Q.VITEC

Erkennen, was möglich ist.

Imagechecker
Vision Q.400 V7

Reference Manual

www.qvitec.de

Q.VITEC

Important symbols

One or more of the following symbols may be used in this documentation:

Warning!
The warning triangle indicates especially important safety instructions. If they are not adhered to, the results could be fatal or critical injury.

◆CAUTION

Indicates that you should proceed with caution. Failure to do so may result in injury or significant damage to instruments or their contents, e.g. data.

◆NOTE

Contains important additional information.

◆EXAMPLE

Contains an illustrative example of the previous text section.

◆PROCEDURE

Indicates that a step-by-step procedure follows.

◆REFERENCE

Indicates where you can find additional information on the subject at hand.

◆ KEY POINTS

Summarizes key points in a concise manner.

◆ SHORTCUTS

Provides helpful keyboard shortcuts.

◆ EXPLANATION

Provides brief explanation of a function, e.g. why or when you should use it.

☛ next page

Indicates that the text will be continued on the next page.

The manual uses the following conventions to indicate elements from the user interface or the keyboard:

"Data field"	Data field entries and option names are rendered in quotation marks.
[Button]	Buttons are indicated by square brackets.
<Key>	Keys are indicated by pointed brackets.

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Chapter 1

Imagechecker in Operation

1.1 Introduction to Image Processing

The whole procedure of image processing consists of several steps. A normal image processing sequence is as follows:

```
┌─────────────────────────┐
│          Start          │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│       Grab image        │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│   Image preprocessing   │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│    Image processing     │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│  Spreadsheet processing │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│      Output values      │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│     Update display      │
└─────────────────────────┘
             ▼
┌─────────────────────────┐
│           End           │
└─────────────────────────┘
```

Flow diagram image processing

The speed of image processing depends on how long it takes the system to carry out the individual steps.

1.2 Serial Image Processing

Image processing can be divided into two subprocesses:

A = Grab image
B = Checking and Result Processing

Image processing as two subprocesses
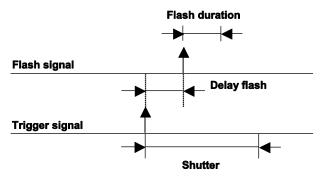
1. Subprocess A = grab image
   The time needed to transfer the camera image into the memory of the image processing system depends on the image data speed of transmission from camera to frame grabber and from the frame grabber to the Imagechecker's main memory.

2. Subprocess B = checking and results processing
   The time needed to test the image preprocessing and image processing routines, the subsequent processing of the results gained from the image processing as well as the data output to the monitor or individual interfaces depends on the specific application. It consists of:

   - execute image preprocessing and image processing routines (checker)

   - process spreadsheet
     continue processing checker results in statistics, formulas, calibration, etc.

   - output results
     transmit output values to interfaces

   - Update GUI
     represents the time needed to Update the screen display. It consists of:
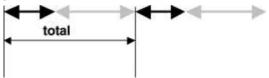
     - Display camera image

     - Update spreadsheet

     - Update checker results

     - Update execution time (see page 188)

Time diagram for the control signals for subprocess B

Serial processing means executing the subprocesses one after the other in sequence. In serial image processing, the sum of the subprocesses equals the total duration of the complete process:
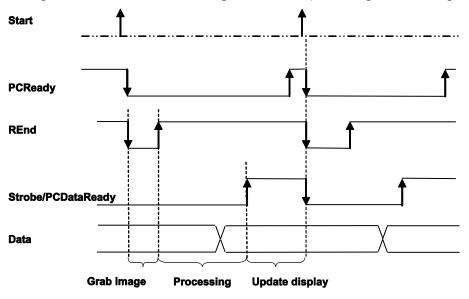
1.3 Control Signals and Time Response

During the image processing, the following control signals may be sent to the interfaces by Vision Q.400:

1. REnd
   indicates when image grabbing begins and ends
2. PCReady
   indicates when the system is ready for the next start
3. Strobe/PCDataReady
   a signal indicates at the digital I/O board and at the serial port (PCDataReady) when the system has finished calculating the results of a new image.

The figure below shows the time diagram for serial processing of control signals.

Time diagram for control signals

☞ ◆NOTE

The diagram shows the typical course of signals at the digital I/O board ANPC 850V3D when data is transferred without handshake. For information on the timing of the older digital I/O boards ANPC 850D and ANPC 850V2D please consult your local dealer.

Chapter 2

User Interface

2.1 Introduction

Start up Vision Q.400 under Windows with a double-click on the Vision Q.400 icon. First, the opening screen below will appear.

Which screen appears next depends on the settings you have made on the "Application" (see page 78) property page under **System Settings → Vision Q.400 Settings**:

Selected setting under "Application to Start With"	Details
None	You start the program with an empty window (see page 30).
Show Vision Q.400 startup dialog	You choose whether you create a new application or open (see page 29) an existing one.
Load last open application:	The selected application will be loaded (see page 31).
Load the following application	

2.1.1   Software Versions Available

The Vision Q.400 software version <Q.400_VersionNumber> is multi-lingual. It supports English, German, and French.

Vision Q.400 is available in three versions:

- Full version
- Simulation version (see page 28)
- Essentials version (see page 29)

2.1.1.1 Simulation Version

For testing and demonstration purposes, there is a simulation version available on the CD-ROM or the USB flash drive. You can download the latest simulation version from our internet page at http://www.qvitec.de http://www.panasonic-electric-works.com.

The simulation version lets you simulate different applications of Vision Q.400. With the help of sample bitmaps you can test the functions and features of Vision Q.400. However, for reasons of software protection, it is not possible to use the simulation version with a frame grabber. Every 5 minutes a message is displayed reminding you that the current version of Vision Q.400 is the simulation version.

☞ ◆**NOTE**

If you would like to receive some advice and support for testing your application, you can buy an inexpensive license for the simulation version from Q.VITEC.

2.1.1.2 Essentials version

For Imagechecker systems using Camera Link and GigE Vision cameras, there is an Essentials version of Vision Q.400. An application created with the Essentials version has the following restrictions:

- A maximum of two cameras is supported.
- You can create only one sequence per camera.
- You can create a maximum of 64 checkers per application.
- You can create only one Action (see page 518).
- You cannot create any IfCase formulas (see page 540).
- The parallel interface is not supported.
- You cannot use any user-defined checkers.
- You cannot use any user-defined execution groups (see page 132).
- You cannot enter individual shutter speeds for the predefined execution groups.

2.1.2 Program Start with Startup Dialog

When you have activated the "Show Vision Q.400 startup dialog" option on the "Application" (see page 65) property page in the Vision Q.400 settings on the **System Settings** menu, the following dialog appears after starting the program:
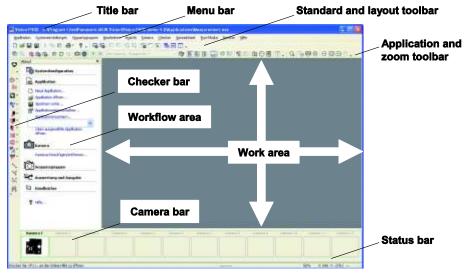
Dialog after starting Vision Q.400

You choose whether you create a new application or open an existing one. The recently opened applications are listed in the dialog box. As soon as you have selected "Open an existing application", the window is activated and you can select an application from the list and start it with [OK].

2.1.3 Starting the Program without Selecting an Application

If you start Vision Q.400 without having selected an application, the following screen is displayed:

Screen after starting Vision Q.400

The **title bar** shows the "Vision Q.400" program name and the three Windows icons, which you can use to minimize the Vision Q.400 window to icon size, enlarge it to full screen or close the window.

The second bar is called the **menu bar**. It contains all the main menus. You will find a detailed description of each main menu and its submenus under the respective chapter/section heading.

The **standard toolbars** are situated directly beneath the menu bar. You can conveniently access frequently used submenus or procedures by clicking on the icon.

Select the checker type you wish to create from the **checker bar** located to the far left. As soon as you have selected a checker, a pop-up menu opens up next to it showing the shapes available for it. You can use it to assign the checker its search/template area, such as a rectangle.

At the left-hand margin of the work area you will find the **workflow window**. Here you see all the operations needed to create a simple application, set out step by step. When you click on a heading highlighted in bold, additional steps are displayed which open up when you click on the relevant dialog box.

The large empty space is the **work area.** This is were you see the camera window(s) and edit all dialog boxes of Vision Q.400. Additional windows show for example the camera image, the spreadsheet, the error log, the font viewer, digital I/O monitor, etc.

In the bottom part of the screen you see the **camera bar**, which is an aid to navigation especially in applications with multiple cameras.

The **status bar** at the bottom of the window shows error messages, icon names, the status of the execution group controller, the mouse cursor position and the gray-value at the mouse cursor.

☞ ◆**NOTE**
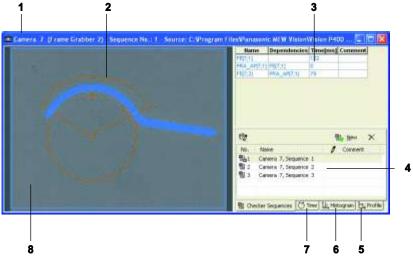
> **Depending on the work mode you are in, the various menus/icons will be activated. Active menus and icons are shown on the screen in bold face/color. You will not be able to call up the inactive menus or icons shown in light gray.**

2.1.4 Camera Window after Loading an Application

When you have loaded an application (**Application → New/Open**) and selected a camera (**Camera → Add/Remove Camera(s)**), the system may display a screen similar to the one below. What will be displayed depends largely on the settings you have made in the **View** (see page 162) menu.

The title bar of the camera window provides the following information (see figure below):

- Number of the current camera
- Number of the frame grabber
- Number of current checker sequence
- source information (i.e. camera or location and file name if you are working with a bitmap)

Camera window

1	Title bar
2	Checker shape
3	Sequence
4	List of checker sequences

5	"Profile Line" tool for image analysis
6	"Histogram" tool for image analysis
7	Information on checker sequence processing time
8	Camera window (work area)

In the camera window the camera image is shown at the left. This is where the user defines the different checkers (see page 165). The graphical results of image preprocessing and processing are displayed if you have activated this option. Change the size and the position of the camera window with the mouse. With large images, use the scroll bars to see different parts of the image.

The right-hand window pane contains four tabs:

- Checker sequences
- Time
- Histogram
- Profile line

Camera window with 4 checker sequences

The right-hand camera window pane containing the checker sequence can be hidden (see page 164).

Checker sequences

This tab page shows the created checker sequences in the bottom half and the checkers relating to the selected sequence in the top half. By default, every camera works with a checker sequence. If you are working with execution groups (see page 129), you can move from one sequence to the next by a mouse-click.

Whenever you create a new checker, the checker is added to the end of the table. The table lists the checkers in the order of their execution, as well as showing additional information - see table.

Column title	Description
Name	This column informs you about the checker name. For each checker name there is an abbreviation (see page 40).
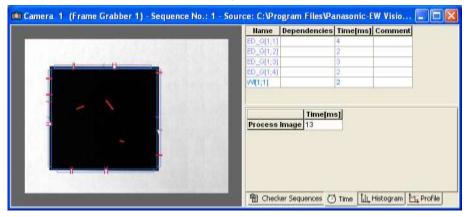
Column title	Description
Dependencies	This columns informs you about the dependencies between the different checkers. Here you see if a position and rotation adjustment uses the coordinates of a checker which needs to be executed first or if a checker needs the coordinates from another checker.
	The checker providing the coordinates for another checker must be **above** the dependent checker in the sequence.
Time (ms)	The time columns lists the processing time for each individual checker.
Comment	This column displays the user-defined text which has been entered under **Checker →** **Properties** on the "General" page in the "Comment" field. Use this field to write down the checker's specific function for this application.

☞ ◆NOTE ―――――――――――――――――――――――――――――――――

It is not possible to create a dependency on the checker(s) belonging to another sequence or camera.

Time

When you select this tab, the execution time for the current selected checker sequence is displayed in the bottom half of the page.
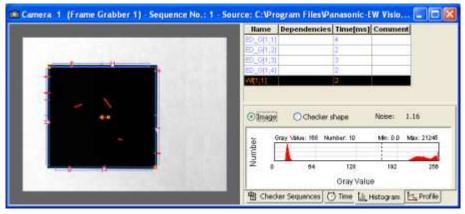
Histogram

When you select this tab, one or more histogram(s) is/are displayed in the bottom half of the page. You can select whether the histograms should refer to the camera image or to the currently selected checker shape.

For **gray-value images**, only one histogram is displayed. The red curve indicates how many pixels have which gray value. By moving the vertical dashed line in the histogram you can read off the number of pixels for each gray value. In the example below, 15850 pixels have the gray value 19. The highest number of pixels (21245) is at a gray value of around 20.

For **color images**, each color channel (red, green, and blue) has its own histogram. The histogram color corresponds to the color of the channel it refers to. To the right of the histograms there are three buttons. Select a histogram and bring it to the foreground by clicking the corresponding button. The values which are selected and displayed by moving the vertical dashed line always refer to this histogram.
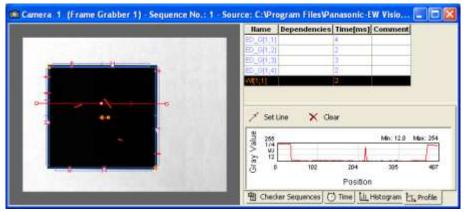
Histogram function in the camera window

Profile

When you select this tab, you can view gray value profiles along a freely selectable line in the bottom half of the window. Choose "Set Line" and then click the mouse to set the start and end points respectively of the line in the camera image.

For **gray value images**, the gray-value profile will be displayed along this line.
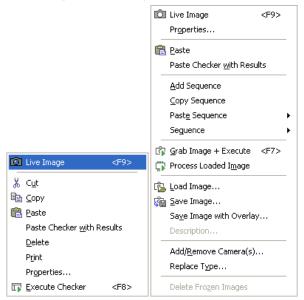
For **color images**, each color channel (red, green, and blue) has its own profile. The histogram color corresponds to the color of the channel it refers to. To the right of the histograms there are three buttons. Select a histogram and bring it to the foreground by clicking the corresponding button. The values which are selected and displayed by moving the vertical dashed line always refer to this profile.

Profile line for image analysis in the camera window

2.1.5   Checker Options

When you click the right mouse button in the camera window or beneath the checker sequence, the system displays a pop-up menu. The pop-up menu contains different options depending on whether you selected a checker in the camera window or from the sequence.

Mouse menu options when a checker has been selected / when no checker has been selected

The options are in alphabetical order.

Menu option	Functionality
Execute checker <F8>	Use this option to execute the selected checker and to open the "Result" page of the property page.
Cut	Deletes a checker from the checker sequence. Use this option if you wish to move a checker to the end of the sequence with cut and paste.
Process image <F7>	The camera takes a new image and the checker sequence is executed. Other cameras and their checker sequences are ignored.
Paste checker with results	Pastes the checker from the clipboard to the end of the checker sequence. Checker results you have inserted into the spreadsheet will also be pasted. However, formulas using the pasted checker results will not be pasted.
Print	Prints all data or parameters set under **Checker → Properties**.
Properties	When you have selected a checker: Opens the property window of that checker.
	When no checker is selected: Opens the property window of the camera.
Paste	Pastes the checker from the clipboard to the end of the checker sequence. Checker results you have inserted into the spreadsheet will NOT be pasted.
Add / Remove	Adds a new camera to the application or removes the camera providing the image for the currently active window from the application. You cannot remove the camera if checker results from this camera have been inserted into the spreadsheet.
Copy	Copies the selected checker from the checker sequence. Use this option and then "Paste" or "Paste Checker with Results" to add a copy of the checker to the end of the sequence.
Live image/memory image	Switches from the memory to the live image of the camera and back.

Menu option	Functionality
Delete	Deletes a checker from the checker sequence.
Paste sequence	Pastes a checker sequence from the clipboard. You can either paste it as a "New" sequence in the "Sequence Controller" window or "Append" it to the current checker sequence (Notes). Checker results you have inserted into the spreadsheet will NOT be pasted.
Add sequence	Adds an empty checker sequence in the "Sequence Controller" window.
Copy sequence	Copies a complete checker sequence to the clipboard. When you copy a sequence, all dependencies remain intact, e.g. if checker 2 depends on checker 1 and if checkers 3 and 4 are copies of checker 1 and 2, then checker 4 depends on checker 3.
Delete sequence	Deletes the selected checker sequence. This option is not available when you have selected the first checker sequence. It cannot be deleted.
Append with results	Pastes a checker sequence from the clipboard. You can either paste it as a "New" sequence in the "Sequence Controller" window or "Append" it to the current checker sequence (Notes). Checker results you have inserted into the spreadsheet will also be pasted. However, formulas using the pasted checker results will not be pasted.

◆**NOTE**

- **If you select "Paste Checker with Results", the checker results in the spreadsheet are copied as well. However, the formulas using the checker results are not copied. This means that you have to edit formulas manually that are supposed to use the copied checker results.**

- **Checker sequences can be linked to indicators via the spreadsheet. If you copy such a checker sequence and use the option "Append with Results", the indicator is copied as well. That means the copied indicator will be linked to the copied spreadsheet result.**

- **Checkers and/or sequences can also be copied to other cameras or applications.**

2.2 Menu Bar

You find the complete set of main menus available in Vision Q.400 in the menu bar.

Menu	Description
Application	• Create, manage and document applications • Start application • Assign colors
System Settings	• Assign passwords • Make, save or restore general Vision Q.400 settings • Configure handling of errors and warning messages during operation and in run mode • Assign application numbers • Make settings for the interfaces
Execution Groups	• Set up groups with various checker sequences of various cameras
Edit	• Cut, copy, paste, and delete elements such as checkers and indicators
View	• Set which elements (toolbars, additional windows, font viewers, error log, etc.) to display on screen
Camera	• Add, remove and manage cameras • Load and save images • Set slice level • Replace camera type
Checker	• Create, modify and execute image processing routines • Create object shapes • Create indicators
Spreadsheet	• Process Spreadsheet
Run mode	• Start and stop run mode
Window	• Bring window on screen on top or put in background • Define window layout
Help	• Call up online help and view installation information like Vision Q.400 version number, serial number, etc.

Place the mouse on one of the main menus and click to open the submenu desired. Active menus are shown in bold face/color, inactive menus are shaded light gray. You may call up menus only when they are active.

This manual contains a chapter for each main menu item. The respective submenus are described in detail in the corresponding chapter.

2.3 Standard Tool Bars

Directly under the menu bar there are four standard tool bars on two lines, which you can hide, move, or replace by your own custom tool bars (see page 171).

When you point your mouse at an icon, a short description of the icon's function, i.e. the tool tip, appears next to the icon. At the same time, the status bar displays a description.

"Standard" tool bar at top left

	New application (see page 50)
	Open application (see page 50)
	Save Application (see page 51)
	Save Application under Different Name (see page 51)
	Cut selected element
	Copy selected element
	Paste selected element
	Print (see page 57)
	Information about Vision Q.400 (see page 559)

"Layout" tool bar at top right

	Save Run Mode Layout (see page 166)
	Save Setup Mode Layout (see page 166)
	Load Run Mode Layout (see page 166)
	Load Setup Mode Layout (see page 166)
	Delete Run Mode Layout (see page 166)
	Delete Setup Mode Layout (see page 166)
	Save Custom User Layout (see page 89)
	Load Custom User Layout (see page 89)
	Reset User Layout to Default (see page 89)
	Cascade (see page 558)
	Tile Windows Vertically (see page 558)
	Tile Windows Horizontally (see page 558)

"Application" tool bar at bottom left

	Start/Execute Application (see page 52)		Show Execution Group Controller (see page 138)
	Stop: Repetitive Start (see page 52)		Show Workflow Window (see page 193)
	Lock grabbing (see page 52)		Show Log Execution (see page 195)
	Save current camera image (see page 222)		Show Spreadsheet Controller (see page 176)
	Load image (see page 221)		Show camera bar (see page 193)
	Grab image + execute (see page 221)		Switch to next camera window (see page 558)
	Process loaded image (see page 221)		View spreadsheet (see page 176)
	Execute checker (see page 464)		Show a Monitor Window for the Interfaces (see page 123)
	Gray-value live image (see page 163)		View parallel interface monitor (see page 125)
	Gray-value memory image (see page 163)		Font viewer (see page 185)
	Run mode (see page 554)		Execution times (see page 53)
	Setup mode (see page 554)		Error logging window (see page 187)
No. 0: All Cameras, Sequence No. 1 ▾ List box for selection of execution groups (see page 133)			Execute program (see page 78)
			Color selection (see page 58)

"Zoom" tool bar at bottom right

	Magnifying glass (see page 44)		Zoom out (see page 44)
	Zoom in selection (see page 44)		Customize (see page 44)
	Zoom in checker (see page 44)		1:1 view (see page 44)
	Zoom in (see page 44)		Hand tool (see page 44)

☞ ◆NOTE

The hand tool and the related mouse wheel controlled functions are only available when the image is larger than the main window.

2.4 Checker and Shape Bar

The checker bar is situated to the far left. It contains icons to create and edit checkers, indicators and image adjustment routines. To select a checker type, click the corresponding icon. The icon meanings, from top to bottom, are listed below:

⬛	Camera Slice Level (see page 223)	🟥	Difference (DI) (see page 358)
🖳	White Balance (see page 279)	🟥	Contour Matching (CM) (see page 380)
☀	Exposure Adjustment (EA) (see page 277)	🟥	Cross Correlation Matching (CCM) (see page 369)
🔄	Position and Rotation Adjustment (PRA) (see page 282)	🅰	Optical Character Recognition (OCR) (see page 401)
🔲	Object Shape (OS) (see page 294)	‖‖‖	Code Reader Checker (CR) (see page 426)
❤	Window (WI) (see page 312)	⤫	Geometry Point-Point (G_PP) (see page 440)
🔴	Feature Extraction (FE) (see page 314)	⤫	Geometry Point-Line (G_PL) (see page 441)
🔻	Edge Detection Binary (ED_B) (see page 330)	⤫	Geometry Line-Line (G_LL) (see page 442)
🔻	Edge Detection Gray Value (ED_G) (see page 340)	🔤	Indicator (see page 448)
🔻	Edge Detection Gray Value Projection (ED_GP) (see page 350)		

☞ ◆NOTE

More icons may appear at the bottom of the checker bar if you have installed plug-ins (see page 560).

When you guide your mouse to the icon, the icon description (tool tip) will appear. The abbreviations (e.g. WI for Windows Checker) shown will help you identify the respective checker type in the sequence list and the spreadsheet later.

When you click on a checker icon, a pop-up menu opens up next to it in which you can select the shape of the checker. After selecting a checker type (e.g. Window Checker), you can assign the checker area a shape (e.g. a rectangle) by clicking on one of the available icons: Only the areas possible for the checker are offered for selection.

General checker shapes		Edge-detection checker shapes	
⬛	Rectangle	⬛	Rectangle with scanning direction
⚫	Ellipse/Circle	⚪	Ellipse/Circle with scanning direction
▽	Polygon	⟍	Line with scanning direction
◎	Doughnut (segment)	◎	Doughnut (segment) with search direction
🌟	Object shape		

For the cross-relation and contour matching checker you can set not only shape and size of the checker, but also of the search area (see page 380). Using edge detection allows you to select the search direction. Follow the direction of the arrow (see page 336).

If you select "Object Shape" as the check area, a dialog box opens up in which you need to select the object shape you want to use.

2.5 Status Bar

Messages in the status bar are aimed to help and support you in your work with Vision Q.400. It may show one of the following status messages:

- Help on icons and menu options
- Error messages
- Execution group with which the application was last run
- Zoom factor
- Mouse position
- Gray value at mouse position

| For Help, press F1 | | No. 0: All Cameras, Sequence No. 1 | | 100% | X: 257 Y: 493 | --- | |

Status Bar

2.6 Function Keys and Shortcuts

You can access some important functions by pressing a function key.

Key	Functionality	Accessible from where?
F1	Open the online help	Vision Q.400 main window
F3	Loads the next image in the demo version	
F5	Execute the application	
F6	Stop repetitive start	
F7	Read and process image of the currently active camera	
F8	Execute the checker	
F9	Switch from live to memory image and vice versa	
F10	Jump with the cursor to the menu bar	
<Ctrl>+L	Switches to setup mode	
<Ctrl>+N	Creates a new application	
<Ctrl>+O	Opens an existing application	
<Ctrl>+P	Prints the current application settings	
<Ctrl>+R	Switches from setup to run mode	
<Ctrl>+S	Saves the current application	
<Ctrl>+<F6>	Switches to the next camera image	
<Ctrl>+<Alt>+<F12>	Opens the execution log window	
<Ctrl> + selecting a checker shape	Without pressing <Ctrl> you need to click exactly the edge of the shape or the moving point of the shape. • To select a checker, you can also click somewhere inside the checker shape. • If the checker is already selected, clicking the checker again will let you move the checker.	
Double-click in the camera window	Activates the hand tool so that you can move the image within the window. With this tool you can seize the image and move it with the mouse. A second double-click deactivates the hand tool.	
<Ctrl>+ double-clicking a checker	Opens the property window and executes the checker	Sequence
<Ctrl>+<↑>	Selects the first checker in the sequence	
<Ctrl>+<↓>	Selects the last checker in the sequence	
<Ctrl> + dragging a spreadsheet row into the "String Reference" column	The result of this column will be used as a string reference for the corresponding OCR checker or code reader (without <Ctrl> the spreadsheet row will be moved)	Spreadsheet
<Shift> + selecting a checker in the sequence	Selects the search area of the checker (without <Shift> the template area will be selected)	Contour matching checker
<Ctrl> + dragging a result value to the field "X /Y Position" under "Position Settings"	Inserts automatically the X and Y coordinates	Indicator

2.7 Zoom Functions

The zoom functions offer a range of options for enlarging, reducing or adjusting the image or segments of it, or moving the zoomed segment around. The maximum reduction when zooming out is 13%, and the maximum enlargement when zooming in is 1000%.

Tool bar with zoom functions.

This tool bar includes icons to run eight different functions:

Icon	Functionality
Magnifying glass	Temporarily enlarge a small segment of the image. When you have activated this zoom function, the cursor appears in the form of the selected icon. Clicking the left mouse button zooms into the image area underneath the magnifying glass. You can also move the magnifying glass around the image by clicking and holding down the mouse button and dragging the mouse. The magnifying glass zoom remains active as you do so. While you are viewing the zoomed image segment, at the right beneath the round magnification window you see the coordinates of the pixel in the middle of the magnifying glass area and the pixel's gray value. To quit the zoom function, click on the icon again, press <Esc> or click the right mouse button.
Zoom in selection	Zoom into a selected area When you have activated this zoom function, the cursor appears in the form of the selected icon. Left-click to set the start point of the zoom area, then click and drag the mouse to expand the rectangular zoomed area. The portion of the image inside the rectangle is enlarged as soon as you release the left mouse button. The function is then automatically deactivated.
Zoom in checker	Enlarge a selected checker shape With this function you can zoom into a selected checker. To do so, click with the mouse on the checker shape. The image is then enlarged so that the checker shape fills the main window. The function is then automatically deactivated.
Zoom in	Enlarge the entire image (up to 1000%) With this function you enlarge the image by zooming into its center point. The function is automatically deactivated after one zoom. You can also enlarge the image by turning the mouse wheel or by pressing the <+> key on the keyboard number pad.
Zoom out	Reduce the entire image (down to 13%) With this function you reduce the size of the image by zooming away from its center point. The function is automatically deactivated after one zoom. You can also reduce the image size by turning the mouse wheel or by pressing the <-> key on the keyboard number pad.
Customize	Adjust the height or width of the image to the size of the main window without distorting the image itself.
1:1 view	The image is displayed on a 1:1 scale, meaning one camera pixel corresponds to one pixel on screen.

Icon	Functionality
Hand tool	Move the image around the main window
	When you have activated this zoom function, the cursor appears in the form of the selected icon. You activate this zoom function by clicking on the icon or by double-clicking inside the image.
	When you press and hold down the left mouse button, the hand icon forms a gripping shape and you can move the image in the desired direction by dragging the mouse.
	To quit the zoom function, click on the icon again, double-click in the image, press <Esc> or click the right mouse button.
	You can also use the mouse wheel to move the image around:
	• To move it horizontally, press <Ctrl> and turn the mouse wheel
	• To move it vertically, press <Shift> and turn the mouse wheel

☞ ◆**NOTE**

The hand tool and the related mouse wheel controlled functions are only available when the image is larger than the main window.

Chapter 3

Application

3.1 What's an Application?

An application is a checking task with all the associated settings which specify the checking task in more detail. This includes:

- Checker definitions
- Camera definitions
- Spreadsheet settings
- The data transmitted via the interfaces

You can create an application, save it under a name of your choice, print it out, number it or assign certain properties to it. There are submenus available under **Application** for all these tasks.

Application menu

Basically, an application should include the following steps:

1. Create a new application
2. Camera selection and settings
3. Image **pre**processing and image processing routines
4. Spreadsheet definition (calibration, value ranges, output to interfaces, calculations)
5. Configure the data transfer via the interface(s)
6. Comment the application for documentation purposes

☞ ◆ **NOTE**

- **The Workflow Window (see page 193) displays the steps required to configure Vision Q.400 and create an application. By default, the win-**

dow is at the left between the checker bar and the main window with the camera image.

- **The properties of an interface, such as the baud rate of the serial RS232 port or the signals transmitted via an interface, are not specific to any single application. They always apply to all Vision Q.400 applications. By contrast, the data to be transferred via an interface must be configured separately for each application.**

3.2 Submenus

The submenus in the **Application** menu will be described in the following sections.

3.2.1 **New**

You can create a new application with **Application** → **New**. With each new application, a new spreadsheet is created. Any other open application will be closed automatically.

Before you start defining the checkers, you need to assign one or more cameras to the application. When you create a new application, the dialog box for assigning cameras appears automatically. You can also use this dialog box to add more cameras later (**Camera** → **Add/Remove Camera(s)...**).

3.2.2 **Open**

With **Application** → **Open** you can open an existing application along with all its accessory components, such as:

- Camera selection and settings
- Creation of image **pre**processing and image processing routines (checkers, object shapes)
- spreadsheet settings (calibration, value ranges, output to interfaces, calculations)
- Application description

When the application your are opening has been created with an older version of the Vision Q.400 software, Vision Q.400 creates a backup copy of the application. When you are in setup mode, Vision Q.400 displays a message with the name of the backup copy, unless:

- You have opened the file via an OLE client or
- You have activated the parameter "Activate Run Mode at Startup" on the "Application" page under **System Settings** → **Vision Q.400 Settings**.

3.2.3 **Close**

With **Application** → **Close** you can close an open application along with all its accessory components.
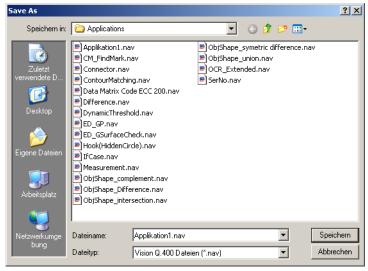
3.2.4 Save

With **Application** → **Close** you save an application. If the access to this function is protected by a password (see page 62), the following window appears:

Enter password

Enter the password. If you save a new application for the first time, the following window appears:

"Save as" dialog box

The system suggests an application name, which you can overwrite. When the application is write-protected, Vision Q.400 opens the "Save As..." dialog box automatically. You can save the application under the previous name. Simply confirm the two prompts asking whether you wish to overwrite the file.

3.2.5 Save As

With **Application** → **Save As...** you can save a new application under any name. If you have previously saved the application, you can save an application with **Application** → **Save As...** again under a new name. In doing so, you will create a second copy with another name, since the application saved previously will remain unchanged under the original name.

The access to **Save As...** can be protected by a password (see page 62).

3.2.6 Start

With **Application → Start** you can execute an application in order to test it or to end an application's interrupt (see next section). This "Start" refers to the complete application; which may consist of several cameras. Please remember that if you have activated the execution group function (see page 138), this may influence the way in which an application is executed.

This function may also be called up with 🖳, the 1st icon in the standard tool bar, or by pressing <F5>.

> ☞   ◆‾N‾O‾T‾E‾ ——
>
> **When you select** Application → Start**, the displayed camera image will be replaced by the current image.**

This is especially important when your PC is configured to start up the image processing system automatically after being switched on. This may be necessary during setup, when you have made several test runs with the application and the conveyor belt has moved the test objects out of the camera range.

Click 🖳 to use the last image saved in the camera's memory; and then execute the application as usual.

> ☞   ◆‾N‾O‾T‾E‾ ——
>
> **When starting an application via an interface, you use the interface to specify whether to include a new camera image or use the last camera image in the memory. This means that in this case the icon setting 🖳 (Lock Grabbing) is ignored: Inputs via the interfaces always have a higher priority than inputs on the user interface.**

3.2.7 Stop: Repetitive Start

With **Application → Stop Repetitive Start** you can interrupt the repeated start of an application without exiting run mode. Then you can, for example, modify your production line and then continue image processing with **Application → Start** even if the run mode start/stop is protected with a password that is unknown to you.

You may also stop and restart executing the application with 🖳 or <F6> and 🖳 or <F5>.

3.2.8 Properties

With **Application → Properties** you open the property page of an application. You may also specify general settings under "General" and enter a comment or description on the "Description" page.

3.2.8.1 Run Mode Settings

On the "Run Mode Settings" property page you specify which data the system will update on-screen during operation, i.e. in run mode. Here you also select the start and processing mode, and define whether the user interface layout will change during a switch from setup to run mode (and vice versa).

Application properties - "Run Mode Settings" property page

Graphic update

The parameters in this frame determine the screen display. If you activate the corresponding options, the system will update the camera image, checkers, indicators, or spreadsheet every time you start an application.

The screen display update is generally quite time-consuming. Please allow extra time for it so that you have sufficient time left for the execution of your inspection task.

You should test to see how much time you will need for updating the checkers and indicators. With extremely fast check sequences, you may want to skip screen updates completely.

☞ ◆NOTE

The settings described above refer to the screen display only. For image processing and output to interfaces, the system will always use current data, even if the screen displays old results.

Execution times update

Execution times are displayed in a separate window (see page 188). You can choose between no display, or having the times displayed during or after run mode. When you activate "After run mode" or "During run mode" the execution times window opens automatically during run mode. If the window is covered by other windows, you can move it to the front by clicking on the 🕸 icon.

Start mode

The following start modes are available:

Start mode	Explanation
Normal start	Starts up image processing with every external start signal (e.g. <F5> or from an interface)
Repetitive start	Repeats image processing from the first start signal a.s.a.p. With the 2nd start signal you stop Vision Q.400, with the 3rd you restart it, etc.
Repetitive / Auto-matic start	Starts and repeats image processing a.s.a.p. after you have started run mode. With the 2nd start signal you stop Vision Q.400, with the 3rd you restart it, etc.
Start immediately	Only available if you have activated "Repetitive start" or "Repetitive / Automatic start".
	By default, Vision Q.400 starts image processing as quickly as possible with the start modes "Repetitive start" and "Repetitive / Automatic start". That means, if you have selected "Start immediately", the next image processing taks is started as soon as the last image processing task is finished. However, you also have the option of specifying an interval between the individual image processing tasks. Deactivate "Start immediately" and enter the interval between the individual starts (in milliseconds) into the field "Start interval". Vision Q.400 will start the individual image processing tasks in this interval.
	If the execution time of an application is longer than the interval specified here, an error message will be output and the next image processing task is started. When this happens for the first time after you have switched to run mode, the error message will also appear on the screen.

Layout switching

You can configure a custom user interface layout (see page 166) for run and setup mode and save it with the application.

- If you want the system to load the run mode layout when you switch to run mode or change applications within run mode, activate the option "Use run mode lay-out"

- If you want the system to load the setup mode layout when you switch to the setup mode, activate the option "Use setup mode layout"

☞ ◆**NOTE**

If you activate these options without having defined the respective user interface layouts, the layout load command is ignored when you switch modes, and a warning is written to the error log file.

3.2.8.2 Description

On the "Description" page, you may enter an application name, the staff member's name as well as a description of the application for documentation purposes. Underneath the description, you will find the file version history.

Application properties "Description" page

3.2.9   Display Colors

With **Application → Display Colors...** you can adjust the color of the different checkers and the slice levels according to your needs.

♦ PROCEDURE

1. **Application → Display Colors**

    You will see a complete list of all checkers available and the camera slice level:

Column	Explanation
Checker type	Type of checker
Shape	Color of the borders of the checker shape

Column	Explanation
Pick point	Color of the center, start, and end point of the shape (select the shape by clicking the pick point)
Object	Color to fill objects found
Result	Color of the cross in the middle of objects found or color of an edge found
Slice level	Color to mark the customized slice level

2. Select *** of the checker in the list (e.g. "Pick Point")**

The ***** (asterisks) in the list show the selected color.

3. Click [Change] or double-click on ***

The color selection dialog appears.

4. Click the left mouse button on a basic color or on any of the colors on the right

5. Use the arrow on the far right to adjust the color brightness

6. Click [OK]

☞ ◆NOTE

When a checker uses an object shape, the shape is displayed in the pick point color of the checker when the checker is selected.

3.2.10 **Print**

With **Application** → **Print** you can print the application components listed below to the printers installed:

- **Checker Parameter...**
  prints from the current camera sequence all checker parameters and settings previously defined for documentation purposes in the checker property page (**Checker** → **Properties**).

- **Spreadsheet...**
  prints the current contents of the spreadsheet complete with formulas and objects for data transfer. This option is active only when you are working in spreadsheet mode.

- **Sequence...**
  prints all checker sequences and the text you entered on the "General" (see page 241) page in the checker properties. A checker sequence describes the image processing routines selected in the order of execution along with the dependencies as defined. Several checker sequences are only available if you have activated the execution group controller (see page 133).

- **Image...**
  prints the current image along with a description and the date.

- **Properties...**
  prints the application properties as well as the general settings for Last Display Update (see page 53) as configured under **Application** → **Properties**.

3.2.11 Color Selection

Use this dialog to define color cuboids that can be used by all checkers of the application. Every color cuboid has a unique number within the application. The number is assigned by Vision Q.400 and cannot be changed. You may assign a user-defined name.

Checker working on the color image can have the   number of a color cuboid as a result.

For each selected color cuboid Vision Q.400 displays

- its unique number within the application
- its reference color (see property page "Color Selection" of the checker), and
- its user-defined name (can be edited).

Color selection dialog

The following options are available:

Option	Description
Add color	Defines a new color cuboid.
Delete color	Deletes the selected color cuboid.
Show selection	Marks all pixels in the current camera image whose three color values are within the selected color cuboid. For the display Vision Q.400 uses the color you have selected under "Display color".
Reference color	Shows the reference color of the color cuboid which corresponds to the values under hue, luminance, and saturation. You can use the color button to change the hue. Click the button and select a color. The new hue is the value of the selected color. Please note that the color shown on the button does not necessarily correspond to the color used for the new hue, as Vision Q.400 uses also the values under luminance and saturation to display the color and the luminance and saturation values will not be changed if you use the button. For further information see the checker description (see page 243).
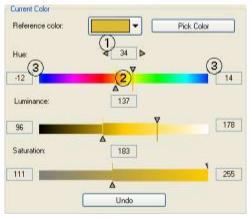
Option	Description
Pick color	Changes the mouse cursor with the first left mouse click to a magnifying glass so that you can zoom into the color area in the camera image. In the middle of the magnifying glass you see crosshairs. With the next left mouse click you select a pixel. Its color values will be displayed under "Current color". With a right mouse click or by pressing <Enter> you end picking a color. If you press <Esc>, the selected colors will be discarded, i.e. the color selection remains unchanged. Please note that here you can select a color from the complete camera image while the checker-specific color selection (see page 243) limits you to the checker shape.
Display color	Colors used to mark all pixels in the current camera image whose three color values are within the selected color cuboid. We recommend selecting a color that contrasts with the reference color.
Undo	Use this to undo all changes since you last clicked or since you last exited the property window.

🖙 ◆NOTE

Please note that the color shown on the button [Reference color] does not necessarily correspond to the color used for the new hue, as Vision Q.400 uses also the values under luminance and saturation to display the color and the luminance and saturation values will not be changed if you use the button.

The colors and numbers displayed have the following meaning:

The box ① next to "Hue" shows the current reference value for the hue. The slider below shows all the colors of the hue cylinder.   The color right in the middle of the slider ② corresponds to the current reference value, i.e. the value in the box above it. The reference value is also related to the relative values ③ displayed to the left and to the right of the slider. They define a range for the hue value. If the current reference value is for example 203 and the relative values to the left and to the right of the slider are -5 and 23, then all hue values between 198 and 226 apply. The calculation uses arithmetic modulo 256, which means that value 256 is the same as value 0.

Using the sliders

You can use the sliders to change the values for hue, luminance, and saturation directly. Click one of the two triangles that mark the value range to activate the triangle. The triangle appears filled with black. As long as a triangle is active, you can move it with the mouse or use the cursor keys to change the value. Use <Shift>+<Tab> to activate the other triangle.

It is possible to change the relative values for the hue by either clicking into the color scale with the left mouse button (the clicked value will become the new relative value) or by clicking the color slide with the right mouse button and move it while holding the mouse button down.

The whole time while you are changing the settings for the color cube, the pixels in the camera image with a color value within the current color cube values will be highlighted with the color assigned to the slice level (see page 55). You can set the color for the slice level either under **Application → Display Colors** or, with a checker-specific color selection, on the property page "Display Colors" (see page 261).

3.2.12 Recent Files

This option shows you a listing of the applications last opened. To open any of these applications, click on it. You can delete (see page 78) the list of recently used applications by selecting [Delete recent file list] under **System Settings → Vision Q.400 Settings → Extras**.

3.2.13 Exit

With **Application → Exit** you exit the Vision Q.400 session.

Chapter 4

System Settings

4.1 Password

With **System Settings** → **Password**, you can assign a password to Vision Q.400. Once you have assigned a password to an application, the following functions are protected:

- Saving application edits (even under another name)
- Changing application numbers
- Changing Vision Q.400 settings
- Starting and stopping the run mode
- Saving changes to the interface parameters
- Changing settings under "Error Handling"

◆PROCEDURE

1. **System Settings → Password**

    If you have not assigned a password yet, proceed to step 3.

2. **If you have already assigned a password for Vision Q.400, enter it under "Current Password"**

3. **Enter your new password under "New Password"**

    If you make no entry, the access to Vision Q.400 is not protected.

4. **Enter your password again under "Confirm New Password"**

5. **Click [OK]**

◆NOTE

- **If you have activated the option "Activate Run Mode at Startup" on the "Application" page under** System Settings→ Vision Q.400 Settings**.**
- **With Windows XP/Windows 2000, you have to differentiate between capitalized and non-capitalized letters even as you enter a password.**
- **Please note that the Windows XP/Windows 2000 password and the password for Vision Q.400 are two separate passwords.**
- **When you use an OLE client to control Vision Q.400, Vision Q.400 ignores password settings for all functions controlled by the OLE client. If**

you wish to protect your application, please implement the password in the OLE client.

4.2 Spreadsheet Password

Use this option to set a password for locking the spreadsheet. If you do not define a password, the spreadsheet can be locked/unlocked by any user.

◆PROCEDURE

1. **System Settings → Spreadsheet Password...**

   Change Spreadsheet Password

   Current

   New password:

   Confirm new

   OK   Cancel

   If you have not assigned a password yet, proceed to step 3.

2. **If you have already assigned a password to the spreadsheet, enter it under "Current Password"**

3. **Enter your new password under "New Password"**

   If you make no entry, the access to locking/unlocking the spreadsheet is not protected.

4. **Enter your password again under "Confirm New Password"**

5. **Click OK**

◆NOTE

This password only applies to locking/unlocking the spreadsheet. The application is protected by a dedicated password (see page 62).

4.3 Vision Q.400 Settings

With **System Settings** → **Vision Q.400 Settings** you determine the behavior of Vision Q.400 independent of an application, for example what should happen with Vision Q.400 when you start or exit Windows XP/Windows 2000. Please note that if there is a password for Vision Q.400, you can only save changes to the settings if you have entered the password correctly when the dialog box was opened.

4.3.1 Application

With these options you determine the application which will be loaded after you have started Vision Q.400. Choose whether you wish to switch to run mode automatically after the selected application has been loaded. In addition, determine when the application will be saved implicitly.

Vision Q.400 settings for applications

Options	Description
None	No application is loaded
Show Vision Q.400 startup dialog	When you switch on the Imagechecker a dialog box (see page 29) is displayed with the choice between creating a new application and opening an existing application.
Load last open application:	The application used last is loaded automatically
Load the following application	The selected application is loaded automatically when the system is started
Activate run mode at startup	Run mode is activated automatically when the application is loaded
Vision Q.400 user name	This option is described in the documentation about user rights management. Please contact the technical support staff if you would like to use manage user rights.

Options	Description
Sleep time before camera detection	Only for GigE Vision cameras.
	Enter the time in seconds that the GigE Vision version of Vision Q.400 has to wait after a start until it tries to access the GigE Vision cameras connected. This option is useful when you start Vision Q.400 automatically after switching on the computer. This may lead to Vision Q.400 trying to access the GigE Vision cameras before they have finished booting. In this case it would not be possible for Vision Q.400 to detect a connected camera. By entering a sleep time you ensure that all cameras connected to Vision Q.400 have booted before Vision Q.400 tries to access them.
	Another use for this option is when you need to re-boot a camera after changing its IP address.

4.3.2 Automatic Startup

Use these options to start Windows XP/Windows 2000 and/or Vision Q.400 automatically after the PC Imagechecker has been switched on. You need to specify a user name, the domain, and a password at login.

> **☞ ◆NOTE**
>
> - **You have to define a Windows NT password before you can configure automatic startup. It is possible to leave the password field empty under Windows XP.**
> - **The password for the Windows XP/Windows 2000 login will be saved unencrypted in the registry file! This means everybody logging in on the PC can read it.**
> - **If you do not belong to a domain, you must leave the "Domain Name:" field empty.**

When you activate the option "and Vision Q.400", both Windows XP/Windows 2000 and Vision Q.400 will be started automatically after the PC Imagechecker has been switched on.

Vision Q.400 settings for automatic startup

4.3.3 Interface Exit Options

Use the dialog box "Interface Exit Options" to specify how you want to exit Vision Q.400 and whether you want Windows to shut down automatically.

Vision Q.400 shutdown settings

You can exit Vision Q.400 via the selected interfaces. If an interface has not been selected, signals coming from this interface will be ignored and a warning appears in the error log. The table below lists the options available:

Settings	Description
Enable exit via the following interfaces	To exit Vision Q.400, you can select one or more interfaces: • Ethernet interface • Serial interface • Parallel interface • OLE interface
Shut down	Specify whether one of the "Shutdown modes" listed below is to be triggered after you exit Vision Q.400.
Shut down Windows and turn off PC	Use this option to shut down Windows and switch off the PC. This feature is not supported by the Q.400S hardware.
Shut down Windows	Windows will be shut down after you exit Vision Q.400 manually or send the shutdown signal via one of the interfaces (Ethernet, serial, parallel, OLE).
Restart PC	This option executes an automatic restart of the system including Windows.

☞ ◆**NOTE**

If you are still using the interface board "ME81" for the parallel interface, you must apply the shutdown signal followed by a start signal in order to initiate the shutdown.

4.3.4 Event Logging

Vision Q.400 writes entries into the system's event log file. The event log may be helpful in tracing problems when you are working with Vision Q.400.

 ◆PROCEDURE

1. **Start → Control Panel**

2. **Select "Administration" or**

3. **Select "Event Logging"**

You can sort the display by source and thus list, for example, all events triggered by Vision Q.400.

4. **Click column header "Source"**

5. **Double-click on an entry to see details about the logged event**

The event information is kept until you manually delete it.

