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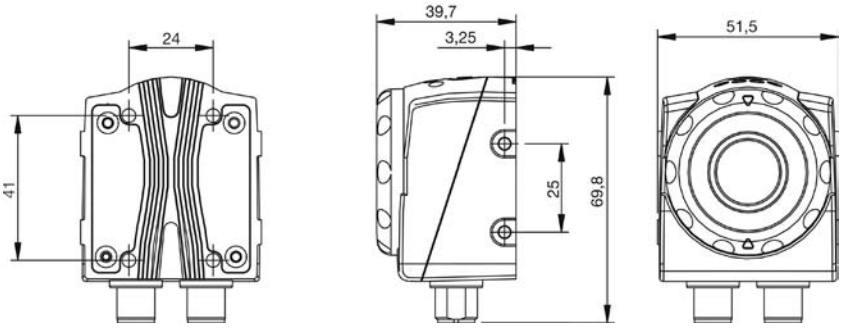
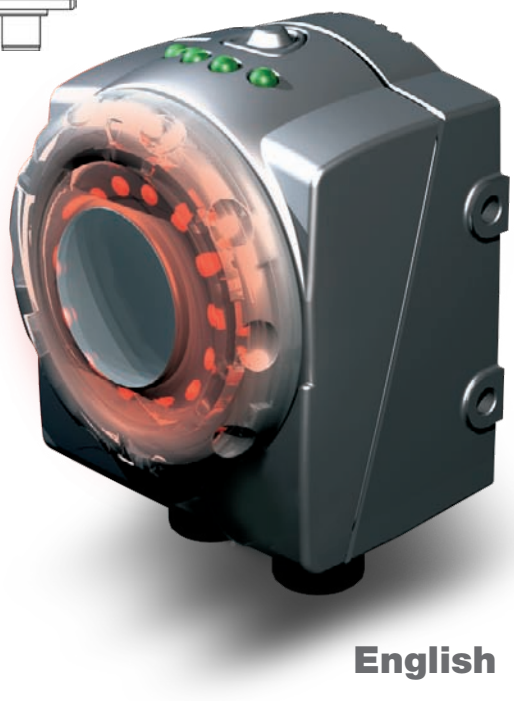
Vision Sensor BVS

Operation Manual





English

www.balluff.com

1 Notes to the User

1.1 About this manual

This Manual is intended as a guide for the BVS configuration and visualization software (ConVis) and the BVS object identification Vision Sensor.

1.2 Organization

The Manual is organized so that the sections build on each other.
Section 1: Notes to the User
Section 2: General Information
Section 3: Installation - Connection - Network Communication
Section 4: BVS ConVis Installation
Section 5: Creating an Inspection
Section 6: Triggers - Locator - Tools - Output signals - Inspection changing
Section 7: BVS and BVS ConVis Reference
Section 8: Periodic Maintenance
Section 9: Legal Notes
Section 10: Glossary
Section 11: Technical Data
Section 12: Index

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.

Notation

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 (see “Components” on page 9).

1.4 Symbols

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

Note
This symbol indicates general notes.

1.5 Abbreviations

BVS	Balluff Vision Sensor
EMV	Electromagnetic Compatibility
Sichtfeld	Field of view
IP	Internet Protocol
OI	Object Identification
ROI	Region of Interest
TCP	Transmission Control Protocol

Note
Other important terms can be found in the glossary

2 General Information

2.1 Scope

This operating manual is valid for BVS Vision Sensors model numbers
– BVS OI-3-00x-E (x stands for a number from 1 to 6) as well as
– BVS OI-3-05x-E (x stands for a number from 1 to 6).

The functionality described in this Manual refers to sensors having firmware version ST 2.2.1.x and operating software BVS ConVis version 1.2 and higher.

2.2 General description

The BVS Vision Sensors are image processing sensors for non-contact acquisition and inspection of objects in a broad range of industrial applications and environments.
In order to be able to inspect an object (part), you must connect the sensor to a PC and configure it using the free BVS ConVis parameterization software.

The ConVis software allows for the visualisation of the images taken by the sensors and the ability to create and set up inspections. It also allows the user to adjust and configure the sensor.

As part of the configuration you will create one or more so-called inspections.

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 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.

Using the BVS ConVis software you can also adapt existing inspections or simulate inspections offline (i.e. without having a sensor connected).

The current version of the BVS ConVis software is available from the Internet at:
Balluff Europa:
http://10.69.25.136/Balluff/de/ProductsChannel/Recherche/TechnicalReferenceSearch.htm?productgroup=Vision%20Sensoren

Balluff North America:
http://www.balluff.com/Balluff/us/ResourcesChannel/Technical+Reference/?menuLevel=2

2.3 Intended use

The BVS Vision Sensors are image processing sensors for non-contact acquisition and inspection of objects 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 medicinal purposes,
– When the safety of persons or of machinery depends on the device functiont.

2 General Information

2.4 Safety advisories

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

Caution!
- This device is NOT a safety component in accordance with the EU Machine Directive! It may not be used when the safety of persons or of machinery depends on the device function.
- 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. Observe the Technical Data!
- 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.
- The manufacturer assumes no liability for improper use. The manufacturer's warranty is void if the sensor has been opened.
- Place the sensor out of service if non-clearable faults occur.

LED radiation!
- The LED radiation 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 as to minimize looking directly into the sensor and LED 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 1.2

In the document: BVS-E_Releasenotes_R120_0906_DE you will find an overview of new functions or revisions for software version 1.2.0 compared with software version 1.1.4. The document can be found on the CD included with the product or in the Internet.

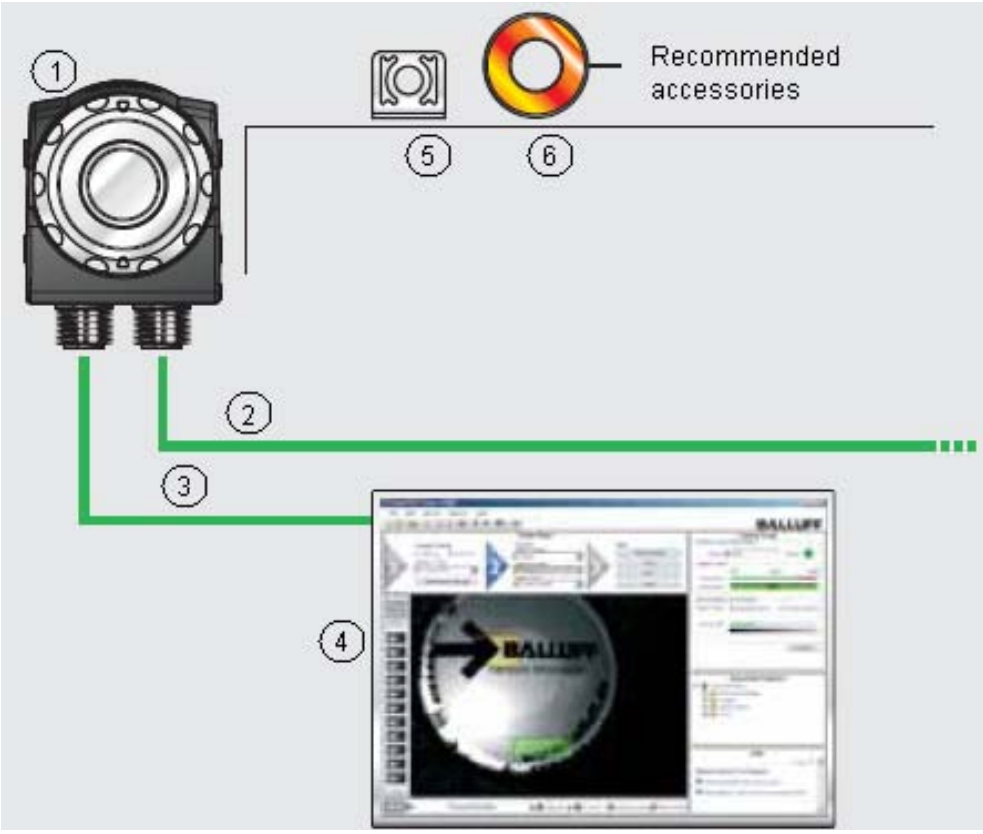
2.6 Revisions to this operating manual

Revisions and any known errors are documented in BVS-E_KnownIssues_R120_0906_DE. This document can be found on the CD included with the product or in the Internet.

2 General Information

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) running under Windows XP with installed BVS ConVis configuration and visualization software.
- 1 connection cable for power supply and inputs/outputs: e.g. BKS-S139-PU-05.
- 1 connection cable for connecting the sensor to the PC
- e.g. BKS-AD-05-RJ45/GS180-05.
- Installation accessories (see section on “Installation")



Legend:
1 Vision Sensor BVS-E
2 Connection cable for BVS-E
3 Connection cable BVS-E ó PC
4 PC with installed BVS ConVis software
5 Accessory mounting bracket
6 Accessory lights

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 "Technical Data".

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:

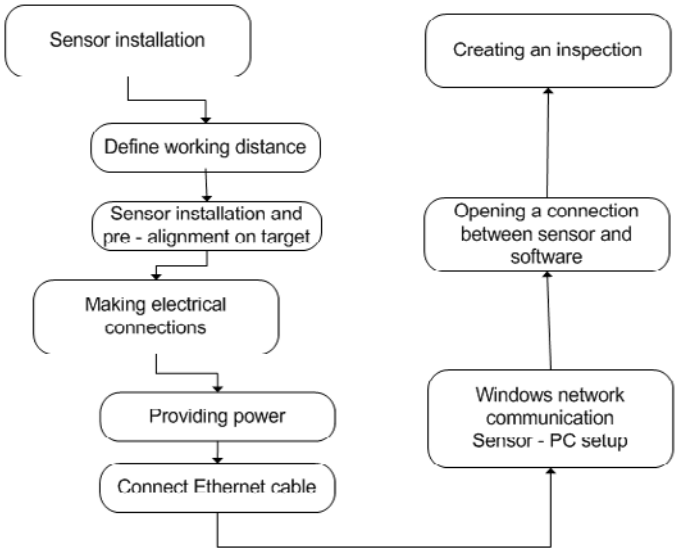


Fig. 3-2: Initial startup sequence

Note
Before first starting up a BVS-E sensor, the current configuration software BVS ConVis version 1.2 must be installed on your PC. For additional information see Section 4.

3 Installation — Connection — Network Communication

3.2 Installing the sensor (installation)

Please read the following definitions and relationships carefully and take these into account when installing the sensor.

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

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 objects farther away appear darker than objects at shorter distances.

Example: A bright object needs to be inspected once at a distance of 10 cm and once again 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.

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.

The larger the field of view, the less the optical resolution. The optical resolution should be taken into account if for example you want to inspect widths at a certain tolerance.
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.

Sensor installation

To make it easier to install the sensor we offer a wide range of accessories.
An overview can be found here: Mounting Accessories
The following illustration shows the mechanical attachment of the sensor using these mounting accessories.

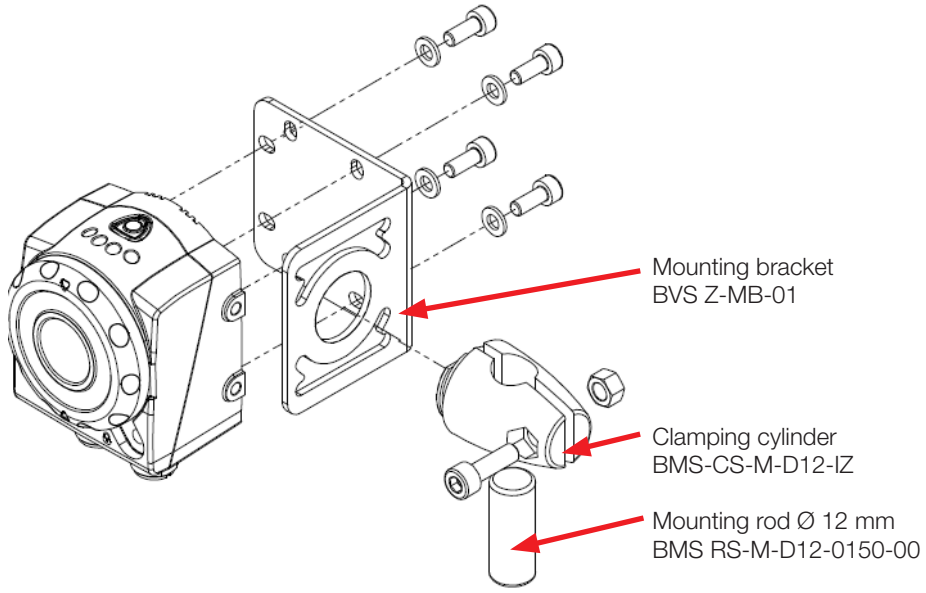


Fig. 3-3: Sensor attachment using mounting accessories

3 Installation — Connection — Network Communication

Do not install the sensor in a location in which the object is exposed to direct sunlight or strong ambient light.

To attach the sensor, use 4 M4 x 6 mm screws, which are included with the sensor.

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.

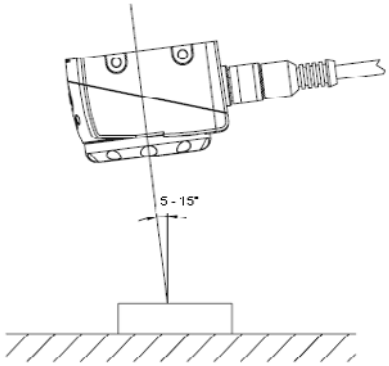


Fig. 3-4: Mounting and aligning the sensor

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 "5.5 Lighting".

Setting the 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

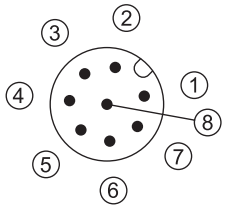
3 Installation — Connection — Network Communication

3.3 Making electrical connections

On the underside of the BVS are two M12 pin contact connectors. In the following we indicate the 8-pin, A-coded connector as PWR IO, and the 4-pin D-coded as TO PC (Ethernet).

3.3.1 Providing power: Connector PWR IO

Pin contact connector, 8-pin, A-coded



Pin	Wire colors for BKS S139	Function
1	White	Input Select
2	Brown	24 V DC
3	Green	Trigger External Light (see Chapter 11.4 for details)
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	Output 3
7	Blue	Ground 0V
8	Red	Trigger input

Supply voltage

Please connect PIN 2 of the PWR IO using an 8-conductor, shielded cable (Recommendation: BKS-S139-PU-XX) 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 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. Light	Output	To synchronize an external light with the sensor, connect PIN 3 of the sensor to the trigger input of the light. **Important:** For all sensors with hardware version < 2.0 the trigger outputs a TTL signal (LOW < 0.8 V; HIGH > 2.0 V). For all sensors with hardware version ≥ 2.0 the trigger outputs a 0 to 24 V signal. **Note:** The hardware version of the sensor can be found if you select INFO from the help menu. Please note that only software version 1.2.2 or higher shows the hardware version correctly. The light must in any case be supplied with power
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 6.1 “Triggers” **Note!:** Trigger inputs must be a PNP (sourcing) input. The BVS NPN and PNP cameras only accepts PNP (sourcing) input.

3 Installation — Connection — Network Communication

Wiring diagram

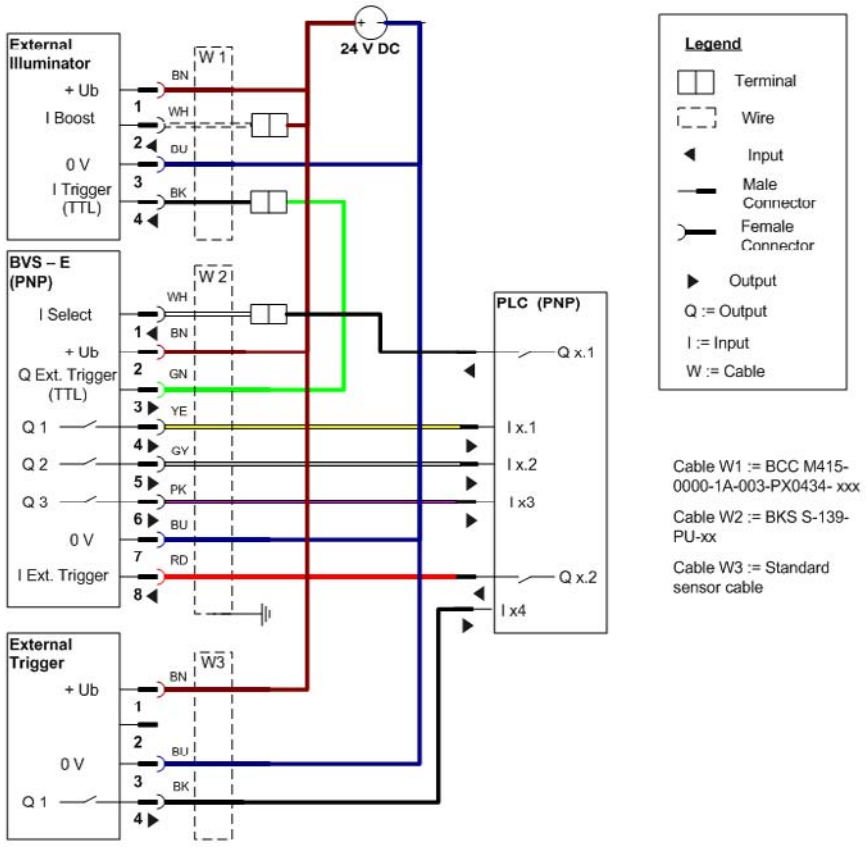
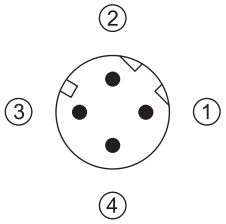


Fig. 3-6: Wiring diagram of the BVS-E sensor

3.3.2 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:

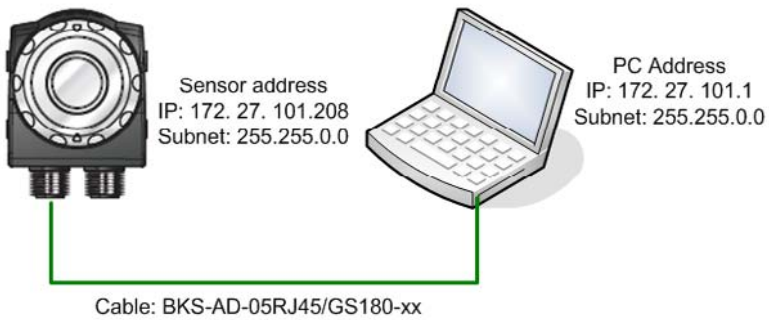


Fig. 3-7: Direct connection of the sensor

3 Installation — Connection — Network Communication

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 BKS-AD-05RJ45/GS180-05 cable.

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

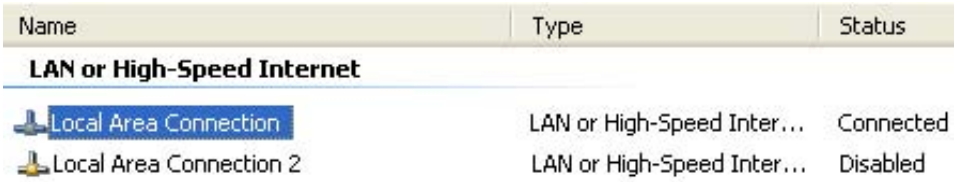
3.4 Windows network communication Sensor ↔ PC setup

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.

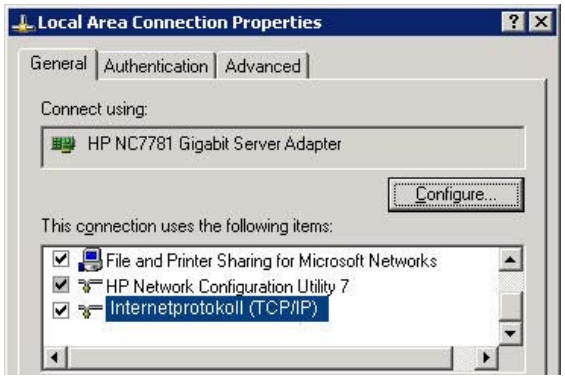
Note
To be able to follow the next instructions, you must have Administrator rights. Please contact your IT representative if you do not have these rights.

Please follow these instructions to check the network settings on your PC and change them as necessary:

- Click on the Windows “Start” button
- Select "Control Panel → Network Connections”
- In the network connections menu select: "View → Details".
  ⇒ Your network connections are displayed as follows:



- Note the display and briefly disconnect the network cable to the BVS-E from the network socket. The following text is displayed in the STATUS column for the corresponding network connection: Network cable removed.
- Use the mouse to select this network connection and then double click on it.



- Select “Internet Protocol (TCP/IP)”. Click again on “Properties”:
- Click on the tab: “Alternate IP Address”
- 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.

- Click on OK to close the “TCP/IP Properties” dialog. Click on OK in the “LAN Properties” dialog.

3 Installation — Connection — Network Communication

After you are finished making your settings, your PC automatically searches for a network on this connection.
Depending on your PC setting, the current status of the network connection is displayed in the Windows taskbar (lower right).

If the sensor is connected to power and the TO PC connector is connected to the PC using the corresponding cable, this symbol will be displayed after a short time:

If it is still searching for a network address, then this symbol is shown:

The IP address of the network connection you are using is now compatible with that of the sensor.

4 BVS ConVis - Installation

4.1 Initial installation of BVS ConVis

In order to configure the sensor, you must have the supplied (or available via download from the Balluff's website) 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	Minimum
Processor(s)	Pentium 4	Pentium 4
Operating system	Windows XP (Service Pack 3)	Windows XP (Service Pack 2)
Clock frequency	≥ 2 GHz	≥ 1 GHz
RAM	1024 MB = 1 GB	512 MB
Available hard disk space	50 MB	35 MB
Screen resolution	1024 x 768 Pixel	1024 x 768 Pixel
Rights	Full access to all files in Programs/Balluff/BVS ConVis 1.2/	Full access to all files in Programs/Balluff/BVS ConVis 1.2/

– CD-ROM drive.
– Installed Ethernet network card and installed driver.

Note
Consult your driver's website and make sure that you have the latest driver's updates installed on your PC.

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 2.0 Redistributable (x86)
2. Microsoft .NET Framework 3.0 Redistributable Package
3. Microsoft Visual C++ Redistributable

Program packages 2 and 3 are included on the CD supplied with the BVS-E.

