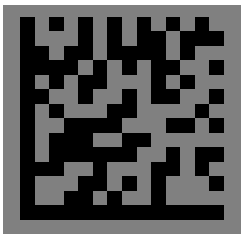
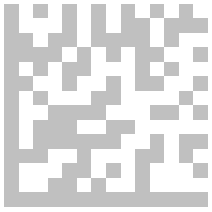
Fig 8-15: Control panel for Read Data Matrix, page 1 and page 2

Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The code was read and successfully compared with the preset character sequence ("validated"). At the same time the determined code quality (actual quality) must be greater than or equal to the preset quality desired value (desired quality). Red: NOK. The code could not be read or the information contained in the code does not correspond to the reference information or the code quality is less than the preset desired value.
Mode	The tool works in different ways depending on which mode is set. – Read code: The code is read. The content and quality can be output. – Compare code: The code is read and checked to see whether the content agrees with the reference content. – Count codes: The number of codes in the ROI is counted and read. If the number lies within the defined limits, the result is OK.
Code content	When a code is read, the “decoded” content is displayed here. The field shows nothing if the code could not be read or the code quality is less or equal to the preset quality desired value.
Quality	The Quality field shows the determined code quality. You set the desired value to specify what overall quality must be identified for the code to be evaluated as OK. If the determined overall quality lies below the preset desired value, the result is NOK, even if the code was able to be read. The default value for the desired value is 0. An explanation of the individual code parameters can be found under “Code Quality Parameters for Data Matrix Codes”.
Count	Count is only visible if “Count codes” mode is selected. The result of the tool in this mode is OK if the number of codes read lies within the MINIMUM and MAXIMUM. If the code number is less than or greater than the defined limits, the result is NOK. – Number of codes ≥ Minimum AND number of codes ≤ Maximum = OK – Number of codes < Minimum OR number of codes > Maximum = NOK By default the tool uses a minimum of 1; the maximum is 100.

8 Inspection tools

Parameter	Description
Compare	Compare is only visible if “Compare code” mode is selected. In this field you enter the character string which you want to compare with the content of the actual Data Matrix code. The result of the tool is: OK if the code was able to be read AND the code quality ≥ desired quality AND the character string that was read AGREES with the preset character string! Otherwise the result is NOK. By pressing AUTO button the the character string of the code read in the reference image is directly applied as compare code. The compare tool allows using those signs as wildcards: "*" := works as wild card for one character or for a whole string "?":= works as wild card for one character only. The tool always always compares the complete string with the content of the read code **Example:** Preset character string: BALLUFF?BVS* OK: BALLUFF_BVS-C; BALLUFF-BVS-E NOK: BALUFF BVS or BVS BALLUFF
Module type	This parameter defines the module brightness you wish to find. Default setting: ALL – **ALL**: The tool reads both dark modules on a light background and light modules on a dark background. – **Light-Dark only**: Only codes with light (white) modules on a dark background are read – **Dark-Light only**: Only codes with dark (black) modules on a light background are read. Examples:  Modules – Light Background  Light Modules – Dark Background
Mirrored codes	By changing this setting you can also reliably read mirror-reversed codes. Default setting: Disables, tool reads unmirrored codes Enabled: Only mirror-reversed codes are read Examples**:**  Normal code 180° rotated  Mirror-reversed code 0° rotated
Mode	By changing this parameter you can set the speed and reliability of the “decoding”. Default setting: – Fast: The tool decodes the code only once – Reliable: The tool decodes the code multiples times with various settings when the code is of poor quality, thereby increasing the decoding reliability. Use FAST when you have to read a large number of codes per second and the codes are characterized by good contrast and resolution. **Note:** With the Reliable setting it may happen that the inspection times fluctuate greatly when reading codes of poor quality

8 Inspection tools

Parameter	Description
Character limit	The parameter character limit defines the minimum/maximum number of characters a read code has to have for a OK result. With this parameter you can ensure that only codes with the correct lenght of characters are accepted.
Marking type	You can use the Marking settings to increase the read reliability depending on the marking type – High contrast: Use this setting for codes with high contrast against the background – Dot-pinned codes: Use this setting to increase the read reliability for dot-pinned Data Matrix codes – Low contrast: Use this setting for codes with low contrast against the background, e.g. codes generated by fax machines. **Examples**:  High contrast  Low contrast  Low contrast

Notes on using

1. The prerequisite for stable and repeatable read results are high contrast between the code you are reading and the image background, as well as even illumination
2. Ambient light (e.g. sunshine, room and machine lighting) can have a strong influence on the read results. We recommend minimizing the effect of ambient light by, for example, using a shade and/or short exposure times and the use of an external auxiliary light.
3. The tool reads all DMC codes found in its ROI. The processing time the tool requires for reading multiple codes is correspondingly higher than for reading only one code.
4. Depending on the settings, the code quality and the number of codes, the tool may require up to several seconds of processing time. If reading needs to take place within a fixed time window, you must verify the processing times using the statistics in Step 3.

8.14 Read QR Codes

The QR Code Reader tool finds and reads QR and Micro QR in the selected ROI.
The result is OK if the code can be read and the determined quality of the code is greater than the set desired value.

The tool can compensate for changes in the code position (X- and Y-direction) as well as the rotation angle if the following conditions are met:
– The QR code and a surrounding quiet zone are located fully within the ROI, and
– the light conditions in the ROI are homogenous.

The following illustration shows the control panel of the tool.
A detailed description of the tool parameters can be found in the table below.
A description of the tool can be found in Section “8.1.1 Selecting the right tools”.

8 Inspection tools

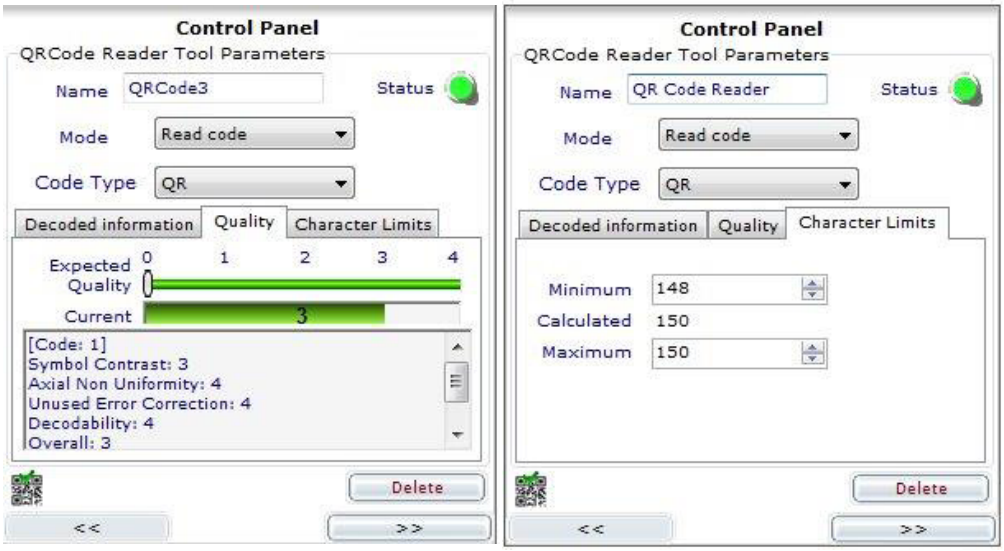


Fig. 8-15: Control Panel for Read QR Codes page 1 and page 2

Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The code was read and successfully compared with the preset character sequence ("validated"). At the same time the determined code quality (actual quality) must be greater than or equal to the preset quality desired value (desired quality). Red: NOK. The code could not be read or the information contained in the code does not correspond to the reference information or the code quality is less than the preset desired value.
Mode	The tool works in different ways depending on which mode is set. – Read code: The code is read. The content and quality can be output. – Compare code: The code is read and checked to see whether the content agrees with the reference content. – Count codes: The number of codes in the ROI is counted and read. If the number lies within the defined limits, the result is OK.
Code content	When a code is read, the “decoded” content is displayed here. The field shows nothing if the code could not be read or the code quality is less or equal to the preset quality desired value.
Quality	The Quality field shows the determined code quality. You set the desired value to specify what overall quality must be identified for the code to be evaluated as OK. If the determined overall quality lies below the preset desired value, the result is NOK, even if the code was able to be read. The default value for the desired value is 0. An explanation of the individual code parameters can be found under “Code Quality Parameters for Data Matrix Codes”.
Count	Count is only visible if “Count codes” mode is selected. The result of the tool in this mode is OK if the number of codes read lies within the MINIMUM and MAXIMUM. If the code number is less than or greater than the defined limits, the result is NOK. – Number of codes ≥ Minimum AND number of codes ≤ Maximum = OK – Number of codes < Minimum OR number of codes > Maximum = NOK By default the tool uses a minimum of 1; the maximum is 100.

8 Inspection tools

Parameter	Description
Compare	Compare is only visible if “Compare code” mode is selected. In this field you enter the character string which you want to compare with the content of the actual Data Matrix code. The result of the tool is: OK if the code was able to be read AND the code quality ≥ desired quality AND the character string that was read AGREES with the preset character string! Otherwise the result is NOK. By pressing AUTO button the the character string of the code read in the reference image is directly applied as compare code. The compare tool allows using those signs as wildcards: "*" := works as wild card for one character or for a whole string "?":= works as wild card for one character only. The tool always always compares the complete string with the content of the read code **Example:** Preset character string: BALLUFF?BVS* OK: BALLUFF_BVS-C; BALLUFF-BVS-E NOK: BALUFF BVS or BVS BALLUFF
Module type	This parameter defines the module brightness you wish to find. Default setting: ALL – **ALL**: The tool reads both dark modules on a light background and light modules on a dark background. – **Light-Dark only**: Only codes with light (white) modules on a dark background are read – **Dark-Light only**: Only codes with dark (black) modules on a light background are read. Examples:  Modules – Light Background  Light Modules – Dark Background
Mirrored codes	By changing this setting you can also reliably read mirror-reversed codes. Default setting: Disables, tool reads unmirrored codes Enabled: Only mirror-reversed codes are read Examples**:**  Normal code 180° rotated  Mirror-reversed code 0° rotated
Mode	By changing this parameter you can set the speed and reliability of the “decoding”. Default setting: – Fast: The tool decodes the code only once – Reliable: The tool decodes the code multiples times with various settings when the code is of poor quality, thereby increasing the decoding reliability. Use FAST when you have to read a large number of codes per second and the codes are characterized by good contrast and resolution. **Note:** With the Reliable setting it may happen that the inspection times fluctuate greatly when reading codes of poor quality

8 Inspection tools

Parameter	Description
Character limit	The parameter character limit defines the minimum/maximum number of characters a read code has to have for a OK result. With this parameter you can ensure that only codes with the correct lenght of characters are accepted.
Marking type	You can use the Marking settings to increase the read reliability depending on the marking type – High contrast: Use this setting for codes with high contrast against the background – Dot-pinned codes: Use this setting to increase the read reliability for dot-pinned Data Matrix codes – Low contrast: Use this setting for codes with low contrast against the background, e.g. codes generated by fax machines. **Examples**:  High contrast  Low contrast Low contrast

Notes on using

1. The prerequisite for stable and repeatable read results are high contrast between the code you are reading and the image background, as well as even illumination
2. Ambient light (e.g. sunshine, room and machine lighting) can have a strong influence on the read results. We recommend minimizing the effect of ambient light by, for example, using a shade and/or short exposure times and the use of an external auxiliary light.
3. The tool reads all QR codes found in its ROI. The processing time the tool requires for reading multiple codes is correspondingly higher than for reading only one code.
4. Depending on the settings, the code quality and the number of codes, the tool may require variable processing time. If reading needs to take place within a fixed time window, you must verify the processing times using the statistics in Step 3.

Note
The cotents of the QR Codes can be tranferred via serial RS232 interface or an Ethernet connection. More information in chapter "Interface"

The parameters of the serial interface can be set in the menu: **Sensor** → **Settings** → **Serial Interface**n.

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9.1 Inspection result over RS232/Ethernet interface

All BVS-E sensors except for the BVS Standard include an Ethernet port for sending inspection results; The Ident and Universal models can also send this data over the RS232 port.
Proceed as follows:

1. Make the electrical connection
2. Configure the interface on the sensor and PC
3. Set the communication mode
4. Select the data to be transmitted

9.1.1 RS232 - Making the electrical connection

- ► Connect PIN 1 (RS232 Rx) to Pin RS232 Tx on the opposite side (e.g. the PC or PLC) ,
- ► Connect PIN 6 (RS232 Tx) to Pin RS232 Rx on the opposite side.
- ► Connect sensor ground to the ground on the opposite side (same potential).

The following illustration shows the diagram for typical wiring to a Sub-D 9-pin connector such as used on PCs and laptops.

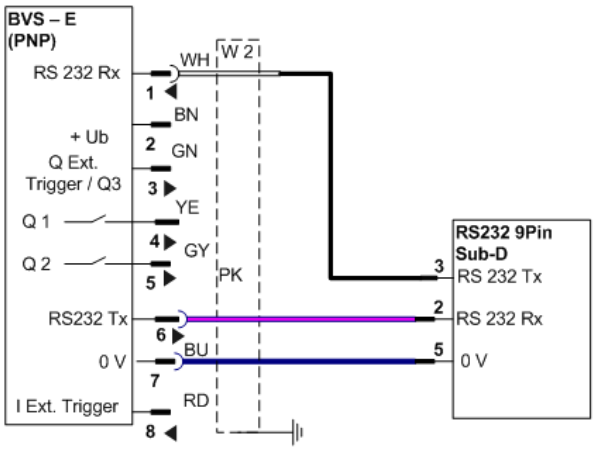

Fig. 9-1: Wiring the RS232 interface to a Sub-D 9-pin connector

9.1.2 Ethernet - Establishing the connection

The sensor plug TO PC must be connected to an Ethernet 10/100 terminal on the communication master using a "crossed" Ethernet cable. We recommend using the BCC M415-E834-AG-672-ES64N8-050 cable.

The IP address of the communication master or sensor should be set to that Ethernet communication is possible.
The BVS Identification accepts socket connections from a client on Port 5423.

9.1.3 RS232 - Setting interface parameters on sensor and PC

Setting interface parameters on the sensor

The parameters for the serial port can be set in the menu: "Sensor → Settings → Serial Port".

Factory default settings for the port are:

Parameter	VALUE (factory default)	Range
Baud rate	57600 Baud	9600 - 115,200 Baud
Data bits	8	7; 8
Parity	none	even, odd, none
Stop bits	1	1; 1,5
Flow control	Off	On / Off
START CHARACTER	<STX> (ASCII sign 0x02 hex)	any combination of ASCII signs (incl. scpecial characters) exept 0x00h
STOP CHARACTER	<CR><LF> (ASCII signs 0x0D hex, 0x0A hex)	any combination of ASCII signs (incl. scpecial characters) exept 0x00h
Delimiters (between information)	&	any ASCII sign exept 0x00h

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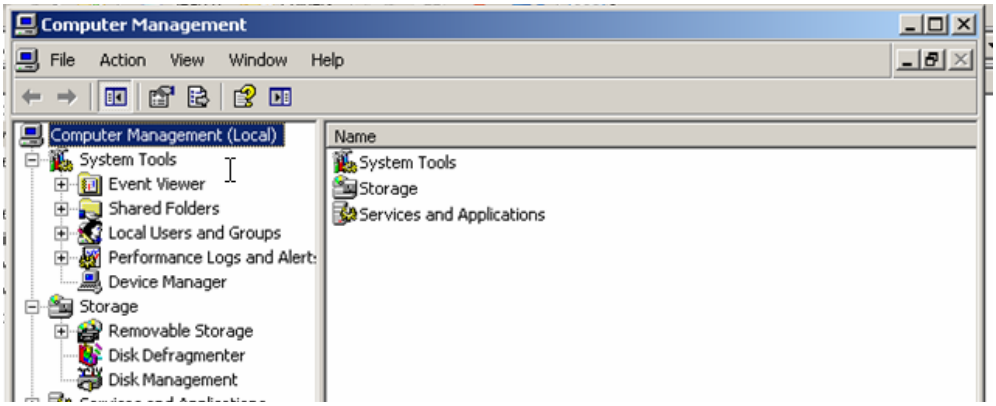
The parameters start & stop character do only affect the responses of the sensor via RS232. When sending commands from PLC this parameters must not be used.
The separator is used for separating the individual data fields in response to the parameters.

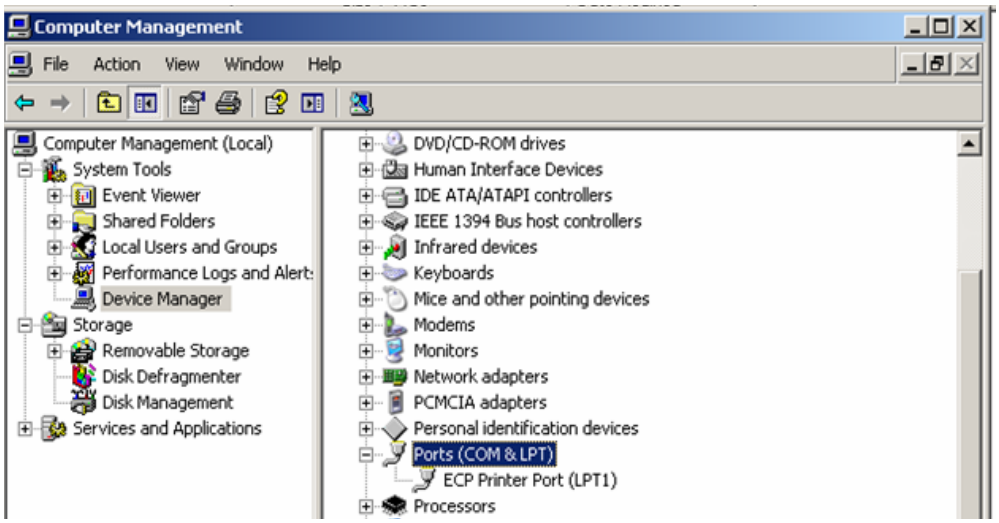
RS232- Setting interface parameters on the PC

In Step 3 Inspection Setting you can set which character is used to subdivide the information contained in the string and which tools are allowed to send information via RS232. The factory default delimiter is “&”.
Windows

- ► Click on the “Start” button and select “Control Panel”.
- ► Select “Administrative Tools” and then “Computer Management”.
  - ⇨ Windows opens this dialog:



- ► Select “Device Manager” and then “Ports”.



RS232 is the COM1 port on most PCs and laptops.

- ► Double-click on the corresponding port (here COM1 was selected) and then select the "Port Settings" tab.
- ► Set the parameters in this dialog so that they agree with the parameters for the sensor port.

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9.1.4 Selecting the communication mode

Click on the "RS232 settings -2" in Sensor Settings menu to change versus "synchronous" or "asynchronous" communication mode.

Parameter	Description
Synchronous	In the Synchronous setting an inspection result is not sent over the RS232 or Ethernet interface unless the sensor has received a valid data request and a result is ready.
Asynchronous	In the Asynchronous setting (RS232 only) the sensor sends an inspection result as soon as it is ready in the sensor. Receipt of a prior data request is not necessary.

Note
The following explanation is valid for the RS232 and the Ethernet interface as well.

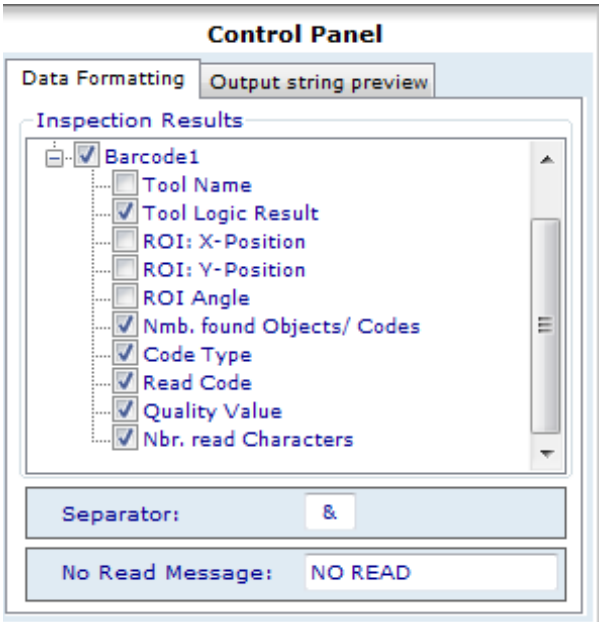
9.1.5 Selecting data sent in “Inspection Result”

By default the sensor sends a variety of data in the inspection result, such as the overall result, inspection name, and for each tool used in the inspection the tool name, the X- and Y-position of the tool ROI, the individual result, the read data, etc.

BVS ConVis offers the possibility of adjusting the sent data to your specific application. To do this proceed as follows:

► Click on the “Initial settings” button (Step 2). Now click on the >> key.

The control panel now shows the list with the result settings.



Only selected parameters (check marks) are sent in the inspection result over the RS232 interface. The parameters may be selected or deselected with the mouse individually or by tool.

Note
Whether a parameter selected or deselected is has no effect on the correct function of the inspection in the sensor.

Some can now set up a "NO READ MESSAGE" in case that a barcode / Datamatrix code reader can not find a code or the code is not readable.

The NO READ MASSAGE is send within the result and replaces the data fields: Nmb of Found

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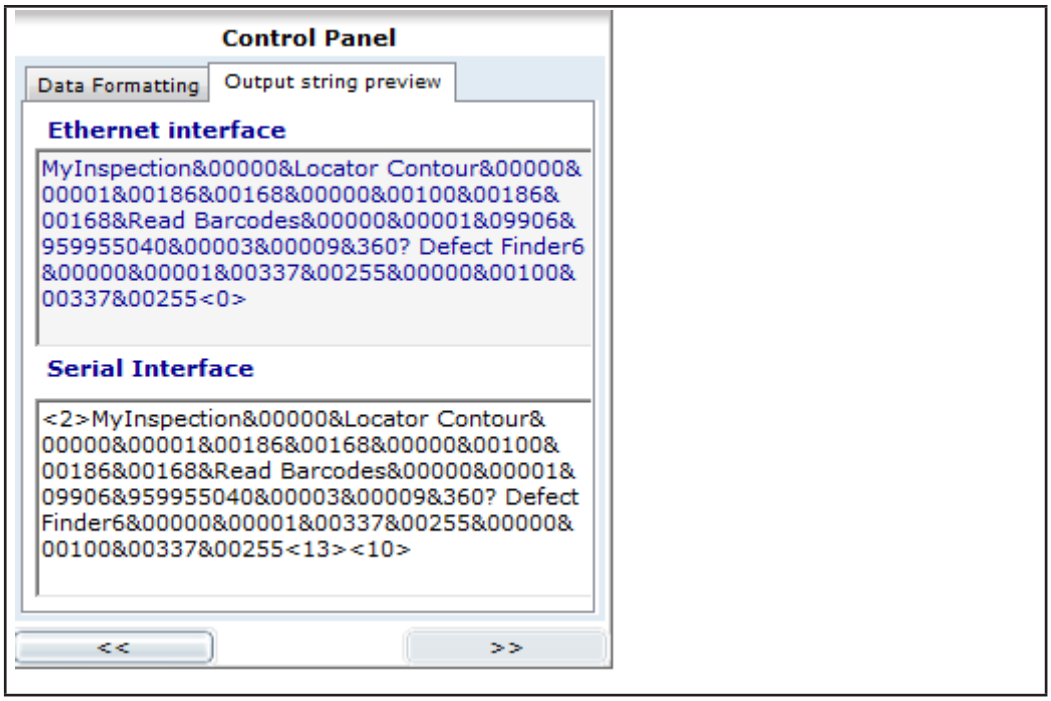
Objects, Code Type, Read Code, Quality value and Number Read Characters of those tools.
Example:
Result if a code was read:
MyInspection & 00000 & 00000 & 00244 & Barcode1 & 00254 & 00001 & 09906 & 000.0 & 1045021 & 00003
Result if no code was found or code was unreadable;
MyInspection & 00000 & 00000 & 00244 & Barcode1 & 00254 & 000.0 & NIO

Descriptions for the tool parameters can be found in the following sections.