The table lists the entries that may appear in the event log file.

Event	Entry
Start/Stop	Vision Q.400 has started.
	The Vision Q.400 Demo has started.
	Vision Q.400 - Manual exit.
	Vision Q.400 - Exit by Ethernet interface.
	Vision Q.400 - Exit by OLE interface.
	Vision Q.400 - Exit by serial interface.
	Vision Q.400 - Exit by parallel interface.
	Exit Vision Q.400.
	Exit Vision Q.400 Demo.
System shutdown	Vision Q.400 has shut down the computer.
Client services	Vision Q.400 is started by an OLE client.
	Vision Q.400 - Register COM Server.
	Vision Q.400 - Unregister COM Server.
Errors	Vision Q.400 was started twice.
	Vision Q.400 Fatal Error: %1.

4.3.5   Frame Grabber

Depending on whether you are using a **Camera Link™** (see page 201) frame grabber or GigE Vision cameras, you have the following options for defining your frame grabber settings.

If you are using Camera Link frame grabbers, you can set the camera type (matrix or line-scan) to be connected to the frame grabber and the Camera Link configuration (see page 201) of each frame grabber under System Settings → Vision Q.400 Settings → Frame Grabber. In addition, you can enter under "Number of image buffers" how many buffers should be created for an image. The buffers are used a s a ring buffer, i.e. the frame grabber writes a captured image in the next free buffer starting with buffer 1. When all image buffers are occupied, the frame grabbers starts with buffer 1 again. If you set "Number of image buffers" to 1, every image capture overwrites the last captured image. If you set "Number of image buffers" to 4, the fifth image capture overwrites the first captured image.

When the cameras are triggered by Vision Q.400, it is not necessary to change the default setting of "Number of image buffers". If the cameras are triggered directly by the frame grabber (i.e. by external trigger), you may have to increase the number of image buffers so that you can capture new images while Vision Q.400 processes the image captured before. Make sure to set the number high enough so that the image buffer containing the currently processed image is not overwritten. If that happens, an error message appears.

Camera Link: Vision Q.400 frame grabber settings

☞ ◆ <u>NOTE</u> ═══

- **In order for you to be able to connect a camera to a frame grabber, the Camera Link configuration and the camera type must match the settings you have made for the frame grabber under "Vision Q.400 Settings".**

- **By default, Vision Q.400 offers frame grabbers and matrix Camera Link cameras of the Camera Link configuration "Base". If you wish to use line-scan cameras or a different Camera Link configuration, please contact the technical support.**

- **If the cameras are triggered externally, we strongly recommend to synchronise the trigger with the Ready signal from Vision Q.400 to prevent an overflow of the image buffer.**

4.3.6 GigE Vision Cameras

This property page only appears when you are using GigE Vision cameras.

When you start Vision Q.400, the software checks for all cameras accessible via the network board, even if the cameras are not located in the subnet of the network board. However, in order for you to be able to use a camera in Vision Q.400, the camera needs to be in the subnet of the network board. Cameras that are **not** in the subnet of the network board will be listed under [Not accessible cameras] and can be inserted into the subnet of the network board (see page 73).

In addition, a camera has to meet the following requirements (apart from being located in the subnet of the network board):

- It must be possible to set an identifier for the camera (GenICam parameter "DeviceUserId").

- It must be possible to switch the camera to trigger mode. (GenICam parameter "TriggerMode"="On").

- It must be possible to set a shutter speed for the camera. (GenICam parameter "ExposureMode"="Timed").

- The camera must support the GenICam parameter "Trig-

gerSelektor"="FrameStart" for starting the image capture.

- It must be possible to trigger the image capture with the software. (GenICam parameter "TriggerSource"="Software").

- The camera must either use a persistent IP address or must be able to get the IP address from a DHCP server. (GenICam-Parameter "GevSupportedIPConfigurationPersistentIP"="1" or "GevSupportedIPConfigurationDHCP"="1").

☞ ◆**NOTE**

- **If one of these conditions is not met, you cannot use the camera in Vision Q.400. In this case the camera will be listed under [Not accessible cameras].**

- **You can use all cameras that are in the subnet of the network board and that meet the conditions listed here in Vision Q.400, even if the cameras are not supported by Vision Q.400 by default.   As Vision Q.400 implements camera functions (see page 202) and this implementation cannot be automated for cameras that are not supported by Vision Q.400 by default, such cameras will be supported** with limitations**: It is only possible to capture images and to set the shutter speed.**

Always grab serial

When you activate this options, all cameras designated to capture an image will capture images serially. This means that the network connection will only have to deal with data from one camera at a time. However, at the same time this increases the time needed for the image capture of all cameras, as the times needed by each camera to grab an image will add up.

If you do not activate the option, image grabbing will be executed almost in parallel. The total capturing time of all cameras is roughly the time needed by the slowest camera. As all cameras try to transfer their data at the same time via the network connection, this may affect the network connection negatively. You can optimize the data transfer via the network connection with the parameters on the property page "Advanced Settings" under **Camera →**
Properties.

By default, the option is not activated, i.e. all cameras grab images in parallel to keep the total time for executing the application as short as possible. The option is not available in the simulation version as the version does not distinguish between parallel and serial image capture.

No. of cameras

The option is only available in the simulation version. Enter the number of cameras to be simulated.

4.3.6.1 Accessible Cameras

The table lists the following items for all cameras accessible by Vision Q.400:

Column title	Description
Number	The cameras are numbered consecutively in the order Vision Q.400 finds them. As this order depends on the current network properties, the number of each camera may differ from one program start to the next. That means that one and the same camera may have different numbers in consecutive program starts.
	To the left of the camera number you see a camera icon. Cameras that are not supported by Vision Q.400 by default are marked with an exclamation mark in a yellow circle. This icon indicates that there are restrictions for using these cameras in Vision Q.400 (see page 70).
IP address	**Note:** This column is not displayed in the simulation version. Contains the camera's IP address (see page 73) that can be provided by DHCP server or entered manually. Alternatively, you can assign an IP address with the option "Force camera into subnet".
Identifier	The camera identifier is necessary for unambiguous identification of a camera as it is not possible to identify GigE Vision cameras by their number or their IP address.
	It is possible to change the identifier of a camera, if you do not have an application loaded:
	• Select the camera whose identifier you wish to change.
	• Click the cell "Identifier"
	• Enter the new text
Type	As GigE Vision cameras are self-descriptive, the camera type is always known in the full version of Vision Q.400. This is why you cannot change the camera type in the full version of Vision Q.400. It is possible to change the camera type in the demo version, if you do not have an application loaded:
	• Select the camera whose type you wish to change.
	• Click the cell "Type".
	• Select the camera type from the drop-down list.
Resolution	As GigE Vision cameras are self-descriptive, the resolution is always known in the full version of Vision Q.400. This is why you cannot change the resolution in the full version of Vision Q.400. It is possible to change the resolution in the demo version, if you do not have an application loaded:
	• Select the camera whose resolution you wish to change.
	• Click the cell "Resolution".
	• Select the resolution from the drop-down list.

It is possible to always grab images serially (see page 70).

4.3.6.2 Not Accessible Cameras

The [Not accessible cameras] button is only available if you do not have an application loaded and if Vision Q.400 has found at least one camera that cannot be used by Vision Q.400.

With this button you open a dialog listing all cameras that are not accessible by Vision Q.400.

☞ ◆NOTE

In the simulation version, always all cameras are accessible.

The table lists the following items for all cameras **NOT** accessible by Vision Q.400:

Column title	Description
Number	The camera number is assigned in the order the cameras are inserted in the list of non-accessible cameras. **Note:** At the top of the list, you find the cameras which are **not** within the subnet of the network board, i.e. they have the lowest numbers. You can force these cameras into one of the subnets (see page 73). All other cameras cannot be used in Vision Q.400. You recognize cameras that cannot be used by the symbol to the left of the camera number: an exclamation mark in a red circle ●. The reason why a camera currently cannot be used will be displayed under "Reason".
IP address	**Note:** This column is not displayed in the simulation version. It contains the camera's IP address (see page 73).
Type	This column displays the camera type. As only the full version of Vision Q.400 may contain not-accessible cameras and GigE Vision cameras are self-describing, the camera type cannot be changed.
Reason	This column displays the reason why the camera cannot be used at the moment. **Note:** Der Grund wird immer auf Englisch angegeben.###QV

4.3.6.3 IP Addresses for GigE Vision Cameras

Depending on whether a camera is accessible for Vision Q.400 or not, you need to proceed differently to set the IP address.

Accessible cameras

When you have not loaded an application, you can select here how the camera gets its IP address:

◆ PROCEDURE

1. **Select the camera for which you wish to set the IP address**

2. **Select the address field**

3. **Open the dialog box with [...] button**

   At the top you see the IP address currently used by Vision Q.400 to access the camera. This address may be supplied by a DHCP server, can be fixed or assigned to the camera temporarily by Vision Q.400. The latter is the case when a camera has been forced into the subnet of the network board temporarily (see page 72). In addition, the host IP address that the camera is connected to is displayed.

4. Select the IP address to be used

With "Use DHCP server" the camera gets its IP address from a DHCP server. With "Use persistent IP address" the IP address is fixed.

5. Enter address for a persistent IP address

The new persistent IP address has to be within the subnet of the network connection to which the camera is connected. The subnet mask is always "255.255.255.0" and cannot be changed. To apply the changes, you need to restart Vision Q.400 and the camera.

6. Stop Vision Q.400

7. Disconnect the camera from the power supply

8. After a moment, reconnect the camera to the power supply

9. Restart Vision Q.400

◆**NOTE**

- **If you have changed the IP address settings, you must restart Vision Q.400. You also need to disconnect the camera from the power supply.**
- **It is not possible to access the camera right away If you have disconnected it from the power supply and reconnected it. How long you have to wait before access is possible depends on the type of camera, the PC used and the current network configuration.**

Not Accessible Cameras

For cameras that are not located in the subnet of a network board, you can select from where the camera gets its IP address. It takes two steps to assign the IP address:

1. Before you can have access to the camera, you first need to insert it temporarily into the subnet of the network board. The camera is assigned an IP address that fits into the subnet of the network board.
2. Then you can either accept the assigned IP address for the camera or change it as described above for accessible cameras.

It is not necessary to assign an IP address to a camera in order to use it. It is sufficient to force the camera temporarily into the subnet of the network board. The camera will remain in the subnet until it is disconnected from the power supply. Use this procedure when you do not wish to change the IP settings of the camera permanently.

If you want to insert a camera temporarily into the subnet of a network board, please proceed as follows:

◆**PROCEDURE**

1. Select the camera you wish to insert into the subnet

2. Select the IP address field

3. Open the dialog box with [...] button

4. Select the insertion mode for the camera

Select "The camera is only forced into the subnet" if you want to insert the camera into the subnet only temporarily. If you also want to assign an IP address, select "The camera is forced into the subnet, and the IP-address is set".

5. Exit Vision Q.400 and restart it

☞ ◆NOTE

Vision Q.400 does not insert cameras automatically into the subnet of a network board in order to avoid inserting invalid cameras by mistake.

4.3.7 Timeouts

Here you can define which timeouts (in seconds) will be used in Vision Q.400.

Vision Q.400 timeout settings

RS232 Interface

When you transfer data or signals to the RS232 interface, the interface has to respond within the time span entered here. If the transfer is not completed by then, an interface error occurs. The minimum timeout is five seconds.

☞ **◆NOTE**

The timeout is only used if you have set the option "Flow Control" to "Hardware" on the RS232 property page.

OLE interface

When you transfer data, images, or signals to an OLE client, the OLE client has to respond within the time span entered here. If the transfer is not completed by then, an interface error occurs. The minimum timeout is five seconds.

☞ **◆NOTE**

- **All data and images have to be transferred in the time span entered here. Even if the data transfer is completed earlier, the time saved is not available for transferring images.**
- **The transfer of data, images, or signals from Vision Q.400 to an OLE client is synchronous. This means that Vision Q.400 waits for the client to acknowledge each transfer. This is why timeouts are often caused by the client not acknowledging the transfer on time.**

Application change

An application change triggered by the interface has to be completed in the time span entered here. If the application change is not completed by then, an error signal is output. As it is not possible to terminate the application change, the process will be completed. However, after the process is complete, the currently loaded application will be closed so that no application is open in Vision Q.400.

If an error signal is output, the Ready signal remains OFF until a correct application changes has been performed.

☞ **◆NOTE**

The timeout is also valid if an OLE client opens a new application in setup mode. This means that if the application cannot be opened in the time span entered here, the (synchronous) command to open the application returns an error message. As it is not possible to terminate the process of opening the application, the process will be completed. However, after the process is complete, the currently loaded application will be closed so that no application is open in Vision Q.400.

4.3.8   Save Settings

When you start Vision Q.400, the system checks whether there is a backup copy. If Vision Q.400 detects a backup copy, it displays a message asking whether the backup copy should be loaded. If you select "No", the file will be deleted.

Vision Q.400 security settings

Save the application implicitly on entering the run mode (see note)	When you activate this option, the application is saved whenever you switch from setup to run mode. This option is deactivated by default.
Save the application implicitly on leaving the run mode (see note)	When you activate this option, the application is saved whenever you switch from run to setup mode. This option is activated by default.
Save the application implicitly on closing in the run mode (see note)	When you activate this option, the application is saved when it is closed in run mode. An application will be closed in run mode when you exit Vision Q.400 while you are in run mode or when you change applications in run mode. This option is activated by default.
Auto save application every n minutes	If you activate this option, Vision Q.400 creates a backup copy in the application folder every n minutes, with n = figure entered as time interval. The default setting is 5 minutes and can be increased in 1-minute steps. This function only works in setup mode, it is switched off during run mode.
Auto save Vision Q.400 settings to file on exit	If you activate this option, all Vision Q.400 settings saved in the registry will be exported to the file "autoSaveVisionQ.400Settings.reg" when you exit Vision Q.400. The file "autoSaveVisionQ.400Settings.reg" is in the installation folder of Vision Q.400 and wll be overwritten if it already exists. This option is deactivated bBy default.

☞ ◆**NOTE**

- **The backup copy is called "~autoSave.sav". In order to be able to open it in Vision Q.400, rename the file and change the extension from *.sav to *.nav. This also prevents Vision Q.400 from displaying the message that a backup copy exists.**

- **If you have activated one of the options "Save the application implicitly on leaving the run mode" or "Save the application implicitly on closing in the run mode", but the application is write-protected, the application will** not **be overwritten.**

4.3.9 Customized Button

Use this option to define which program will be executed when you click 🔲 . You can enter any program here.

Configuration dialog box for the customized button

◆PROCEDURE

1. **Under "Program" you enter the program path**
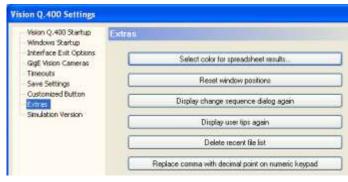
   or

   Click [...] to select the path with the explorer
2. **Under "Parameter" you can enter program parameters, if required**
3. **Select "Disable Button during Run Mode" if you want to deactivate the button 🔲 in run mode**
4. **Use [Test] to check whether the button works as intended**

4.3.10 Extras

This tab contains some additional functions which make it easier to use Vision Q.400.

Vision Q.400 settings under "Extras"

Color for results inserted in spreadsheet

Vision Q.400 indicates which checker results on the "Result" page have already been inserted in the spreadsheet by displaying them with a special background color. Use this option to change the background color.

☞ ◆**NOTE**

> **The selected background color is a default setting in Vision Q.400 and valid for all applications.**

When you click this button, the dialog box for selecting a color (see page 55) is displayed. The default background color appears in the top and bottom right field of the dialog box under "User-Defined Colors". Select one of these fields if you wish to return to the default background color.

Reset stored window positions

Both the main screen and the windows displaying the checker properties can be moved and resized, as desired. When you exit Vision Q.400, the system stores the position of the windows. In some cases, for example when you change the screen resolution, it is possible that a window is moved out of the visible area and can no longer be accessed. If this happens, use this button to return all windows to their default position.

Show change sequence dialog again

If you are using execution groups, it may occur that checkers are displayed in the camera window which do not belong to the checker sequence currently selected. When you then click on one of these "non-belonging" checkers in the camera window, the "Change Sequence" dialog box appears by default, asking whether you want to switch to the sequence to which the selected checker belongs. You can disable this dialog box. Click the "Show change sequence dialog again" button to re-enable it.

Show user tips again

There are information dialog boxes in Vision Q.400, which automatically display useful user tips after the installation, e.g. the dialog box with the information on the currently supported cameras that appears when you start Vision Q.400. Every information dialog can be deactivated by selecting "Show information on startup" so that it will not be displayed the next time. If you select this function, all information dialog boxes which you have deactivated will be displayed again.

Delete recent file list

With this button you delete the list of recently used files. Note that you can only delete the current list status: When you open or save an application after clicking the "Delete recent file list" button, it is entered in the list of recent files.

Replace comma with decimal point on numeric keypad

With this button you replace the comma in your keyboard number pad with a decimal point. This helps you input decimal values on the spreadsheet. When you click the button the label changes to "Replace decimal point with comma on numeric keypad", enabling you to reset the key assignment to its original status.

☞ ◆NOTE ───────────────────────

> **When you have clicked this button you must exit Vision Q.400 and restart your computer for the new setting to take effect.**

4.3.11 Simulation Version

This property page appears in the Vision Q.400 simulation version only. Here you can select the camera types you wish to use in the simulation version. Analog cameras are no longer supported.

If you want to work with **Camera Link cameras** (see page 201), select "Camera Link." The simulation version does not distinguish between the various Camera Link frame grabbers. It supports the Camera Link cameras ANPVC 1040, ANPVC 1021, and ANPVC 1210.

If you want to use Camera Link frame grabbers and cameras which need the Camera Link configuration "Full", please select "Camera Link Full". Please note that Vision Q.400 does not support this Camera Link configuration by default.

If you want to work with **GigE Vision cameras** (see page 207), choose "GigE Vision". The simulation version supports the black-and-white GigE Vision cameras ANPG 830D, ANPG 831D, ANPG 832D, and ANPG 835D and the GigE Vision color cameras ANPG 830CD, ANPG 831CD, ANPG 832CD, and ANPG 835CD.

If you want to work with user-defined cameras that are supported by an image acquisition interface in Vision Q.400, select "Image Acquisition Interface". For Imagechecker systems using Camera Link, GigE Vision, and user-defined cameras, there is an Essentials version of Vision Q.400. Please select "Essentials Version", if you use the simulation version to create or load applications for the Essentials version.

☞ ◆NOTE ───────────────────────

> **If you have changed the simulation version settings, you need to restart Vision Q.400.**

4.4 Save Settings to File

When you select this command, a dialog box opens up in which you can assign a file name. Then all settings not specific to an application but globally applicable throughout the Vision P400 system are saved to a file of type *.reg.

The following settings are saved:

- the settings for the Vision P400 interfaces;
- the settings for the Frame Grabber, in particular the connected cameras;
- the settings for Vision P400 error handling;
- the settings for Vision P400 timeouts;
- the settings to start and end Vision P400 and to activate and quit run mode, such as the name of the application to be loaded when Vision P400 starts up,
- the assignment of application names to the application numbers used on an interface-controlled application change; and
- Vision P400 internal settings.

With this function you can easily transfer the Vision P400 settings to a different computer by copying the file to the target computer and loading it there by way of the "Restore Settings from File" command.

☞ ◆NOTE

You cannot edit the *.reg file you create by way of the "Save Settings to File" command, so as to prevent important Vision P400 settings from being unintentionally discarded and Vision P400 from being prevented from running correctly when you read in the file.

4.5 Restore Settings from File

When you select this command, a dialog box opens up in which you can select a file of type
*.reg (see page 81). In files of this type all settings are stored which are not applica-
tion-specific but globally applicable throughout the Vision Q.400 system.

☞   ◆**NOTE**

- **When you run the "Restore Settings from" command, the settings
  stored in this file overwrite the current Vision Q.400 settings on the
  computer on which you are running the command.**
- **When you run the "Restore Settings from File" command, Vision Q.400
  is automatically terminated and you must restart the program.**

4.6 Error handling

In Vision Q.400, there are different types of errors (see page 570). The settings in the menu **Error Handling** are only valid for warnings.

You will receive a warning if a **calculation error** occurs in the **spreadsheet** or when **executing individual checkers**. The calculation of a checker fails, for example, if the dependencies could not be established or if an algorithm did not find any objects for evaluation. A spreadsheet calculation error occurs, for example, if the system tries to divide a result by zero.

As a rule, warnings do not influence the operation of the system, apart from the time needed to write the warning into the file "error.txt" and into the "Error Logging" window (this option can be switched off in run mode). In the "Error Logging" window (see page 187) you can see all warnings displayed while the program is running. You can only view the file "error.txt" after you have exited the program.

If the number of warnings exceeds a user-definable limit, you can configure an appropriate message that will appear on your screen.

In **Error Handling** → **Error Handling** you define Vision Q.400's response to errors of the type warning. The access to this function can be protected by a password (see page 62).

"Error Handling" dialog box

4.6.1   Global Settings

The error file "error.txt" is not created new every time Vision Q.400 starts up; the existing file is opened and new entries are appended at the end. To prevent the error file from becoming too large, use "Maximal File Size" to limit the size of the file. Every time it starts up, Vision Q.400 checks whether the size of the error file has exceeded the permitted maximum. If the error file has exceeded the permitted maximum size, Vision Q.400 creates a maximum of one copy of the error file "error.txt" under the name "error.txt.bak" (if a file with this name already exists it is overwritten) and deletes the content of the "error.txt" file.

You can also specify when error entries are written to the error file "error.txt" (see page 85). If you select "Buffered", warnings are not written to the file directly, but are stored in a buffer in the memory. The size of the buffer is defined by the figure selected in the right field. When you leave Vision Q.400, the system writes the contents of the buffer into the error file "error.txt".

When you select "Continuously", all warnings are directly written into the error file. The number of entries is limited by the figure selected in the input box at the right.

☞ ◆**NOTE**

- **If unexpected (see page 564) or fatal errors (see page 565) occur, the system automatically uses "Continuous" mode, meaning all such errors are written immediately to the error file. In this case, possible limits set for the file size will be ignored.**
- **Writing into the error file influences the time response of your application. We therefore recommend that you use the setting "Buffered".**

4.6.2 Run Mode Settings for Warnings

In run mode there are two additional possibilities to deal with warnings:

If you activate the parameter "Write to Error Log" with a mouse click, the system will write warnings not only into the file "error.txt", but also into the "Error Logging" window of the application. This setting is only valid for run mode. In setup mode, all warnings are always displayed in the "Error Logging" window. You can empty the error log with **Error Handling** → **Clear Error Log** or the <Del> key.

With "Show Notification Dialog after <n> Entries" you define a limit for warnings. If the number of warnings reaches this limit, a window appears with an appropriate message. This setting is only valid for run mode. In setup mode, there is no notification window.

In the example below, the maximal number of warnings to ignore has been set to "20".
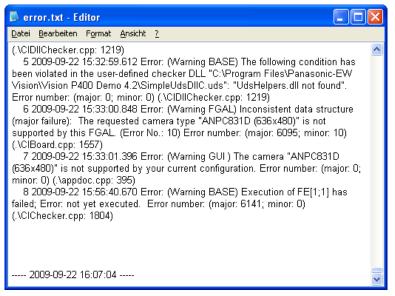
Ignore warnings (limit)

This configuration option is useful during the installation phase. It makes it easier to find problems that occur only sporadically while the system is in operation.

4.6.3 Error File "error.txt"

In the installation folder (e.g. In the installation folder (e.g. C:\Program Files\QVITEC\Vision Q.400 <Q.400_VersionNumber>) you will find the "error.txt" file. This file contains error descriptions (see page 569) which help you to analyze the errors that have occurred.

Every time the program starts up a new section with the current date and time is created at the end of the file. Each error or warning is written in a new line.

Extract from an "error.txt" file

4.6.4 Clear Error Log

This option deletes the entries in the error log. You can protect this option with a password to prevent the error log from being deleted by mistake.

☞ ◆NOTE

This option does not delete entries in the error file "error.txt".

4.7 Application Numbers

With **System Settings** → **Application Numbers** you can number any application saved. Initially, Vision Q.400 assigns the numbers automatically every time you add a new application to the list. If you want to change the application numbers and your Vision Q.400 system is password-protected, you will be required to enter the password. To display the application numbers, however, the password is not required. You use the application numbers (see page 103) to switch (see page 118) from one application to the next.

☞ ◆**NOTE**

> **The time required for an application switch depends on the size of the applications. This means that, depending on the number of cameras and checkers, as well as on the display settings, the time required for an application switch may vary. If your application is time-critical, we recommend doing test runs to determine the time required for switching applications.**

Numbering applications

You can overwrite the existing application number with a new number. Click in the column labeled "Number" and type in a new number. The table will be updated when you move the cursor out of the cell.

☞ ◆**NOTE**

> **If you enter a number already assigned to another application, Vision Q.400 will not accept the change.**

You insert an application by clicking [Add]. Depending on whether you have selected a row when you add an application, Vision Q.400 inserts the application below the selected row or at the beginning of the list. Delete an assigned application number by selecting the corresponding row and clicking [Remove]. Alternatively, press <Del> **or Backspace.**

To change the application assigned to a number, click [...] and select an application in the dialog box.

The column "Parallel I/O Bits" (see page 118) shows the bit pattern required by the parallel interface to enable switching to the application with this number.

☞ ◆NOTE ═══

- **The P I/O bit pattern is always the application number minus 1, e.g. for application number 1 the P I/O bit pattern is 0000 0000.**
- **You can assign application numbers up to 9999. However, changing to an application with an application number exceeding 256 is only possible via the Ethernet, serial, or OLE interface.**

4.8 Action

Under **System Settings** → **Action** you can set the ring buffer size for camera images that are to be saved when the Action is triggered. The standard setting is 12 images and applies to all Actions. The dialog box is password-protected.

Action settings: Ring buffer size

4.9 User Interface Layout

In Vision Q.400 you can customize the appearance of your user interface in layouts. In this, a distinction is made between

- layouts with non-application-specific settings which are used when no application, or no layout saved in the application, is loaded, and
- layouts with application-specific settings which are saved with the respective application.

Name	Layout type	Which data are stored in it?	Icons and commands in Vision Q.400
User interface layout (see page 89)	non-application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows	Save with Load with Delete with System Settings → **User Interface Layout** → Save as/Load/Reset User Layout
Start layout (see page 166)	application-specific	• Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Automatically configured and saved (see page 166) by Vision Q.400
Setup mode layout (see page 166)	application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Save with Load with Delete with View → Application Layouts → Save/Load/Delete Setup Mode Layout
Run mode layout (see page 166)	application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Save with Load with Delete with View → Application Layouts → Save/Load/Delete Setup Mode Layout

With "User Interface Layout" you define independently of the **specific application** how the Vision Q.400 user interface is to look when no application, or no layout saved in the application, is loaded.

When you select **System Settings → User Interface Layout → Save as User Layout** or click the icon , the current appearance and position of the tool bars, the menu bar and the dockable windows is saved (see page 171). The position and size of the camera windows and of the spreadsheet are not saved, because those settings are **application-specific**, and are saved along with the application.

With **System Settings** → **User Interface Layout** → **Reset to Default Layout** or by clicking the icon ⊠ you can restore the Vision Q.400 default settings at any time.

☞ ◆NOTE ═══

- **Whenever you have changed the layout of the user interface, you must save your changes explicitly by choosing** System Settings → User Interface Layout → Save as User Layout**, otherwise they will be lost the next time Vision Q.400 starts up.**
- **When you have selected** System Settings → User Interface Layout → Reset to Default Layout**, you must restart Vision Q.400 for the default setting to be applied.**
- **When an application is loaded, the settings made here are normally overwritten by one of the layouts stored in the application. Whether this happens, and with which layout from the application, depends on the application settings (see page 166).**

4.10 Interfaces

Vision Q.400 supports the following interfaces:

- Ethernet interface (see page 92)
- Serial Interface (see page 94) (that is, via RS232)
- Parallel interface (see page 109)
- OLE (see page 121)
- Camera (no sending of data and signals)

All settings you make under **Interfaces** are globally applicable to every application you have loaded. To be able to continue using your interface settings in the next session, you must save them when you exit Vision Q.400. Saving the interface settings is protected by password (see page 62), if you have defined a password under **System Settings → Password**.

Sending signals

On the interfaces' property pages you select a) whether the interface will be used (all except OLE) and b) which signals will be sent by Vision Q.400. If you select the check box, the signal will be sent. Activate this option with a mouse-click.

Signal	Meaning
REnd	REnd (read end) signifies that the image has been read in. This means that the next image can be captured, or the next object can be placed before the camera lens.
PCReady	Indicates that Vision Q.400 is ready to continue running the application – that is, a new start signal will be accepted.
PCDataReady	Signals that the current results are available.
Application change completed	Sends a signal when the application has been changed successfully.
Start lost	Signals that a start signal was sent to Vision Q.400 before the PCReady signal was issued and that the start signal has been ignored. With the parallel interface, the signal "Byte Overflow" can be transferred instead.

The following signals are selected indirectly:

Signal	Meaning
PCReady OFF	Vision Q.400 is ignoring all input commands, because the system is busy. This signal will be sent if you have activated the PCReady signal on the interface's property page.
PCDataReady OFF	Indicates that the data from the previous execution are no longer valid. This signal is sent if you have selected PCDataReady.
Error	Indicates that an error has occurred.

Vision Q.400 automatically recognizes available interfaces. For example, if you have connected the mouse to the serial interface COM2, Vision Q.400 suggests COM1 as the available interface.

Transfer sequence

The transfer sequence depends on the order in which you have assigned spreadsheet results to the interface, i.e. either by drag & drop or via the context menu. If you use drag & drop to select spreadsheet data for output to the serial interface, for example, the selected spreadsheet cell will be marked in the color code you have defined for the interface. The data are

transmitted automatically after the application has been executed. You can change the transfer sequence in the "Objects for Data Transfer" (see page 535) window.

Open the "Objects for Data Transfer" dialog window with the sequence, for example for the

Ethernet interface, with a click on the Ethernet symbol [Ethernet I/O] to the left of the spreadsheet.

The image processing flow diagram (see page 22) shows that values are output after the spreadsheet has been processed. For every interface, the values for "Signals to be Sent" are output together with the selected spreadsheet entries.

☞ ◆ **NOTE**

During communication via the interfaces, interface errors can occur during run mode. You can resolve interface errors (see page 566) without exiting Vision Q.400.

4.10.1 Ethernet

Vision Q.400 supports Ethernet I/O communication using the Internet Protocol (IP), with Transmission Control Protocol (TCP) or User Datagram Protocol (UDP) transport layers.

☞ ◆ **NOTE**

Vision Q.400 currently supports a single connection at any one time.

The modes of operation are listed in the table below. The mode of choice will partly depend on the capabilities of the connected unit.

Mode	Description
Client (TCP)	Vision Q.400 acts as a TCP client and makes a connection to a TCP server for sending and receiving data.
Server (TCP)	Vision Q.400 acts as a TCP server and responds to a connection request from a TCP client for sending and receiving data. Note that the Vision Q.400 server currently supports a single connected client at any one time.
Peer (UDP)	Vision Q.400 sends and receives data from a user-defined peer. UDP is a connectionless mode of operation and is faster than TCP.

Open the properties page shown below by selecting **System Settings → Interfaces → Ethernet I/O...**:

Property page of Ethernet interface in ASCII protocol mode

Use Ethernet interface

When the check box "Use Ethernet interface" is deselected, Vision Q.400 does not use the Ethernet interface. You can configure data for transfer to the Ethernet interface, but Vision Q.400 will not send data or signals when in run mode.

Settings

Feature	Settings
Mode	Client (TCP), Server (TCP), Peer (UDP)
Client connect timeout (s)	Specifies how long Vision Q.400 waits during program startup for a TCP client to request a connection before issuing an error message. The default is 2 seconds. Values between 1 and 3600 seconds are allowed.
Local Host	Lists the available IP addresses and the associated Media Access Control (MAC) addresses. The IP address is automatically determined from the MAC address.
Local Port	Specifies the Local Port number at the specified host address. The default port number is 9094. Values between 1 and 32767 are allowed. In client mode, the Local Port number is not required since the system automatically selects a port. Avoid using a port number below 1025, since these are generally reserved for system services. The port number used here should be known to the connecting unit, i.e. the client or peer.
Remote Host	Specifies the Remote Host address. This can be defined in the dot format, or as a PC name. For the sake of convenience, the local addresses are available for selection.
Remote Port	In Client and Peer modes, this specifies the connected host's port number. The default port number is 9094. Values between 1 and 32767 are allowed.

4.10.2 Serial I/O

Vision Q.400 supports serial I/O communication via RS232.

Choose **System Settings → Interfaces → Serial I/O...** to open the following property page:

Property page of serial interface in ASCII protocol mode

Use serial I/O

When the check box "Use Serial I/O" is deselected, Vision Q.400 does not use the serial interface. You can configure data for transfer to the serial interface, but Vision Q.400 will not send data or signals when in run mode.

☞ ◆ **NOTE**

When you have changed the setting for this option, you must exit and restart Vision Q.400 in order for the changes to take effect.

Communication Protocol

See "Communication Protocol (see page 96)".

Settings
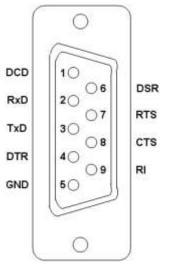
The **baud rate** setting will depend on the PC hardware.

Feature	Settings
Baud rate	75; 110; 134.5; 150; 300; 600; 1200; 1800; 2400; 4800; 7200; 9600; 14400; 19200; 38400; 56K; 57600; 115200
Data bits	5;6;7;8
Parity	No, Odd, Even
Stop bits	1; 1.5; 2

Feature	Settings
Flow control	Select • "None" if you are not defining a handshake. • "Xon/Xoff" if the handshake is defined via the software. • "Hardware" if the handshake is performed by wiring.

4.10.2.1 Pin Assignment and Pin Connection

The following sections explain how to connect the Imagechecker correctly to an external device depending on the settings of the "Handshake" parameter. The Imagechecker has a 9-pin male connector.

Pin assignment of the 9-pin male RS232 port on the Imagechecker

Parameter "Flow Control" = None

The figure below illustrates how to use a Sub-D plug to make a simple three-wire connection between the Imagechecker and an external device.

Most simple connection via the serial interface
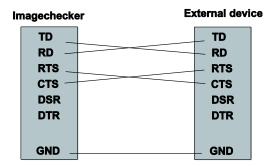
Parameter "Flow Control" = Xon / Xoff

To improve the data transfer, a three-wire-connection is often used together with the XON/XOFF protocol. When the receiver is ready to accept data, it sends the signal XON (this usually corresponds to code DC1 = ASCII code 11h). As long as the receiver is still busy pro-

cessing data, it sends the signal XOFF (code DC3 = ASCII code 13h). Please note that this connection method only works when you set the parameter "Flow Control" to "Xon / Xoff" and when the external device actively supports the XON/XOFF protocol.

Parameter "Flow Control" = Hardware

Another way to improve the data transfer is to set the devices to perform a hardware handshake. This does not only mean a connection of data lines (depending on the configuration the lines are crossed or not), but also to connect the pins RTS and CTS. CTS (CLEAR TO SEND) is used by the external device to indicate that it is ready to receive data. Usually the external device sends this signal as a reaction to receiving the signal REQUEST TO SEND from the Q.400. Data transfer only takes place when both RTS and CTS are active (low).

Connection with handshake

☞ ◆**NOTE**

The hardware handshake uses the timeouts you set in the Vision Q.400 settings on the "Timeouts (see page 75) property page. If you are using MEWTOCOL as the communication protocol, the Handshake timeout and the MEWTOCOL timeout are added together.

4.10.3 Communication Protocol

Vision Q.400 uses communication protocols for data and signals that are processed by Ethernet and serial I/O interfaces. Every interface has its own protocol settings, which can be configured on the respective property pages.

Settings option "Communication Protocol"

Here you specify the communication protocol that Vision Q.400 will use for the data and signals. The following protocols are supported:

Protocol	PLC Type
ASCII (see page 97)	All PLC types that support this protocol
MEWTOCOL (see page 99)	FP series from Panasonic Electric Works

Depending on the communication protocol you have selected, the options on the property page of the serial interface and in the dialog box opened by the [Settings...] button will vary.

Terminator for Data Sending

Every time Vision Q.400 sends data to an external device, the terminator will be added at the end of the data package. In the "MEWTOCOL" communication protocol this option cannot be changed, and is set as "CR" (Carriage Return).

Terminator for Data Reception

The terminator for receiving data is required whenever external devices send data to Vision Q.400. Here you set the code indicating that signal transmission is complete and that this is the end of the data transfer. If there is no terminator, Vision Q.400 cannot interpret the signals it has received. In the "MEWTOCOL" communication protocol this option cannot be changed, and is set as "CR" (Carriage Return).

4.10.3.1 ASCII Communication Protocol

If you select "ASCII" under "Communication Protocol," the property page for the serial or the Ethernet interface is displayed.

Settings

If you choose [Settings] a dialog box opens up. Here, you can set the data header and a flag to mark data errors.

The following options are available:

Option	Description
Data output with header	User-definable one-digit code that precedes spreadsheet data in the data packages to send
Error code character	User-definable one-digit error code that is used for errors (see page 570) occurring during the spreadsheet calculation

Signals to be sent

Here you define which signals are to be transmitted. In the "ASCII" communication protocol the following signals are available:
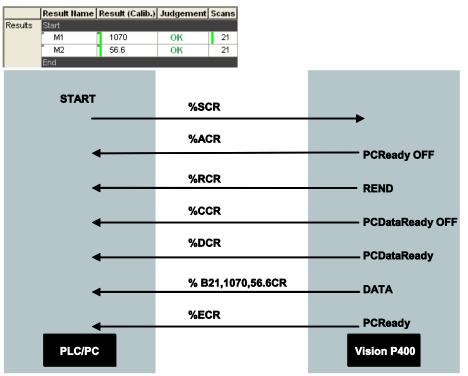
Signal	Activate sending on the property page?
REnd	Yes
PCReady	Yes
PCDataReady	Yes
Start lost	Yes
Application change completed	Yes
Error	Is always sent automatically
Execution result error	If an error (see page 570) occurs during calculations on the spreadsheet, the user-defined single-digit error code specified in the "ASCII Settings" dialog box ([Settings...] button) is transmitted.
Action error	Always sent, as defined on the "General" tab of the "Actions" property page (see page 520).

Data output from Vision Q.400 to a PLC or PC

✦ **EXAMPLE**

Vision Q.400 automatically outputs the values marked in the spreadsheet. In this example, the default signals to be sent, e.g. %B, are used as the header for spreadsheet data output.

	Result Name	Result (Calib.)	Judgement	Scans
Results	Start			
	M1	1070	OK	21
	M2	56.6	OK	21
	End			

Vision Q.400 sets the **PCDataReady** signal before it sends data to the PLC. As long as Vision Q.400 does not send **PCDataReadyOFF**, the data from the last scan remain valid and can be requested by the PC or PLC. **PCDataReadyOFF** can only be sent if you have executed one scan and the signal **PCDataReady** has been set once.

Data request from a PLC or PC to Vision Q.400

✦ **EXAMPLE**

You are requesting spreadsheet data to be sent to a PC or SPS. From the first spreadsheet row, you want Vision Q.400 to send the number of scans and the calibrated result; from the second row, you want it to send the calibrated result via the interface.

	Result Name	Result (Calib.)	Judgement	Scans
Results	Start			
	M1	1070	OK	21
	M2	56.6	OK	21
	End			

The data protocol for the data request would then look like this:

Vision Q.400 sets the **PCDataReady** signal before it sends data to the PLC. As long as Vision Q.400 does not send **PCDataReadyOFF**, the data from the last scan remain valid and can be requested by the PC or PLC. **PCDataReadyOFF** can only be sent if you have executed one scan and the signal **PCDataReady** has been set once.

4.10.3.2   MEWTOCOL Communication Protocol

If you select "MEWTOCOL" under "Communication Protocol," the property page for the serial interface looks like this:

"Serial" property page for MEWTOCOL as communication protocol

MEWTOCOL is a communication protocol that enables communication between Imagecheckers of the Q.400 series and PLCs of the FP series from Panasonic Electric Works. This means the scan results (calculation and evaluation data) can be written to PLC registers (DT, FL, L). You can also write signals (such as PCReady) to an output (Y), an internal flag (R) or a link relay (L).

Settings

If you choose [Settings] a dialog box opens up. Here you set the values to be transmitted as defaults in certain situations.

"MEWTOCOL Settings (System)" dialog box

The following options are available:
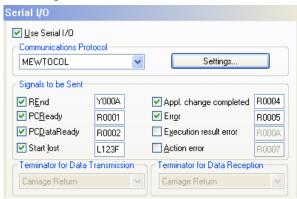
Option	Description
ET-LAN unit (Ethernet I/O only)	For Ethernet I/O interfaces only. Adds an ET-LAN unit header to each MEWTOCOL message. The source station number is sent in the header and is therefore required for this option.
Long message format (ET-LAN, MEWNET-H only)	Long format MEWTOCOL messages are generated. Standard MEWTOCOL message length: up to 118 bytes. Long format message length: up to 2048 bytes.
Source station number (PC)	Specifies source station number, or "All Stations" (to indicate "[send] from an unspecified station").
Destination station number (PLC Unit)	Specifies source station number, or "All Stations" (to indicate "[send] from an unspecified station").
Timeout	Time span within which the PLC is expected to reply to transmitted data or signals.
Values in case of error	Values transmitted in case of an execution error (see page 570)
Values if an execution group was not executed	Values transmitted if an execution group was not executed (see note)

☞ ◆NOTE

- **The values under "Values if an execution group was not executed" are only transmitted if you have activated the "Always send the data of all execution groups" option in the "Objects for Data Transfer" (see page 530) window.**
- **It is advisable to use the value range limit rather than zero.**

Signals to be sent

Here you define which signals are sent and the address to which the value is to be transmitted. If signals are not selected, the address field is grayed out.

Signal	Activate Sending on the Property Page?
REnd	Yes and define flag/output/address
PCReady	Yes and define flag/output/address
PCDataReady	Yes and define flag/output/address
Start lost	Yes and define flag/output/address
Application change completed	Yes and define flag/output/address
Error	Yes and define flag/output/address
Execution result error	If errors (see page 570) occur during calculations on the spreadsheet, or the checker whose result is to be transmitted cannot be executed or calculated, the user-defined value you specify in the "MEWTOCOL Settings" dialog box ([Settings…] button) is transmitted. An execution error can occur, for example, when an Integer-type result value is to be transmitted but the value exceeds the range specified for integers.
Action error	Depending on the setting on the "General" tab of the "Actions" property page (see page 520) and the settings made here, this signal is or is not transmitted.

When you have activated a signal for output, you can change the destination address for the signal. The address for the signals is composed of the memory area and the memory address. You can set internal flags (R), outputs (Y), or link relays (L) for the memory area. The memory address is subdivided into a decimal and a hexadecimal portion. For the first three characters, decimal figures can be set; the fourth character is the hexadecimal number 0-F. For the relevant settings for data transfer, please refer to the table (see page 103).

☞ ◆ NOTE

The number of outputs, internal flags, and link relays depends on the connected PLC. For the "MEWTOCOL" communication protocol, the terminators for sending and receiving data are preset and cannot be changed.
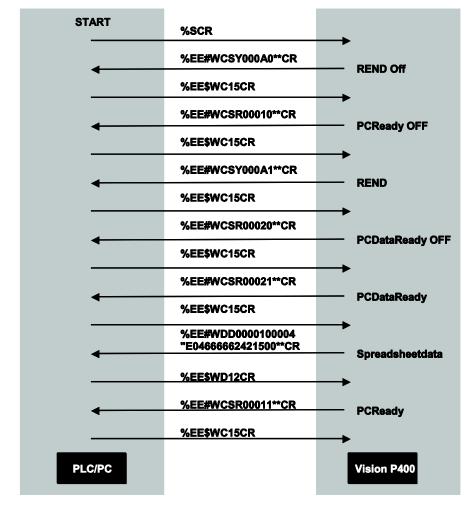
Data output from Vision Q.400 to a PLC or PC

✌ ◆ EXAMPLE

Vision Q.400 automatically outputs the values marked in the spreadsheet. In addition, the REnd, PCReady, and PCDataReady signals are activated in the interface's property page and are likewise output.

	Result Name	Result (Calib.)	Judgement	Scans
Results	Start			
	M1	1070	OK	21
	M2	56.6	OK	21
	End			

Signals to be Sent

☑ REnd	Y000A	☐ Appl. change completed	R0004
☑ PCReady	R0001	☐ Error	R0005
☑ PCDataReady	R0002	☐ Execution result error	R000A
☐ Start lost	L123F	☐ Action error	R0007

The data protocol would then look like this:

PLC/PC		Vision P400
START		
	%SCR →	
	← %EE#WCSY000A0**CR	**REND Off**
	%EE$WC15CR →	
	← %EE#WCSR00010**CR	**PCReady OFF**
	%EE$WC15CR →	
	← %EE#WCSY000A1**CR	**REND**
	%EE$WC15CR →	
	← %EE#WCSR00020**CR	**PCDataReady OFF**
	%EE$WC15CR →	
	← %EE#WCSR00021**CR	**PCDataReady**
	%EE$WC15CR →	
	← %EE#WDD0000100004 "E04666662421500**CR	**Spreadsheetdata**
	%EE$WD12CR →	
	← %EE#WCSR00011**CR	**PCReady**
	%EE$WC15CR →	

4.10.4 Signal Codes for Data Transfer

Below, you find a list with all signal codes which can be exchanged between the Imagechecker (ICH) and the PLC/PC or other peripheral devices. Depending on the direction of communication, the same or differing signal codes are used for the two communication protocols ASCII and MEWTOCOL.

- In the PLC/PC → Imagechecker communication direction ASCII and MEWTOCOL use the **same** signal codes.

- In the Imagechecker → PLC/PC communication direction ASCII and MEWTOCOL use **different** signal codes.

☞ ◆NOTE

The terminators for sending and receiving data are user-definable (see page 94) when you are using the "ASCII" communication protocol. For the "MEWTOCOL" communication protocol the codes are fixed.