4.1.2 Initial installation

Note
The following instructions apply to the initial initial installation of the BVS ConVis software. First please perform the steps described in the section "Updating the software" if version 1.1.4 or older of the BVS ConVis software is already installed on your PC.

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

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

Note
If the menu is not automatically displayed, start the installation program manually.

► Select "Run…" from the Start menu and enter "X:\setup.exe", where "X" represents the drive letter for the CD drive in your system.

► After the installation program is started the terms of use are displayed. Read the terms of use for the software carefully. The software will only be installed after you have agreed to the terms of use.

4 BVS ConVis - Installation

► Select the directory where you want the program installed.
► Then follow the instructions on the screen.
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.

► Restart the PC to finish the installation process.

4.1.3 Firewall settings

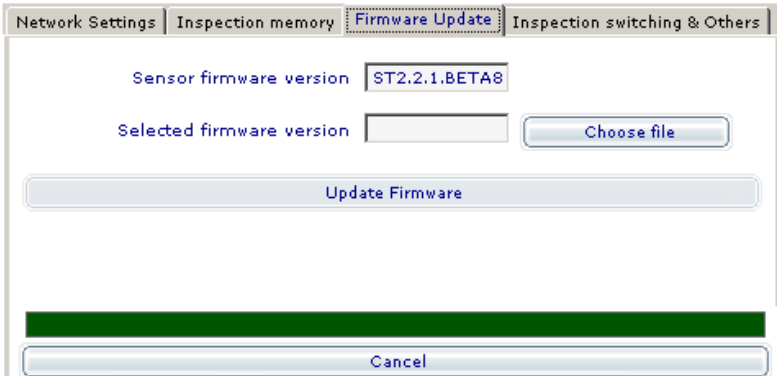
After installation of the BVS ConVis software check the settings of your firewall. The software uses UDP protocol on ports 5090 and 5091 to locate sensors.
The software uses TCP/IP protocol on port 5423 for communication.
Please check whether your firewall allows these ports and if necessary enable the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

4.2 Updating from Version 1.1.4 or earlier to 1.2.0

Do you already have software version 1.1.4 or earlier of BVS ConVis installed?
Then proceed as follows to update to version 1.2.0:
► If you are currently running version 1.1.4, please exit it first.
► Install version 1.2.0 as described in Section 4.1.2.
► You do not have to UNINSTALL version 1.1.4 or older first.

Note
If you uninstall software version 1.1.3 or older the associated BVS inspections and images will be erased. Please save those inspections before uninstalling the software.

► Then start version 1.2.0 and connect to the sensor.
⇒ The software automatically checks the firmware version on the sensor and shows you the result in a dialog box.
► 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 dialog box and shows you the folder with firmware files (file extension .sfw2)
► Please select the file having the highest version number.
Example: Assuming these two files are available: ST_2.2.1A.sfw2 and ST_2.2.2B.sfw2. Please select ST_2.2.2B.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.
The connection between the sensor and the software is automatically closed.

4 BVS ConVis - Installation

Note
Start the sensor TWICE to finish the firmware updating from 0.0.5 to ST 2.2.1.

After successful updating, open the connection and check whether your inspections function the same as before the update. Pay close attention to the parameters - some minor adjustments may be required.
Especially in the case of inspections using the “Contrast” and “Pattern” tools you may need to adjust the tool parameters.
For additional information refer to the CD in document:
BVS-E_Releasenotes_R120_0906_DE, Section: Changes to the software compared with version 1.1.4 and older.

Note
Note that version 1.2.0 of the BVS ConVis software cannot be started on your PC at the same time as an older version!

Converting inspections

To convert an old inspection saved on your PC (version 1.1.4 or older) to an inspection compatible with version 1.2.0, proceed as follows:

- ► Click on “Open from PC” in the “File” menu.
- ► Then select “File type” “.bvs” 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 .bvs2 as the “File type”. Click on OK
  ⇒ The software now saves the file in the new version – all new functions are now available.
- ► Select Test or Run and check whether your inspections function the same as before the update. Pay close attention to the parameters - some minor adjustments may be required - especially in the case of inspections using the “Contrast” and “Pattern”.
  For additional information refer to the CD in document:
  BVS-E_Releasenotes_R120_0906_DE, Section: Changes to the software compared with version 1.1.4 and older.

4 BVS ConVis - Installation

4.3 Complete overview

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

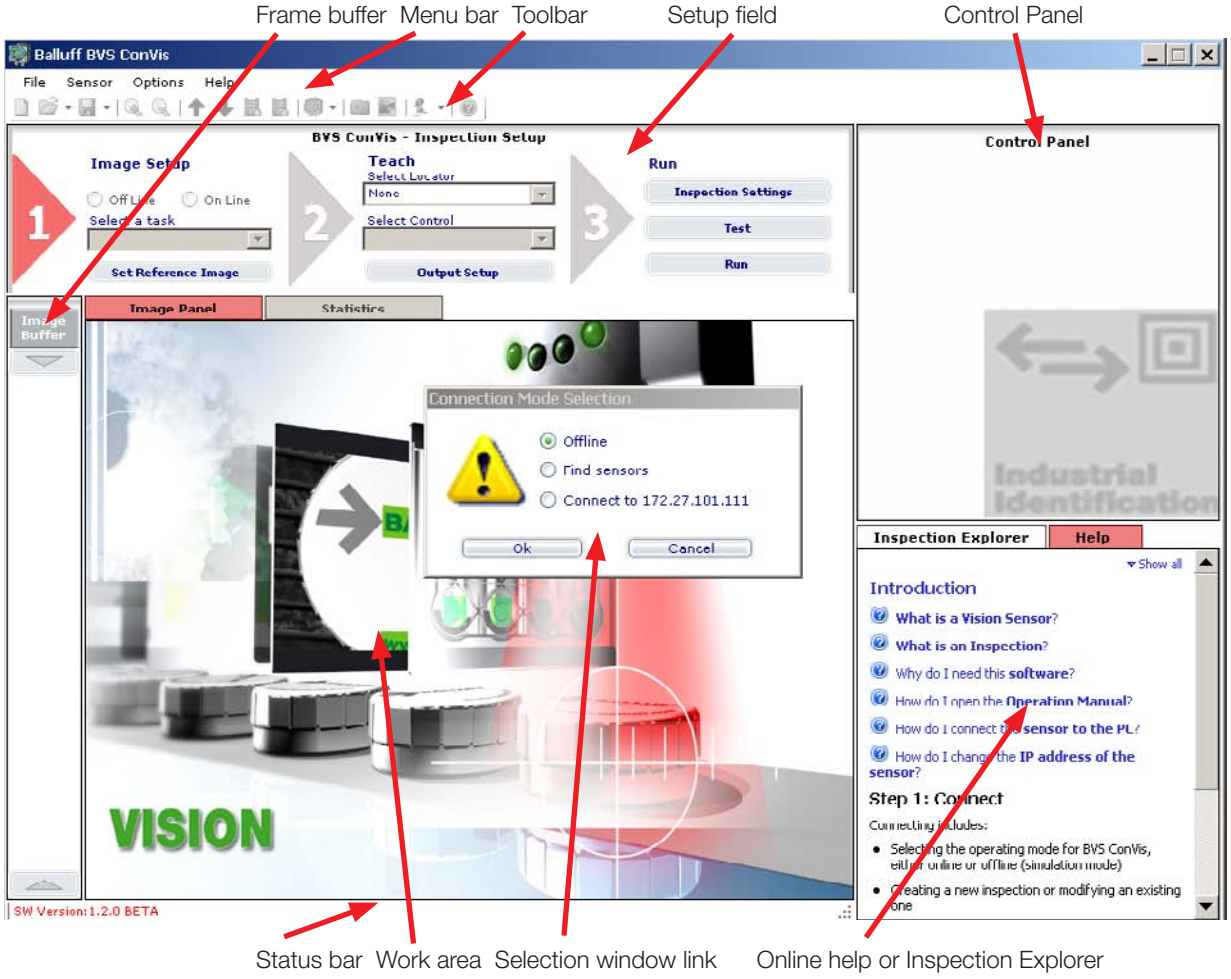


Fig. 4-1: GBVS user interface – Overall view

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

4.4 Connect sensor and software

Definition

For “New sensor start” the procedure is described as follows:

1. Close (if open) connection between software and sensor.
1. Disconnect cable from PWR IO connector.
1. Connect cable to PWR IO connector.

4 BVS ConVis - Installation

4.4.1 PC-Sensor direct connection

Prerequisite
BVS ConVis installed on the PC.
Directly connect PC to sensor (see Fig. 3-7)
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 Pin2: 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. Continue with Section "5 Create Inspection”. If “Find sensor” does not locate a sensor, or the found sensor is highlighted in RED, then refer to Section "7.3.4 Error remediation”.

4.4.2 Sensor in 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 "7.5 Updating the sensor firmware".

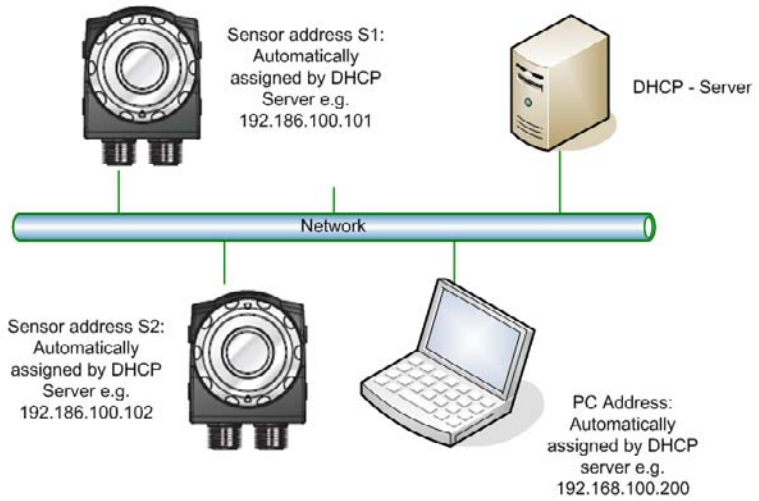
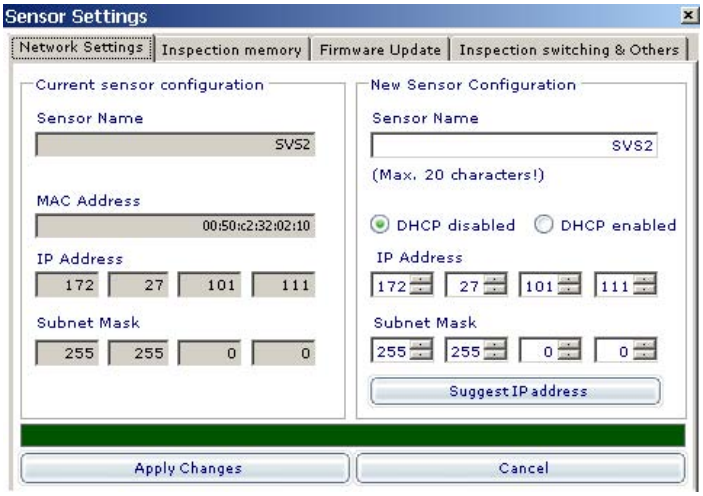


Fig. 4-2: DHCP connection of the sensor

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".

4 BVS ConVis - Installation



- 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 BKS-AD-05RJ45/GS180-05 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, on the top of the sensor, 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 (Standard: 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

Definition

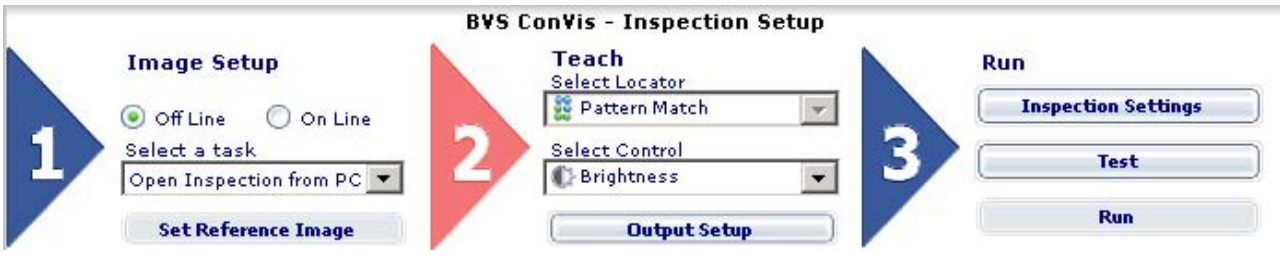
What we refer to as an “Inspection” is a configuration file which is created using the BVS ConVis software and can be stored on the sensor (or PC).
An “inspection” consists of:
– A ‘taught’ reference image,
– The so-called Control tools (short tools), which inspect one or more image regions (hereinafter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

Features may be, for example, the contrast at a particular location in the image (on the object) or the width of the object. Up to 25 features can be checked at the same time in an inspection.
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.

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 software from the sensor. 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”.

5.1 Basic condideations

Here are a few tips to facilitate correct configuration of the BVS:
- Determine which product feature you want monitored;
- Determine the working distance for the sensor - the camera should be focused so that the feature to be inspected is as large as possible;
- Provide correct, even lighting;
- Minimize the influence of ambient light on the target;
- Meticulous selection of the controls during setup and testing will result in accurate inspection; this may result in testing multiple controls to determine the best results
- Set the Control parameters and tolerances accurately – attention to the parameters and tolerances of each Control during setup will help ensure the robustness of the inspection.

Typically a “good” part’s inspection may not match 100% with the taught reference image. Position offsets or light level fluctuations can affect the match score. Any "bad" part should differ from a "good" part in as many characteristics as possible allowing for a large gap between the match score of the good and the bad parts. We recommend trying several good parts while

5 Creating an inspection

testing your application as well as several bad parts. Be sure to consider eventual changes in lighting conditions and part position variations when choosing the appropriate Control(s) tolerances or “Desired Values”.

The following sections discuss the individual STEPS with their options and selectable parameters.

5.2 Step 1: Image setup

Step 1 Image setup This first step of the BVS software allows you to perform the following operation:

– Selecting the operating mode for the BVS ConVis: Online or Offline (simulation mode).
– Select the current Task; create a new inspection or open an existing inspection to modify or view.
– Select the basic settings for the Vision Sensor while in Online mode.
– Selecting the reference image to use for setting up your inspection.

5.2.1 Creating a new sensor inspection

Note
Once you have successfully followed all the instructions in 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.

- ► Select in STEP1 “Online”; the BVS GUI software will now open the “Connection Mode Selection” window.
- ► Select “Find BVS”. The software now shows all found sensors at the right side of the screen, in the CONTROL PANEL. Select which sensor on the network to connect to in order to establish communication.
- ► Click the “Connect” button and the software will try to establish a connection with the sensor: if success, a message will appear, displaying the current connected BVS model type and the related Firmware version
- ► After the connection to the BVS sensor is established, if no Task is currently selected (STEP 2 and STEP 3 triangles are disabled and displayed with grey colors), BVS ConVis will automatically select “New Inspection” Task and starts displaying images acquired by the sensor in the IMAGE PANEL.
  ⇒ On the right upper side of the screen the ConVis Software now shows the"Basic Settings" in the control panel.
- ► If you have an inspection selected or loaded already select "New Inspection" from the drop-down menu below the "Select a Task" label.
  ⇒ The software will now open the "Model Type Selection" window.
- ► Choose the same BVS Model as your BVS sensor (either Standard or Advance) and press the "Ok" button.
  ⇒ The BVS GUI will now display "Basic Settings" parameters at the right side of the main window, in the CONTROL PANEL.

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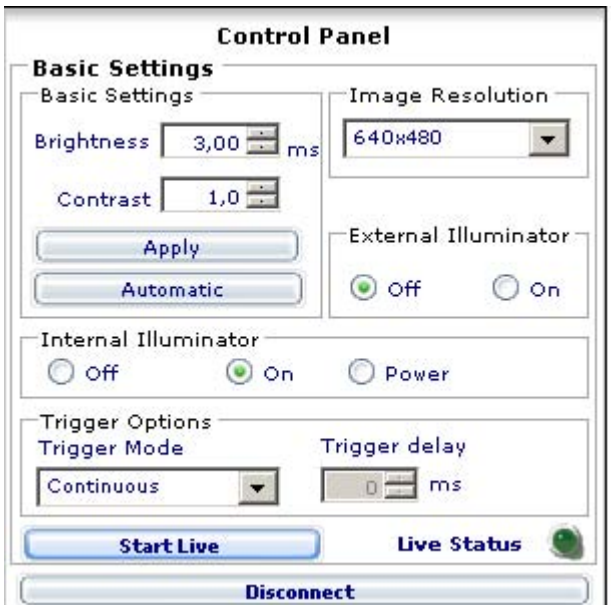


► Turn the focus ring on the sensor to set the focus. Turning the ring clockwise brings farther objects into focus. Turning the ring counter-clockwise brings closer objects into focus.

Fig. 5-1: Setting the focus

► Manually change the Brightness (Exposure time) and the Contrast (Gain) until the image is clearly defined or until the image has a good contrast and brightness level.
Press the “Auto exposure” button and to allow the BVS change the Brightness value automatically.
► Click on Trigger mode and change it to “External rising edge” or “External falling edge” if your part moves and you are using an external sensor to trigger the BVS (example; a through beam sensor detects the parts presence and signals the BVS to start the inspection). (see also “6.1 Triggers”)
► Click on “Stop Live mode” and then on “Set reference image”.

The following sections contain detailed information such as:
– Online and Offline modes
– Creating a new inspection
– Basic sensor settings.
Read on in Section 5.3 to learn how to further configure your sensor.

5.2.2 Operation Modes

As mentioned above, BVS ConVis offers two different operating modes:
1. *Online mode* with active sensor connection;
2. *Offline mode:* no active sensor connection, the inspection is simulated using images stored

5 Creating an inspection

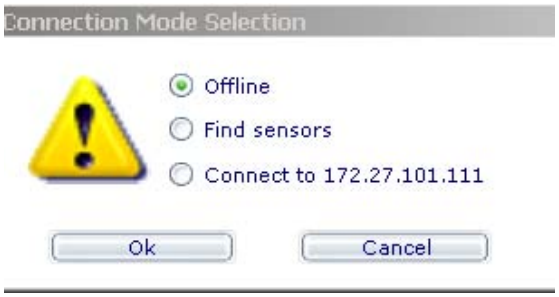
in the PC. The PC handles processing of the tools. This operation mode lets you simulate an inspection using previously stored images, thus you can test or configure an inspection without a connected BVS sensor.

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.

5.2.3 Establish a connection with the sensor – Online mode only

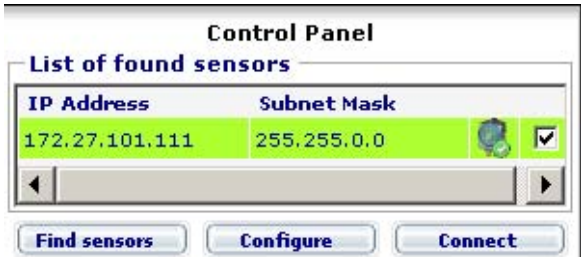
After starting the software this window is shown:



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

"Find sensors" operating field

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 at the right side of the main window:



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, representing the selected sensor to establish a connection.
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.
In this case see Section "7.3.4 Error remediation" for troubleshooting.
If the list contains multiple sensors, click on the control box in the last column to select the sensor you want to open a connection to.

5.2.4 Creating or opening an inspection

Once communication has been established with the sensor the next step for both Online and Offline modes is to either create a new inspection or load an existing one

Please click on the drop-down menu "Select a Task" ▼ 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 OI Standard:** An inspection with the tools from the standard model is created. **BVS OI Advanced:** An inspection with the tools from the advanced model 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 inspection 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 those images in Step 3 “Test and Run”. (see Section "5.4: Test and Run the inspection”)

More information about the differences between the Standard and Advances models can be found in Section 11.1.

After you have selected either the Standard or Advanced model, BVS ConVis opens a file dialog 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.

5 Creating an inspection

Creating a new inspection in Offline mode

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

If you choose "Open Inspection from PC" the BVS GUI opens a File Dialog. This dialog shows the list of inspections stored on the PC in the designated Project folder. Choose the file you wish to load into the BVS and press the "Open" button.
Inspection files of type *.bvs2 (software version 1.2.0 and higher) or (after changing the file type) .bvs (software versions 1.1.4 or older) can be opened.

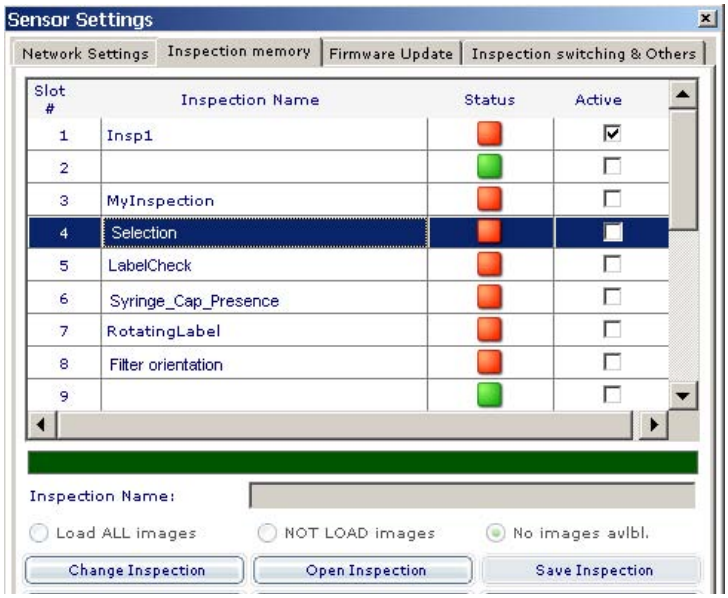
After selecting the file you want to open, click on OK; the file is loaded and STEP 2 is automatically activated. You can then test the inspection offline or connect to a sensor and load the inspection on to the sensor.

Important!
A type **.bvs** inspection file must be converted into one of type **.bvs2** before you save it to the sensor.
The software does automatically converts the **.bvs file** into a **.bvs2 file** if you choose "Save on PC" and then OK. The original .bvs file is kept for further usage.

Note
After conversion you shall test your inspection to be sure that it still works reliably. Please note the instructions for the tools “Contrast Check” and "Pattern Detect" in section “6.3 Tools for inspection”.