9.1.6 Result String Preview

If you switch to rider Output String Preview you'll can check how your result string will look alike with the current selections you did in the Data Formatting rider



9.1.7 Send modes and commands Overview

In general the sensor then only sends data if they have first been requested by a "master" (e.g. PC or PLC). The request takes the form of the master sending one of the following commands to the sensor:

Available commands	Description
GETCURRENTSCRIPTID	Requests the number of the inspection which is currently running on the sensor..
SETCURRENTSCRIPTID	Switches from the current inspection to the inspection whose number is sent with this command as a parameter.
CHKSERLINE	Checks the status of the RS232 connection.
TRIGGER	Triggers the sensor if Ethernet- RS232 is set as the trigger mode.
GETSTRINGRESULTS	Requests the NEXT inspection result.
TEACH	After receiving this command the sensor learns a new reference picture. If the tools Read Barcode or Read Data matrix code are working in "Compare code" mode and option AUTO is set, then the code, read in the reference picture, will be taken as reference code.

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Parameterization commands

The sensor replies to a received command with an acknowledgement and, depending on the command, with additional data. We distinguish between parameterization commands (commands which set or query the "parameters" in the sensor.
In the following the commands GETCURRENTSCRIPTID, SETCURRENTSCRIPTID, CHKSERLINE, TRIGGER, TEACH as well as the possible sensor replies are described in detail:

GETCURRENTSCRIPTID		
Parameter: none	Sensor reply	"**OK& INSP <INSP_NMB>**"
	<INSP_NMB>	Current inspection number Value: 0 - 19
Requests the inspection number from the sensor. Syntax: GETCURRENTSCRIPTID<NUL>		

Possible sensor replies based on the status	
Status	**Sensor reply**
Inspection present on sensor:	OK& INSP <Insp_nmb>
No inspection present on sensor:	

SETCURRENTSCRIPTID			
Parameter: <INSP_NMB>		Sensor reply	"OK&INSP <INSP_NMB>"
<INSP_NMB>	Current inspection number Value: 0 - 19	<INSP_NMB>	Set inspection number value: 0 - 19
Instructs the sensor to run the inspection next which is given as a parameter. Syntax: SETCURRENTSCRIPTID&< INSP_NMB ><NUL>			

Status	**Sensor reply**
Inspection present and change possible:	OK&<Insp_nmb>
Inspection with this number not assigned on sensor:	ERR&EMPTYSLOT
Wrong number:	ERR&PARAMNOTVALID
Sensor connected to ConVis	ERR&INVALIDSTATUS

CHKSERLINE		
Parameter: none	Sensor reply	LINEOK
Checks the status of the RS232 connection Syntax: CHKSERLINE<NUL>		
Possible sensor replies based on the status:		

Status	**Sensor reply**
Connection present and OK	OK&LINEOK
No connection	No sensor reply

TRIGGER		
Parameter: none	Sensor reply	OK&ACK
Triggers an inspection if trigger mode is set to RS232/Ethernet. Syntax: TRIGGER<NUL>		
Possible sensor replies based on the status:		

Status	**Sensor reply**
Sensor can be triggered	OK&ACK

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TEACH		
Parameter: none	Sensor reply	OK

Syntax: TEACH<NUL>

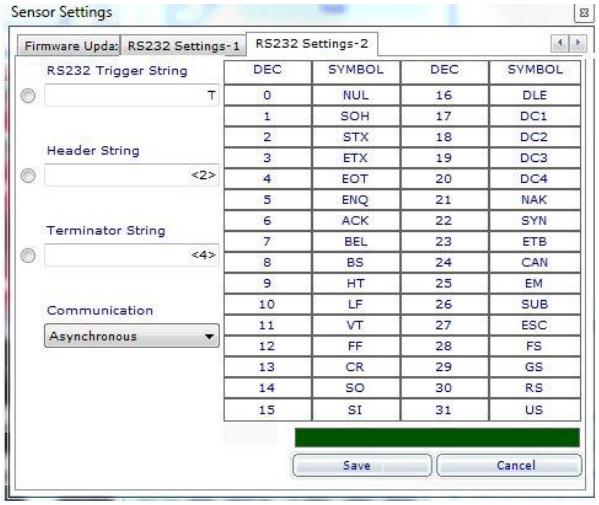
Possible sensor replies based on the status:

Status	Sensor reply
Teach of sensor activated	OK

Additional settings

Via Menu "Sensor Settings" - "RS232 settings-2" you can change those settings for the RS232 interface:

1. String Trigger: Allows you to define an additional string to the trigger e.g. a T.
2. Start String / End String : Here you can define which characters mark the beginning and the end of any command!. As a standard the start string is STX, whereas CR and LF is the end string. To change those characters you have to first selecte the appropriate button to select the string you want to change. Then delete the existing text and add any new characters from your keyboard as start or end string. If you'll need to add special characters: Double-click with the mouse on the text label for the special character you want to insert in the table left of the text box, for example on ETX to add a END of TEXT line. Those characters WILL NOT BE USED for the ethernet commands.
3. Communication Mode: asynchronous or synchronous. This setting only affects how the RS232 interface sends out the result data. Without additional request (asynchronous) or with an additional request (synchronous).



Result commands and result communication

The replies to the GETSTRINGRESULTS command differ essentially from the other commands. For result transmission the BVS-E Identification sensor has two different operating modes: Synchronous and asynchronous communication.

Synchronous communication

If the RS232/Ethernet interface is run in this mode, the sensor only sends an inspection result if it was first requested by a “master” (PC or PLC) using the command GETSTRINGRESULTS and a result is available in the sensor.

A result is only available AFTER an inspection has been run. If a result is prematurely requested from the sensor, the sensor replies with NODATA. The timing is shown in the following diagram:

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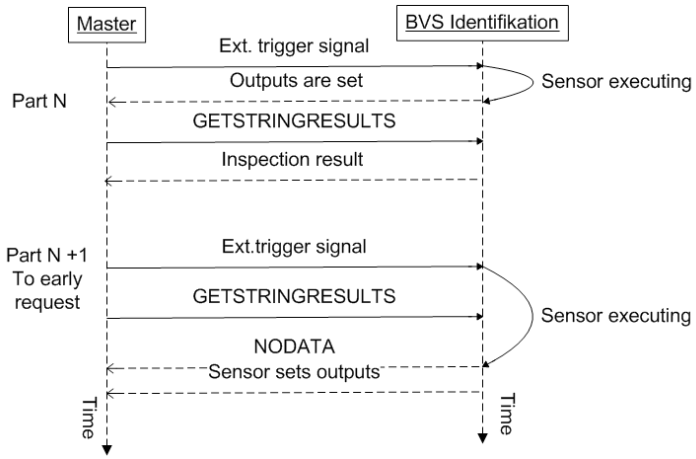

Fig. 9-2: Synchronous communication

Note
If the sensor is triggered via RS232 or Ethernet the sensor will reply with the string OK&ACK; if the sensor is triggered via digital input there won't be a response on the interface.

In the diagram the request for the result for Part N is correct, but for the next part the request is sent too early – the master then receives as a reply: NODATA.

Asynchronous communication – RS232 interface only!

The sensor always sends the current inspection result over the interface as soon as it is available in the sensor. No external request is required. The timing for asynchronous communication is as follows:

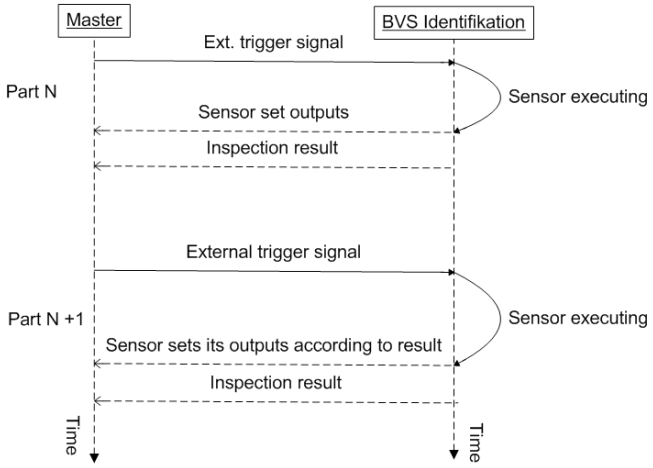

Fig. 9-3: Asynchronous communication

Note
If the sensor is triggered via RS232 or Ethernet the sensor will reply with the string OK&ACK; if the sensor is triggered via digital input there won't be a response on the interface.

The exact structure of an inspection result depends on the number of tools in the inspection, their type and their parameters. Each inspection has its own, individual inspection result. Therefore a complete description of all possible inspection results is not possible. The structure of every inspection result does however follow a fixed “grammar", which is described here using "EBNF notation".

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An introduction to EBNF notation can be found at:
http://en.wikipedia.org/wiki/EBNF

```
<response message > = <Start string><type><epilogue>
<start string> = <STX> (ASCII sign 0x02h) | <user defined start string>
(*can be set with  BVS ConVis*)
<type> = <success> | <failure>
<success> = <SuccessID>< separator ><bytelenght><separator>
<inspection result>]
<failure> = "ERR"< separator >"INVALIDSTATUS"
<SuccessID> = "OK"
<bytelenght> = <digit><digit><digit><digit><digit> (* byte length of
message after next delimiter*)
<Inspection result> = <inspection name> <separator> <inspection logic
result> <separator> <tools results> [<separator> <logical_tools
results>] <epilogue>;
<Inspection name> = <UTF-8_string>; (*Inspection name UTF-8 coded*)
<inspection logic result> = "0001" | "0000";(* 0001:=FAILURE, 0000:=
Success *)
<tools results> = <tool result>[<separator> <tool result>]; (*list of
Inspection tools results*)
<tool result> = <tool name> <separator> <tool logic result> <separator>
<tool param result> [<separator> <tool param result>];
<logical_tools results> = <tool name> <separator> <tool logic result>
<tool name> = <UTF-8_string> (the tool name UTF-8 coded)
<tool logic result> = "0001" | "0000";(*0001:=ERROR, NOT OK, 0000:=
RESULT OK*)
<tool param result> = <INT_As_String> | <DOUBLE_AS_STRING> (*for order
of parameters for each tool see table below*)
<INT_AS_STRING> = < digit >,< digit >,< digit >,< digit >,< digit >;
<DOUBLE_AS_STRING> = < digit >,(".“| < digit >), (".“| < digit >),(".“|
< digit >), (".“| < digit >);
<digit> = "0" | "1" | "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9" ;
<character> = ( <digit> | <alphabetic character>);
<digit> = "0" | "1" | "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9" ;
<alphabetic character> = "A" | "B" | "C" | "D" | "E" | "F" | "G"| "H" |
"I" | "J" | "K" | "L" | "M" | "N"| "O" | "P" | "Q" | "R" | "S" | "T" |
"U"| "V" | "W" | "X" | "Y" | "Z" | "a" | "b" | "c" | "d" | "e" | "f" |
"g"| "h" | "i" | "j" | "k" | "l" | "m" | "n"| "o" | "p" | "q" | "r" |
"s" | "t" | "u"| "v" | "w" | "x" | "y" | "z" ;
<epilogue> = <terminator>;
<terminator> = <CR><LF> | <string to be defined by user>
(*can be defined with BVS ConVis*);
<CR> = 0x13h (*Hexadecimal ASCII value*)
<LF> = 0x10h (*Hexadecimal ASCII value*)
<STX> = 0x02h
```

Example

Result of an inspection named Insp_Example with 1 Read Data Matrix Code tool;
start character <STX>; <CR><LF> (these characters are invisible in normal text).

```
@OK&00079&Insp_Example&00000&Datamatrix1&00000&00516&00223&000.0&00001&1
234567890&00003<CR><LF>
```

The following table gives a detailed overview of the information in the above example according to the defined "grammar".

Partial string in the result	Description
<STX>	Start character corresponds to `<start string>`
&	Separator corresponds to `< separator >`

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Partial string in the result	Description
OK	Success message corresponds to <SuccessID>
00079	The following message is 79 bytes long (counting from the next & character) Corresponds to <bytelength>. After the next separator following the <Bytelength> the inspection result <Inspection result> begins
Insp_Example	Inspection name corresponds to <inspection name> in the <inspection result>
00000	Inspection overall result here is OK. Corresponds to <inspection logic result>
Datamatrix1	Tool name corresponds to <tool name> in <tool result>
00000	Tool result here is OK. Corresponds to <tool logic result>
00516	ROI tool X-position is a <tool param result> and corresponds to the Parameter 3 “ROI X-Position”, see below
00223	ROI tool Y-position is a <tool param result> and corresponds to the Parameter 4"ROI Y-Position”
000.0	ROI tool rotation angle is a <tool param result> and corresponds to the Parameter 5 "ROI angle offset”
00001	The number of codes read in the ROI is a <tool param result> and corresponds to the Parameter 6 “Code number”
1234567890	Code content is a <tool param result> and corresponds to the Parameter 7 “Code content”
00003	Overall code quality is a <tool param result> and corresponds to the Parameter 8 "Code quality"
<CR><LF>	Terminator as defined by the user

Selection/ Deselection of "OK" and Length information

Now some can select or deselect the leading “OK” and byte length of the result string via Menu Sensor -> Settings. As default OK and the byte length information are transferred

Trigger over RS232 (light blue characters are use here only for better description.)
REQ: TRIGGEROK&ACK
RES: MyInspection&00000&Barcode1&00000&00244&00254&000.0&00002&09906&1045021&00000&00007&09906&959955040&00000&00009

External Trigger (light blue characters are use here only for better description.)
REQ: External trigger via digital input
RES: MyInspection&00000&Barcode1&00000&00244&00254&000.0&00002&09906&1045021&00000&00007&09906&959955040&00000&00009

Differences to Version 1.3:
Light blue characters are use here only for better description., red characters show the difference between 1.3 and 1.4.
Trigger over RS232
REQ: TRIGGEROK&ACK
RES: OK&00111&MyInspection&00000&Barcode1&00000&00244&00254&000.0&00002&09906&1045021&00000&00007&09906&959955040&00000&00009

External Trigger
REQ: External trigger via digital input
RES: OK&00111&MyInspection&00000&Barcode1&00000&00244&00254&000.0&00002&09906&1045021&00000&00007&09906&959955040&00000&00009

9 Interface

9.2 Structure of the inspection results

All tools have these general parameters:

Parameter Number	Tool parameter	Description
1	Tool name	Name of the tool
2	Tool result	NOK (corresponds to 0001) or OK (corresponds to 00000)
	Errorcodes: 0007	NOT OK, ROI outside image (due to Locator offset)
	0024	NOT OK, Code matching failed
	0025	NOT OK, Code quality check failed
	0026	NOT OK, Code nbr code found out of range
3	ROI: X-Position	X-position of the origin of the tool ROI BEFORE rotation
4	ROI: Y-Position	Y-position of the origin of the tool ROI BEFORE rotation
5	ROI: Angle offset	Angle offset of the tool ROI if rotated 0.0 – 360 degrees when set up by the user.

IIn the following you will find individual parameters which the tool provides in addition to the general parameters:

Check bright-ness// Compare contrast tool

Parameter number	Tool parameter	Description
6	Actual value	Average brightness in the ROI 0 - 100

Check contour tool

Parameter number	Tool parameter	Description
6	Threshold value	Set binarization threshold value 0 - 255
7	Reference number	Number of reference points in the reference contour
8	Number of edges	Number of reference points found
9	Actual value	Result value 0-100

Count edges tool

Parameter number	Tool parameter	Description
6	Edge type	Set edge type
7	Number of edges	Number of reference points found (N, see parameter numbers)
8	X-coordinate 1st point	X-value of the first found edge
9	Y-coordinate 1st point	Y-value of the first found edge
10	X-coordinate 2nd point	
11	Y-coordinate 2nd point	
…		
2*N +6	X-coordinate point N	X-coordinate of the last point
2*N +7	Y-coordinate point N	Y-coordinate of the last point

Check
If X/Y is deselected, the coordinates are NOT sent.

9 Interface

Width tool

Parameter number	Tool parameter	Description
6	Actual value	Width in pixels
8	Edge type	Set edge type
9	X-coordinate 1st point	X-value of the first found edge
10	Y-coordinate 1st point	Y-value of the first found edge
11	X-coordinate 2nd point	X-value of the second found edge
12	Y-coordinate 2nd point	Y-value of the second found edge

Check
If X/Y is deselected, the coordinates are NOT sent.

Check position tool

Parameter number	Tool parameter	Description
6	Edge	Set edge type
8	X-coordinate 1st point	X-Value of the first found edge
9	Y-coordinate 1st point	Y-Value of the first found edge
10	Actual value	

Pattern detect locator

Parameter number	Tool parameter	Description
6	Object found	0= Pattern not found; 1= Pattern found
7	X-coordinate	X-coordinate of the pattern
8	Y-coordinate	Y-Coordinate of the pattern
9	Rotation angle	Rotation angle of the found pattern
10	Actual value	Current actual value of the Detect Pattern Match

Pattern detect tool

Parameter number	Tool parameter	Description
6	Number	Number of patterns found. Value range 0 - N
7	X-coordinate of 1st pattern	X-coordinate Pattern 1
8	Y-coordinate of 1st pattern	Y- Koordinate Muster 1
9	Angle of 1st pattern	Angle rotation of Pattern 1
10	Actual value 1st pattern	Actual value Pattern 1
11	X-coordinate of 2nd pattern	X-coordinate Pattern 2
12	Y-coordinate of 2nd pattern	Y-coordinate Pattern 2
13	Angle of 2nd pattern	Angle rotation of Pattern 2
14	Actual value of 2nd pattern	Actual value Pattern 2
4*N +3	X-coordinate of pattern N	X-coordinate Pattern N
4*N +4	Y-coordinate of pattern N	Y-coordinate Pattern N
4*N +5	Angle of 2nd pattern	Rotation angle Pattern 2
4*N +6	Actual value of 2nd pattern	Actual value Pattern 2

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360° Pattern detect locator

Parameter number	Tool parameter	Description
6	Object found	0 = Pattern not found; 1= Pattern found
8	X-coordinate	X-coordinate of the pattern
9	Y-coordinate e	Y-coordinate of the pattern
10	Rotation angle	Rotation angle of the found pattern in whole degrees. Note: Degree number changes positively clockwise
11	Actual value	Current actual value of the pattern detection

Example

… 360GRAD&00000&00472&00090&00000&00001&00300&00100&00015&00097

Here: X-coordinate: 300; Y-coordinate 100; Rotation angle: 15 deg.; Agreement: 97 percent.

Character Verifiction tool

Parameter number	Tool parameter	Description
6	Current value	The current value is the similarity of the characters present on the check part with the reference characters in percent.
7	Manual threshold value	The set threshold value.

Datamatrix code locator

Parameter number	Tool parameter	Description
6	Code content	The code content of the read code, character sequence
7	Overall code quality	Gesamtqualität des gelesenen Codes. Wert 0 - 4
8 to 11	Single Values Code Quality	Those quality parameters are transferred: 8 = Symbol Contrast, 9 = Axial distortion, 10 = Unsused error correction, 11 = Decodability
12	Character length	Number of characters in the read code.
13 and 14	X-/ Y-Position	X-/Y Position of the found code.
15	Rotation angle	Rotation angle of the found pattern in whole degrees. **Note:** Degree number changes positively clockwise!

Read Data Matrix tool

Parameter number	Tool parameter	Description
6	Code Number	The number of the found DMC codes in the tool ROI
7	Code content	The code content of the first read code, character sequence
8	Overall code quality	Overall quality of the code read. Value 0 - 4
10, 11,12,13	Single Values Code Quality	Those quality parameters are transferred: 10 = Symbol Contrast, 11 = Axial distortion, 12 = Unsused error correction, 13 = Decodability
14	Character length	Number of character in the read code.
		Parameters for a 2nd to N-th Code

Example

Two DMC Codes found in one ROI:
OK&00130&Insp2&00000&Datamatrix1&00000&00316&00243&000.0&**00002**
&FIRSTCODE&00003&3&4&4&4&0009 &SECONDCODE&00004&4&4&4&4&00010
Red: General data
Orange: Data of first DMC Code
Brown: Data of 2nd DMC Code

9 Interface

Barcode locator

Parameter number	Tool parameter	Description
6	Code type	Type of the found barcode, see table below Barcode tool
7	Code content	The code content of the read code, character sequence
8	Overall code quality	Overall quality of the code read. Value 0 - 4
9 to 13	Single Values Code Quality	Those quality parameters are transferred: 9 =Decode, 10 =Symbol Contrast, 11 = Minimum Edge Contrast, 12 = Modulation, 13 = Decodability
14	Character length	Number of character in the read code
15 and 16	X-/ Y-Position	X-/Y Position of the found code
17	Rotation angle	Rotation angle of the found pattern in whole degrees. **Note:** Degree number changes positively clockwise!

QR Code locator

Parameter number	Tool parameter	Description
6	Code type	Type of the found QR code , see table below Barcode tool
7	Code content	The code content of the read code, character sequence
8	Overall code quality	Overall quality of the code read. Value 0 - 4
9 to 12	Single Values Code Quality	Those quality parameters are transferred: 9 =Symbol Contrast, 10 = Axial distortion, 11 = Unsused error correction, 12 = Decodability
13	Character length	Number of character in the read code
14 and 15	X-/ Y-Position	X-/Y Position of the found code
16	Rotation angle	Rotation angle of the found pattern in whole degrees. **Note:** Degree number changes positively clockwise!

Read QR Code tool

Parameter number	Tool parameter	Description
6	Code number	Number of codes found in the ROI. Value 0 - N
7	Code type	The found QR code type
8	Code content	The code content which was read. Character sequence
9	Overall code quality	Overall quality of the code read. Value 0 - 4
10 to 13	Single Values Code Quality	Those quality parameters are transferred: 10 = Symbol Contrast, 11 = Axial distortion , 12 = Unsused error correction, 13 = Decodability
14	Character length	Number of character in the read code

If Number of Code is greater than 1, then parameters 8 to 15 are transferred again for each code in that ROI. The code type is constant for all read codes.
f there are two codes in the ROI which have the same code content, the number of found codes is automatically set to 1

Read Barcode tool

Parameter number	Tool parameter	Description
6	Number of Code	Number of read barcode inside the tool ROI
7	Code type	Type of the found barcode , see table below Barcode tool
8	Code content	The code content of the read code, character sequence
9	Overall code quality	Overall quality of the code read. Value 0 - 4
10 to 14	Single Values Code Quality	Those quality parameters are transferred: 10 =Decode, 11 =Symbol Contrast, 12 = Minimum Edge Contrast, 13 = Modulation, 14 = Decodability
15	Character length	Number of character in the read code

If Number of Code is greater than 1, then parameters 8 to 15 are transferred again for each code in that ROI. The code type is constant for all read codes.
If there are two codes in the ROI which have the same code content, the number of found codes is automatically set to 1.

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Example

2 Codes of Code 39 are read at the same time:
OK&00124&Insp2&00000&Barcode3&00000&00316&00243&000.0&00002&00001
&ABC-01&00004&4&4&4&4&400006&EXT221RT&00003&4&3&4&4&400008

Blue: General tools data
Red: Data of first Code 39
Green: Data of 2nd Code 39

Overview of the different Codetypes:
Each different codetype is transmitted via RS232/Ethernet interface using a 5-digit-number.
This table shows which codetype belongs to which number:

Number	Represents this barcode type
0	Code 128
1	Code 39
2	Codabar
3	Interleaved 2 of 5
4	EAN 13
5	EAN 8
6	UPC-E
7	Postnet
8	IMB
9	Pharmacode
10	PDF 417
11	UPC-A
12	GS1-128

Code type QR-Code

Number	Code type
0	QR -Code
1	Micro-QR

Note
For any code reading tools some can set a NO READ MESSAGE via STEP2 – "Output Settings" → "Data Formatting" (press >> button in the Control Panel to get there). As a standard the tool sets the NO READ .