Signal codes for the PLC/PC → Imagechecker communication direction

✌ ◆EXAMPLE

Request of a single data string: **%*dCR**
Request of several data strings: **%*d,d,dCR**
%   Flag for start of transmission
*   to be recplaced by signal code
d   to be replaced by data string
CR   indicates the end of communication

Example output: %RCR, %ACR,%ECR,%DCR and %TCR

Signal name	Signal	ASCII	Description
Start	S	53h	Start signal executes the application. With start mode = "Repetitive Start" and "Repetitive / Automatic Start" the start signal works as a start/stop signal (see page 53). Example: %SCR Start signal executes execution group Example: %S010CR (starts execution group No. 10)
Start without grabbing a new image	SN		Start signal executes the application without grabbing a new image Example 1: %SNCR Example 2: %SN010CR (starts execution group No. 10) Using the command **SN** has the same functionality as sending the signal "Lock Grabbing" (see page 52) over the parallel interface.
Start/Stop run mode	K	4Bh	Start/Stop Run Mode **Note:** **This signal is the only signal that Vision Q.400 processes in setup mode. Please take care not to send the signal by accident. If you do, Vision Q.400 switches to run mode while you may still want to edit your application.**
Spreadsheet data re-quest	B	42h	Spreadsheet Data Request Example: %BM1/Result,M2/JudgmentCR (spreadsheet cell defined by <result name>/<column heading>)
Change the limit values of a spreadsheet row	T... U/L	54h	Change value of upper/lower limit (U/L) in a row Example: %TM1/L/1000CR (the new lower limit for row with result name "M1" is 1000, see figure below) **Note:** **Do not forget to enter the decimal point. Vision Q.400 does not accept a comma!**

Signal name	Signal	ASCII	Description
Change an OCR reference value on the spreadsheet	F	46h	Change the reference value for OCR results on the spreadsheet Example: %FM3/ABCDCR (M3 is a user-defined result name in the spreadsheet, see figure below)
Change multiple OCR reference values on the spreadsheet	G	47h	Change multiple OCR reference values for OCR results on the spreadsheet Example: %GO1/ABC,O2/CDECR changes the reference values of rows O1 and O2 to ABC and CDE respectively (spreadsheet cell defined by <result name>/<new reference value>).
Reset spreadsheet statistics	H	48h	Reset statistics of the spreadsheet: Example: %HCR (the spreadsheet statistics and the number of scans are reset. This happens AFTER the next start signal.)
Application change	X	58h	Change Application Example: %X002CR (change to application No. 2) or %X"C:\Temp\Example.nav" (change to application "Example.nav")
Exit	Q	51h	Exit Vision Q.400 and automatically shut down Windows where appropriate (depending on the setting (see page 78)) Example: %QCR
Cancel grab	C	43h	Cancel grabbing when timeout is infinite, e.g. when reading images with a line-scan camera.
White balance	W	57h	Only for color cameras. To recalculate the factors for the white balance function for a camera. Format: %W<camera number>CR Examples: %W1CR or %W12CR
Discard images	N	4Eh	Only Camera Link, external camera trigger Images that have been captured, but not processed yet, will be discarded without being processes. Example: %NCR
Current status	M	4Dh	Read current status of Vision Q.400 (run mode or setup mode)
Application properties	O1..6	4Fh	Read the properties of the current application Example: %O1CR 1. Path of the currently loaded application ("-" when no application has been loaded) 2. Name of the currently loaded application 3. Author of the currently loaded application 4. Description of the currently loaded application 5. Number of the currently loaded application (when an application number has been assigned). If not, "-1" will be output. 6. Currently selected language
Data that are transmitted	U	55h	Read the data to be transmitted via the interface Example result: %UFE[1;1]AreaSize_1|Value|4:FE[1;1]gravity_X_Coordinate_1|Value|6:FE[1;1]angle_1|Value|6 : separates the rows from each other | separates the data from each other

Signal name	Signal	ASCII	Description
License check	L...	4Ch	Checks whether the dongle of the Q.400 has a valid license for the license code transmitted. Example: %L"TEST_123123123" Response: %L0 means that there is no valid license available. %L1 for a valid license. %L2 for a simulation version.

This figure shows the spreadsheet according to the signal code description.

Signal codes for the Imagechecker → PLC/PC communication direction

Signal name	Description	ASCII protocol	MEWTOCOL protocol
PCReady	System ready for next task	E (45h)	The register configured under "Signals to be sent" is set.
PCReadyOFF	All entered commands are ignored	A (41h)	The register configured under "Signals to be sent" is reset.
Run mode start-ed/stopped	Confirmation that Vision Q.400 has started or stopped run mode or is in run mode	K (4Bh)	When transfer of PCReady, REnd or PCDataReady is active, no additional %KCR is sent. If those signals are inactive, a %KCR is sent.
REnd	Read image end	R (52h)	The register configured under "Signals to be sent" is set.
REndOff	Image grab signal reset ended		The register configured under "Signals to be sent" is reset.
PCDataReady	Result data is available.	D (44h)	The register configured under "Signals to be sent" is set.
PCDataReadyOFF	No result data available	C (43h)	The register configured under "Signals to be sent" is reset.
Spreadsheet data output	Output of the contents of the selected or requested spreadsheet cells	B (42h) (changeable)	• With automatic data output the MEWTOCOL protocol is used. • The response to an external data request is as in the ASCII protocol
Reference value for OCR result has been changed in the spreadsheet	Confirmation that the OCR reference value has been changed	F (46h)	As in ASCII protocol: %FCR
Multiple reference values for OCR re-sults have been changed in the spreadsheet	Confirmation that the OCR reference values have been changed	G (47h)	As in ASCII protocol: %GCR
Change notify	Confirmation of change of upper/lower limit	T (54h)	As in ASCII protocol: %TCR

Signal name	Description	ASCII protocol	MEWTOCOL protocol
Spreadsheet statistics reset	Confirmation of statistics reset	H (48h)	As in ASCII protocol: %HCR
Start lost	A start signal was sent to Vision Q.400, but the system was not ready for another start signal.	L (4Ch)	The register configured under "Signals to be sent" is set.
Application change completed	Confirmation that Vision Q.400 has loaded the desired application	X (58h)	The register configured under "Signals to be sent" is set.
Quit	Close Vision Q.400 and, depending on the presetting, shut down Windows.	Q (51h)	As in ASCII protocol: %QCR
Setup mode	Vision Q.400 is in setup mode.	N (4Eh)	As in ASCII protocol: %MCR
License request	Result of the license request	V (56h)	As in ASCII protocol: %LCR

Error messages to RS232

Signal	Description	ASCII	MEWTOCOL
Z	Unregistered data error: Example: %ZCR means application does not exist.	5A	The register configured under "Signals to be sent" for "Execution Result Error" is set.
! (changea- ble)	Execution Result Error (see page 570), e.g. data error on spreadsheet: Example: %B 33 , ! , 1 , ! , 0CR **Note:** **The character indicating execution result errors is user-definable (see page 94) on the property page of the serial interface.**	21h	The register configured under "Signals to be sent" for "Execution Result Error" is set. In place of the erroneous value, the value set under "Values in Case of Error" is transmitted.
?	Error message: Example: %?CR This error can be caused by all unknown commands, by an action error or by an erroneous signal from the PLC.	3Fh	The register configured under "Signals to be sent" for "Error" or "Action Error" is set.

◆**NOTE**

- **All signals listed above, except %K (Start/Stop run mode) are only accepted or sent if two conditions are met:**
  - **The signal PCReady of the Q.400 is ON.**
  - **The system is in run mode.**
- **The time required for an application switch depends on the size of the applications. This means that, depending on the number of cameras and checkers, as well as on the display settings, the time required for an application switch may vary. If your application is time-critical, we recommend doing test runs to determine the time required for switching applications.**
- **If you want to view the input signals coming in via the serial interface, we recommend using the Microsoft "Hyperterminal" program or the interface monitor (see page 123) built-in to Vision Q.400.**
- **When you change the application, the old application is saved implicitly unless it has been write-protected. In this case Vision Q.400 does not save the application but rather writes a warning into the error log if you have activated the option "Write to Error Log" under Error Handling (see page 84).**
- **If you send a start signal via the serial interface with an execution group number although the "Allow group switching" option is not activated, the group number is ignored and Vision Q.400 executes the whole application.**
- **If the "Allow group switching" option is activated and you send a start signal with an execution group number that does not exist, the start signal is ignored. The "Start Lost" signal is sent to all interfaces and "Start Signal Lost" is written into the error log file.**

- **The execution group number sent together with the start signal must be either exactly three or four digits long. If the number has less digits, the execution group number must be sent with leading zeros.**
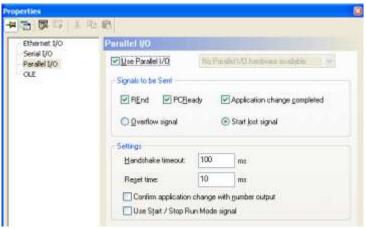
4.10.5 Parallel I/O

Vision Q.400 supports the following digital I/O boards:

- For Q.400: ANPC 850V3D from hardware version ANPC 442V6CED (ANPC 850V2D (until ANPC 442V5CED) limited availability, only on request), andANPC 850D (until ANPC 442V3CED, out of stock))
- For Q.400MA, Q.400MD, Q.400XD: ANPC 850V3D

The I/O boards differ where it comes to connecting and controlling the flash as well as the timing of some signals.

The parallel interface provides 16 input/output channels which are opto-isolated.

All selected numeric spreadsheet data as well as several control and warning signals are transmitted. In addition to this, you can switch from one application to another via the digital I/O.

Property page of the parallel interface

Use Parallel I/O

When the check box "Use Parallel I/O" is deselected, Vision Q.400 does not use the parallel interface. It is possible to configure data for transfer to the parallel interface, but Vision Q.400 will not send data or signals when in run mode.

◆**NOTE**

When you have changed the setting for this option, you must exit and re-start Vision Q.400 in order for the changes to take effect.

Signals to be sent

Signal	Activate sending on the Parallel I/O property page?
REnd	Yes
PCReady	Yes
Application change completed	Yes
Start lost/Overflow	Yes, select the signal to be sent with a mouse click

Settings

| Setting option	Functionality
Timeout for handshake	Time for timeout in handshake communication (see page 115)
Reset time	Time for resetting the strobe signal (see page 113) and the data signals, if "Forced Rest" under **Spreadsheet → Objects for Data Transfer → Parallel I/O** is not activated.
Data signals are never reset	• Activated: The data signals change only if the execution result of the application changes. **Note:** This option only has an effect if the options "Handshake" and "Forced Rest" under **Spreadsheet → Objects for Data Transfer → Parallel I/O** are not activated. • Not activated (default setting): All data signals will be reset at the next start of the application.
Confirm application switch with number output	After Vision Q.400 has switched to another application, the number of the new application is output as binary data. After the next start signal the output signals are reset.
Use start / stop run mode signal	When you activate this option, Vision Q.400 uses the next start signal to switch from setup to run mode or vice versa. (When using the digital I/O board ANPC 850D you also need to send the application change signal = Pin 12).

☞ ◆**NOTE** ──────────────────────────
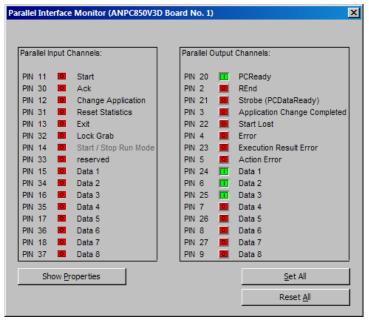
When you have selected the start mode "Repetitive Start" or "Repetitive / Automatic Start" for this application (see page 53), you stop Vision Q.400 by setting the start signal and start it again with the next start signal.

4.10.5.1 Available Input and Output Signals

The input and output signals are displayed in the "Monitor: Parallel Interface" window, which varies according to the installed interface board. Open the interface monitor with the command **View → Parallel Interface Monitor** or by clicking [icon]. Use the button [Show Properties] to open the property page of the parallel interface (see page 109).
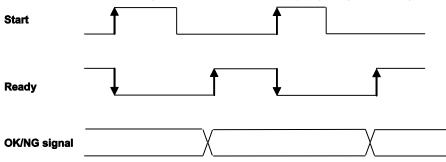
Parallel interface monitor with digital I/O board ANPC 850V3D

> 🖙 **◆NOTE**
>
> **You can set all output signals in setup mode with the Monitor: Parallel Interface" option for test purposes.**

4.10.5.2 Starting the Image Processing

The image processing is started with a rising edge at the start signal. The Ready signal goes OFF. When the processing is completed, the Ready signal goes ON again.

Time diagram when starting the Imagechecker

4.10.5.3 Set the Transfer Mode

When transferring data volumes up to 1 byte, in the "Objects for Data Transfer" window you can choose between transfer with handshake (see page 115) and without handshake (see page 113). The data volume is displayed in the window on the last row of the table next to "Sum:".

Data output with less than 1 byte

Data transfer with handshake has the advantage that the transfer of each byte of data will be confirmed with an acknowledge signal by the receiving station, thus ensuring a safe data transfer.

If you are not using execution groups, and transfer more than 8 bits of data, transfer must be performed with handshake. If you do not activate the option "Handshake", a timeout will occur.
When using execution groups (see page 120) it is usually not possible to determine beforehand how much data will be transferred. In this case it is up to the user to determine the transfer mode.
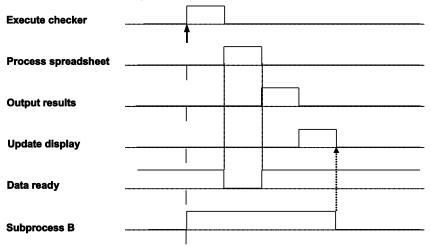
No Handshake

You do not need to use a handshake if the amount of data to be transferred is 1 byte or less and if you prefer a simple communication protocol. Deactivate the option "Handshake" on the "P I/O" page of the "Objects for Data Transfer" window.

Transferring data without handshake

When the system has calculated the results of the new image and the data is ready at the D registers for output, the Strobe signal goes ON to inform the peripheral device that it can read the data from the D registers now.

Time diagram for data output without handshake

TSt   Minimum length of the start signal (about 1ms)

Tp   Processing time (time it takes to execute the whole application)

Tr   Time needed for image grabbing (depends on the camera type)
          System time between ACK ON and the reset of the Strobe signal (ca. 300 - 400µs).

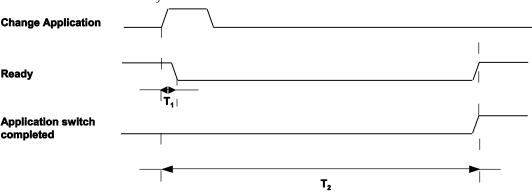TS1   System time between data output and setting the Strobe signal

1 The system start is triggered: The start signal is about 1ms long. The Imagechecker will only accept the start signal when it is ready, i.e. when the PCReady signal is ON. If the Imagechecker receives a start signal while PCReady is OFF, the "Start lost" signal is output (depending on the parameter settings).

2 The falling edge of PCReady indicates that the application has been started. The falling edge of REnd indicates that the Imagechecker is grabbing and transferring the image to the main memory.

3 When the image-checking results have been calculated, the spreadsheet including all formulas is updated. Then the data selected for output are output via the interfaces. This is indicated by the Strobe signal (PCDataReady).

4 When the application has been executed and the monitor display has been updated, PCReady is set to ON again. Now you can start the application again.

5 At the next start signal, the Strobe signal will be reset together with PCReady.

Forced reset

You can extend the duration of the signal switch by activating the parameter "Forced Reset" and by entering the desired time span under **System Settings → Interfaces → Parallel I/O** in the field "Reset Time". The Strobe signal and the D registers will be reset after the time you have entered.

The status of the D registers does not change until the next process.

1. Strobe is set after output of the data byte
2. Data and Strobe are automatically reset after the defined reset time
   Tr 10 ... 10000ms
3. Reset of the data byte after Tr

Reset Strobe signal after reset time

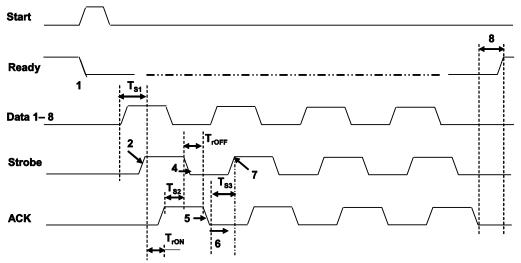TR1: Reset time 1. In this example, the Strobe signal and the D registers will be reset after TR1 and before the Ready signal.

TR2: Reset time 2. In this example the reset time is very long. The Strobe signal and the D registers will be reset after TR2 and after the Ready signal. If you have set a reset time longer than the data output of the next application start, an error message appears.

Handshake

When you transfer data of more than 1 byte, you must perform the data transfer with handshake. When you transfer data of less than 1 byte, you may choose whether to perform the data transfer with handshake or not.

Data transfer with handshake has the advantage that the transfer of each byte of data will be confirmed with an acknowledge signal by the receiving station, thus ensuring a safe data transfer.

Time diagram - handshake

TS1	System time between data output ON (D1 - D8) and rising edge of the Strobe signal (1.2ms).
TrON	Time between Strobe ON and the rising edge of the ACK signal.
TS2	System time between ACK ON and the reset of the Strobe signal (ca. 160µs).
TrOFF	Time between Strobe OFF and the falling edge of the ACK signal.
TS3	Time between ACK OFF and the rising edge of the Strobe signal (3ms).
Start	The Q.400 reacts to a rising edge and does not need an impulse.
Byte xx	With a 16-bit value, byte 1 is the lower and byte 2 the higher byte.
1	The data (D1 - D8) are output to the parallel interface.
2	Once the output of the first byte has been started, Strobe switches from OFF to ON within 1.2ms (TS1).
3	After the PLC has received the Strobe signal, it sets the ACK signal to ON (TrON).
4	When the ACK signal goes ON:

> • The Imagechecker checks whether the ACK signal has been reset within the time span set for handshake timeout (parameter in Vision Q.400, TrOFF< = handshake timeout). If the ACK signal does not occur on time, Vision Q.400 outputs an interface error. In ad-

dition, the ERROR signal is switched ON.

- The Strobe signal is set to OFF automatically.

5   After the Strobe signal has gone OFF, the PLC sets the ACK signal to OFF (TrOFF).

6   When the ACK signal goes OFF:

- The Imagechecker checks whether the ACK signal has been reset within the time span set for handshake timeout (parameter in Vision Q.400, TrOFF< = handshake timeout).

7   When ACK is OFF and TS3 has elapsed, the Imagechecker outputs the next byte and sets the Strobe signal to ON.

8   When the last byte has been output and its reception has been confirmed with the ACK signal, all data signals will be set to 0 by Vision Q.400.

9   When all bytes have been output, the Q.400 needs some time for postprocessing (depending on the application settings, for example to update the user interface) and then sets the Ready signal to ON.

☞ ◆ **NOTE**

- **The internal timer function of the Imagechecker has a resolution of 10ms.**
- **In handshake mode, make sure that the strobe signal from Vision Q.400 is acknowledged with an ACK signal from the other device.**
- **The confirmation from the ACK signal has to be applied to the output channel for at least 1ms!**
- **The ACK signal needs to be reset within the time set in "Handshake Timeout" (property page Parallel I/O (see page 109)) after the Strobe signal has been reset by Vision Q.400.**

4.10.5.4   Transfer of Spreadsheet Data

Spreadsheet data are transferred byte by byte via 8 data channels. Both numerical and Boolean data are transferred in the same sequence as they appear in the "Objects for Data Transfer" window of the parallel interface.

Numerical data	Measurement results, statistical data and results from calculations Data types: INT8 = 1 byte; INT16 = 2 byte; IEEE float = 4 byte
Boolean data	OK/NG judgments, Boolean formula results Data types: INT1 = 1 bit (8 Boolean data = 1 byte)

The number of bytes to be output depends on the number of data.

◆EXAMPLE

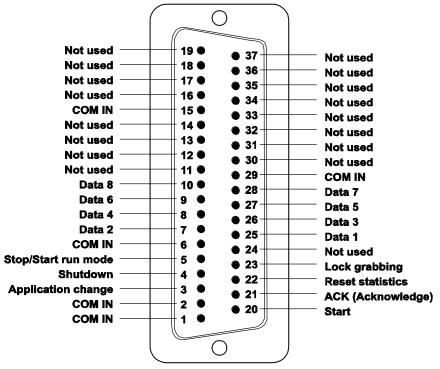Output of 19 Boolean values, 2 INT16 and 1 INT8 and 1 IEEE:

Byte 1 = bit 0 ... 7	8 x INT1
Byte 2 = bit 8 ... 15	8 x INT1
Byte 3 = bit 16 ... 18	3 x INT1 (bit 19 - 23 is equal to 0)
Byte 4 and 5 = -222	1 x INT16
Byte 6 = 199	1 x INT8
Byte 7 and 8 = 55353	1 x INT16
Byte 9 to 12 = 123,456	1 x IEEE

◆NOTE

- **Optimize the speed of the data transmission by putting the Boolean data before the numerical data in the spreadsheet (8 Boolean data = 1 byte).**
- **Before data can be output, they have a data type (see page 527) assigned automatically (1 to 4 bytes). If the value to be transferred exceeds the possible maximal value of the selected data type, a byte overflow error will be output.**
- **If a data bit has the logical state ON, the output transistor is switched through. This means there is no voltage on the output.**
- **As the number of channels for data transfer is limited, please determine under** System Settings → Interfaces → Parallel I/O **whether output channel 5 should be used to indicate a byte overflow or a lost start (see page 109) signal.**

4.10.5.5   Change Application

You can use the parallel interface to switch from one application to another. The number of the application is transferred via the input channels 1 - 8. Send the application number and execute the application switch by sending the signal "Change Application".

Time diagram for the application change

T1:   Setting of the Ready signal: ON -> OFF
      The Ready signal is turned OFF ca. 2 to 10ms after the "Change Application" signal.

T2:   Setting of the "Application switch completed" signal: OFF -> ON
      After the "Change Application" signal the "Application switch completed" signal is set to ON. The next Start signal or "Change Application" signal resets the "Application switch completed" signal.

☞ ◆NOTE

- **The time needed for an application change (T2) depends on the size of your applications, in particular**
  a) on the checkers used and
  b) on the number of cameras.
  For time-critical applications perform test runs to determine the time needed for an application change.
- **When you change the application, the old application is saved implicitly unless it has been write-protected. In this case Vision Q.400 does not save the application but rather writes a warning into the error log if you**

**have activated the option "Write to Error Log" under Error Handling
(see page 84).**

- **Under certain conditions it is possible to execute an application change
even if the Ready signal is OFF. This is for example possible if no appli-
cation has been loaded after the program start and a timeout has oc-
curred. In this case Vision Q.400 performs the application change even
if the Ready signal has been turned OFF by the timeout.**

Sending application numbers via the parallel interface

Use **Application → Application Numbers** to access the dialog box below. Here you may
assign numbers to your applications. The entry in the column "P I/O Bits" shows you the bi-
nary signal that needs to be applied to the parallel interface in order to switch to that applica-
tion.

Assigning numbers to applications for application changes via the interface

☞ ◆**NOTE** ───

**The P I/O bit pattern is always the application number minus 1, e.g. for ap-
plication number 1 the P I/O bit pattern is 0000 0000.**

Confirm application switch with number output

When you activate the option "Confirm application switch with number output" at the bottom
of the property page of the parallel interface, Vision Q.400 outputs the number you have sent
to the parallel interface after the application switch has been completed successfully.

4.10.5.6   Start/Stop Run Mode

When you activate the check box "Use start / stop run mode signal", you can send a com-
mand to the parallel interface to switch from setup to run mode. Set the signal "Start/Stop
Run Mode" (pin 7).

☞ ◆**NOTE** ───

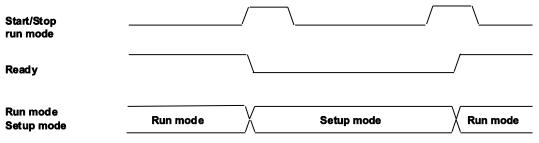**Please note the following when you are using the signal "Start/Stop Run
Mode":
The signal "Start/Stop Run Mode" is the only signal that Vision Q.400 pro-**

cesses in setup mode. For this reason, in setup mode take care not to send the signal by accident. If you send the signal, Vision Q.400 switches to run mode while you may still want to edit your application.

You can prevent an accidental switch from setup to run mode by activating the "Use start / stop Run Mode signal" checkbox only when you have finished setting up your application(s). Vision Q.400 ignores the signal to start or stop run mode if the check box is not activated.

Time diagrams to start/stop run mode

The diagrams show the timing of the different digital I/O boards available when you switch from run mode to setup mode.

Time diagram for ANPC 850V3D and ANPS 850D when starting/stopping run mode

☞ ◆**NOTE**

Please note the special behavior of digital I/O board ANPC 850D: When Vision Q.400 is in run mode, the program reacts as follows when it receives the signal "Change Application":

- **The signal "Start / Stop Run Mode" is set: Vision Q.400 switches to setup mode.**
- **The signal "Start / Stop Run Mode" is not set: Vision Q.400 changes the application.**

4.10.5.7   Executing an Execution Group

The number for the execution group is transferred as a binary signal (decimal values 0 - 255) via input channels 1 - 8. Send the binary signal corresponding to the number via the input channel along with a start signal. Then the application is executed with the relevant execution group.

The table below shows some examples of binary data for execution groups.

Execution group number	Signal to parallel I/O
0 (All Cameras, Sequence No. 1)	0000 0000
1	0000 0001
2	0000 0010
5	0000 0101

☞ ◆$\overline{\text{NOTE}}$

- **If you send a start signal with an execution group number that does not exist, the start signal is ignored. The "Start Lost" signal is sent to all interfaces and "Start Signal Lost" is written into the error log file.**
- **If you send a start signal together with an execution group number via the interface although the "Allow group switching" option under** Execution Groups → Properties **is not activated, Vision Q.400 ignores the group number and executes precisely the execution group configured in the "Use always this group" pick list (see page 133).**

4.10.6 OLE

Vision Q.400 can be used as an OLE Automation Server. The ActiveX Control "VisionQ.400DataControl" is registered automatically during the installation so that you can access the interface.

The methods, properties, and events of ActiveX Control "VisionQ.400DataControl" are described in the document "VisionQ.400ActiveXControl.doc", which is stored in the installation folder. Sample programs for using ActiveX Control can be found in the subfolder \Demo Clients in the installation folder.

Signals to be sent

Signal	Definition VI-SIONQ.400_SIG_	Activate Sending on the Property Page?
REnd	PCREND[OFF]	Yes
PCReady	PCREADY[OFF]	Yes
PCDataReady	PCDATAREADY[OFF]	Yes
Application change completed	CHANGE_NOTIFY	Yes
Start Lost[*]	START_LOST	Yes
Action error	ACTION_ERROR	As defined on the "General" tab of the "Actions" property page (see page 520)
PCError	PCERROR	Is always sent automatically
Start and stop run mode	START_RUNMODE STOP_RUNMODE	Is always sent automatically Is always sent automatically

[*]When you use a client and startApplication() to start Vision Q.400 and the start has failed, the signal "Start Lost" is not sent to the client. Instead, startApplication() returns FALSE.

Start Vision Q.400 Hidden by an OLE Client

When you start Vision Q.400 via an OLE client and you have activated this option, the program will start without window and flash screen. This means you can only access Vision Q.400 via the client.

☞ ◆**NOTE** ═══

- **When you try to exit Vision Q.400 with at least one OLE client still connected, a message appears asking whether you want to exit Vision Q.400 nevertheless. If you confirm with "Yes", Vision Q.400 closes the connection to each OLE client.**
- **If you exit Vision Q.400 via an OLE client and there is no other OLE client connected, Vision Q.400 will be exited without requesting confirmation from the user.**

4.10.7 Camera

With GigE Vision cameras, it is possible to start the image capture directly at the camera. To do this, open the camera property page "Advanced Settings" and set "Trigger Source" to "External Trigger". Then you can use the camera as an interface in run mode and trigger the start of the application by activating the option "Start application by external camera trigger".

☞ ◆**NOTE** ═══

- **The interface "Camera" is only available for GigE Vision cameras.**
- **The interface "Camera" is not available in the simulation version of Vision Q.400.**

If you start the application execution with an external camera trigger and you wish to use an execution group (see page 133), it is not possible to enter the number of the execution group via the camera interface. This is why you can determine here, which execution group number should be used. The following options are available:

Option	Description
All cameras, sequence No. 1	No execution group number will be used. The whole application will be executed (execute all cameras with their execution group 1).
Use the execution group of the camera	Vision Q.400 will use the execution group belonging to the camera which received the start signal. If camera No. 1 received the start signal, then execution group No. 1 will be started.
Use an execution group sent by parallel I/O	The number of the execution group to be used will be transmitted by the parallel interface: Before the application is executed, Vision Q.400 reads the input data bits at the parallel interface and interprets them as the execution group number. If you have activated this option, but the parallel interface does not exist or has not been activated, the complete application will be executed.
Use an execution group sent by another interface	The number of the execution group to be used will be transmitted BEFORE the application start by a different interface than the parallel interface. Currently, you can only use the OLE interface. If you have activated this option and no execution group number has been transmitted, the complete application will be executed.

☞ ◆**NOTE** ───────────────────────────────────

- **If an application uses several cameras with external triggers, only the camera triggered first will also start the execution of the application.**
- **Vision Q.400 only processes the image when the capturing of that image has triggered the start of Vision Q.400. If images have been captured before that did** not **trigger the start of Vision Q.400 because Vision Q.400 was not ready, the images will be discarded.**

4.10.8 Monitor Interfaces

To open the "Monitor Interfaces" window, choose **System Settings → Interfaces → Monitor Interfaces** or **View → Monitor Interfaces**. Here you can monitor the signals and/or data that are sent or received via the Ethernet, serial, parallel, or camera interface (only for GigE Vision cameras). The signals and/or data are displayed in a buffered table with four columns. The buffer can store up to 500 entries. This means the entries at the beginning of the table will be overwritten when the table is full.

Final table entries are identified by black shading in the first column. Data with light blue shading are transferred via handshake (see page 115).

The table columns display the following content:

First column	Time	In	Out	Data transfer
Row number. The last entry is marked in black.	Point in time when the signals and/or data were sent or received	Signals and/or data received	Signals and/or data sent	OK = Data transfer was successful NG = Error during data transfer. Please check the connected peripheral device.

The display of signals and/or data in the columns "In" and "Out" depends on the interface you have selected:

Interface	Display
Ethernet and serial	The columns display exactly the characters that have been sent or received. Please note that the separators (see page 505) for sent data are user-definable. Non-printable characters such as "\t" cannot be displayed correctly on the monitor, but will be sent as a normal character string.
Parallel	• Data: the bit pattern that has been sent or received • Signals: Signal name
Camera	You can see whether the camera's trigger signal to start the application has been accepted or ignored.

The following parameters are available:

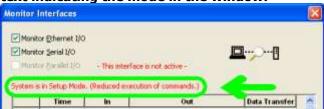| Option	Description
Monitor <interface>	Select the interface whose data communication is to be displayed: Ethernet, serial, parallel, or camera.
Lock update	When you activate this option, no new entries are displayed, even if Vision Q.400 has sent or received signals and/or data. Activate this option if you want to review old entries in the table without having older entries overwritten by newer ones.
Sorted by time	As the monitoring function is buffered, older entries may sometimes be listed before newer ones. Choose [Sorted by Time] to sort the table entries so that the oldest entries are displayed at the top and the newest at the bottom.
Clear	Use this button to delete all entries from the table.

Please note the following when you are working with interface monitoring:

NOTE

- **Vision Q.400 must be in run mode to be able to send and receive signals and data. During setup mode (icon is active) no new signals or data are displayed. If the system is in setup mode, you see a red message text indicating the mode in the window.**

- **Signals and/or data are only recorded when the "Monitor Interfaces" window is open. When you close and reopen the window, monitoring is restarted, i.e. the table is empty again.**
- **When you switch from the serial to the parallel interface (or vice versa), monitoring is restarted (Vision Q.400 deletes all entries in the table).**
- **If the data transferred or received are too long to fit in the table, click into the cell with the left mouse button. In this case, the data will be displayed as a tool tip.**

- **If the camera is monitored, only the start signal from the camera that has triggered the execution of the application will be displayed.**

4.10.9 Parallel Interface Monitor

With the command **System Settings → Interfaces → Parallel Interface Monitor** or

View → Parallel Interface Monitor or by clicking the icon [icon], you can monitor the line states of the parallel interface and the communication with a remote station

- in run mode and
- make changes in setup mode for testing purposes.

Parallel interface monitor (with digital I/O board ANPC 850V3D)

For each input and output signal, the monitor displays the pin number where the signal will be output or received as well as the status and the signal name. The pin number for the signal depends on the type of digital I/O board you are using.

In the "Parallel Input Channels" column, you can supervise the input status, e.g. whether or not the starting signal originates as it should from a peripheral device connected to the parallel interface.

In the "Parallel Output Channels" column, you can edit the signals on the output channels in setup mode and thus test the output devices. In run mode, you can only supervise the output status with the "Parallel Interface Monitor".

This function is especially valuable when you need to check the communication in handshake mode (see page 115).

[icon] **◆NOTE**

- **The display is updated with every change of a signal.**

- **We recommend switching off the parallel interface monitor when you are in run mode. Otherwise, it may effect the time response of the system negatively.**
- **If you have activated (see page 109) the option "Start lost signal" under** System Settings → Interfaces → Parallel I/O**, the text for "Byte overflow" changes to "Start lost" (and vice versa).**
- **When you have deactivated the sending of a signal on the property page of the parallel interface, e.g. the PCReady signal, the name of the signal is grayed out on the parallel interface monitor. To open the property sheet use** System Settings → Interfaces → Parallel I/O **or click the button [Show Properties].**

4.11 Language

With **System Settings** $\rightarrow$ **Language** you can define which of the available languages you want to use.

When you have changed the language setting, you need to restart Vision Q.400 to see the menu in the selected language.

👉 ◆NOTE

- **The languages are always listed in the language configured for your operating system. This is not necessarily the same language as is currently being used for Vision Q.400.**
- **The language currently being used by Vision Q.400 is flagged in the language list by a black dot. As any change of language selection only takes effect the next time Vision Q.400 is started up, the language used the next time Vision Q.400 is started up is additionally flagged in the list by a white dot with a black surround, if it differs from the language currently being used.**

    Englisch (USA)
    Französisch (Frankreich)
    • Deutsch (Deutschland)

Chapter 5

Execution Groups

5.1 What Are Execution Groups?

An execution group is a group of one or more checker sequences (see page 31). Execution groups offer you the opportunity to divide your application into logical subsidiary tasks.

You can perform many checking tasks without using execution groups. So first try to create the application directly, without configuring custom execution groups, and start the application. When you do so, the system works in the background with internal, predefined execution groups. Any application created by this simple method can be subsequently expanded as needed, and organized into user-defined sequences and execution groups.
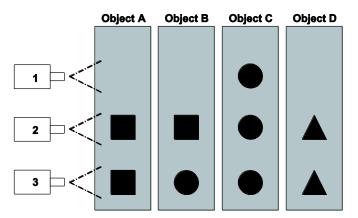
For more complex checking tasks, you can subdivide your application into logical subsidiary tasks performed in single checker sequences which can be grouped according to your requirements and executed together. Execution groups are useful, for example when:

- You have to perform different, rapidly changing checking tasks, such as when tasks vary from picture to picture.
  If each task has different application properties, you must carry out an application change (serial   (see page 103)or parallel (see page 118)). This takes considerably more time however.
- You wish to save processing time, e.g. by only executing those checker or checker sequences you really need.
- You want to carry out more detailed checks dependent on the initial check results, and use IfCase formulas (see page 540) for the purpose.

✌ ◆**EXAMPLE**

The application uses three cameras. On every start signal the application checks different objects containing three differently shaped parts in varying composition. For this you need three different checker sequences (triangle, square, circle) for each camera. Camera 1 only checks the circle however, meaning it only needs one checker sequence.

Set up the following checker sequences in the camera window checker sequence for the three cameras:

Camera 1	Sequence 1	Circle
Camera 2	Sequence 1	Square
	Sequence 2	Circle
	Sequence 3	Triangle
Camera 3	Sequence 1	Square
	Sequence 2	Circle
	Sequence 3	Triangle

From the object-specific checker sequences create execution groups (see page 140) to check objects A to D:

	Object A	Object B	Object C	Object D
Execution group	Group No. 13	Group No. 14	Group No. 15	Group No. 16
Included sequences	**Camera 2,** sequence 1	**Camera 2,** sequence 1	**Camera 1,** sequence 1	**Camera 2,** sequence 3
	Camera 3, sequence 1	**Camera 3,** sequence 2	**Camera 2,** sequence 2	**Camera 3,** sequence 3
			Camera 3, sequence 2	

Then you activate use of execution groups under "Execution Group Properties" (see page 133) with the "Allow group switching" option. Now you can use the various execution groups to check the different objects. To check object C, for example, you run execution group 15.

◆NOTE

You can run the execution groups manually by starting the application (see page 52). In run mode you can run the execution groups via the following interfaces: parallel, serial, and OLE.

5.2 Execution Group Types and Their Differences

Vision Q.400 features three types of execution groups, differentiated by their numbers:

- 1 System-internal execution group (group 0)
- 12 Predefined execution groups (group 1 to 12)
- 4083 User-specific execution groups (group 13 to 4095)

Execution group	Type	Contents
Execution group 0	system-internal	Sequence number 1 of all connected cameras (for each connected camera the system defines one sequence number 1)
Execution group 1 to 12 icon	predefined, not deletable	Sequence no. 1 of camera <Number of camera> For each connected camera the system defines one sequence (no. 1, icon) and one execution group, which contains precisely that sequence (icon). The group number corresponds to the number of the camera.
Execution group 13 to 4095 icon	user-defined	Any number of sequences of up to 12 cameras, but each sequence only once per execution group.

☞ ◆**NOTE**

- **The system is set by default to run (see page 133) the system-internal execution group 0 in response to a start signal. This means you can operate the system with all cameras without having to create your own sequences or execution groups.**

- **Because you can only edit the system-internal predefined sequences and execution groups but not delete them, the icons are displayed with a padlock.**

- **User-defined objects - that is, the sequences with a number greater than 1 and the execution groups 13 to 4095 - are identifiable by their "unlocked" icons ⬛ or ⬛.**

- **You can assign each execution group an individual shutter speed for capturing the image (not available for execution groups that are triggered by IfCase formulas).**

5.3 Properties and Usage

In this dialog box you configure how you want to use execution groups.

Default for execution group properties

Use always this group

If the "Use always this group" option is activated, in setup and run modes the execution group selected from the list box to the right of it is always used. By default it is "No. 0: All Cameras, Sequence No. 1". On every start signal the execution group configured here is executed and the execution group list box on the tool bar is grayed out. Commands to change execution group are ignored.

☞ **◆NOTE**

- **If you have activated the "Use always this group" option, it is not possible to switch to a different execution group. On every start signal via the interfaces the execution group configured here is executed, even if the command contains a different execution group number.**
- **It is not possible for analog cameras to grab images individually. Instead, Vision Q.400 always grabs the images of** all **cameras of an application. That means when an application uses analog cameras and you start an execution group with only 1 camera, Vision Q.400 still grabs images from all 4 cameras.**
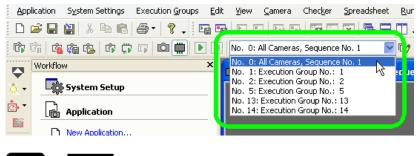
Allow group switching

With this option you activate the possibility to switch to another execution group and thus also to use your own execution groups. Execution group switching occurs

- in setup mode via the list box on the "Application" (see page 38) tool bar and
- during run mode via the interfaces (see page 120) or via the list box on the "Application" tool bar, if you have activated the "Enable the combobox (for execution group selection in the tool bar) during Run Mode" option.

Enable the combobox (for execution group selection in the toolbar) during Run Mode

If you check this checkbox, the toolbar list box for the execution groups is also available in run mode, so you can select and run a different execution group without quitting run mode.
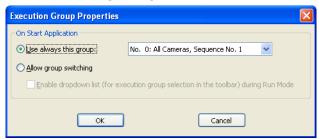

☞ ◆ **NOTE**

Execution of the execution groups depends on the mode **(see page 135) you are in and on the** settings **you make here in the "Execution Group Properties".**
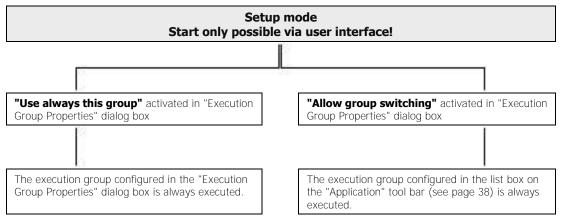
5.4 Executing an Execution Group

Execution of the execution groups depends on the **mode** you are in and on the **settings** you made on the execution group property page (see page 133) under **Execution Groups** →
Execution Groups Properties....
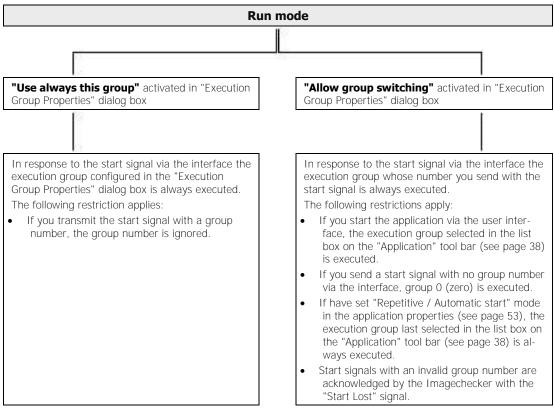
Default for execution group properties

In setup mode

In run mode

Run mode

"Use always this group" activated in "Execution Group Properties" dialog box	**"Allow group switching"** activated in "Execution Group Properties" dialog box

| In response to the start signal via the interface the execution group configured in the "Execution Group Properties" dialog box is always executed.

The following restriction applies:

• If you transmit the start signal with a group number, the group number is ignored. | In response to the start signal via the interface the execution group whose number you send with the start signal is always executed.

The following restrictions apply:

• If you start the application via the user interface, the execution group selected in the list box on the "Application" tool bar (see page 38) is executed.

• If you send a start signal with no group number via the interface, group 0 (zero) is executed.

• If have set "Repetitive / Automatic start" mode in the application properties (see page 53), the execution group last selected in the list box on the "Application" tool bar (see page 38) is always executed.

• Start signals with an invalid group number are acknowledged by the Imagechecker with the "Start Lost" signal. |

The execution group status is displayed in the bottom right corner of the status bar. Every time the application starts up you can see there which execution group has been executed.

5.5 Result Output

Vision Q.400 only outputs those results which could be calculated.

Checker results can be calculated if:

- The checker is used in any of the sequences belonging to the executed execution group(s).

Formula results can be calculated if:

- All checkers used in the formula can be calculated
- All formulas used in the formula can be calculated
- The formula does not use any checkers or other formulas (e.g. formulas which only contain the value "TRUE" or which contain a fixed numeric value)
- The formula is a global formula.

☞ ◆NOTE

- **Enter all checker results you wish to send to an interface in the window "Objects for Data Transfer". Please note that only the results which could be calculated can be sent to the interface.**

- **When you use IfCase formulas to execute execution groups condition-ally, it is not possible to know beforehand which results will be output when the application is executed. Therefore, we recommend including the number of execution groups which are triggered by IfCase formulas in the result output. This will make it easier to identify and interpret the data output. This option is available for the file and OLE interfaces (see page 515).**

5.6 Execution Group Controller

The Execution Group Controller lists all execution groups with their assigned camera(s) and sequence(s). You manage all execution groups in a single window, accessed by the command **Execution Groups → Execution Group Controller** or **View → Execution Group Controller** or by clicking the icon.

Execution Group Controller

The Execution Group Controller window is divided into four sections. On the left is the camera pane and on the right the execution group pane. At the top you see the available cameras (on the left) and execution groups (on the right), and at the bottom the associated checker sequences.

Camera pane (left)	Execution group pane (right)
• At the top left you see the list of connected cameras.	• At the top right you see the execution groups.
• At the bottom left you see the sequences belong-	• The predefined execution groups 1 to 12 are identified by the padlock icon . You cannot add or re-

Camera pane (left)	Execution group pane (right)
ing to the camera selected above. In front of the sequences used in an execution group there is a ✔. Unused sequences are marked by a ⏻. • The first sequence of each camera is predefined and cannot be deleted. It is identified by the padlock icon 🖼. The other sequences with the 🖼 icon can be deleted. When deleted, the sequence is deleted together with all included checkers (see note).	move sequences to or from predefined groups. • You can add and remove any sequences to and from the user-defined execution groups 13 to max. 4095 (🖼 icon). • You can edit the names and commentaries of all execution groups. • If there is a green arrow ➡ in front of an execution group, this signifies that the sequence selected in the bottom left half of the window is used in this execution group. • At the bottom right you see the sequences belonging to the camera sequence selected above. The sequence selected in the bottom left half of the window is marked by a green arrow ➡. • You can assign individual shutter speeds (see page 154) to each camera.

Available options

Each pane contains its own specific options.

Options in the left-hand pane	Explanation
🖼 Add/Remove Camera(s)...	Opens the dialog box for adding or removing cameras (see page 205).
🖼 New Add new sequence	Adds a new sequence to the camera. You set the checkers by copying them in the camera image from other sequences or setting new ones (double-click on the sequence in the Spreadsheet Controller to jump directly to the sequence).
✕ Delete Delete sequence	This option is active only if you have selected a sequence. Deletes the selected sequence from the application. Note that this also deletes the checkers included in the sequence! If any checker results of the selected sequence have been entered on the spreadsheet, you receive a warning.

Options in the right-hand pane	Explanation
🖼 Properties... Properties	Opens the "Execution Group Properties" (see page 133) dialog box. Here, you can select a specific execution group for application startup or activate group switching.
🖼 New Add a new execution group	Adds a new execution group. The new execution group automatically receives the next available group number, which also appears in the name. You can rename the execution group at any time.
✕ Delete Delete execution group	This option is only active if you have selected a deletable execution group (execution groups 1 - 12 are predefined and cannot be deleted). Deletes the selected execution group from the application.
🖼➡ Insert Insert Sequence into Group	This option is active only if you have selected a sequence at the left. You can add each sequence to an execution group only once; otherwise, a warning message appears. Inserts the selected sequence into the execution group selected at the top right.
🖼 Remove Remove Sequence from Group	This option is active only if you have selected a sequence in an execution group at the right. Removes the selected sequence from the execution group selected at the top right. The sequence and its checkers are retained.

☞ **◆NOTE** ═══

- **The 🖉 icon indicates that you can make entries in this column. Double-click to open the comment or name field for editing.**

- **Note the difference between deleting and removing! When you delete a sequence from an execution group (on the left in the Execution Group Controller) - that is, from the list of checker sequences belonging to the camera selected above - you also delete all of its checkers! When you remove a sequence from an execution group (at the right in the Execution Group Controller), you leave the sequence and its checkers in place.**

- **Sequences cannot be deleted if they belong to an execution group or if they are number 1 (predefined sequence).**

5.6.1 Creating a user-defined execution group

You can define (see page 140) up to 4083 execution groups (a total of 4095 execution groups minus 12 predefined execution groups). To create an execution group, select one or more checker sequences of one or more cameras to compile a custom grouping of your checking tasks.

Each execution group is assigned a unique number by the system as well as a name which you can change at any time.

When you start an inspection via the interfaces, you can additionally select the execution group. In this case, only the checker sequences in this execution group are executed. Depending on the interface you are using, please proceed as follows:

☞ **◆NOTE** ═══
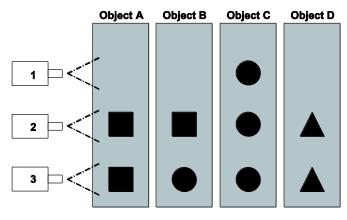
If, for example, you want to start execution group 64:

- **For Ethernet or serial interfaces: Send the start command (in this case: "%S064<cr>").**

- **For parallel interfaces (in this case 01000000 [binary for 64]): Create the data inputs. Next, send the start signal.**

The procedure for creating execution groups is illustrated by a further example.

✌ **◆EXAMPLE** ═══

The application uses three cameras. On every start signal the application checks different objects containing three differently shaped parts in varying composition. For this you need three different checker sequences (triangle, square, circle) for each camera. Camera 1 only checks the circle however, meaning it only needs one checker sequence.

Set up the following checker sequences in the camera window checker sequence for the three cameras:

Camera 1	Sequence 1	● Circle
Camera 2	Sequence 1	■ Square
	Sequence 2	● Circle
	Sequence 3	▲ Triangle
Camera 3	Sequence 1	■ Square
	Sequence 2	● Circle
	Sequence 3	▲ Triangle

From the object-specific checker sequences create execution groups (see page 140) to check objects A to D:

	Object A	Object B	Object C	Object D
Execution group	Group No. 13	Group No. 14	Group No. 15	Group No. 16
Included sequences	**Camera 2,** sequence 1	**Camera 2,** sequence 1	**Camera 1,** sequence 1	**Camera 2,** sequence 3
	Camera 3, sequence 1	**Camera 3,** sequence 2	**Camera 2,** sequence 2	**Camera 3,** sequence 3
			Camera 3, sequence 2	

The procedure shows how to create execution group 13 for inspection of object A.