Opening an inspection from the sensor

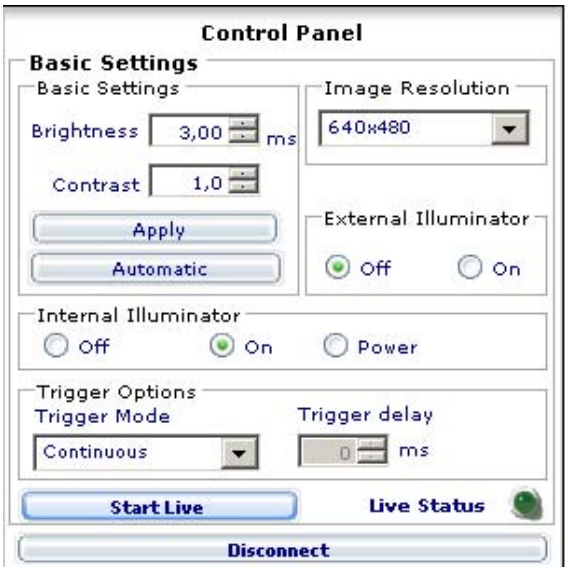
After selecting “Open from sensor" the BVS ConVis software opens a dialog box displaying the inspections stored in the sensor. Select one of them.



5 Creating an inspection

5.2.5 Basic settings – Online mode only

After selecting “New inspection” in Online mode, the Control Panel will display the Basic Settings of the sensor. Before changing the Basic Settings parameters, press the "Start Live" button. The camera will start capturing images and you will be able to view changes made to the Sensor Settings.



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 "Start Live" button

Parameter	Description
Brightness	Changing the Brightness (or exposure time) value will affect the image brightness. The higher the value you set, the brighter the visible image. Minimum value: 0.1; Maximum value: 100. Standard: 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. Adjust the brightness so that there is a high degree of contrast between the features and the background.
Contrast	By changing the Contrast (or gain) 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; Standard 1.0 Below you will find examples for low, medium and high contrast value.  Low contrast Medium contrast High contrast
Automatic	Pressing the Automatic button acts like an auto exposure; the sensor automatically adjusts the exposure time for the image setup. This value will vary depending upon the current ambient lighting conditions. Use this function for quickly viewing an image. You should still set brightness manually to achieve optimal results.

5 Creating an inspection

Parameter	Description
Image resolution	**Note:** Setting image resolution is possible only with BVS-E Advanced models. Represents the pixel resolution currently used by the sensor; this parameter affects the image dimension in pixels. By changing the image resolution the number of pixels per image line and column is changed. There are three possible image resolutions. The lower the image resolution (the lower the detail accuracy), the faster the image acquisition. **Note:** Changing the Image Resolution will cause a new inspection creation. The BVS software GUI does not allow for you to work with multiple image resolution at the same time. You can select the following resolutions: Resolution — Description 640x480 — High resolution. Attainable inspection rate: approx. 20 Hz 320x240 — Medium resolution. Attainable inspection rate: approx. 40 Hz 160x120 — Low resolution. Attainable inspection rate: approx. 80 Hz **Note:** Using a low image resolution may affect the robustness of the control execution. The lower the resolution, the fewer pixels and thus a reduction of information in the image. Avoid low image resolution usage with measuring controls (Position, Edge Count and Width)
External light	– On: An external light connected to the Trigger output (Pin 8 on the PWR IO connector) is triggered as soon as a new part is to be inspected. (**Note:** See page 13 for details of trigger output level.) – Off: The external light is not triggered.
Internal light	– Off: The internal ring light is turned off. – On: The internal ring 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. The Power function was incorporated for higher speed applications where you do not want to increase the exposure time (which increase the processing time).
Trigger mode	You can select from among 3 different trigger modes: – **Continuous (Standard):** The sensor records images at the fastest possible frequency, without an external trigger. The BVS captures and processes images without interruption. The time interval between the individual images may be subject to fluctuation. – **External rising edge:** The BVS captures and processes an image as soon as the rising edge of an external signal (from 0 V to 24 V) is registered on the trigger input. – **External falling edge:** The BVS captures and processes an image as soon as the falling edge of an external signal (from 24 V to 0 V) is registered on the trigger input.
Trigger delay	By changing the trigger delay parameter you can delay the start of image recording and processing by up to 500 ms after an external trigger signal is received.
Start / 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	The connection between the sensor and the BVS ConVis software is automatically interrupted. You can then continue to work in Offline mode.

5 Creating an inspection

Please take time in setting up the sensor and acquiring a good image, in focus with high contrast between the respected part features to be analyzed. This is the most important step in creating a robust and repeatable inspection.

5.2.6. Creating a reference image

Clicking on “Set reference image” specifies the currently displayed image as the "Master or Golden Image" which will be the base comparison of the inspection. All future images acquired will be compared to this image.

5.3 Step 2: Teach

After specifying the reference image, the software progresses to STEP 2. The following operations are available in this step:

– Inserting a Locator tool (short Locator) allowing the sensor to find the object inside the image.
– Inserting Control Tools allowing the sensor to check the object features.
– Configuring outputs.

5.3.1 Selecting and positioning tools

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

Control tool symbol	Name	Description
	Check Brightness	Compares the average brightness value in the ROI with the set minimum and maximum value
	Compare Contrast	Compares the maximum contrast value in the ROI with the set minimum and maximum value.
	Check Contour	Checks whether the contour (shape) of the current part (feature) agrees with the contour from the reference image.
	Count Edges	Counts the edges in the ROI (along a line) and checks whether the number lies between the permissible minimum and maximum.
	Compare Width	Compares the width in pixels between two edges and checks whether it lies between the permissible minimum or maximum.
	Detect Pattern Match	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.
	Check Position	Finds the position of the first edge in the ROI and checks whether it lies between the permissible minimum and maximum.

After you have selected a Tool from the drop down menu the cursor changes to an icon of each respected tool. Move the cursor to the desired location within the Image Panel and left click the cursor to position the control tool. The Control Panel displays the default parameters for this tool. Below the Control Panel the Inspection Explorer displays the parameters for all tools associated with the inspection. To adjust the parameters for your application, use the graphical controls provided in the Control Panel for each Control tool .

5 Creating an inspection

The calculated result of a Control is indicated by the Status indicator turning green or red; the frame of the ROI shown inside the IMAGE PANEL will be displayed in the same color as the status indicator..
By adjusting the parameters of the each tool in the Control Panel you define:
– When the tool returns OK or NOT OK,
– What the tool should take into account in the evaluation.

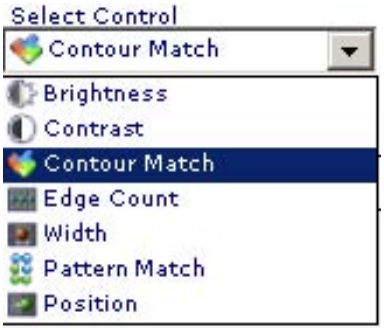
Note
Clicking on the tool ROI in the work area displays the Control's parameters in the Control Panel.

Note
Please take into account that the more Controls an Inspection has the higher the processing time for the Inspection.

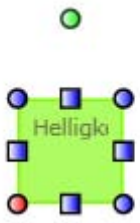
If you require more than one tool in your inspection, insert them one after the other. A maximum of 25 tools is possible.

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.
► 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.

5 Creating an inspection

Positioning

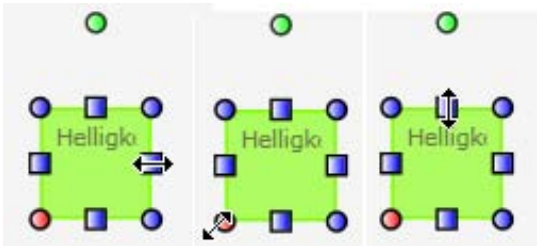
Changing the position of the ROI:

- ► 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 the ROI 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:

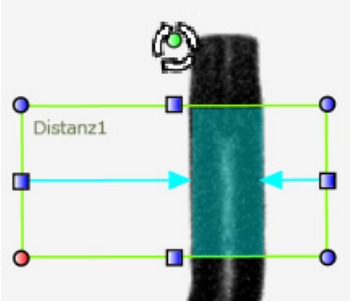


- ► Now LEFT click and change the size of the ROI by moving the mouse with the button held down.

Changing the rotation angle of the ROI

Changing the rotation angle of the ROI:

- ► Position the mouse pointer on the green dot above the ROI.
  ⇒ The mouse pointer symbol changes as follows:



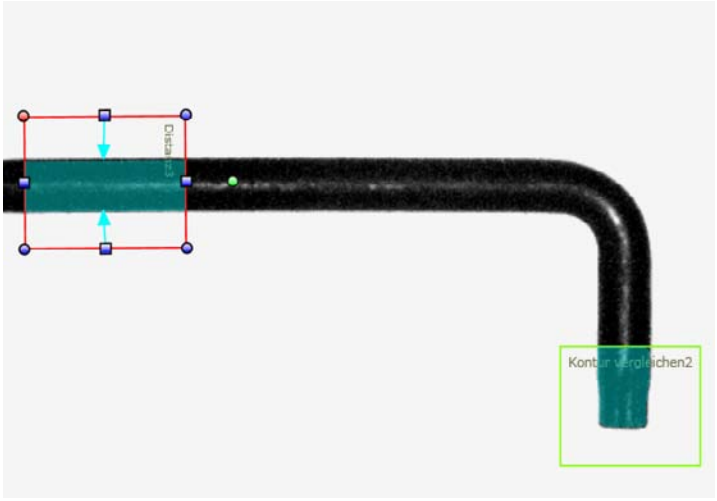
- ► Now LEFT click and ROTATE the ROI in the desired direction. The RED corner point of the ROI always shows you the starting point or the ROI's origin. For example to check a position from UP to DOWN, you must rotate the ROI so that the red corner point comes to rest at upper LEFT!

Deleting a tool

To delete a tool from the inspection, either click on the ROI of the tool in the “Work Area” or on the name of the tool in the Inspection Explorer. Then click on the “Delete” key in the tool Control Panel.

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

5 Creating an inspection



Key combinations shortcuts

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

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

5.3.3 Selecting the 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 "6.2 Locator tools".

Standard version

Advanced version

5.3.4 Setting tool parameters

BVS ConVis 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 Control Panel 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".

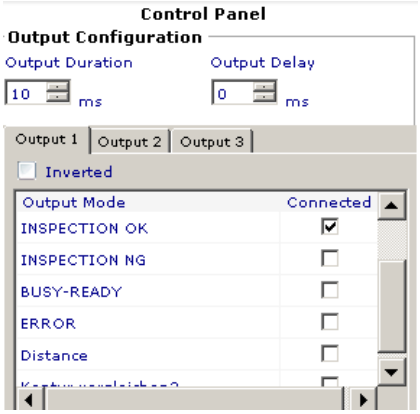
5 Creating an inspection

Details about the tools and their parameters can be found starting here: Section 6.3.5 ff.

- ► 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.

5.3.5 Setting outputs

- ► After all the tools have been created, positioned, and parameterized, please click on the “Output Setup” button.
  ⇒ The ConVis software now displays the settings for “Output Setup”.



- ► Click on the tab with the corresponding output name to configure the output.
- ► Above the tab you can set the parameters “Pulse duration” and “Switching delay” for all the outputs.

More information on the available output functions, the Output Duration and Output Delay parameters can be found in Section “6.4 Configuring the outputs.”
After you have set the output functions, exit Step 2 and click on the “Inspection settings” button to continue with “Step 3: Test and Run.”

5.4 Step 3: Test and Run the inspection

After specifying the reference image, the software activates STEP 3. This step includes:
- – Adjusting the inspection settings
- – Testing the inspection – offline or online.
- – Saving the inspection to the sensor

5.4.1 Inspection settings

In the inspection settings you specify:
- – Whether images are to be saved on the sensor,
- – Whether the Teach key should be activated or not.

“Save images on sensor” specifies whether the sensor should for example save defect images. The default setting is “Deactivated”, i.e. no images are saved on the sensor.
If you select “Activated,” you can use the selection list to determine under which circumstances an image will be saved on the sensor.

Parameter	Description
All	Sensor saves all images.
If part OK	The sensor only saves an image if all the tools return OK.
If part defective	The sensor only saves an image if at least ONE tool has returned NOT OK.

Note
The sensor can store a maximum of 10 images. As soon as an eleventh image needs to be saved, the first stored image is overwritten.

5 Creating an inspection

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.

Teach key

This parameter is used to specify whether the Teach key on the sensor should be activated. The default setting is deactivated.
When the Teach key is activated you can teach a new reference image.

To do this proceed as follows:
► Press the Teach key oncel.
⇒ The sensor turns on the green pointer LEDs for 20 seconds.
If you press the Teach key again within these 20 seconds, a new reference image is taught once you release the Teach key.

Note
Please note that when teaching a reference image, the position and size of the ROIs for the tools are NOT adjusted. We recommend using the Teach key ONLY if you have ensured that the inspection features have the same size and position in the new reference image as in the old image.

5.4.2 Testing the inspection

Click in STEP 3 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 Control Panel.
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” and in the Inspection Explorer.

Note
The images must be saved as BITMAP (.bmp) and have a resolution of 640x640 pixels with a bit depth of 8 bits.
Are you unsure whether your image meets the requirements?
Then open Windows Explorer, search for and open the folder containing your image, right-click on the image and select Properties. Then select the Summary tab and compare the information there with the requirements.

"Test"

In testing, the Control Panel 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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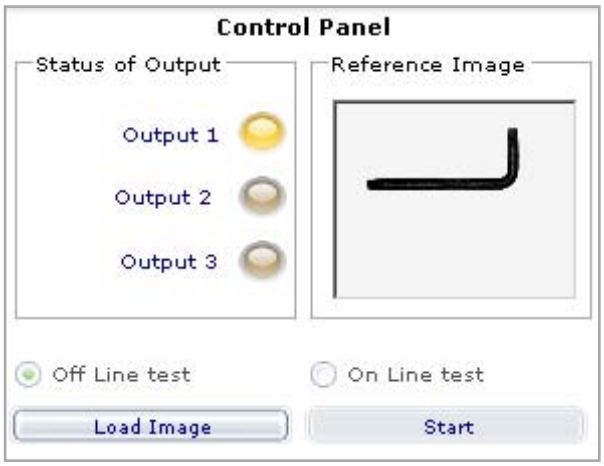


Buttons	Description
Load image	Offline mode only. Loads additional images into the frame buffer. The loaded images can then be tested according to the current Inspection settlings.
Start / Stop	Online mode only Sensor begins to acquire images; the Inspection execution is performed on the PC; the results are updated.

5.4.3 Running an inspection

To save and run the inspection on the sensor, click in Step 3 on the “RUN” button (under the “Test” button). The Control Panel 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
Graphic Enabled	The sensor sends the current images and the evaluations to the PC. The PC displays them in the “Image panel” area.
Statistics and timing	The sensor does not send images to the PC. The PC shows: a) The execution results for each tool. b) The execution time for each tool and the total execution time. c) Statistics on how many “parts” were tested and how many of these were good and bad. These values may be used to evaluate the performance of the inspection currently performed by the sensor.
Start / Stop	Starts and stops application of the inspection.

Note
After pressing the “Start” button the SVS2 GUI will ask you to save the current Inspection into one of the 20 available sensor Slots. Each Inspection can be given an individual name for an easy identification.
If your sensor is running a firmware version older than ST.2.1 you will see only 8 memory Slots available for inspection saving.

"Graphic Enabled" and "Statistics & Timing"

After starting in “Run” 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”.

Note
Operating the sensor with “Graphic Enabled” reduces the sensor performance significantly, which is why not every image is displayed in this mode.

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 "10.1 Inspection times."
"Stop" then stops running of the inspection.

If you notice that you need to change parameters of the tools while you are performing your test or while running your Inspection, then click stop in the Control Panel; click back to STEP 2 and modify the tool parameters as necessary. Then click on Test or Run to restart the Inspection analysis.

The sensor has now been configured and is ready for operating in standalone mode.

Disconnecting the sensor from the PC

If the inspection works as desired, you can disconnect the sensor from the ConVis software: Click on "Offline" or Press the pull-down menu under the "Sensor" Menu and select "Disconnect.

The sensor now runs autonomously. You may now disconnect the Ethernet cable from the sensor (if desired). We recommend sealing the to PC (Ethernet) 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..

5.5 Lighting

Basic considerations

One of the most important technical factors to solve an application is lighting. Failure or Success in solving an application often depends on choosing the correct lighting.
Lighting conditions are critical aspects in all machine vision applications, thus they have to be carefully set and preserved during the whole Inspection process. Failure to consider the importance of lighting in the application will often result in unstable and undesirable inspection results.

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.

Notes for proper use of lights

– **Keep the lighting of the field of view and the object 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.

– **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 have a recognizable contrast from their 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 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 may cause saturation of the scene. In such cases we recommend use of an external diffuser 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

5 Creating an inspection

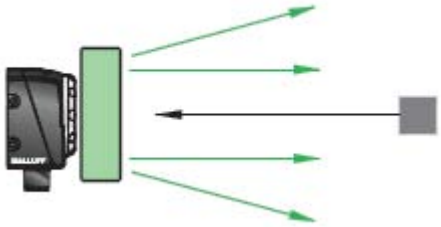
than 300 mm or parts need to be inspected using background lighting.

Below you will find a brief description of the lights offered by Balluff:

Types of lights

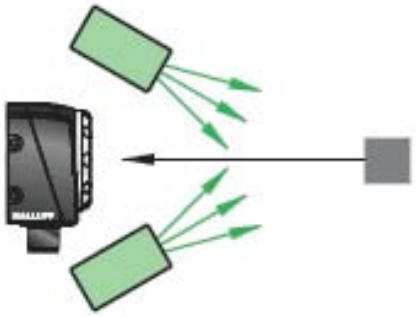
– **Ring light**

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.



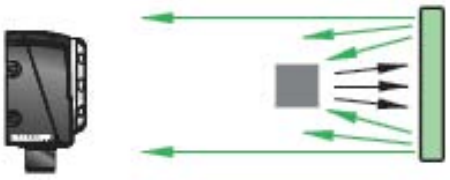
– **Incident light**

This type of lighting 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 light onto 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. When backlighting is applicable it is a preferred means of illumination..
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 usually must be larger than the inspection area.



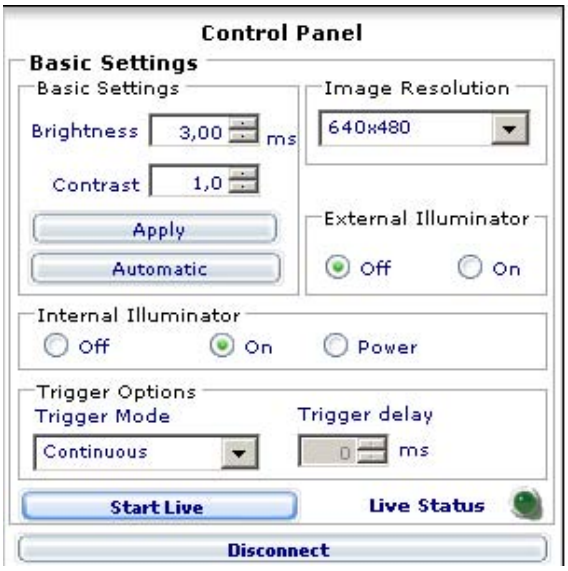
Typical applications include sorting of objects by shape and dimensions, measuring distances between chip connection pins, checking objects for holes or cracks.

The “List of available accessories” includes the technical data for the lights offered by Balluff.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

6.1 Triggers

In general a trigger signal starts an event – together with the BVS a trigger signal triggers image recording and processing (i.e. the trigger signal serves as an initiator for the image sensor). You can set trigger mode and the trigger delay in the Basic Settings Control Panel.



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

Trigger modes

The BVS distinguishes from among three 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).

Trigger delay

By changing the trigger delay parameter you can delay the start of image recording and processing by up to 500 ms after an external trigger signal is received. Use this parameter for example to ensure that the image is recorded when the object is actually in the field of view. External trigger always means that the sensor is triggered by an electrical signal which can be generated for example by a photoelectric sensor.

Note
We recommend when first checking Test mode that the continuous trigger be used, which makes it easier to test the tools and their proper setting.

Note
Be sure the sum of delay time and the Inspection duration time is always considerably less than the time period between two parts to be inspected. If you infringe this rule the sensor is not able to give a result for every part.

6.2 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.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

Locator for changing part and feature location

If the “searched” feature on the part you are inspecting is always in the field of view however not in the same location, a locator can be used to compensate changing part locations from image to image.

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.

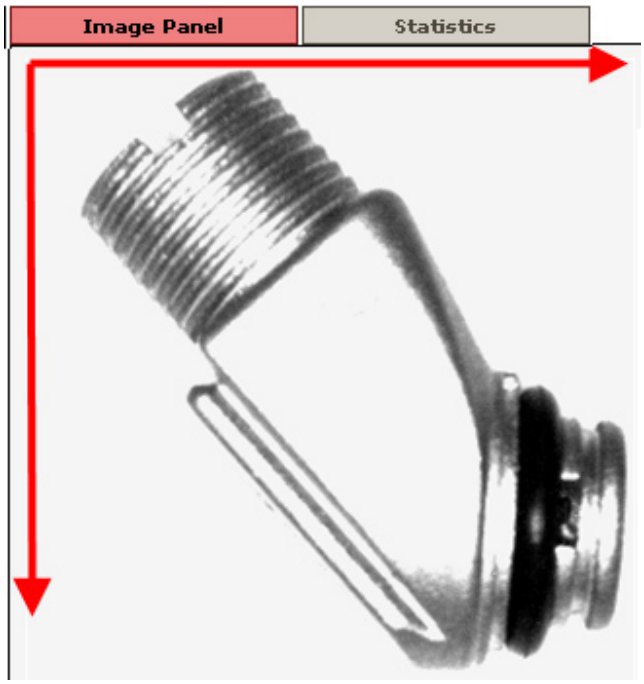
Notes
- There can be only ONE locator tool in an inspection
- If the locator returns a NOK, then none of the other tools in the inspection are checked. Then only the ROI of the locator is shown in RED in the current image or reference image. The ROIs for all the other tools are not displayed.