360° Detect contour locator, Check contour tool

Parameter number	Tool parameter	Description
6	Number of found contours	The number of found contours having a similarity with the learned template greater than the desired value.
7	X-Position Normal	The non-transformed X- and Y-Position of the contour
8	Y- Position Normal	
9	Rotation angle	The rotation angle of the found contour in degrees. Note: The degree number changes clockwise!
11	X-Position transformed	The transformed X- and Y-Position of the contour
12	Y-Position transformed	

9 Interface

Examples

Center point and transformed point are the same (here only the parameters which the tool sends are shown) :
...360Contour&00000&00320&00240&000.0&00001&00370&00369&00000&00100&00370 &00369

Center point and transformed point shifted:
…360Contour&00000&00320&00240&000.0&00001&00370&00369&00000&00100&00257 &00320

Check contours tool

Parameter number	Tool parameter	Description
6	Number of found contours	The number of found contours having a similarity with the learned template greater than the desired value.
7	X-Position Normal Contour 1	The non-transformed X- and Y-position of the 1st contour
8	Y- Position Normal Contour 1	
9	Rrotation angle Contour 1	The rotation angle of the 1st contour in degrees. Note: The degree number changes clockwise!
10	Actual value Contour1	Agreement between 1st contour and desired contour in percent
11	X-Position transformed	The transformed X- and Y-position of the 1st contour
12	Y-Position transformed	
13	X-Position Normal Contour 2	The non-transformed X- and Y-position of the 2nd contour
14	Y- Position Normal Contour 2	
15	Rrotation angle Contour 2	The rotation angle of the 2nd contour in degrees.
16	Actual value Contour 2	Agreement between 2nd contour and desired contour in percent
17	X-Position transformed	The transformed X- and Y-position of the 2nd contour
18	Y-Position transformed	

ADDITIONAL DATA for CONTOUR POINTS!
8 parameters per contour point unless parameters are deselected.

Examples

Center point and transformed point are the same (here only the parameters which the tool sends are shown):
... Konturzaehlen&00000&00145&00240&000.0&00002&00116&00400&
-0001&00100&00116&00400&00222&00400&-0001&00099&00222&00400

The center point and transformed point are shifted – here a correction of 116 in X and 100 in Y:
…Konturzaehlen&00000&00145&00240&000.0&00002&00116&00400&
-0001&00100&00000&00000&00222&00400&-0001&00099&00106&00000

10 Outputs

10.1 Setting outputs

After clicking on “Set outputs” you can assign the desired results to the outputs and to the function "Store Image" in the control panel (upper right in the screen). By default these are deactivated.
The following results can be combined with one or more outputs:

- The result of the Locator tool, i.e. objects found or not.
- **Standard models only:**
  - PART PRESENT: The result of the Locator tool
  - PART OK: Collective result. All tools return OK.
  - PART DEFECTIVE: Collective result. At least one of the tools returned NOK.
- **All other models:** The result of a logical operation, e.g. a logical AND, OR or NOT.
- **AI models:**
  - The result of a tool (OK or NOK).
  - Toggle: If an output is assigned a Toggle, then the level changes (similar to a flip-flop) from 0 to 1 or 1 to 0 as soon as the next inspection is available. There is no relationship to the inspection result. This allows you to use the Toggle signal to verify an inspection result, such as “part OK”.
  - Busy-Ready: As long as the sensor is busy calculating the current inspection result, the output is switched (HIGH). The output turns off as soon as the sensor is ready to run the next inspection.

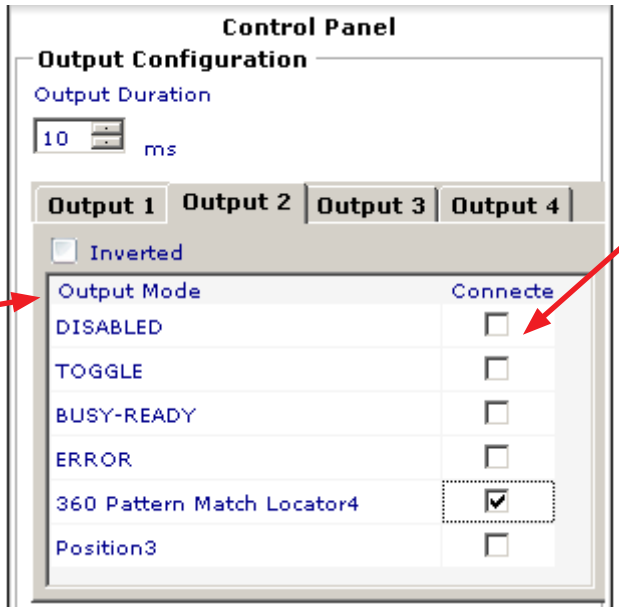
Note
The Busy-Ready signal is NOT valid if the inspection is changed using the digital inputs (see Section "11 Changing Inspections and External Teaching").

- **Error:** New trigger signal was received even though the last cycle is not yet complete.

Note
The output functions Toggle, Busy-Ready and Error are NOT updated in the control panel in Step 3 “Apply”.

Note
In the Control Panel and "Set Outputs" an Output 3 is displayed. This is WITHOUT FUNCTION in the BVS Identification and BVS Universal sensors.
To use the external trigger output as an additional output, you must connect a signal to OUTPUT 4. If the output remains DEACTIVATED, then it continues to function as a trigger output and can be parameterized using STEP 1.

In this column are the possible functions (results) which can be combined with this output.



If a function is combined with an output, this is indicated by a check mark.

10 Outputs

Parameter	Description
Output duration	Specifies the output duration in milliseconds. The output retains its last value for this duration. By default the duration is 10 ms, i.e. all outputs retain their values for 10 ms after the inspection result becomes available. **Special case:** Output duration 0 ms. If you set 0 ms as the output duration, the output retains its state as long as the same result value is present. Pulse duration 0 ms implements a “signal extender”. An example of this can be found below in the "Timing" section.
Inverted	If you select “Inverted” the output goes “Low” when the tool returns OK, i.e. an inverted output is switched if the result is incorrect, and turned off if the result is correct. The default setting is for the output to be “High” when the result is OK.

Note
Changing the output duration affects each of the three (or four) outputs.

Please be sure that the output duration is always significantly less than the time span between two part inspections. If you violate this rule, the sensor is unable to provide a result for each part.

Note
The “Output duration” parameter also accepts 0 ms as a time.
If this setting is selected, then the output retains its state as long as the same status is present. In other words: Output duration 0 ms implements a “signal extender”.

Image Saving

Use “Image Saving Condition” to specify whether and under what conditions the sensor should save images (e.g. defect images). This setting applies only to the current inspection, i.e. a different setting can be used for other inspections.

“Image Saving” is activated only in Run mode (sensor connected to ConVis) or in autonomous mode.

In Run mode the images which meet the set conditions are also saved to a special directory on the PC. The directory can be set using the Options menu point.

Up to 10 images can be stored on the sensor, or up to 10,000 on the PC.
If you save an 11th image (or n more than 10,000), the oldest stored image is overwritten.

The default setting is “Deactivated”, i.e. no images are saved on the sensor or PC. If you select “Activated”, you can use the selection list and the logical operations (except for BVS-E Standard) to determine under what conditions an image should be saved.

Note
The images are stored in normal RAM. This means that after the sensor is powered off the images are NO LONGER available.

Note
As the image saving conditions can now be set via the logic conditions it is important to setup the right saving conditions for all inspections on a BVS Identification or BVS Universal after updating the sensor to Firmware ST 2.4.x.y

Logical operations

With a BVS Advanced, Identification, or Universal model you can use logical operations to assign a logic function or a chain of operations to each output.

Note
Logical operations are only available on BVS-E Advanced, Identification, or Universal models.In this case the fixed definition for “Part present”, “Part OK” and “Part defective” are no longer available.

After clicking on "Set output" the "Set outputs" view is displayed.

10 Outputs

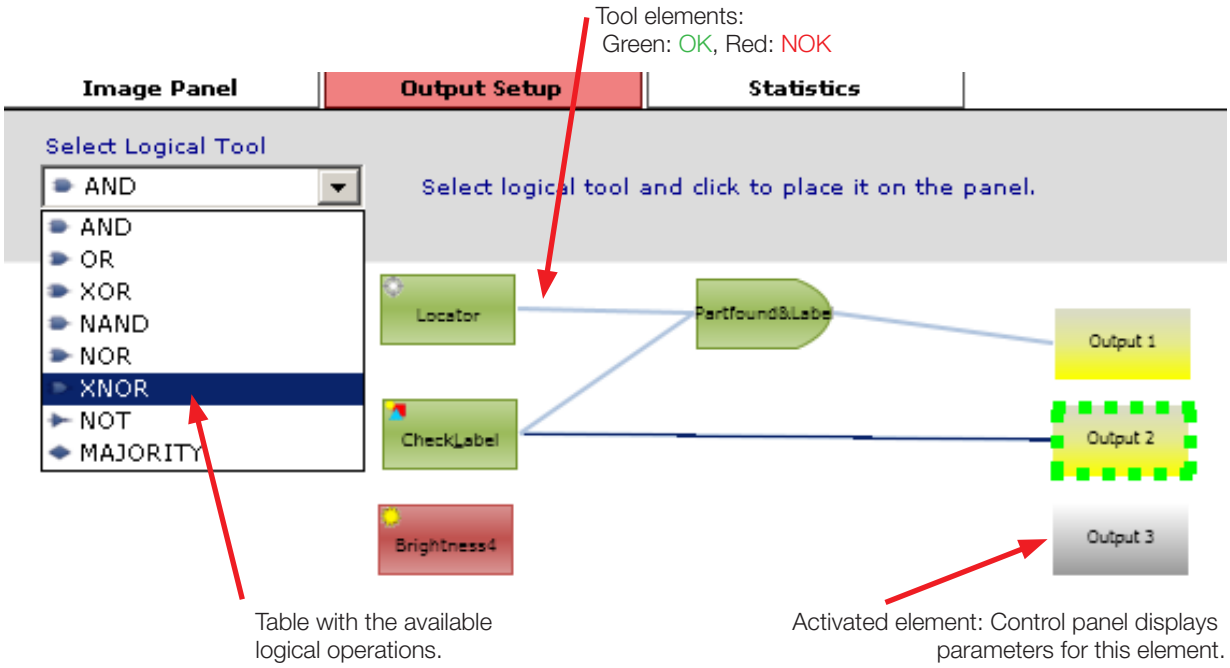


Fig. 10-1: "Set outputs" view with tools and logical operations

Proceed as follows to use a logical operation:

► Select a logical operation from the list and click in the "Set outputs" view.
⇨ The selected operation is then displayed by the software as follows:

Symbol	Meaning
	Operation has no links, or too few links to provide a result.
	Link is present; Result is OK
	Link is present; Result is NOK

► After clicking on the symbol for the inserted operation, the control panel for the operation is displayed:

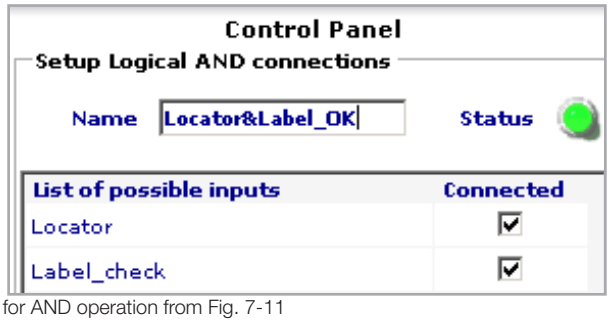


Fig. 10-2: Link table for AND operation from Fig. 7-11

From the "List of possible inputs" you can now select the tools and logical operations which you want to apply to the current operation.
The following table shows the available logical operations. A logic table for the required MINIMUM NUMBER of links is shown for each operation.
Legend: I1: Input 1; I2: Input 2; O: Output of the operation; OK: Good; NOK: Bad

10 Outputs

Symbol	Name	Meaning
	AND	Logical AND of the inputs (links). Note: If AND is applied to more than two links, then it is OK if all links are OK.

I1	I2	O
0	0	0
0	1	0
1	0	0
1	1	1

Symbol	Name	Meaning
	OR	Logical OR of the inputs (links). Note: If OR is applied to more than two links, then it is OK if at least one link OK.

I1	I2	O
0	0	0
0	1	1
1	0	1
1	1	1

Symbol	Name	Meaning
	NOT	Logical NOT of the input (link). The **NOT** operation (or Inverter) says that the state of the output will be opposite to the state of the input. Note: NOT allows a maximum of 1 link!

I	O
0	1
1	0

Symbol	Name	Meaning
	XOR	Logical XOR of the inputs (links). The Exclusive OR (**XOR**) operation says the output will be **OK** if the inputs are different Note: XOR allows a maximum of2 links!

I1	I2	O
0	0	0
0	1	1
1	0	1
1	1	0

Symbol	Name	Meaning
	NAND	Logical NAND of the inputs (links). The **NAND** operation says if and only if all inputs are **OK**, the output will be **NOK**. Note: If NAND is applied to more than two links, then it is **NOK** if all links are **OK**..

I1	I2	O
0	0	1
0	1	1
1	0	1
1	1	0

Symbol	Name	Meaning
	NOR	Logical NOR of the inputs (links). Note: The **NOR** operation says if any inputs is **OK**, the output will be **NOK**..

I1	I2	O
0	0	1
0	1	0
1	0	0
1	1	0

Symbol	Name	Meaning
	XNOR	Logical XNOR of the inputs (links). The Exclusive **NOR** (XNOR) operation says the output will be **NOK** if the inputs are different. Note: XNOR allows a maximum of 2 links!!

I1	I2	O
0	0	1
0	1	0
1	0	0
1	1	1

Symbol	Name	Meaning
	Majority	The result of the Majority is OK if OK is present on MORE links than set in the MINIMUM parameter. Majority allows a maximum of 25 links. **Example:** A Majority is linked to 5 results. The Majority is then OK under the following conditions.

Minimum	Number of HIGH links	O
1	0	0
1	1 or more	1
2	2 or more	1
3	3 or more	1
4	4 or more	1
5	5	1

10 Outputs

10.2 Timing of the outputs and timing diagrams

The timing of the outputs is explained using the following example:
– You want to test 4 parts (A-D).
– Only Part C is NOK.
– The parts arrive spaced 2500 milliseconds from each other.
– The cycle time for the inspection shall be 500 ms.
– The set output duration is 1000 ms (or 0 ms – Red Lines. For explanation see below Case A) and B)).
The outputs are assigned as follows:
– Output 1: Part OK;
– Output 2: Toggle;
– Output 3: Busy-Ready.
No outputs are inverted!

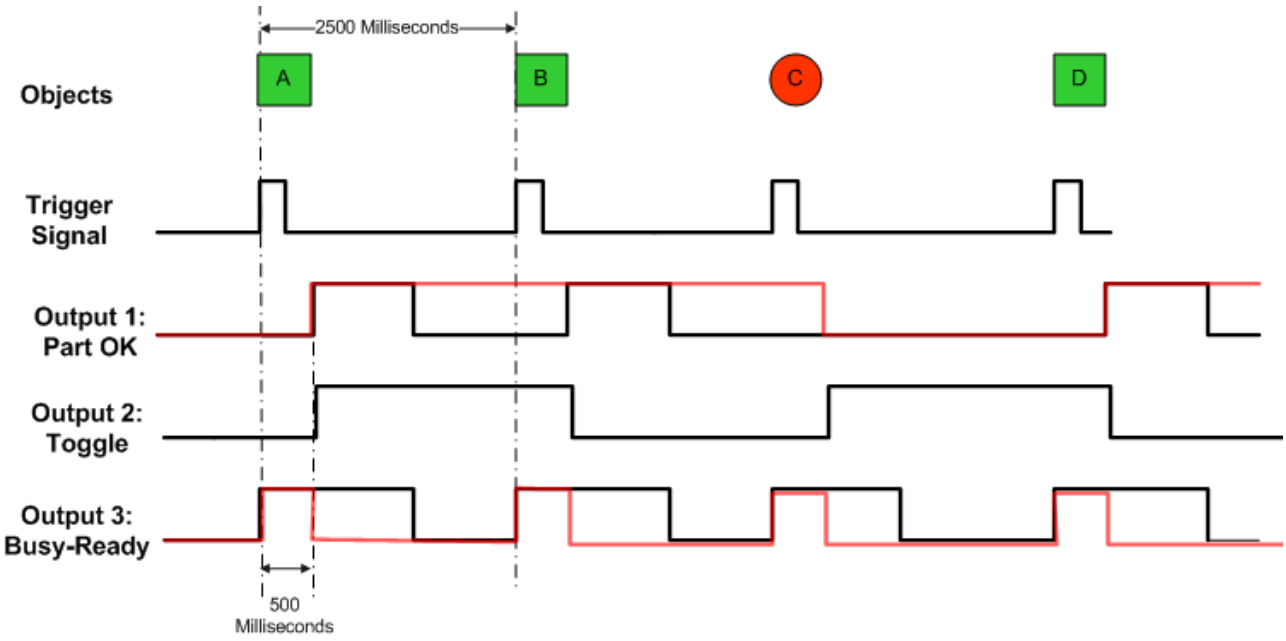


Fig. 10-3: Diagram for output timing

First we want to take a closer look at the sequence of the signals which are independent of the inspection result: Trigger, Busy-Ready and Toggle:

1. The Trigger line shows the trigger signal present on the Trigger input of the sensor; the rising edge is used for triggering.
2. The Busy-Ready signal goes HIGH for each part as soon as the trigger is present and turns off when Output 1 ”drops” (exception: output duration 0, then the Busy-Ready signal drops immediately as soon as there is a result for the current inspection).
3. The Toggle signal goes HIGH as soon as the inspection result for Part A is present, and LOW as soon as the result for Part B is present, etc. After each edge transition of the Toggle signal there is also a new inspection result present on Input 1. This means inspection results can be distinguished from each other on Output 1 even when the level is the same.

How do outputs which depend on the result of the inspection (e.g. Part OK, or the result of a tool) behave?

Two different cases can be seen in the diagram:
Case A) Output duration 1000 ms (black line). Output 1 goes HIGH as soon as a part (Part A and B) is detected as good. After the set output duration expires, the output drops again to LOW.
For Part C there is no status change – the output remains LOW until the result for Part D is available.

10 Outputs

Case B) Output duration 0 ms (red line).). Here again Output 1 goes HIGH as soon as Part A is detected as good, but does not drop back to LOW. Instead it retains its state. Since Part B is also good, the HIGH state remains until the result for Part C has been calculated. Part C is defective – the output goes to LOW until and remains LOW until the result for Part D is available.

In both cases you could also reliably determine the result in a PLC by means of the logical operation on Output 1 with the status of the Toggle output.

11 Inspection changing and external teaching

You can store up to 20 inspections on the BVS-E Vision Sensor. However, only one inspection at a time is activated, i.e. only one of 20 inspections can be run at a time.
There are various ways to change the current inspection:
While the Sensor is connected with Convis please select "Sensor menu → Settings → Inspection" buffer tab. Now select the inspection you want to activate and then click on: Activate inspection.

While the sensor is running standalone:

Sensor type	Ways to external inspection switching
BVS Standard, BVS Advanced	1. Changing WITHOUT reply using SELECT input (recommended only for already existing installations) 2. Change WITH reply using SELECT and TRIGGER input 3. Change WITH reply AND external teaching using SELECT and TRIGGER input 4. External teaching using SELECT input. 5. Change inspections using the Monitor
BVS Ident, BVS Universal	1. Change inspections using RS232 or Ethernet interface 2. External teach using RS232 or Ethernet interface Refer to Section"9 Interface" for both options 3. Change inspections using the monitor

Attention!
Ready delay!
In the first 10 seconds after turning the sensor on NO SWITCHING or EXTERNAL TEACHING PERMITTED!
Changing inspections using digital in- and outputs is not suitable for making a selection before each new part. It is also unsuitable for performing parts sorting.

11.1 Inspection change WITHOUT reply

CAUTION!
Changing inspections WITHOUT a reply is NOT permitted for new projects. Instead, use inspection changing with reply or changing via the interface.

All protocols use digital pulses with a minimum pulse duration set using the BVS ConVis software. The default setting is a pulse duration of 10 ms.
Information on how to activate one of the other protocols or change the minimum pulse duration can be found in Section “12.2.10 Sensor Settings (Changing inspections and miscellaneous)” .

We recommend using the “**Change inspection WITHOUT reply**" protocol only for already existing sensor applications. For new installations we recommend using “Change inspection WITH reply”. To change inspections only the SELECT input (Pin 1) is needed.

Note
If the sensor does NOT respond to the pulses sent from a PLC via SELECT or the trigger input, then check the supply voltage for the sensor. There must be a connection between the sensor GND and PLC ground. The supply voltage must also be the same.

Prologue

The protocol consists of 2 parts: A “prologue” which enables changing, and the "inspection number" to activate.
The protocol consist of digital pulses of between 10 and 100 ms followed by pauses of the same length (pulse-pause 1:1). The pulse duration must correspond to the set minimum pulse duration.
The “prologue” consists of 3 pulses having the same minimum pulse duration which are applied to the SELECT input. The prologue must be sent within a time window of $t_{timeout} = 1{,}9 * 6 * t_{pulse\ duration}$, otherwise the change is cancelled.
Example: Assume the set minimum pulse duration is 40 ms. 3 pulses and 3 pauses must be sent for the prologue, i.e. the prologue can be sent in a minimum of 240 ms, and in a maximum of 456 ms.
The prologue prevents an inspection from being changed accidentally by noise pulses.

11 Inspection changing and external teaching

Inspection number

Following the prologue the “Inspection number” is sent - at least 1, a maximum of 20 pulses. Only the pulses are evaluated which are sent within a time window of $t_{timeout}$= 1,9 * 40* $t_{pulse\ duration}$. After this time window has passed no pulses are accepted on the Select input.

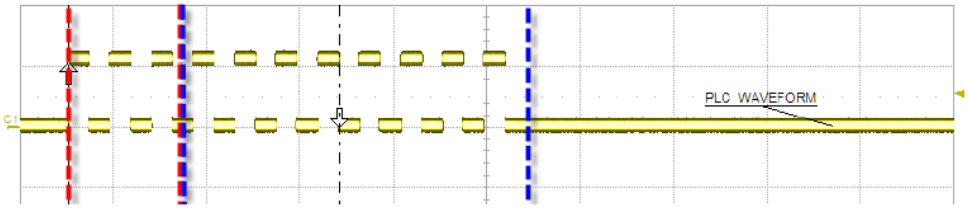
Example

Assume the cycle time of your PLC, i.e. the time for a complete program cycle, is approx. 40 ms. Then set the pulse duration to at least 40 ms. Now all pulses having a minimum pulse duration of 40 ms are accepted.

Notes
The minimum selectable pulse duration is 10 ms; the maximum selectable pulse duration is **100 ms**.
The duty cycle is always 50%, i.e. the pause duration must be the same as the pulse duration (1:1).
Switching using the Select input is ONLY ACTIVE as long as the sensor is NOT connected to the PC.

The following figure shows a trace representing selection of Inspection Number 8 using the digital Select input. The pulses could be generated by a PLC for example.
The region between the dashed red lines contains the prologue pulses; a change from Low to High represents a pulse.

Note
The pause between the prologue and the "inspection number" should be 1.5 times of the set pulse duration..