◆ PROCEDURE

1. **Create a new application**

2. **Add three cameras**

3. **For each camera set up the corresponding number of checker sequences with checkers and with comments**

Next the checker sequences are compiled into execution groups according to the objects being checked.

4. **Execution Groups → Execution Group Controller**

The Execution Group Controller is displayed. It shows the three cameras and the three predefined execution groups. Camera 1 is selected at the top left. At the bottom left you see the sequence 1 created for camera 1 with the comment "Circle".

5. **At the top right under "Execution Groups" select** 📷 New
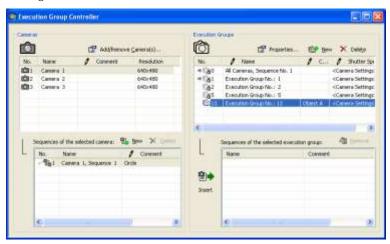
The group list includes a new execution group which is assigned the lowest unused sequence number - that is, 13.

6. **Click to select new execution group**

Double-click on the execution group name to rename it. You can also edit the entry in the Comments column. In this example, "Object A" was entered via dou-

ble-click in the "Comments" field in order to make the execution groups easier to distinguish.

For object A the execution group requires sequence 1 of camera 2 and sequence 1 of camera 3.

7. At left under "Camera" select camera 2

To now add sequences to the new execution group, first select the camera whose checker sequence you want to assign to the group.

8. Select sequence 1 at the bottom left in the list of checker sequences

In front of the sequences already in use in an execution group there is a ✔. Sequences not yet used in any execution group are marked by a ⏻.

9. Select Insert

   or

   use drag & drop to select a sequence from the left-hand half or the checker sequence and drag it into the camera window

   The selected sequence then appears in the execution group and is marked by a green arrow ➡. At the top right, the arrow indicates the execution groups in which the selected sequence is used.

10. Repeat the last three steps for sequence 1 of camera 3

5.6.2 Adding Sequences to a User-Defined Execution Group

You can add more sequences to an existing execution group any time. Either use the execution group controller as for creating user-defined execution groups (see page 140) or drag & drop the sequence from the list of checker sequences to the right of the camera window.

☞ ◆NOTE ─────────────────────────────────

You can use as many sequences as you like from up to 12 cameras. However, every sequence can only be used ONCE within an execution group.

In the example we will add sequence 1 from camera 1 to execution group 16.

Adding sequences with the execution group controller

◆PROCEDURE ─────────────────────────────────

1. **Execution Groups → Execution Group Controller**

   The Execution Group Controller is displayed.

2. **In the top left half of the window, select camera 1**

3. **In the top right half of the window, select execution group 16**

4. **In the bottom left half of the window, select the required sequence**

5. **Click** Insert

Now sequence 1 from camera 1 is displayed on the right under execution group 16. The green arrow mark helps you to identify it quickly. At the top right, the arrow indicates all the execution groups using this sequence. At the bottom right, the arrow indicates where the sequence is located in the execution group.

Adding sequences with drag & drop from the camera window

You can also add sequences to the execution group by dragging & dropping sequences from the camera window into the execution group controller.

◆ PROCEDURE

1. **Execution Groups → Execution Group Controller**

   The Execution Group Controller is displayed.
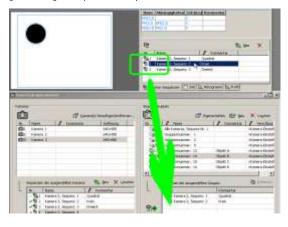
2. **In the top left half of the execution group controller, select the camera from which you want to drag the sequence**

3. **In the top right half of the execution group controller, select the execution group you want to expand**

   In the example we add sequence 2 from camera 2 to execution group 14.

4. **In the camera window, select the sequence with a left mouse click and hold the mouse button down**

   If you move the mouse and the cursor looks like ⊘, you have got the sequence in a firm hold.

5. **Drag the sequence to the right bottom half of the execution group controller**

The cursor changes to look like [cursor icon] when you are moving it to an area where you may drop the sequence.

![NOTE icon] ◆**NOTE**

The drag & drop function only works as expected when you have selected the same camera in the execution group controller and in the camera window from which you try to drag the sequence.
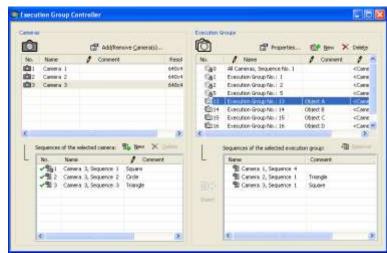
5.6.3 Remove a Sequence from a User-Defined Execution Group

![PROCEDURE icon] ◆PROCEDURE

1. Execution Groups → Execution Group Controller

The Execution Group Controller is displayed. The example shows how to remove sequence 4 from camera 1 from the execution group 13.

2. In the top right half of the window, select execution group 13

Below, you see all sequences belonging to this execution group.

3. In the bottom right half of the window, select "Camera 1, Sequence 4"

4. Click 🔲 Remove

A message appears, asking for confirmation. If you select [Yes], the sequence will be removed from the execution group.

5.6.4 Delete a User-Defined Execution Group

◆ PROCEDURE

1. Execution Group → Execution Group Controller

The execution group controller is displayed (e.g. Execution Group No.: 13; Object A).

2. In the top right half of the execution group controller, select the execution group you want to delete

3. Click ✕ Löschen

or press

<Del>

A message appears, asking for confirmation. If you select [Yes], the sequence will be removed from the execution group.

5.6.5 Change an Execution Group Number or Name

◆ PROCEDURE

1. **Execution Group → Execution Group Controller**

   The Execution Group Controller is displayed.

2. **With the right mouse button, select the execution group to which you wish to assign a new number**

   The context-sensitive pop-up menu appears.

3. **Select "Change Group Number ..."**

The following dialog box appears.

Change Execution Group Number and Name

Old group number:	16
Old group name:	Execution Group No.: 16
New group number:	16
New group name:	Execution Group No.: 16

OK   Cancel

4. Enter the new execution group number

5. Change the name, if required

The original execution group name also contains the execution group number. If you assign a new number to the execution group, it may be confusing later if you do not modify the name accordingly.

6. Click [OK]

◆**NOTE**

You can change the name of an execution group any time by double-clicking the name field, entering a new name and confirming with <Enter>.

5.7 Reading Images

The reading of images varies depending on which camera type you are using:

- For analog and Camera Link cameras, Vision Q.400 always grabs the images of all cameras connected to the system but only processes those with a sequence entry in the execution group being executed. You will find the relevant settings on the "Frame Grabber" tab (see page 69) under **System Settings** → **Vision Q.400 Settings**.
- For GigE Vision cameras, Vision Q.400 always grabs the image of only the cameras that have a sequence entry in the execution group being executed.

5.8 Set Shutter Speeds Individually

You can assign individual shutter speeds (see page 154) to each camera. As a default, the shutter speed from the camera property page is used.

When you double-click the field "Shutter Speed" of an **execution group**, the button [...] appears. Select the button [...] to open the dialog box "Shutter Speed for Execution Group Cameras".

When you click the field "Shutter Speed" of a **camera**, a drop-down list appears with the shutter speeds available for this camera. Select the shutter speed from the drop-down list. Leave the shutter speed set in the camera properties or select a shutter speed for each camera of the execution group.

If all cameras should use **the same shutter speed**, set the correct shutter speed for one camera and then apply it with the button [Apply shutter time to all cameras] to all other cameras of the execution group.

Dialog box "Shutter Speed for Execution Group Cameras"

☞ ◆NOTE

If an execution group is triggered by an ifCase formula, there is a setting in the formula editor to define whether the cameras used in this execution group should grab a new image before the execution group is executed. If you activate the checkbox "Grab" in the formula editor, new images will be grabbed with the shutter speeds set individually for the cameras.

If "Grab" is not activated, Vision Q.400 uses the shutter speeds set in the camera properties as the image(s) will already have been captured.

Chapter 6

Edit

6.1 Introduction

In the main menu **Edit** you will find several submenus which you can use to cut, paste, copy, insert and delete previously selected checkers and parameters:

Submenus in the "Edit" menu

 ◆ NOTE

These submenus are not available in run mode.

All options available from the menu are accessible from the work area via the pop-up menu. Depending on whether or not you have selected an object, the pop-up menu contains different options (see page 35).

6.2 Submenus

The submenus in the **Edit** menu will be described in the following sections.

6.2.1 Cut

With **Edit** → **Cut** you can cut out a selected text or a checker either to delete it or to re-insert it somewhere else with **Edit** → **Paste**.

The cut item will be deposited into the buffer until you cut or copy another item. Once an item is cut, you may re-insert it repeatedly, as needed.

6.2.2 Copy

With **Edit** → **Cut** you can cut out a selected text or a checker to re-insert it somewhere else with **Edit** → **Paste**.

The item copied will remain in the buffer (clipboard) until you copy or cut out another item. Once an item is copied, you may re-insert it repeatedly with **Edit** → **Paste**.

6.2.3 Paste

With **Edit** → **Paste**, you can re-insert an item that has previously been either copied or cut.

☞ **◆NOTE**

> **Initially, the pasted shape of a checker lies exactly on top of the original checker. Select the center point of the shape, hold down the mouse button and drag it to the desired location. The pasted checker will be added to the end of the sequence.**

An item copied or cut will remain in the buffer until you cut or copy another item. In other words, once cut or copied, you can re-insert the item repeatedly at other locations with **Edit** → **Paste**.

6.2.4 Delete
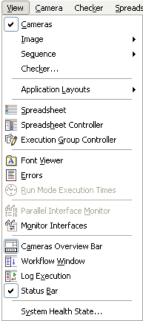
With **Edit** → **Delete**, you can delete the item you have selected. Unlike cut or copied items, a deleted item is not deposited in the buffer. As such, it cannot be re-inserted.

Chapter 7

View

7.1 Introduction

The **View** submenus allow you to configure which components will appear on the screen display in the camera window (see the following sections):

Submenus in the "View" menu

With the exception of the "System Health State...", "Checker...", "Sequence", "Image", "Tool Bars..." and "Colors..." options, all submenu options work just like on/off toggle switches. If a submenu option is marked with a check mark, the corresponding item (e.g. the status bar) will be shown on the screen.

7.2 Submenus

The submenus in the **View** menu will be described in the following sections.

7.2.1 Cameras

With **View** → **Cameras** you can switch on/off the camera image(s) and the associated checker sequence(s). If you have connected multiple cameras, you can switch between the individual cameras using camera bar (see page 193) or the **Window** menu, or by clicking on .

7.2.2 Camera Image

With **View** → **Image** → **Live/Memory** or the <F9> key, you can switch back and forth between memory and live image. You can also use the corresponding icons.

- Live image
- Memory image

Select live or memory image display

We recommend using the live image for image adjustments and the memory image when creating new checkers.

7.2.3 **Sequence**

You find the following display options in the submenu **Sequence**.

Submenus under "Sequence" in the View menu

With **View → Sequence → Hide/Show** you can switch on/off the checker sequence, which is displayed at the right side of the work area.

With **View → Sequence → Adjust Column Width** you can make the longest entry in a column determine the column width in the sequence.

With **View → Sequence → Properties...** you can define which columns will be displayed in the sequence.

When you select this option, the following dialog box appears:

Sequence columns available for display

☞ ◆ **NOTE**

Please note that it is not possible to hide the column "Name". By default, the column "ActiveX Name" is hidden.

7.2.4 Checker

You can configure the visibility and mode of display of checkers and indicators in Vision Q.400 as you need. The settings you make here apply to the camera indicated on the dialog box title bar at the top.

You can also make custom settings on the "Visibility" (see page 262) property page for each checker, object shape or indicator.

Under **View** → **Checker...** you enter the camera-specific settings for the visibility of checkers and indicators:

Define visibility for all checkers and indicators of a camera

Parameter	Explanation	Condition
Shapes	Switch checker shapes on/off	Only checkers
Gray image processing results	Show/hide gray image processing results	Only checkers
Processed objects	Show/hide the objects computed in image processing and display in this way: • **Filled:** Processed objects are displayed in the color (see page 55) selected by the user. • **Not filled:** Processed objects are not filled, only the borders are visible.	Only checkers
Processing results	Switch image processing results on/off	Only checkers
Draw indicators	Show/hide indicators	Only indicators
All executed checkers/indicators of a camera	All checkers and indicators of one camera processed during the last execution of the application are displayed. This includes checkers from ALL sequences which have been used for calculating the IfCase formula.	Only if you are using IfCase formulas
Only the checkers / indicators of the last executed sequence	Displays only the checkers and indicators of the sequence executed last when calculating the IfCase formula.	No condition

The following buttons are available:

Button	Explanation
Show	All parameters relating to the display of the current element are activated. The setting determining whether processed objects are filled or not filled does not change.
Hide	All parameters relating to the display of the current element are activated. The setting determining whether processed objects are filled or not filled does not change.
Apply settings to all cameras	With this button the settings of the current camera are applied to all other cameras.

☞ ◆ NOTE ═══════════════════════════════════

For run mode you can disable display of all checkers, object shapes and indicators entirely. To do so, activate the relevant "Graphic Update" parameters on the "Run Mode Settings" property page under Application → Properties**. The properties of the application have priority over the settings you make here or on the "Visibility" property page.**

7.2.5 Application Layouts

In Vision Q.400 you can customize the appearance of your user interface in layouts. In this, a distinction is made between

- layouts with non-application-specific settings which are used when no application, or no layout saved in the application, is loaded, and
- layouts with application-specific settings which are saved with the respective application.

Name	Layout type	Which data are stored in it?	Icons and commands in Vision Q.400
User interface layout (see page 89)	non-application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows	Save with 🖫 Load with 🗔 Delete with ❎ System Settings → **User Interface Layout** → Save as/Load/Reset User Layout
Start layout (see page 166)	application-specific	• Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Automatically configured and saved (see page 166) by Vision Q.400

Name	Layout type	Which data are stored in it?	Icons and commands in Vision Q.400
Setup mode layout (see page 166)	application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Save with 🖼 Load with 🔲 Delete with 🗙 View → Application Layouts → Save/Load/Delete Setup Mode Layout
Run mode layout (see page 166)	application-specific	• Position and appearance of menu bar • Position and appearance of tool bars • Position and appearance of dockable windows • Position and size of camera windows • Position and size of spreadsheet	Save with 🖼 Load with 🔲 Delete with 🗙 View → Application Layouts → Save/Load/Delete Setup Mode Layout

In "Application Layouts" a distinction is made between the start layout (see below), the setup mode layout and the run mode layout. All layouts include **application-specific** settings for the user interface adapt to the specific mode. So it is advisable in run mode, in which no settings can be made anyway, to hide the toolbar and checker bar so as to make more space for the windows with camera images and execution times etc.

Start layout

The start layout of an application is configured implicitly by Vision Q.400 with the application, and determines the appearance of the Vision Q.400 user interface when you load an application in setup mode. As the start layout contains no information on the Vision Q.400 toolbar and menu bar, their settings remain unchanged. In run mode the start layout is used whenever an application change takes place and no run mode layout is stored in the newly loaded application.

The appearance of the start layout depends on the time of saving:

- In setup mode the start layout is generated from the layout of the user interface at the time the application was saved.

- In run mode, the application is automatically saved when you quit run mode. The start layout is generated from the layout of the user interface at the time setup mode was quit.

☞ ◆**NOTE**

Before switching to run mode, configure the layout so that you can work with it the next time the program starts up, because this layout is implicitly saved as the start layout of this application when you exit run mode, provided you do not then save the application again in setup mode.

The following user interface elements are stored in the various layouts:

	Start layout	**Setup mode layout**	**Run mode layout**
Position and appearance of menu bar	No	Yes	Yes
Position and appearance of tool bars	No	Yes	Yes
Position and appearance of dockable windows	Yes	Yes	Yes
Position and size of camera windows	Yes	Yes	Yes
Position and size of spreadsheet	Yes	Yes	Yes

Saving application layouts

The procedure describes how to create and save a run mode layout.

◆ PROCEDURE

1. **Open required windows**

    Configure your layout the way you want it for run mode. Open and position all necessary windows, such as for the camera(s), spreadsheet, workflow, execution log, etc.

2. **Adapt window position and size**

3. **Hide unwanted tool bars**

    You can hide unwanted tool bars to create more space on screen. In run mode most toolbars are not needed, or have no effect.

4. **Save your finished layout with** 🖼️

    or by choosing

    View → Application Layouts → Run Mode Layout → Save Layout

5. **Select** 💾

    or choose

    Application → Save

    If you do not save the application, you will not be able to load the layout the next time the program starts. Repeat the procedure if you want to configure a setup mode layout.

Loading application layouts

In setup mode you can load your own custom-defined setup or run mode layout at any time.

◆ PROCEDURE

1. **Select** 🔲 **to load the run mode layout or** 🔲 **for the setup mode layout**

    or choose

View → Application Layouts → Run/Setup Mode Layout → Load Layout

All windows are restored to the sizes and positions you saved as the layout for this application.

Automatic loading of layouts on mode switching

When you switch from setup to run mode or back again, you can have Vision Q.400 load the run or setup mode layout.

◆PROCEDURE

1. **Application → Properties**

2. **If not yet visible, select "Run Mode Settings" property page**

3. **Under "Layout Switching" activate the desired parameter**

4. **Application → Save**

◆NOTE

- **You can also activate the options under "Layout Switching" when you did not create the layout concerned. the layout load command is ignored when you switch modes, and a warning is written to the error log file.**
- **If you have not checked the "Load setup mode layout when leaving run mode" checkbox or the layout does not exist, the start layout is loaded when you quit run mode.**

7.2.5.1 Showing and Hiding Tool Bars

By default, the five Vision Q.400 tool bars are docked beneath the menu bar, and feature all available icons. Because most icons are grayed out in run mode, it is advisable in run mode to hide the tool bars and checker bars so as to make more space for the windows with camera images and execution times etc. Alternatively, you can also create your own custom (see page 172)tool bar containing only the icons available in run mode, which takes up less space and can be positioned wherever you like (see page 171).

List of available standard tool bars

Hiding tool bars

To hide unwanted tool bars:

 ◆ PROCEDURE

1. **Right-click in the free gray area next to or beneath the menu bar or a tool bar**

   A pop-up menu appears containing the five tool bars. In this example the "Layout" tool bar is to be hidden.

2. **Left-click to select "Layout"**

   The selected tool bar is hidden and the pop-up menu closed.

Showing tool bars

To redisplay hidden or unintentionally closed tool bars:

 ◆ PROCEDURE

1. **Right-click in the free gray area next to or beneath a tool bar**

A pop-up menu appears containing the five tool bars. Currently visible tool bars are indicated by a check mark in front of the name. There is no checkbox for hidden tool bars. In the example the hidden "Application" tool bar is to be restored to view.

2. Left-click to select "Application"

The selected tool bar is redisplayed and the pop-up menu closed.

7.2.5.2 Repositioning Toolbars

By default, the five Vision Q.400 tool bars are docked beneath the menu bar, and feature all available icons. Each tool bar can be detached from its docked position and positioned as a floating box at a different position on the screen.

◆ PROCEDURE

1. Point the cursor to the start of the tool bar

Each tool bar starts at the left with a vertical dotted line. This line also acts as a separator between adjacent tool bars.

The cursor shape changes to ✛.

2. Click and hold down the left mouse button

This detaches the tool bar from its anchorage.
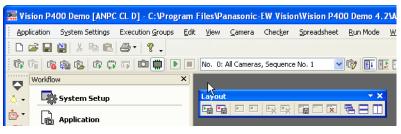
3. **Drag the tool bar to where you want it in the window**

   When you move the cursor along the window margin, Vision Q.400 tries to dock the tool bar there. When you move the cursor to the middle of the window, the tool bar is displayed on screen in a separate, floating tool bar box when you release the mouse button. In this case the "Layout" tool bar is to be placed in a dedicated box
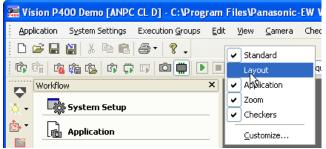
4. **Move the cursor into the middle of the window**

5. **Release the mouse button**

The layout tool bar box can be moved at any time.

> ☞ ◆**NOTE**
>
> • **When you close a tool bar box, you hide the tool bar. It is not reset to its original position. To redisplay the tool bar, right-click in the gray area where the tool bar was previously positioned. All available tool bars are displayed, with the currently visible ones indicated by a check mark. Select the tool bar you want to redisplay by left-clicking on it and it reappears at the position it was in before being hidden.**

> • **You can save the customized user interface as your layout and load it when required. You can also save different layouts with more or fewer tool bars for setup and run mode with the application (see page 166) and load the relevant layout automatically on switching mode (see page 166).**

7.2.5.3 Customize Tool Bars

By default, the five Vision Q.400 tool bars feature all available icons. You can create your own custom tool bars featuring the icons you need most frequently. A custom tool bar is a good

idea in run mode, for example, because only a small number of icons can be used in that mode while most are grayed out.

◆ PROCEDURE

1. **Right-click in the free gray area next to or beneath the menu bar or a tool bar**

    A pop-up menu appears containing the five tool bars.

2. **Click on "Customize..."**

    The following dialog box appears:

3. **Click on [New]**

    The following dialog box appears:

4. **Enter a name for the tool bar and click [OK]**

Give your tool bar a descriptive name; in the example it is "RUN". The new tool bar appears at the end of the tool bar list.

At the same time, a new, empty bar is displayed at the top underneath the standard tool bars.

5. In the "Customize" window select the "Commands" tab

6. **Left-click on the " Start" icon and hold the mouse button down**

7. **Drag the icon onto the empty tool bar and release the mouse button**

8. **Drag & drop all the command icons you want to use onto the tool bar**

9. **Click on [Close]**

Icons for commands which are not currently available are grayed out as usual (in the example the icons for "Stop: Repetitive Start" and switching to setup mode, as we are in setup mode).

10. **Position the finished tool bar**

User-defined tool bars can be docked onto the window margin or onto other tool bars just like standard tool bars, or can be positioned as separate floating boxes. The tool bar name is displayed on the title bar of floating tool bar boxes.

◆NOTE

You can save the customized user interface as your layout and load it when required. You can also save different layouts with more or fewer tool bars for setup and run mode with the application (see page 166) and load the relevant layout automatically on switching mode (see page 166).

7.2.6 Spreadsheet

With **View → Spreadsheet** or by clicking you switch the spreadsheet window on/off.

7.2.7 Spreadsheet Controller

The "Spreadsheet Controller" window allows you to view only selected checker results and formulas in the spreadsheet and the "Objects for Data Transfer" window.

If you are not using execution groups
Depending on the item you have selected, the spreadsheet and the "Objects for Data Transfer" window display formulas and checker results from

- the whole application (all cameras, all sequences) or
- a selected camera with its sequences or
- One specific sequence of a camera

To open the Spreadsheet Controller choose **View → Spreadsheet Controller** or click on the

 icon. The window is displayed at the left as a separate tab page in the area with the workflow window. The Spreadsheet Controller is a useful tool for navigation and for reducing the display down to the data of a camera, sequence or execution group. You can use this function as follows:

- Restrict (see page 179) the spreadsheet display to the results of the selected sequence/execution group
- Restrict (see page 181) the display in the "Objects for Data Transfer" window to the results of the selected sequence/execution group
- Camera Window Switching (see page 183)

Spreadsheet Controller without execution groups: At top normal display; at bottom with comments

If you are using execution groups

When you work with execution groups, there are additional items available:

- all cameras with sequence number 1 (corresponds to executing the application in run mode without execution groups)
- user-defined execution groups with one or more cameras and sequences

The following rules apply for the display of checkers and formulas:

- A checker result is displayed if its checker belongs to the entry selected in the spreadsheet controller.
- A formula (exemption: IfCase formulas) is displayed if
  - all the checker results used in this formula belong to the entry selected in the spreadsheet controller.
  - all the formula results used in this formula belong to the entry selected in the spreadsheet controller.
  - the formula is independent of checker results, e.g. it only contains the value "TRUE".
  - it is a global formula (see page 547).
- An IfCase formula is displayed if at least one result used in the formula belongs to the entry selected in the spreadsheet controller.

♦EXAMPLE

A formula uses the results of a feature extraction checker from camera 8, sequence 1 and a binary edge detector from camera 9, sequence 2. The formula is displayed when you select one of the following entries in the "Spreadsheet Controller" window:

- All Cameras, All Sequences (= whole application) or

- the user-defined execution group 13 containing both camera 8, sequence 1 and camera 9, sequence 2

The formula WILL NOT be displayed with any of the following selections in the "Spreadsheet Controller" window:

- the predefined execution group No. 8 (because one checker is part of a sequence which does not belong to the execution group for camera 8)

- the predefined execution group No. 9 (because one checker is part of a sequence which does not belong to the execution group for camera 2)

- any user-defined execution group which contains only one of the cameras or sequences

- "Exec. grp. num. 0: All Cameras, Sequence No. 1" because a sequence with number 2 is used

An exemption to this rule are formulas containing no checker, e.g. a global formula or a formula containing only the value TRUE.

The display rules for the spreadsheet are also valid for the "Objects for Data Transfer" window: Vision Q.400 only lists checker and formula results which are executed with the execution group and are selected for data transfer to the interface. If you select another camera or execution group in the spreadsheet controller, the display changes.

♦NOTE

- **The selection you have made in the spreadsheet controller to limit the spreadsheet display will not be saved when you save the application.**

- **If you have hidden spreadsheet rows, you can temporarily display them again by clicking on the** 🔍 **icon in the Spreadsheet Controller. Then the** 🔲 **icon is displayed on the spreadsheet to the left of the actually hidden but temporarily visible rows.**

		Result Name	Value	Result (Calib.)	Judgement
Results	Start				
		FE[1;1]areaSize_1	47482	47482	OK
	🔲	FE[1;1]gravity_X_Coordinate_1	205.88	205.88	OK
	🔲	FE[1;1]gravity_Y_Coordinate_1	266.68	266.68	OK
		FE[1;1]angle_1	165.27	165.27	OK
	End				

7.2.7.1 Restricting Spreadsheet View
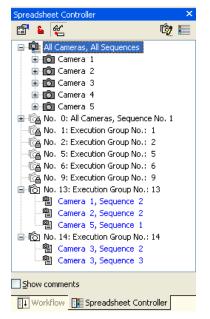
If you have connected a lot of cameras and the spreadsheet contains a large number of checker results, it will become less clearly readable. Clicking on an execution group with the spreadsheet open results in only the spreadsheet rows containing the results of checkers from this execution group being displayed. All other rows are hidden.

◆ PROCEDURE

1. View → Spreadsheet Controller **or select** 🔳

   The Spreadsheet Controller window opens up, or if already open is placed in the foreground.

2. **Click on "All Cameras, All Sequences"**

The spreadsheet shows all inserted results. Results of checkers not executed on the last startup because they belong to a different execution group are marked in blue. Next the view is to be restricted to all results of execution group 13.

3. Select group number 13

The spreadsheet then only shows the results relating to the checkers from execution group 13. The restriction to execution group 13 is also indicated on the spreadsheet title bar.

	Result Name	Result (Calib.)	Judgement	NG Max
Results	Start			
	ED_B[1;1]numberOfTotalEdges	7	Not Executed	1
	FE[2;1]numberOfTotalObjects	3	Not Executed	1
	FE[2;1]areaSize_1	23568	Not Executed	1
	FE[2;1]areaSize_2	332	Not Executed	1
	FE[2;1]areaSize_3	114	Not Executed	1
	FE[5;1]numberOfTotalObjects	7	OK	1
	End			

☞ ◆ **NOTE**

- **The selection you have made in the spreadsheet controller to limit the spreadsheet display will not be saved when you save the application.**
- **If you have hidden spreadsheet rows, you can temporarily display them again by clicking on the 👓 icon in the Spreadsheet Controller. Then the ▭ icon is displayed on the spreadsheet to the left of the actually hidden but temporarily visible rows.**

	Result Name	Value	Result (Calib.)	Judgement
Results	Start			
	FE[1;1]areaSize_1	47482	47482	OK
▭	FE[1;1]gravity_X_Coordinate_1	205.88	205.88	OK
▭	FE[1;1]gravity_Y_Coordinate_1	266.68	266.68	OK
	FE[1;1]angle_1	165.27	165.27	OK
	End			

7.2.7.2 Restricting View of Output Data

The "Objects for Data Transfer" window can only display a certain number of results at once. When you have opened the "Objects for Data Transfer" window and click on an execution group in the Spreadsheet Controller, only the results relating to checkers from that execution group are displayed. All other results are hidden.
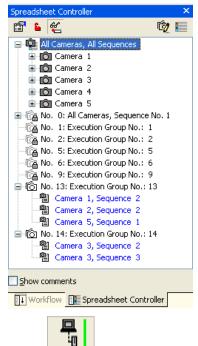
◆ PROCEDURE
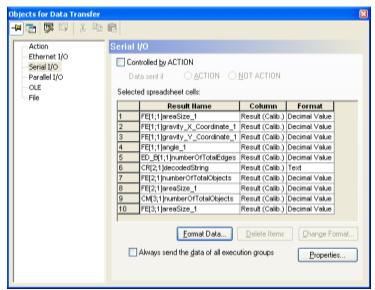
1. View → Spreadsheet Controller **or select** 🔡

    The Spreadsheet Controller window opens up, or if already open is placed in the foreground.

2. **Click on "All Cameras, All Sequences"**

3. **Click**
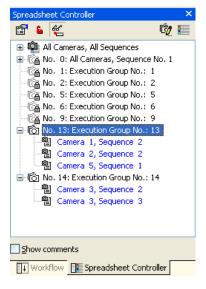
The "Objects for Data Transfer" window displays all results to be output via the RS232 interface. Next the view is to be restricted to all results of execution group 13.

4. Select group number 13

The window then only shows the results relating to the checkers from execution group 13.
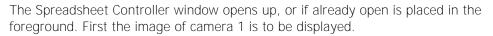
7.2.7.3 Camera Window Switching

With the Spreadsheet Controller you can quickly switch from one camera window to the next via the sequences.

 PROCEDURE
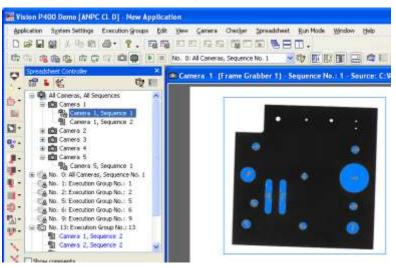
1. View → Spreadsheet Controller **or select**

The Spreadsheet Controller window opens up, or if already open is placed in the foreground. First the image of camera 1 is to be displayed.

2. Click on "All Cameras, All Sequences"

3. Select camera 1

4. Double-click on a sequence

The camera window jumps to the image of the selected camera. In the example sequence 1 of camera 1 is displayed.
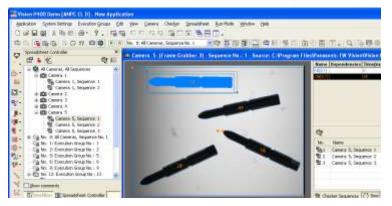
Now you want to switch to camera 5.

5. Select camera 5

6. Double-click on a sequence

In the example sequence 1 of camera 5 is displayed.

7.2.8   Execution Group Controller

The Execution Group Controller (see page 138) lists all execution groups with their assigned camera(s) and sequence(s).

Execution Group Controller

There are two categories of execution groups:

- Predefined execution groups (see page 132), e.g.: Group number 1 includes "Camera 1, Sequence no. 1", group number 2 includes "Camera 2, Sequence no. 1" etc., up to 12, if you are using 12 cameras in the application
- User-defined execution groups (see page 132) (group 13 to 255) which you can create (see page 140) or expand (see page 145) yourself.

7.2.9   Font Viewer

With **View** → **Font Viewer** or by clicking 🅰 you switch the font viewer window on/off. The font viewer is a tool for viewing and editing existing fonts. You can either

- view or delete individual patterns,
- view or delete all patterns for a label, or
- view or delete a complete font.

When you select this option, the window below appears. When you have selected a font, you find all the labels belonging to that font and the different patterns that have been registered for a particular label.

The figure below shows a font called "Credit_card" and the label "3" with different patterns.

"Font Viewer" window

Name

This field displays the name of the selected font. Click [...] to select another font. Use the [Clear Font] button to delete the currently selected font.

Label

In this part of the window you select the label you wish to view. On the right side you find a list of available labels. Click on any label to display the registered pattern(s). Use the [Delete Label] button to delete the selected labels together with all their patterns.

Pattern

In this part of the window you select the pattern you wish to view. On the right side you find a list of registered patterns for the selected label. Selecting a pattern displays this particular pattern in an enlarged version on the left side of the window. You can select a pattern either by clicking on it in the "Number of Patterns" list or by using the arrow buttons of the index counter [◄][►] at the bottom of the window.

Use the [Delete Pattern] button to delete the currently selected pattern. When you delete the last pattern of a label, the label is deleted, too.

☞ ◆**NOTE**

> **If you have defined an OCR checker so that it uses a font (see page 404), the classifier is recalculated every time you add or delete a pattern to the font.**

Optimize

Use this part of the window to optimize the font. Under "Source" and "Target" select the type of font, then select [Optimize Font]. Vision Q.400 saves the optimized font in a new file. Depending on the selection you made under "Target", the file name is different: XXX_Opt_Dl.nft when you have selected the option "Dark on Light" under "Target" or XXX_Opt_Ld.nft when you have selected the option "Light on Dark" under "Target". Next, turn to the property page "General" of the OCR checker and use [Set Font] to assign the optimized font to the checker.

7.2.10 Error logging window

Use **View** → **Errors** or click 📄 to switch on/off the "Error Log" window. Depending on your configuration of the error handling (see page 83), this window lists all errors and warnings which have occurred during the operation of Vision Q.400.

Error logging window

Column	Explanation
Count	Running numbers for errors
Time	Date and Time
Level	Error types: Warning/fatal error Warning: e.g. dependency error Fatal error: e.g. hardware defect

Column	Explanation
Class	Where in the software did the error occur
Error	Error number
Description	Error description

In addition, you can save this information in the file "error.txt" (see page 569). This file is located in the Vision Q.400 installation folder (e.g. C:\Program Files\QVITEC\Vision Q.400 <Q.400_VersionNumber>).

> ☞ **◆NOTE**
>
> - **The content of the file "error.txt" is deleted with every start of the program. If you need the contents of this file, you should rename the file prior to starting Vision Q.400 again.**
> - **If you need support, copy the file "error.txt". Print out the file and fax it to Q.VITEC together with the form for user feedback (see page 572).**
> - **When the "Error Logging" window is displayed and active on the screen, you can delete its content by choosing** System Settings → Error Handling → Clear Error Log **or by pressing the <Del> key.**

7.2.11 Run Mode Execution Times

With **View** → **Run Mode: Execution Times** or by clicking 🕥 you can show/hide the window with the execution times in Run mode. When the execution times are displayed depends on the settings in the application properties (see page 53).

	Time[ms]	Min (ms)	Max (ms)
Grab Image	16	16	16
Process Image	15	15	15
Process Spreadsheet	0	0	0
Transfer Data to External	0	0	0
Last Display Update	9	9	11
Inspection	40	40	43
Scans per Second	25	23	25

Execution times

The table shows the inspection times of the last application as well as the fastest and the slowest inspection time from all inspections:

- Grabbing of images
- Execution of all checker sequences
- Spreadsheet
- Data output
- Last update of the screen display

The entries can be described as follows:

Parameter	Explanation
Grab image	Time between the start of an inspection cycle and the time when the last image has been grabbed
Process image	Time between the end of image grabbing and the end of executing all checker sequences
Inspection	Total duration of an inspection cycle
Scans per second	Number of complete inspection cycles that can be executed per second. If an inspection cycle takes longer than 1 second, the value displayed will be<1

In order to shorten the total inspection time, Vision Q.400 tries to perform its task as parallel as possible. This goes especially for image grabbing and executing checker sequences. This is why it is possible that checker sequences belonging to the first camera already are being executing before the last image has been grabbed.

Executing image grabbing and image processing in parallel shortens the total duration of an inspection cycle, i.e. the total duration is shorter than the sum of image grabbing time and execution time of the individual checker sequences.

During parallel execution the symbol ":-)" appears to the right of the time value next to "Process Image". If the value displayed is "0", the execution of the checker sequences had been finished before the last image was grabbed. (Please note that the smiley symbol only appears in the release version of Vision Q.400 as the simulation version works with simulated image grabbing.)

☞ ◆**NOTE**

- **Only use the time displayed under "Inspection" if you need to know the total duration. As a rule, the time under "Inspection" is lower than the sum of the times in the other rows, but never higher, because Vision Q.400 executes the inspection tasks as parallel as possible.**
- **If you are using IfCase formulas to start an execution group, the execution time for the execution group will be displayed in the row "Process Spreadsheet".**
- **The simulation version of Vision Q.400 does not use cameras, but loads the images as a file. Consequently, the times displayed under "Grab Image" have not been measured, but have been computed by Vision Q.400 to give you the most accurate possible idea of how long image grabbing would take when using cameras. But please note that these computed times differ from the time measured when using real cameras. This is why the window displays all times depending on the computed times in blue.**
- **To find out the exact times for executing an application you need to use the release version of Vision Q.400.**

7.2.12 Parallel Interface Monitor

With the command **System Settings → Interfaces → Parallel Interface Monitor** or

View → Parallel Interface Monitor or by clicking the icon [icon], you can monitor the line states of the parallel interface and the communication with a remote station

- in run mode and
- make changes in setup mode for testing purposes.

Parallel interface monitor (with digital I/O board ANPC 850V3D)

For each input and output signal, the monitor displays the pin number where the signal will be output or received as well as the status and the signal name.   The pin number for the signal depends on the type of digital I/O board you are using.

In the "Parallel Input Channels" column, you can supervise the input status, e.g. whether or not the starting signal originates as it should from a peripheral device connected to the parallel interface.

In the "Parallel Output Channels" column, you can edit the signals on the output channels in setup mode and thus test the output devices. In run mode, you can only supervise the output status with the "Parallel Interface Monitor".

This function is especially valuable when you need to check the communication in handshake mode (see page 115).

[icon] ◆NOTE

- **The display is updated with every change of a signal.**
- **We recommend switching off the parallel interface monitor when you are in run mode. Otherwise, it may effect the time response of the system negatively.**

- **If you have activated (see page 109) the option "Start lost signal" under** System Settings → Interfaces → Parallel I/O**, the text for "Byte overflow" changes to "Start lost" (and vice versa).**
- **When you have deactivated the sending of a signal on the property page of the parallel interface, e.g. the PCReady signal, the name of the signal is grayed out on the parallel interface monitor. To open the property sheet use** System Settings → Interfaces → Parallel I/O **or click the button [Show Properties].**

7.2.13 Monitor Interfaces

To open the "Monitor Interfaces" window, choose **System Settings → Interfaces → Monitor Interfaces** or **View → Monitor Interfaces**. Here you can monitor the signals and/or data that are sent or received via the Ethernet, serial, parallel, or camera interface (only for GigE Vision cameras). The signals and/or data are displayed in a buffered table with four columns. The buffer can store up to 500 entries. This means the entries at the beginning of the table will be overwritten when the table is full.

Final table entries are identified by black shading in the first column. Data with light blue shading are transferred via handshake (see page 115).

The table columns display the following content:

First column	Time	In	Out	Data transfer
Row number. The last entry is marked in black.	Point in time when the signals and/or data were sent or received	Signals and/or data received	Signals and/or data sent	OK = Data transfer was successful NG = Error during data transfer. Please check the connected peripheral device.

The display of signals and/or data in the columns "In" and "Out" depends on the interface you have selected:

Interface	Display
Ethernet and serial	The columns display exactly the characters that have been sent or received. Please note that the separators (see page 505) for sent data are user-definable. Non-printable characters such as "\t" cannot be displayed correctly on the monitor, but will be sent as a normal character string.
Parallel	• Data: the bit pattern that has been sent or received • Signals: Signal name
Camera	You can see whether the camera's trigger signal to start the application has been accepted or ignored.

The following parameters are available:

Option	Description
Monitor <inter-face>	Select the interface whose data communication is to be displayed: Ethernet, serial, parallel, or camera.
Lock update	When you activate this option, no new entries are displayed, even if Vision Q.400 has sent or received signals and/or data. Activate this option if you want to review old entries in the table without having older entries overwritten by newer ones.
Sorted by time	As the monitoring function is buffered, older entries may sometimes be listed before newer ones. Choose [Sorted by Time] to sort the table entries so that the oldest entries are displayed at the top and the newest at the bottom.
Clear	Use this button to delete all entries from the table.

Please note the following when you are working with interface monitoring:

◆ **NOTE**

• **Vision Q.400 must be in run mode to be able to send and receive signals and data. During setup mode (icon is active) no new signals or data are displayed. If the system is in setup mode, you see a red message text indicating the mode in the window.**

• **Signals and/or data are only recorded when the "Monitor Interfaces" window is open. When you close and reopen the window, monitoring is restarted, i.e. the table is empty again.**

• **When you switch from the serial to the parallel interface (or vice versa), monitoring is restarted (Vision Q.400 deletes all entries in the table).**

• **If the data transferred or received are too long to fit in the table, click into the cell with the left mouse button. In this case, the data will be displayed as a tool tip.**

• **If the camera is monitored, only the start signal from the camera that has triggered the execution of the application will be displayed.**

7.2.14 **Camera Bar**

The camera bar shows thumbnail images from all connected cameras in ascending order. The camera bar is started by default with Vision Q.400 and docked in a fixed position at the bottom of the screen above the status bar. You can show and hide the camera bar as required

by choosing **View** → **Camera Bar** or by clicking on the ▦ icon.

Click on the next thumbnail view to switch from one camera to the next. The image from the current selected camera is displayed in large format in the main window and its thumbnail is framed in green. If the camera image is larger than the window, such as because you have used a zoom function (see page 44), a red segment marker in the thumbnail indicates the area of the image currently on display in the main window. You also see the red segment marker on the thumbnails which are currently not selected.

Camera bar with thumbnail views of the 5 connected cameras

You can alter the height of the camera bar. Position the cursor on the border between the main window and the camera bar until the cursor turns into ⬍. If you now press and hold down the left mouse button, you can enlarge or reduce the bar. The thumbnails are displayed correspondingly smaller or larger.

7.2.15 **Workflow Window**

The workflow window displays the steps required to configure Vision Q.400 and to create and launch an application. By default, the window is at the left between the checker bar and the main window with the camera image.

The menu items in the workflow window are arranged so that you can locate the key steps in configuring an application quickly and easily.

All functions in the workflow window are also available in the submenus on the main menu bar or on the tool bars.

Workflow Window

☞ ◆ **NOTE** ────────────────────────────────────
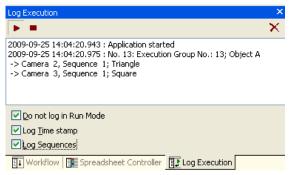
You can assign applications numbers (see page 86). You can select all applications which you have assigned a number by way of the list box and open them with "Open Selected Application".

7.2.16 **Log Execution**

With **View** → **Log Execution** or by clicking you can create an additional "Log Execution" tab in the workflow window. The execution log records information including when an application was started, which execution group was executed with which checker sequences in the process, and which IfCase formula activated which execution group to execute.

Example of an execution log

The following options are available:

Option	Functionality
Do not log in run mode	The log is only kept in setup mode.
Log timestamp	The date and time of the application execution are logged
Log sequences	If you activate this option, apart from the number of the executed execution group the camera and sequence numbers are also displayed. That is helpful when you are working with IfCase formulas.

7.2.17 **Status Bar**

With **View** → **Status Bar**, you can choose whether to switch on/off (see page 30) the status bar (see page 42).

7.2.18 **System Health State**

Use **View** → **System Health State** to display the following system parameters:

- fan speed,
- system temperature,
- CPU temperature,
- IDE temperature, and
- temperature of the power supply

It depends on your hardware and software configuration of Vision Q.400 whether respectively which parameters can be displayed.

Displaying the system health state

Chapter 8

Camera

8.1 Introduction

Vision Q.400 supports the following camera interfaces:

- Camera Link cameras (see page 200), where digital image data is processed in a PC via a frame grabber using a Camera Link (see page 201) interface.

- GigE Vision cameras (see page 207), where digital image data is transferred via Ethernet for processing in a PC.

- Cameras supported by a plug-in image acquisition interface. A plug-in allows you to capture images with camera types that are not supported by default by Vision Q.400. It is not possible to describe the features of those camera types here. Please refer to the documentation of the plug-in for more information. If you wish to use a plug-in, please contact the technical support. The cameras supported by the image acquisition interface are referred to as "user-defined cameras".

The respective camera models belonging to these three camera interfaces are referred to as "camera types." The current configuration of Vision Q.400 only supports one camera interface at a time. Accordingly, all cameras used in an application have to work with the same interface.

Vision Q.400 supports color cameras. The captured images are three-channel images with the channels red, green, and blue, independent of which color format has been selected on the camera. Every channel contains a byte image representing the corresponding share of the color in the image. This way it is possible to apply existing image-processing algorithms on the individual channels. However, due to the properties of the operating system this method makes it necessary to convert the image to a one-channel 24-bit image for display. This may slow down the image display.

☞ ◆NOTE

- **A checker that has been created for a color camera cannot be copied to a gray-value camera and vice versa.**
- **Gray-value cameras can only replace gray-value cameras, and color cameras can only replace color cameras.**

It is possible to replace a camera interface with another when loading an application. In an open application you can only replace the camera type of the camera interface.

Replacing camera types in an open application

Read the information on the correct procedure here (see page 224).

Replacing the camera interface in an application to be loaded

If you are loading an application that uses a camera interface which is not supported by the current Vision Q.400 configuration, you can replace the application's cameras with the cameras supported by the configuration. A message will ask you whether you wish to replace the camera type and inform you about   what will happen next.

When you select "Yes" to change the camera interface, Vision Q.400 proceeds as follows:

- Vision Q.400 automatically saves the original application under a new name. The layout of the file name is as follows: <original name>_BCR.nav

- Vision Q.400 displays a dialog box where you have to assign a camera type of the

new camera interface to each camera used in the application. Then confirm with [OK].

The left column in the dialog box lists all cameras in the application to be loaded together with the camera number and type. Use the middle column of the list   to select the new camera type to replace the old type. The right column contains the identifiers of all cameras with the same camera type as the one selected in the middle column. Every camera needs to have a unique identifier, or an error message will be displayed.

- Vision Q.400 replaces the old camera types with the new ones and continues with the loading of the application.
  The application will not be saved automatically after the camera types have been replaced. You have to save the application manually so that the new camera types will be known even after you have reloaded the application.

The table below informs you about which camera interface can be replaced by another interface when you load an application.

	to		
From	**Camera Link**	**GigE Vision**	**User-defined cameras**
Camera Link		Yes	Yes
GigE Vision	No		Yes
Interfaces	No	Yes	

☞ ◆ **NOTE**

- **It is only possible to replace the camera interface in the application if you load the application in setup mode. It is not possible to load the application in run mode.**
- **Alternatively, you can replace the camera interface with the simulation version by changing the configuration (see page 80) of the simulation version.**
- **An application needs to be saved once with Vision Q.400 before you can replace the camera interface with a different interface. It is possible to use the simulation version to save the application before converting the camera variant.**

8.1.1 Camera Link Camera Types and Frame Grabbers

The Vision Q.400 delivery standard supports the following Camera Link (see page 201) camera types:

Black-and-white cameras	Color cameras
ANPVC 1210D	ANPVC 2040D
ANPVC 1211D	ANPVC 2266D
ANPVC 1040D	
ANPVC 1021D	
ANPVC 1510D	

These camera types are used for the Camera Link configuration (see page 201) "Base". The software settings depend on the hardware used – you need a Camera Link frame grabber board.