6.2.1 Applying the locator

Locator tools are inserted, positioned and enlarged in the inspection like normal Control tools. More information on using tools can be found in Section “5.3.1 Inserting tools”.

No Locator: Fixed ROIs

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.



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.

Example

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.

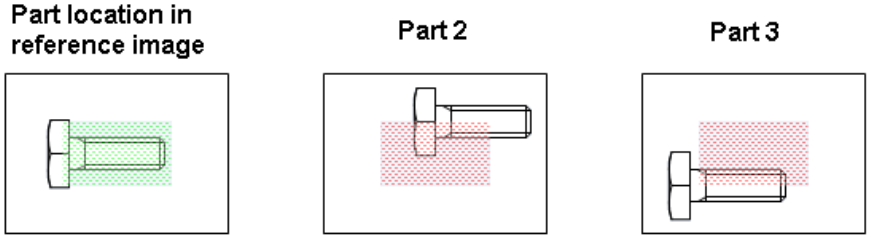


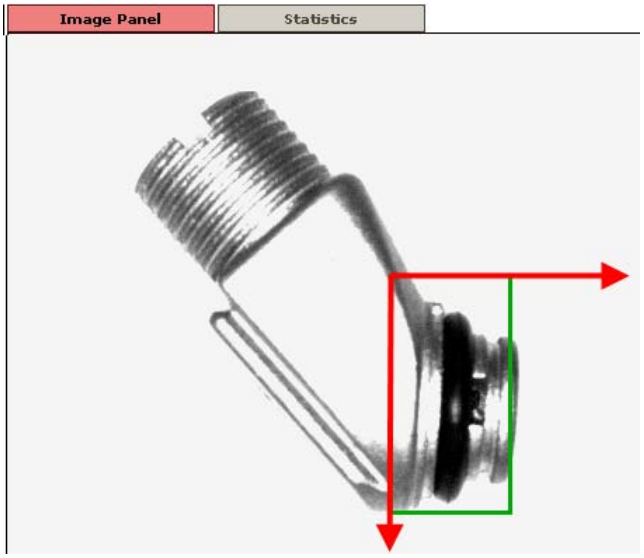
Abb.6-1: Changing part location without locator

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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 vary with "position" of Locator

If there is a locator in an inspection, then all the Control 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

The first image at left shows the part location in the reference image; the “Pattern Match” 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.

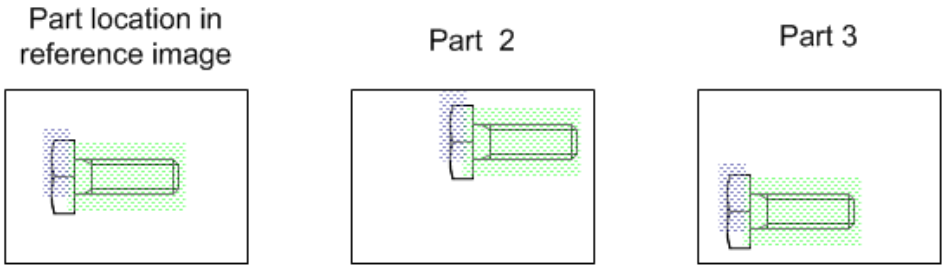


Fig.6-2: Changing part location with locator

6 Trigger – Locator – Tools – Outputs – Inspection Changing

6.2.2 Brief description of 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
	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 Match	Searches within the search region (outside rectangle) for the pattern that was learned in the reference image (inner rectangle). 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 Match	**Note**: 360° Pattern Match is only available with BVS-E Advanced models. Searches within the search region (outside rectangle) for the pattern that best matches the pattern learned (inside rectangle) 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 NOT symmetrical (e.g. a square or a circle). Target objects with less than 4 corners will not be recognized.

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. For additional information see Section “6.4 Configuring the outputs”.

After you have added a locator to the current inspection, the Control Panel shows its current parameters.

The following sections contain detailed descriptions of the locator tools.
– Position Locator (also referred to as “Edge Locator”)
– Pattern Detection Locator

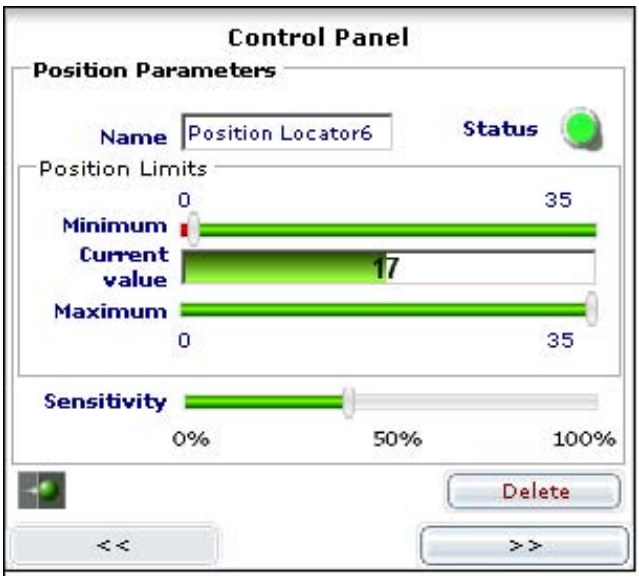
6.2.3 Position Check locator

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.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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.

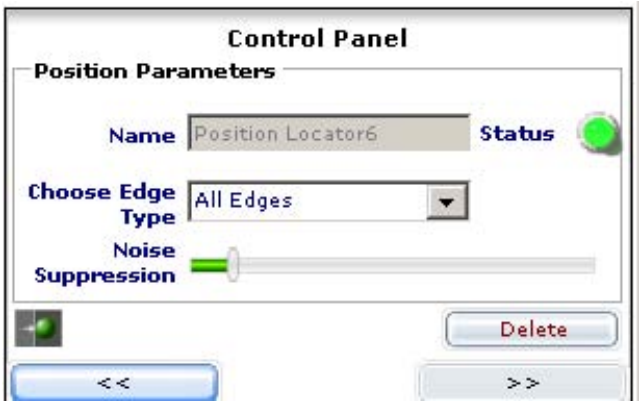
Note
With this tool ONLY one position change in the set direction can be located.



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.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

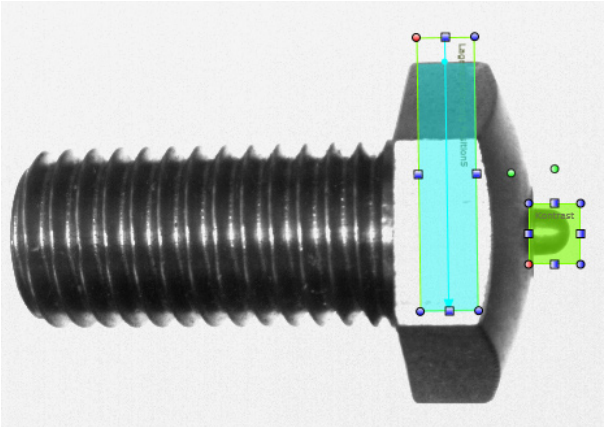


Parameter	Description
Edge type	Determines an edge type to search for in the image. The selection possibilities are: – Select **All Edges** to detect transitions from bright to dark or dark to bright. – Select **only Black-to-White** edges to find only transitions from dark to bright. – Select **only White-to-Black** 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”.

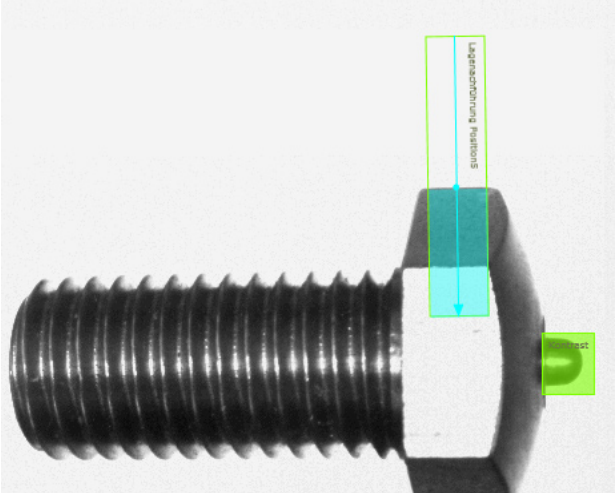
Example

When locating the position of a screw in the vertical direction (i.e. from up to down and vice versa) and to check if the part on the screw head is present or not (e.g. using a contrast tool). To do this, insert the “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).



6 Trigger – Locator – Tools – Outputs – Inspection Changing

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.

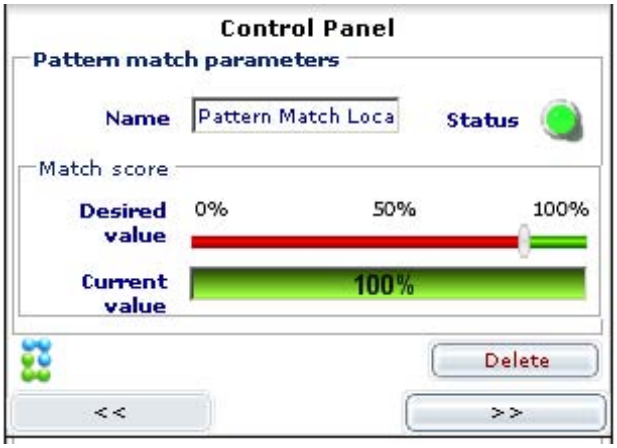


6.2.4 Pattern Match locator

The “Pattern Match” locator searches within the search region (outer rectangle) for the pattern (inner rectangle) which best fits the taught pattern. It "founds" a pattern and passes its position to other tools,when the actual value exceeds the match score..

The result of the Pattern Match 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 locator into the inspection the following Control Panel is displayed:

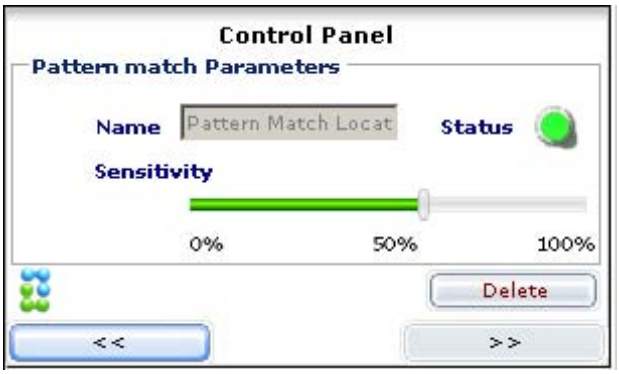


Parameter	Description
Name	Name of the tool Max. length 256 characters
Status	Green: OK. The similarity of the pattern found within the search region with the parameterized pattern is greater than the set desired value. Red: NOK. No pattern found whose similarity is less than or equal to the set desired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

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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 considered valid. 100% = Identical pattern, 0% = No similarity. The default value is 85%.
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 >> key 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

Example

Check the orientation of chip cards.
OK is terminals at upper right; NOK is any other location.

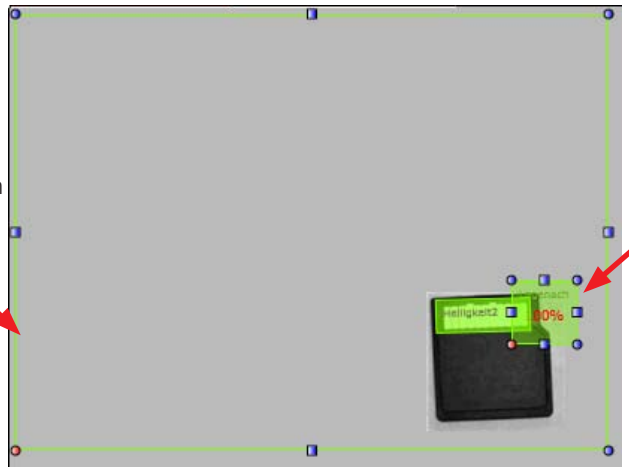
Since the chip cards can be found anywhere in the field of view but only in 2 different positions (terminal up or terminal down), we are using here the "Pattern Match" locator.
After insertion we see two frames, with one lying inside the other. The outer frame marks the search region, the inner ROI of the target pattern. 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 region – if the pattern lies outside the search region (but still within the image area of the sensor), the pattern will not be found.

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

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

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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 target pattern.

In this example the Pattern Match Locator was positioned for two reasons:

1. The corner is different from the 3 other corners and is therefore UNIQUE - in this way a reference to the orientation of the card can be determined..
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.

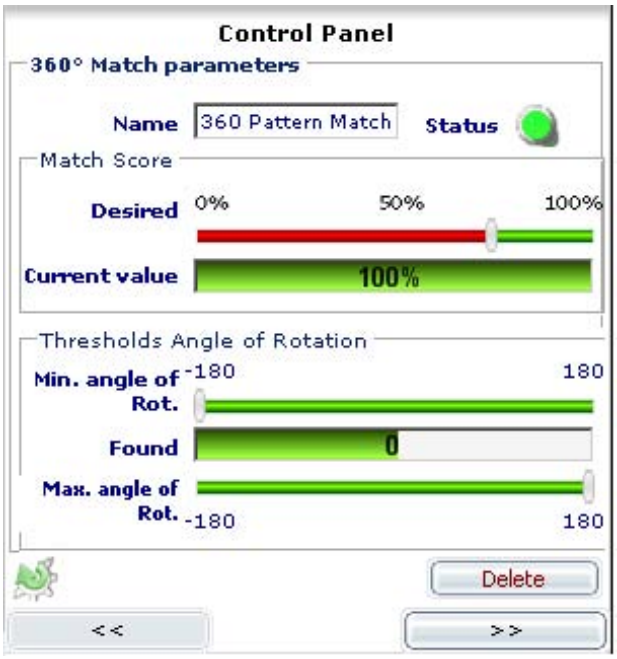
But if the card orientation is wrong, as in this illustration …

... then the card is not found – the inspection in this case is NOK. If the card is allowed to have any direction use the 360° Pattern Match Locator to solve this application.

6.2.5 360 Degree Pattern Match locator

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

The “360 degree Pattern Match” 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 Match” into an inspection, the software will show you two rectangles: The search region – and the inner rectangle, representing the target pattern to be searched in the region delimited by the search region. The pattern searched for by the tool is defined by the “corner points” in the ROI of the reference image and their location with respect to each other.
The software shows you all the corner points found in the search region as **LIGHT BLUE** dots. Please note that the pattern searched for should be defined by at least 5 corner points.
The tool uses the following Control Panel:



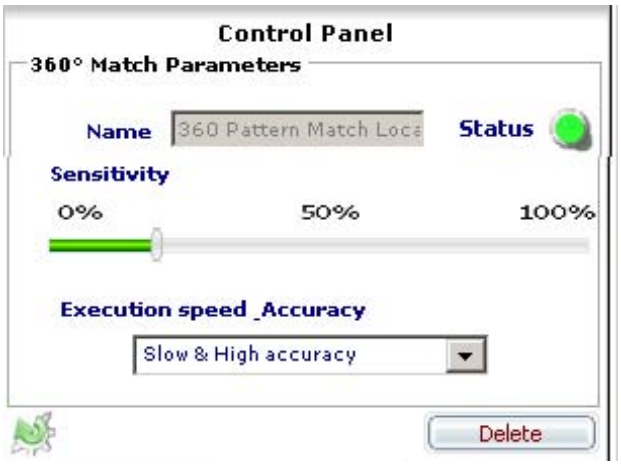
Parameter	Description
Name	Name of the tool Max. length 256 characters.
Status	Green: OK. The found pattern has an actual value greater than or equal to the set desired value. The rotation angle of the pattern lies within the limits Min. rotation angle and Max. rotation angle. Red: NOK. Either no pattern 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 region and the reference pattern must be for the tool to return OK.
Actual value	The actual value is the similarity of the found pattern with the reference pattern in percent. Actual value 100% means the pattern identical to reference pattern.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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.

After clicking the >> key the second "page" of the Control Panel is displayed:



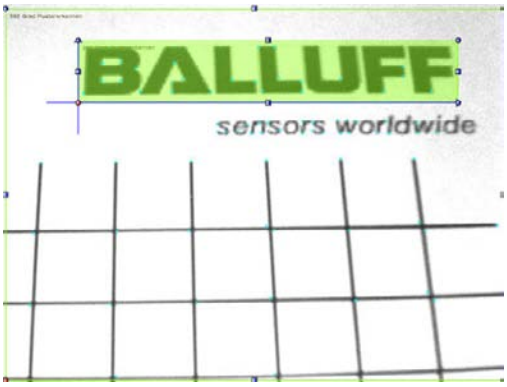
Parameter	Description
Sensitivity	By changing the sensitivity you can affect which corner points are detected by the tool. The greater the sensitivity the less the contrast and sharpness needs to be for a corner point to be detected. The sensitivity is set by default at 20 percent. We recommend changing the sensitivity only if your inspection does not work using the default setting.
Acquisition time - 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.

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

1. The feature may not be round. Round features (parts) may not guarantee reliable locating, since no definitive corner points can be detected.
2. The feature may not be symmetrical.
   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.
3. 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.
   We advise to use additional lighting to compensate for reflections and eliminate the need to tilt the sensor.

In 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:

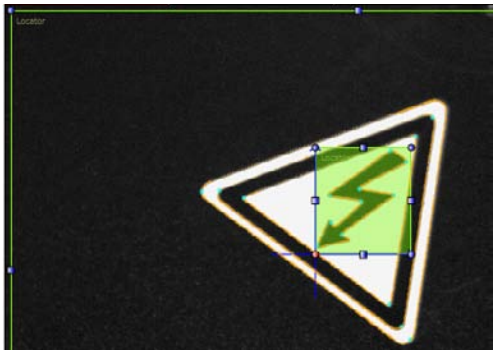
6 Trigger – Locator – Tools – Outputs – Inspection Changing



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.

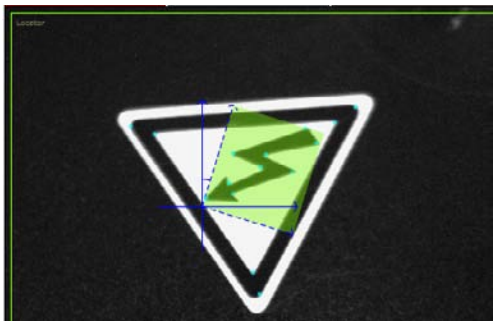
Example

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 “360° Pattern Match Locator” tool:

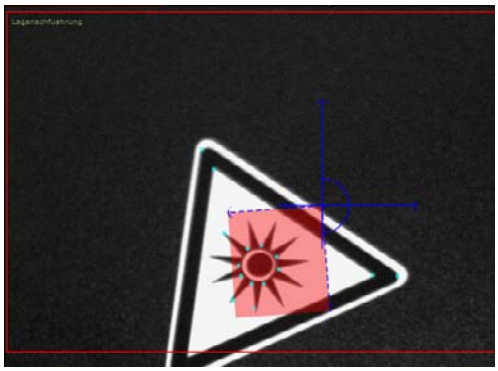


The target pattern is the lightning bolt – defined by the ROI. Also displayed is the orientation of the pattern - represented by the dark blue coordinate system. The origin always lies on the VERTICAL AXIS!
In the following illustration a rotated label positioned differently is found and its rotation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

6 Trigger - Lagenachführung - Werkzeuge - Ausgänge - Inspektionsumschaltung



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. Select a search region and ROI only as large as absolutely necessary!

6.3 Tools for inspection

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 position 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.

6.3.1 Selecting the right tools

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

"Brightness" tool

Use

Brightness tool 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.
Brightness Control can be used to verify if a certain feature is present or absent in the portion of the image included in ROI borders. Examples of usage for Brightness are:
– Checking the presence of a white label on a dark box;
– Differentiating dark objects from white objects;
– Checking if a signal lamp is on or off and if it has the correct brightness.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

"Contrast" tool

Contrast Control calculates the difference, given as ratio, between the lightest and the darkest group of pixels within the ROI. Considering a ROI characterized by 50% of black pixels and the remaining pixels white: the calculated contrast value is 100%. Considering a ROI characterized by pixels having the same brightness level, the calculated contrast value is 0%.

Use

Contrast Control can be used for the following applications:
- Presence and absence verification of a feature inside the ROI e.g. a label or an O-Ring.
- Integrity controls: verification if the assembled object contains all the required parts.
- Liquid level controls on transparent bottles - with background lighting.

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. 6-3a shows a good part with printing, Fig. 6-3b a bad part without printing.

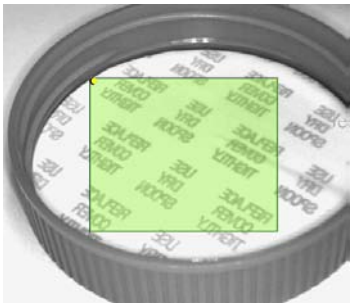


Fig. 6-3a Inspection for the correct printing OK

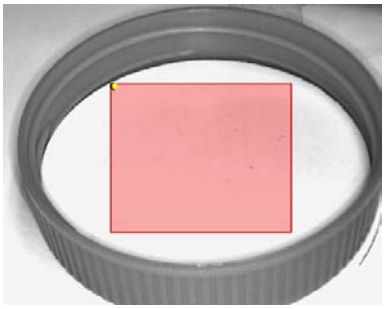


Fig. 6-3b Inspection for the correct printing NOK

"Contour Match" tool

The tool “Contour Match” determines the outline (contour or shape) of a feature (part) within the ROI. The determined contour is compared with the learned reference contour and the degree of similarity is displayed as an 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 Match 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 “Contour Match” 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
- Integrity controls: verification if the assembled object have the required shape.

"Edge Count" tool

“Edge Count” 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.

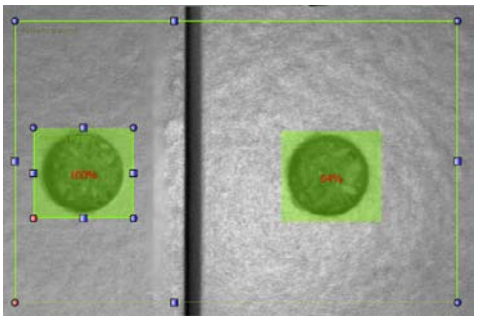
Use

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
- Count the number of features

6 Trigger – Locator – Tools – Outputs – Inspection Changing

"Pattern Match" tool

In pattern match operation, the target object and current object are compared to determine if they are similar.
The Pattern Match Control searches for all the occurrences of the target inside the search area and determines their position and the number of occurrences found. In this way it is possible to detect the horizontal translations and either the vertical displacement of the object among the inspection area.
The Pattern Match Controls allows for finding horizontal and vertical positions within the SEARCH AREA. It can be used to compensate rotational displacement up to a maximum of 5-10 degrees. More than one pattern can be found in the image, e.g.