The region between the dashed blue lines contains the data pulses; here you can count 8 pulses, i.e. Inspection Number 8 is being selected.

Note
If the number of pulses sent within the data frame is greater than 20, the request is rejected. Likewise if 0 pulses are sent.
If you use this protocol, then the sensor also activates empty memory locations if a corresponding pulse sequence is received.

11.2 Inspection change with reply and inspection change with reply and ext. teaching

The protocol for **inspection changing WITH reply** and the version **with reply and external teaching** can be activated using the BVS ConVis software (see also Section “12.2.10 Sensor settings → Changing inspections & miscellaneous”).
Balluff offers for this protocol an example function module for Siemens S7 and Codesys compatible controllers.

Note
Inspection change with feedback is only available for BVS Standard and Advanced models. The BVS Ident and Universal models can be switched only via RS232 or Ethernet interface or by using the BVS Monitor.

To change inspections the SELECT and Trigger inputs are needed.
All input signals are then accepted by the sensor only if they are longer than the minimum pulse duration set in the software (menu "Sensor → Settings → Change inspection → Minimum pulse duration").
Input signal levels are defined as follows: HIGH corresponds to 24 V; LOW corresponds to 0 V. This applies to sensors with NPN output.

Both versions of inspection change with reply have the same protocol –
however, in the version with external teaching a new reference image is learned as soon as an

11 Inspection changing and external teaching

inspection is selected twice. More information can be found below: “Definitions → Duplicate selecting”.

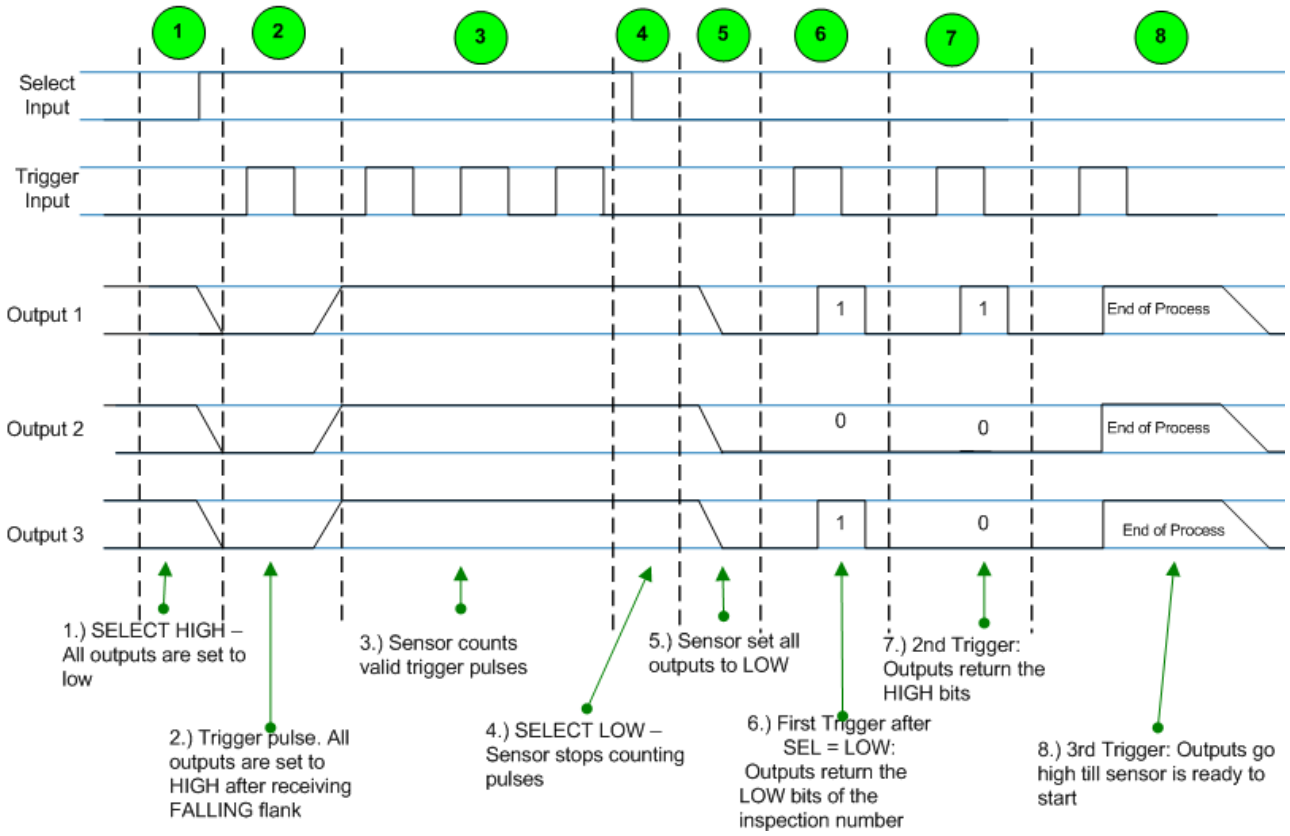


Fig.11-1: Timing diagrams Phase 1 to 8

The protocol for inspection changing with reply is divided into 8 phases:

PHASE 1: Initializing, Step 1
The SELECT input is set to HIGH. Sensor reply: All outputs are set to LOW if the minimum pulse duration for SELECT is OK and the output pulse duration set for the outputs has expired.

PHASE 2: Initializing, Step 2
The PLC sends a trigger pulse. Sensor reply: All outputs are set to HIGH. The sensor is now ready to receive trigger pulses.

PHASE 3: Send inspection number
The sensor counts all the valid trigger pulses. Outputs remain HIGH. 3 pulses are shown in the diagram.
For example, to select Inspection 1, one trigger pulse must be sent; for Inspection 10, ten pulses are required.

Note
If no pulse is received in Phase 3, or a non-permitted pulse number (e.g. a number >20! or a number which refers to an unassigned memory location), then no change is made, and the sensor retains the current inspection. In this case the sensor returns the previous inspection number.

PHASE 4: Finish sending inspection number
Set SELECT Input to LOW.

Phase 5: Initialize reply

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The sensor replies to Phase 4 by setting all outputs to LOW. The sensor does not count any more trigger pulses!
NO trigger pulses are accepted on the input during the time in which the outputs are still HIGH but SELECT is already LOW.

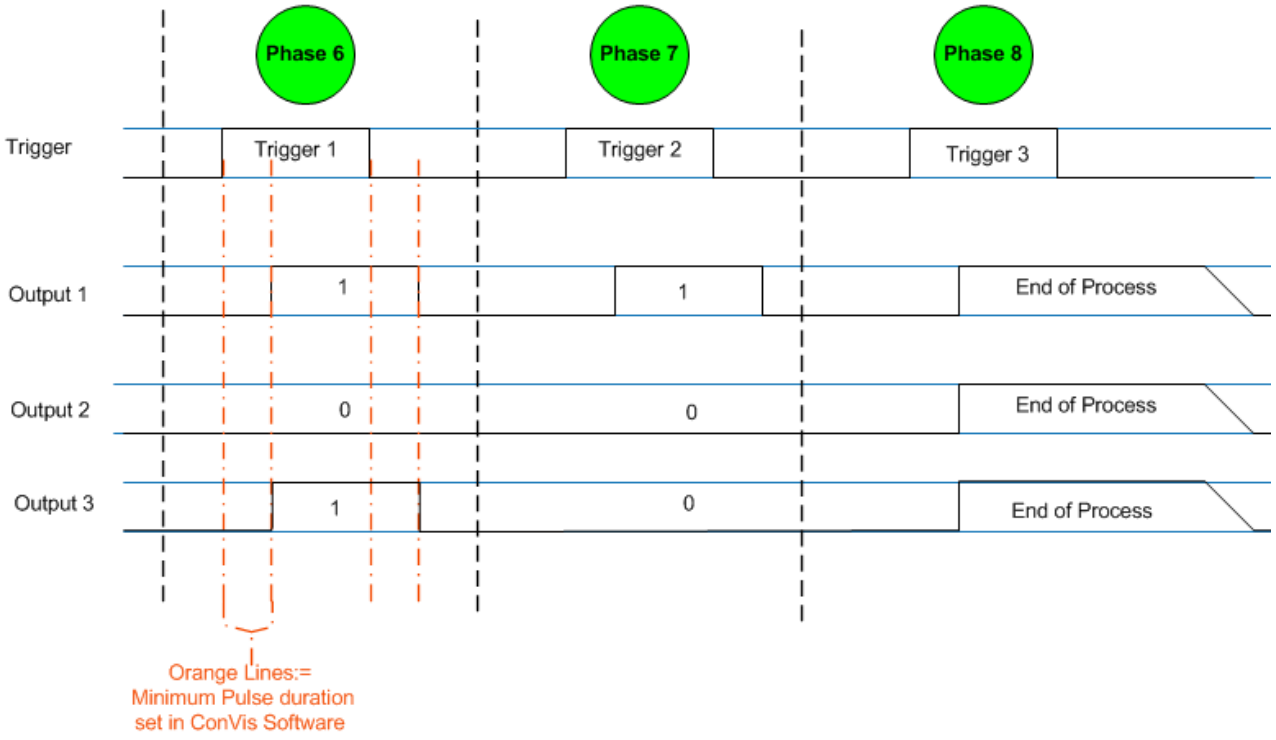

Fig.11-2: Detailed timing diagram for reply, Phase 6 to 8

Phase 6: Reply 1 - Least significant bits
PLC sets trigger pulse to HIGH. Sensor reply: Outputs return (delay time = minimum time after rising trigger edge) the first 3 bits (lease significant bits) for the set inspection number (see also Fig. 8-2).

Output 1 is always the lowest value bit, Output 3 the highest value bit.
In the example for Fig. 2: O3 := $1 * 2^2$, O2:= $0 * 2^1$; O1 := $1 * 2^0$

PLC sets trigger pulse to LOW. Sensor reply: Outputs return to LOW after delay time = minimum duration.

Phase 7:
PLC sets trigger pulse to HIGH for the second time. Sensor reply: Outputs return (delay time = minimum time after rising trigger edge) the second 3 bits (most significant bits) for the set inspection number. (see also Fig. 11-2)

Output 1 is always the lowest value bit, Output 3 the highest value bit.
Using the Fig. 2 example: O3 := $0 * 2^5$, O2:= $0 * 2^4$; O1 := $1 * 2^3$

PLC sets trigger pulse to LOW. Sensor reply:
Outputs return to LOW after delay time = minimum duration.
In the example from Fig. 8-2:
From PHASE 6:= O3 := $1 * 2^2$, O2:= $0 * 2^1$; O1 := $1 * 2^0$
From PHASE 7:= O3 := $0 * 2^5$, O2:= $0 * 2^4$; O1 := $1 * 2^3$
This would correspond to Inspection Number 13!

Phase 8:
PLC sets trigger pulse to HIGH for the third time. Sensor reply: Outputs go (delay time = minimum

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time after rising trigger edge) HIGH.
The sensor now initializes the selected inspection.
As soon as the sensor is initialized, the outputs are set to LOW. The sensor is now ready.

Note
Until firmware version ST 2.3.0.40.1 including, the sensors are ready after 2 second since the end of Phase 8!

Timeouts

Two timeouts are defined in the protocol
Timeout 1 (TO1)
TO1 starts in PHASE 1 after the rising edge of the SELECT input.
TO1 is triggered if after 4 seconds the SELECT input is not set to LOW.
If TO1 was triggered, then the sensor goes to Phase 5 and sets the outputs to LOW.
If a valid number of trigger pulses was received in PHASE 3, the sensor changes over to this inspection, otherwise the current inspection remains active.
In Phases 6 and 7 the corresponding inspection number is returned.
Timeout 2 (TO2)
TO2 starts in Phase 4 either after the falling edge of the SELECT input or if TO1 has been triggered.
TO2 is triggered if after 4 seconds following Start LESS than 3 trigger pulses were received.
If TO2 was triggered, the sensor does not change the inspection! The inspection that was active before the begin of the inspection number remains active.

Definitions

Attention!
The ready delay of the sensor is 10 seconds! Do not switch the inspection within those first 10 seconds.
The minimum pause between two inspection switching's is 2 Seconds!

Protocol restart
The protocol is restarted (even if not all phases have run) AS SOON AS SELECT changes again from LOW to HIGH.
Example: As soon as the SELECT input is set again to HIGH in PHASE 5, the next received trigger pulse does NOT start PHASE 5 but rather PHASE 2.

Minimum pulse duration
The minimum pulse duration is set in the BVS ConVis software.
The default setting for minimum pulse duration is the minimum possible 10 ms. The maximum may be 100 ms.
Each input signal (Trigger + Select) must be present for the minimum pulse duration in order to be accepted; they may however have different lengths or be longer than the minimum pulse duration.
Example: Set minimum duration: 25 ms
Trigger 1: 45 ms; Trigger 2: 20 ms; Trigger 3: 40 ms
Here: Trigger 2 was not accepted.

We recommend setting the minimum duration on the sensor as follows:
Minimum duration = cycle time of PLC – 5ms.
Example: PLC cycle time: 80 ms – minimum duration then 75 ms

Note
The sensor counts the trigger pulses for Phase 3 for a maximum of 4 seconds! All trigger pulses must be sent within this time.

Valid pulse number
A single trigger pulse is valid if its duration is greater than the minimum pulse duration set in the software.
The sent pulse number (total of all trigger pulses in Phase 3) is valid under the following conditions:
– Pulse count LESS THAN OR EQUAL TO 20!
– Memory location with inspection number = pulse number is assigned!
– Pulse number was sent within 4 seconds.

11 Inspection changing and external teaching

Duplicate selection of an inspection
The software allows you to select from between two different options:
1. Inspection with reply, and
2. Inspection with reply and Teach

Option 1: In this case the sensor retains the active inspection when inspection selection is duplicated. It is not re-initialized.

Inspection changing with reply and external teaching

Option 2: In this case also the sensor retains the active inspection when inspection selection is duplicated, but after the second select the sensor learns a new reference image.
We recommend using the second option if for example you are using the Vision Sensor to check expiration dates on well positioned parts. You should never use this function if each inspected part can have a different location, since the position of the ROIs is not adjusted when using external teaching. Nor is the ROI adjusted for the Locator tool. If your teaching part has a different location at the time of teaching than did the previous part, your inspection will likely no longer function!

Selecting empty inspections
The sensor never allows an “empty” memory location (one that contains no inspection) to be selected.

11.3 External teaching

11.3.1 General information

Use External Teach only if the new part you want to teach is correctly positioned in the image. Correct in this context means that the new part has as little offset in the X- and Y-position or rotation compared with the previous part. This is because when teaching externally the location of the tool ROIs or of the Locator ROI and search area cannot be adjusted.
If your new part therefore is offset from the previously learned part, the inspection will likely be unsuccessful!

Firmware versions ST2.4.x.x of the BVS-E allow you to teach a new reference mage (and thereby a new reference contour or pattern) even after you have completed parameter setting using ConVis.

External teaching generally takes place in 2 steps:
Step 1: Activate Teach
Step 2: Record new reference image

After the first step the sensor waits for 60 seconds for a trigger signal. If the sensor is triggered (continuous, external or via RS232 resp. Monitor), then
1. The sensor initiates an image recording.
2. The tools, e.g. Detect Pattern Match, Compare 360° Contour or Read DataMatrix use a new reference sample / reference contour / reference code.
3. The reference image is evaluated (inspected) using the newly set tools, and
4. the digital outputs as well as the interface data are provided.
5. The newly recorded image is saved as a reference image.

As long as this sequence persists, the sensor ignores all further trigger signals.

11.3.2 Step 1: Activate Teach

There are 5 ways to activate Teach:
1. Inspection change with reply and External Teach,
2. Using the SELECT input,
3. Using the RS232/Ethernet interface
4. Using the Teach Button
5. Using the BVS-E Monitor

External Teach with inspection change and reply
To use this method activate the option
SEL + Trigger-Change & Ext. Teach in the “Sensor Settings” menu.

To teach a new reference image, perform an inspection change **TWICE** as described in the above section. After the second selection a new reference image is taught.

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External Teach only with SELECT
Activate the option: SEL - Ext. Teach in the “Sensor Settings” menu to use this option.
Switching requires only the **SELECT** input.
The sensor then learns a new reference image as soon as a value pulse is present (longer than the set minimum pulse duration” on the SELECT input.
A HIGH level on the input is 24V; LOW is 0V! This applies as well to sensors with NPN outputs.

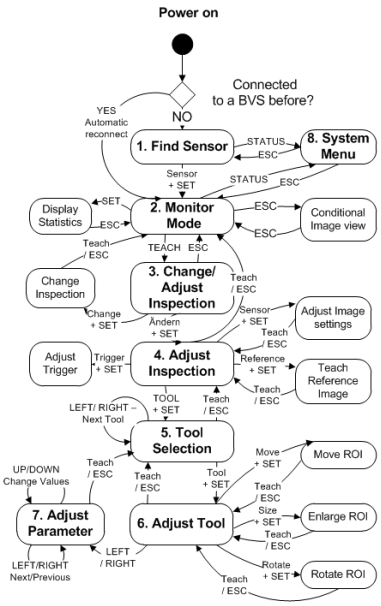
RS232 / Ethernet interface
BVS Ident & Universal only.
To use this option the sensor must send the TEACH command via RS232 or Ethernet. See also description for the TEACH command.

External Teach using Teach key
To use this set the option:
Teach Key in “Sensor Settings” menu to activated. The Teach key is deactivated by default.

To teach a new reference image using the Teach key, proceed as follows:
► Press the Teach key once.
⇨ Sensor response: LED Output 1 on.
► Press the Teach key again
⇨ Sensor response: LED Output 1 off, LED Output 2 on.
The next time a trigger signal arrives (or immediately if using continuous trigger) the sensor learns a new reference image. If the Teach key is not pressed within 20 seconds after the first press, the sensor resumes its normal status.

Teaching wih BVS-E Monitor
External Teach using BVS-E Monitor to teach in a new reference image, the monitor must be connected to the sensor. Open the "Adjust Inspection" menu (see also monitor manual for further reference). Select then the icon "Reference". The teach will be activated after you have pressed the button "TEACH" on the monitor.

Note
Behavior of Bar Code and DataMatrix tools / Locators:
If the Read Bar Code or Read DataMatrix Code tools are running in Compare Code mode and the AUTO option is set, the code which is read in the new reference image is used as the reference cod as soon as the sensor learns a new reference image.
Each newly read code is then compared with the reference code!



11.4 Delay time for inspection change

The delay time is the time from counting the last pulse to the moment when the inspection is active. The actual delay time for changing an inspection depends on the inspection itself, since each inspection may contain a different number of tools. The maximum delay time is between 1 and 3 seconds.

Note
The Busy-Ready signal is not valid while changing an inspection. The signal may show “Ready” while the sensor is actually busy changing the active inspection.

If you are using inspection change with reply or with reply and external teach, the delay time is indicated by the HIGH signal of the outputs in Phase 8. The inspection is ready to use as soon as all outputs have returned to LOW.

12 Reference BVS & BVS ConVis

12.1 First installation of BVS ConVis

All the information and instructions needed for initial installation of the software can be found in Section "4.1 First installation of BVS ConVis".

12.2 Reference BVS ConVis Software

In the following sub-sections you will find a reference for each operating element of the BVS ConVis software.

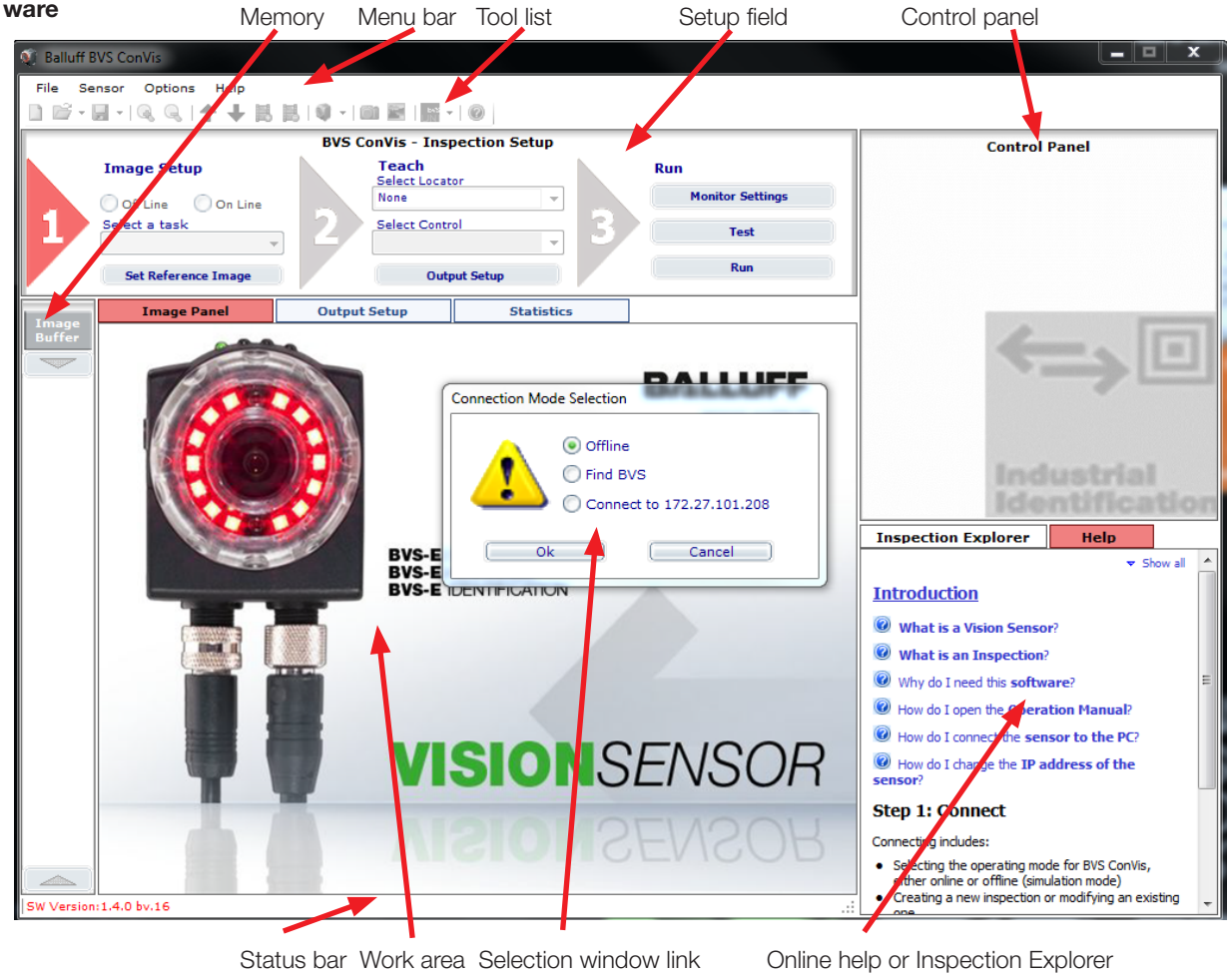
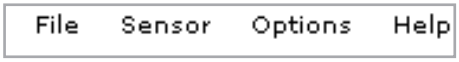


Fig. 12-1: BVS user interface - Overall view

12.2.1 Menu bar



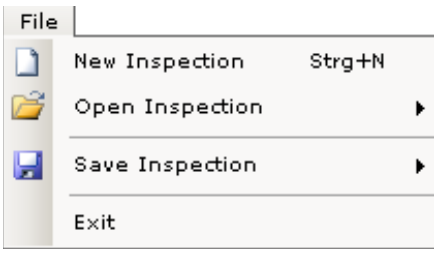
The menu bar provides access to the functions for

- Loading and saving inspections,
- Changing sensor settings such as the IP address or the inspection under “Sensor”
- Changing “Settings” such as the software language,
- Opening the operating manual or other information (“Help”).