☞ ◆NOTE

- **You can define an individual camera type for every camera.**
- **For information on how to connect the flash please refer to the hardware manual of your Imagechecker.**

For Camera Link cameras, the following submenus apply:

"Camera" menu: submenus

☞ ◆NOTE

For Camera Link color cameras refer to the information in the chapter on GigE Vision cameras.

8.1.1.1 Camera Link

Camera Link is the proprietary name of a standard interface used to transfer image data from digital cameras to frame grabbers. In Camera Link interfaces, cameras, cables, and frame grabbers are designed specifically for the Camera Link transmission protocol.

Camera Link was established in 2000 by the Automated Imaging Association (AIA) as an international standard for industrial image processing.

8.1.1.2 Camera Link configuration

The following configuration variants of Camera Link cameras and frame grabbers are available:

- Base
- Medium
- Full

The Vision Q.400 delivery standard supports only the "Base" variant cameras and frame grabbers.

All three variants use the same software. The main difference between the three consists in:

- the data transfer speed, which increases from "Base" to "Full."
- the required number of connections to a Camera Link frame grabber:
- Base: One connection per camera
- Medium and Full: two connections per camera

The Camera Link configuration for a particular camera type is specified by the camera definition and cannot be changed.

A Camera Link frame grabber can have the following number of connected cameras, depending on the camera and frame grabber type:

- Base: up to two (with camera type "Base")
- Medium and Full: one each (with camera type "Medium" or "Full")

In Camera Link configurations, camera and frame grabber types must be compatible. Incorrect settings can result in system malfunction as described under "Ensuring Hardware/Software Compatibility (see page 209)".

The following table provides an overview of Camera Link configuration data:

Data transfer speeds

Camera Link configuration	Data throughput
Base	Up to 243MB/s; theoretically, up to 132 images/s with 1600x1200 pixels and 8- bit gray scale; in practice, this depends on the camera used
Medium	Up to 486MB/s; 264 image/s with 1600x1200 pixels; 8-bit gray scale
Full	Up to 486MB/s; 354 image/s with 1600x1200 pixels; 8-bit gray scale

Additional data

Transmission mode	symmetrical signal transmission at low voltage levels (using the Low Voltage Differential Signaling [LVDS] protocol)
Maximum pixel frequency	85MHz An even higher volume of data can be transmitted via parallel streams (taps).
Bit width per pixel	between 8 and 16 bits
Connector	MDR-26 connector (Standard CL) or HDR-26 connector (MiniCL)
Cable length	generally up to 10m

8.1.2   GigE Vision

In the standard version, Vision Q.400 supports the following GigE Vision cameras:

Black-and-white cameras

- ANPG 830D / ANPG 830PD (with Power-over-Ethernet)
- ANPG 831D / ANPG 831PD (with Power-over-Ethernet)
- ANPG 832D / ANPG 832PD (with Power-over-Ethernet)
- ANPG 835D / ANPG 835PD (with Power-over-Ethernet)

Color cameras

- ANPG 830CD / ANPG 830CPD (with Power-over-Ethernet)
- ANPG 831CD / ANPG 831CPD (with Power-over-Ethernet)
- ANPG 832CD / ANPG 832CPD (with Power-over-Ethernet)
- ANPG 835CD / ANPG 835CPD (with Power-over-Ethernet)

The GigE Vision standard does not mean that the functionality of cameras from different manufacturers has been standardized (the standard requires only a minimum of standardized functions). Rather, it means that a standardized interface is able to recognize the camera's functionality and to set the parameters as required. For example, the flash signal output of a camera is not standardized. Every camera manufacturer can implement this function in his own way.

As a consequence, camera manufacturers need to make almost all camera parameters accessible to the user so that the user can use the functionality to the full extent. As there is a multitude of parameters, users would have to be camera experts to be able to set all camera parameters correctly.

Vision Q.400 does not make all parameters of a camera accessible to a user, but only certain important functions like outputting a flash signal: The user does not need to know the parameters required for this function. If you do need to change other parameters of the camera, you can use an additional tool that is usually supplied by every camera manufacturer.

8.1.2.1 Standard "GigEVision"

The standard "GigE Vision" was published in 2006 by AIA (Advanced Imaging Association). It defines a set of communications protocols for industrial cameras which uses Gigabit Ethernet for transferring images. The aim of the standard was to establish a high degree of interoper-

ability between the products of different manufacturers, especially between cameras and software libraries.

With the help of the GigE Vision standard cameras can connect automatically to all important image-processing libraries without the need to develop or maintain special plug-ins or drivers.

The main advantage of GigE Vision compared to competing technologies are:

- easily available and well-known infrastructure
- supports the GenICam standard via plug and play
- sufficient bandwidth for most of the current camera designs
- cable lengths of up to 100 meters without additional hardware, extendable almost indefinitely with switches
- a practically unlimited number of cameras can be used in the system
- wide spectrum of network topologies for creating specific systems
- cost-effective and inexpensive due to standard hardware like network boards (instead of frame grabbers) and standard network cables

GigE Vision is a set of protocols that builds on UDP/IP and allows making use of the maximum capacity possible. The main components are:

- GVCP (GigE Vision Control Protocol) transfers the communication to control the camera, especially reading from and writing to the camera's registers.
- GVSP (GigE Vision Streaming Protocol) transfers the image data from the camera.
- Bootstrap registers: A set of obligatory registers for controlling the most important camera parameters. These registers serve to identify the camera and to establish a connection. Additional camera-specific registers are defined by the GenICam standard.

☞ ◆**NOTE**

For further information see www.gigevision.com.

8.1.2.2 Standard "GenICam"

The standard "GenICam" was published in 2006 by EMVA (European Machine Vision Association). The idea was to create a uniform API (Application Programming Interface) for the end users of cameras for industrial image processing. On the basis of the different transfer technologies the standard allows a simple integration of different components like cameras and image-processing software libraries.

GenICam does not depend on the technology of the communication layer (also called Transport Layer). Apart from GigE Vision, GenICam can also be implemented with USB, Camera Link, and other interfaces. GenICam consists of three main modules:

- GenApi,
- SFNC and
- GenTL.

GenApi

GenApi (short for GenICam Application Programming Interface) allows the description of the camera's full functionality within an XML configuration file which is usually saved directly in the camera, which makes automatic configuration even easier. By reading and interpreting the configuration file, a software library automatically gains access to the complete functionality of the camera.

SFNC

SFNC (short for Standard Features Naming Convention) is a kind of meta structure of GenApi and contains a convention for naming typical functions of image-processing cameras. SFNC defines a universal camera model which is implemented in most cameras that are available commercially. The model allows users and programmers to understand cameras conforming to the standard without studying the camera documentation in detail.

GenTL

GenTL (short for GenICam Transport Layer) describes the interface for capturing image sequences (or additional non-image data) independent of the technology of the transport layer and platform (operating system, programming language, etc.). GenTL identifies and integrates all connected devices (cameras), administers access for different applications, configures applications, and controls the image-capturing process.

☞ ◆**NOTE**

For further information see www.genicam.org.

8.2 Submenus

The submenus in the **Camera** menu will be described in the following sections.

8.2.1 Adding/Removing Cameras

The command **Camera → Add / Remove Camera(s)** opens a dialog box with all cameras known to Vision Q.400.

The dialog box will look differently depending on

- the hardware configuration you are using,
- the number of frame grabbers you are using, or
- whether you create a new application or add cameras to an existing application.

8.2.1.1 Camera Link cameras

If you are using a Camera Link (see page 201) frame grabber, you can choose different camera types for the connected cameras, and change the camera types later.

☞ ◆NOTE

- **The camera dialog box will vary, depending on the number of frame grabbers you are using.**
- **When you start Vision Q.400, the program checks the connected cameras, and displays only those cameras in the selection dialog box. If you change the configuration of the connected cameras, you must restart Vision Q.400 in order to display the new configuration in the camera dialog box.**
- **If the cameras that are connected to a frame grabber are not displayed in the dialog box, the Camera Link configuration (see page 201) for this frame grabber is not compatible with the Camera Link configuration of the supported camera types. In this case, please change the frame grabber's Camera Link configuration in accordance with that of the supported camera types, and restart Vision Q.400.**
- **When you are creating a new application, the first connected camera is preselected in the dialog box. If you want to close the dialog box without adding the preselected camera, choose the [Do Not Select] button.**
- **With existing applications you can add and remove cameras in one step.**

The procedure for creating new application and expanding existing applications is the same.

◆PROCEDURE

1. **Select one or more cameras by clicking the corresponding button**

The first known camera is already selected for you.

2. **From the "Camera Type" list box, select the camera type for the connected camera**

3. **Select the correct image format on the right**

4. **Click [OK]**

Number of image buffers

Enter here how many images Vision Q.400 should buffer before processing them. Buffering images is helpful when you work with an external camera trigger. This option allows you to realize pipelining. If you set the number of image buffers to 2, you can capture a new image while the last image is being processed. Or you can capture five images before you start processing the first one.

Vision Q.400 occupies an image buffer when image capturing is started and releases it as soon as the image buffered has been processed. The difference between captured images and already processes images is the number of free image buffers. The number of image buffers always applies to all cameras connected. The default is 1.

☞ ◆ **NOTE**

If an image capture is triggered, but there is no image buffer available, Vision Q.400 outputs an image capturing error. To avoid this error, use the PCReady signal for synchronization. The number of free image buffers is the difference between the number of images captured and the number of PCReady signals received.

8.2.1.2 GigE Vision Cameras

With **Camera → Add/Remove Camera(s)** you open a dialog box with two lists: On the left is the list of **accessible** cameras, which may contain any number of cameras. On the right is a list with twelve entries (a maximum of twelve cameras can be used in an application). Use drag & drop to add to the list the cameras to be used **in the application**. The position of a camera in the list represents the camera number of the camera within the application. If an entry in the list is empty, it means there is no camera with that number used in the application.

The following options are available:

Option	Procedure
Add camera(s) to the application	Drag & drop a camera from the list on the left to any position in the list on the right. As soon as a camera is used in the application, it will be grayed out in the left list. This means you can use each camera only once per application.
Change the camera number	Drag & drop the camera to a different position in the right list
Remove camera	Select camera and then select button [Remove]

☞ ◆**NOTE**

- **You can only use a camera in an application if you have assigned the camera an identifier that is unique within the application. If the identifier is not unique, a warning message appears and you need to change the identifier (see page 71) in order to be able to use the camera.**
- **When you create an application, the first camera from the list of accessible cameras is added at position 1 of the list of cameras used in the application.**

Description of the tables in the dialog box

Column title	Description
Number	The cameras are numbered consecutively in the order Vision Q.400 finds them. As this order depends on the current network properties, the number of each camera may differ from one program start to the next. That means that one and the same camera may have different numbers in consecutive program starts. To the left of the camera number you see a camera icon. Cameras that are not supported by Vision Q.400 by default are marked with an exclamation mark in a yellow circle. This icon indicates that there are restrictions for using these cameras in Vision Q.400 (see page 70).
IP address	**Note:** This column is not displayed in the simulation version. Contains the camera's IP address (see page 73) that can be provided by DHCP server or entered manually. Alternatively, you can assign an IP address with the option "Force camera into subnet".
Identifier	The camera identifier is necessary for unambiguous identification of a camera as it is not possible to identify GigE Vision cameras by their number or their IP address.
Type	Displays the camera type. You can change the camera type in the simulation version (see page 71).
Resolution	Displays the resolution of the camera. You can change the resolution in the simulation version (see page 71).

The procedure for creating new application and expanding existing applications is the same.

◆ PROCEDURE

1. **Drag & drop a camera from the list on the left to any position in the list on the right**

   As soon as a camera is used in the application, it will be grayed out in the left list. This means you can use each camera only once per application.

   The position of a camera in the list represents the camera number of the camera within the application.

8.2.1.3 Removing Cameras from an Application

You can remove cameras from an existing application at any time.

Analog and Camera Link cameras

With analog and Camera Link (see page 201) configurations, the procedure is the same:

◆ PROCEDURE

1. **Camera → Add / Remove**

2. **To remove one or more cameras, click on the corresponding button(s) identified by checkmark(s).**

   The cameras are then once again displayed without the checkmarks.

3. **Click [OK]**

   For each camera you have selected, Vision Q.400 asks you to confirm whether you want to remove it from the application.

4. **Choose [Yes] to confirm**

   If you confirm, the camera will be removed from the application.

GigE Vision Cameras

For GigE Vision cameras, please proceed as follows:

◆ PROCEDURE

1. **Camera → Add / Remove**

2. **Select camera and then select button [Remove]**

8.2.2 Properties

With **Camera → Properties…** you open a camera's property page.

Depending on the type of frame grabber, there are different property pages available for the camera:

	Frame grabber type	
Property page	**Camera Link**	**GigE Vision**
Camera (see page 211)	✓	✓
Camera settings (see page 213)	✓	✓
Advanced settings (see page 214)	✓	✓
Image format (see page 212)	✓	✓
Image processing (see page 216)	✓	✓
Frame Grabber (see page 218)	✓	
Camera Image (see page 219)	✓	✓

◆ NOTE

Ensure that the camera settings are compatible with the settings for Vision Q.400. For a list of potential errors involving hardware/software settings, please refer to Ensuring Hardware/Software Compatibility (see page 209).

8.2.2.1 Ensuring Hardware/Software Compatibility

◆ NOTE

- **The hardware settings on your camera and the software settings in Vision Q.400 must be in agreement.**
- **The following tables list potential malfunctions that can be caused by incorrect hardware/software settings. Depending on the camera interface (Camera Link (see page 201) or GigE Vision), different modifications need to be done.**

Possible causes of Camera Link cameras malfunctioning

Event	Hardware / Camera setting	Software setting
Unsynchronized image		Selected camera resolution is not consistent with the camera setting.
		Camera type set in the software is not the same as the camera type connected.
Timeout during image capture		Camera type set in the software is not the same as the camera type connected.
		The "Timeout" value on the property page "Camera Settings" (see page 201) is too short.
No flash signal available		The option "Send Flash Signal" on the property page "Frame Grabber" (see page 218) has not been activated.
Vision Q.400 does not recognize the camera at startup	The camera is not connected properly.	
The camera image is black	The camera is not connected properly.	The shutter speed is too short. Change the shutter speed setting on the property page "Camera Settings" (see page 201).
		The camera aperture is closed.

Possible causes of GigE Vision cameras malfunctioning

Event	Hardware / Camera setting	Software setting
Timeout during image capture		The "Timeout" value on the property page "Camera Settings" (see page 201) is too short.
No flash signal available	The flash signal cable is not connected correctly to the camera.	
Vision Q.400 does not recognize the camera at startup	The camera is not connected properly.	
The camera image is black	The camera is not connected properly. The camera aperture is closed.	The shutter speed is too short. Change the shutter speed setting on the property page "Shutter Speed".
Camera delivers disturbed images	• The settings of the network board and possible of other network components connected to the camera (e.g. switches), do not follow the recommendations given in the document "GigE_Hints". Please note that the value for "Max Camera Packet Size" from the property page "Advanced Settings" is calculated from the settings. The value should not be smaller than 9000 (Byte). • Switches and/or cables do not conform to the recommendations in the document "GigE_Hints" .	Make sure that the values for "Interpacket Delay" and "Transmission Delay" displayed under "Transport Layer" on the property page "Advanced Settings" conform to the recommendations in the document "GigE_Hints".

8.2.2.2 Camera

The property page "Camera" displays information about the currently selected camera.

Option	Valid for	Description
Type	all camera types	Displays the camera type you have selected.
Image size in pixels		Displays the camera image size in pixels (width x height).
Cable type required		Displays the type of cable required for the selected camera type.
Mode		Displays the camera's current grabbing mode.
Camera Link information	Camera Link only	Displays the current Camera Link configuration.
Identifier	GigE Vision only	Identifier of the camera (see page 71)
IP address		IP address of the camera (see page 73)
Subnet mask		Subnet mask of the camera (see page 73)
Network connection		Name of the network connection where the camera is connected.
Write parameters to file		Use the button [Write Parameters to File] to save the parameters of a GigE Vision camera in a file. There are two file formats available: • TXT file with the current parameter values and permissible value ranges • XML file with a description of the camera parameters as it is stored in the camera
Generate camera description		This button only appears in the full version of Vision Q.400 for GigE Vision cameras that are not supported by default. In order for Vision Q.400 to be able to use such cameras in the simulation version of Vision Q.400, you need a description file containing the most important properties of the camera, for example its name and the size of its images. When you select the button [Generate camera description], the description file "FgalCameras_SimulGigE.ini" with the required camera properties will be created in the installation folder of the full version of Vision Q.400. If the file already exists, a backup copy of the file will be saved under "FgalCameras_SimulGigE.ini.bck". Then the new entries will be appended to the existing file. To use the camera in the simulation version of Vision Q.400, you need to copy the file "FgalCameras_SimulGigE.ini" to the installation folder of the simulation version.

Image transformation

Use the drop-down list "Image Transformation" to select if and how the camera image is to be transformed after capture. Please note that transforming the image takes up processing time. How long it takes to transform the image depends on the size of the image captured. Transforming the image prolongs the total image capturing time.

The following image transformations are available:

Type of image transformation	Description
None	The image is not transformed after capturing, i.e. it remains unchanged.
Rotate 180°	The image is rotated by 180° Grad after capturing.

Type of image transformation	Description
Mirror vertically	The image is mirrored along the vertical axis after capturing.
Mirror horizontally	The image is mirrored along the horizontal axis after capturing.

If you have activated partial scan mode on the camera property page "Image Format", the following applies:

- The image transformation has no effect on the **position** of the selected image area of the camera, i.e. the image area is always the same.
- When you have activated "Apply image transformation only to the partial scan area", Vision Q.400 will cut the partial scan area out of the complete camera image first before applying the image transformation. If the option is not activated, image transformation is executed first over the whole camera image and then the partial scan area will be cut out.

☞ ◆**NOTE**

- **In the simulation version of Vision Q.400 all image transformation settings will be ignored when you first start Vision Q.400, i.e. camera images are not transformed. Select "Execute image transformation" to execution image transformation also in the simulation version. The option remains activated until you restart Vision Q.400. That means that after a restart Vision Q.400 ignores the image transformation settings again.**
- **Please note that the image transformation settings are global Vision Q.400 settings and always apply to all applications.**
- **If you load an application that contains different image transformation settings than those saved for a camera, you will receive a warning message. Vision Q.400 always uses the camera's currently selected image transformation settings.**

8.2.2.3 Image Format

On the property page "Image format", both "Full frame mode" and "Partial scan mode" are available.

Grab mode	Description
Full image mode	The image comprises the maximal view range of the camera (default setting).
Partial scan mode	The image comprises only a section of the camera's field of view. The camera transfers only the specified number of lines to the image memory. The partial scan is performed in the camera and determines the volume of the image file that is to be transferred to the frame grabber.

Camera Link and GigE Vision cameras use different "Partial Scan Settings". Follow the procedure for your camera configuration.

Camera Link

To set the image capture mode, please proceed as follows:

◆ PROCEDURE

1. **Select mode**

   Full image: mode: The entire image area is transmitted.

   Partial scan mode: Only one or two sections of the field of view – that is, only the specified image rows – are transmitted.

2. **Defining the number of image areas**

   With the option "One area mode" or "Two areas mode" you can define the limits of a partial scan in terms of either one or two image areas.

   If you are using two image areas the following restrictions apply:

   - The areas must not overlap.

   - The coordinates of the two areas – that is, the respective pairs of start and end rows – must be in ascending order.

3. **Defining image areas**

   A partial scan consists of complete image rows. Every area is defined by a start and an end row. Start and end columns cannot be defined.

GigE Vision

For GigE Vision cameras, you can only set **one** image area, and the values for width and height need to be dividable by 4.

To set the image capture mode, please proceed as follows:

◆ PROCEDURE

1. **Select mode**

   Full image: mode: The entire image area is transmitted.

   Partial scan mode: Only one section of the image,   i.e. only the specified image rows and columns, are transmitted. The section is defined by its upper left corner and its width and height.

2. **Enter start coordinates of the image area**

3. **Enter width and height of the image area**

   The values for width and height need to be dividable by 4, or an error message will be displayed.

8.2.2.4 Camera settings

The "Camera Settings" property page displays the settings options for the currently selected camera type.

Option	Description
Shutter speed	Sets the shutter speed for the camera.
Timeout	To **limit** the image acquisition time, choose "Timeout" and enter the time limit (in seconds) in the input field at the right. When the timeout has been exceeded, the image capture is canceled. The following warning appears: "A timeout has occurred during image acquisition."
Infinite Wait	To enable **unlimited** image acquisition time, choose "Infinite Wait". Image acquisition will continue until you have chosen [Cancel Grab].
Send flash signal	When this option "Send flash signal" is activated (default setting = OFF), Vision Q.400 sends a signal to the connected flash. You can set a delay for the camera or for the flash, if required, under "Camera Flash Delay".

Camera flash delay

The following settings are available:

Option	Setting	Explanation
Delay mode	No delay	Flash signal is sent with no delay.
	Camera with delay function	Camera shutter is triggered after a delay.
	Flash is delayed	Flash signal is sent with a delay.
Delay time (µs)	<Number>	Enter the delay in µs.

☞ ◆**NOTE**

> **For GigE Vision cameras, the flash signal can usually only be output for cameras that are supported by Vision Q.400 by default (see page 202).**

8.2.2.5 Advanced Settings

Depending on whether you are using Camera Link or GigE Vision cameras, the "Advanced settings" page contains different parameters.

Camera Link

The following parameters are available:

Parameter	Setting	Explanation
Image trigger	Internal trigger	**Vision Q.400** triggers the image capture for all connected cameras.
	External trigger	The **frame grabber** triggers the image capture for all connected cameras. **Note:** Please contact our technical support to find out whether this option is available for your application.
	Input 0 – 7	Only visible, when "Trigger Source" has been set to "External Trigger". Number of the input that will be used for sending the external trigger signal to the frame grabber.
	High/Low	Set whether the flash signal from the frame grabber should be active at "High" or "Low".

GigE Vision

The following parameters are available:

Parameter	Setting	Explanation
Trigger source	Software trigger	**Vision Q.400** triggers the image capture of the camera.
	External trigger	The **camera itself** triggers the image-grabbing.
External trigger active	Rising edge	Image capture will be triggered by a **rising edge**.
	Falling edge	Image capture will be triggered by a **falling edge**.
Flash polarity	High/Low	Set whether the flash signal output by the camera is active when "High" or "Low".
Parameters under "Transport Layer" (see notes)		
Max. camera packet size Byte]	Cannot be edited	Determines the size of image data packets that the camera sends to Vision Q.400. Vision Q.400 sets the highest possible value internally. The value cannot be edited. For further information see the document "GigE_Issues.pdf".
Interpacket delay [Byte]	<Number>	Time that elapses between two packets of image data sent by the camera. The delay is output in byte. One byte corresponds to 8 nanoseconds. The recommended value is calculated by the following formula: ((Max. camera packet size + 12) * (Number of cameras per network connection - 1)) + 12. For further information see the document "GigE_Issues.pdf".
Transmission delay [ms]	<Number>	During image capture, the camera usually sends the first image data packet as soon as possible to Vision Q.400. If the "Transmission delay" is bigger than 0, the sending of the first image data packet to Vision Q.400 will be delayed by this time. If several cameras share one network connection, you can use the parameter "Transmission delay" to schedule the data transmission from each camera to Vision Q.400. For further information see the document "GigE_Issues.pdf".
Heartbeat Timeout [ms]	<Number>	Rate in which the connected camera checks whether Vision Q.400 still answers its requests. If Vision Q.400 does not respond, the camera terminates the connection with Vision Q.400. The camera cannot be accessed by Vision Q.400 anymore. If Vision Q.400 tries to communicate with the camera, the error message "device lost" is returned. In this case, you need to close and restart Vision Q.400.

◆**NOTE**

- **For GigE Vision cameras, the advanced settings are usually only available for cameras that are supported by Vision Q.400 by default (see page 202).**
- **In the simulation version, the parameters under "Transport Layer" are write-protected and cannot be changed. When you create an application with the simulation version, all parameters under "Transport Layer" will be set to the default values and the parameter "Max. Camera Packet Size" will be set to the smallest possible value (576).**
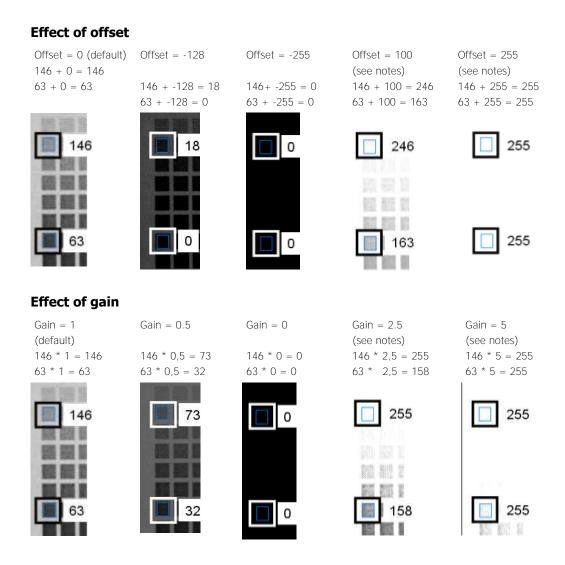
8.2.2.6 Image Processing

With Camera Link and GigE Vision cameras, you can perform basic image preprocessing **on the frame grabber** under **Cameras → Properties → Image Processing**. The property page "Image processing" differs depending on the camera type.

Camera Link

The following options are available:
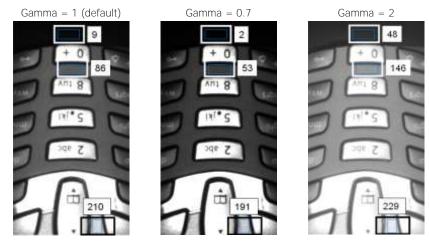
Option	Description	Permissible value range
Offset	Adds a value to each pixel. Regulates image brightness.	-255 – 255
Gain	Multiplies every pixel with a multiplication coefficient. Regulates image contrast.	0 – 20
Gamma	Gamma correction: • Gamma =1: All pixels remain unchanged • Gamma <1: Darker pixels are dampened more strongly than lighter ones. • Gamma >1: Darker pixels are amplified more strongly than lighter ones.	0 – 10
Invert gray values	Inversion of black and white as well as the gray values in between.	-
Reset to default values	Offset, gain, gamma, and gray-value inversion are reset to their default values.	-

Effect of offset

Offset = 0 (default)
146 + 0 = 146
63 + 0 = 63

Offset = -128

146 + -128 = 18
63 + -128 = 0

Offset = -255

146+ -255 = 0
63 + -255 = 0

Offset = 100
(see notes)
146 + 100 = 246
63 + 100 = 163

Offset = 255
(see notes)
146 + 255 = 255
63 + 255 = 255

Effect of gain

Gain = 1
(default)
146 * 1 = 146
63 * 1 = 63

Gain = 0.5

146 * 0,5 = 73
63 * 0,5 = 32

Gain = 0

146 * 0 = 0
63 * 0 = 0

Gain = 2.5
(see notes)
146 * 2,5 = 255
63 *   2,5 = 158

Gain = 5
(see notes)
146 * 5 = 255
63 * 5 = 255

Effect of gamma

Gamma = 1 (default)	Gamma = 0.7	Gamma = 2

NOTE

- **The gray value range is from 0 to 255. When the value exceeds 255, saturation is reached.**
- **As the image processing algorithms described above are executed on the frame grabber, the results may differ in the simulation version.**

GigE Vision

The following options are available:

Option	Description	Effect
Black level	The black level (or offset) depends on the camera type and is output in 100 levels. The black level allows to add a relative value to the gray value each pixel originally had.	With cameras supported by Vision Q.400 by default, the original gray value will not be changed when the black level is 0. With a black level of 100, 16 gray value levels will be added.
Gain	Multiplies every pixel with a multiplication coefficient.	With cameras supported by Vision Q.400 by default, the amplification can be entered in levels from 0 to 20DB. This means that the amplification is not linear.

8.2.2.7 Frame Grabber

The property page "Frame Grabber" displays information about the frame grabber. It is only available if you use Camera Link cameras.

Type

The system detects the frame grabber type automatically and displays the appropriate type.

Grab mode

Shows which grab mode has been selected for the current application.

Grab mode	Explanation
Single	The application is using only **one camera**.
Parallel	The application is using more than one camera.

Cameras used

Shows which cameras are used in the application.

8.2.2.8 Camera Image

The "Camera Image" property page is only visible in the simulation version. Here you can select a file which will be used as the camera image.

Image of current application

In the Vision Q.400 simulation version you can select a file for each camera in an application, to be used as the image. The name of the file will be saved with the application, but not the file itself. This allows you to use different images for the same camera in different applications.

☞ ◆**NOTE**

Use relative path names if you also want to run the application on a different computer. For the "Image of Current Application" field a relative path name is initially relative to the folder in which the application is saved. Refer to the example to find out in which order the folders are being searched. The absolute path name currently being used is displayed as a tool tip.

✌ ◆**EXAMPLE**

Application location: C:\Program Files\QVITEC\Applications
Location of Vision Q.400 simulation version: C:\Program Files\QVITEC\Vision Q.400 Demo <Q.400_VersionNumber>

The entry "memorychip1.bmp" in the field "Image of current application" means that the file "memorychip1.bmp" will be searched in this order in the following folders:

1. C:\Program Files\QVITEC\Applications

2. C:\Program Files\QVITEC\Applications\Images

3. C:\Program Files\QVITEC\Vision Q.400 Demo <Q.400_VersionNumber>

4. C:\Program Files\QVITEC\Vision Q.400 Demo <Q.400_VersionNumber>\Images

5. Current work folder

If the file exists in several of these folders, the file from the first folder that it is found in will be used.

As well as the method of selecting a file by the browse function with 📂, you can also drag & drop a file from the Explorer into the camera window. If you press <Shift> at the same time, the file from the Explorer is saved as the camera image for the current application.

Click on the ✖ button to delete the entry under "Image of Current Application". The associated file is not deleted. If you have not selected a file - meaning the input box is empty - the file you selected under "Vision Q.400 Default Camera Image" is used as the camera image.

Vision Q.400 default camera image

Here you can select a file, which will be used as the predefined default camera image. The predefined image of a camera applies to all applications, and is used whenever no file is selected under "Image of Current Application" or the selected file does not exist. Here, too, you can use relative path names.

☞ ◆**NOTE**

As opposed to the relative path names under "Image of Current Application", relative path names here are only interpreted relative to the installation folder of your Vision Q.400 simulation version, to the subfolder "Images" of this folder or to the current work folder.

The absolute path name currently being used is displayed as a tool tip.

As well as the method of selecting a file by the browse function with 📂, you can also drag & drop a file from the Explorer into the camera window. If you press <Ctrl> at the same time, the file from the Explorer will be entered here as the predefined default Vision Q.400 camera image.

Get Vision Q.400 default camera image

If you click on this button, the file entered under "Vision Q.400 Default Camera Image" is applied as the image for the current application, meaning it is entered under "Image of Current Application".

Get image of current application

If you click on this button, the file entered under "Image of Current Application" is applied as the predefined image for all applications of Vision Q.400, meaning it is entered under "Vision Q.400 Default Camera Image". In this, please note that for the camera image of the current application relative path names are always relative to the installation folder of your Vision Q.400 simulation version. That means that you can only import an image with a relative path name from "Image of Current Application" if the file to which it links is also in the installation folder of your Vision Q.400 simulation version.

☞ ◆**NOTE**

- **When you select a new file, the new image is only displayed after the next grab image command (press <F7> to grab and process an image or <F5> to execute the application). Note that for files which have not been created by Vision Q.400 certain restrictions (see page 221) apply.**

- **If a file name is entered under "Image of Current Application" and the file exists, it is used; otherwise the file entered under "Vision Q.400 Default Camera Image" is used.**

- **If no file name is entered under "Image of Current Application", the file entered under "Vision Q.400 Default Camera Image" is used.**

- **If the file under "Vision Q.400 Default Camera Image" does not exist, a black image is output labeled "Error".**

- **Please note that the file name entered under "Vision Q.400 Default Camera Image" is not stored in the application, but is computer-specific. So if you run an application on a different computer than the one on which you created it, and you have not defined a camera-specific image under "Image of Current Application", the image specified on the execution computer under "Vision Q.400 Default Camera Image" is used for the camera.**

8.2.3   Grab Image + Execute

With **Camera → Grab Image + Execute**   or by selecting 🔲 you grab a new image with the camera and execute all checkers which have been assigned to the image.

👉 ◆**NOTE**

When you select Camera → Grab Image + Execute**, the loaded image will be replaced by the current image, unless the function "Lock Grabbing" (see page 52) has been activated.**

8.2.4   Process Loaded Image

With **Camera → Process Loaded Image** or by clicking 🔲 you test all defined checkers on an image loaded (see page 221) from a storage device or your hard disk.

This gives you the opportunity for a test run of the checkers on a predefined image.

8.2.5   Load Image

With **Camera → Load Image** you can load an image which has been saved by Vision Q.400 in bitmap format (.BMP) without overlay (see page 223). Images in the following formats can also be loaded: .PNG, .TIFF, .JPG.

This way you have an opportunity to test checkers on a test image rather than a live image or just to display the image on the screen. If you have saved a description with the image (see page 222), it will be displayed together with the image. This option only exists for images in bitmap format.

If the image you wish to load is bigger than the image format of the currently active camera type, the areas beyond the valid image size will be cut. If the image is smaller, the areas which are not covered by the loaded image are filled with black.

You can also load an image with drag & drop: Select the bitmap file in the Windows Explorer, drag it to Vision Q.400 and drop it in the camera window. If you work with the demo version and press <Ctrl> when you drop the image, the dragged image will be saved as the prede-fined camera image (see page 211) for this camera. This is the same option as "Get image of current application" on the property page "Camera Image" (**Camera → Properties...**).

☞ ◆ NOTE

- **To load a bitmap image, you need to switch the display to memory image with** View → Image → Memory**. You cannot load an image in live mode.**

- **Loading an image will activate lock grabbing (i.e. the function usually executed by clicking ⬚). This way the loaded image will not be over-written by the new camera image. However, lock grabbing will not be activated when you drag & drop a bitmap from the Windows Explorer.**

- **When you wish to use a bitmap which has not been created by Vision Q.400, make sure that it uses a color table which maps the pixel values 0...255 to the RGB colors (0,0,0)...(255,255,255). For more information on bitmaps, please see http://msdn.microsoft.com/library/default.asp?url=/library/en-us/gdi /bitmaps_85ke.asp.**

- **Note that file formats such as .PNG or .JPG contain compressed image data which may produce unexpected results during analysis.**

8.2.6 Save image

With **Camera → Save Image** or by clicking ⬚ you can save the current camera image shown on screen in .BMP, .JPG, .PNG or .TIF format. You can save an image description along with the image in bitmap format.

Enter description of the image to be saved

> 👉 ◆‾NOTE ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾
>
> - **If you press the left <Shift> button when you select "Save image", the dialog for entering a comment will not be displayed.**
> - **In the dialog box "Save image as", check whether the field "File name" contains a file extension. If the field contains the extension ".bmp", but you have selected "JPG/JPEG files (*.jpg, *.jpeg)" under "File type", the corresponding file extension will be appended, e.g. "Image0.bmp.jpg".**

8.2.7 Save Image with Overlay

Use the command **Camera → Save Image with Overlay...** to save the current image on the monitor including all the checker shapes, indicators, and results displayed. The following file formats are available: .BMP and .JPG.

> 👉 ◆‾NOTE ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾
>
> - **The saved image can be used for documentation purposes. However, images with overlay cannot be loaded and displayed in Vision Q.400.**
> - **Check whether the field "File name" contains a file extension. If the field contains the extension ".bmp", but you have selected "JPG/JPEG files (*.jpg, *.jpeg)" under "File type", the corresponding file extension will be appended, e.g. "Overlay_Image0.bmp.jpg".**

8.2.8 Description

This option displays the image description of a bitmap image. It is only active when you have loaded a bitmap image that has a description.

8.2.9 Slice Level

This function is only available for black-and-white cameras.

With **Camera → Slice Level** or by clicking 🔲 you set static slice levels for transforming the gray-value image in the camera memory into a binary image.

On the screen display, all pixels lying in between the upper and lower threshold are marked in the color (see page 55) selected for camera slice level.

The camera slice level set here will be available to all checkers of a camera needing binarization slice levels. Use the property page "Algorithm" of a checker to define whether you would like to use the camera slice level set here   as the static slice level for the checker or a checker-specific (see page 236) slice level.

There are two possibilities to set the camera slice level:

- Manually by clicking and moving the slider's triangles
- Automatically via the button [Automatic]

8.2.10 White Balance

The white balance function helps to sensitize the camera to the color temperature of the light where the image capturing takes place. As the white balance function is executed during the image capture, all checkers of the selected camera will work on the balanced image.

The white balance function works as follows: First select an image area that is a neutral gray. For teaching the white balance, the mean gray value of all pixels in this image area will be calculated. Afterwards, the factors for each of the color channels red, green, and blue will be calculated that will map the mean gray value to the target gray value. When the white balance is applied, Vision Q.400 recalculates the captured camera image with the calculated factors to obtain a balanced image.

See here (see page 279) for information on how to perform white balance.

8.2.11 Replace Type

Use this option if you wish to replace the camera type used in your application. Depending on the camera interface, the dialog box looks differently.

- For Camera Link cameras, use the drop-down list box with the model numbers or the resolution to select a different camera type to replace the current type.

- For GigE Vision cameras, drag the new camera type from the left side ("Accessible cameras") to the right side ("Selected Cameras") into the line with the current camera type.

When you select this option, Vision Q.400 displays a warning message with items you need to check before changing the camera type.

- Check the camera settings (see page 211).

- Check whether the checkers can stay at the positions where you set them for the old camera types and modify their size and/or position, if necessary.

When you select "Yes" to change the camera type, Vision Q.400 proceeds as follows:

1. Vision Q.400 automatically saves the original application under a new name. The layout of the file name is as follows: <original name>_BCR.nav

2. Vision Q.400 displays a dialog box in which you select the new camera type and confirm with [OK].

3. Vision Q.400 replaces the old camera types with the new ones.

4. Vision Q.400 saves the application under the original name. Now the new camera types are supported.

5. Vision Q.400 is closed automatically

Start the program again.

☞ ◆NOTE ——————————————————————

It is possible to change the camera type in the dialog "'Add/Remove camera(s)".

8.2.12 Delete Frozen Images

With this command you delete NG images from the image memory, when the action (see page 520) has been triggered on the Spreadsheet. The Action enables you to hold NG images in run mode on screen, such as when specific errors occur or a specific number of errors has been reached for example. On switching from run to setup mode you can save the displayed NG image. When you then switch back to run mode, the first or last NG image is displayed, depending on the setting.

☞ ◆NOTE ——————————————————————

This command is also available by way of the pop-up menu in the image.

8.2.13 Cancel Grab

With **Camera** → **Cancel Grab** you can cancel an image capture that has already been started.

☞ ◆NOTE ——————————————————————

It is not possible to cancel grabbing for analog cameras.

Chapter 9

Checkers

9.1 What is a Checker?

Checkers are flexible image processing tools that group several image processing algorithms together and execute them. They either
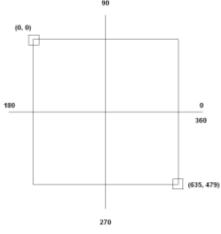
- work directly on an image area or
- Deduce results from the findings of other checker results.

One checker that works directly on an image area is the feature extraction checker. It calculates certain object features in an image, such as the object's size, etc.

The second type of checkers to work with the results of other checkers, are the position and rotation adjustment checkers and the geometry checkers. Position and rotation adjustment checkers are used to reposition an image area which is being worked on by a checker based on the results of another checker (see page 282). A geometry checker calculates, for example, the distance between two points calculated by another checker.

The unit for checker results concerning point coordinates, length, distance, or area size are all in **pixels**. All checker results concerning angles use **degrees** as a unit.

The following system of coordinates applies for all coordinates and angles in Vision Q.400:

System of coordinates in Vision Q.400

9.1.1 Available Checker Types and Usage

This section contains an overview of the available checkers and their typical usage.

Object Shape (OS)		
Algorithm	Interlinking of the result objects of different checkers to form an inspection area	Morphological filter Object filters Quantity operations
Usage	Calculation of the inspection area for objects with complex or variable contours	
Example	Combination of various located objects to form a checker shape.	

Window (WI)		
Algorithm	Binary, pixel-counting	Gray-value filter Morphological filter Object filters
Usage	Presence check Area calculation Surface inspection	
Example	Holes present = OK Surface = OK	

Edge Detection Binary (ED_B)		
Algorithm	Binary (with pixel accuracy)	Gray-value filter Morphological filter Object filters
Usage	Fast measurement of length/distance Fast angle measurement	
Example	Width of groove = OK	
	Slots cut properly = OK	

Edge Detection Gray Value (ED_G)		
Algorithm	Gray Value (accurate to sub-pixel level, based on the Sobel filter)	Noise reduction Smoothing size Direction-sensitive
Usage	Measurement of length/distance Angle measurement Coplanarity check Surface inspection Fractured edges	
Example	Distances/orientation and coplanarity of the plug pins = OK	
	Scratches in the surface, fractured edges = NG	

Edge Detection Gray Value Projection (ED_GP)		
Algorithm	Gray Value (accurate to sub-pixel level, based on gray value projection)	Noise reduction Smoothing size Direction-sensitive
Usage	Very fast measurement of length/distance of edges and edge pairs	
Example	Distances/orientation of the plug pins = OK	
	Edge measurement within a ring segment	

Difference (DI)		
Algorithm	Image pattern subtraction Pattern matching (with subpixel accuracy) Gray-value differential Binary object detection	Morphological filter Object filters Sorting
Usage	Print check Punch check Quality check of injection-molded parts (completeness, ridges)	
Example	Print = NG	
	Ridge near the gate mark	

Feature Extraction (FE)		
Algorithm	Binary	Gray-value filter Morphological filter Object filters Sorting
Usage	Object count Position check Roundness check Presence check Thickness check	
Example	Bending radius and center position = OK	
	Checking minimal and maximal thickness of joint ring = NG	
	Check position (angle, X- and Y-coordinate) of 9 objects	
	Checking white squares in a dark grid	

Contour Matching (CM)

Algorithm	Contour-based pattern matching	
Usage	Presence check Counting of objects Very stable position and orientation recognition	
Example	Position and rotation detection when - object sizes vary - the illumination is likely to change	
	objects can be hidden or covered partially	

Cross Correlation Matching (CCM)

Algorithm	Correlation-based pattern matching	
Usage	Presence check Counting of objects Very stable position and orientation recognition	
Example	Position and rotation detection when - Objects which vary in shape and texture - Objects in fuzzy images (contours get blurred in fuzzy images) - the illumination is likely to change	

Optical Character Recognition (OCR)		
Algorithm	Segmentation by binary and size data Classifier, gray-value and binary proper-ties	Gray-value filter Morphological filter Object filters Sorting
Usage	Read and verify: • Plain writing • Laser print Object recognition	
Example	Laser print on a box = OK	
	Read ID code of an IC Distinguish labels	

Code Reader (CR)		
Algorithm	Detect and read 1D and 2D codes	
Usage	Reading labels or codes to identify parts	
Example	Read data matrix code ECC200 or bar code Code 39	

Geometry Checker (G_PP, G_PL, G_LL)		
Algorithm	Geometrical calculation of: • Point-to-point distance • Point-to-line distance • Intersection of two lines • Angle between two lines	
Usage	Measure punched parts Measure modules and components	
Example	Measure tooth flanks	

Indicator		
Usage	Presentation of inspection results: • Display of check values • Display of lines, rectangles, ellipses, circles,… • Display of bitmaps • Display of judgment results	

9.1.2   Gray-Value and Binary Checker

With checkers that work directly on the image, we distinguish between color, gray-value, and binary checkers.

- Color checkers work on the original color image.
- For a black-and-white image, gray-value checkers use the original gray-value image, for a color image they use one of the color channels of the color image.
- Binary checkers need a binary image, so a black-and-white image is derived from the gray-value image. With color images, the binary image is derived from a color channel of the color image or from the color image directly.

The image area worked on is called the shape. All checker operations (except for certain settings of the difference checker, the cross-relation matching, and the contour matching checker) are executed exclusively within the range of the shape and do not extend to the overall input image. This results in significant gains in the processing speed.

To derive a binary image for a binary checker from the original image, Vision Q.400 uses binarisation slice levels for black-and-white and color images. Use either a **global threshold**

(see page 223) by clicking on ☁ or a customized, **checker-specific** threshold for individual checkers. Customized means that the slice level is valid only for the checker on whose property page you define it. You can select either a static or a dynamic slice level.

The **global** slice level is only available for black-and-white cameras and applies to all binary checkers in the sequences for the selected black-and-white camera with the exception of

those checkers for which you have set a checker-specific slice level. To derive a binary image for a binary checker directly from a color image, Vision Q.400 uses the checker-specific color selection.

9.1.3 Template

On this page, you may enter templates (image sections) needed as a reference for checkers.

9.1.4 Checker-Specific Slice Levels

This function is always available for black-and-white cameras. For color cameras, the function is only available when you have selected a color channel as the image source on the property page "Image Source". You can choose whether you want to use a **static** or **dynamic** slice level for the checker.

Both for static and dynamic slice levels, the screen display shows all pixels lying in between the upper and lower threshold in the color selected for the checker's slice level. You can set the color for the slice level either under **Application → Display Colors** in the column "Slice Level" for the corresponding checker-type or you make a checker-specific setting on the property page "Display Colors" (see page 261).

Image areas within the binarisation thresholds are called "Selected" or "Object" in the checker description. Pixels found beyond the threshold are called "Not Selected".
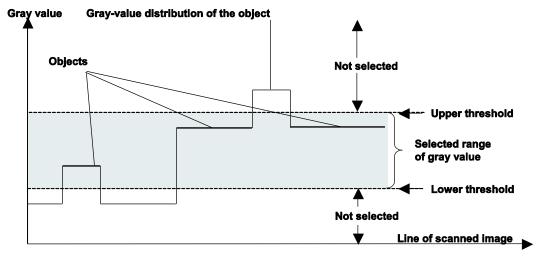
☞ ◆NOTE

- **If a checker depends on a position and rotation adjustment, the customized slice level applies to the adjusted shape. If you want the slice level to apply to the original shape, you need to delete the dependency of the position and rotation adjustment before setting the customized slice level. After determining the slice level, re-create the dependency relationship.**
- **If a checker depends on an exposure adjustment, this is taken into account when you set a customized slice level.**

Static slice levels
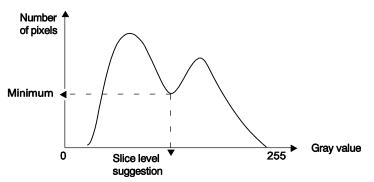
If you are using static slice levels, you can select for white-and-black cameras whether you would like to use the checker-specific slice level on the property page "Algorithm" of the checker or the camera slice level set under **Camera → Slice Level** in both cases the slice levels selected can be adapted to changing light conditions with an exposure adjustment checker.