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

Use

Use “Pattern Match” for example for the following applications:
– Verifying the integrity of an object (i.e. a label on a box)
– Control of absence/presence of objects.
– Part orientation control - e.g. pattern is present at bottom or top of the part.
– Counting of the number of objects equivalent to the target one and currently present inside the image.

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 as shown below.
Fig. 6-4a shows a successful inspection, and Fig. 6-4b a bad part

Fig. 6-4a Pattern detection of a shampoo bottle seal: OK

Fig. 6-4b Pattern detection of a shampoo bottle seal: NOK

"Position" tool

The “Position” tool searches for the position of the first edge (transition) between:
– A light and a dark area (White to Black)
– A dark and a light area (Black to White)
in the current image. If this position lies within the set limits, then the tool returns: OK, otherwise: NOK.

Use

Use the “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. “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 the set minimum or maximum, the result is OK.
– Checking correct part location – see example below.
– Checking whether a seal is fully closed.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

Example

Correct application of a nozzle on a bottle needs to be checked. We insert the “Position” locator into the image. Then we change the value for Maximum so that an incorrectly placed nozzle results in a value greater than the permissible Maximum. If the actual value is greater than the maximum value, the position of the nozzle is NOK.
Fig. 6-5a shows a correctly placed nozzle; Fig. 6-5b shows an incorrectly placed nozzle.

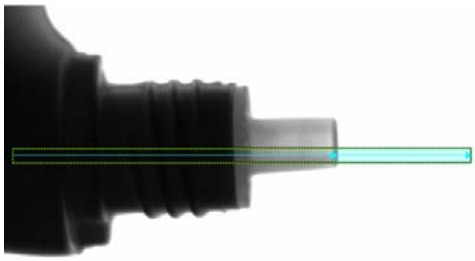


Fig. 6-5a Position checking of the nozzle of a dish liquid bottle: OK

Fig. 6-5b Position checking of the nozzle of a dish liquid bottle: NOK

6.3.2 Multiple tools in an inspection

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 use more than one tool in an inspection, then the inspection (the part) is OK if all tools return OK. If only one tool returns NOK, the inspection is NOK.

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

The cycle time of an inspection is always as follows:
- The cycle 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 provide a result (either OK or NOK).
- As soon as all the results have been calculated, the outputs are set accordingly and kept on for the pulse duration.
- The sensor is ready for another inspection cycle.

More information on the topic of the time response of the inspection can be found in Section “6.4 Setting outputs" and "10.1 Inspection times".

Note
If an output is configured for the result "PART OK, this output will only be “High” if all the tools in the inspection have resulted in an OK status. If an output is configured for the result PART NOK, it is “High” if at least one of the tools has resulted in a NOK status.

6.3.3 Selection and positioning

More information on selecting and positioning tools can be found in Section “5.3.1 Selecting and positioning tools”.

6.3.4 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

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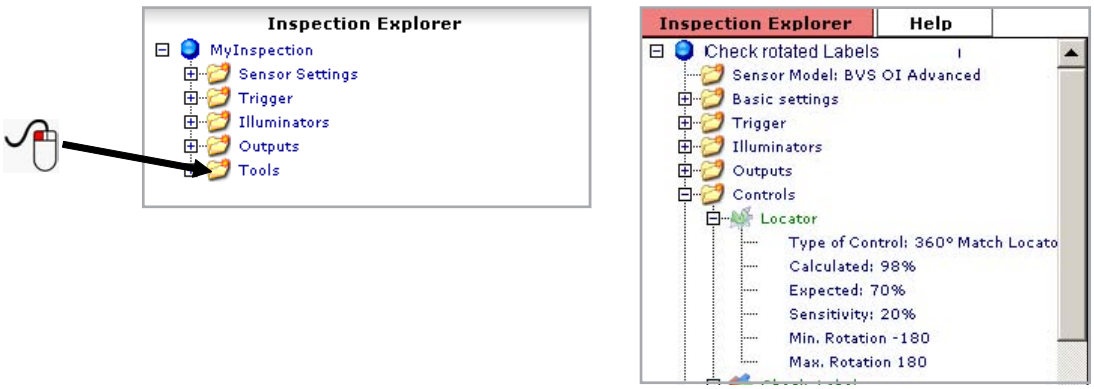


The following sections contain detailed descriptions of each tool.

6.3.5 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 "6.3.1 Selecting the right tools"

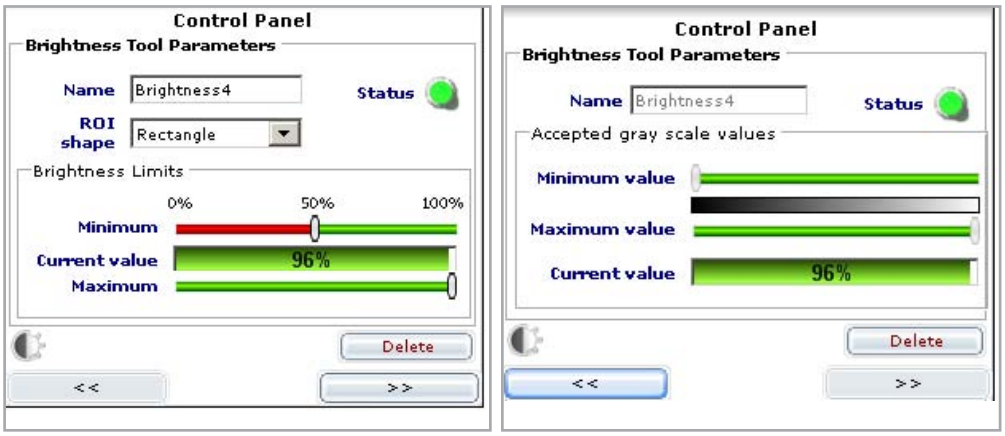


Fig. 6-6: Control Panel for Brightness, page 1 and page 2

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.

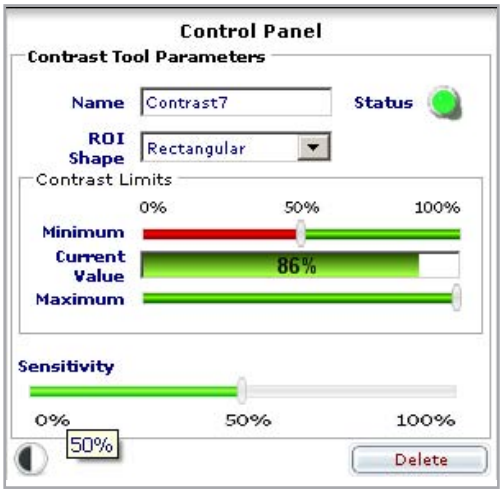
Parameter	Description
Minimum and Maximum gray value	If the minimum gray value is 0 and the maximum gray value 255, then the average brightness of all pixels in the ROI is calculated. You can use the minimum gray value for example to remove dark pixels and dark areas from the evaluation by increasing the value. You can use the maximum gray value for example to remove bright pixels and dark 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. Brightness checking 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 not that ambient light can have a strong influence on the evaluation. We recommend shading the feature you are inspecting from ambient light when using "Brightness"!
2. "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.

6.3.6 Contrast

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 "6.3.1 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
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.

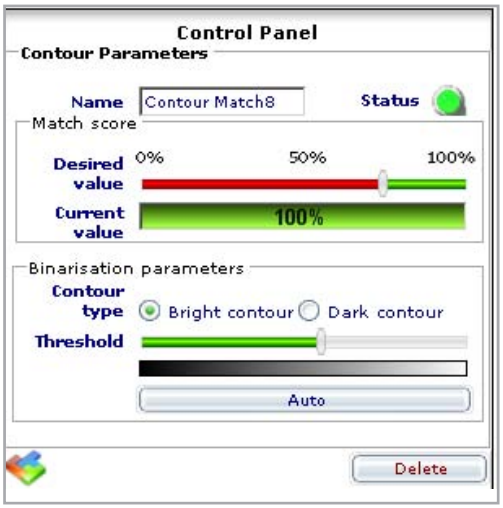
Parameter	Description
Minimum & Maximum	The result is OK as long as the actual value lies between Minimum and Maximum. The result is NOK if the actual value is less than the minimum value or greater than the maximum value. The default value for the Minimum is 50%; the default value for Maximum is 100%. – 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:

1. Updating from software version 1.1.4 or older to version 1.2.0: In versions 1.1.4 or older the maximum contrast was ALWAYS calculated. Please test your inspection after updating and adjust the sensitivity parameter as needed if the inspection does not run as usual after the update.
2. "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.

6.3.7 Contour Match

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 "6.3.1 Selecting the right tools"



Parameter	Description
Name	Name of the tool. Max. length 256 characters.
Status	Green: OK. A contour similar to the reference contour was found. Red: NOK. No contour was found or the similarity of the found contour lies below the specified desired value.

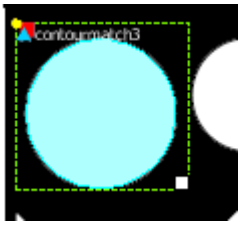
Parameter	Description
Desired value	The desired value represents the threshold value for similarity (actual value) of the current contour to the reference contour. If the actual value exceeds the desired value, the tool returns OK. 100% = reference contour is identical with the current contour, 0% = 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.
Automatic	After clicking, the best threshold value for the ROI is determined once.

Notes on using:

1. “Contour Match” looks only for closed contours (shapes) 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. “Contour Match” 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!

Example

The bright circle in the illustration below is 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!

6.3.8 Edge Count

The following illustrations show the Control Panel of the tool. A detailed description of the tool parameters can be found in the table. A description of the tool can be found in Section “6.3.1 Selecting the right tools”.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

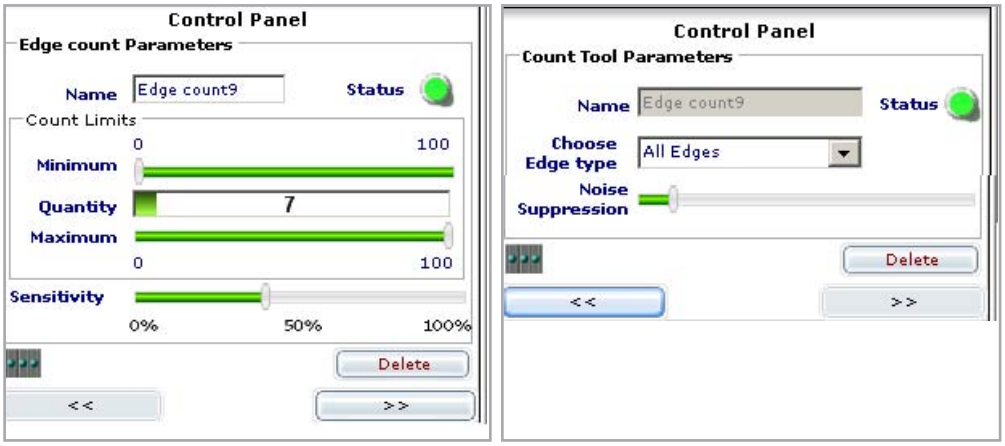


Fig. 6-7: Control Panel for “Edge Count” page 1 and page 2

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, this can alter the number of detected edges.
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 **Black-to-White** edges to find ONLY transitions from dark to bright. – Select only **White-to-Black** 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 “Edge Count” 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) are detected as GOOD, then you must set the minimum to 0!

6.3.9 Width

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 "6.3.1 Selecting the right tools".

Fig. 6-6: Control Panel for Width, page 1 and page 1

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.
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 **Black-to-White edges** to find ONLY transitions from dark to bright. – Select only **White-to-black edges** to detect transitions from bright to dark. – Select **Automati**c 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.

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

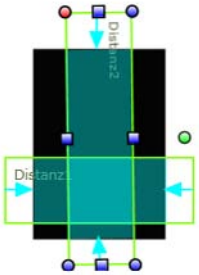
Notes on using:
1. The “Width” tool cannot compensate for a position shift of the feature. If the position of the feature can shift within the sensor field of view, you must use a Locator tool.
2. Since two edges need to be found in order to determine a width, the minimum error is at least ± 2 pixels!

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:

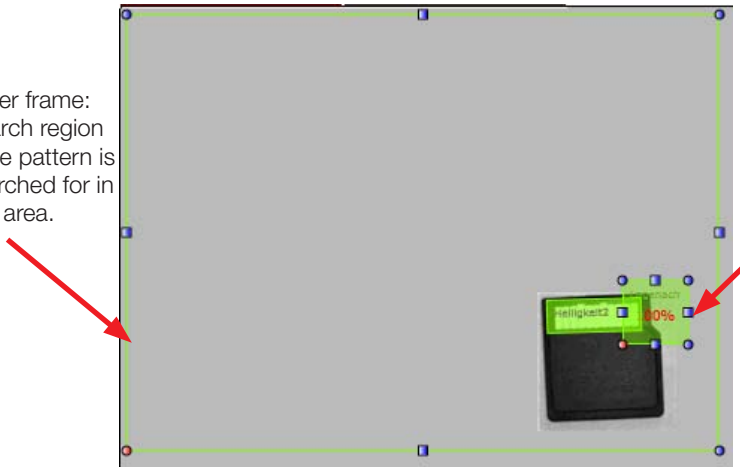
The found actual width is indicated by the light blue lines inside the ROIs. By using the Minimum and Maximum parameters you can set how far the actual width is allowed to deviate from the width found in the reference image in order to be still considered acceptable.



6.3.10 Pattern Match

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

Outer frame: Search region – the pattern is searched for in this area.



Inner frame: ROI – having the found pattern

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 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 “6.3.1 Selecting the right tools”.

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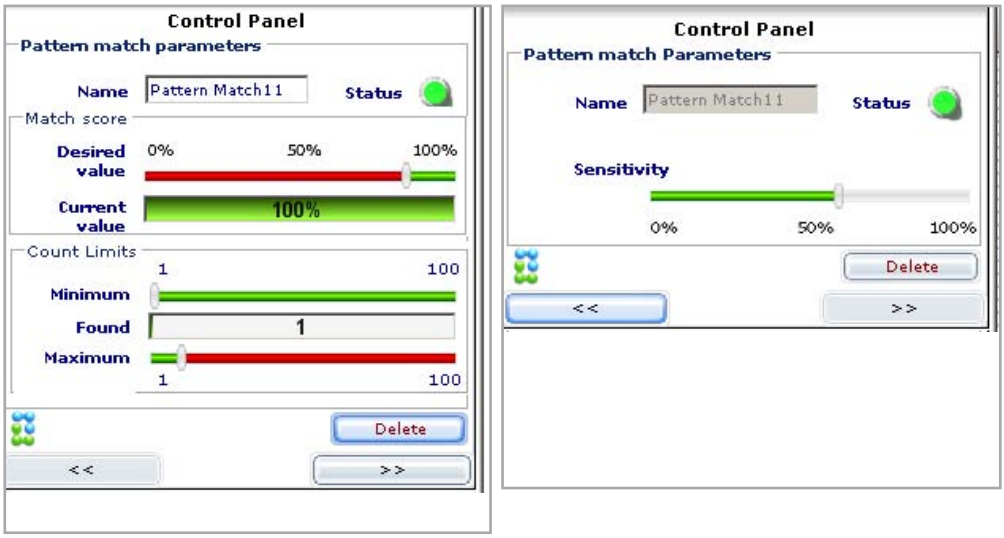


Fig. 6-9: Control Panel for Pattern Match, page 1 and page 2

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%.
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 within MINIMUM and MAXIMUM. If no patterns are found or the actual number 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 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

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 run time for the “Pattern Match” tool depends greatly on the size of the ROI and search

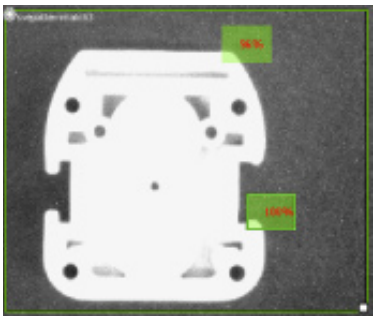
area. The larger the area, the more time is required. Therefore we recommend setting the ROI and search area as small as possible but as large as necessary.

3. In order to rotate “Pattern Match” 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.



6.3.11 Position

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 “6.3.1 Selecting the right tools”.

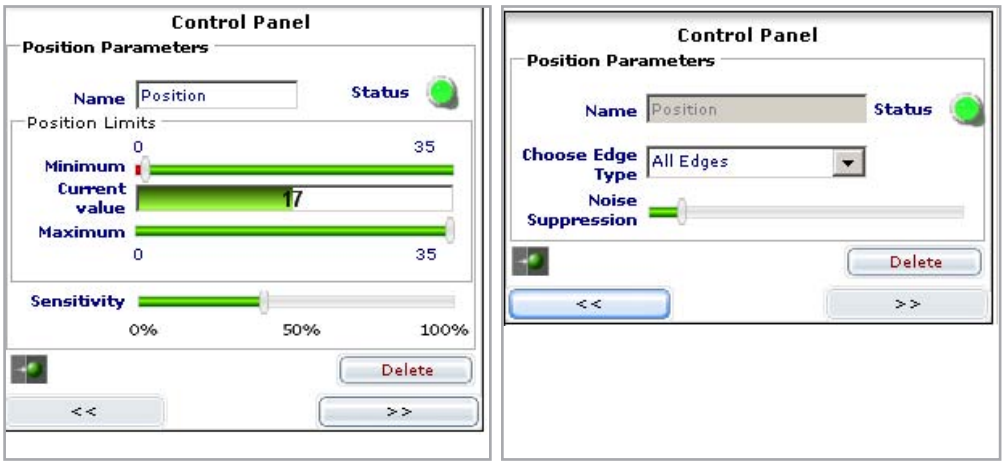


Fig. 6-10: Control Panel for Position, page 1 and page 2

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.

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 **Black-to-White edges** to find only transitions from dark to bright. – Select only **White-to-Black 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 “Position edge” 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”.

6.4 Setting outputs

After clicking on “Output Setup” you can assign the desired results to the outputs 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.
- **Advanced models only:** The result of a logical operation, e.g. a logical AND, logical OR 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.
- **Both 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 "6.5 Changing inspections and External Teach").

- Error: One of the following errors occurred:
  - Cycle time of the inspection was greater than the set switching delay, i.e. there is still no result available at the time the outputs are supposed to switch.
  - New trigger signal was received even though the last cycle is not yet complete.
  - The sensor is still busy running the last inspection, but a new inspection is supposed to be started.
  - Firmware error – a firmware error occurred during the inspection. The sensor must be restarted and cannot continue to run the inspection.

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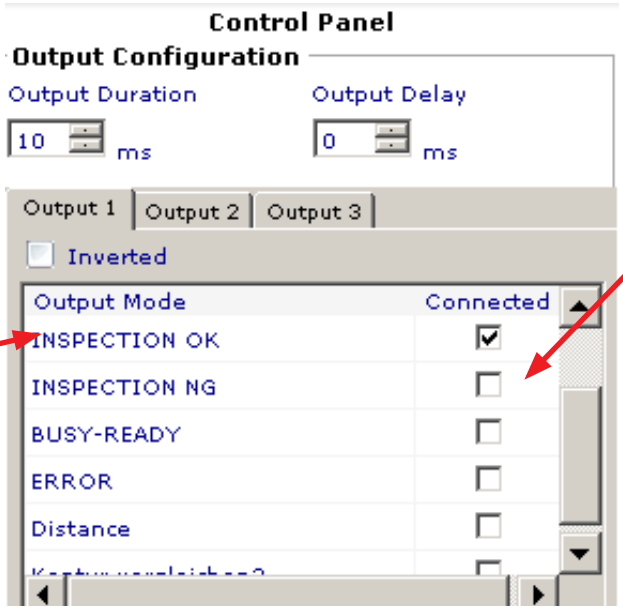
Note
The output functions Toggle, Busy-Ready and Error are NOT updated in the Control Panel in Step 3 “RUN”.

After clicking on “Set outputs” you can assign the desired function to the outputs in the Control Panel (upper right in the screen).

Note
If you are using an Advanced model, the "Output Setup" view is displayed in the middle of the software. In this view you can create logical operations and assign them to the outputs. More information about logical operations can be found later in this section.
By default these are deactivated.

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.

Parameter	Description
Output 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. Output duration 0 ms implements a “signal extender”. An example of this can be found below in the "Timing" section.
Output delay	The output delay is the time between the trigger and when the inspection result is present on the outputs. If the cycle time for calculating the inspection is less than the set output delay, the outputs only become active after the switching delay time has expired. If the cycle time for calculating the inspection is greater than the set output delay, the outputs become active as soon as the inspection has been calculated. In this case the ERROR result is also HIGH. The output delay thus defines the minimum time after which a result can be present on the outputs.
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 and output delay affects each of the three outputs.

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Please be sure that the total of output delay and output duration is 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”.

Logical operations

Logical Tools perform logic operations on one or more logic inputs and produce a single logic output. The Logical Tool inputs are logical results of the Inspection Controls.
Logical Tools are useful to configure a logical network between Inspection Controls and BVS sensor outputs: in this way it is possible to connect the result of a subset of Inspection Controls to a single output of the sensor.
Logical Tools are positioned graphically on the OUTPUT SETUP PANEL using the mouse. When you insert a Logical Tool, the CONTROL PANEL displays the set of possible inputs that can be connected to the logical tool; a Logical Tool input can only be an inspection Control or a Logical Tool already inserted in the Inspection.
The execution of one of these Tools provides a single result, representing the logical result calculated during the Tool processing. There are two possible values for the result of a Logical Tool:
– SUCCESS: Tool gave a positive outcome, a Boolean TRUE
– FAILURE: Tool gave a negative outcome, a Boolean FALSE

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

After clicking on "Output Setup" the "Output Setup" view is displayed.