12 Reference BVS & BVS ConVis

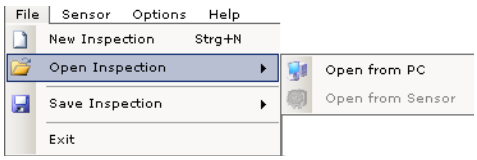
File

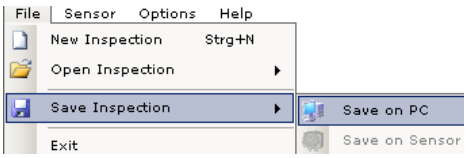
The File menu contains the following menu points



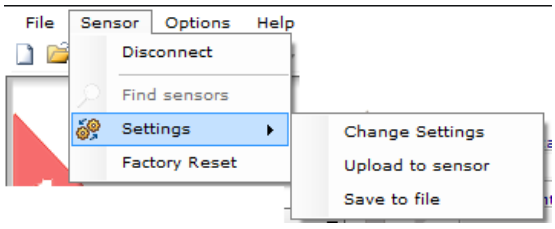
Function	Description
New inspection	Create a new inspection.
Load inspection	Loading an inspection either from the PC or from the sensor.
Save inspection	Saving the current inspection either on the PC or on the sensor.
Exit	Quitting the ConVis program.

Menu points “Load inspection” and “Save inspection” give you access to the files stored in the personal computer (loading from the PC, saving on the PC) or in the sensor memory (loading from the sensor, saving on the sensor).





Sensor



Function	Description
Open connection	Opens the connection mode window - continue from section "5.3.3 Opening a connection to the sensor - Online mode only".
Find sensors	Searches for all sensors connected in the network. More information can be found in "5.3.3 Opening a connection to the sensor - Online mode only".
Settings	Change Settings – With "Change Settings" you can change the current sensor settings. – With "Upload to sensor" you can upload previously saved sensor settings from PC to your sensor. – With "Save to PC" you can save the current sensor parameters to a PC. Please note that you can only upload sensor parameters to a sensor.

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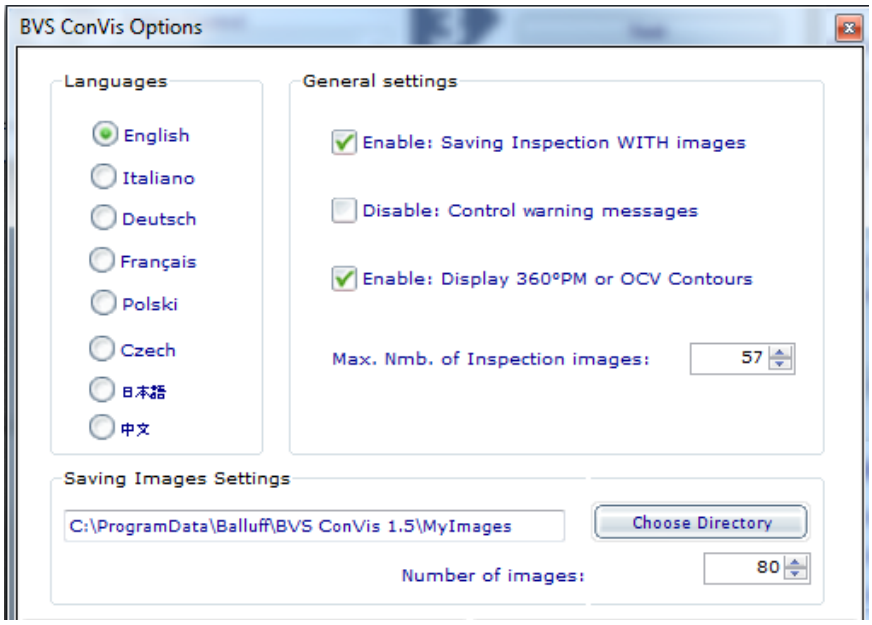
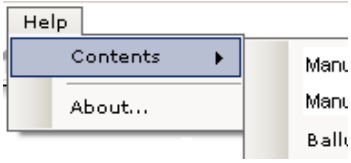
Settings

Clicking on “Settings” opens this window:



Function	Description
Settings	The following settings are available: – Save inspection with images Default: Enabled. If this setting is disabled, then when “Save inspection on PC” is selected only the reference image is saved in the inspection file but not the images from the frame buffer. – Turn off tool warning messages. Default: Disabled. If this setting is enabled, then the “Pattern detect” and “360° pattern detect” tools do not warn you when ambiguous ROIs have been selected. – Show contours for “360° pattern detect” Default: Enabled. If disabled, then the contours found by the “360° pattern detect” tool are NOT displayed in the reference image. – Max. number of images per inspection Default: 19. Minimum: 19; Maximum: 100. This setting specifies how many images maximum can be stored in one inspection file..
Language	Set display language for the user interface.
Save images on PC	If “Save images” is enabled in INSPECTION SETTINGS, then in Run mode (if Show images is enabled) an image is always saved on the PC when one is also saved on the sensor. **Example:** In the current inspection the following is selected under “Save images”: If inspect. defective. Now an image is always saved in the specified directory when the inspection finds a defect. After reaching the maximum number of images the first image is overwritten (ring memory).

Help



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Function	Shortcut	Description
Contents		Opens the operating manual in Acrobat Reader
About		Displays information about the software version and the connected sensor.

12.2.2 Toolbar

The toolbar provides quick access to the main software functions. Each symbol stands for a function; to activate a function, left-click on the corresponding symbol.

The toolbar is divided into various sections.

Functions associated with the “File” menu

Symbols	Function (from left to right)	Description
	New inspection	Creating a new inspection.
	Load inspection	Loading an inspection either from the PC or from the sensor.
	Save inspection	Saving the current inspection either on the PC or on the sensor.

Zoom In / Out

Symbols	Function (from left to right)	Description
	Zoom In	The current image is displayed in 2x zoom. You can click "Zoom in" multiple times.
	Zoom Out	The current image is displayed in reduced size

Note
The current zoom setting is retained in Live mode (Step 1) and in Test and “Apply” mode in Step 3. It is not possible to change the zoom factor live.

Frame buffer

Symbols	Function (from left to right)	Description
	Previous image	Displays the previous image in the working area.
	Next image	Displays the next image in the working area.
	Insert image	Inserts an image file in the frame buffer.
	Delete image	Deletes the current image from the frame buffer.

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Connect and search for sensor

Symbols	Function	Description
	Sensor	Searches for sensors or connects to a sensor.

Save screenshot and image

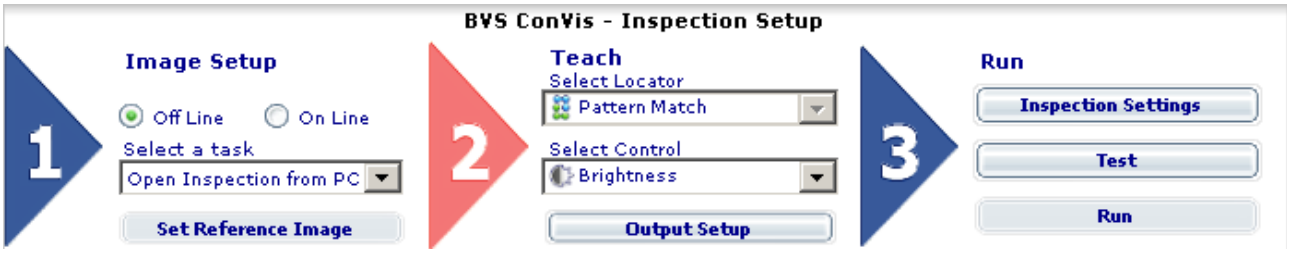
Symbols	Function (from left to right)	Description
	Screenshot	Saves a screen shot of the BVS ConVis software.
	Save image	The image currently displayed in the working area is saved.

Help

Symbol	Function	Description
	Help	Opens online help.

12.2.3 Setup field

Each step is indicated by a number; the currently active step is highlighted in **LIGHT RED**, inactive steps are shown in **BLUE** or **GRAY**.



Step 1: Connect - Select image settings
Step 2: Parameterize tools and outputs
Step 3: Test and apply

Note
You can return to an earlier step by clicking on the triangle with the corresponding number. The selected step is then highlighted. To skip forward again: To go from Step 1 to Step 2, you must click on the “Set reference image” button. To go from Step 2 to Step 3, you must apply at least one “Tool” to the current inspection.

12.2.4 Control panel

Depending on which step you are in, different parameter dialog boxes are shown in the control panel. For example, in Step 1 the list with the found sensors is shown along with the parameters for the Locator tool or the output configuration.
After first starting the software the operating field is empty. The various functions of the control panel are described in detail in the sections: Setting up an inspection, Basic settings, Locator tool, Tools, Setting outputs, Testing and applying.

12.2.5 Frame buffer

The frame buffer shows thumbnails of the last 20 images recorded by the sensor and loaded from the PC.

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As soon as the images are loaded, their thumbnails appear in the frame buffer. The image current shown in the “Image display” field is highlighted by a red border. Simply clicking on the corresponding thumbnail or using the arrows in the toolbar allows you to change to another image.

The “Insert image” and “Delete image” (Section 3 of the toolbar, see Section 12.2.2) allows you to add images or delete images from the frame buffer if no images are currently being recorded.

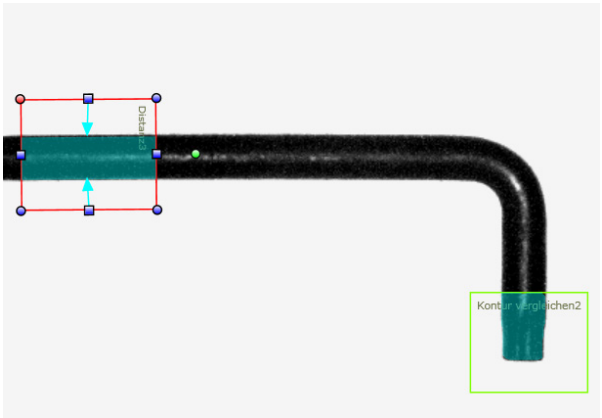
The frame buffer also shows thumbnails while the sensor is connected to the PC and is recording images (so-called Live mode).

Note
After opening an inspection from the sensor, the images stored in the sensor are loaded to the frame buffer and displayed. Depending on the mode selected for saving images in “Inspection settings”, these will be Good or Defect images.

12.2.6 Image display / working area

The “Image display” shows images. Depending on the mode, this will be the reference image, the image currently being recorded by the sensor, or an image selected from the frame buffer.

In Step 2 and Step 3, "Image display" also shows the names and ROIs of all the tools used in the inspection. Shown are tools which return an OK result (green border); and tools which return a NOK (red border).



12.2.7 Inspection Explorer

The Inspection Explorer shows
- Sensor settings
- Trigger parameters
- Operating parameters for the light, both internal and external
- The parameters for the tools used in the current inspection.

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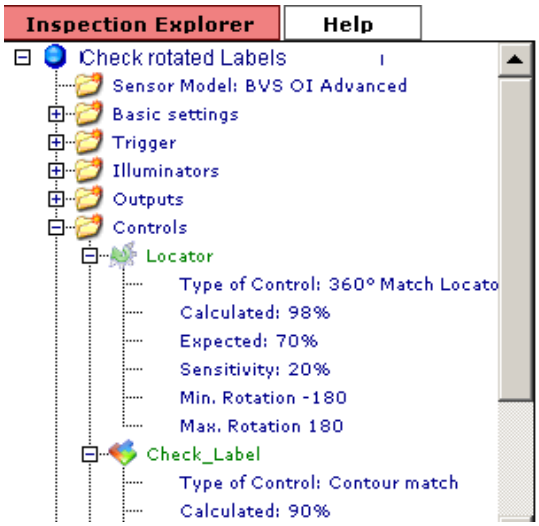
These are displayed in a file structure.
To expand a file structure and display more detailed information, click on the ⊞ symbol next to the respective name. To reduce a display level, click on the ⊟ symbol.



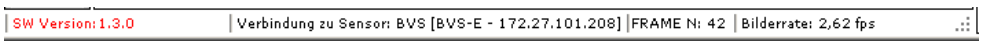
12.2.8 Help field

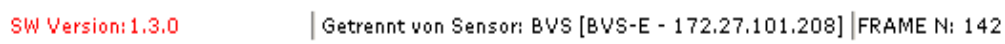
The Help field shows online help. The information displayed in Help changes with the displayed steps or tools.
Under Help you can find information on the following topics:
– Introduction and opening a connection
– Setting up an inspection
– Sensor basic settings
– Trigger parameters
– Using and setting parameters for inspections
– Tools and their parameters

Help appears in the form of a list of questions; simply click on the ? symbol in front of the respective question to view the answer.
Click on “Show all” to expand all the answers, and “Hide all” to reduce all the answers.

12.2.9 Status bar

The status bar provides a quick overview of the status of BVS ConVis and the sensor.
It shows:
– The current connection status
– IP address and name of the sensor





12.2.10 Sensor settings

After clicking on “Sensor settings” the software opens this window:
6 tabs can be seen in the window above:
1. Network settings
2. Inspection memory
3. Update firmware
4. Inspection change
5. RS232 settings-1
6. RS232 settings-2

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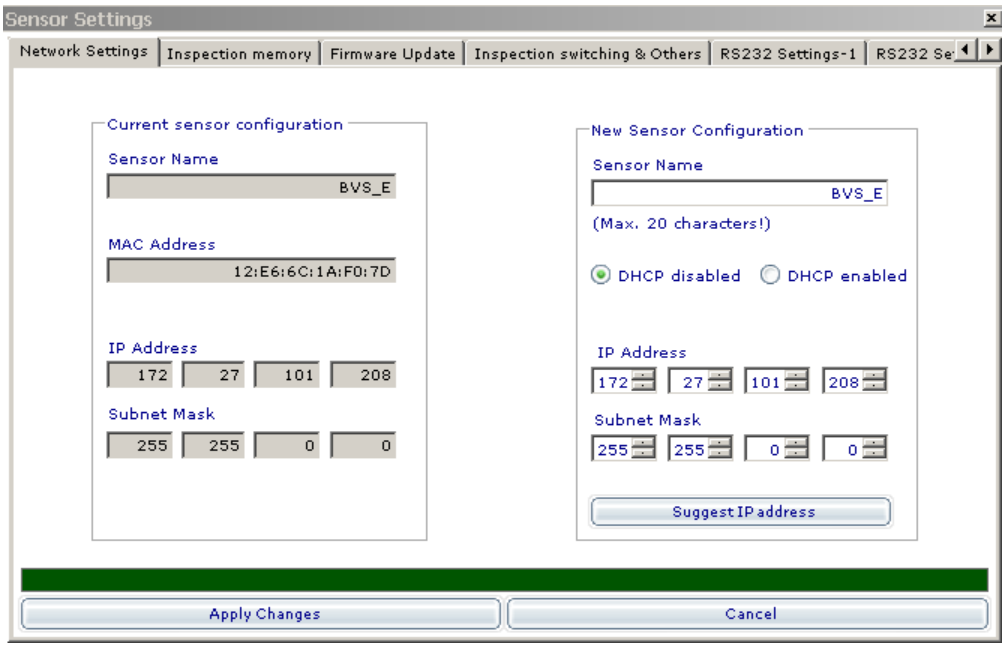
Network settings



On the “Network settings” tab you can see at left (gray shading) the current sensor settings. The parameters in the white background can be used to change the following sensor parameters.

Parameter	Description
Sensor name	Changing the sensor name. A maximum of 20 characters is allowed. For example you can include the location of the inspection in the sensor name. This makes it easier to associate the sensors later.
DHCP disabled/ enabled	A detailed description of this parameter and DHCP in general can be found in the Section “Sensor in network with DHCP server”.
IP address, subnet mask	A detailed description of the IP address and subnet parameters can be found in the section "Changing static sensor IP address".
Suggest IP address	After clicking the button the software shows you a suggestion for the sensor IP address. Please check whether this IP address is already assigned and is compatible with the set PC address.

Inspection memory

After clicking on “Inspection buffer” you are shown an overview of the slots available on the sensor for inspections.

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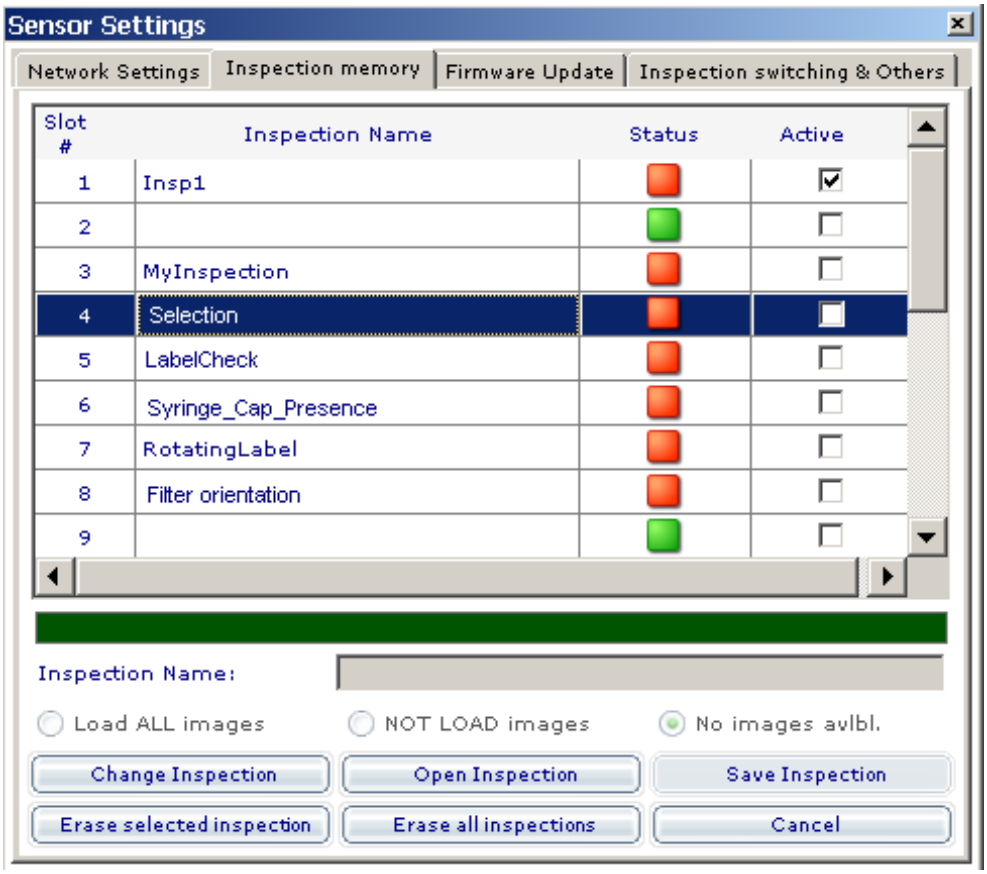

Each inspection has a unique identification number (slot number) and a name. A GREEN square is shown in the Status column if the slot is empty, and a RED square if the location is occupied. The ACTIVE column shows the currently active inspection indicated by a check mark. The active inspection is the one which the sensor will run after disconnecting the sensor from the software.

Note
To select an inspection, click on the slot number or the inspection name. The list entry is then highlighted in blue. In the illustration above for example Inspection 6 is selected.

The buttons below have the following functions:

Parameter	Description
Activate inspection	The selected inspection is activated
Load inspection	The selected inspection is loaded from the sensor to the software where it can be tested or adjusted.
Save inspection	Only active if you are using the "Save inspection on sensor" or "Apply" in Step 3 is being used to automatically save the inspection. The inspection is saved in the selected slot number.
Delete selected inspection	The selected inspection is permanently deleted. **CAUTION:** There is no security prompt!
Delete all inspections	All inspections are permanently deleted from the sensor. **CAUTION:** There is no security prompt!
Cancel	Closes the windo

Update firmware For additional information see Section “12.5 Updating the sensor firmware”.

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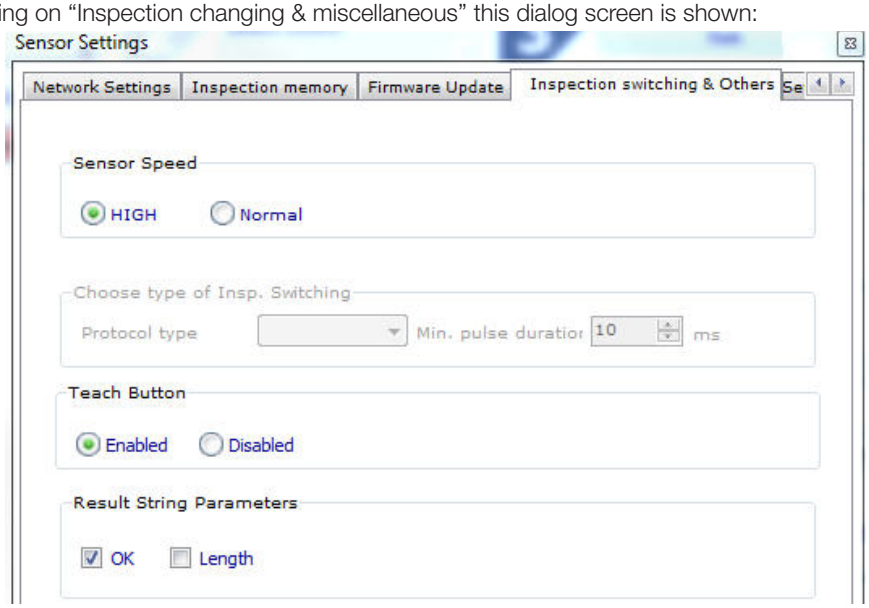
Inspection changing and miscellaneous

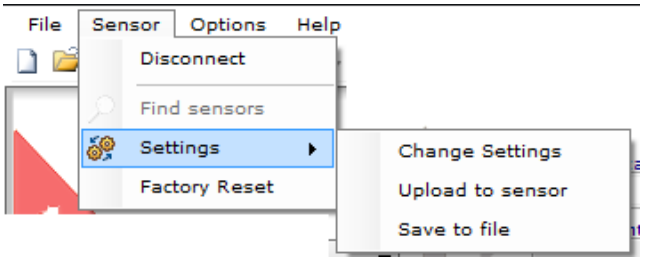
After clicking on “Inspection changing & miscellaneous” this dialog screen is shown:



You can make the following settings:

Parameter	Description
Sensor speed HIGH / Normal	For Advanced model only! Default: Normal. After switching to High the higher cycle speed is turned on. This significantly reduces the cycle times for the inspection.
Teach Button	With these settings, you can disable or enable teaching a new part via the teach button.
Result String Parameter	Those settings allow selecting whether the "OK" tag and/or the byte length are going to be transmitted in the result string or not. The default is, that the "OK" tag and the byte length are transmitted. More information can be found in Section 9.1

12.2.11 Upload and save sensor settings



With "**Change Settings**" you can change the current sensor settings
With "**Upload to sensor**" you can upload previously saved sensor settings from PC to your sensor. Please note that you can only upload sensor parameters to a sensor of the same type e.g. from a BVS Ident to a BVS Ident.
With "**Save to PC**" you can save the current sensor parameters to a PC; the file extension is “.dno”. These settings will be saved to the file:

- Sensor name
- Sensor type
- Firmware version of the sensor
- IP address
- Sub net mask
- DHCP modus and
- RS232 & Ethernet interface settings

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12.3 Connecting the sensor to the software

Note
Up to and including firmware version ST 2.4.0.xx it was necessary to reboot the sensor after the IP address or other sensor settings have been changed. Any sensor with firmware ST 2.5.0.xxwill automatically restart after a change was made.For any sensor with older firmware version, you need to folllow this description:

Definition
For “New sensor start” the procedure is described as follows:
1. Close (if open) connection between software and sensor.
2. Power down the sensor (do not disconnect the cable).
3. Power up the sensor.