With static thresholding, all the image areas whose values are within the range of the binary thresholds are marked in the gray-value image. These areas are called **objects**

Static slice levels

You can set the slice levels for binarisation either with the help of the slider or let Vision Q.400 calculate the values automatically. This is done with the help of the gray-value histogram and the position of the minima in this histogram. Please note that the calculated values are only a suggestion to help you set the slice level. They will not be recalculated when you execute the checker.
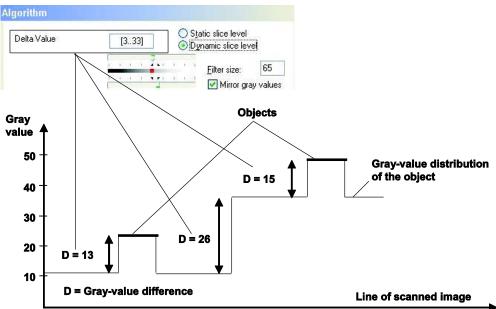
Custom slice level - automatic calculation

Dynamic thresholding

With dynamic slice levels, the slice levels are always checker-specific, i.e. there are no camera slice levels available. It is **not** possible to adapt the slice levels selected to changing light conditions with an exposure adjustment checker.

With dynamic slice levels, the average gray value is calculated in the environment of the pixel. The environment is defined by the filter size. The dynamic slice level value refers to the difference between the gray value of the current pixel and the mean value of the surrounding pixels within the filter area. The image areas in the gray-value image whose difference (the delta value) falls within the pre-set range, are then marked. These areas are called objects, too. Whereas a static slice level searches for pixels lying in a certain range of gray values, a

dynamic slice level searches for a certain difference in the gray values compared to the environment.

Dynamic thresholding

Apart from the two slice levels the dynamic thresholding needs to additional parameters.
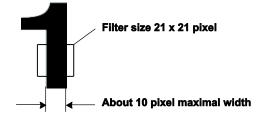
- Filter size
- Mirror gray values

Filter size

The "Filter Size" is set to 65x65 by default, but only one axis is displayed on the screen. The filter should be at least twice as big as the maximal size of the target object is on the X-axis and Y-axis.

◆EXAMPLE

If the figure is about 10 pixels wide, the filter width should be at least 21 pixels wide.

👉 ◆**NOTE** ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━

- **Use the mouse to measure the size of an object. Simply position the cursor on the beginning and the end of the object and subtract the co-ordinates displayed in the status bar from each other.**
- **Use the mouse to determine the gray value of a pixel. Simply position the cursor on the pixel, and the gray value is displayed in the bottom right corner of the status bar.**
- **The way objects are generated depends not only on the slice level setting. Filters also influence object generation.**

Mirror gray values
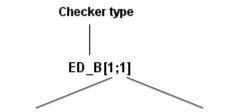
To calculate the dynamic slice level it is necessary to smooth the image. To calculate the smoothing on the margins of the checker shape, gray values outside of the checker shape are also used. Normally in smoothing, the gray values of the image are simply applied at this point for calculation purposes. This can produce unforeseeable effects however, especially at the image edge or in images with strong contrasts. That is why there is the possibility to mirror the gray values inside the checker shape for smoothing of the image edge to the outside.

9.1.5 Checker Label

For ready identification, each checker has been assigned an exclusive label that is used throughout Vision Q.400. The user cannot change this checker label. It is made up of:

- Checker type,
- Camera number, and
- Checker number

The serial number always relates to the checker type. Camera numbers and checker numbers are counted from one (1), meaning the first checker of each type is assigned the number 1. An example is the first checker for binary edge detection which is configured for camera number 1. The following label is generated for this checker:

Checker type
│
ED_B[1;1]

Camera number   Checker number

Explanation of checker label

Element type	Name	Abbreviation	Icon
Checker	Exposure adjustment	EA	☀️
	Position adjustment	PA	🔄
	Position and rotation adjustment line-point	PRA_LP	

Element type	Name	Abbreviation	Icon
	Position and rotation adjustment angle-point	PRA_AP	
	Position and rotation adjustment two points	PRA_2P	
	Position and rotation adjustment three points	PRA_3P	
	Window checker	WI	
	Feature extraction	FE	
	Edge detection binary	ED_B	
	Edge detection gray value	ED_G	
	Difference checker	DI	
	Contour matching	CM	
	Optical character recognition	OCR	
	Code reader	CR	
	Geometry point-line	G_PL	
	Geometry point-point	G_PP	
	Geometry line-line	G_LL	
Object shape	Object shape	OS	
Indicator	Indicator	IN	

9.1.6 Property Sheet

The checker properties are defined in the so-called property page. It is made up of the following pages:

- General
- Algorithm
- Image filters
- Object filters
- Shape
- Dependencies
- Judgment
- Result
- Adjustment

- Adjustment width
- Template
- Parameters
- Customize
- Character separation
- Model
- Model parameters
- Template area
- Code Model Parameter

- Visibility

- **Image source** (only for checkers working on color images)

- **Color selection** (only for checkers working on color images)

- Display colors

However, not every one of these pages is available for every checker. The "Template" page, for example, is available for the difference checker only.

The sections below describe which properties specifically may be entered on which page. You will also learn about the dialog elements and parameters common to many checkers.

9.1.6.1 Icons

When you open a checker's property page, the following icons appear at the top of the property page window:

⊡	Stay visible	✂	Cut selection
⊡	Make transparent	▤	Copy selection
▨	Apply	▣	Paste selection
▥	Execute checker		

The icon ⊡ is always active by default when you open the property page. It allows you to open a second property page if you wish to transfer the results from a different checker via drag & drop. This is useful, for example, when you need the coordinates from an edge detection checker for a position adjustment. If the property pages are concealing the camera image, but you want to keep it on view, click ⊡ to make the checker property pages transparent.

When you click ▨, you confirm all the changes you have made on that page and apply them to the checker.

Click ▥ to execute a checker. The program automatically puts the "Result" page in front.

With the standard icons ✂, ▤ and ▣ you can cut or copy previously selected items such as checkers, results, parameters, etc. to the buffer and paste them to a different position.

9.1.6.2 General

On this page, you have the opportunity to enter a **comment** about each checker. This comment appears in the sequence.

ActiveX name

You need the ActiveX name of a checker if you wish to read or modify the checker's parameters via an ActiveX client. The ActiveX client can only access the checker via its ActiveX name.

The ActiveX name is defined by Vision P400 when you create the checker. You can modify the name when you have set the checker.

Color

For position and rotation adjustment checkers, you may also change the **color** in which the checkers providing the reference values for the adjustment are displayed. The **color** is used both in the sequence list and in the camera image.

Force error to NG

In some instances, it makes sense to treat an error as an NG judgment so that an application is executed completely. For example, a formula contains the result of a feature extraction checker. If the checker does not find an object, it generates an error for the whole formula. If you know that this can happen, but still wish to execute the formula, you need to convert the error to an NG signal. In this case, select "Yes", and the formula will be executed even if the feature extraction checker does not find an object.

Enable execution

Select "No" to stop the checker from being executed. This can be useful, for example, if you do not need the checker for processing the current image, but you do not want to delete it from the sequence list, because you may need the checker again later on. Even if you have disabled the execution of a checker, you can still make all checker settings, as only the execution is disabled.

9.1.6.3 Image source

This property page is only available for checkers created for a color camera. Here you select on which image (= source) a checker is to be executed. A checker can be executed on the color image or on the color channel of an image. Which image sources are available depends on the checker type.

Apart from the three default color channels Red, Green, and Blue or a combination of them, you can also use the channels Hue, Lightness, Saturation or Hue, Saturation, and Value, respectively (http://en.wikipedia.org/wiki/HSL_and_HSV). When you select an HLS channel, it will be derived from the three standard color channels.

Checker type	Image source	Remark
Window (WI)	Color image or channel	
Feature Extraction (FE)	Color image or channel	Which features can be calculated depends on the image source.
Edge Detection Binary (ED_B)	Color image or channel	
Edge Detection Gray Value (ED_G)	Channel	
Edge Detection Gray Value Projection (ED_GP)	Channel	
Difference (DI)	Channel	
Contour Matching (CM)	Color image or channel	
Cross Correlation Matching (CCM)	Channel	
Optical Character Recognition (OCR)	Color image or channel	When you select "Color image" as the image source, the features used for classification will be calculated on the red channel.

Checker type	Image source	Remark
Code Reader Checker (CR)	Channel	

When the three default color channels Red, Green, and Blue are combined, the gray-value image that the checker is executed on will be calculated from the three color channels with this formula:

FactorRed * RedValue + FactorGreen * GreenValue + FactorBlue * BlueValue + Offset

The factors Red, Green, and Blue are in the range between -1.0 to 1.0, the offset is in the range of 0 to 255. If the calculated gray value is below zero, it will be represented as 0. If it is above 255, it will be displayed as 255. Within the valid range, the gray value will be rounded to a whole number to get a valid byte value. The default values for the factors Red, Green, and Blue are 0.299, 0.587, and 0.114 as well as 0 for the offset. Use the button [Reset factors] to reset the specified values to the default values.

☞ ◆NOTE

If it is necessary for understanding the checker's property sheet, the image source will be displayed next to the name of the property sheet.

9.1.6.4 Color Selection

This property page only will be displayed if the checker has been created for a color camera and when you have selected "Color Image" on the property page Image Source". In this case the binary object used by the checker will be calculated not on the basis of the slice levels on the property page "Algorithm", but on the basis of the color values you set here. For example, if you have selected the color red for a feature extraction checker, Vision Q.400 extracts all red objects from the checker shape and calculates their features.

The color properties of the objects are defined by cuboids in the HLS color model: If the three color values of a pixel lie within the cuboid, the pixel is selected, otherwise it is not selected.

There are two possibilities of selecting a color for a checker:

- Use application defined colors
- Use a checker-specific color

Use application defined colors

When you activate the check box, the checker uses one or more of the application's color cuboids, which have been defined under **Application → Color Selection**. To enter one or more color cuboids into the list on the checker's property page, proceed as follows:

◆PROCEDURE

1. Application → Color selection **or** ≡

2. Select color from the list

3. Drag & drop color into the checker's property page

4. **Drag & drop additional colors into the checker's property page, if required**

   The color cuboid will be entered into the list complete with its unique number, its reference color, and its name (if you have assigned one). You can use each color cuboid once per checker. If you have inserted a color by mistake, use the button [Remove color] to remove it from the list.

Use a checker-specific color

If you want to use a checker-specific color, you have two possibilities:

- You can select the color with the list box [Reference color].
- You can pick the color in the camera image.

Select the color via the list box [Reference color]

◆ PROCEDURE

1. **Activate check box "Use application defined colors"**

   The list box shows the reference color of the color cuboid which corresponds to the values under hue, luminance, and saturation.

2. **Select the color via the list box [Reference color]**

   This changes the hue value to the value of the color selected. Please note that the color shown on the button does not necessarily correspond to the color used for the new hue, as Vision Q.400 uses also the values under luminance and saturation to display the color and the luminance and saturation values will not be changed if you use the button.

Pick color in the camera image

◆ PROCEDURE

1. **Activate check box "Use application defined colors"**

2. **Select [Pick color]**

3. **Move mouse cursor into the checker shape**

4. **Click left mouse button to activate the magnifying glass**

5. **Select a color with a left mouse click**

   With every addition click of the left mouse button the color in the crosshairs will be added to the selected colors until you finish the color selection with a click of the right mouse button or by pressing <Enter>. The new cuboid in the HLS color model is the smallest cuboid containing all the colors you picked. If you press <Esc>, the selected colors will be discarded, i.e. the cuboid in the HLS color model remains unchanged.

   While you are picking colors in the camera image, the colors hue, luminance, and saturation as well as the button [Reference color] keep getting updated to correspond to the current color selection.

The colors and numbers displayed have the following meaning:

The box ① next to "Hue" shows the current reference value for the hue. The slider below shows all the colors of the hue cylinder.   The color right in the middle of the slider ② corresponds to the current reference value, i.e. the value in the box above it. The reference value is also related to the relative values ③ displayed to the left and to the right of the slider. They define a range for the hue value. If the current reference value is for example 203 and the relative values to the left and to the right of the slider are -5 and 23, then all hue values between 198 and 226 apply. The calculation uses arithmetic modulo 256, which means that value 256 is the same as value 0.

Using the sliders

You can use the sliders to change the values for hue, luminance, and saturation directly. Click one of the two triangles that mark the value range to activate the triangle. The triangle appears filled with black. As long as a triangle is active, you can move it with the mouse or use the cursor keys to change the value. Use <Shift>+<Tab> to activate the other triangle.

It is possible to change the relative values for the hue by either clicking into the color scale with the left mouse button (the clicked value will become the new relative value) or by clicking the color slide with the right mouse button and move it while holding the mouse button down.

The whole time while you are changing the settings for the color cube, the pixels in the checker shape with a color value within the current color cube values will be highlighted with the color assigned to the slice level (see page 55). You can set the color for the slice level either under **Application → Display Colors** or, with a checker-specific color selection, on the property page "Display Colors" (see page 261).
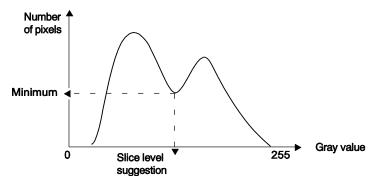
9.1.6.5 Algorithm

For black-and-white images or when you are using the color channel of a color image, you set the slice levels for an individual checker (see page 236). You can select either a static (default value) or a dynamic slice level. Activate the corresponding option button and set the slice levels as required.

"Algorithm" page of a feature extraction checker

You will obtain a rough setting by dragging (hold down mouse button while moving left/right) both triangles or by clicking into the gray scale. Use the cursor keys for changing the values by 1 (left/right) or 8 (up/down).

Click [Automatic] to have Vision Q.400 calculate a slice level (see page 236).

Custom slice level - automatic calculation

For binary checkers you also define whether objects should be within the slice levels (selected) or outside the slice levels (not selected).

9.1.6.6 Image Filters

Vision Q.400 differentiates between image and object filters (see page 258). Each filter type has its own property page. There are two types of image filters: gray-value and binary.

- Gray-value filters are used for preprocessing a gray-value image before thresholding. For a black-and-white camera, the original gray-value image is used; for a color camera, a color channel of the color image is used. Gray-value image filters do not work directly on a color image.

- Binary filters are executed after thresholding. They work on the objects detected by thresholding or by the checker-specific color selection.

The filters are executed in the following order:

1. Gray-value image filters
2. Thresholding with regards to the setting under "Object Type"
3. Binary image filters
4. Object filters

The filters, which you select on the property page "Image Filters" or "Object Filters," will be used within one checker shape only. The gray-value image and binary image filters available for a checker are listed in the checker description. The filter settings are only valid for the checker for which they were set.

The following gray-value filters are available:

Filter name	Parameters and other available settings	Description
Sigma	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11 Difference: 0 - 255	Non-linear smoothing with the sigma filter. The sigma filter carries out a non-linear smoothing of the gray values of the input image. All pixels are checked in a rectangular window (defined by "Filter Size"). All of this window's pixels that differ from the current pixel by less than "Difference" are used for calculating the new pixel. The new pixel is the average of the chosen pixels. If all differences are larger than "Difference," the gray value is adopted unchanged.
Gauss	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11	Smoothes images by means of discrete Gauss functions. The Gauss filter uses the discrete Gaussian function to smooth images. The smoothing effect increases when you increase the filter size. For border treatment the gray values are reflected at the image borders.
Mean	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11	Smoothes images by averaging. The mean filter carries out a linear smoothing with the gray values of the input image. The filter matrix consists of ones (weighted equally) and has the selected filter size. The result of the convolution is divided by the filter size. For border treatment the gray values are reflected at the image borders.
Sobel	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11	Detects edges (amplitude) using the Sobel operator. The Sobel filter calculates the first derivative of the image and is used as an edge detector.

Filter name	Parameters and other available settings	Description
Emphasize	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11 Emphasize Contrast: 0 - 100	Enhances image contrast. The emphasize filter emphasizes high-frequency areas of the image (edges and corners). The resulting image appears sharper. "Emphasize Contrast" measures the increase in contrast. The division frequency is determined by the filter matrix size: The larger the matrix, the lower the division frequency. For border treatment the gray values are reflected at the image borders.
Gray Skeleton		Thinning of gray-value images. The gray skeleton filter applies a gray-value thinning operation to the input image. Figuratively, the gray value "mountain range" is reduced to its ridge lines by setting the gray value of "hillsides" to the gray value at the corresponding valley bottom. The resulting ridge lines are at most two pixels wide. This operator is especially useful for thinning edge images. The filter preserves the contours.
Dot Print Enhancement	Dot size: 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23 Dot filter type: "dark, "light", "all" Emphasize Contrast: -1, 1, 2	Enhances circular dots in an image. The dot print enhancement filter enhances circular dots of diameter "Dot Size" in the input image. This filter is particularly suitable for the segmentation of dot prints, e.g., in OCR applications. Enhancement is done using matched filters with filter masks that have been adjusted to a particular dot size. The "Dot Filter Type" selects whether dark, light, or all dots in the image should be enhanced. The parameter "Enhance Contrast" can be used either to increase the contrast of the output image (Enhance Contrast > 0) or to dampen the values in extremely bright areas that would be cut off otherwise (Enhance Contrast = -1).
Dilation rectangle	Rectangle width: 3 - 511 Rectangle height: 3 - 511	Determines the maximum gray value within a rectangle. The gray-value dilation rectangle calculates the maximum gray value of the input image within a rectangular mask (defined by "Rectangle Width" and "Rectangle Height") for each pixel. For border treatment the gray values are reflected at the image borders.
Erosion rectangle	Rectangle width: 3 - 511 Rectangle height: 3 - 511	Determines the minimum gray value within a rectangle. The gray-value erosion rectangle calculates the minimum gray value of the input image within a rectangular mask (defined as"Rectangle Width" and "Rectangle Height") for each pixel. For border treatment the gray values are reflected at the image borders.
Closing Shape	Filter size: 3 - 511 Shape: "octagon," "rhombus"	Performs a gray-value closing with a selected mask. The filter applies a gray-value closing to the input image with the structuring element of the selected "Shape." The mask's offset values are 0 and its horizontal and vertical size is defined by "Filter size." The setting "octagon" for "Shape" uses an equilateral octagonal mask which is a suitable approximation of a circular structure. The setting "rhombus" for "Shape" uses a rhombic mask. For border treatment the gray values are reflected at the image borders.

Filter name	Parameters and other available settings	Description
Opening Shape	Filter size: 3 - 511 Shape: "octagon," "rhombus"	Performs a gray-value opening with a selected mask. The filter applies a gray-value opening to the input image with the structuring element of the selected "Shape." The mask's offset values are 0 and its horizontal and vertical size is defined by "Filter size." The setting "octagon" for "Shape" uses an equilateral octagonal mask which is a suitable approximation of a circular structure. The setting "rhombus" for "Shape" uses a rhombic mask. For border treatment the gray values are reflected at the image borders.
Invert image		The operator inverts the gray values of an image.
Corner detection filter	Filter size: 3x3, 5x5, 7x7, 9x9, 11x11 Variance: 0 - 0.3	Searches for corners in images. The corner detection filter extracts gray-value corners from an image. The bigger the filter size, the more pronounced the corners appear. The higher the variance value, the fewer corner points will be detected.
Anisotropic Smoothing	Smoothing Grade: 50 - 100 Iterations: 1 - 30 Neighborhood: 4, 8 4-fold neighboring relationship 8-fold neighboring relationship	Smoothes images by edge-preserving anisotropic diffusion. The anisotropic smoothing filter carries out an iterative, anisotropic smoothing process on the mathematical basis of physical diffusion. In analogy to the physical diffusion process describing the concentration balance between molecules dependent on the density gradient, the diffusion filter carries out a smoothing of the gray values dependent on the local gray-value gradients. For iterative calculation of the gray value of a pixel, the gray-value differences in the 4-fold or 8-fold neighboring relationship, respectively, are used. "Smoothing Grade" increases the smoothing effect but blurs the edges a little more (values from 80 to 90 percent are typical). **The parameter "Iterations" determines the number of itera**tions (typically 3 to 7).
Median Rectangle / Circle	Filter size: 1 - 101 Border Treatment: "continued", "cyclic", "mirrored"	Median filtering with different rank masks. Using various rank masks, the median filter performs a non-linear smoothing of the gray values of the input image. The filter uses a circular or rectangular mask, respectively. Several border treatments can be chosen for filtering: • "continued": Continuation of edge pixels • "cyclic": Cyclic continuation of image edges • "mirrored": Reflection of pixels at the image edges The circular/rectangular mask is placed over the image such that the mask's center of gravity touches all of the objects' pixels once. For each of these pixels all neighboring pixels touched by the mask are sorted in ascending order by their gray values. Thus, each of the sorted gray-value sequences contains exactly as many gray values as the mask has pixels. From these sequences the median is selected and entered as resulting gray value at the corresponding output image.
Isotropic Diffusion	Iterations: 0 - 500 Sigma: 0.1 - 50.0	Performs an isotropic diffusion of the image. This corresponds to a folding of the image matrix with a Gaussian mask with standard deviation Sigma. If the "Iterations" parameter is 0, a fold of this kind is explicitly carried out.

Filter name	Parameters and other available settings	Description
Anisotropic Diffusion	Mode: Method according to Weickert, Perona-Malik or parabolic Contrast: 0.0 - 100.0 Theta: 0.0 - 3.0 Iterations: 1 - 30	Performs an anisotropic diffusion of the image based on the Perona and Malik model. This process is also termed non-linear isotropic diffusion. The object of anisotropic diffusion is to eliminate wide-area image disturbances such as noise without blurring image edges. The distinction between edges and areas is made by the slice level defined as "contrast" for the size of the gray value difference between adjacent pixels.
Coherence Enhancement	Sigma: 0.0 - 1.0 Rho: 0.0 - 30.0 Theta: 0.1 - 0.5 Iterations: 1 - 500	Performs an anisotropic diffusion on the image aimed at enhancing the coherence of the structures in the image - in particular, diffusively joining interrupted image edges without smudging them perpendicular to the edge direction.
Mean Curvature Flow	Sigma: 0.0 - 1.0 Theta: 0.1 - 0.5 Iterations: 1 - 500	Produces a smoothing of the image toward the image edges - that is, along the level lines. The edges of the image do not blur in the process. In order to define the edge directions in a more stable way, particularly where input data is subject to noise, an additional isotropic smoothing operation can be inserted prior to calculation of the gray value gradients. The "Sigma" parameter determines the amount of this smoothing as the standard deviation of the associated Gaussian kernel.
Shock filter	Mode: Laplace, Canny Sigma: 0.0 - 5.0 Theta: 0.1 - 0.7 Iterations: 1 - 100	Sharpens the focus of image edges.
Gray Opening Rectangle	Rectangle width: 3 - 15 Rectangle height: 3 - 15 (only odd values are permitted)	Performs a gray value opening with a rectangular mask (defined by "Rectangle Width" and "Rectangle Height"). For border treatment the gray values are reflected at the image borders.
Gray Closing Rectangle	Rectangle width: 3 - 15 Rectangle height: 3 - 15 (only odd values are permitted)	Performs a gray value closing with a rectangular mask (defined as "Rectangle Width" and "Rectangle Height"). For border treatment the gray values are reflected at the image borders.
Binomial	Filter height: 1 - 37 Filter width: 1 - 37 (only odd-number values are permissible)	Smoothes images by means of a binomial filter. Binomial filters are an excellent approximation of Gaussian filters and can be calculated very efficiently using whole-number operations. For this reason, binomial filters are very fast.
Separate median filtering	Filter height: 1 - 199 Filter width: 1 - 199	Median filtering with different rank masks. Using various rank masks, the median filter performs a non-linear smoothing of the gray values of the input image. The filter uses a rectangular mask. Separate median filtering is considerably faster than normal median filtering, and its runtime is virtually independent of the filter mask size.

Filter name	Parameters and other available settings	Description
Gaussian Filter Derivative	Sigma X / Y: 0.2 - 50.0 Component: "none", "x", "y", "gradient", "xx", "yy", "xy", "xxx", "yyy", "xxy", "xyy", "det", "mean_curvature", "gauss_curvature", "eigen-value1", "eigenvalue2", "main1_curvature", "main2_curvature", "kitchen_rosenfeld", "zuni-ga_haralick", "2nd_ddg", "de_saint_venant", "area", "laplace", "gradient_dir", "eigenvec_dir"	Calculation of various Gaussian derivatives as well as sizes derived from the result. Here, the Gaussian function parameter - that is, the smoothing - is called "Sigma." "Sigma X" refers to smoothing in column direction; "Sigma Y" signifies smoothing in row direction. The parameter "Component" describes the function used to calculate the derivative.
Scale image	Scale factor: 0,001 - 1 Offset: 0 - 500	The gray values of the original image are scaled by the scale factor and then the offset is added.
Illuminate	Rectangle height: 1 - 199 Rectangle width: 1 - 199 Factor: 0.0 - 5.0	Illuminating images helps to improve contrasts. Very dark parts of the image will be lighter, very bright parts will become darker. Use the parameter "Factor" to scale the illumination effect. Please note the spotlight effect: If an image contains a dark object in front of a light background, the part of the object near the object's contour will be illuminated, but also the light background. This is the effect of lighting an object with a strong spotlight. This is also true for light objects in front of a dark background. In this case, the fictitious spotlight darkens the object.
Equalize histogram		Image contrasts are improved by equalizing the histogram. This transformation equalizes the cumulative histogram. The maxima in the original histogram are spread and this increases the contrast in image areas where the maxima occur most frequently. As a consequence, areas that appear homogeneous will have more visible contrast. However, it also increases noise in the image.
Gray range rectangle	Rectangle height: 1 - 199 Rectangle width: 1 - 199	Set the maximum amplitude of gray values within a rectangle. This filter transforms the gray values of the input images with the help of a rectangular mask (set width and height). The range of gray values (minimum to maximum) is calculated within the mask. The result is entered into the output images.

For details on the effects of the parameters please refer to the relevant literature or consult Technical Support.

The following binary filters are available:

Filter name	Parameters and other available settings	Function
Opening	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	Opens an object by means of a circular structuring element. Opening eliminates small objects (smaller than the circular structuring element) and smoothes an object's boundaries.

Filter name	Parameters and other available settings	Function
Closing	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	Closes an object with a circular structuring element. Closing smoothes the object boundaries. It closes holes within an object which are smaller than the circular structuring element of radius "Filter Radius".
Opening - Closing	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	Opening followed by Closing.
Closing - Opening	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	A closing followed by an opening.
Opening (vertical)	Filter height: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Opens a region with a rectangular structuring element, in this case a vertical line. Opening (vertical) performs an erosion on the input object, followed by a dilation. The size of the structuring element is determined by the parameters "Filter Height". As with all opening variants, larger structures are preserved, while small regions such as lines or points are eliminated.
Closing (vertical)	Filter height: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Close a region with a rectangular structuring element, in this special case a vertical line. Please refer to Closing (horizontal).
Opening (horizontal)	Filter width: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Open a region with a rectangular structuring element, in this special case a horizontal line. Please refer to Opening (vertical).
Closing (horizontal)	Filter width: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Closes a region with a rectangular structuring element, in this case a horizontal line. Closing (horizontal) performs a dilation on the input object, followed by an erosion. The size of the rectangular structuring element is determined by the parameters "Filter Width". As with all closing variants, object boundaries are smoothed and holes within an object that are smaller than the rectangular structuring element are closed.
Invert objects	Invert objects: True / False	Toggle switch that sends objects from foreground to background and vice versa. Unlike the option "Object Type - Selected/Not Selected" on the "Algorithm" properties page, this function is executed after the gray-value and morphological filters.
Binary skeleton		Computes the binary skeleton of a region. The filter calculates the skeleton of the input regions.
Dilation circle	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	Dilates an object with a circular structuring element. This filter enlarges objects and smoothes object boundaries. It also closes holes in the object that are smaller than the rectangular mask.
Dilation rectangle	Filter height: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110 Filter width: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Dilates an object with a rectangular structuring element. This filter enlarges objects and smoothes object boundaries. It also closes holes in the object that are smaller than the rectangular mask.

Filter name	Parameters and other available settings	Function
Erosion rectangle	Filter height: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110 Filter width: 1 / 2 / 3 / 4 / 5 / 7 / 9 / 12 / 15 / 19 / 25 / 33 / 45 / 60 / 110	Erodes an object with a rectangular structuring element. This filter reduces objects and smoothes object boundaries. Objects smaller than the rectangular mask are eliminated.
Erosion circle	Filter radius: 1.5 / 2.5 / 3.5 / 4.5 / 5.5 / 7.5 / 9.5 / 12.5 / 15.5 / 19.5 / 25.5 / 33.5 / 45.5 / 60.5 / 110.5	Erodes an object with a circular structuring element. This filter reduces objects and smoothes object boundaries. Objects that are smaller than the circular mask are eliminated.
Combine dot prints	Dot size: 1 - 100	This special filter is used to combine dots extracted with the gray-value filter "Dot Print Enhancement" to the dot print characters.
Area Boundary	Ignore touching objects: True / False	Ignores objects touching the edge of the shape. This filter is used to determine whether an object that is to be processed should be allowed to touch the checker shape. If "Ignore Touching Objects" is set to "True", it is permissible for an object to touch the shape. If the parameter is set to "False," it is not permissible for an object to touch the shape.
Inner rectangle	Minimal rectangle width: 10 - 12000 Minimal rectangle height: 10 - 12000 Minimal area size: 4 - 2147483647 Erosion rectangle size: 1 - 37	The filter determines the largest axis-parallel rectangles that fit into a region. The values for minimal width, height, and area size define the properties of the expected rectangles. In addition, you can set a mask for erosion.

☞ ◆**NOTE**
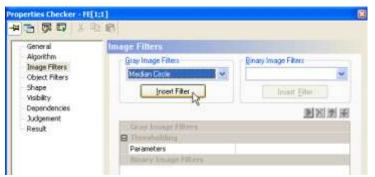
Gray-value and binary filters are described in detail in the standard literature on image processing (see page 574).

Selecting image filters

To select gray-value or binary filters, please proceed as follows:

◆ PROCEDURE

1. **Under "Gray Image Filters" select the filter you want to insert into the filter list**

2. **Select the [Insert Filter] button**

   The selected filter is added at the end of the list. The [Insert Filter] button is active only if you have selected a filter.

   You can add as many filters as you like, and you can also have multiple entries of the same filter. All filters in the list are executed consecutively, top down. If a list is empty, the filter will not be executed.

Changing a parameter setting

For most of the image filters there are one or more parameters to set. To change a default parameter setting, please proceed as follows:

◆ PROCEDURE

1. **Click the "+" sign next to the filter name to display the parameter list**

2. **To change the setting, click to the right of the parameter name**

   You can either edit the parameter setting directly or select an entry from the list box. If you can edit the setting directly, a box underneath displays the valid range of setting values.

Testing the filters set

You can test the filters you have set directly on the current camera image. Please proceed as follows:

◆ PROCEDURE

1. **Using a left mouse-click, select the first filter in the list**

2. **Click ▶ to execute the filter on the camera image**

   The symbol is active only if you have selected a filter. Vision Q.400 executes the filter, displays the filter results in the checker shape, and selects the next filter in the list.

3. **Keep clicking ▶ until you have tested all filters**

◆ NOTE

- **If instead of selecting the first filter, you have selected a filter further down the list, and you click ▶, Vision Q.400 executes the selected filter in addition to all filters that have been defined up to that point in the list. Vision Q.400 displays the filter results and selects the next filter.**

- **The thresholding parameters can only be set on the "Algorithm" page. To test the effects of thresholding in combination with image filters, you can use the non-editable entry "Thresholding" with the subentry "Parameters" in the list between the gray value and binary filter lists, provided the checker supports thresholding.**

- **If a checker depends on an exposure or a position and rotation adjustment, these will be taken into consideration during testing. If that is undesirable, you should delete these dependencies before testing the filters and reinstall them afterwards.**

Deleting a filter

To delete a filter from the list, please proceed as follows:

◆ PROCEDURE

1. **Select the filter to be deleted from the filter list**

2. **Click ❌ to delete the filter**

   The symbol is active only if you have selected a filter.

Moving a filter

◆ PROCEDURE

1. **Select the filter you want to move**

2. **Click 🔽 or 🔼 to move the filter one row up or down the list**

   The symbols are active only if you have selected a filter.

Using a customized image filter file

If you have selected the option "Use Customized Image Filter DLL (*.ifd)", the property page "Image Filters" looks as shown below:

*"Image Filters" page with selected *.ifd file*

Under "DLL Name" select the image filter file you want to use. Vision Q.400 checks whether the selected file is a valid *.ifd file.

If you are working with a customized image filter, the standard Vision Q.400 gray-value and binary image filters are not available. You can only use the filters from the image filter file. If the image filter file does not contain any gray-value filters, for example, this filter type is not available.

However, with thresholding, the following difference applies: If the image filter file contains thresholding algorithms, you can only use the file-specific thresholding. However, if the image filter file does not contain any thresholding functions, you can use the default Vision Q.400 thresholding functionality from the "Algorithm" page.

If the image filter file contains editable parameters, these will be listed. To change a parameter setting, please proceed as described above.

If you are using a user-defined image filter file, you can neither delete nor move a filter. However, you can test the parameters and their settings. Please proceed as described under "Testing the Set Filters".

To enable you to test the parameters step by step, Vision Q.400 displays the non-editable entry "No Parameters" under "Gray Filter Parameters", if there are no parameters to be set. This also goes for the thresholding and binary filter parameters.

If there is no entry under "Gray Filter Parameters" or "Binary Filter Parameters," and the entry "No Parameters" does not appear, either, the selected image filter file does not provide any filters of that type.

☞ ◆**NOTE**

- **If you have activated the option "Use Customized Image Filter DLL (*.ifd)" on the "General" page and you have not selected an image filter file, or have selected an invalid file, there is no entry in "DLL Name" and the checker generates an error upon execution.**
- **The functionality of the filter parameters depends on the selected image filter file and cannot be described here.**

9.1.6.7 Object Filters

The following object filters are available after the binary filter operations:

- **Eliminate Holes**
  A hole is defined as an image area which is fully enclosed by one and the same object and which is not part of that object. In the case of a light object, a hole would be dark and vice versa. Whether a given hole should be closed or not depends on the size (pixel count). You need to enter a lower and an upper limit (inclusive) for the hole size in the columns "Lower Limit" and "Upper Limit". The default is 1 to 100. The maximum limit depends on the connected camera.

- **Select Objects**
  With this filter, the objects can be selected by size as measured in pixels. As with the suppression of holes, a lower and an upper limit (inclusive) has to be defined. This time, however, the object's size is the relevant criterion. The maximal limit depends on the camera.

- **Select Separated Objects** (only for the OCR checker)
  When you are working with character separation in the OCR checker, this object filter is applied to the objects found after character separation. That is to say, the objects are first selected unseparated, then character separation is carried out and then the object filter is applied.

With the feature extraction checker it is also possible to fine-tune the selection of objects with a formula (see page 326).

"Object Filters" page of a feature extraction checker

9.1.6.8 Shape

On this page, you may modify the checker shapes which have been entered interactively with the mouse during the creation of the checker (see page 269). The following shapes are available:

- Rectangle
- Ellipse
- Polygon
- Doughnut

- Rectangle -> (only edge detection)
- Ellipse -> (only edge detection)
- Line -> (only edge detection)
- Doughnut-> (only edge detection gray value projection)

An ellipse may be transformed into a circle by selecting "Circle" in the field "Type". The transformation occurs in maintaining the top left point and by using the length of the ellipse's conjugate axis (shortest axis) for the circle diameter.

In reverse, a circle can be transformed into an ellipse by clicking on "Ellipse". The parameters of the circle will be maintained. The difference between a circle and an ellipse that looks like a circle only becomes apparent when the shape coordinates are altered: With the ellipse, the main and conjugate axes may be modified independently of each other. With the circle, both axes are of the same length and will consequently be altered simultaneously.

A line -> may be modified into either a horizontal or a vertical line. To this end, the line's projections onto the image edges will be used and shifted in such a way that the starting point of the line is maintained. The reverse is also possible. While the line type is changed, the parameters remain unchanged.

With edge detectors with line -> or rectangle -> as shape, the shape's orientation may be set in the "Angle" field. With edge detectors with the shape ellipse ->, the scanning direction may be selected either "clockwise" or "counterclockwise" in the "Scanning Direction" field.

The following tables list the parameters which describe a shape:

Polygon (Closed Progression)

Parameter	Meaning
Type	Type of shape (polygon)
Center point	Coordinates of the center point
Point	List of polygon-supporting points

Rectangle

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Starting point	Coordinates of the upper left point of the rectangle
End point	Coordinates of the lower right point of the rectangle

Ellipse

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Top left point	Coordinates of the upper left point of the enclosing rectangle
Bottom right point	Coordinates of the lower right point of the enclosing rectangle

Doughnut

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Outer circle edge point	Left upper corner of the enclosing rectangle of the outer circle
Inner circle edge point	Left upper corner of the enclosing rectangle of the inner circle
Starting point	Coordinates of the starting point of the doughnut section on the outer circle
End point	Coordinates of the end point of the doughnut section on the outer circle

Rectangle ->

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Starting point	Coordinates of the upper left point of the enclosing rectangle
End point	Coordinates of the lower right point of the enclosing rectangle
Angle	Scanning direction for the edge detectors

Ellipse-> (Elliptic Arc)

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Top left point	Coordinates of the upper left point of the enclosing rectangle
Bottom right point	Coordinates of the lower right point of the enclosing rectangle
Starting point	Coordinates of the starting point of the elliptic arc
End point	Coordinates of the end point of the elliptic arc
Scanning direction	Scanning direction for the edge detectors (clockwise, counterclockwise)

Line->

Parameter	Meaning
Type	Type of shape (line, horizontal line, vertical line)
Center point	Coordinates of the center point
Starting point	Coordinates of the starting point of the line
End point	Coordinates of the end point of the line
Angle	Orientation of the line

Doughnut->

Parameter	Meaning
Type	Type of shape
Center point	Coordinates of the center point
Outer circle edge point	Left upper corner of the enclosing rectangle of the outer circle
Inner circle edge point	Left upper corner of the enclosing rectangle of the inner circle
Starting point	Coordinates of the starting point of the doughnut section on the outer circle
End point	Coordinates of the end point of the doughnut section on the outer circle
Scanning direction	Scanning direction for the edge detectors (clockwise, counterclockwise)

☞ ◆NOTE

- **All coordinates must fall within the image range. The image range depends on the camera used. All angles (see page 228) must be within the range of 0 − 360 degrees.**
- **When you change the parameters in such a way that parts of the shape come to lie outside the image area, Vision Q.400 will only accept your changes if you have activated the option "Allow positions outside the image area".**

9.1.6.9 Display Colors

Use this property page to define which colors should be used to display the individual checker elements in the camera image. Normally, the display colors defined under **Application** →

Display colors are used for all checkers of a type. You can change these settings for a checker to enhance the visibility of display colors of certain checker elements. For example, if a feature extraction checker works on a color image with a colored background, it is possible that the display colors of the application do not offer enough contrast with the background color.

The following options are available:

Option	Description
Use application settings	The display colors of the application are used. Use the button [Application settings...] (see page 55) to see the current display colors.
Use element settings	If you want to display the checker in different colors than the standard colors, activate the option and define new display colors under "Colors Element".
Colors element	Use the list box to select colors for the shape, the pick point, the object, and the result.
Apply settings to other elements	This button opens a dialog where you can apply the checker-specific display colors to other elements like checkers, sequences, etc.

You can assign checker-specific colors to the following elements:

Column	Explanation
Shape	Color of the borders of the checker shape
Pick point	Color of the center, start, and end point of the shape (select the shape by clicking the pick point)
Object	Color to fill objects found
Result	Color of the cross in the middle of objects found or color of an edge found
Slice level	Color to mark the customized slice level

9.1.6.10   Visibility

On the "Visibility" property page you customize the mode of display for elements such as checkers, object shapes and indicators. As a rule, the visibility settings you make under **View → Checker...** apply to all elements of the current camera (see page 165). They can differ from the camera settings in order to alter the on-screen visibility for certain elements such as checkers and indicators, such as if the screen view threatens to become unclear when there are large number of elements.

As long as an element uses the camera-specific settings the "Use camera settings" option is active. You can view these settings by clicking the "Camera Settings" button. Any change to the camera settings applies to all checkers, object shapes and indicators for which the "Use camera settings" option is active.

Default settings for the visibility of an element

To vary the settings from the camera settings, choose the "Use element settings" option. This makes the previously grayed out parameters available.

Element-specific visibility settings

You can switch the following parameters on or off:

Parameter	Explanation
Shapes	Switch checker shapes on/off
Gray image processing results	Show/hide gray image processing results
Processed objects	Show/hide the objects computed in image processing: • **Filled:** Processed objects are displayed in the color (see page 55) selected by the user. • **Not filled:** Processed objects are not filled, only the borders are visible.
Processing results	Switch image processing results on/off
Draw (only for geometry checkers, object shapes and indicators)	Show/hide element

The following buttons are available:

Button	Explanation
Camera settings	Opens the dialog box with the camera settings (see page 165). The camera settings apply to all checkers, object shapes and indicators for which the "Use camera settings" option is active.
Show	All parameters relating to the display of the current element are activated. The setting determining whether processed objects are filled or not filled does not change.
Hide	All parameters relating to the display of the current element are deactivated. The setting determining whether processed objects are filled or not filled does not change.
Apply settings to other elements	When you click this button, a dialog box opens up with which you can transfer the setting of the element you are currently working on to other elements. This means that when you have changed the visibility settings of a feature extraction checker, you can also apply the new settings to other feature extraction checkers or to other elements (see below).

☞ ◆**NOTE**

- **For geometry checkers, object shapes and indicators there is only the "Draw" parameter. It defines whether the element is displayed or not.**
- **Note that the element you selected in the checker sequence window is always displayed on screen, even when the selected visibility settings dictate that it should be hidden.**
- **For run mode you can disable display of all checkers, object shapes and indicators entirely. To do so, activate the relevant "Graphic Update" parameters on the "Run Mode Settings" property page under** Application → Properties**. The properties of the application have priority over the settings you make on the "Visibility" property page.**

Apply settings to other checkers

With this button you open a dialog box with which you can apply the setting of the element you are currently working on to all other elements or to elements of the same type.

Transferring visibility settings of a feature extraction checker

Under "Elements" you specify whether all elements (checkers, indicators and object shapes) or only the elements of the same type (indicated dynamically in the dialog box) are to adopt the settings.

Under "Location" you specify the areas of the application for which the elements selected above are to adopt the visibility settings. The displayed parameters change according to the situation from which you opened the dialog box.

Parameter as in image	Explanation
Current sequence "Camera 1, Sequence 1"	The first parameter offers you the current checker sequence as the application area.
All sequences of "Camera 1 (Frame Grabber 1)"	The second parameter offers you all sequences of the camera to which the current element belongs as the application area.
All sequences of the application	The new visibility settings are applied to the entire application - meaning all checker sequences of all cameras.

When applying the settings of an element to other elements, you should note the following points:

Selected settings	Transfer from -> to	Effect
"Use camera settings" is activated	Irrelevant	Only this parameter is activated on the target element; all other settings remain unchanged
"Use element settings" is activated and additional parameters have been individually set	Checker -> Checker	Settings are applied 1:1
	Checker -> Geometry checker, object shape or indicator	Depends on the setting of the "Processing results" parameter. If it is active, "Draw" is also activated.
	Geometry checker, object shape or indicator -> Checker	Depends on the setting of the "Draw" parameter. When it is activated, the effect is the same as clicking the [Show] button - that is, all visibility settings are activated. When it is deactivated, the effect is the same as clicking the [Hide] button - that is, all visibility settings are deactivated.
	Geometry checker, object shape or indicator -> Geometry checker, object shape or indicator	The setting for "Draw" is applied.

9.1.6.11 Dependencies

You may enter a checker's dependencies on this page. It may be dependent on exactly one position and rotation adjustment. The checker providing the position and rotation adjustment must be above the dependent checker in the sequence list. When you install that dependency, the "Position and Rotation" window will give you a choice of all those adjustments which satisfy this condition, i.e. which appear in the sequence list before the dependent checker.

If the checker uses static slice levels, you may define one exposure adjustment each for the upper and lower slice levels. This is done in the fields "Lower Exposure" and "Upper Exposure". Again, you will only be able to choose from exposure checkers on the sequence list above the dependent checker. When the checker uses a color image, Vision Q.400 only offers exposure adjustment checkers which use the same image source as the selected checker.

9.1.6.12   Judgment

The judgement indicates whether the checker's calculations have been judged as good (OK) or not (NG). From all the checker results exactly one result is selected and used for the judgement. The judgement is considered good when the result chosen falls within the pre-set range of limits. When a checker is judged as NG, the checker shape will be displayed with red-white dotted lines.

The checker's result to be used for the judgement is determined by a pre-set process that cannot be modified by the user.

Frequently, the judgement is defined as the number of objects worked on. As such, the judgements can be used for ready identification of missing or additional unwanted objects.

9.1.6.13   Result

This page lists checker results. These results may refer to the entire checker shape (e.g. window checker) or to individual objects in the shape (e.g. feature extraction checker). With the latter, a list is generated containing the object-specific results for each object evaluated.

Besides the checker results, this page usually also displays the **execution state**, the **time**, and the **judgment**.

"Result" page of a feature extraction checker

If the execution state is OK, this means that the checker calculation has been successful. All other entries in the field "Execution State" indicate that there is an error (see "Error Log" (see page 187)) or they give a status message (see page 570) for your information.

Highlighting results in the camera image

When you click a result from the list, the corresponding object is highlighted in the camera image. With the keys at the bottom you can leave the highlighting as it is or highlight different results:

Key	Highlighted result
Spacebar	The result selected with the left mouse button is highlighted as long as you hold down the key.
Up arrow	The result above the result selected with the left mouse button is highlighted as long as you hold down the key.
Arrow left	The result left of the result you have selected with a left mouse click will be highlighted as long as you press this key.
Down arrow	The result below the result selected with the left mouse button is highlighted as long as you hold down the key.
Arrow right	The result right of the result you have selected with a left mouse click will be highlighted as long as you press this key.

Only the results within the current displayed image segment are highlighted in the camera image. If a result is outside the segment, but still within the camera image (such as because only part of the complete image is visible after zooming), you can move the current image segment so that the result is positioned in the middle of it. To do so, double-click on the result.

If the result is outside the camera image (this is often the case with indicators), it is usually not possible to move the current image segment so that the result is positioned in the middle of it. In this case a warning message appears on the screen.

When you have inserted a result into the spreadsheet, it is color-highlighted in the checker result list. The default color is a light blue. You can change the default color under **Application → Vision Q.400 Settings → Extras** with the button [Color for Results Inserted in Spreadsheet] (see page 78).

When you want to quickly locate a result already inserted into a spreadsheet, select the result, right-click and choose "Show in the Spreadsheet".

☞ ◆NOTE ═══════════════════════════════════════
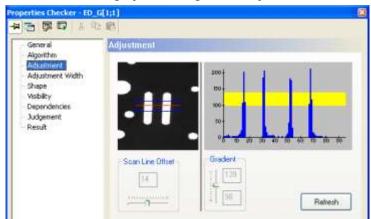
The result must be selected uniquely, meaning only a single color-highlighted result can be selected.

When you select the "Show in the Spreadsheet" function the following happens:

- The spreadsheet is displayed.
- The Spreadsheet Controller is displayed in the workflow window
- Even hidden rows are displayed on the spreadsheet.
- The current spreadsheet row selection is deleted.
- The spreadsheet row belonging to the result is selected and the spreadsheet is scrolled so that the row is within the visible area of the spreadsheet.

9.1.6.14 Adjustment

The "Adjustment" page contains help suggestions for the adjustment of checker parameters. With an edge-detection gray-value checker, for example, the course of the gradient amount is represented as an intersection line in the image. Consequently, the optimal gradient value for the detection of a gray-value edge is readily determined.