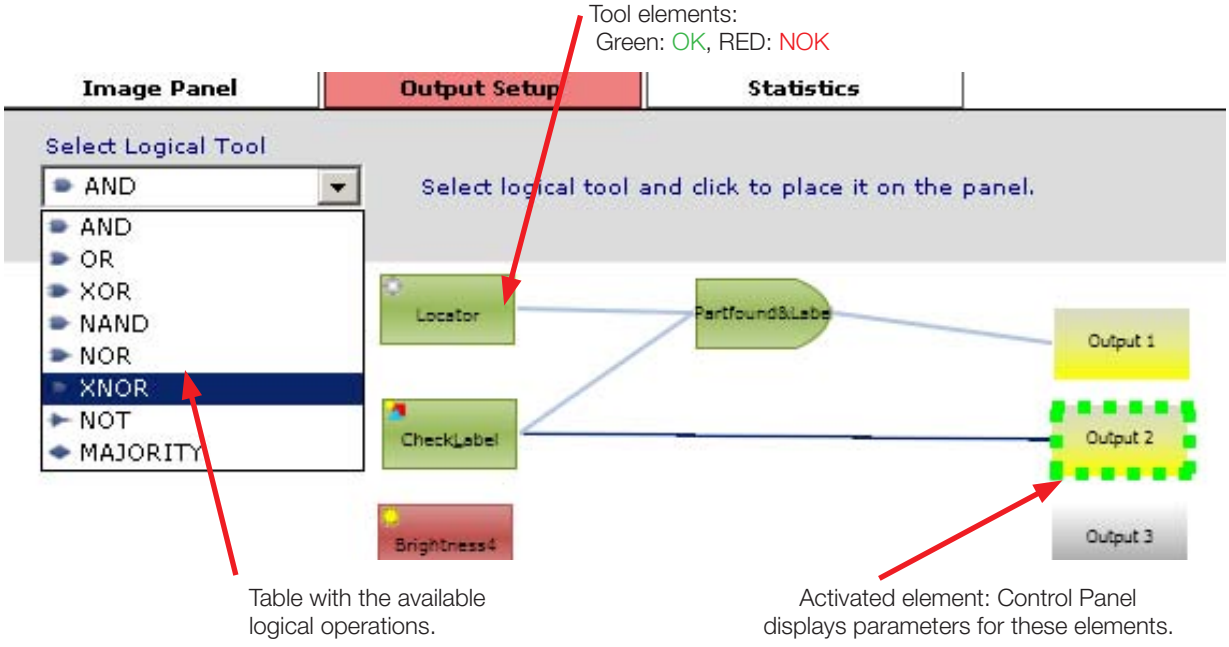

Fig. 6-11: “Output Setup” view with tools and logical operations

Proceed as follows to use a logical operation:
► Select a logical operation from the list and click in the “Output Setup” view.
⇒ The selected operation is then displayed by the software as follows:

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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:

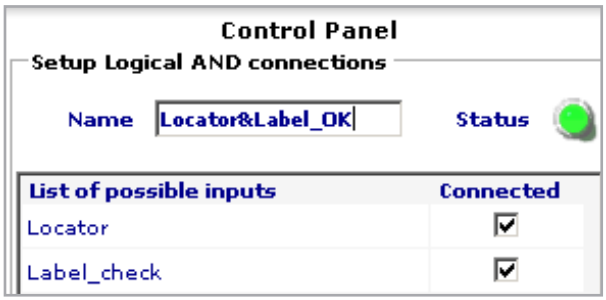

Fig. 6-12: Link table for AND operation from Fig. 6-11

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 teach operation.
Legend: E1: Input 1; E2: Input 2; A: Output of the operation; OK: Good. NOK: Bad

Symbol	Name and Short Description	Meaning	
	AND (All OK = OK, else NOK)	Logical AND of the inputs (links). Note: If two or more inputs (links) are connected to **AND** then it is OK if and only if ALL inputs are OK.	E1 / E2 / A 0 / 0 / 0 0 / 1 / 0 1 / 0 / 0 1 / 1 / 1
	OR (Any OK = OK, else NOK)	Logical OR of the inputs (links). Note: If two or more inputs (links) are connected to **OR** then it is OK if ANY link is OK..	E1 / E2 / A 0 / 0 / 0 0 / 1 / 1 1 / 0 / 1 1 / 1 / 1
	NOT (Inverter)	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!	E / A 0 / 1 1 / 0

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Symbol	Name and Short Description	Meaning
	XOR (Different = OK, Same = NOK)	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 of 2 links!
	NAND (All OK = NOK, else OK)	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.
	NOR (Any OK = NOK, else OK)	Logical NOR of the inputs (links). Note: The **NOR** operation says if any inputs is OK, the output will be NOK.
	XNOR (Different = NOK, Same = OK)	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!
	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

E1	E2	A
0	0	0
0	1	1
1	0	1
1	1	0

E1	E2	A
0	0	1
0	1	1
1	0	1
1	1	0

E1	E2	A
0	0	1
0	1	0
1	0	0
1	1	0

E1	E2	A
0	0	1
0	1	0
1	0	0
1	1	1

Minimum	Number of HIGH links	A
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

Output timing

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 is 500 ms.
- The set pulse duration is 1000 ms (resp. 0 ms – red lines for Output 1 and Output 3).
- The output delay is 0 ms.

The outputs are assigned as follows:

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– Output 1: Part OK;
– Output 2: Toggle;
– Output 3: Busy-Ready.

No outputs are inverted!

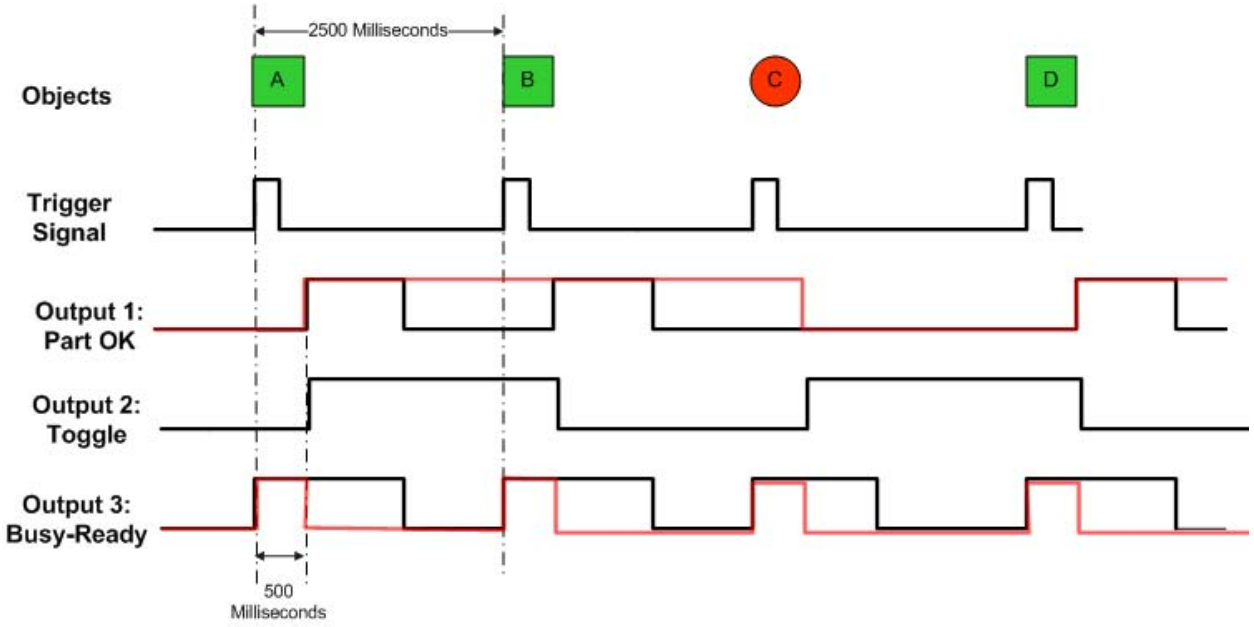

Fig. 6-13: Diagram for output timing

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: pulse 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 even with the same level on Output 1.

How do outputs which depend on the result of the inspection (e.g. Part OK, or the result of a tool) behave?
In general: If no switching delay is set or the switching delay is less than the cycle time for the inspection, these outputs are immediately switched.

Two different cases can be seen in the diagram:
Case A) Pulse 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 pulse 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.

Case B) Pulse 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.

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6.5 Changing inspection and External Teach

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:

– If the sensor **is connected** to the software: Sensor menu - Settings - Inspection buffer tab. Select the inspection you want to activate and then click on: Activate inspection.
– If the sensor **is not connected** to the software you can change inspections from a PLC for example by using the digital inputs.

There are 4 different protocols for changing inspections using digital inputs are defined:

1. Change WITHOUT reply using SELECT input (default)
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.

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 “7.2.10 Sensor Settings → Inspection change & miscellaneous”.

6.5.1 Inspection change WITHOUT feedback

The inspection changing protocol WITHOUT feedback is activated by default. To change inspections only the SELECT input (Pin 1) is needed.

Note
If the sensor does NOT respond to the signals 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 and PLC ground. The supply voltage must also be the same.

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.

Prologue

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* $t_{pulse\ durationr}$ otherwise the change is cancelled.
Exmple: 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.

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. .

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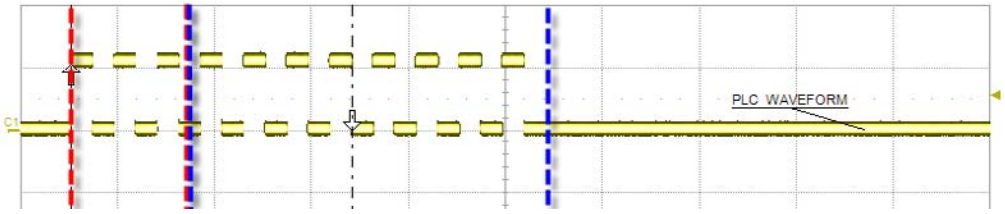
The following figure shows an oscillogram representing selection of Inspection Number 8 using the digital Select input. The pulses could be generated by a PLC for example.
The region between the dashed red lines contains the prologue pulses; a change from Low to High represents a pulse.



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.

Note
If you use this protocol, then the sensor also activates empty memory locations if a corresponding pulse sequence is received.

6.5.2 Inspection change with feedback and inspection change with feedback and Ext. Teach

The protocol for **inspection changing WITH feedback** and the version **with feedback and external teaching** can be activated using the BVS ConVis software (see also Section “7.2.10 Sensor settings → Inspection change & miscellaneous”).

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").
For the input signals HIGH is 24 V, and LOW is 0 V. This applies to sensors with NPN outputs as well.

Both versions of inspection change with feedback have the same protocol - however, in the version with external teaching a new reference image is learned as soon as an inspection is selected twice. More information can be found below: “Definitions → Double selecting”.
The protocol for inspection changing with feedback is divided into 8 phases:

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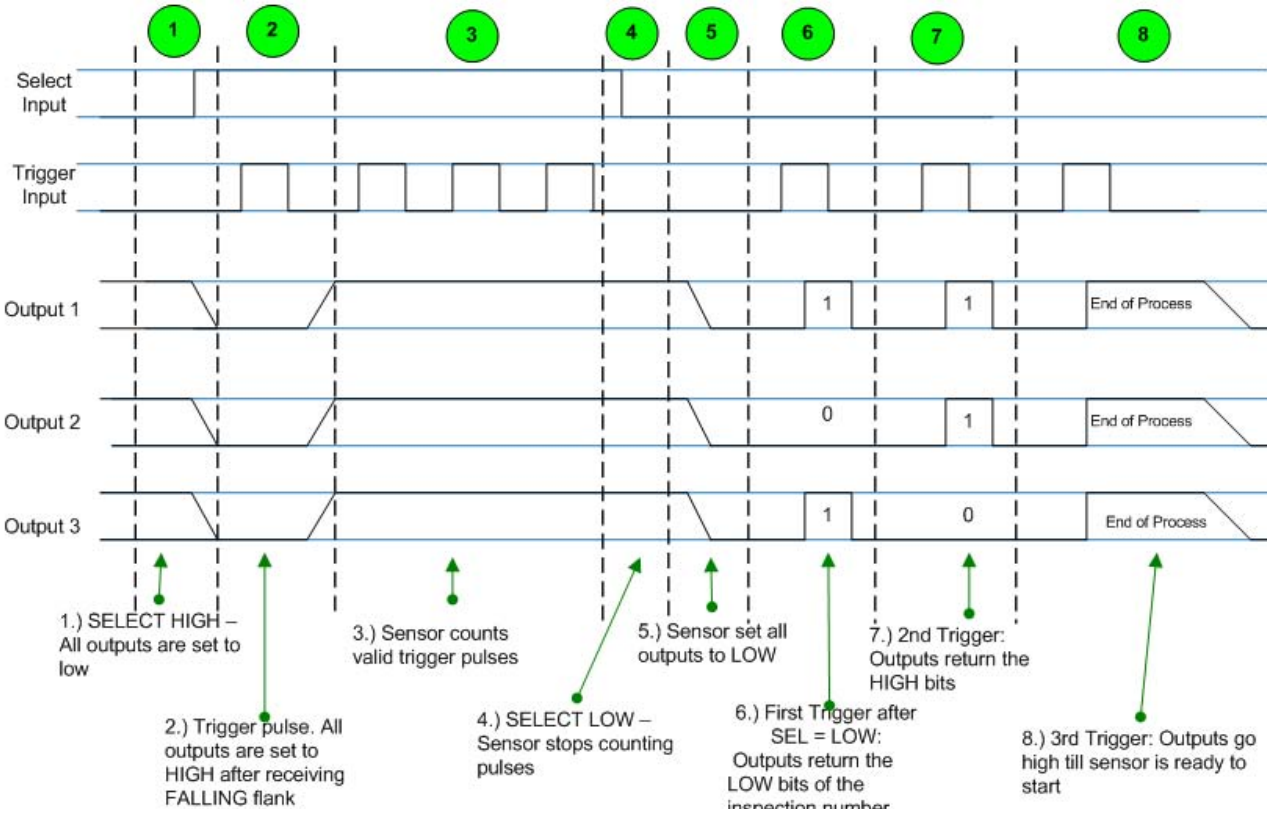

Fig. 6-14: Timing diagrams Phase 1 to 8

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 1
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 feedback
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.

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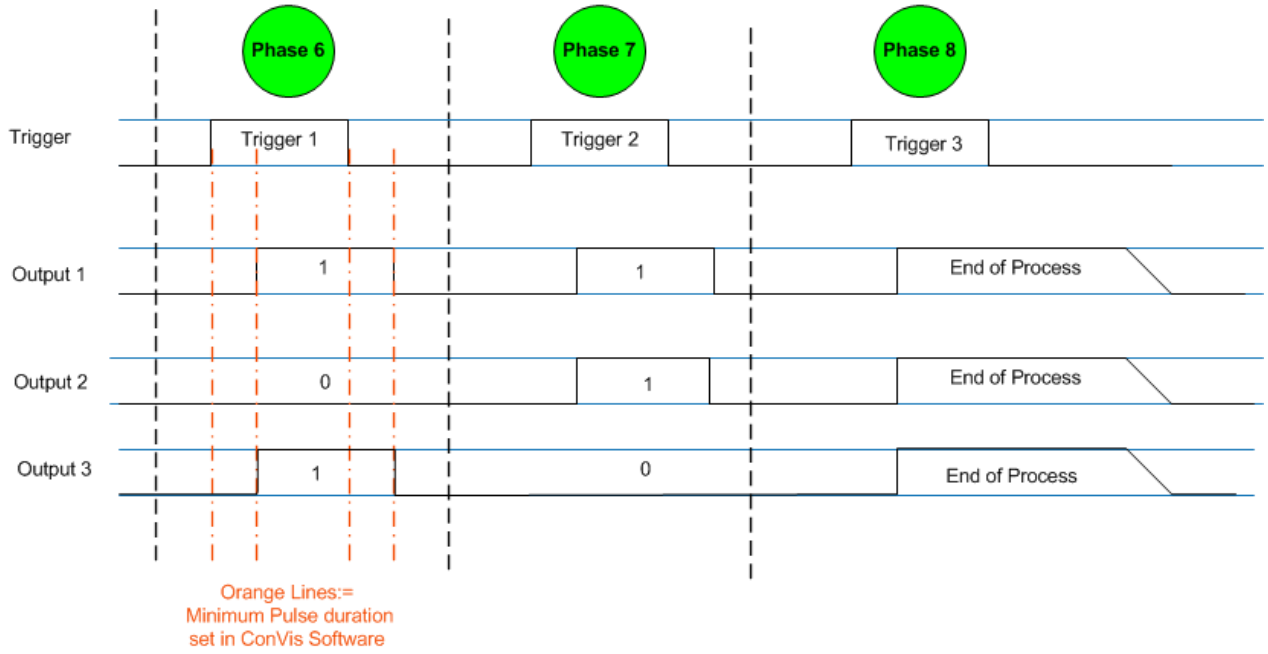


Fig. 6-15: Detailed timing diagram for reply Phase 6 to 8

Phase 6: Feedback 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 (LSB) for the set inspection number (see also Fig. 6-15).

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: Feedback 2 - Most significant bits
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 (MSB) for the set inspection number. (see also Fig. 6.15)

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

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

Which insspection number did the sensor "feedback" in the example from Fig. 6.15 ?

From PHASE 6:= $O3 := 1 * 2^2$, $O2:= 0 * 2^1$; $O3 := 1 * 2^0$
From PHASE 7:= $A3 := 0 * 2^5$, $A2:= 1 * 2^4$; $A3 := 1 * 2^3$
This would correspond to Inspection Number 29!

Phase 8: End of Process
PLC sets trigger pulse to HIGH for the third time. Sensor reply: Outputs goes (delay time = minimum 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 to start.

6 Trigger – Locator – Tools – Outputs – Inspection Changing

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 LESS than 3 trigger pulses were received after 4 seconds after start.
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

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: 45ms; Trigger 2: 20 ms; Trigger 3: 40 ms
Here: Trigger 2 was not accepted.

We recommend to set the
using the cycle time of the PLC as the value for the minimum duration.

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.

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

Inspection change with feedback and external teach

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

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 good 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.

6.5.3 External teach

The protocol for external teaching can be activated using the BVS ConVis software (see also Section “7.2.10 Sensor settings → Inspection change & miscellaneous”).

> **Note**
> If the External Teach protocol is activated, NO inspection change will take place. To change inspections and use external teaching, please use the protocol "Inspection change with reply and teach".

To use External Teach function only the SELECT input is needed.
The sensor then learns a new reference image as soon as a valid pulse (longer than the set minimum pulse duration) is present on the SELECT input.
.
For the input signal HIGH is 24 V, and LOW is 0 V. This applies to sensors with NPN outputs as well.

6.5.4 Inspection change delay time

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.

7 Reference BVS & BVS ConVis

7.1 Initial installation of BVS ConVis

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

7.2 Reference BVS ConVis software

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

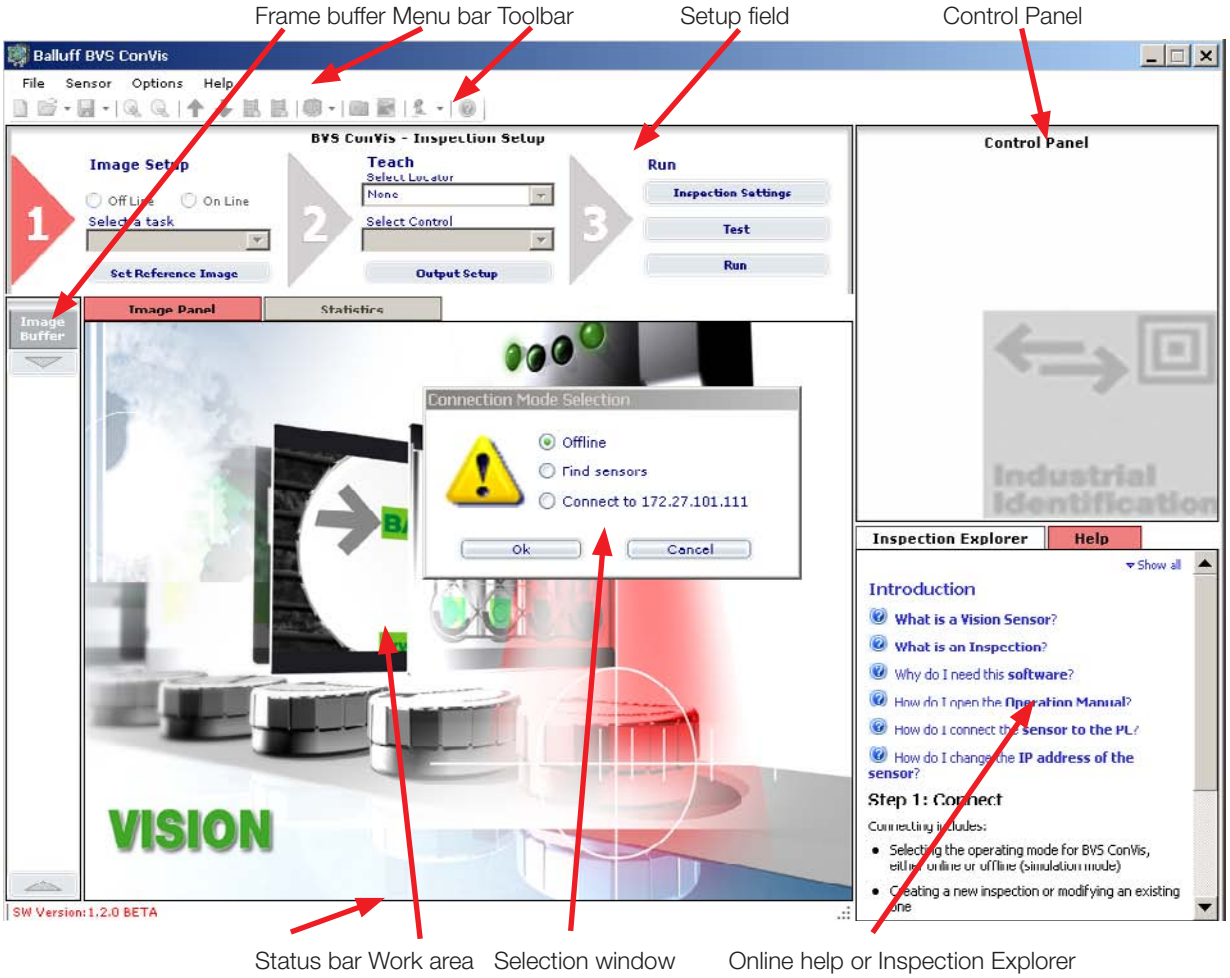
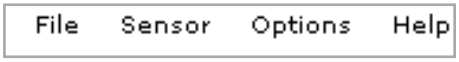


Fig. 7-1: BVS user interface

7.2.1 Menu bar



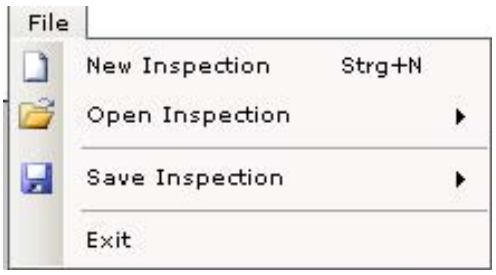
The menu bar provides access to the functions for

- 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”).