12.3.1 PC-Sensor direct connection

Prerequisite
– BVS ConVis installed on the PC.
– Directly connect PC to sensor (see Fig. 3-8)
– Windows network connection established (see Section 3.4).

To create a connection between the sensor and the BVS ConVis software, please follow these instructions:
- ► Connect sensor to power (connector PWR IO Pin 2: 24 V DC; Pin 7: 0 V).
- ► Unplug all existing Ethernet cables from your PC.
- ► Plug the TO PC connector into the Ethernet 10/100 terminal on your PC using a crossed Ethernet cable.
- ► Start the BVS ConVis software.
- ► To configure the sensor using the software, you must click on “Find sensors” in the “Select connection mode” window. After a short wait time the software will display the found sensors in the so-called control panel (upper right).
- ► Click on the “Connect” button. The software reports "Connected to BVS”.
  ⇨ You have successfully established communication and may now configure the sensor.

12.3.2 Sensor in a network with DHCP server

Definition

Dynamic Host Configuration Protocol (DHCP) allows you to assign a network configuration to network devices from a server. DHCP allows network devices which are connected to an existing network to be automatically configured.

Note
DHCP protocol is only available in firmware version ST 2.21A or higher. Sensors having older firmware require a firmware update. To do this, connect the sensor directly to the PC (see above) and then read the sections "3.4 Setting up Windows network communication Sensor ↔ PC" and "12.5 Updating the sensor firmware".

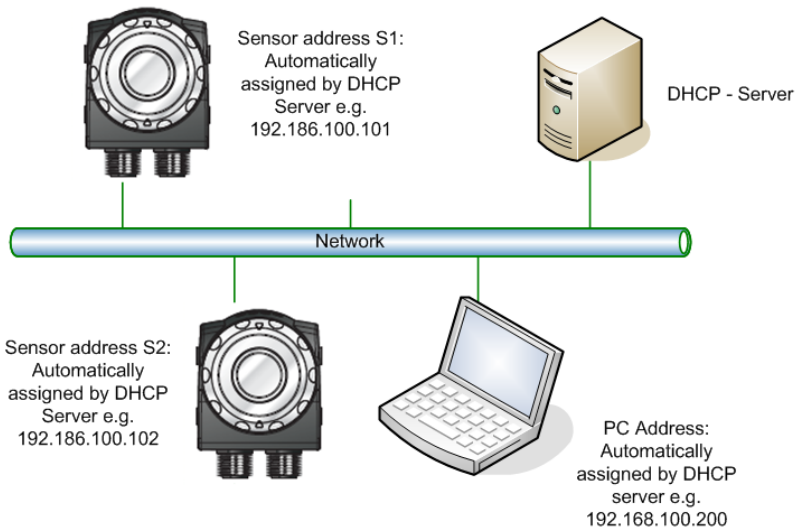

Fig. 12-2: DHCP connection of the sensor

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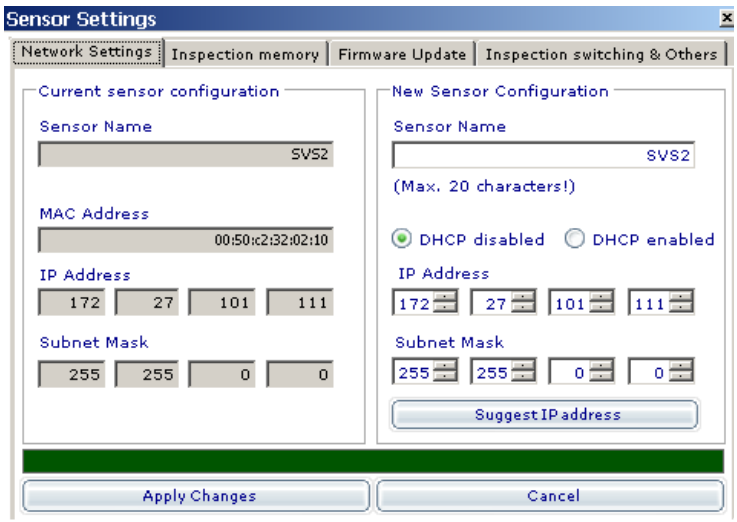
To incorporate multiple sensors into a network with DHCP protocol, initial startup for each sensor must be carried out as described in Section 3 and “DHCP protocol” must be enabled in the sensor settings.
To do this proceed as follows:

► After you have made a connection between software and sensor, click on menu item "Sensor" and then select "Settings".



► Then select “Enable DHCP” and close the window.
► Now click on offline.
► Disconnect the network plug from the PC.
► Then connect the TO PC connector to an RJ-45 network socket (e.g. using the BCC M415-E834-AG-672- ES64N8-050 cable).

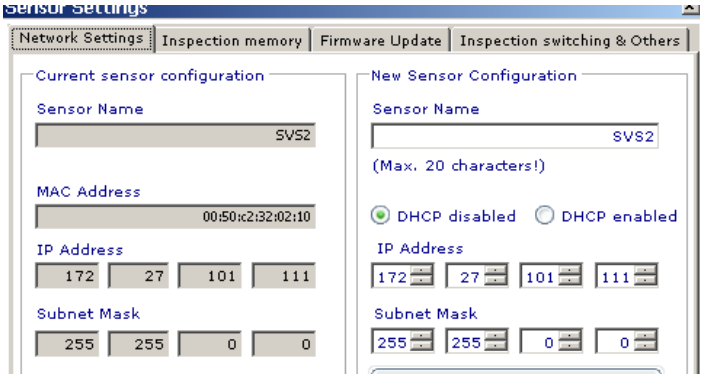
After the restart the sensor waits for 3 minutes for instructions to configure using the DHCP server (LED2 flashes). As soon as a network address has been assigned, LED2 turns off. If after 30 seconds no network address has been assigned, the sensor uses the preset IP address (Default: 172.27.101.208).

► Connect your PC to the DHCP network. As soon as a connection is opened, you can use “Find sensor” to make a connection between sensor and software.

12.3.3 Changing the static sensor IP address

The factory setting for all BVS sensors is: 172.27.101.208. You can however use the ConVis software to assign each BVS sensor its own static IP address. The static IP address is used if DHCP protocol is not enabled or the sensor has not received a network address via DHCP within 3 minutes after power-up.
To change the IP address of a sensor, follow these instructions:

► Connect your PC to the sensor as described in the previous section.
► In the menu bar select “Sensor”.
► Then select “Network settings”.
⇨ ConVis opens the "Sensor settings" window:



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► On the right side you can change the sensor name, the IP address and the subnet mask.

Note
If the following information for changing the IP address is not followed, it will not be possible to establish a connection between the sensor and the PC.

– The “Name” field has a maximum length of 20 characters.
– The new IP address MUST be different from the IP address of your PC!
– The new IP address or subnet mask MAY NOT be 0.0.0.0.
– The new IP address may not begin with 127 (e.g. 127.0.0.1). These IP addresses are reserved for internal PC communication.

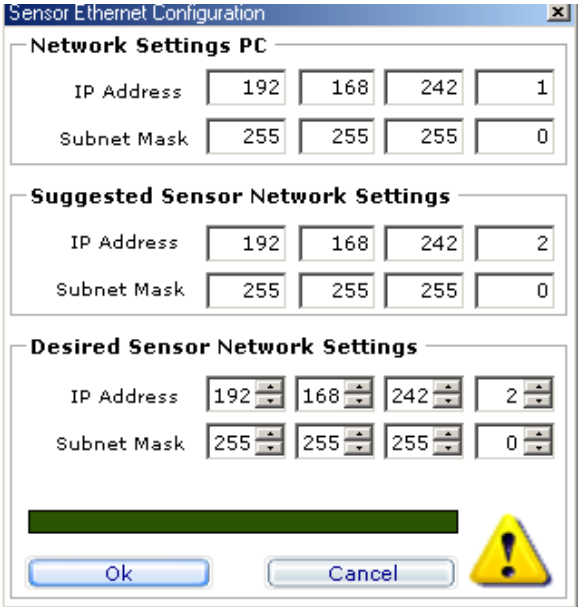
► Click on “Save changes” to save the new settings in the sensor.

Attention!
The new settings do not become active **until the sensor has been restarted**. Until then the old settings continue to be used. Restart happens automatically in case sensor firmware is ST 2.5.0.0 or higher.

There is another way of changing the sensor IP address:
Prerequisite: There is no connection between the sensor and the PC.

► In Step 1 of the software click on “Online”.
► Then select “Find sensor”. BVS ConVis searches for all connected sensors and displays them in the list at upper right.
► Select the list entry of the sensor whose IP address you want to change.
► The click on “Configuration.

This window appears:



Above is the current address of the PC. In the center is a SUGGESTION for the setting. Below you will find the entry fields for making the setting (use only the arrow buttons, numerical entries and mouse scrolling).
After clicking on OK the IP address is sent to the sensor and saved there.

Note
The new IP address does not become effective until after the next sensor restart. Restart happens automatically in case sensor firmware is ST 2.5.0.0 or higher

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12.3.4 Fault elimination

"Find sensors" is a search function which automatically finds and localizes any sensors in the network and displays their IP addresses and subnet mask information.
In the following are solutions for the most frequent errors:

"Find sensors"

No sensors found in the network
Use the "Sequence diagram for structured troubleshooting and connection problems between BVS-E and PC" in the Appendix.
The IP address of the sensor is highlighted in RED.
"Find sensors" is a search function which finds all the sensors in a network. After the search, each sensor is checked individually to see whether a connection between the software and the PC is possible - and if not, the software displays the IP address of the sensor highlighted in **RED**.

This error may have the following causes:
- Sensor is already connected to a BVS ConVis software.
  This can occur if the sensor connected to a network which is accessible by multiple users. When one of the users connects to the sensor, this sensor will appear highlighted in red to all other users.
- The IP address of the sensor is not compatible with the network address of the PC, e.g. when there is a direct connection between the sensor and the PC. Please proceed as described in the section "Setup Windows network communication between sensor and PC".
- The sensor IP address was changed but the sensor not yet restarted
- If the software and sensor are disconnected after changing the IP address and then "Find sensor" is used to open a connection without first restarting the sensor, the IP address of the sensor will be shown highlighted in red.
  Proceed as follows
  - ► Close the connection between sensor and software.
  - ► Restart the sensor and wait for a short time.
  - ► Find the sensor again.

12.4 Updating the software

Each sensor is shipped with the newest available BVS ConVis software.
If you want to update your ConVis software, please simply follow these steps:

- ► Please contact your Balluff sales man and order the update DVD.
- ► After you have received the new software you have to first uninstall the old software using the Microsoft Windows software function:
- ► Click on the Windows "Start" button.
- ► Control panel → Add or remove programs → Select software.
- ► Select BVS ConVis from the list of installed programs and click on the "Remove" button on the right side of the screen.
  - ⇨ Windows will now uninstall the BVS ConVis software.
- ► Install version 1.3 as described in Section 4.1.2.

12.5 Updating the sensor firmware

Each BVS sensor is shipped with the most current firmware. The firmware version in the sensor works reliably only with the BVS-ConVis version contained on the accompanying DVD.

Whether the sensor firmware is compatible with the respective BVS-ConVis software is checked by the software when opening a connection to the sensor. If the software is older than the firmware in the sensor, you receive the following message:
"Unknown firmware, a connection could not be opened to the sensor."

If the firmware is older than the software, then the following message appears:
"Please update the sensor firmware. Otherwise correct sensor function cannot be guaranteed!"
In this case proceed as follows:
- ► Use the following table to check whether you can perform an update with Version 1.5:

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Firmware in sensor	Current firmware
	ST2.4.0.XX
ST2.2.1.XX	Can not be updated Please contact our Service department.
ST2.3.0.XX	The sensor can only be updated if the serial number is higher than 1101001 or B11A0001 e.g. 1139042 or B11C00034. 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor needs to be restarted after the update.
ST2.4.0.XX	The sensor should only be updated if the inspection in the PC is NEWER than the version on the sensor. The following actions are carried out: 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor needs to be restarted after the update. **4. BVS Ident and BVS Advanced Sensors:** In the new version the image saving conditions of each inspection can be set via the logic conditions. It is important to setup the right saving conditions for all inspections after updating the sensor to Firmware ST 2.4.x.y as the old Conditions like ALL; ONLY GOOD; ONLY BAD are not maintained anymore. **5. BVS Ident only:** Be sure to check the RS232 Communication mode setting (Synchronous, Asynchronous) in the Sensor Settings Menu after the update as there is only one setting for the whole sensor anymore.
ST2.5.0.XX	The sensor should only be updated if the inspection in the PC is NEWER than the version on the sensor,or if you need new functions or a bugfix provided with this version. The following actions are carried out: 1. All sensor inspections are saved to PC. 2. Firmware update 3. The sensor automatically restarts after the update!

General update sequence

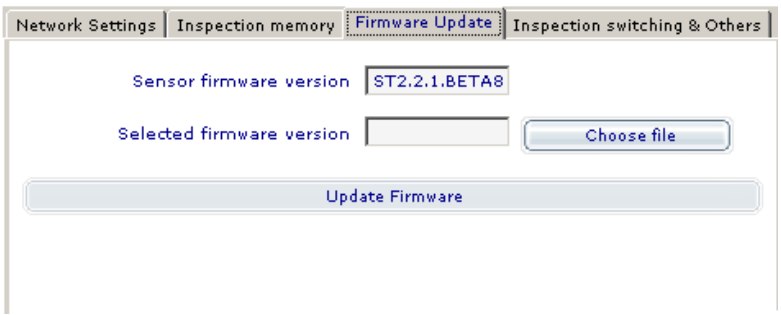
Close the dialog with the message that the sensor firmware is out of date.

- ► Select the “Settings” entry from the Sensor menu.
  - ⇨ The Sensor Settings dialog box opens.
- ► Click on the “Update firmware” tab.
  - ⇨ The firmware version currently available on the sensor is shown in the field: “Sensor firmware version”.
- ► Now click on the “Select firmware” button.
  - ⇨ The software opens a file dialog box and shows you the folder with firmware files (file extension .sfw2).
- ► Select the file having the highest version number.

Example

Example: Assuming these two files are available: ST_2.3.1.01.sfw2 and ST_2.3.2.03.sfw2. In this case select ST_2.3.2.03.sfw2.

- ► Now click on the “Update firmware” button.



The BVS ConVis software now updates the sensor and displays the progress; after successful updating of the firmware a message appears.

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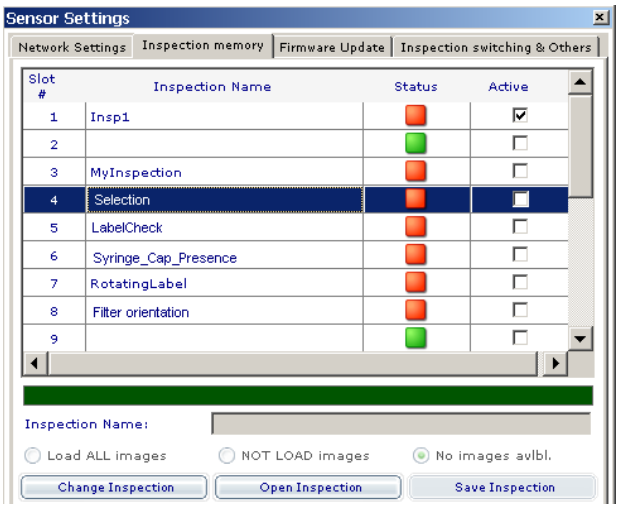
12.6 Replacing sensors

If you need to replace an already installed BVS with a new BVS, please follow the instructions below and carry out the steps in the given order:

1. If possible, connect to the device you wish to replace. Please note that this stops any ongoing inspection. After connecting, all BVS outputs are disabled.
2. Load the current inspection from the sensor to the PC. Click on STEP 1. Place one of the inspection parts in the image field on which the sensor is currently focused and make a live image. This is the prerequisite for aligning the replacement sensor.
3. Save all the inspections on the sensor to the PC by loading them one by one from the sensor and then saving them on the PC. Note which inspection is currently active (this is indicated in the list of available inspections on the sensor by a check mark).



4. Note the firmware version of the sensor ("Help g Info" menu).
5. Close the connection between sensor and PC.
6. Remove the “old” sensor. First unplug the PWR IO connector, then the TO PC connector; then remove the mounting screws.
7. Install the “new” sensor. First attach the sensor. Then first plug in the TO PC connector, then the PWR IO connector.
8. Open a connection between sensor and PC and go online.
9. Focus the new sensor on the part located in the part located in the image (from step 2.).
10. Load all inspections from the PC to the sensor. Keep the same order as they were stored on the old sensor.
11. Activate the last active inspection.
12. Test the inspection online. Note whether the inspection is correctly carried out. If not, please adjust the inspection parameters (especially the Brightness parameter in Step 1) until the inspection runs reliably.

12.7 Recovery mode

The BVS sensors permit opening of a special Recovery mode.

Attention!
Please use Recovery only if the sensor does not function and you are unable to open communication between the BVS ConVis software and the sensor.

Attention!
Recovery mode is intended only for error remediation. The sensor is not permitted to control machines when in Recovery mode.

12.7.1 Starting Recovery mode

To open Recovery mode, please follow these instructions:

- ► Disconnect the sensor from power (if connected).
- ► Press the Recovery/Teach button on the top side of the sensor before you connect the sensor to the power supply, and hold it down until the output LEDs on the sensor begin to flash.
  - ⇨ The sensor will now run in Recovery mode.

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- ► Now connect the sensor to the BVS ConVis software as described in Section 12.3.1.
- ► Select “Online” and then “Open inspection from BVS”.
- ► Now select the active inspection (the one whose check box in the last column is checked) and then click on “Load inspection".

12.7.2 Fault elimination on the sensor

- ► Save the inspection on the PC. Click on "File → Save → Save on PC".
- ► Now click on the Inspection Explorer and note the sensor model for the connected sensor: BVS OI Standard or BVS OI Advanced.
- ► Now load (“File → Load → Load from PC”) the following inspection from the PC:
  Sensor model BVS OI Standard: **BVS-E_RESCUE_Standard.bvs5,**
  Sensormodel BVS OI Advanced: **BVS-E_RESCUE_Advanced.bvs5**
  Sensormodel BVS ID: **BVS-E_RESCUE_Identification.bvs5**
  Sensormodel BVS UR: **BVS-E_RESCUE_Universal.bvs5**
- ► Now save this inspection on the sensor in the slot where the currently activated inspection is stored: “File → Save → Save on sensor”.
  ⇨ The activated inspection is now checked.
- ► Double-click on the line with the check.
  ⇨ Slot is highlighted in dark blue.
- ► Now click on “Save inspection”.
- ► Click on “Offline”.
- ► Restart the sensor WITHOUT pressing the Recovery/Teach button.
- ► Check the following functions:
  - The two yellow LEDs on the sensor flash, the sensor records images.
  - You are able to open a connection between the sensor and the BVS ConVis software.
  - If you cannot open a connection between the sensor and BVS ConVis, please contact our Service department. The contact address can be found on the last page..
- ► Please provide us with the defective inspection which you stored on the PC.

Please send the inspection file via e-mail to the following addresses:
In America: applications@balluff.com
In Europe: service@balluff.de
re: Defective inspection

If the problem cannot be remedied by these means, or if you are unable to connect to the sensor even in Recovery mode, then please contact our Service department.

Resetting the sensor to factory defaults

From Version 1.4 onwards BVS ConVis allows resetting a sensor to its factory default settings. This deletes all inspections and tools from the sensor. The IP number and subnet mask are restored to the factory setting, and a standard inspection is stored in a memory slot.

- ► Please connect to the sensor,
- ► Select menu Sensor → Factory Reset.
- ► If you press now OK on that window the sensor will be reset

12.8 BVS-Monitor and ConVis

Using the ConVis software you can create a backup copy of the inspections saved on the BVS Monitor or store new inspections on the monitor. In addition you can use ConVis to update the Monitor firmware.

12.8.1 Connecting ConVis to the Monitor

Connect the Monitor to the PC (use accessory cable BCC M415-E834-AG-672- ES64N8-050, network settings same as connecting to the sensor).
Start the software in the PC and then select Find Sensors. Connect to the displayed Monitor (Default IP: 172.27.101.207; Name: VSM).
The window is then opened:

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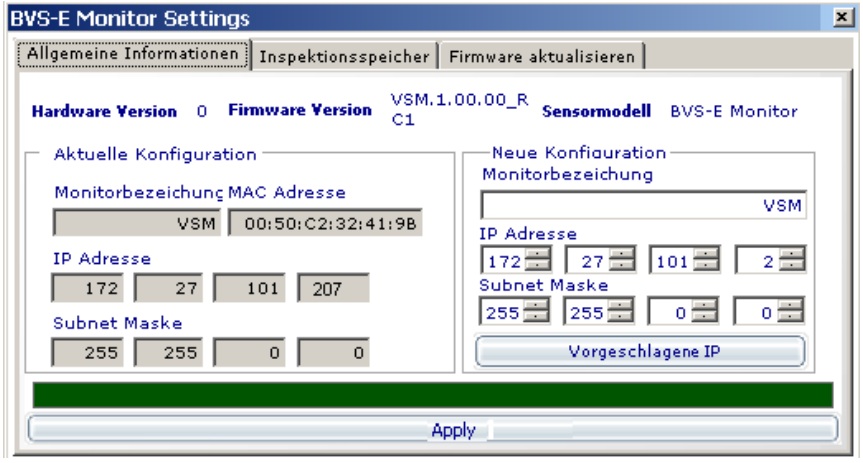

Using the General Information tab you can assign a different station name or another network setting to the Monitor.

12.8.2 Creating backup copies of the inspections

Copy inspections from the Monitor to the PC or vice-versa, or delete inspections from the sensor from the Inspection Memory tab.

Right-click in the inspection list: Option Select/deselect all.

12.8.3 Updating firmware

Select the Update firmware tab.
Now find the firmware you want to update using the Monitor

Note
The file name of the Monitor firmware must always begin with VSM.

Updating of the Monitor firmware begins after clicking on the button. **UNDER NO CIRCUMSTANCES** should power be interrupted during the updating process.
Restart the Monitor after the update has been successfully finished.

13 Periodic Maintenance

Other than cleaning the front surfaces protecting the optics, BVS sensors require only minimal maintenance.

A full maintenance of the system includes:
– Removing dust and foreign bodies from the sensor housing and optics regularly, at least every two months.
– Updating the configuration software to the latest version.

While the sensor is being serviced its results are not reliable, and it should not be used during this time.

Please use only a clean, soft cloth to remove dust from the lens cover. If necessary, dampen the cloth with a mild, non-abrasive cleaning solution.

Use care when cleaning the sensor – do not change its current alignment.

NEVER use the following substances to clean the sensor and the lens cover:
– Alcohol-based cleaners or solvents;
– Wool or synthetic cloths.

Inspection and maintenance intervals may be longer or shorter depending on the application, amount of particulates in the air, and operating conditions.

14 Legal Notes

14.1 Copyright notice

14.2 Purpose of the Operating Manual

This operating manual contains operating instructions and technical documentation for BVS-E Vision Sensors and BVS Configuration and Visualization software ConVis, a software product produced by Balluff GmbH.
All specifications and instructions in this operator's manual, especially the Safety Notes section, must be strictly observed.
This operator's manual must be carefully stored so that it is always available.
The information and illustrations in this operating manual were carefully checked to the best of our ability. Nevertheless, Balluff GmbH cannot assume any liability for the correctness and completeness of this information, since in spite of all due care errors and mistakes cannot be completely avoided. In particular this information and the illustrations do not constitute agreements as to condition according to § 434 of the German Civil Code or guarantees according to § 443 of the GCC.
The information in this manual is based on current knowledge and experience of Balluff GmbH. Due to the great number of possible influences when using the BVS-E Vision Sensors, this does not free the user of his obligation to perform his own testing and experimentation.
No legally binding assurance of certain properties or suitability for a specific purpose can be derived from the information in this operating manual.
It is the user's responsibility to observe any property rights and provisions.