"Adjustment" page of a gray-value edge detector

9.1.6.15 Template

On this page, you may enter templates (image sections) needed as a reference for checkers.

9.2 Submenus

With the **Checker** submenus you create checkers for image adjustment and checking, object shapes and indicators. From the checkers you select a type, a shape and where appropriate a search area. When you have selected a checker, indicator or object shape in the camera image, you can execute the object or view or print the properties on screen.

Checker	Spreadsheet	Run Mode	Wind

- New Exposure Adjustment ▶
- New Position Rotation Adjustment ▶
- New Object Shape
- New Processing ▶
- New Geometry ▶
- New Indicator
- Print…
- Properties…
- Execute

"Checker" submenus

Checkers are used either for image PRE-adjustment or for actual checking:

Area of use	Available checkers	Functionality
Adjustments	Exposure Adjustment	Compensating for fluctuations in brightness
	Position adjustment Position and rotation adjustment by: • line-point • angle-point • two points • three points	Position adjustment and/or rotation of a checker shape
	Object Shape	Create a user-defined static or dynamic checker shape based on results of a feature extraction checker
Image processing	Inspection Checkers: • Window checker • Feature Extraction • Edge Detection Binary • Gray-value edge detection checker • Edge detection with gray value projection • Difference Checker • Contour Matching • OCR checker • Code Reader	Checker for the actual image processing
	Geometry checkers: • Point-point • Point-line • Line-line	Calculate results based on results of other checkers
	Indicator	Highlight results on screen using geometric figures, images or texts (also result-dependent)

Below you will find procedures describing how to create checkers with the tool bar and how to rotate checker shapes.

9.2.1   Creating Checkers of Different Shapes

With "simple" shapes like rectangle and line, you only need two left mouse clicks to define the checker shape. The first mouse click sets the start point, the second the end point.

For more complex shapes like polygon, doughnut, or ellipse with direction, the procedures for defining the checker shape are more complicated, see below.
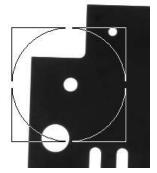
◆ **NOTE**

You can cancel setting a checker shape any time by pressing <Esc>.

9.2.1.1 Doughnut Shapes

◆ **PROCEDURE**
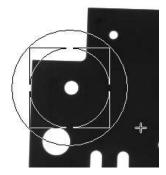
1. **Click a checker type available for doughnut shapes, e.g. feature extraction**

2. **Click the checker shape doughnut**

3. **Click the left mouse button within the image area to define the start point**

4. **Move the mouse to determine the size of the first circle**

5. **Click the left mouse button to close the first circle**
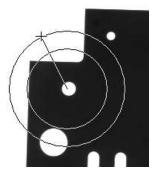
6. **Move the mouse either towards the center of the first circle or outwards to determine the size of the second circle**

7. **Click the left mouse button to close the second circle**

8. **If you want to use the entire doughnut as the search area, right-click to quit defining the shape**

   or
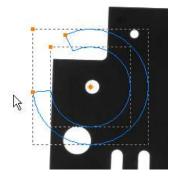
   If you only want to use a segment of the doughnut as the search area, left-click to define the start point of the search area

Vision Q.400 always scans clockwise. Independent of whether you move the mouse clockwise or anti-clockwise to set the end point, the scanning area will always be the section between the start point you have just clicked and the end point.

9. Left mouse click on the end point of the scanning area

Vision Q.400 displays the doughnut (ring segment) selected as the search area in the color you chose for this checker type. You also see the rectangles surrounding the doughnut (ring segment) with dashed lines.
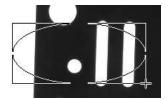
9.2.1.2 Elliptic Shapes for Edge Detection

 ◆ PROCEDURE
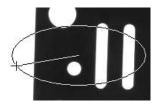
1. Click a checker type available for elliptic shapes, e.g. binary edge detection

2. Click the checker shape ellipse with scanning direction

3. Click the left mouse button within the image area to define the start point

4. Move the mouse to determine the size of the ellipse
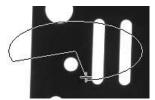
5. Left mouse click to set the ellipse size

6. Click the left mouse button on the start point of the scanning area
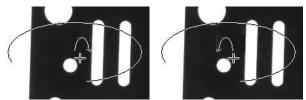
7. If you wish to use the whole ellipse as the scanning area, click the right mouse button and continue with step 9

8. Left mouse click on the end point of the scanning area

Vision Q.400 always scans clockwise. Independent of whether you move the mouse clockwise or anti-clockwise to set the end point, the scanning area will always be the section between the start point you have just clicked and the end point. Next, you need to set the scanning direction of the elliptic arc.
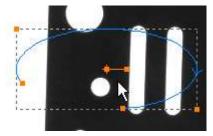
9. Move the mouse to the right to scan clockwise for edges or to the left to scan anti-clockwise

The curved arrow originating from the center point of the ellipse indicates the search direction.

10. Click the left mouse button to finish setting the shape

The elliptic arc defined by start and end point is displayed in the color you have selected for this checker type. Note the arrow head on the checker line indicating the scanning direction (anti-clockwise in this example):
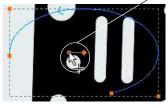
Change scanning direction
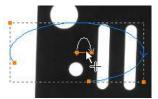
◆PROCEDURE

1. **Select the grip point of the checker**
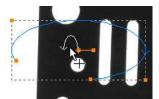
   Left: grip point, right: center point
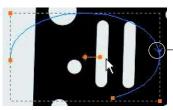
2. **Move the mouse so that the arrow indicating the scanning direction appears**

3. **Move the mouse to the other side of the center point to change the scanning direction**

4. **Click the left mouse button to set the new scanning direction**
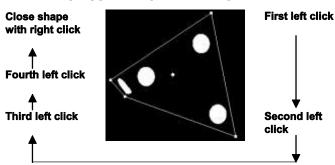
   Arrow indicating new scanning direction

9.2.1.3 Polygon Shapes

1. **Click a checker type available for polygon shapes, e.g. feature extraction**

2. **Click the checker shape polygon**

3. **Click the left mouse button to define the start point**

4. **Click the left mouse button as many times as you need to surround the check area**

5. **Close the polygon shape with a right mouse button click**

9.2.2 Rotating a Checker Shape
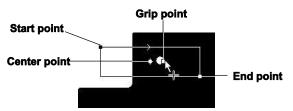
1. **Select the checker shape you wish to rotate**
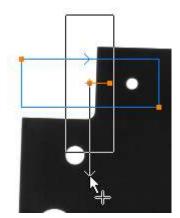
   The checker is highlighted. The start, end, center and the grip point appear as little squares; the center point is additionally marked by a cross.

2. **Position the cursor on the grip point and hold the left mouse button down**
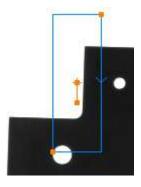
3. **Move the cursor to rotate the checker into the desired position**

A white arrow appears to help you find the right direction and angle.

4. Release the left mouse button when the checker shape has reached the desired position

☞ ◆ **NOTE**

If a checker shape does not rotate as desired, the reason is that the checker shape is moved outside of the image area by the rotation. In this case, activate the "Allow positions outside the image area" option on the "Shape" property page of the checker and then rotate the shape you want.

9.3 Exposure Adjustment Checker

If you use a binary checker, the custom slice level can be adjusted for each new image using an exposure adjustment checker. The exposure adjustment checker calculates the average value of all gray values of the shape and subtracts it from a reference value.

The result (difference) will be added to the current slice level. This is how changes in the light intensity can be compensated for.

9.3.1 Algorithm

Enter the reference value in the field "Reference Brightness". This value is subtracted from the current value. The difference can be modified further with the "Coefficient of delta correction" parameter. The percentage differential value determined is applied. For example, if you enter 200 as the parameter the difference is doubled. If you enter 50, the difference is halved.

☞ ◆NOTE

It is not possible to enter the parameter "Reference Brightness" directly. When you click [Update Reference Value] on the "Result" page, the currently measured average brightness becomes the reference brightness.

The following parameters are available:

Parameter	Permissible value range
Reference brightness	0 ... 255
Coefficient of delta correction	0 ... 200

9.3.2 Shape

The following shapes are available:

- Rectangle
- Ellipse
- Polygon
- Doughnut
- Object shape

9.3.3 Result

The value in the field "Delta Brightness" is the difference between the average brightness and the reference value. This difference has not been modified by the coefficient of delta correction. The value in the field "Average Brightness" is the average of all gray values of the selected shape.

Click [Update Reference Value] to adopt the current average brightness as displayed in the "Result" page as the reference value. Now, when you click the "Algorithm" page, you will find this value in the field "Reference Brightness". Making the current average brightness the reference value means that the "Delta Brightness" becomes zero, and the value displayed on the "Result" page is changed.

"Result" page of an exposure adjustment checker

9.4 White Balance

The white balance function helps to sensitize the camera to the color temperature of the light where the image capturing takes place. As the white balance function is executed during the image capture, all checkers of the selected camera will work on the balanced image.

The white balance function works as follows: First select an image area that is a neutral gray. For teaching the white balance, the mean gray value of all pixels in this image area will be calculated. Afterwards, the factors for each of the color channels red, green, and blue will be calculated that will map the mean gray value to the target gray value. When the white balance is applied, Vision Q.400 recalculates the captured camera image with the calculated factors to obtain a balanced image.

9.4.1 Algorithm

Use this dialog to define for each color camera whether the white balance should be adjusted for each image capture.

Property page "Algorithm" before teaching

Use the white balance function as follows:

◆ PROCEDURE

1. **Select "Use white balance"**

   The first step is teaching.

2. **Select shape**

When you first activate the function, no shape has been selected and the button text reads [Set shape type]. You can select rectangle, ellipse, polygon, or doughnut as the shape.

3. Select [Set shape]

You can change the shape type later by selecting a new shape and confirming with the button [Change shape type].

4. Use the mouse to select a white or neutral gray area for the white balance
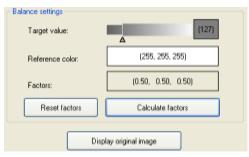
The procedure is the same as for creating checkers (see page 270).

5. Set the target value for the white balance

Click the triangle of the slider. You can move the triangle in any direction as long as you hold the left mouse button down. Alternatively, use the cursor keys to change the current value by 1 as long as the triangles is displayed with a black filling (i.e. it is selected).

6. Select [Calculate factors]

Vision Q.400 captures a new camera image, determines the average gray value in the selected area and calculates the factors for the white balance from the result. The average gray value will be output under "Reference color", the factors in the order red, green, blue under "Factors". If it is not possible to calculate the factors for white balance, for example because this would require dividing by zero, you will see (---, ---, ---) displayed under "Factors". In this case it is not possible to adjust the white balance of the image.

Available options

The following options are available:

Option	Description
Use white balance	Activates the white balance function
New shape type	Defines the shape of the image area where the reference color for the white balance will be determined.
Change/ Set shape type	When you first activate the white balance function, the button text reads [Set shape type]. Once you have set a type, the button reads [Change shape type].
Target value	The gray value to which the reference color is mapped using the factors for white balance.
Reference color	The average gray value determined in the selected area to calculate the factors for the white balance.

Option	Description
Reset factors	Sets all white balance factors to 1.0 and the value under "Reference color" to the value under "Target value" so that no white balancing takes places even though the function is activated.
Calculate factors	Calculates the factors for the white balance. If the factors could be calculated, the balanced image will be displayed.
Display original image	Displays the original image before white balancing. The button remains activated until you click it again. Only then the balanced image will be displayed again.

☞ ◆**NOTE**

- **The original (unbalanced) image can be displayed as long as it has not been deleted implicitly in Vision Q.400. Images will be deleted implicitly for example when Vision Q.400 switches to run mode. When the original, unbalanced image has been deleted implicitly, the button "Display original image" is disabled.**

- **In run mode you can send a command via the serial, the Ethernet or the OLE interface to recalculate the factors for the white balance.**

9.4.2 Shape

The following shapes are available:
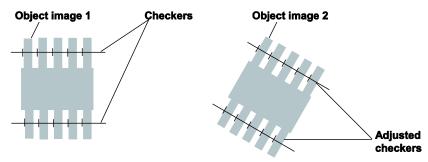
- Rectangle
- Ellipse
- Polygon
- Doughnut

9.5 Position and Rotation Adjustment Checkers

Position and Rotation Adjustment Checkers (PosRot checker) are used if the shape's position has to be adjusted to the current position of the object to be checked.

This is necessary if the position (x; y; α) of the object to be checked is different from the template position of the checker. In such a case, the checkers have to be adjusted to the new object position. The example below shows how checkers measure the distance between IC pins. As the chips may come to lie in a different position under the camera, the checkers (in this case edge detectors) need to be moved and rotated to fit the new position.

Position and rotation adjustment

There are five types of position and rotation adjustment checkers:

- Position Adjustment (PA)
- Position and Rotation Adjustment Line-Point (PRA_LP)
- Position and Rotation Adjustment Angle-Point (PRA_AP)
- Position and Rotation Adjustment Two Points (PRA_2P)
- Position and Rotation Adjustment Three Points (PRA_3P)
  (the abbreviations in brackets are used in Vision Q.400 for the preprocessing checkers)

In this section you find a general description which applies to all position and rotation adjustment checkers.

☞ ◆ NOTE

A checker which uses a dynamic object shape as its shape cannot use position and rotation adjustment.

9.5.1 Reference Value

Position and rotation adjustment checkers do not calculate results from the shape to be checked but use results from other checkers to obtain the necessary correction value. In order to do so, the user assigns a checker whose results will be used as reference value. Which values are used for reference and on which checker the PosRot checker will depend is defined on the "Dependencies" page of the PosRot checker.

You can remove a checker value you inserted in the "Dependencies" property page by right-clicking on the value you want to remove and choosing "Remove" from the pop-up menu.

Highlighting results in the camera image

When you click on a result from the list on the property page, the object concerned is highlighted in the camera image. With the keys at the bottom you can leave the highlighting as it is or highlight different results:

Key	Highlighted result
Spacebar	The result selected with the left mouse button is highlighted as long as you hold down the key.
Up arrow	The result above the result selected with the left mouse button is highlighted as long as you hold down the key.
Down arrow	The result below the result selected with the left mouse button is highlighted as long as you hold down the key.

Only the results within the current displayed image segment are highlighted in the camera image. If a result is outside the segment (such as because only part of the complete image is visible after zooming) you can move the current image segment so that the result is positioned in the middle of it. To do so, double-click on the result.

9.5.2   Current Value

You find the current value of a checker serving as a reference value for a PosRot checker in the column headed "Current Value" on the "Dependencies" page.

9.5.3 Base Values
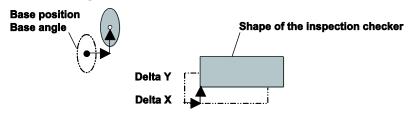
The values base position/base angle define the point of origin of the adjustment. They are calculated from the reference values and appear on the "Algorithm" page once you have executed the checker. All correction values refer to the base position/base angle:

Base position and angle for position and rotation adjustment

9.5.4 Correction Value

All position and rotation adjustment checkers provide correction values for all the dependent checkers so that the shape's position can be adjusted. Up to three adjustment values are calculated, depending on the type of position and rotation adjustment: **Delta X, Delta Y** and the **Delta angle**.

Correction value for position and rotation adjustment

A change of the angle will be adjusted if you selected the adequate position and rotation adjustment type.

The correction values (delta values) are obtained from the base and the current values. Correction values are always whole numbers, as checker shapes can be adjusted only with pixel accuracy.

The following checkers provide reference values for a position and rotation adjustment and can be used as reference checkers in the dependency list of a PosRot checker:

Checker	Reference value
Edge Detection Binary (ED_B)	Point, angle
Edge Detection Gray Value (ED_G)	Point, angle (correction is not executed with subpixel values)
Edge Detection Gray Value Projection (ED_GP)	point, 2nd point (in "execution mode" = "edge pair")
Difference (DI)	Point, angle of the pattern matching on the "Results" page
Feature Extraction (FE)	Gravity, angle, smallest rectangle rotated, circumcircle, hidden circle (result values should refer to the same real object)
Contour Matching (CM)	Point, reference point, angle
Code Reader (CR)	Point
Geometry Point-Point (G_PP)	Gravity, angle ALPHA
Geometry Point-Line (G_PL)	Foot point
Geometry Line-Line (G_LL)	Intersection point, angles ALPHA and BETA

Checkers and checker results which do not appear in the table above cannot be entered into the dependency list, i.e. other checkers cannot be used to determine reference values for a position and rotation adjustment.
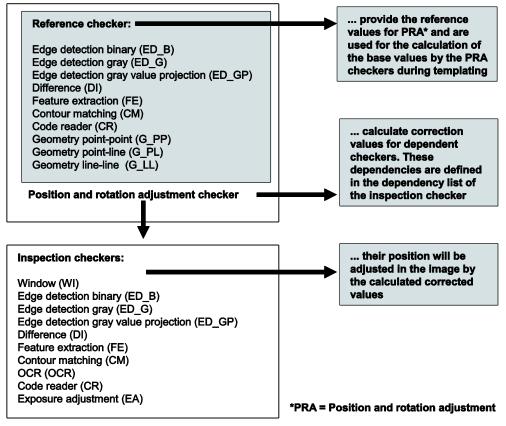
☞ ◆‾NOTE‾ ——————————————————————————

The center of motion and the direction can be provided by several checkers but should refer to one and the same real object.

9.5.5   Dependency of a Shape Position

The diagram shows what each type of checker/preprocessing checker is used for.

Reference checker:

Edge detection binary (ED_B)
Edge detection gray (ED_G)
Edge detection gray value projection (ED_GP)
Difference (DI)
Feature extraction (FE)
Contour matching (CM)
Code reader (CR)
Geometry point-point (G_PP)
Geometry point-line (G_PL)
Geometry line-line (G_LL)

Position and rotation adjustment checker

... provide the reference values for PRA* and are used for the calculation of the base values by the PRA checkers during templating

... calculate correction values for dependent checkers. These dependencies are defined in the dependency list of the inspection checker

Inspection checkers:

Window (WI)
Edge detection binary (ED_B)
Edge detection gray (ED_G)
Edge detection gray value projection (ED_GP)
Difference (DI)
Feature extraction (FE)
Contour matching (CM)
OCR (OCR)
Code reader (CR)
Exposure adjustment (EA)

... their position will be adjusted in the image by the calculated corrected values

*PRA = Position and rotation adjustment

Usage of position and rotation adjustment checkers

When establishing dependencies, take into account that:

- **Reference checker**
  provide the values during "teaching" Vision Q.400 the point of origin of the adjustment. These values are used to calculate the base values x0, y0 and α0 during teaching and are updated with every inspection.

- **Position and rotation adjustment checker**
  calculate and save the base values during "teaching" Vision Q.400 the point and angle of origin of the adjustment. With every inspection they use the current and the base values to calculate the correction values Δx, Δy and $\Delta\alpha$.

- **Correction values Δx, Δy and $\Delta\alpha$**
  are added to the base values and the shape will be moved to the right position.

Enter the results of the reference checker on which the PosRot checker depends into the "Dependencies" page of the PosRot checker. Transfer the results via drag & drop from the "Result" page of the reference checker.

When entering the checker results into the table, reference and current values are the same. The values will differ only after the checker has been executed. Current values will be used as

new reference values in the column "Reference Value" when you click [Copy Current Values]. This will also make Vision Q.400 recalculate the base values.

Always click [Copy Current Values] if
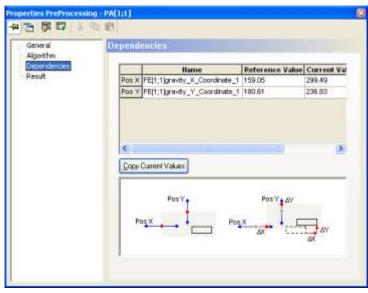
- you have already executed the checkers and add a new checker afterwards or
- the position of one of the checkers depending on a position and rotation adjustment has been changed.

☞ ◆NOTE ─────────────────────────────────

- **If you set a position and rotation adjustment checker, we recommend saving the image as a bitmap. When you need to add checkers later, use the saved bitmap image to define the checkers and their dependency from the position and rotation adjustment.**
- **Copying the current values and recalculating the base values does not mean the checker will be executed.**
- **Not all checker results can be entered into the dependency list.**
- **A PosRot Checker cannot be executed if a checker it depends on has not been executed. As a result, the checkers depending on the PosRot checker will not be executed, either.**
- **If you use the results of a feature extraction checker, for example, make sure that you always use the same object for the dependencies. You have to make sure that the sequence of the objects in the result list is correct either by using the option "Output Order" on the "Algorithm" page or by using filters.**
- **When you have carried out a position and rotation adjustment at least once, i.e. the position of the checkers depending on the PosRot checker has been adjusted accordingly, it is not sufficient to click [Copy Current Values] when you need to set new checkers. The values for the position / rotation adjustment have been updated, but the checkers set before still depend on the original base values and need to be adjusted manually. Otherwise, they will not be positioned correctly when you execute the application again. Only after the manual adjustment can you set new checkers.**
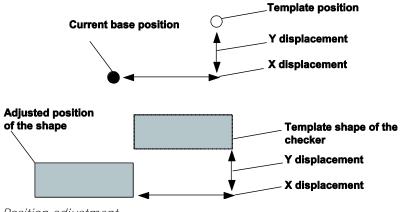
9.5.6 Position Adjustment Checker

Reference checker	Reference value	Base value	Result
ED_B, ED_G, ED_GP **FE** **DI** **CM** **CL** **G_PP, G_PL, G_LL**	X-coordinate Pos X and / or Y-coordinate Pos Y	The reference value in the dependency list and the base value of a position adjustment checker are identical	Current and delta values for X-coordinate Y-coordinate
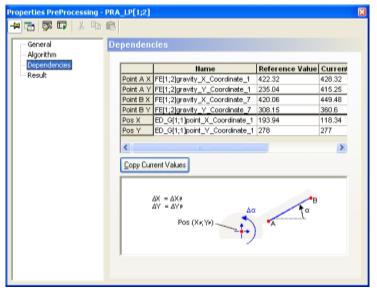
"Dependencies" page of a position adjustment checker

By clicking on the checkbox in the "Use" column, you delete the corresponding row. This way it is possible to execute the position adjustment in one direction only. You can replace a row by dragging & dropping a new result from an inspection checker's "Result" page.
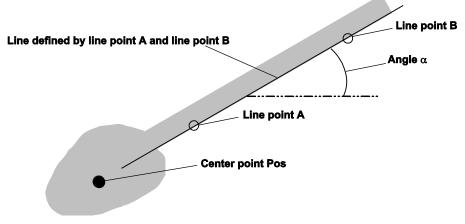
Position adjustment

9.5.7 Position and Rotation Adjustment Line-Point

Reference check-er	Reference value	Base value	Result
ED_B, ED_G, ED_GP **FE** **DI** **CM** **CL** **G_PP, G_PL, G_LL**	Center point Pos (center of motion and point of origin of the displacement) Points defining the line: line point A line point B	Center point Pos Angle α is the angle between the horizontal line and the line defined by line point A and line point B	Current and delta values for: X-coordinate Y-coordinate Angle

"Dependencies" page of a position and rotation adjustment line-point checker
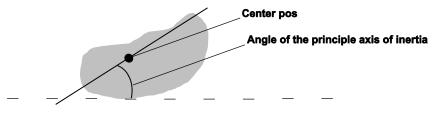
Example for position and rotation adjustment line-point

9.5.8   Position and Rotation Adjustment Angle-Point

Reference checker	Reference value	Base value	Result
ED_B, ED_G, ED_GP **FE** **DI** **CM** **CL** **G_PP, G_PL, G_LL**	Center point Pos Angle α of the object position provided by a feature extraction or edge detection checker, for example	The reference values in the dependency list and the base values are identical for position and rotation adjustment	Current and delta values for: X-coordinate Y-coordinate Angle

"Dependencies" page of a position and rotation adjustment angle-point checker

Example for position and rotation adjustment angle-point

◆NOTE
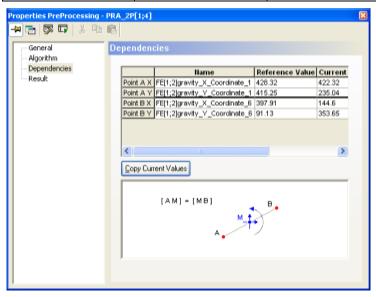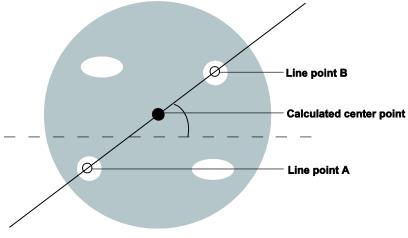
The reference angle entered under "Angle" can be in the range of 0° to 180° or 0° to 360°. This depends on the angle result from the reference checker used for the position and rotation adjustment. The PRA_AP checker determines the valid angle range automatically from the reference checker result to calculate the correction angle.

9.5.9   Position and Rotation Adjustment Two Points

Reference checker	Reference value	Base value	Result
ED_B, ED_G, ED_GP **FE** **DI** **CM** **CL** **G_PP, G_PL, G_LL**	Points defining the line: line point A line point B	Center: center point M of the straight line which is defined by the line points Angle α between the horizontal line and the line defined by line point 1 and line point 2	Current and delta values for: X-coordinate Y-coordinate Angle
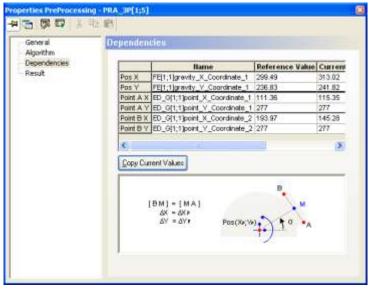
"Dependencies" page of a position and rotation adjustment two points checker
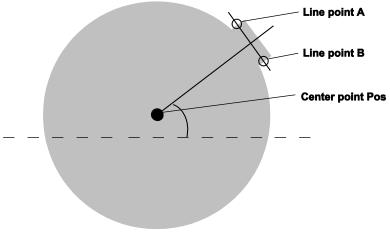
Example for position and rotation adjustment two points

9.5.10 Position and Rotation Adjustment Three Points

Reference check-er	Reference value	Base value	Result
ED_B, ED_G, ED_GP FE DI CM CL G_PP G_PL G_LL	Center point Pos Points defining the line: line point A line point B	Center point Pos Angle α between the line defined by the line points and the horizontal line Vision Q.400 calculates the center point of the line defined by line point A and line point B. The center point and the point Pos define another line. The angle of this line in relation to the horizontal line is the base angle (angle α).	Current and delta values for: X-coordinate Y-coordinate Angle

"Dependencies" page of a position and rotation adjustment three points checker

Example for position and rotation adjustment three points

9.5.11 **Algorithm**

On the "Algorithm" page of the position and rotation adjustment checker Vision Q.400 displays the base values (see page 284) after the first execution of the checker.

9.5.12 **Result**

The following results can be obtained from a position and rotation adjustment checker:

- Current Position X
- Current Position Y
- Current Angle (not position adjustment checker)
- Delta X
- Delta Y
- Delta Angle (not position adjustment checker)

Delta values are correction values (see page 284) and are calculated with the base value and the current value.

9.6 Object Shape

In many inspections it is sufficient to use a predefined, unchanging area which can be moved around the image with a position adjustment. For check areas of constantly changing shape and/or size (such as bread rolls), or for complex check areas (such as conductor tracks) that is not possible, or only with great effort. For these cases you can use the object shape. The function defines a check area using pre-calculated objects and then analyzes this area precisely.

Four steps are necessary for this:

1. Determine the objects which define the check area. This is done using feature extraction checkers.
2. Define the check area from those objects. You use the object shape for this.
3. Assign the check area to other checkers, such as a feature extraction checker.
4. Execute the actual inspection

How you use the object shape is explained on the basis of two different examples.

- Object shapes for amorphous objects (see page 300) by bread rolls which are to be examined for burnt areas
- Object shapes for complex objects (see page 306) by conductor tracks which are to be examined for defects

The following checkers can use an object shape as a shape:

Exposure Adjustment (EA) (see page 277)

Window (WI) (see page 312)

Feature Extraction (FE) (see page 314)

Optical Character Recognition (see page 401)

Code Reader Checker (CR) (see page 426)

◆ **NOTE**

The object shape must be positioned in the checker sequence BEFORE the inspection checker which is to use the object shape as a shape.

9.6.1 **Dependencies**

"Dependencies" property page to calculate the object shape

There are basically two cases in which you can use an object shape:

1. The shape of the check area changes on every check. In this case you need a dynamic shape.
2. The shape of the check area remains the same, but it is so complex that it can only be created with great effort (such as using a polygon), or it consists of multiple unconnected areas, or it contains "holes". In this case you need a static shape.

Dynamic shape

When you select a "Dynamic shape", the check area is calculated on every check from the objects you dragged into the list of dependencies. This means that the check area changes as soon as one of the objects used for its calculation changes.

☞ ◆ NOTE

Checkers which use a dynamic object shape cannot be adjusted with a position adjustment. By contrast, position adjustment is possible for checkers which use a static object shape.

Since the check area is always calculated from the current objects, it may occur that one of the objects is empty or does not exist in the current check. For this case it is advisable to activate the "Allow empty objects for dynamic shapes" option. Then empty or non-existent objects are ignored in calculation of the check area and the check area is calculated only from the other objects. If you have not activated "Allow empty objects for dynamic shapes", the check area is not calculated when one of the objects is empty or does not exist, and the object shape returns a dependency error as the result.

Static shape

If you choose "Static shape" the check area is calculated at the following points in time:

- When you first activate the "Static shape" option button
- When you add a new object to the dependencies list or
- When you select one of the two icons (see below).

The check area is not recalculated on every check. This means the static object shape enables you to calculate a complex check area once in advance and then reuse it for every check. Static object shapes can also be adjusted in the image with a position adjustment.

Available buttons

Button	Functionality
	Only available when you have activated "Static shape" and the object list contains at least one object. This updates the selected object, meaning you recalculate the static check area with the updated object.
	Only available when you have activated "Static shape" and the object list contains multiple objects. This updates all objects, meaning you recalculate the static check area with the updated objects.
	Deletes the selected object from the dependencies list. Alternatively, you can also right-click on the object you want to delete and from the pop-up menu choose "Delete". A static check area is recalculated in this case.

Highlighting results in the camera image

When you click on a result from the list on the property page, the object concerned is highlighted in the camera image. With the keys at the bottom you can leave the highlighting as it is or highlight different results:

Key	Highlighted result
Spacebar	The result selected with the left mouse button is highlighted as long as you hold down the key.
Up arrow	The result above the result selected with the left mouse button is highlighted as long as you hold down the key.
Down arrow	The result below the result selected with the left mouse button is highlighted as long as you hold down the key.

Only the results within the current displayed image segment are highlighted in the camera image. If a result is outside the segment (such as because only part of the complete image is visible after zooming) you can move the current image segment so that the result is positioned in the middle of it. To do so, double-click on the result.

There are two ways of displaying an object used in an object shape:

1. The object is displayed as it exists currently in the checker from which it originates.
2. The object is displayed as it is stored in the object shape.

These two displays modes of the object shape usually do not match.

- For the dynamic object shape option 1 is the standard view, as in it the current object from the checker is always used.
- For the static object shape option 2 is the standard view, as in it the object from the shape is always used.

The <Ctrl> key can be used to switch display mode.

Type of object shape	When <Ctrl> is not pressed	When <Ctrl> is pressed
Dynamic shape	The current shape of the result in the checker is displayed.	The shape of the result which the object had when the result was inserted into the object list is displayed.
Static shape	The shape of the result which the object had when the result was inserted into the object list, or on the last update of the object, is displayed.	The current shape of the result in the checker is displayed.

The "Formula" field contains the formula used to calculate the check area from the objects. The default uses the combination of all objects in the object list. The combination of objects is indicated in the formula by "+". If you select "User-defined", you can enter your own custom formula (see page 297). To do so, open the Formula Editor by clicking the [Change Formula >>] button.

9.6.1.1 Formula Editor to Calculate the Object Shape

This formula calculates the complement of two objects.

Formula Editor to calculate the object shape

All objects in the object list can be interlinked by way of the operators and brackets. You can use each object as often as you want. The following operators are available:

Symbol	Operator	Example
+	Combination	A+B
*****	Intersection	A*B
-	difference	A-B
/	Symmetric difference	A/B
~	Complement of the object for the complete image	~A

The examples in the table are merely representative; more than two objects can also be inter-linked. If there are more objects available than can be displayed in the Formula Editor, use

the and buttons to display the previous and next objects. To check the formula click on the [Apply] button (Formula Editor remains open) or click [OK] (Formula Editor is closed).

You can insert operators and object names as follows into the formula:

- Select the relevant buttons at the right
- Type the formula directly into the input box

If you are creating the formula using the buttons and have checked the "Insert blank" check-box, a blank is inserted into the formula before the button text is inserted. With "Insert CR" a carriage return is inserted after each object.
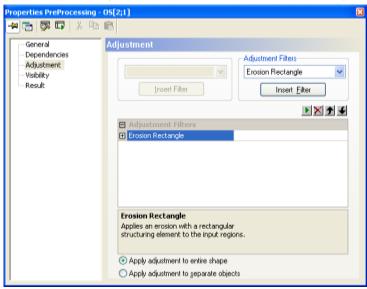
📢 ◆NOTE

If you clear everything from the formula input box or do not enter anything in the first place, the system automatically uses the combination of all objects in the object list.

Button	Description
OK	Use this button to save all changes and close the formula editor. Please note that this is only possible if the entered formula is correct. Otherwise you will get a warning message.
Apply	Use this button to accept all changes to the formula. The editor window stays open. Please note that this is only possible if the entered formula is correct. Otherwise you will get a warning message.
Undo	Use this button to undo all changes which you have made since you have last clicked [Apply].
Cancel	Use this button to leave the formula editor without saving any of the changes made since you have last clicked [Apply].

9.6.2 Adjustment

With the filters you enter on the "Adjustment" property page you can modify the check area you are calculating. These filters corresponds to the binary image filters (see page 246).

"Adjustment" property page to modify an object shape
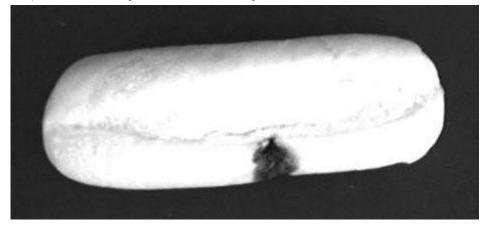
In use of the adjustment filters you have two options for influencing the order of the individual steps when calculating objects:

- If you choose "Apply adjustment to whole shape", the object shape is calculated in this order:

  1   Calculate the check area based on the formula entered under "Dependencies"

  2   Apply the filter to the calculated check area

- If you choose "Apply adjustment to separate objects", the object shape is calculated in this order:

  1   Apply the filter of each individual object

  2   Calculate the check area based on the formula entered under "Dependencies"

☞   ◆NOTE

It makes no difference whether you use "Apply adjustment to separate objects" or edit the objects first through the filters of the feature extraction checker. There is only a difference when you use the same objects in different object shapes: If you edit the objects with feature extraction checker filters, the edited objects are used in all object shapes. But if you use the adjustment filters of the object shape, you can edit the objects in every object shape with different filters.
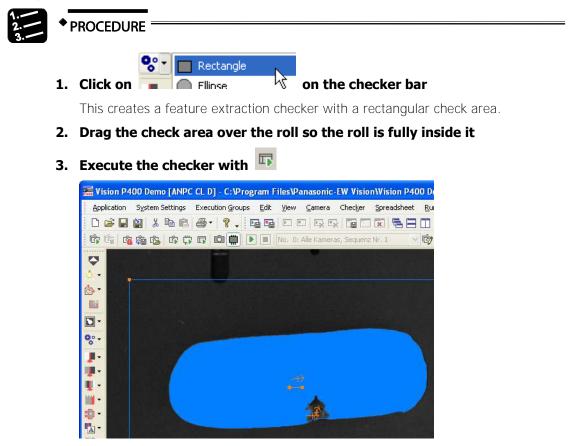
9.6.3   Example with an Amorphous Object

The bread roll in the example image is to be examined for burnt areas (black staining). The shape of the roll may be different in every check.

Identifying the roll

First you must find the roll.

◆ PROCEDURE

1. **Click on** [Rectangle / Ellipse] **on the checker bar**

   This creates a feature extraction checker with a rectangular check area.

2. **Drag the check area over the roll so the roll is fully inside it**

3. **Execute the checker with**

The burnt spot is currently not part of the object found - the bread roll. It must, however, be added to the object using a filter so that it later belongs to the check area and can be assessed. To do this use a binary closing filter, to be found on the "Image Filters" (see page 246) property page of the feature extraction checker. Alternatively, you can also use the unfiltered object in the object shape and configure the closing filter on the "Adjustment" property page of the object shape.

4. **Select the "Image Filters" property page of the feature extraction checker**
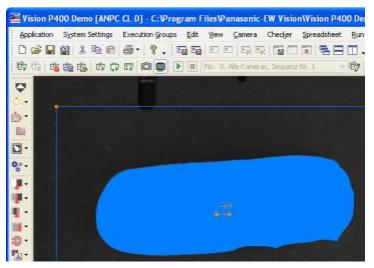
5. **Under "Binary Image Filters" in the list box select "Closing"**

6. **Click on [Insert Filter]**

7. **Double-click on "Closing" to set the filter radius**

8. **In the "Filter Radius" list box select the setting "60.5"**

   You can test the effects of the filter with the configured parameters in the camera image by clicking the ▶ icon.

9. **Execute the checker with** ⬛

   Now an area corresponding to the shape of the bread roll is marked out.

Define the complete roll as the check area for the object shape

As the bread roll is to be examined for defects, the complete roll with no burn marks must be defined as a check area.
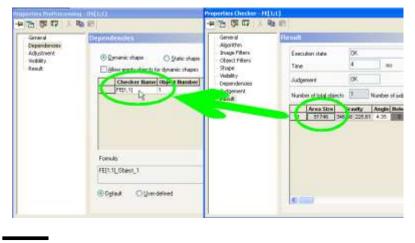
◆PROCEDURE

1. **Click on** [icon] **on the checker bar**

   The properties window of the object shape opens up on the "Dependencies" page. The object shape enables the irregular roll shape to be defined as a dynamic shape for the feature extraction checker which is to check the roll for burnt spots.

2. **Open the Properties window of the feature extraction checker**

3. **Click on the "Result" property page**

4. **Drag the result with the mouse from the result series belonging to the selected object into the dependencies list of the object shape**

◆NOTE

Make sure the "Dynamic shape" option is activated on the "Dependencies" page of the object shape. Only then will the check area be recalculated on every check and adjust to the current shape of the roll

Assign the object shape check area for the actual check

In the last step you assign the check area you identified by way of the feature extraction and object shape to another feature extraction checker which examines the roll for burnt spots.

◆ PROCEDURE

1. **Click on** [icon] **on the checker bar**

   When you click on a checker on the checker bar, the shapes available for that checker are displayed on a submenu. If you have not yet created an object shape, the "Object Shape" option is grayed out.

2. **Click on "Object Shape"**

   The "Object Shape Checker" window appears.

3. **Confirm OF(1;1) with [OK]**

4. **Execute the checker with** [icon]

   On the result page all nonconformance to the complete (ideal) bread roll is listed. Based on the results under "Area size", "real" and "unreal" defects can be distinguished.

So as to only find "real" defects, set the limit values on the "Object Filters" property page

5. **Click on "Object Filters"**

6. **Activate "Select Objects"**

7. **In "Lower limit" enter a value above the largest "unreal" defect**
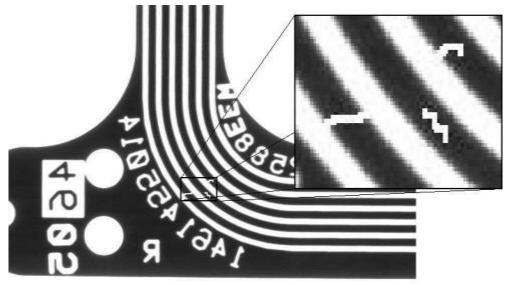
8. **Execute the checker with**

Now only the burn mark is detected as a defect.

9.6.4 Example with a Complex Static Object

The conductor tracks in the example image are to be examined for cracks, fractures or other defects. The check area remains the same in every check (static object shape). It is possible to check the conductor tracks with the aid of polygons, but it is very involved. You would have to create a separate checker for each track. It is easier to calculate the check area for all conductor tracks with one object shape.

Identify the conductor tracks

First you must find the conductor tracks as objects. To do so, use an image with defect-free conductor tracks.

◆ PROCEDURE

1. **Click on** [Rectangle / Ellipse] **on the checker bar**

   This creates a feature extraction checker with a rectangular check area.
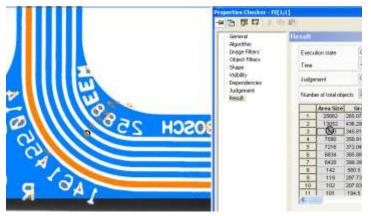
2. **Drag the check area over the conductor tracks so the conductor tracks are fully inside it**

3. Execute the checker with

With the default settings of the feature extraction checker other objects are found in addition to the conductor tracks. You have two options to use only the conductor tracks for the check area:

1. You use only the objects which represent conductor tracks

2. You exclude all objects which are not conductor tracks.
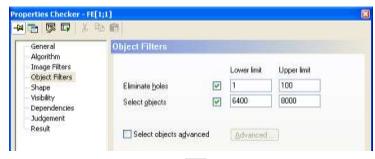
The example shows how you can apply the second option. The objects are sorted in descending order of area size. Clicking on the individual results highlights the associated object in the camera image (orange by default).

When you click on the objects in the result list in succession, you find that the conductor tracks have an object size of between around 5900 and 7500. With this data you can use an object filter (see page 258) to separate the conductor tracks from the other objects.

4. Click on the "Object Filters" property page

5. Activate "Select Objects"

6. In the "Lower limit" field enter 5900

7. In the "Upper limit" field enter 7500

8. Execute the checker with

Now only the conductor tracks are found.

Define the defect-free conductor tracks as the check area for the object shape

As the conductor tracks are to be examined for defects, the defect-free conductor tracks must be defined as a check area.
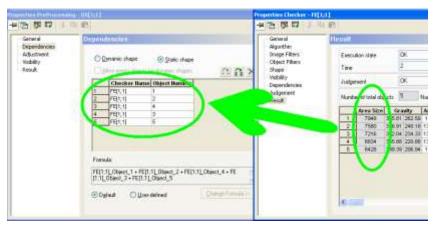
◆ PROCEDURE

1. Click on **on the checker bar**

The properties window of the object shape opens up on the "Dependencies" page.

2. Activate "Static shape"

3. Open the Properties window of the feature extraction checker

4. Click on the "Result" property page

5. For each track drag a result with the mouse into the dependencies list of the object shape

It is not possible to transfer more than one result at once into the dependencies list.

If multiple objects are entered in the dependencies list of an object shape, the combination of the areas of the individual objects is used as the check area by default. This is indicated by the fact that in the formula field all entered objects are linked by a "+" (for combination) and that the "Default" option is activated.

☞ ◆ NOTE ─────────────────────────────

Make sure the "Static shape" option is activated on the "Dependencies" page of the object shape. As a result the check area is calculated once when you apply the settings with 🔲 or switch to another property page. The check area is not recalculated during the check. In this way you can calculate complex check areas such as the conductor tracks in advance and reuse them over and over.

Assign the object shape check area for the actual check

In the last step you assign the check area you identified by way of the feature extraction and object shape to another feature extraction checker which examines the conductor tracks for cracks, fractures or other defects.

◆ PROCEDURE

1. **Click on** **on the checker bar**

   When you click on a checker on the checker bar, the shapes available for that checker are displayed on a submenu. If you have not yet created an object shape, the "Object Shape" option is grayed out.

2. **Click on "Object Shape"**

   The "Object Shape Checker" window appears.

3. **Confirm OF(1;1) with [OK]**

   To find defects on the conductor tracks a number of other settings are required.

4. **Click on the "Algorithm" property page**

5. **Under "Object type" choose "Not selected"**
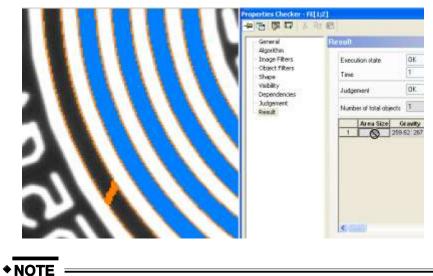
   Consequently the feature extraction checker returns all conductor track nonconformance as its result.

6. **Execute the checker with**

If the conductor tracks are defect-free the feature extraction checker returns no results.

If the conductor tracks have cracks or fractures, the feature extraction checker finds objects.

☞ ◆**NOTE**

Checkers which use a dynamic object shape cannot be adjusted with a position adjustment. By contrast, position adjustment is possible for checkers which use a static object shape.

9.7 Window Checker

The window checker works in the binary image and counts the pixels selected or not selected within its shape.

9.7.1 Algorithm

Depending on whether you are processing a gray-value image, a color channel of a color image or a color image, you can either use checker-specific slice levels (see page 236) or the checker-specific color selection (see page 243). How to set checker-specific slice levels or perform a checker-specific color selection is described in the chapter about the checker property sheets (see page 246).

"Algorithm" page of a window checker

Object type

Here you determine which pixels will define an object. If you choose "Selected", the objects will be generated from the pixels within the specified binarisation range. If you choose "Not Selected", the objects will be generated from the pixels which fall outside the specified range.

9.7.2 Image/Object Filters

All image (see page 246) and object filters (see page 258) are available.

9.7.3 Result

"Area Size" describes the number of pixels counted. The OK or NG judgement refers to the values entered for "Area size: Lower/Upper limit" on the "Judgement" property page.

9.7.4 Shape

Four different shapes are available for a window checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut
- Object Shape

"Shape" page of a window checker

☞ ◆NOTE

- **All coordinates must fall within the image range. The image range depends on the camera used. All angles (see page 228) must be within the range of 0 – 360 degrees.**
- **When you change the parameters in such a way that parts of the shape come to lie outside the image area, Vision Q.400 will only accept your changes if you have activated the option "Allow positions outside the image area".**

9.8 Feature Extraction Checker

The feature extraction checker calculates the features of those objects which remain after binarisation and filtering with binary filters.

9.8.1 Algorithm

Depending on whether you are processing a gray-value image, a color channel of a color image or a color image, you can either use checker-specific slice levels (see page 236) or the checker-specific color selection (see page 243). How to set checker-specific slice levels or perform a checker-specific color selection is described in the chapter about the checker property sheets (see page 246).

"Algorithm" page of a feature extraction checker

Object type

Here you determine which pixels will define an object. If you choose "Selected", the objects will be generated from the pixels within the specified binarisation range. If you choose "Not Selected", the objects will be generated from the pixels which fall outside the specified range.

Area boundary

Use this parameter to define whether or not an object to be processed will be allowed to touch the shape. If "Area Boundary" is set to OFF, an object to be processed will not be permitted to touch the shape. If the parameter is set to "ON", the object to be processed will be permitted to touch the shape.

Parameter "Area Boundary"

With "Area Boundary" set to "ON", object 1 and object 2 would be processed. With "Area Boundary" "OFF", only object 1 would be processed since object 2 touches the shape.

Labeling

If "Labeling" is "OFF", all pixels within the selected range will be gathered into an object. If, however, "Labeling" is "ON", only pixels linked to one another within the 8-fold neighboring relationship will be gathered into one object.

Labeling OFF → 1 object   **Labeling ON → 3 objects**   **8-fold-neighboring relationship**

Parameter "Labeling"

As shown in the example, the three black objects are treated as one object with "Labeling" = "OFF". Vision Q.400 calculates the center of gravity for this object as well as the features selected on the "Algorithm" page. With "Labeling" = "ON", the objects are treated as three separate objects. Vision Q.400 then calculates the center of gravity and the selected features for each of the three objects individually.