7 Reference BVS & BVS ConVis

File

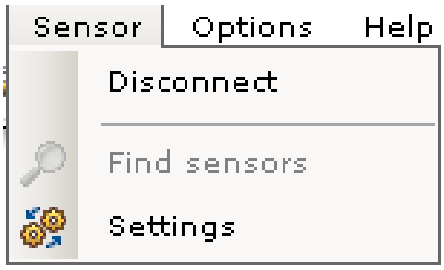
The File menu contains the following:



Function	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.
Quit	Quitting the ConVis program.

“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

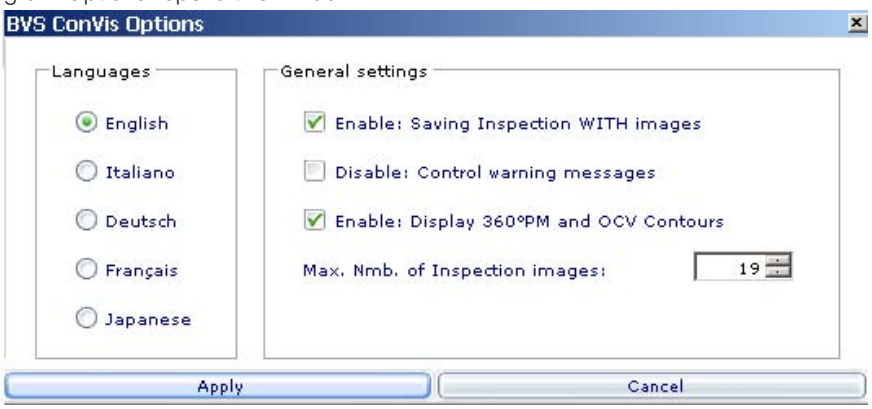


Function	Description
Connect / Disconnect	Opens the connection mode window – continue from section "5.2.3 Opening a connection to the sensor - Online mode only".
Find sensors	Searches for all sensors connected in the network. More information can be found in "5.2.3 Opening a connection to the sensor - Online mode only".
Settings	Opens the "Sensor settings" window. For additional information on sensor settings see Section “7.2.10"

7 Reference BVS & BVS ConVis

Settings

Clicking on “Options” 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 Match" 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. English, Italian, German, French, Japanese

Help

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

7.2.2 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.

7 Reference BVS & BVS ConVis

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 “Run” 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.

Connect and search for sensor

Symbol	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.

7 Reference BVS & BVS ConVis

7.2.3 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 Run

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.

7.2.4 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 Control Panel is empty. The various functions of the Control Panel are described in detail in the sections for setting up an inspection, basic settings, Locator tool, tools, setting outputs, testing and applying.

7.2.5 Frame buffer

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

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 7.2.2) allows you to add images or delete images from the frame buffer if no images are currently been 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.

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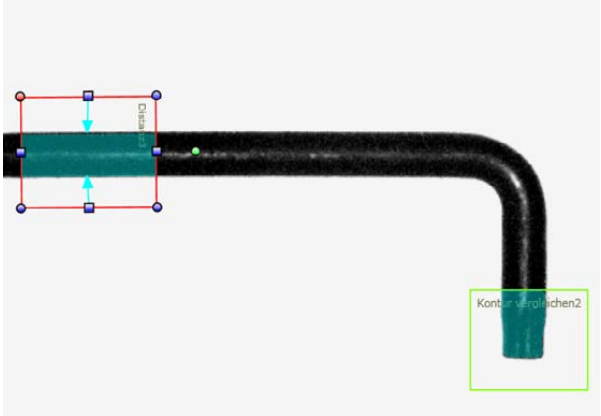
7.2.6 Image display / working area

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.

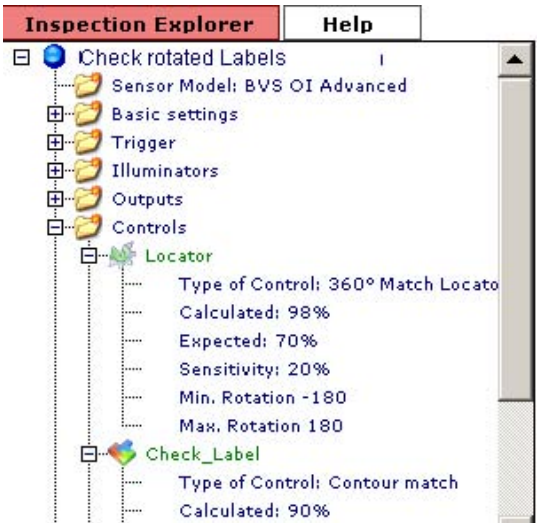
In Step 2 and Step 3, "Image display" also shows the names and ROIs of all the tools used in the inspection. Shown are tools which return an OK result (green border); and tools which return a NOK (red border).



7.2.7 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.

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.



7.2.8 Help window

The help window 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

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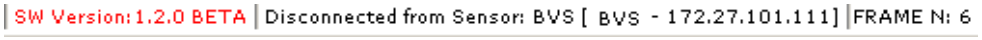
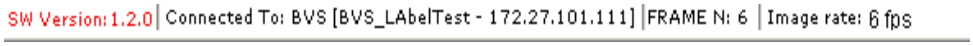
– Tools and their parameters

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.

7.2.9 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

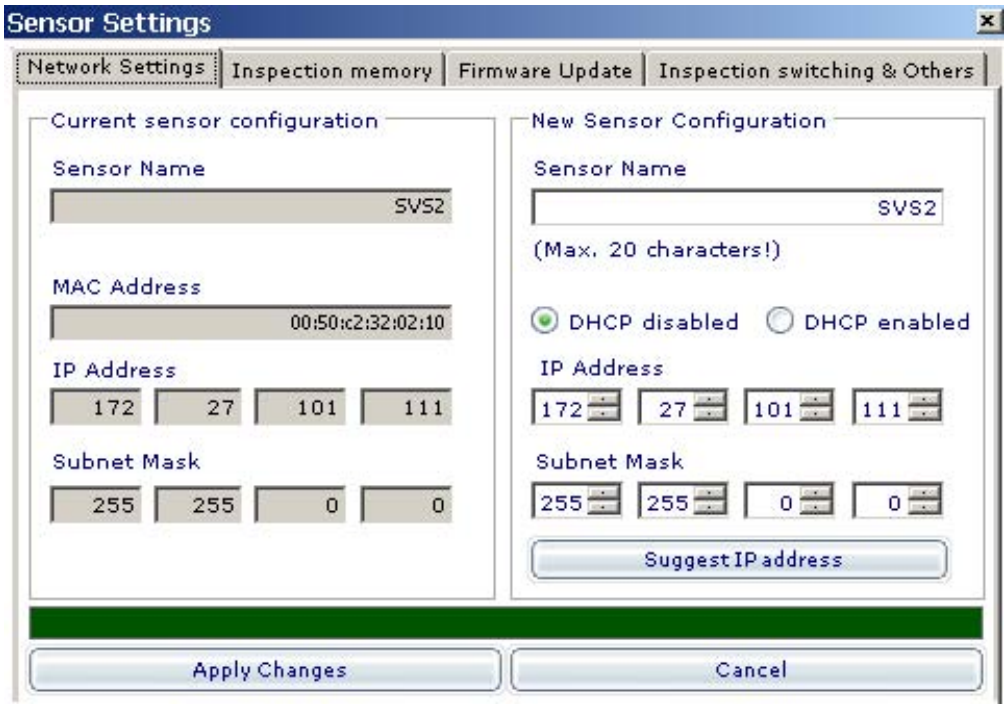




7.2.10 Sensor settings

After clicking on “Sensor settings” the software opens this window:
4 tabs can be seen in the window above:
1. Network settings
2. Inspection buffer
3. Update firmware
4. Change inspection

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.

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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 enabled / disabled	A detailed description of this parameter and DHCP in general can be found in the Section “Sensor in network with DHCP server”.
IP Adress 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 buffer

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

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 4 is selected.

The buttons below have the following functions:

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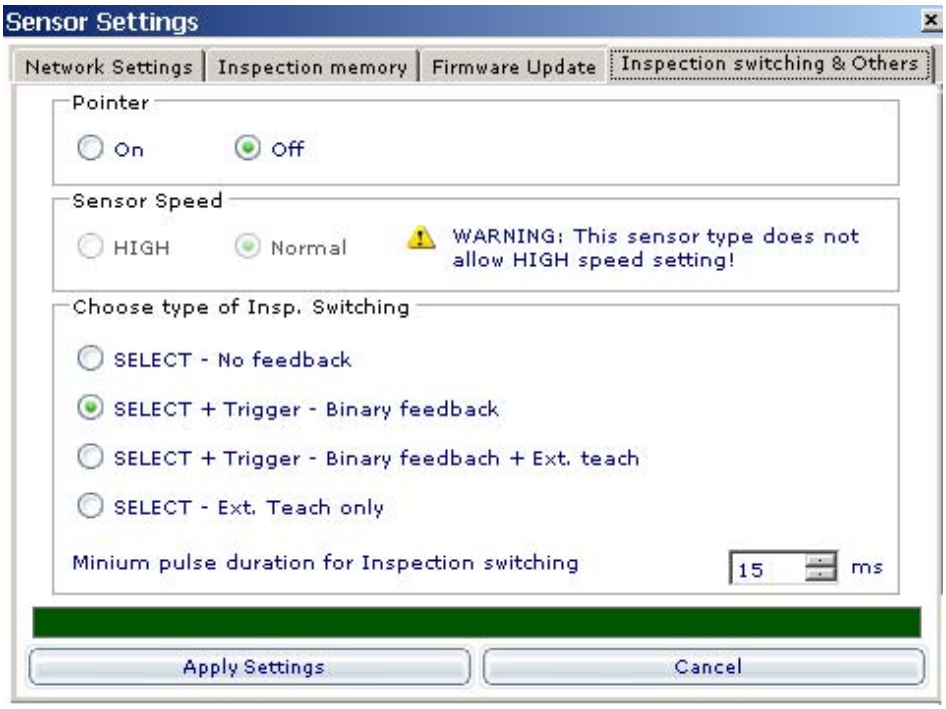
Parameter	Description
Activate inspection	The selected inspection is activated
Load inspection	The selected inspection is loaded from the sensor to the software where it can be tested or adjusted.
Save inspection	Only active if you are using the "Save inspection on sensor" or "Run" in Step 3 is being 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 window

Update firmware

For additional information see Section "7.5 Updating the sensor firmware".

Inspection change & Other

After clicking on "Inspection changing & Other" this dialog screen is shown:



You can make the following settings:

Parameter	Description
Pointers on / off	Turns the green alignment aid LEDs on or off. Align the sensor so that the object lies between the points in the INTERSECTION POINT. **Important:** The LEDs indicate points OUTSIDE the actual field of view. Please note that pointers should be turned off for normal operation as they will interfere with image quality.
Cycle 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.

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Parameter	Description
Inspection change	These 4 options are available: – SEL – No reply – SEL + Trigger – Reply – SEL + Trigger – Reply + Teach – SEL – Teach only More information can be found in the section "6.5 Changing inspection and External Teach"
Minimum pulse duration	Defines how long a pulse must be present on the Select input or Trigger input for it to be accepted when changing inspections WITHOUT a reply from the sensor.

7.3 Connecting the sensor to the software

Definition
For “New sensor start” the procedure is described as follows:
1. Close (if open) connection between software and sensor.
2. Disconnect cable from PWR IO connector.
3. Connect cable to PWR IO connector.

7.3.1 PC-Sensor direct connection

Prerequisite
– BVS ConVis installed on the PC.
– Directly connect PC to sensor (see Fig. 3-7)
– 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.

7.3.2 Sensor in 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 2.2.1A 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 "7.5 Updating the sensor firmware".

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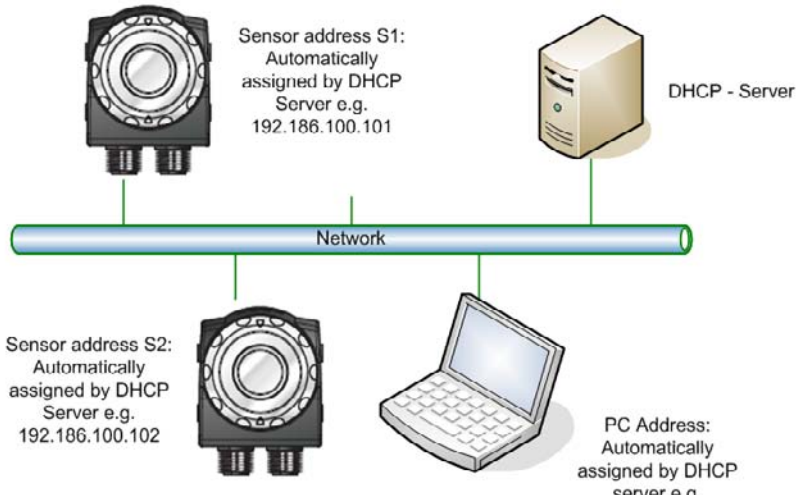
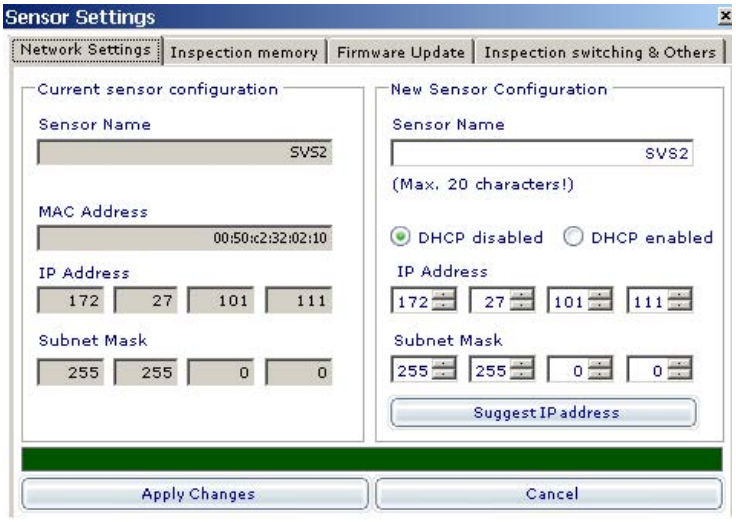


Fig. 7-1: DHCP connection of the sensor

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 BKS-AD-05RJ45/GS180-05 cable).
- ► Restart the sensor (reapply power)

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.

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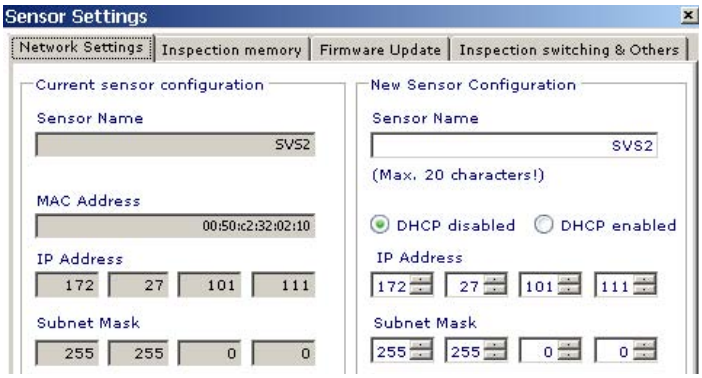
7.3.3 Changing the static IP address

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 of 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:



- ► 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 field name has a maximum length of 20 characters. Use English 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.

Note!
The new settings do not become active until the sensor has been restarted. Until then the old settings continue to be used.

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:

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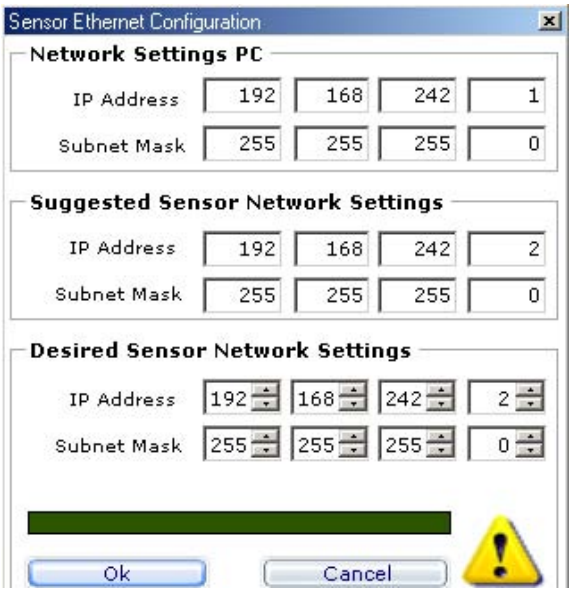


Above is the current address of the PC. In the center is a SUGGESTION for the setting. Below you will find the entry fields for making the setting (use only the arrow buttons, numerical entries and mouse scrolling).
After clicking on OK the IP address is sent to the sensor and saved there.

Note
The IP address does not become effective until after the next sensor restart.

7.3.4 Error remediation

"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 "Flowchart: Troubleshooting Connection BVS - PC" in the Appendix.

"Find sensors"

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 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. This can e.g. happen the first time trying to connect a brand new sensor with the PC.
  ► Please Check the IP address on the PC and verify that it conforms as described in "Setup Windows network communication between sensor and PC".
  ► Select "Online" again, then "Find sensors".
  ► After the sensor has been found by the ConVis software, click the "Configure" button and change the IP address so that it fits to the IP address of your PC. Restart the sensor after you have changed the IP address!
– 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

7 Reference BVS & BVS ConVis

7.4 Updating the software

Each sensor is shipped with the newest available BVS ConVis software.
Balluff provides updates with improved and new functions for this software on their Web site.

If you want to update your ConVis software, please simply follow these steps:

Uninstall the 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.
- ► Now download the 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”.
  ⇒ Now the update of the BVS ConVis software is installed.

7.5 Updating the sensor firmware

Each BVS sensor is shipped with pre-installed software, the so-called firmware; the firmware version in the sensor is compatible with the BVS ConVis version on the supplied CD-ROM. If you update BVS ConVis on your PC, you also need to update the sensor firmware.

To update the sensor firmware proceed as follows:
- ► Connect your PC to the desired sensor.
- ► Select “Settings” from the “Sensor” menu, then click on the “Update firmware” tab.
  ⇒ The firmware version currently available on the sensor is shown in the field: “Sensor firmware version” is displayed.
- ► Now click on the “Select firmware” button.
  ⇒ The software opens a dialog box and shows you the folder with firmware files (file extension .sfw2).
- ► Please select the file having the highest version number.

Note
An overview of the firmware versions can be found in the Appendix.

Example

Assuming these two files are available: ST_2.2.1A.sfw2 and ST_2ST_2.2.2B.sfw2
- ► Please select ST_2.2.2B.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.
The connection between the sensor and the software is automatically closed.
- ► Restart the sensor to finish the firmware update.

Note
When updating for the first time from firmware 0.0.5 to firmware ST2.2.1.sfw2 you must restart the sensor TWICE to finish the firmware update.

Note!
Do not interrupt power during the update process. This could result in data loss and malfunction!

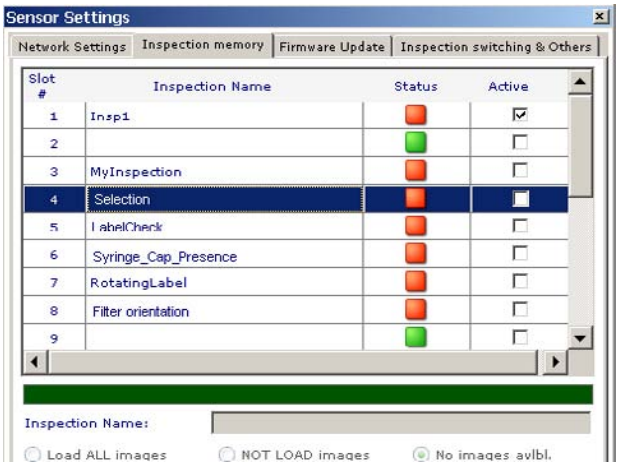
Note
To identify the current firmware in the sensor, simply click on “Info…" in the “Help” menu while the sensor is connected. The software displays a dialog box with the current software and firmware version.

7.6 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.

7 Reference BVS & BVS ConVis

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 → 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.

7.7 Recovery mode

The BVS sensors permit opening of a special Recovery mode.

Note!
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.

Note!
Recovery mode is intended only for error remediation. The sensor is not permitted to control machines when in Recovery mode.

7.7.1 Opening 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.

Now connect the sensor to the BVS ConVis software as described in Section 7.3.1.
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".

7.7.2 Error remediation on the sensor

- ► Save the inspection on the PC. Click on “File → Save → Save to PC”.
- ► Now click on the Inspection Explorer and note the sensor model of 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: RESCUE_BVS-OI-Standard.bvs,Sensor model BVS OI Advanced: RESCUE_BVS-OI-Advanced.bvs
- ► 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 US: 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.

8 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.

9 Legal Notices

This manual describes the functionality of the BVS “ConVis” configuration software, a package for visualizing and operating all BVS object identification sensors.

The ConVis software is a software product produced by Balluff GmbH.

BALLUFF is entitled – but not obligated – to make updates or upgrades of the software 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 Operating Manual and the BALLUFF General Terms and Conditions.

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Our General Terms and Conditions and the corresponding Operating Manual are moreover available at
http://www.balluff.com/Balluff/de/FooterChannel/de/AGBs.htm

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10 Glossary

10.1 Inspection times

The overall time required for an inspection depends on three factors:
– Exposure time
– Recording time
– Processing 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.

Recording 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. 16 ms to transmit an entire image. This time is reduced considerably if only a part of the overall image is recorded.