14.3 Legal terms and conditions

All deliveries of products and all other services of Balluff GmbH are subject solely to the current General Terms and Conditions of Balluff GmbH (in the following abbreviated "AGB") and the specifications in this operating manual.
Provision of the software is subject solely to the current AGB, the terms in this operating manual as well as the terms of the "Balluff End-User Agreement". You may use the software only in agreement with these terms and conditions.
If you do not already have them, Balluff GmbH will gladly provide you with a copy of the current AGB upon request. The current AGB are also available for downloading from the website of Balluff GmbH at:
http://www.balluff.com/Balluff/de/FooterChannel/en-gb/General%20Terms%20and%20Conditions
The current form of the "Balluff End-User License Agreement" can be found in the Appendix to this operating manual or in the installation directory of the BVS software as file BLF_EULA-BVSConVis1-5_yymm_EN (yy: year e.g. 14; mm: month e.g. 01).
The BVS ConVis software may be installed only on systems which meet the conditions described in Section "4.1.1 Minimum system requirement". Installation on any other system is prohibited.
You may install and operate the BVS ConVis software on a maximum of **TWO** systems per **ONE** purchased sensor.
The BVS ConVis software may be used only together with Balluff Vision Sensors (BVS) type BVS-E. Operation of BVS ConVis **WITHOUT** a connected BVS-E is only permitted if you have purchased at least one BVS-E sensor of Balluff GmbH and are using the software for processing a new inspection or improving an existing inspection.

14.4 3rd party software

The BVS ConVis 1.5 software uses program packets of MICROSORT .NET FRAMEWORKS Version 3.5 or higher. These program packets are essential for operating the BVS ConVis software. Please allow these programs to be installed when prompted. The program packets are subject to the software terms and conditions and licensing provisions of Microsoft Corporation. You must agree to these conditions separately from the conditions which apply to the Balluff ConVis software.

14.5 Updates and upgrades

BALLUFF is entitled - but not obligated – to make updates or upgrades of the software available from the BALLUFF Web site or in any other form. In such a case BALLUFF is entitled - but not obligated – to inform you of updates or upgrades.
Making use of such upgrades or updates presumes that you accept the validity of any updated

14 Legal Notes

operating manual and the “Balluff End-User License Agreement”, the current AGB as well as the additional provisions in the operating manual.
If this operating manual is used together with software which contains a “Balluff End-User License Agreement", then the contractually agreed to license applies both to the software and to this operating manual.

14.6 Trademarks

The product, goods, company and technology names are trademarks of the respective companies. In particular: Microsoft®, Windows®, Windows XP®, .NET FRAMEWORK ® and Windows 7® are registered trademarks of Microsoft Corporation ; QR Code (R) is a registered trademark of Denso Wave Incorporated.

15 Glossary

15.1 Inspection times

The overall time required for an inspection depends on three factors:
– Exposure time
– Image acquisition time
– Execution time

Exposure time:
The exposure time is also referred to as the “shutter opening time.” The amount of light which reaches the image sensor is directly proportional to the exposure time and to the available light. The longer the exposure time, the greater the amount of light which reaches the image sensor, assuming the available light is constant.

To set the correct exposure time, please take these three factors into account:
– Speed of the parts to be inspected: Rapidly moving parts require shorter exposure times, since otherwise the images will be blurred.
– Parts count per second: This represents a limitation to the exposure time. When the number of parts per second is high, the required exposure time must be short, since otherwise the required number of parts cannot be achieved.
– Available light: The more light is available, the shorter the exposure time can be.

If the exposure time needs to be shortened, certain considerations can help to maintain the quality of the recorded images:
– Increasing the brightness of the inspection area
– Increasing the amplification, where amplification (ratio of input to output) refers to an increase in contrast.

Image acquisition time: The time required to record an image. After the image sensor is exposed, the image must be sent to the sensor’s memory. It takes approx. 30 ms to transmit an entire image. This time is reduced considerably if only a part of the overall image is recorded.

Execution time: The time required to process the recorded image. This depends on the operations used for the inspection and the tools employed.

15.2 Other terms

Working distance:
Minimum and maximum distance between the sensor lens and the object.

Focal length:
Distance from the lens to the point at which a collimated beam of light entering the lens is brought to a point at the digital image sensor.

Gray scale:
The gray value scale is used to link a brightness value of a pixel to a numerical value. For a gray value scale with 255 possible values (corresponds to 8 bits) black is assigned a value of 0 and white a value of 255.

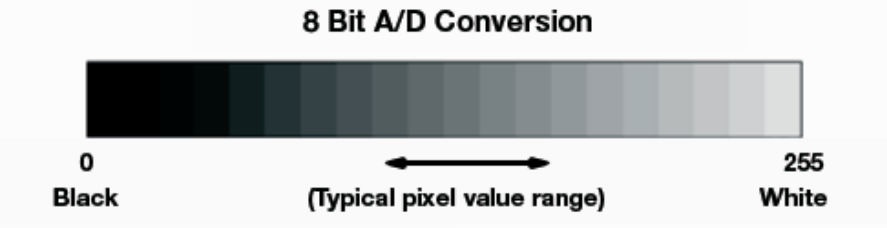

Fig. 12-1: Gray scale

15 Glossary

Inspection:
An inspection consists of a reference image and the tools you use to distinguish certain features on an object. If all the features meet certain parameters set when the inspection was created, the result of the inspection is OK; otherwise it is NOK.

Inspection result:
Possible results are: OK, if all the tools in the inspection return a positive result. NOK, if at least one tool returns a negative result or if one or more tools are not processed because the Locator tool returns an NOK result.

IP address:
The IP address is a unique address which identifies a network device. It functions similar to a telephone number. Just as you need the telephone number of a person in order to call them, you can only communicate with the sensor if you know its IP address. The IP address consists of four numbers separated by decimal points. The default address of all BVS-E sensors is: 172.27.101.208

Contrast
Contrast is the brightness difference between two adjacent regions in the image. The correct illumination should maximize the contrast between a good and bad feature.

Locator tool:
A Locator tool can be used to compensate for changing part locations from image to image as long as the part does not leave the sensor field of view.
The locator tool “tracks” the part position within the field of view and aligns all other tools according to the current part location.
There can be only **ONE** locator tool in an inspection.

LED:
Light Emitting Diode, an electronic semiconductor element which sends out light. This light is relatively bundled and of high intensity.
When looking directly into the light source of the BVS you may experience momentary glare or experience minor irritation (e.g. green points).
The light source of the BVS-E sensors does conform to the Exempt Group of IEC 62471:2006-07 and therefore does not represent a "photobiological risk" for the eye. Still, do not look directly into the light source.
Reference image:
Stored reference image. The pattern (or contour) detected by the tools “Pattern detect”, “360 degree pattern detect” and “Contour detect” is defined by the pattern(s)/contour(s)/corner points contained in the ROI of the reference image. The reference image has no direct influence on any of the other tools; it serves then as a reference for the good or bad part to be detected.

"Region of Interest":
The ROI (Region of Interest) is the image area indicated by a frame and which is inspected by a tool. In case of the “Pattern detect” and “360 pattern detect” tools the searched for pattern is defined by the ROI; the image area on the other hand is defined by the search region.

Field of View:
The field of view is the area which the sensor is able to see at a given working distance. The following relationships are given: The field of view becomes greater with increasing working distance. The light intensity of the illuminated object falls with the square of the working distance.

Note
The increase in the field of view is determined by the focal length of the installed lens, see table for working distances in Section 13.2

Status:
Inspection result for a single inspection/measurement (status may be OK or NOK).

16 Technical Data

16.1 General Technical Data

16.1.1 List of available models

Model code **BVS OI– 3 –0XX– E**

Balluff Vision Sensor

Sensor/Function
OI = Object Detection
ID = Identification
UR = Universal

Resolution in pixels
3 = 640x480

Type
First position: 0 = Red light
1 = Infrared

Second position: 0 = Standard model
5 = Advanced model
9 = Special

Third position: 1 = 8mm lens; PNP switching outputs
2 = 8mm lens; NPN switching outputs
3 = 12mm lens; PNP switching outputs
4 = 12mm lens; NPN switching outputs
5 = 6mm lens; PNP switching outputs
6 = 6mm lens; NPN switching outputs
7 = 16mm lens; PNP switching outputs

Interface
E = Ethernet

Each sensor is marked on the back side with the model and ordering code as well as the serial number:

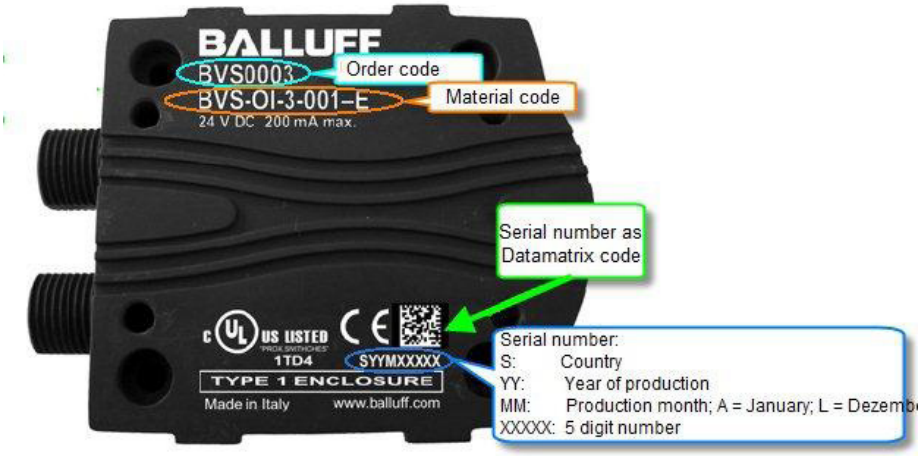

Fig. 16-1 Sensor type identification

16.1.2 Mechanical data

Housing material	Aluminum alloy / ABS
Dimensions (mm)	58 x 52 x 40
Connection type	M12 8-pin A-coded M12 4-pin D-coded
Optical surface	PMMA
Enclosure rating	IP54 (with connectors)

16 Technical Data

16.1.3 Dimensions

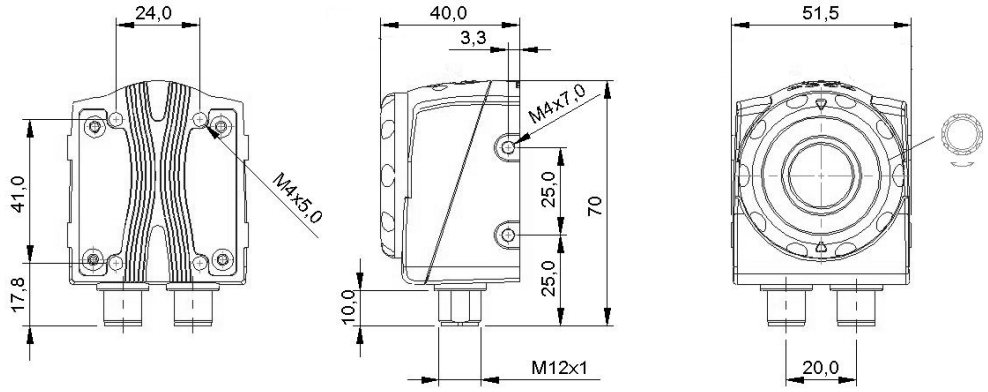

Fig. 16-2: BVS-E, dimensions (in mm)

16.1.4 Optical data

Image sensor	CMOS - black/white-VGA 640x480
Maximum optical resolution	depending on focal length. Maximum: 0,1 mm
Recommended working distance	50 – 300 mm, with corresponding auxiliary light up to 1000 mm
Light (Sensors with numbers 0xx)	Direct light, red, switchable Wavelength: 632 nm (sensors hardware version 4 and higher) 617 nm (sensors up to hardware version 4)
Light (Sensors with numbers 1xx)	Direct light, infrared, switchable Wavelength: 870 nm

Filter diagram of Infrared models

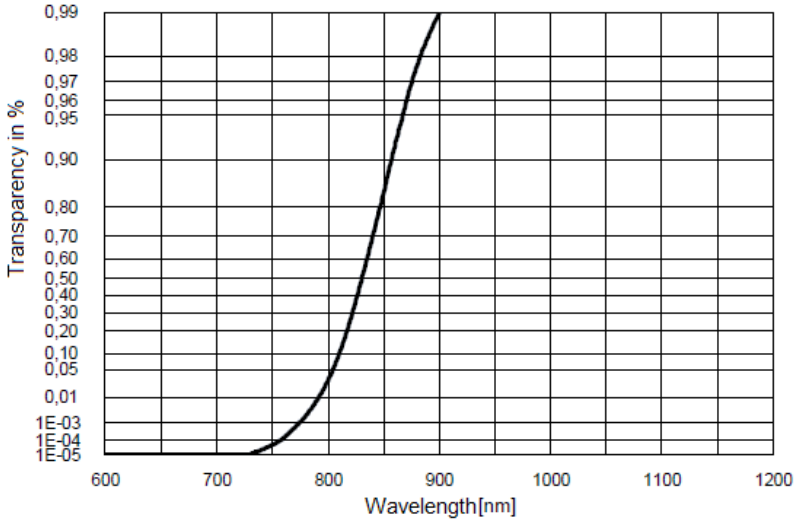

Fig. 16-3: Filter diagram of infrared models

16.1.5 Ambient data

Enclosure rating per	IP54
Reverse polarity protected	YES
Short circuit protected	YES
Operating temperature	-10° C … +55° C
Storage temperature	-25° C … +75° C

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16.1.6 Differences between the models

Function	Standard	Advanced	Ident	Universal
Selectable image resolution (640x480; 320x240; 160x120)	NO	YES	NO	YES
Locator 360 pattern detect	NO	YES	NO	YES
Logical operations	NO	YES	YES	YES
High cycle speed	NO	YES	NO	YES
Tools Object identification	YES	YES	NO	YES
Read Barcode & Datamatrix	NO	NO	YES	YES
Locators 360° Contour Match, Barcode & Datamatrix	NO	NO	NO	YES
360° Count Contours & 360° Defect finder	NO	NO	NO	YES
Outputs	3 + 1 optional	3+1 optional	2 +1 Optional	2 +1 optional
RS 232 Interface	NO	NO	YES	YES

16.2 Technical Data Standard and Advanced

16.2.1 Available models

Standard

Ordering code	Light colour	Lens	Model code	Material number
BVS0003	Red	8 mm	BVS OI- 3- 001-E	154518
BVS0004	Red	8 mm	BVS OI- 3- 002-E	154519
BVS0005	Red	12 mm	BVS OI- 3- 003-E	155392
BVS0006	Red	12 mm	BVS OI- 3- 004-E	155393
BVS000E	Red	6 mm	BVS OI- 3- 005-E	178118
BVS000C	Red	6 mm	BVS OI- 3- 006-E	178117
BVS0013	IR	6 mm	BVS OI-3-105-E	222221
BVS0012	IR	12 mm	BVS OI-3-103-E	222220
BVS0014	IR	8 mm	BVS OI-3-101-E	222222

Advanced

Ordering code	Light colour	Lens	Model code	Material number
BVS000J	Red	8 mm	BVS OI- 3- 051-E	179008
BVS000P	Red	8 mm	BVS OI- 3- 052-E	181542
BVS000K	Red	12 mm	BVS OI- 3- 053-E	179009
BVS000N	Red	12 mm	BVS OI- 3- 054-E	181540
BVS000L	Red	6 mm	BVS OI- 3- 055-E	179010
BVS000R	Red	6 mm	BVS OI- 3- 056-E	181544
BVS000W	Red	16 mm	BVS OI- 3- 057-E	212 295
BVS0015	IR	8 mm	BVS OI-3-151-E	222223
BVS0017	IR	12 mm	BVS OI-3-153-E	222225
BVS0016	IR	6 mm	BVS OI-3-155-E	222224
BVS0018	IR	16 mm	BVS OI-3-157-E	222226

16 Technical Data

16.2.2 Working distances and field of view

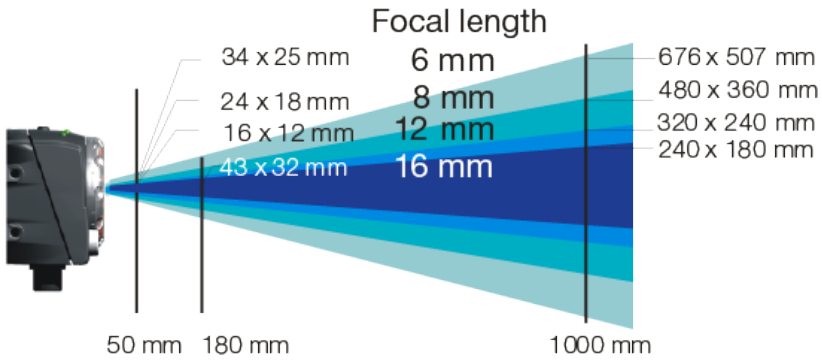


Fig. 16-4 Field of view for sensor models

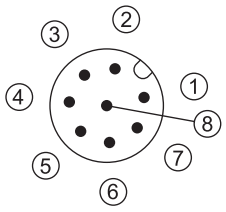
Working distances

Working distance (mm)	BVS-xx-3-0x5-E BVS-xx-3-0x6-E (6mm lens)	BVS-xx-3-0x1-E BVS-xx-3-0x2-E (8mm lens)	BVS-xx-3-0x3-E BVS-xx-3-0x4-E (12mm lens)	BVS-xx-3-0x7-E (16mm lens)
50	34x25	24×18	16x12	—
100	68x51	48x36	32x24	—
180	122x91	86x65	58x43	43x32
200	135x101	96x72	64x48	48x36
300	203x152	144x108	96x72	72 x54
400	270x203	192x144	128x96	96x72
500	338x253	240x180	160 x120	120x90
700	473x355	336x252	224x168	168x126
1000	676x507	480x360	320x240	240x180

Minimum distance of BVS yy-3-0x7-E: 180mm
Minimum distance of BVS yy-3-1x7-E: 230mm

16.2.3 Electrical connections

M12 8-pin: (power and I/O)



Pin	Wire colors BCC M418-0000	Function
1	White	Input Select
2	Brown	24 V DC
3	Green	Trigger output – External light **or** (serial number 0943xxx or higher only) Output 4
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	Output 3
7	Blue	Masse 0 V
8	Red	Trigger input

Connecting external lights

To use the sensor without integrating into the machine environment, connect Pin 2 of the PWR IO connector to 24 V DC and Pin 7 to ground.
If you want to use an external light with the BVS, connect it as follows:

- ► Connect the light to the supply voltage specified in its data sheet.
- ► If present, connect the external trigger input for the light to Pin 8 of the PWR IO connector.

Note
The external Trigger output on sensors with hardware version < 2.0 is a TTL output (LOW = 0V; HIGH = 5 V).
The external Trigger output on sensors with hardware version > 2.0 is a 24V output

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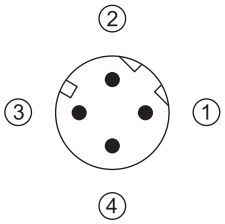
TO PC — Pin contact panel connector, 4-pin



Pin	Function
1	Rx+
2	Tx+
3	Rx-
4	Tx-

To set the sensor parameters, the TO PC connector must be connected to the Ethernet 10/100 terminal of a PC or to a network terminal. We recommend using the BCC M415-E834-AG-672-ES64N8-050 cable.

16.2.4 Electrical data

Operating voltage Us	24 V DC ±10 %
Ripple Upp	1 V max with light 2 V max without light
No-load current Io	max. 200 mA at 24 V DC
Switching outputs	3 x PNP- or NPN-Transistor; configurable
	1x Trigger- or switching output PNP (24 V)
Digital inputs	1x Trigger, 1x Select
Output current	max. 100 mA per output
Output saturation voltage	< 2 V
Output signal on output Ext. light trigger	Sensors with hardware version ≥ **2.0** **Trigger signal 0/24 V DC**
	Note: The hardware version of the sensors can be verified by software by clicking on INFO in the Help menu.
Parameter setting interface	1x M12 4-pin – Ethernet 10/100 Base T
Default settings	Sensor IP: 172.27.101.208 Subnet : 255.255.0.0
Ready delay	10 seconds

Features

Parameter setting	BVS ConVis for Windows XP and Windows 7
Typical detection rate [Hz] BVS Standard BVS Advanced	 3 - 15 (depending on processing function) 3 - 50 (depending on processing function)
Number of inspection slots:	20
Size of defect image buffer	10 images
Number of tools per inspection	max. 255. refer to notes in section 5.4.1

16 Technical Data

16.2.5 LED indicators

The BVS has four LEDs.

LED	Display	Function
LED 1	Green	Power on
LED 2	Orange	Output 1 indicator
LED 3	Orange	Output 2 indicator
LED 4	Green	Network connection

16.2.6 Hardware versions

Several various hardware versions of the BVS-E Standard and Advanced exist.
An overview of the differences between the versions can be found in the following table

Property	Sensor hardware version				
	Version 0	Version 1	Version 2	Version 3	Version 4
Trigger output	5 V TTL	5 V TTL	24 V DC	24 V DC	24 V DC
LED color, wavelength	Amber, 617 nm	Amber, 617 nm	Amber, 617 nm	Amber, 617 nm	Red, 633 nm
Output 4	NO	NO	YES; after update to ST 2.3.x or higher	YES, after update to ST 2.3.x or higher	YES
Power Mode with ConVis 1.3	NO	NO	NO	YES	YES
Focus lock	YES	NO	NO	NO	NO
First serial number	0741001	0907001	0943016	1016001	1046001(BVS ID only) 1103016 (other BVS-E types)
Pointer LED	YES	YES	YES	NO	NO

16.3 Technical Data Identification and Universal

16.3.1 Available models

Identification

Ordering code	Light colour	Lens	Model code	Material number
BVS0001	Red	8 mm	BVS ID- 3- 001-E	154520
BVS000T	Red	12 mm	BVS ID- 3- 003-E	186856
BVS000Y	Red	16 mm	BVS ID- 3- 007-E	212296
BVS001C	IR	8 mm	BVS ID- 3- 105-E	222229
BVS0019	IR	12 mm	BVS ID- 3- 101-E	222227
BVS001A	IR	6 mm	BVS ID- 3- 103-E	222228
BVS001E	IR	16 mm	BVS ID- 3- 107-E	222230

Universal

Ordering code	Light colour	Lens	Model code	Material number
BVS001M	Redt	8 mm	BVS UR-3-001-E	227224
BVS001N	Red	12 mm	BVS UR-3-003-E	227225
BVS001L	Red	6 mm	BVS UR-3-005-E	227223
BVS001P	Red	16 mm	BVS UR-3-007-E	227226
BVS001H	IR	8 mm	BVS UR-3-101-E	227220
BVS001J	IR	12 mm	BVS UR-3-103-E	227221
BVS001F	IR	6 mm	BVS UR-3-105-E	227219
BVS001K	IR	16 mm	BVS UR-3-107-E	227222

16 Technical Data

16.3.2 Working distances and field of view

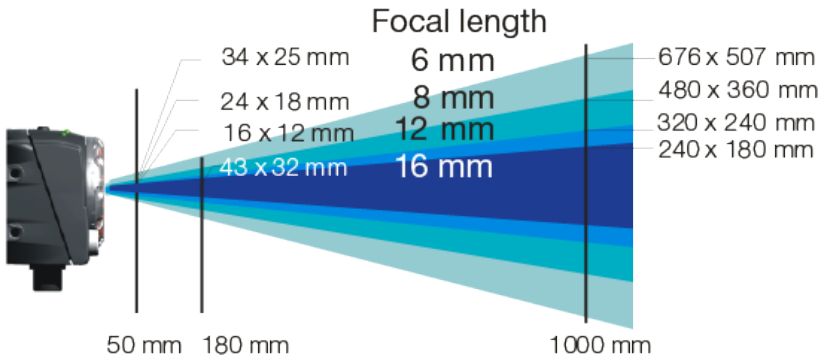


Fig. 16-5 Field of view for sensor models

Field of view sizes and minimum module size

Field of view sizes and minimum module sizes for barcode and DMC,
Field of view: Horizontal x Vertical, yy = ID or UR.

Typ BVS yy-3-xx5-E (6 mm)

Working distance (mm)	Field of view (mm)	Minimum module sizes (mm)	
		Barcode	DMC
50	34x 25	0,09	0,18
100	68x51	0,18	0,37
200	135x101	0,37	0,74
500	338x253	0,92	1,85
1000	676x507	1,85	3,70

Typ BVS yy-3-xx1-E (8 mm)

Working distance (mm)	Field of view (mm)	Minimum module sizes (mm)	
		Barcode	DMC
50	24×18	0,07	0,13
100	48×36	0,13	0,26
200	96×73	0,26	0,53
500	240×182	0,66	1,31
1000	480×360	1,31	2,63

Typ BVS yy-3-xx3-E (12 mm)

Working distance (mm)	Field of view (mm)	Minimum module sizes (mm)	
		Barcode	DMC
50	16×12	0,04	0,09
100	32×24	0,09	0,18
200	64x48	0,18	0,35
500	160×120	0,44	0,88
1000	320×240	0,88	1,75

Typ BVS yy-3-xx7-E (16 mm)

Working distance (mm)	Field of view(mm)	Minimum module sizes (mm)	
		Barcode	DMC
180	43x32	0,12	0,24
200	48x36	0,13	0,26
Working distance (mm)	**Field of view(mm)**	**Minimum module sizes (mm)**	
		Barcode	**DMC**
500	120×90	0,33	0,66
700	168×126	0,46	0,92
1000	240×180	0,66	1,31

Minimum distance of BVS yy-3-0x7-E: 180mm
Minimum distance of BVS yy-3-1x7-E: 230mm

16 Technical Data

The following barcodes can be read:

- Interleaved 2-of-5,
- Code 39,
- Code 128,
- Pharmacode,
- Codabar,
- EAN 8
- EAN 13
- UPC-A
- UPC-E
- PDF 417
- GS1-128

Required minimum width of the narrowest code module: 1.75 pixels
Bars capable of being differentiated
The Data Matrix Code reader tool can read the following code:
Data Matrix ECC 200 per ANSI standard (only even bit numbers
Required minimum width of the narrowest code module: 3.5 pixels
Maximum size of a code module: 16 pixels

Read field diagrams

The read field diagrams are valid for BVS ID and BVS UR-versions with the correspondent lenses.
Please note:
For blue line is valid starting at 180mm distance for all BVS xx-3-007-E,
and from 230mm starting at 230mm for all BVS xx-3-107-E with xx: ID or UR.

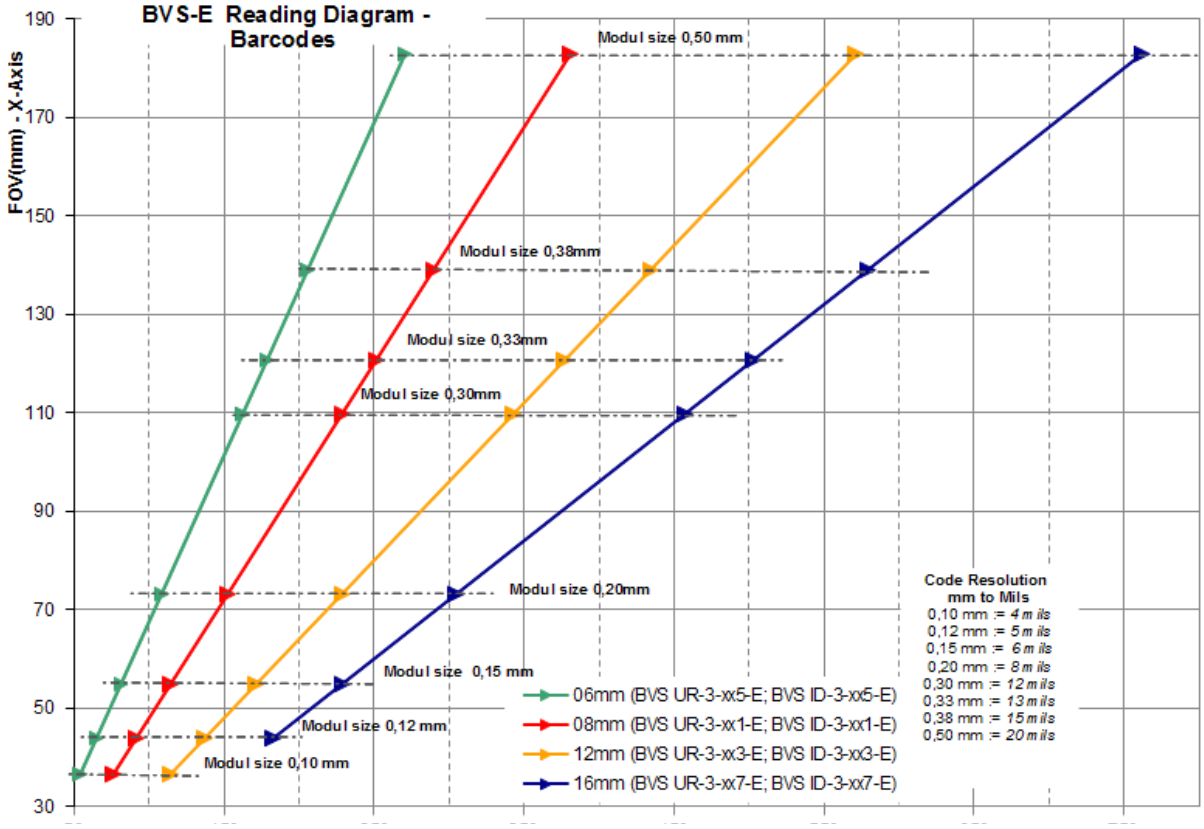


Fig. 16-6 Read field diagram for a barcode

Minimum distance of BVS yy-3-0x7-E: 180mm
Minimum distance of BVS yy-3-1x7-E: 230mm

16 Technical Data

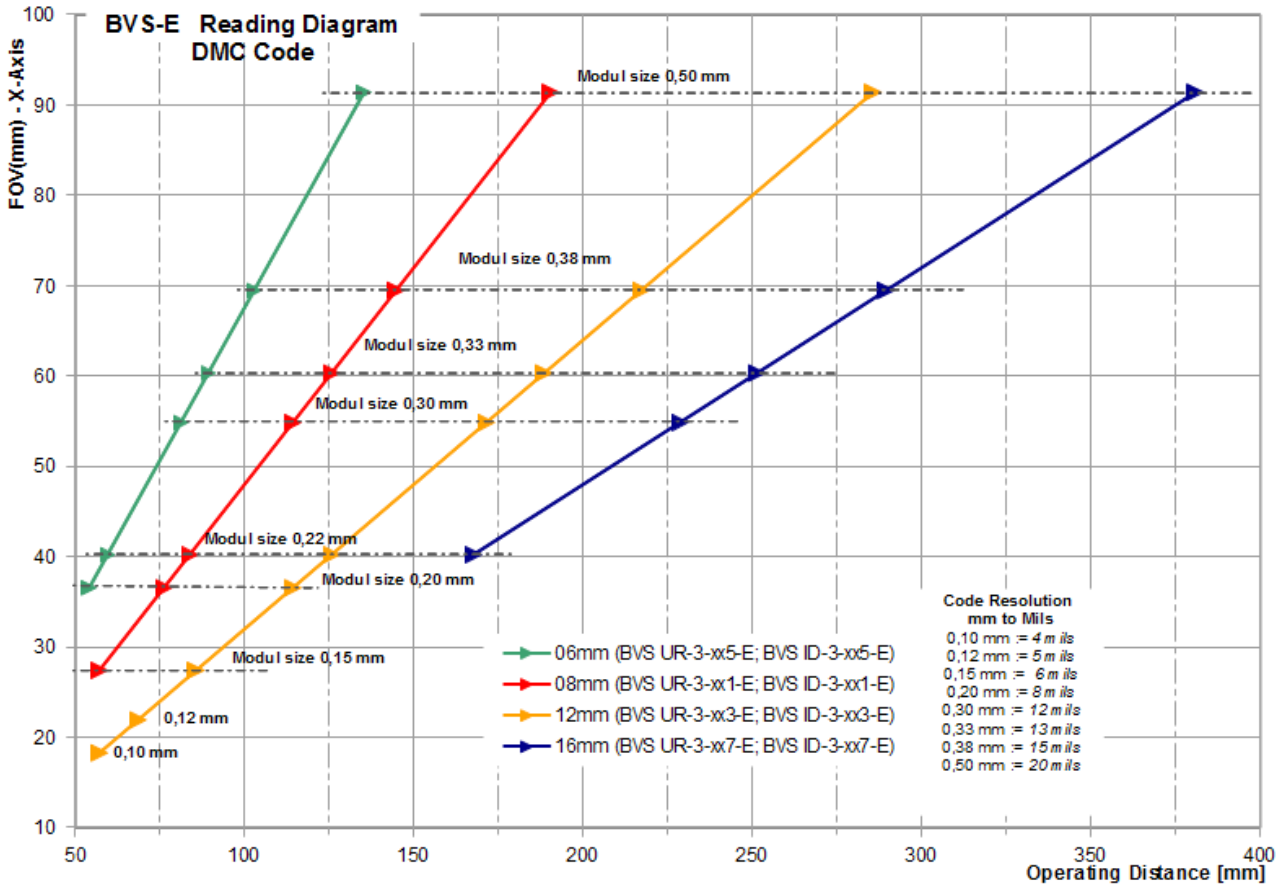
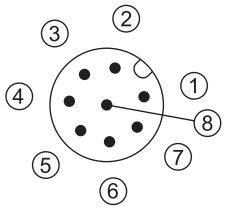


Fig. 16-7 Read field diagram for a Data Matrix code
Minimum distance of BVS yy-3-0x7-E: 180mm
Minimum distance of BVS yy-3-1x7-E: 230mm

16.3.3 Electrical connections

M12 8-pin: (power and I/O)



Pin	Wire colors BCC M418-0000	Function
1	White	RS 232 Rx
2	Brown	24 V DC
3	Green	Trigger output – External light **or** Output 4
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	RS 232 Tx
7	Blue	Ground 0 V
8	Red	Trigger input

To use the sensor without integrating into the machine environment, connect Pin 2 of the PWR IO connector to 24 V DC and Pin 7 to ground.

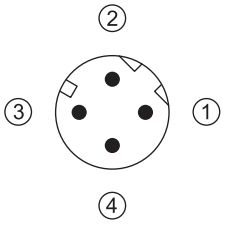
Attention!
Never connect or disconnect the PWR IO cable while power is on. Neither at the sensor side nor on the cabinet side.

16 Technical Data

Connecting external lights

If you want to use an external light with the BVS, connect it as follows:
- ► Connect the light to the supply voltage specified in its data sheet.
- ► If present, connect the external trigger input for the light to Pin 8 of the PWR IO connector.

TO PC — Pin contact panel connector, 4-pin



Pin	Function
1	Rx+
2	Tx+
3	Rx-
4	Tx-

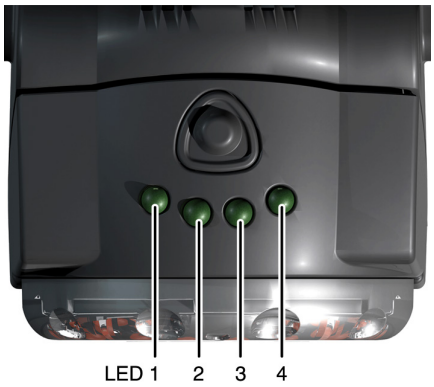
To set the sensor parameters, the TO PC connector must be connected to the Ethernet 10/100 terminal of a PC or to a network terminal. We recommend using the BCC M415-E834-AG-672-ES64N8-050 cable.

16.3.4 Electrical data

Operating voltage Us	24 V DC ±10 %
Ripple Upp	1 V max with light 2 V max without light
No-load current Io	max. 200 mA at 24 V DC
Switching outputs	2 x PNP-Transistor; configurable 1x Trigger- or switching output PNP (24 V); configurable
Digital inputs	1x Trigger
Output current	max. 100 mA per output
Output saturation voltage	< 2 V
Output signal on output Ext. light trigger	Trigger signal 0/24 V DC
Parameter setting interface	1x M12 4-pin – Ethernet 10/100 Base T
Default settings	Sensor IP: 172.27.101.208 Subnet : 255.255.0.0
Output interfaces	RS-232: 9.6 -115.2 Kbaud; Ethernet TCP/IP: 10/100Mbit Base-T
Ready delay	10 seconds

16.3.5 LED indicators

The BVS ID or UR has four LEDs.



LED	Display	Function
LED 1	Green	Power on
LED 2	Orange	Output 1 indicator
LED 3	Orange	Output 2 indicator
LED 4	Green	Network connection

16 Technical Data

16.4 Declaration of Conformity

CE The CE Marking means that the BVS sensors as well as the lights conform to the requirements of the EU Directives 2004/108/EWG (EMC and 2006/25/EG Artificial optical radiation) as well as the EMC Regulation.
In our EMC Laboratory, which is accredited by the DATech for Testing Electromagnetic Compatibility, it has been verified that these Balluff products meet the EMC requirements of Generic Standard EN 60947-5- 2:2007.

Strong optical beams, such as from LEDs, may affect proper function of the sensor. This is why our lights are tested by an independent, certified testing agency according to the newest prevailing standard (IEC 624710.
BVS sensors as well as our lights fall into the “Exempt Group” or (infrared lights only) into “Risk Group 1” and are therefore considered highly safe.

LED beam!
- The LED ring in the BVS Sensor is classified in the **Exempt Group** per IEC 62471:2006-07.
- Do not look directly into the light source - there is a risk of glare and irritation!
- Install the sensor so that it is not possible to look directly into the light source.

The definitions of the individual risk groups per IEC 62471 are as follows:

Exempt Group:	No photobiological danger.
Risk Group 1:	Normal restrictions through the behavior of the user mean the light source represents no hazard.
Risk Group 2:	Lamps that may pose photobiological hazards to the eye or skin from even a moderate exposure duration but which first cause an avoidance reaction or thermal discomfort
Risk Group 3:	Lamps represent a hazard even from momentary or short-time exposure. Use in normal lighting is not permitted

Contact

Technical support
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E-Mail: balluff@balluff.com

Additional information on other Balluff products and solutions can be found on the Internet at:
www.balluff.com/balluff/

Requests and suggestions
If you have suggestions for improvement and ideas for this product, please let us know. Use the contact information provided above.

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Code quality parameters

Code quality parameters for barcodes

The BVS Identification Sensor determines the most important quality parameters for barcodes **based** on ISO 15416. There is **no standardized** determination of quality parameters (also called VERIFICATION) possible, since this would require devices which are manufactured, assembled and regularly calibrated according to ISO 15416-1.

The determined quality parameters may used for example to monitor the quality of the codes at the read station. Codes with poor quality can thereby be reliably identified and rejected.

Quality Parameters according to ISO 15416	Quality Parameters Tool Read barcode	Description
Decoding	Decoding	Barcode decodable (Value = 4) or defective and not decodable (Value = 0)
Symbol contrast	Symbol contrast	The contrast difference between the brightest point in the background and the darkest point of the bars in the barcode. Causes of low values are generally: When setting: – Poorly selected image setting – insufficient contrast – Insufficient image resolution – if the sensor is too far away from the code, light and dark modules “smear” together due to optical effects. In production: – Poor print quality – e.g. low toner – Ambient light on the target code – Failure, e.g. of external auxiliary light
Minimal reflectance	IS NOT CALCULATED	What is calculated is the distance between the darkest and lightest point in the code. Only if the difference between the two points is greater than a specified value is the min. reflectance 4, otherwise 0.
Edge contrast	Min. edge contrast	Minimum contrast between 2 adjacent elements (bars and gaps) in the code. Causes of low values are generally: – Poorly selected image setting - insufficient contrast – Insufficient image resolution – if the sensor is too far away from the code, then bars and gaps smear together due to optical effects. – Poor print quality – bars are printed too wide.
Modulation	Modulation	Modulation is a measure of the evenness of the barcode. Code with strong reflections or changing contrasts have a low modulation value. – High value: Code print is even; bars and spaces are well separated – Low value: Strong and weakly contrasted code; bars and spaces are smeared together
Defects	NOT DETERMINED	Causes are generally: – Poorly printed or too thin bars – Dirt on the code – “Holes” or “lines" in the bar
Decodability	Decodability	The cause of poor decodability is generally related to the following reasons: – Poor print – bars smeared or printed too wide – Insufficient image resolution. The sensor is too far away from the code.
OVERALL QUALITY	Overall quality	The value of the overall quality corresponds to the poorest value of all the quality parameters.

The quality data are **not** determined for PDF417; Postnet, IMB and Pharmacode.

Code quality parameters

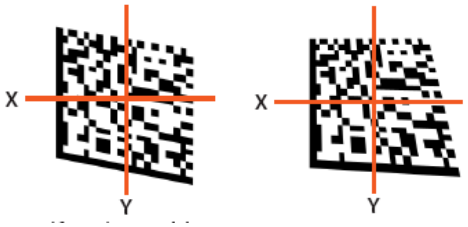
Code quality parameters Data Matrix codes

The BVS Identification Sensor determines the most important quality parameters for Data Matrix based on ISO 15415. There is no standardized determination of quality parameters (also called VERIFICATION) possible, since this would require devices which are manufactured, assembled and regularly calibrated according to ISO 15415-1.

The determined quality parameters may used for example to monitor the quality of the codes at the read station. Codes with poor quality can thereby be reliably identified and rejected.

Quality parameters according to ISO 15416	Quality Parameters tool Data matrix code	Description
Symbol contrast	Symbol contrast	The symbol contrast is the difference in brightness between light and dark modules and the quiet zone. The greater the symbol contrast the higher the value. Causes of poor symbol contrast may include: When setting: – Poorly selected image setting - insufficient contrast – Insufficient image resolution - if the sensor is too far away from the code, light and dark modules “smear” together due to optical effects. In production: – Poor print quality - e.g. low toner – Ambient light on the target code – Failure, e.g. of external auxiliary light
Modulation	NOT DETERMINED	Represents the ratio of black to white in the code. If the ratio is unbalanced, the value for modulation falls. Reasons may include: – Light reflections on the print/code carrier – Declining print quality 
Defective fixed patterns	NOT DETERMINED	Evaluates the condition of the L-shaped "Finder Patterns, the "Alternating Patterns" and the quiet zone. The more errors are present in these parts of the code, the lower the value.
Decoding	Decodability	If the Data Matrix code is decidable, then the value for decidability is 4, otherwise 0.
Axial distortion	Axial distortion	Ration of the module side lengths in the horizontal and vertical direction. The more balanced (e.g. for square modules), the higher the value for axial distortion. A compressed code, for example, has a low value for axial distortion, so that the value of this parameter drops in proportion to the distortion. 

Code quality parameters

Quality parameters according to ISO 15416	Quality Parameters tool Data matrix code	Description
Grid distortion or general distortion	NOT DETERMINED	The modules in a DM code lie ideally on an evenly arranged symbol grid. Distortions (parallel distortion, rounding) can cause the actual module position from the desired positions, which lowers the value for grid distortion. Example for codes with strong grid distortion: 
Unused error correction	Unused error correction	Data Matrix ECC200 codes are equipped with error correction mechanisms. The greater the value for these parameters, the less defective the code (covered, painted over, etc.).
OVERALL QUALITY	Overall quality	Overall quality of the code. Where: The value of the overall quality corresponds to the poorest value of all the quality parameters.

Flowchart: Troubleshooting Connection BVS – PC

Please use this flowchart if you can not establish a connection between BVS – E type sensor and PC

Connect the BVS power cable. The far left LED (sensor lens is facing down) number 1 indicates sensor power.

Is LED on?

No → The BVS sensor is not getting power. Please verify the sensor is wired correctly and check the power supply for proper current, polarity and voltage.

Yes

The 4 pin M12 connect on the BVS is used to connect the BVS to the Ethernet port of your PC. Is your computer connected to the BVS?

No → Secure a BVS Connection cable and connect BVS and the computer ethernet port.

Yes

Did you ever connected the BVS with the PC before? If so:
The far right LED number 4 indicates "Connection" state of the sensor. Is LED on?

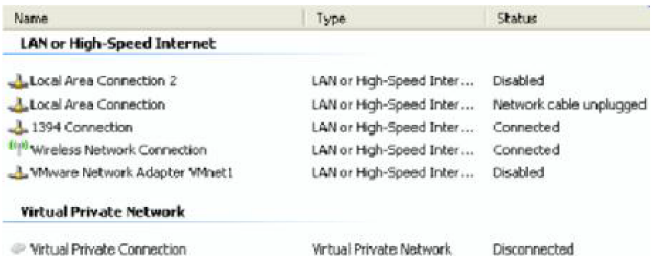
yes → The BVS sensor is stucked in "Connected" state. Please check if a BVS ConVis software is still running on your PC.

No → Please check all processes running on your PC. Start your Windows task manager by press CTRL + ALT + DEL. Now click the tab: Processes. Search if there is a process called SVSSocketManager.exe; If so: Select it with the mouse, then press the right mouse button and select: End process.

Repower the sensor after this procedure.

No

Check if WINDOWS has a network connection established.
Select: Settings or Control panel --> NETWORK CONNECTIONS --> LAN CONNECTION . In the NETWORK CONNECTION menu select: View ' Details. Your network connections are displayed as shown at right..



NEXT

Check the Network connections while you unplug the network cable from the BVS. The windwo should show the message "Network cable unplugged" for one of your Local Area Connections.

Did you configure the IP address of the BVS and PC according to the connection section in the BVS manual before you continue troubleshooting?

No → Check the IP address on your PC and verify that it conforms to the setup procedure in the manual. As a pre-configured factory default, all BVS`s have the following IP address: 172.027.101.208. The ConVis Software allows you to setup an indiviual IP address for every BVS, example 172.027.101.199. For more information please see the operation manual. Please check the IP settings of your LAN connection. Please ensure that you have set an IP address for your PC to work with those set for the BVS. For example:
Sensor: 192.168.101.50 PC: 192.168.101.1
Sensor: 172.27.101.208 PC: 172.27.101.1

Yes

Yes

Please connect the network cable to the PC again. Windows should now display "Connected" next to your Local Area Connection Start the BVS ConVis Software and click "Online" and select FIND.
Did the software find the connected BVS?

Yes → You should now be able to start using the BVS in Live Mode.

No

Go to the START button, then Programs, then Accessories and select "Command prompt". This opens the DOS console. Now write PING followed by the IP-Address of the BVS and press enter.
Does the statistics display shows that all 4 packets have been received?

No → Please check if you have a firewall running. If so: Please check if PING command is allowed or not. Either disable your firewall or try to enable PING commands

Yes

Start the BVS ConVis software click ONLINE online, then FIND.
Did the software find the connected BVS?

No → Please check if you are working over any routers, gateways, or firewalls. If so: Please try to use a direct connection between sensor and PC. Either turn off the firewall or if you must have a firewall running on your PC: please ensure that the TCP port 5423 is enabled and not used by any other program. If it is not enabled, please enable this port in order to proceed. If this does not resolve the connection issue then disable any Anti- Virus and Anti-Spyware programs.

Yes

Please press connect. Now your sensor should run in Live mode.
If the sensor disconnects from the ConVis software intermittently please follow those hints given in Technote 9

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