Processing time: The time required to process the recorded image. This depends on the operations used for the inspection and the tools employed.

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

Image Panel | Output Setup | Statistics

Control	Execution Result	Execution Time
Exp. Time + Img. Acquisition time		14,96 ms
Execution time Control	Pass	348,26 ms
Locator	Pass	329,74 ms
Check_Label	Pass	17,58 ms
Brightness4	Pass	0,84 ms
Partfound&LabelOK	Pass	0,00 ms
Output duration time:		10,00 ms
Total execution time		**373,22 ms**
Maximum execution time		**436,31 ms**
Output delay time:		0,00 ms
Insp. per second		**2,68 Insp./sec**

From the above example the actual overall cycle time is 373 ms, but the maximum cycle time is 436 ms.
The “Tool cycle time” is included in “Processing time.”

10 Glossary

10.2 Other terms and definitions

Current image:
Image recorded by the sensor which is subjected to processing/inspection.

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.

CMOS
Complementary Metal Oxide Semiconductor. Chip technology of the digital image sensor. Consists of a set of light-sensitive elements arranged in a matrix (→ pixels) which are exposed by means of a glass window on the top side of the chip.

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.

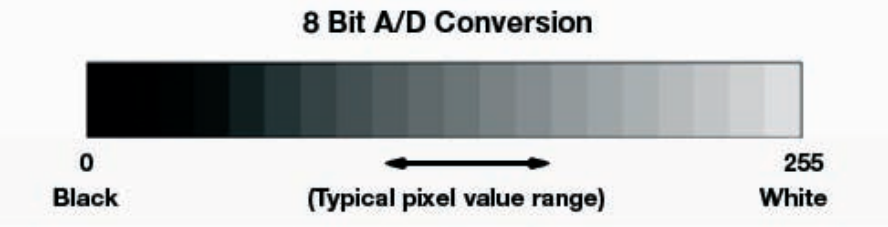


Fig. 10-1: Gray scale

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.

10 Glossary

LAN:
Abbreviation for “Local Area Network,” refers to a computer network limited to a small area (office or building).

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.

PMMA
The optical surface of the sensor housing is made of PMMA, an "acrylic glass."
PMMA is relative scratch-proof. See also:
http://en.wikipedia.org/wiki/Acrylic_glass

Reference image:
Stored reference image. The pattern (or contour) searched for by the "360 pattern detect" and "Contour Match" tools 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 Match” 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 11.2.

Status:
Inspection result for a single inspection/measurement (status may be OK or NOK).

11 Technical Data

11.1 List of available models

Model code **BVS OI– 3 –0XX– E**

Balluff Vision Sensor

Sensor/Function
OI = Object detection and identification

Resolution in pixels
3 = 640x480

Type
First position: 0 = Red light

Second position: 0 = Standard model
5 = Advanced model
9 = Special

Third position: 1 = 8mm lens; PNP outputs
2 = 8mm lens; NPN outputs
3 = 12mm lens; PNP outputs
4 = 12mm lens; NPN outputs
5 = 6mm lens; PNP outputs
6 = 6mm lens; NPN outputs

Interface
E = Ethernet

Differences between Standard and Advanced

Function	Standard	Advanced
Selectable image resolution (640x480; 320x240; 160x120)	NO	YES
Locator 360 pattern detect	NO	YES
Logical operations	NO	YES
High cycle speed	NO	YES

Available models

Standard

Ordering code	Model code	Material number
BVS0003	BVS OI- 3- 001-E	154518
BVS0004	BVS OI- 3- 002-E	154519
BVS0005	BVS OI- 3- 003-E	155392
BVS0006	BVS OI- 3- 004-E	155393
BVS000E	BVS OI- 3- 005-E	178118
BVS000C	BVS OI- 3- 006-E	178117

Advanced

Ordering code	Model code	Material number
BVS 000J	BVS OI- 3- 051-E	179008
BVS 000P	BVS OI- 3- 052-E	181542
BVS 000K	BVS OI- 3- 053-E	179009
BVS 000N	BVS OI- 3- 054-E	181540
BVS 000L	BVS OI- 3- 055-E	179010
BVS 000R	BVS OI- 3- 056-E	181544

11 Technical Data

11.2 Working distances and field of view

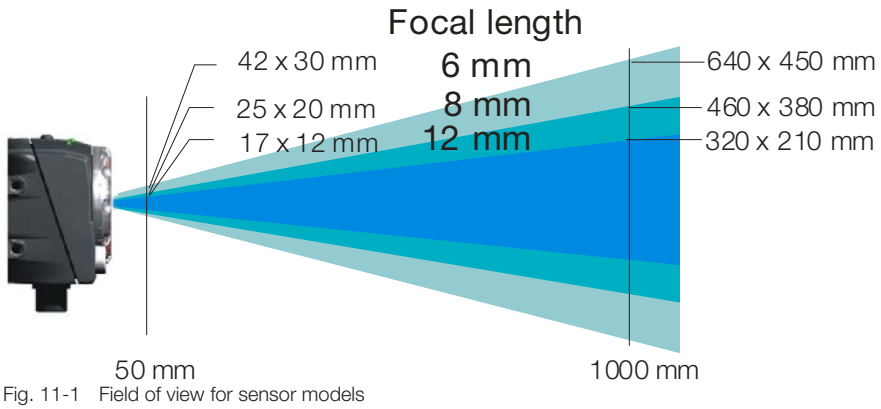


Fig. 11-1 Field of view for sensor models

Working distances

Working distance (mm)	BVS-OI-3-001-E BVS-OI-3-002-E	BVS-OI-3-003-E BVS-OI-3-004-E	BVS-OI-3-005-E BVS-OI-3-006-E
50	25×20	17×12	42x30
80	40×30	25×20	60x41
110	55×40	33×25	80x55
200	100×70	60×50	138x92
300	145×103	90×65	201x140
400	186×132	121×82	265x189
500	236×167	150×110	320x232
1000	460×380	320×210	640x450

11.3 Dimensions

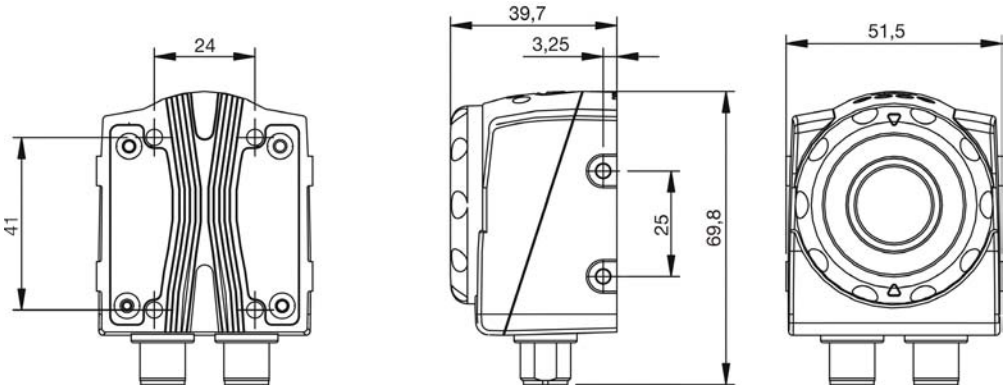


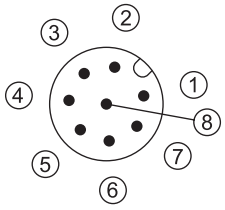
Fig. 11-2: BVS-E, dimensions (in mm)

11 Technical Data

11.4 Technical data Electrical connections

M12 8-pin: (power and I/O)

PWR IO — Pin contact panel connector, 8-pin



Pin	Wire colors BKS S139	Function
1	White	SELECT Inspection select
2	Brown	24 V DC
3	Green	Trigger External Light (see Note below)
4	Yellow	Output 1
5	Gray	Output 2
6	Pink	Output 3
7	Blue	Ground 0V
8	Red	Trigger input

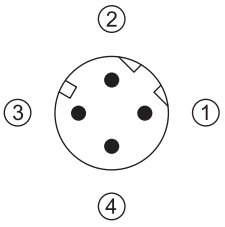
Connecting external lights

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 of all sensors with hardware version < 2.0 is a TTL output (LOW = 0 V, HIGH = 5 V).
All sensors with hardware version > 2.0 come with a 24 V trigger output..

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 BKS-AD-05RJ45/GS180-50 cable.

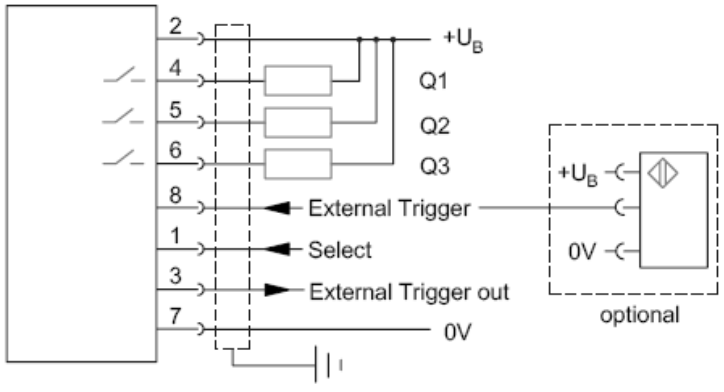


Fig. 11-3 Wiring the PWR IO female with NPN output

11 Technical Data

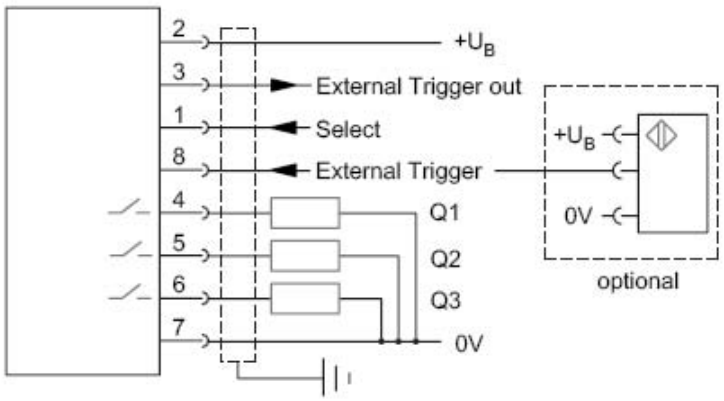


Fig. 11-4 Wiring the PWR IO female with PNP output

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)

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 Sensors with HW version < 2.0: 1x Trigger output PNP (5 V TTL) Sensor with HW version ≥ 2.0: 1x trigger output 24 VDC
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	For all sensors with hardware version < 2.0: Trigger signal TTL logic (LOW < 0.8 V; HIGH > 2.0 V) For all sensors with hardware version ≥ 2.0: Trigger signal 0/24 VDC **Note:** The hardware version of the sensor can be found if you select INFO from the help menu. Please note that only software version 1.2.2 or higher shows the correct hardware version.
Parameter setting interface	1x M12 4-pin – Ethernet 10/100 Base T

Features

Parameter setting	BVS ConVis for Windows XP
Typical detection rate [Hz]	3 - 30 (depending on processing function)
Number of inspection slots:	20
Size of defect image buffer	10 images

11 Technical Data

Optical Data

Image sensor	CMOS – black/white, VGA 640x480
Maximum optical resolution	0.2 mm
Recommended working distance	50 – 300 mm, with corresponding auxiliary light up to 1000 mm
Light	Direct light, red, switchable
Alignment aid	LED, green, switchable

Ambient Data

Enclosure rating per IEC 60529	IP54
Reverse polarity protected	YES
Short circuit protected	YES
Operating temperature	-10° C … +55° C
Storage temperature	-25° C … +75° C

11.5 Soft- & Firmware revisions

Software version	Release date
1.1.1	24.09.2007
1.1.3	28.01.2008
1.1.4	22.08.2008
1.2.1	30.06.2009
1.2.2	07.10.2009

Firmware versions

The following firmware versions have been published to date

Software versions 1.1.1 - 1.1.4:

Version	Release date
0.0.1	24.09.2007
0.0.3	14.11.2007
0.0.4	28.01.2008
0.0.5	22.08.2008

Software version 1.2.0 and higher:

Version	Release date
ST 2.2.1.02	15.08.2009
ST 2.2.1.03	07.10.2009

11.6 Display LEDs

The BVS OI 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

11 Technical Data

11.7 Declaration of Conformity

LED radiation!
- The LED radiation 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 as to minimize looking directly into the sensor and LED 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.

CE The CE Marking means that our products meet the requirements olf the EU Directives 2004/108/EWC (EMC) and conform to the EMC Law.

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 the following Generic Standards:

- EN 50 081-2 (Emission) and
- EN 50 082-2 (Noise Immunity)

Contact

Technical support
If you have questions or should a problem occur, please read the detailed Operating Manual first. If you require additional technical support, please contact Balluff:
Europe
Phone: +49 7158 173-0
E-Mail: balluff@balluff.de service@balluff.de

North America
Phone: 1-800-543-727-2200
E-Mail: balluff@balluff.com

Additional information on other Balluff products and solutions can be found on the Internet at:
www.balluff.com/balluff/

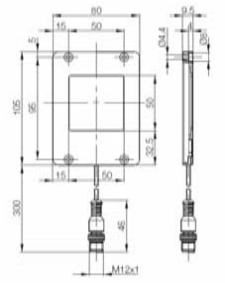
Requests and suggestions
If you have suggestions for improvement and ideas for this product, please let us know. Use the contact information provided above.

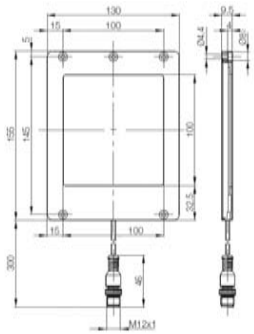
12 Index Directory

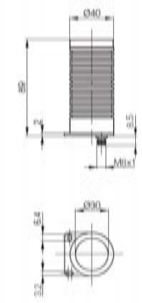
12 Index Directory

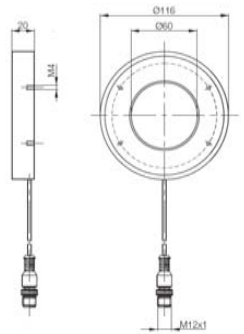
List of available Lights

Light Type	Back light	Back light	Spot light	Spot light	Ring light	Ring light
Type code	BAE-LX-VS-HR050	BAE-LX-VS-HR100	BAE LX-VS-SR030-S75	BAE LX-VS-SW030-S75	BAE LX-VS-RR100	BAE LX-VS-RI100
Order Code	BAE000F	BAE000H	BAE002R	BAE002T	BAE000J	BAE000K
Supply voltage Us	24 V DC	24 V DC	24 V DC	24 V DC	24 V DC	24 V DC
Effective operating current Ie	< 250 mA	< 400 mA	< 100 mA	< 100 mA	< 800 mA < 1350 mA (Boost mode)	< 800 mA < 1350 mA (Boost mode)
Trigger Input	No	No	Yes TTL 5- 24V	Yes TTL 5- 24V	Yes	Yes
Light source, Color, Wave-length	LED, Red, 617 nm	LED, Red, 617 nm	LED, Red, 630 nm	LED; White ; ---	LED, Red, 617 nm	LED, Infrared, 875 nm
Active surface	Square 50x50 mm	Square 100x100 mm	Ø 30 mm	Ø 30 mm	Ø 100/60 mm	Ø 100/60 mm
Mechanical Connector	M12 Connector, 4 poles	M12 Connector, 4 poles	M8 Connector, 4 poles	M8 Connector, 4 poles	M12 Connector, 4 poles	M12 Connector, 4 poles
Dimensions in mm	105×80×9,5 mm	155×130×9,5 mm	Ø 40 mm x 89 mm	Ø 40 mm x 89 mm	Ø116×20,5 mm	Ø116×20,5 mm
Mounting	4x M4 screws	4x M4 screws	2x M4 screws	2x M4 screws	4x M4 screws	4x M4 screws
Housing material:	Anodized Aluminium	Anodized Aluminium	Anodized Aluminium	Anodized Aluminium	Anodized Aluminium	Anodized Aluminium
Optical Surface	PMMA	PMMA	PMMA	PMMA	Glass	Glass
Weight	155 g	340 g	160 g	160 g	360 g	360 g
Enclosure rating per IEC 60529	IP 54	IP 54	IP 65	IP 65	IP 54	IP 54
Reverse polarity protected	Yes	Yes	Yes	Yes	Yes	Yes
Short circuit protected	Yes	Yes	Yes	Yes	Yes	Yes
Ambient Operating tempera-ture Ta	-10...+55°C	-10...+55°C	-10...+40°C	-10...+40°C	-10...+55°C	-10...+55°C
Storage temperature	–25...+75 °C	–25...+75 °C	–25...+70 °C	–25...+70 °C	–25...+75 °C	–25...+75 °C





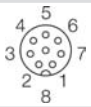
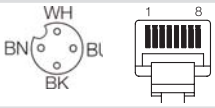
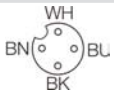


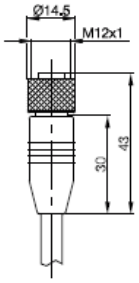


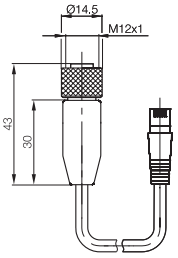
The diffuser **BAM OF-VS-001-D-RX100** ensures even light without disturbing reflections in applications with reflective surfaces. The diffuser is made of high-quality glass and can be installed directly on the light.

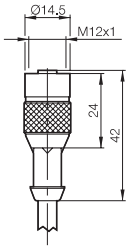
List of Available Accessories

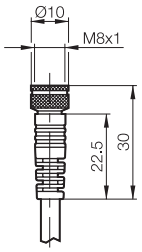
Cables

Connector	BKS-S139	BKS AD-05RJ45	BKS-S 19	BKS-S 74
Version	Straight female	Straight female/RJ45	Straight female	Straight female
Use	Connection cable BVS-E and BVS-C	Configuration cable for BVS-E	Connection cable for background and ring light	Connection cable for spot light
Type code	BKS-S139-PU-05*	BKS AD-05RJ45/GS180-05*	BKS-S 19-3-PU-03	BKS-S 74-3-03
Supply voltage U_S	10...30 V DC	10...30 V DC	10...30 V DC	10...30 V DC
Cable	5 m molded-on PUR	5 m vulcanized PUR	3 m molded PUR	3 m molded PVC
No. of wires × cross-section	8×0.25 mm²	4×0.34 mm²	4×0.34 mm²	4×0.34 mm²
Degree of protection per IEC 60529	IP 67	IP 65	IP 68 per BWN Pr. 20	IP 67
Ambient temperature range T_a	–25...+90 °C	–25...+70 °C	–25...+70 °C	–25...+90 °C
View of female side				
	*Knurled ring used for shielding!	Additional cable lengths on request: 1.5 m, 3 m, 10 m, 15 m, 20 m	Additional cable lengths on request: 10 m, 15 m, 20 m	



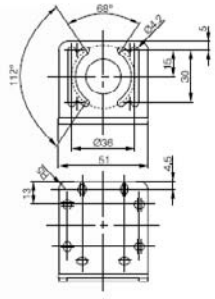


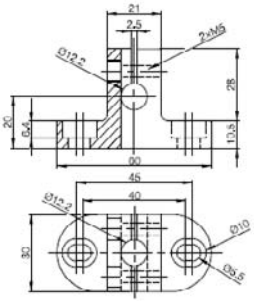


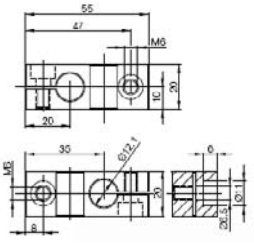


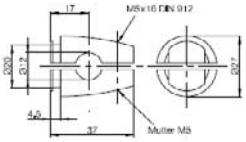
Mounting Accessories

Description	Mounting bracket	Base holder	Cross-connector	Clamping cylinder
Version	For Vision Sensors and clamping cylinders	for 1 rod Ø 12 mm (vertical or horizontal)	for 2 rods Ø 12 mm	
Use	Holding Vision Sensors for mounting on base plates or using BMS Mounting System	for mounting on base plates or extrusions	Connecting element for 2 rods Ø 12 mm	Accommodates all holders, sensors and reflectors
Type code	BVS Z-MB-01	BMS CU-M-D12-A040-00	BMS CC-M-D12-B-00	BMS CS-M-D12-IZ
Material	GD-Zn	Anodized aluminum	Anodized aluminum	GD-Zn

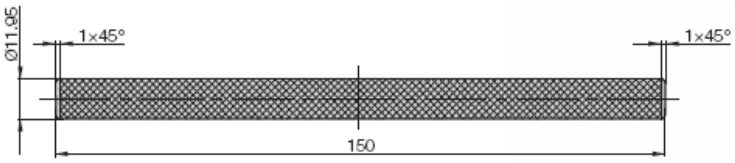








Mounting rods Ø 12 mm, anodized aluminum
BMS RS-M-D12-0150-00 = 150 mm
BMS RS-M-D12-0250-00 = 250 mm
BMS RS-M-D12-1000-00 = 1000 mm
(for user assembly)
The mounting rods are knurled full-length.
This prevents any position change.



List of Available Accessories

Starter kits

Starterkit for BVS-E - Standard
(model code BVS Z-SK-OI-01)
Includes a BVS OI-3-001-E Vision Sensor, mounting bracket, installation accessories, connectors, documentation and quick guide.

Starterkit for BVS - Advanced
(model code BVS Z-SK-OI-03)
Includes BVS OI-3-051-E Vision Sensor, mounting bracket and accessories, connectors for PWR IO and TO PC connection, documentation and quick guide.

Flowchart: Troubleshooting Connection BVS – PC

BALLUFF
sensors worldwide

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?

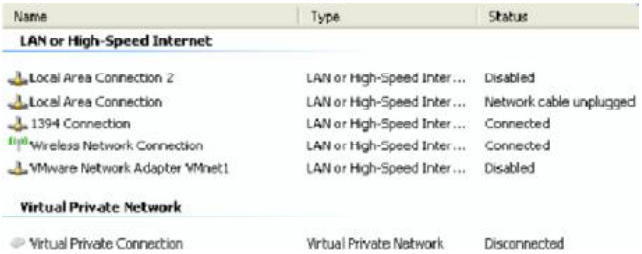
yes → The BVS sensor is stucked in "Connected" state. Please check if a BVS ConVis software is still running on your PC.

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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