If the checker uses a color image, there is a third option "By color" apart from "On" and "Off". When you select this option, all pixels that have the color selected on the property sheet "Color Selection" and that are linked to one another within the 8-fold neighboring relationship will be gathered into one object.

With "By color", Vision Q.400 creates an object for each selected color independent on whether the checker shape contains pixels with that color or not. If there are no pixels with the color specified, the area result is 0.

Angle (for each object)

Use this parameter to control whether Vision Q.400 should output the angle between the inertia axis and a virtual horizontal line (0° to 180°) or whether Vision Q.400 should determine the object orientation (0° to 360°) by taking into the account the center of gravity.

Maximal number of objects

Use this parameter to limit the number of objects to be processed. You may process a maximum of 32767 objects. When there are more objects than the maximal number entered, Vision Q.400 only calculates and displays the features of the set number of objects in the order specified under "Output Order" on the "Algorithm" page and ignores the rest. The selected objects will be subjected to binary filter operations and their number will be limited especially by the size limits to which all objects must conform.

Parameter values

The following parameter values are valid for the "Algorithm" page of the feature extraction checker:

Parameter	Permissible value range
Selected range	-254 ... 254
Maximal number of objects	1 ... 32767
Object type	Selected / Not selected
Area Boundary	ON / OFF
Labeling	On / Off or Off / By color / On
Angle (for each object)	Inertia axis (0°-180°): angle between the inertia axis and a virtual horizontal line
	Orientation (0°-360°): angle between the inertia axis and a virtual horizontal line taking into account the center of gravity

9.8.1.1 Output Order

This parameter determines the sequence order in which the objects will appear in the results list. Depending on which object features are calculated, you can display the objects according to different criteria in ascending or descending order. One typical sorting criteria for objects is an ascending output order sorted by size or coordinates. Further possibilities of sorting the output are:

Setting	Way of sorting the output	Example
Character mode	If the objects form a rough line, they will be output as you would read a text, i.e. they will be sorted from top left to bottom right ("ascending") or from bottom right to top left ("descending"). Vision Q.400 uses the object's point of gravity for sorting.	
Column-by-column	If the objects form a rough column, they will be sorted in columns from top left to bottom right ("ascending") or from bottom right to top left ("descending"). Vision Q.400 uses the object's point of gravity for sorting.	
Circular order	If several objects are situated in a roughly circular fashion around the center of the checker shape, the output order is determined by the angle between the virtual line from the object's point of gravity to the checker's center point and a virtual horizontal line.	
Angle	The objects will be sorted by their angle to a virtual horizontal line.	
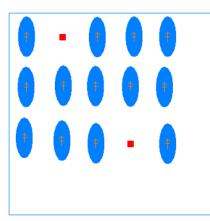
Output order "List"

The output order "List" helps you to determine whether an object is at the position where you expect it to be or not. First, you need to teach Vision Q.400 a list of objects which are all correctly positioned. The position of the object in this list is equal to the number of the object in the result list of the checker.

☞ ◆**NOTE**
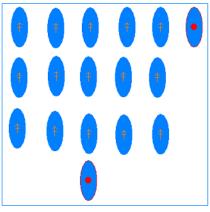
If you want to use the output order "List", the checker cannot depend on a position and rotation adjustment checker.

When you execute the checker, Vision Q.400 compares the position of all objects detected with the positions of the objects taught in the list. When an object cannot be detected, its object number appears read in the result list of the checker. All object features are displayed as "-". In the checker shape, Vision Q.400 indicates with a red square the position of an object that should have been there but could not be detected.

	Area Size	Gravity		Angle	Holes	Roundness	Co
1	2613	88.21	73.45	90	0	0	
2	-	-	-	-	-	-	
3	2613	244.21	74.45	90	0	0	
4	2613	325.21	73.45	90	0	0	
5	2613	399.21	73.45	90	0	0	
6	2613	87.21	184.45	90	0	0	
7	2613	169.21	181.45	90	0	0	
8	2613	240.21	182.45	90	0	0	
9	2613	317.21	183.45	90	0	0	
10	2613	392.21	184.45	90	0	0	
11	2613	83.21	296.45	90	0	0	

If the checker detects additional objects, i.e. objects not included in the taught list, the new objects are added to the end of the result list of the checker. The object number of the first of these objects is the number of objects in the object list plus 1. In the checker shape an additionally found object is marked by a red circle and red border.

	Area Size	Gravity		Angle	Holes	Roundness	Co
7	2613	169.21	181.45	90	0	0	
8	2613	240.21	182.45	90	0	0	
9	2613	317.21	183.45	90	0	0	
10	2613	392.21	184.45	90	0	0	
11	2613	83.21	296.45	90	0	0	
12	2613	166.21	302.45	90	0	0	
13	2613	241.21	308.45	90	0	0	
14	2613	318.21	310.45	90	0	0	
15	2613	399.21	309.45	90	0	0	
16	2613	473.21	73.45	90	0	0	
17	2613	240.21	411.45	90	0	0	

When you create the list of objects, Vision Q.400 enters the object coordinates from the list automatically into the spreadsheet. For the lower respectively upper limit Vision Q.400 uses the coordinates minus/plus 10 pixel. You can modify these limits in the spreadsheet according to your requirements. When you execute the checker, Vision Q.400 relates a detected object to an object from the list if the object coordinates are within the limits entered in the spreadsheet.

The list of objects is not updated automatically. If you wish to add an object to or delete an object from the list, select the [Update List] button to update both the list of objects and the spreadsheet.

If an object cannot be detected, its coordinates will be judged with "Forced NG" in the spreadsheet. In the example Vision Q.400 could not detect object 2. The result cells for the coordinates are empty, the judgment is "Forced NG".

	Result Name	Value	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start					
	MG[1;1]Schwerpkt_X_Koord_1	88.21	88.21	78.21	98.21	OK
	MG[1;1]Schwerpkt_Y_Koord_1	73.45	73.45	63.45	83.45	OK
	MG[1;1]Schwerpkt_X_Koord_2			158.21	178.21	Forced NG
	MG[1;1]Schwerpkt_Y_Koord_2			65.45	85.45	Forced NG
	MG[1;1]Schwerpkt_X_Koord_3	244.21	244.21	234.21	254.21	OK
	MG[1;1]Schwerpkt_Y_Koord_3	74.45	74.45	64.45	84.45	OK

Example with spreadsheet results when you use output order "List"

If you have selected results from an object to be output to an interface and Vision Q.400 has been unable to find the object, Vision Q.400 will output an error. The judgment output will be NG.

Creating the output order "List"
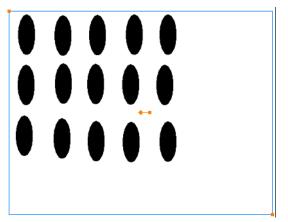
This is how you create the output order "List" to check the correct position of objects. Use a Boolean formula to check at one glance whether all objects from the list are detected at the expected position. Please proceed as follows:

◆ PROCEDURE

1. **Grab an image where all objects of which you wish to check the position are positioned correctly.**

   Set the checker so that all objects are inside the shape.

2. **On the "Algorithm" page, select output order "List"**

3. **In the pull-down list to the right of "Output Order" select the sorting order for entering the objects into the list**

   Please note that the sorting order selected here only influences the order in which objects are entered into the list of objects. If you select "Line-by-line" and "Descending" as the sort order, for example, the objects are inserted in descending order into the object list. The positions of the objects are always checked by way of the coordinates; the feature extraction checker always checks them using the gravity coordinates.

For the sort order of the object list the same orders are available as for the output order (except for the "List" order).

4. Open the spreadsheet if you need to modify the upper and lower limits for the coordinates

By default, Vision Q.400 uses the coordinates minus/plus 10 pixel for the lower respectively upper limit.

	Result Name	Value	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start					
	MG[1;1]Schwerpkt_X_Koord_1	88.21	88.21	78.21	98.21	OK
	MG[1;1]Schwerpkt_Y_Koord_1	73.45	73.45	63.45	83.45	OK
	MG[1;1]Schwerpkt_X_Koord_2	168.21	168.21	158.21	178.21	OK
	MG[1;1]Schwerpkt_Y_Koord_2	75.45	75.45	65.45	85.45	OK
	MG[1;1]Schwerpkt_X_Koord_3	244.21	244.21	234.21	254.21	OK

The coordinates in the spreadsheet will be judged OK if the object is detected at the expected position. If an object has not been found, the judgment is "Forced NG" and the result fields are empty.

5. Create Boolean formula with Spreadsheet → Insert Formula → Boolean

6. Open the formula by double-clicking in the name cell

7. Activate "Insert always" next to the operator "&"

8. In the spreadsheet column "Judgment" select the first result from the object list with a left mouse click

9. Press <Shift> key and hold the key down

10. In the "Judgment" column, select the last result of the object list with a left mouse click

11. Transfer results to the formula editor with drag & drop

12. Release left mouse button, then release <Shift> key

13. Click [Apply]

14. Click [OK] to save the formula and to close the formula editor

The formula will be judged OK when all objects are detected at the expected position. It will be NG if at least one object has not been detected.

If you also wish to find out whether more than the expected number of objects have been detected, insert the checker result "Number of Judged Objects" into the spreadsheet and set its upper and lower limits to the expected number of objects. Create a Boolean formula for this result or add the result to the formula created above.

"Number of Judged Objects" is the number of objects in the result list of the checker. It also contains the not detected objects. Consequently, if the "Number of Judged Objects" is bigger than the number of objects in the object list, Vision Q.400 has detected additional objects.

"Number of Total Objects" is the number of detected objects in the current image. Please note that this figure does not indicate whether all objects have been detected at the expected position. For example, if Vision Q.400 detects an object at a position that differs from the expected position, the result "Number of Total Objects" equals the number of expected objects. Nevertheless, the checker result is not as it should be, because one object is positioned incorrectly. The result "Number of Judged Objects" gives a better indication, because it will be increased by 1 compared to the number of expected objects because the "empty" result entry for the object detected at a different position will be included.

☞ ◆NOTE ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━

If you have created formulas based on the output order "List" and if you have updated the object list later with the [Update List] button because objects have been added or deleted, the formulas are NOT updated automatically. Please modify the formulas manually. Vision Q.400 will remind you with a message.

9.8.1.2 Features

The system always calculates an object's area size, the coordinates of its center of gravity and the location of its principal axis of inertia:

- **Area size**
  Area size of the object in pixels

- **Center of gravity**
  coordinates of the object found

- Angle of the principle axis of inertia in degrees

For color images, Vision Q.400 also outputs the unique color number for each object.
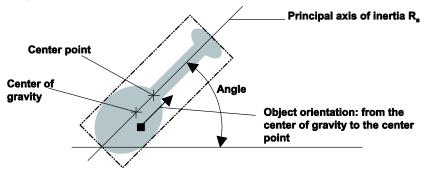
Result in column "Color"	Description
-1	This color result will be output under the following circumstances:
	• The parameter "Labeling" on the property page "Algorithm" is set to "Off". this makes Vision Q.400 to combine all detected objects independent of their color into one object. Consequently, there is no unique color any more for that object.
	• The parameter "Object type" on the property page "Algorithm" is set to "Not selected". This makes Vision Q.400 select the "background", which does not have a unique color.
0	The checker works with a checker-specific color selection. The parameter "Use application defined colors" on the property page "Color selection" is deactivated.

Result in column "Color"	Description
>0	The checker uses the application-specific color selection. The parameter "Use application defined colors" on the property page "Color selection" is activated. Vision Q.400 displays the number assigned to the color.

You can select additional object features to be calculated and to be output in the result list. These are:
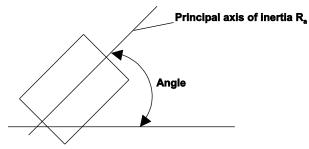
Angle

This is the **angle** of the principal inertia axis Ra to a virtual horizontal line. The result is in the range between 0° and 180°.

Angle and principal axis of inertia Ra

With **angle** and **orientation** Vision Q.400 calculates the angle and orientation of the principal inertia axis Ra to a virtual horizontal line. The result is in the range between 0° and 360°.
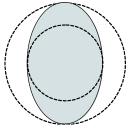
Angle and orientation of the principle axis of inertia Ra

Holes

Refers to the number of holes in the object.

Roundness

Roundness is the ratio of the smallest circumference to the greatest inner circle of an object. Roundness in the case of a circle without holes is = 1. If an object contains holes or if it is not a circle, roundness is > 1. If you select this feature, you can choose between "Ascending" and "Descending" in addition to "Output Order".

Calculate the roundness of an object
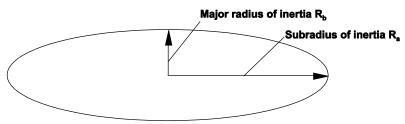
Compactness

If L is the length of the contour and F is the area of an object, then compactness is defined as:

$$Compactness = \frac{L^2}{4F\pi}$$

Eccentricity

Eccentricity refers to the ratio of Ra to Rb, that is to say in the case of an object with equal inertial radii such as a circle or a square = 1, otherwise > 1.

Calculate eccentricity
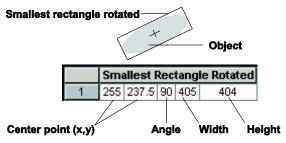
Major radius of inertia

The major radius of inertia is Ra.

Smallest rectangle rotated

The smallest comprising rectangle, that is to say the coordinates of its center point, its width, its length and the orientation of its principal axis are output. The rectangle does not have to be parallel to the coordinate axes.
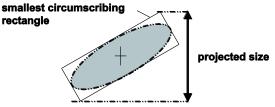
The width of the rectangle is the edge length of the longer edge, the height is the length of the shorter edge. Accordingly, the width is always bigger than or equal to the height. The orientation is determined by the direction of the longer edge and will be output in the range of 0 to 180 degrees.

Calculate the smallest rectangle rotated

Projected size
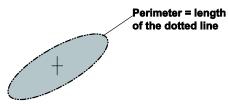
The projected size is defined by the length of the edge of that rectangle which the object circumscribes. Vision Q.400 calculates the length of the edges of the smallest circumscribing rectangle parallel to the axis. The width is the length of the edge parallel to the X-axis, the height the length of the edge parallel to the Y-axis. The first result column outputs the length in X direction, the second column the length in Y direction.

Calculate the projected size with the help of the smallest circumscribing rectangle

Perimeter

The perimeter is the circumference of an object expressed in pixels.

Calculate the perimeter

Circumcircle
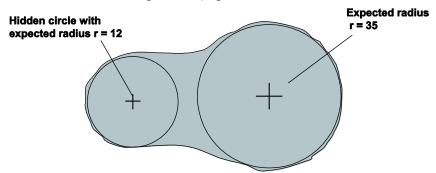
The coordinates of its center point and its radius are displayed.

Calculate the circumcircle

Hidden circle
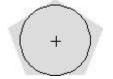
With this option you can detect circles which are partially hidden. This may be useful in determining the radius of rounded edges or bent components, for instance. As a result you obtain the circle which fits best into the rounded contour of the object. If there are several circles possible, the circle with the radius closest to what has been entered under "Expected Radius" will be listed on the "Result" page (center point coordinates and radius). The field "Expected Radius" only appears after you have selected "Hidden Circle" from the "Features" selection box on the "Algorithm" page.

Possible hidden-circle results depending on the expected radius

Inner circle

The coordinates of its center point and its radius are displayed.

Calculate inner circle

Rectangularity

To determine rectangularity, a rectangle is first identified which has the same first and second moments as the input region. Calculation of the rectangularity is based solely on the area of the difference between the identified rectangle and the input region scaled to the area of the rectangle. In the case of perfect rectangles the result is 1. The less the object is like a rectangle, the lower is the result value.

The table shows an example. The first and second moments (arrows) are identical in both objects.

	Result < 1 Difference area between the object being checked (circle) and the identified rectangle
	Result = 1 No difference between the object being checked (rectangle) and the identified rectangle

Mean gray value

This is the average gray value of all pixels belonging to an object. This feature can only be calculated if the checker does **not** use a color image.

Contrast

This is the gray value difference between the object's mean gray values and the background's mean gray values. The background is defined as a rectangle circumscribing the object and enlarged by 5 pixels all around minus the object itself. This feature can only be calculated if the checker does **not** use a color image.

Ratio
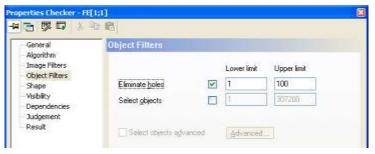
This is the quotient from the area size of an object and the number of pixels in the checker shape. This feature can only be calculated if the checker does not use a color image.

9.8.2   Image Filters

All image filters (see page 246) are available.

9.8.3   Object Filters

You can fine-tune the filter conditions for objects with the help of a formula. To do so, check the "Select objects advanced" checkbox to enable the [Advanced >>] button. Click this button to open the formula editor.

"Object Filters" page of a feature extraction checker

9.8.3.1 Formula-based Object Selection

You can define conditions to fine-tune object selection. The conditions are based on the calculated features and operators. Enter a range for every feature.

Operator	Icon
AND	&
OR		
NOT	~

Which features are available depends on the selection you have made under "Features" on the "Algorithm" page. If there are more features available than can be displayed in the formula editor, use the buttons [<<] and [>>] to display the previous/next feature. The filter selects objects within ranges. You specify the range as <feature name>[<lower limit>..<upper limit>]. To check the consistency of the formula click the [Apply] button (further information (see page 537) on using the formula editor).

◆EXAMPLE

You wish to use only objects for feature extraction with a roundness between 1.1 and 2 and an area size of 100 to 5000 pixels. Your formula should read as follows:

9.8.4 Judgment

The criterion for the judgement is the number of objects for which the features have been calculated. This must be within the limits of "Number of judged objects: Lower limit" and "Number of judged objects: Upper limit" (inclusive) for the judgement to be OK. You can enter a valid range limit from 0 to 32767. The default settings are 0 and 128.

9.8.5 Shape

Four different shapes are valid for use with a feature extraction checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut
- Object Shape

9.8.6 Result

The result list displays the features calculated for each object processed. The objects are listed in the order specified in the parameter "Output Order".

Features which have not been calculated appear in the list, but are displayed with a dark gray background.

In addition, the field "Number of Judged Objects" specifies the number of objects for which features have been calculated. "Total Number of Objects" displays the number of objects counted before the limit defined by the parameter "Maximum Number of Objects" was applied.

Left-click on a feature in the result list to highlight the object to which it belongs in the camera window. If the object is large enough, the object is highlighted. Small objects are often too small be clearly discernible, despite highlighting. Consequently, small objects themselves are not highlighted, but a circle is drawn around the center of gravity of the object. This circle is also drawn on large objects if their center of gravity is outside of the object, to enable the link to be made between the center of gravity and the object.

When you click on a result in the "Smallest Rectangle Rotated", "Circumcircle", "Hidden Circle" or "Inner Circle" columns this result is additionally highlighted.

Feature	Contents of the result column(s)
Area size	Area size in pixel
Center of gravity	1. X Coordinate 2. Y Coordinate
Angle	Angles in degree
Holes	No. of holes
Roundness	1 for a perfect circle, otherwise > 1.
Compactness	1 for a perfect circle, otherwise > 1.
Eccentricity	Major radius of inertia divided by its subradius (1: circle/square, else > 1)
Major radius of inertia	Radius
Smallest rectangle rotated	1. X coordinate of the center point 2. Y coordinate of the center point 3. Angle of the principle axis of inertia in degrees 4. Width of the smallest rectangle rotated 5. Height of the smallest rectangle rotated
Projected size	1. Surrounding rectangle parallel to the coordinate axes: length of X part 2. Surrounding rectangle parallel to the coordinate axes: length of Y part
Perimeter	Perimeter in pixel
Circumcircle	1. X coordinate of the center point 2. Y coordinate of the center point 3. Radius
Hidden circle	1. X coordinate of the center point 2. Y coordinate of the center point 3. Radius
Inner circle	1. X coordinate of the center point 2. Y coordinate of the center point 3. Radius

Feature	Contents of the result column(s)
Rectangularity	1 for a perfect rectangle, otherwise < 1.
Mean gray value	Displays the mean gray value of the segmented objects. 0 means black, 255 means white.
Contrast	This is the contrast between the segmented objects and the background calculated with the following formula: Contrast = ((MeanValueBackground - MeanValueForeground)/(MeanValueBackground + MeanValueForeground))*100 The background is the circumscribing rectangle, which has been expanded by a dilation (mask size 5).

☞ ◆**NOTE**

If you are not sure what the value in the result column refers to, select a result with the mouse and wait until the tool tip is displayed.

9.9 Binary Edge Detection Checker

The binary edge detection checker searches for the edges in a binary image.

9.9.1 Algorithm

Depending on whether you are processing a gray-value image, a color channel of a color image or a color image, you can either use checker-specific slice levels (see page 236) or the checker-specific color selection (see page 243). How to set checker-specific slice levels or perform a checker-specific color selection is described in the chapter about the checker property sheets (see page 246).

"Algorithm" page of a gray-value edge detector

When you use the shape rectangle with scanning direction, you may also select the edge calculation mode. You may combine the edge search modes "First Edge", "Two Edge" or "Multi Edge" with the edge calculation modes "Top Edge" and "Average Edge". When you select search mode "Two Edge", the calculation mode "MinMax" is also available. Altogether there are seven search mode variations available to you.

☞ ◆ **NOTE**

> **All pixels which satisfy the specified search criteria and can be accessed via the 8-fold neighboring relationship even across several neighbors are considered part of the same edge.**

The edge search modes work as follows:

- **First Edge**
  traces only the first edge in the scanning direction. The distance previously put out in the results for each edge is used to determine the first edge. It is always

the edge with the lowest distance value (see page 336).

- **Two Edge**
  traces the first and last edge in the scanning direction.

- **Multi Edge**
  traces all edges in the scanning direction and outputs them in the order in which they appear in the scanning direction.

"1. "Top Edge", "Average Edge" and "MinMax" define how the representative of an edge is to be determined. They are edge calculation modes.
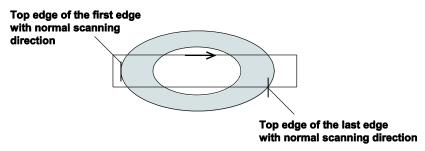
- **Top Edge**
  means that the first pixel in the scanning direction which is associated with an edge is chosen as the representative for that edge.

- **Average Edge**
  means that, with the help of a regression straight line, the position of the representative is calculated from the position of all pixels belonging to an edge.
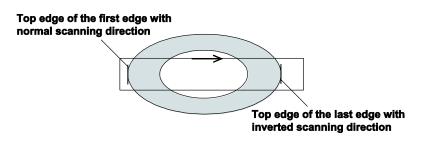
- **MinMax**
  means that of all edge representatives only the first and the last are used. The last edge is the edge found first when you inverse the scanning direction. This calculation mode is only available for the rectangle shape with scanning direction and when you select the "Two Edge" search mode.

**Top edge of the first edge
with normal scanning
direction**

**Top edge of the last edge
with normal scanning direction**

Search mode "Two Edge" with calculation mode "Top Edge"

**Top edge of the first edge with
normal scanning direction**

**Top edge of the last edge with
inverted scanning direction**
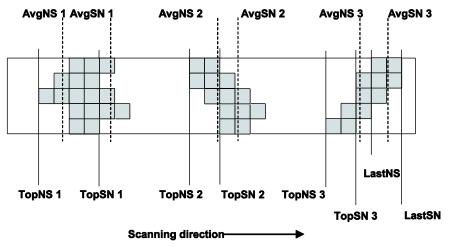
Search mode "Two Edge" with calculation mode "MinMax"

With every search mode you define whether Selected -> Not Selected (SN) transitions and/or Not Selected -> Selected (NS) transitions should be found. You can select both SN **and** NS transitions when you have selected the search mode "Two Edge" or "Multi Edge".

Pixels will belong to an edge only if one of the transitions defined can be found. The system always selects the pixel on the selected side of the transition.

In the figure below, all edges that can be found are drawn in for the three dark objects. "1. "Top Edges" are represented by continuous lines, "Average Edges" by dotted lines. The edges are numbered in sequence following by the scanning direction and are identified with S/N in correspondence with their transition.

Search modes "Top Edge" and "Average Edge"
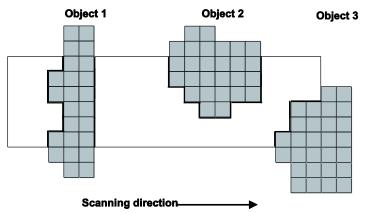
The table below lists what edges can be found with what settings as per the preceding example:

Edge search/ calculation mode	NS transitions	SN transitions	NS and SN transitions
1. Top edge/first edge	TopNS 1	TopSN 1	Not permissible
1. Top edge/two edge	TopNS 1 and TopNS 3	TopSN 1 and TopSN 3	TopNS 1 and TopNS 3
1. Top edge/multi edge	TopNS 1 to TopNS 3	TopSN 1 to TopSN 3	All top transitions
Average edge/first edge	AvgNS 1	AvgSN 1	Not permissible
Average edge/two edge	AvgNS 1 and AvgNS 3	AvgSN 1 and AvgSN 3	AvgNS 1 and AvgNS 3
Average edge/multi edge	AvgNS 1 to AvgNS 3	AvgSN 1 to AvgSN 3	All avg transitions
MinMax/two edge	TopNS 1 and LastNS	TopSN1 and LastSN	TopNS1 and LastSN

☞ ◆**NOTE**

If you use a rectangle as a shape for a checker, an edge will be found only if it crosses each of the two sides running parallel to the scanning direction but none of the other sides.

In the figure above, only the edges of object 1 will be found. The checker is improperly positioned to detect the edges of objects 2 and 3 since they do not satisfy the requirement just described. What is more, the fact that the edges of object 2 and 3 cross the checker shape on only one side may even have a negative effect on the edge calculation of object 1! This is why you should take special care to position the shape when defining an edge detection checker with a rectangle shape.

Aside from the type of edge transition, additional parameters may be defined to narrow the search. "Maximal Number of Edges" will limit the number of edges to be processed. This option is available only in Multi Edge. In "First Edge" this parameter is limited to 1, in "Two Edge" it is limited to 2. If more edges are found than defined in "Maximal Number of Edges", they will be processed in the order of the scanning direction up to the number specified by "Maximal Number of Edges" and their results displayed.

"Algorithm" page of a gray-value edge detector

A maximum of 255 edges may be processed. If more than 255 edges are found in a given shape, an error message will appear and none of the edges will be processed.

With the parameters "Depth" and "Width" it is possible to more narrowly define which pixels are to be considered edge pixels.

- **Depth**
  refers to the depth of the object in scanning direction. If a transition occurs, the

entry in "Depth" determines how many pixels deep (in scanning direction) the object which caused the transition needs to be in order to be treated as an object.

- **Width**
  refers to the width of an object (orthogonal to the scanning direction). This means that with the shapes line and circular arc, width always equals 1 since a line/ circular arc has no width.
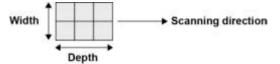
Basically, the parameters of depth and width mean that a model is generated which corresponds to the depth and width specified. A transition is accepted as an edge point only if a model position exists which contains the point of transition and if all the pixels which are covered by the model are part of the object which caused the transition.

✦ **EXAMPLE**
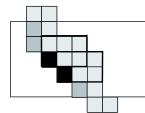
"Depth" = 3 and "Width" = 2 generate the following model:
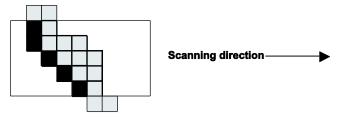
If this model is applied to the two light-gray objects in the figure below, only the black pixels will be detected as edge points. This is because the layer of the model shown (outlined in bold, black lines) containing the potential edge points is the only part to meet the edge's requirement of "Width" = 3 and "Depth" = 2.

If, however, you were to set "Depth" = 2, all points marked in gray would be accepted as edge points since with regard to these points the model would be considered within the bounds of the object.

In summary, the six edge search modes permit the following parameter values:

Search mode	Shapes			Transitions		
	Line	Ellipse	Rectangle	SN	NS	SN and NS
1. Top edge/first edge	Yes	Yes	Yes	Yes	Yes	No
1. Top edge/two edge	Yes	Yes	Yes	Yes	Yes	Yes
1. Top edge/multi edge	Yes	Yes	Yes	Yes	Yes	Yes
Average edge/first edge	No	No	Yes	Yes	Yes	No
Average edge/two edge	No	No	Yes	Yes	Yes	Yes
Average edge/multi edge	No	No	Yes	Yes	Yes	Yes
MinMax/two edge	No	No	Yes	Yes	Yes	Yes

Search mode	Number of edges	Depth[*]	Width[*]	
			Rectangle	Line/Ellipse
1. Top edge/first edge	1	1…999	1…999	1
1. Top edge/multi edge	1…128	1…999	1…999	1
Average edge/first edge	1	1…999	1…999	1
Average edge/multi edge	1…128	1…999	1…999	1

[*] The upper limit for this value also depends on the image format of the camera and the checker size.

☞ ◆**NOTE**

- **If the sides of a rectangle shape are not parallel to the sides of the image, then the model created in defining the depth and width must also be rotated. The resulting discretionary effects may mean that the rotated model is not positioned entirely within the object, even if one would expect it. As a consequence, anticipated edge points will not be accepted and unanticipated edge points will be accepted. If that happens, please enlarge or reduce the shape accordingly.**
- **If the values "Depth" and "Width" are greater than the current length or width of the shape, then no object will be found. In that case, the message "No object" will be displayed in the field "Execution State" upon execution of the checker.**

9.9.2 Image/Object Filters

All image (see page 246) and object filters (see page 258) are available. The gray-value filters will be used prior to binarisation, all others will be used afterwards.

9.9.3   Shapes and Scanning Directions

With edge detection checkers, three different types of shape are available:

- Line with scanning direction
- Ellipse with scanning direction
- Rectangle with scanning direction

For each shape, you can determine one of the following scanning directions:

Shape	Scanning directions
Line	1 scanning direction: from start to end point
Ellipse	2 scanning directions: clockwise or counterclockwise
Rectangle	1 scanning direction: from the start to the end page

Determining the scanning directions is part of defining the checker.

☞ ◆ **NOTE**
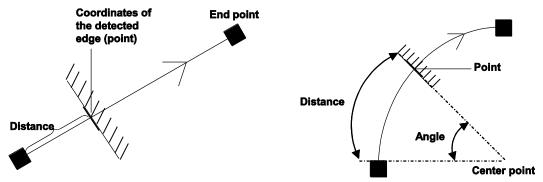
In contrast to all other checkers, the rectangle can be oriented in any direction when used in edge detection. Its sides do not have to be parallel to the image sides.

9.9.4   Result

The following table shows which results can be obtained from which shape, search and calculation mode.

Shape	Edge search mode	Edge Calculation Mode	Result			
			Distance to point or line	**Coordinates of Edge Representative**	**Angle**	**Raster**
Line->	1. First edge	---	Yes	Yes	No	---
	Two edge	---	Yes	Yes	No	Yes
	Multi edge	---	Yes	Yes	No	Yes
Ellipse ->	1. First edge	---	Yes	Yes	Yes	---
	Two edge	---	Yes	Yes	Yes	Yes
	Multi edge	---	Yes	Yes	Yes	Yes
Rectangle ->	1. First edge	1. Point	Yes	Yes	No	---
		Average	Yes	Yes	Yes	---
	Two edge	1. Point	Yes	Yes	No	Yes
		Average	Yes	Yes	Yes	Yes
		MinMax	Yes	Yes	No	Yes
	Multi edge	1. Point	Yes	Yes	No	Yes
		Average	Yes	Yes	Yes	Yes
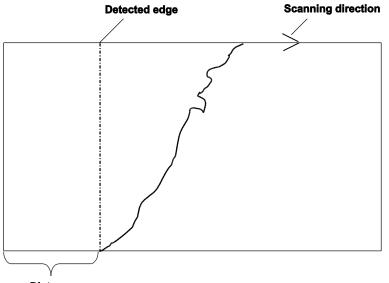
The **"distance"** output here will also be used to determine the first edge. It is always that edge whose representative is closest in distance to the reference point (starting point) or the reference line. In case of two edge representatives of equal minimal distance, it is not defined which of the two is to be considered first.

Distance with line-> and ellipse->

With **"Top Edge"**, the edge representative is the first pixel in the scanning direction to satisfy the search criteria. Due to the binarisation process, this pixel inevitably lies on the not-selected side of a transition and since its coordinates "Point" will be used as edge coordinates, it follows that the edge will always fall in the not-selected area.
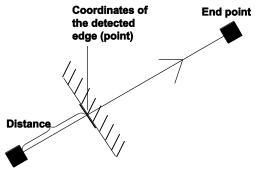
Distance with calculation mode "Top Edge"

With **"Average Edge"**, a regression line is calculated from the x- and y-coordinates. The edge representative is then calculated with the help of these regression lines on the center line of the shape type rectangle. All edge representatives of the Average Edge thus lie on the center line of the shape (rectangle). The coordinates will always be indicated by two decimals.
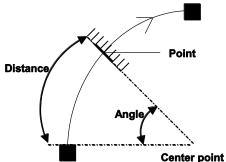
The distance output is determined in a different manner for each of the three shape types:

- With a line, it is the distance of the edge representative to the starting point of the line.

Coordinates of the detected edge (point)

End point

Distance
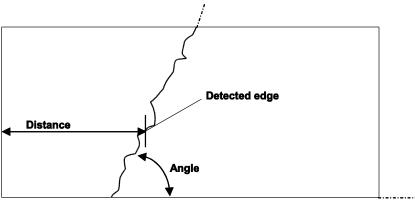
Starting point
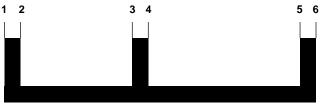
- With an ellipse it is the length of the elliptic arc from the starting point to the edge representative. With the circular arc, the opening angle of the circle segment between the beginning of the arc and the edge point found on the arc is indicated in Angle.

Point

Distance

Angle

Center point

- With rectangle, the direction of the edge is indicated in **"Angle"**. The angle determines the orientation of the straight line which was gained by means of linear regression from the coordinates forming the edge point. Please note that the angle refers to the coordinate system of the image and not to the checker shape.

Detected edge

Distance

Angle

The result **"Raster"** always is the distance between one edge and the next edge. In the example below, the raster result would be the distance between edge 1 and 2, between edge 2 and 3, etc. The raster result for the last edge is always "0".
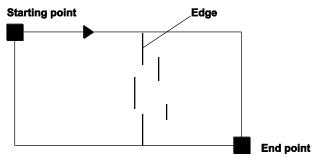
The **"Number of Judged Edges"** is used for the judgment. OK means that this number falls within the specified lower and upper limits (inclusive). If not, the judgment will read NG (not good).

The field **"Number of Total Edges"** informs you about how many edges have been found altogether.

9.10 Gray-Value Edge Detection Checker

The gray-value edge detection checker finds edges in the gray-value image. A maximum of 255 edges is processed for calculating the results.

How gray-value edge detection works

9.10.1 Algorithm

The "Algorithm" page contains four groups with different parameters for defining the checker.

- Edge type
- Edge parameters
- Edge search mode
- Edge calculation mode (only if the checker shape is a rectangle)

As with binary edge detection, all checker shapes work with two edge types.

"Algorithm" page of a gray-value edge detector

9.10.1.1 Edge Type
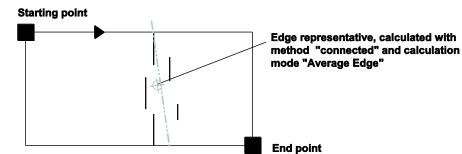
Here you define which type of edges you wish to detect (Light to Dark or Dark to Light). The pull-down list on the right defines the contrast properties of the edge. If your image has a high contrast, as is usually the case with back-light applications, choose high contrast. Then

the system uses a standard algorithm for calculating the edge representatives. When the image is noisy or very noisy, the system uses smoothing algorithms to maintain a high level of accuracy in spite of difficult processing conditions.

NOTE

- **Please keep in mind that using smoothing algorithms will slow down the inspection.**
- **Please note that if you wish to search with "Edge Search Mode" = "First Edge", you need to define the edge type to be detected first. If you leave both edge types selected, you will get a warning message when you try to select "First Edge".**
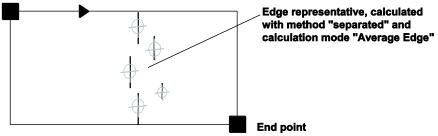
If you use the rectangle shape, a second pull-down list appears on the right side of the page. Here you select whether you wish to use the method separated or connected. When you use connected, all edge representatives detected within a certain image area will be combined to form an edge, e.g. for calculating the regression line. This way you obtain exactly one edge representative. The angle of the fitted line is displayed as the angle of the edge.

Starting point

Edge representative, calculated with method "connected" and calculation mode "Average Edge"

End point

Gray-value edge detection with method "connected"

When you use separated as the edge detection method, every single detected edge will be used as an edge representative.

Starting point

Edge representative, calculated with method "separated" and calculation mode "Average Edge"

End point

Gray-value edge detection with method "separated"

9.10.1.2 Edge Parameters

With this parameter group you determine the minimal gradient. If you are using the rectangle shape, more parameter fields appear on your screen, depending on the method selected before.

- **Minimal Gradient**
  defines how high the edge gradient (gray-value difference between a pixel and its neighbors) needs to be at a given pixel in order for it to be accepted as an edge point (see page 345). The minimal gradient is automatically calculated in a first step. The default value displayed on the "Adjustment" property page is about two thirds of the maximal gradient detected in the checker area. You can adjust the minimal gradient on the "Adjustment" (see page 345) page.
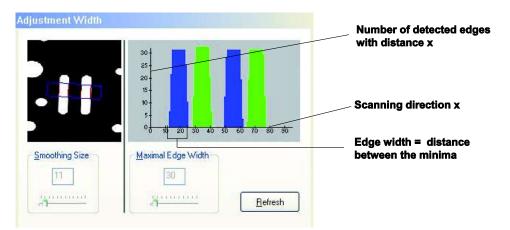
☞ ◆ **NOTE**

The minimal gradient should be at least ten. With gradients any smaller than this, the edge points will vanish in the image noise.

- **Minimal Edge Length**
  defines the minimal length which an edge piece must have in order to be considered in the calculation of the edge representative.
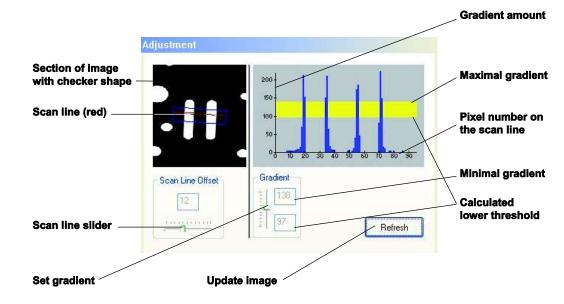
If an edge piece is shorter than the specified minimal edge length, the piece will be discarded. This way it is possible to eliminate runaways as shown in the figure above. The remaining edge calculations will be executed based on this preprocessing.

- **Maximal Edge Angle**
  indicates how large the angle between an edge piece and the reference line may
  be in order for the piece to be used in calculating the edge representatives. If the
  angle is exceeded, the edge pieces will be discarded. The default setting is 70°.
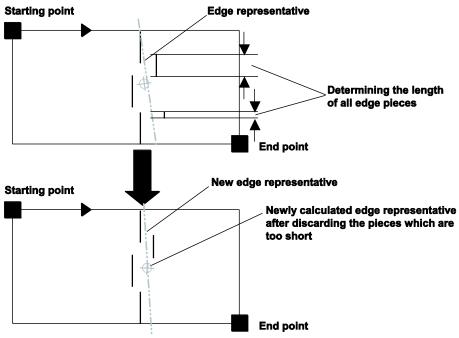
Adjustable Edge Parameters for Rectangle Shape and Method "Connected"

- **Maximal Edge Width**

  shows the setting you have made on the page "Adjustment Width" (see page 348). There you find all gray-value edges marked in color (dark-to-light edges are marked blue, light-to-dark edges in green). An edge is considered valid if the distance between two minima in the histogram is smaller than the value under "Maximal Edge Width". If the distance is higher, the edge is discarded as too indistinct and too blurred.
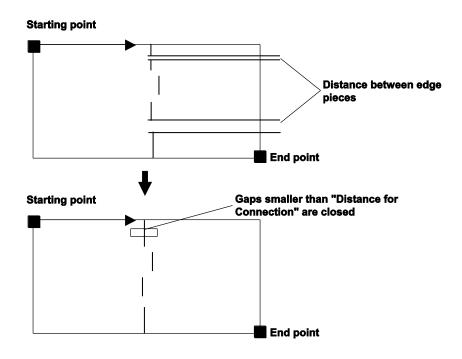
- **Smoothing Size**

  shows the setting you made on the "Adjustment Width" (see page 348) property page. The default is 11.

Adjustable Edge Parameters for Rectangle Shape and Method "Separated"
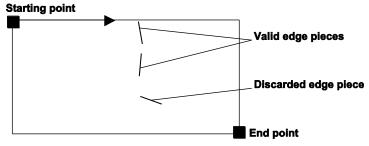
- **Distance for Connection**

  indicates how large the distance between two edge pieces may be so that the system closes the gap automatically.

9.10.2 Adjustment

Below, you will find assistance with the settings for the parameter "Minimal Gradient" from the "Algorithm" page.
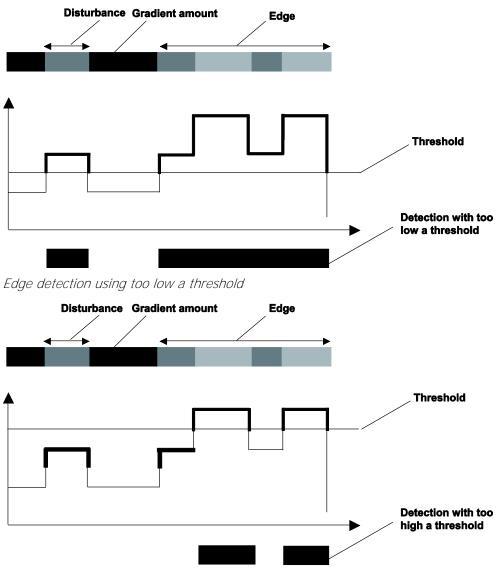
"Adjustment" page of a gray-value edge detector

The gradient amount is calculated along the scan line and shown in blue in the display. The gradient amount is the gray-value difference between a pixel and its neighbors.

The thresholding process is described in more detail in the drawings below. It is assumed that the edge takes up the right half of the drawing. Moreover, it is assumed that the average gray values on the right side are part of the edge, while the ones to the left represent a disturbance.

If, as is common practice, only one threshold is used, it often turns out that this threshold is only capable of detecting the entire edge plus the disturbances or else merely a portion of the edge.

The example serves to demonstrate this case and illustrates the result in the two figures below.

Edge detection using too low a threshold
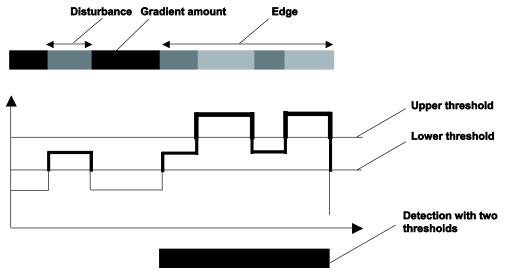
Edge detection using too high a threshold

The process in use in Vision Q.400 utilizes two thresholds (yellow area on the "Adjustment" page), whereby the lower is implicitly calculated from the upper. In the first step, it marks all pixels as edge points which are equal to or greater than the upper threshold. These pixels are called starting points. In the second step, all the neighboring pixels of the starting points which lie above the lower threshold are added in. Next, all pixels above the lower threshold which are neighbors of the previously added pixels are added and so on. This process is continued until no more pixels can be added.

The process detects an edge whenever at least one edge point lies above the upper threshold with some tolerance: Gaps in the edge may be filled if its pixels lie above the lower threshold.

Disturbances with pixels which exceed the lower, but not the higher threshold will not be detected, however.

The result of this process is illustrated in the figure below.

Edge detection with two thresholds

The "Adjustment" page is structured in accordance with the process in use. In the upper left hand corner you see an image segment with the selected shape. With the shapes Line and Elliptical Arc, the edge gradients are calculated along the shape and displayed in the diagram at the right of the page. With the rectangle shape, the gradients are calculated along a line within the sha**pe. The line's orientation corresponds to the orientation of the shape. The line** position within the shape can be changed by means of the slider "Scan Line Offset". The gradient diagram on the page corresponds to the diagrams in the example above.

The parameter "Minimal Gradient" represents the upper threshold in the process used.
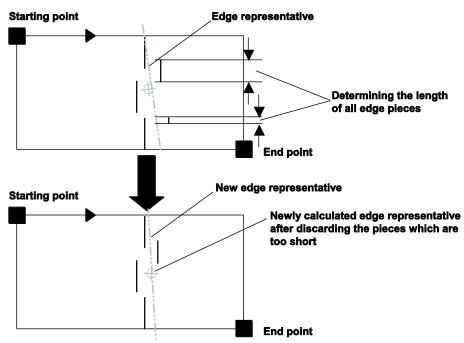
It may be changed with the slider Gradient. Its value is displayed in the upper window of the slider. In the lower window you will find the implicitly calculated lower threshold. The area between the lower threshold and the minimal gradient is marked in the diagram to the right of the page.

An edge is detected when the gradient amount lies at least one edge point above the upper threshold, i.e. above the value in "Minimal Gradient". Within the diagram, this means that at least one point of the diagram must protrude beyond the marked area. All the pixels above the lower threshold and which are associated with the starting points will be adjoined. In figure 10, these are all the pixels which protrude into the marked area and which are neighbors to one of the pixels protruding from the marked area.

The edge points detected are illustrated in the image segment of the "Adjustment" page.

9.10.3 Adjustment Width

This page is only active when you use a gray-value checker with a rectangle shape and the method "Connected". It assists you in determining the correct settings for the parameters "Maximal Edge Width" and "Smoothing Size" on the "Algorithm" page.

"Adjustment Width" page of a gray-value edge detector

The histogram evaluates the checker shape column by column, that means vertically to the scanning direction. It is the sum of all detected edges. The histogram is calculated with a smoothing algorithm and depicts all gray-value edges in color (transitions from dark to light in blue, transition from light to dark in green).
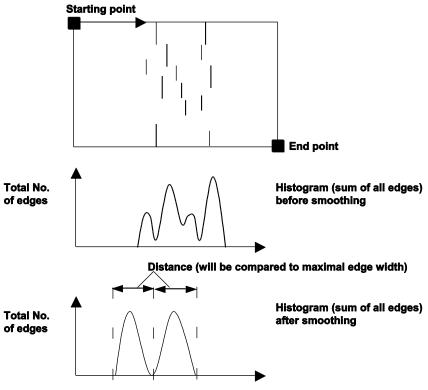
The histogram shown above is optimum as it shows very distinct minima and maxima. The distances between the minima are smaller than the value under "Maximal Edge Width" so that each transition is considered an edge.

Maximal Edge Width

Use the slider "Maximal Edge Width" to determine the maximal distance between two minima in the histogram. All minima which are further apart than this value are not considered an edge because it is concluded that the edge is too blurred and indistinct.

Smoothing Size

"Smoothing Size" determines the setting for the histogram smoothing. Use the slider to determine the right smoothing factor. Changing the smoothing factor may result in a histogram with more or fewer minima, or minima that have been moved. The smoothing size selected should be set in such a manner that each edge has a maximum or two minima, respectively.

Histogram before and after smoothing

9.10.4 **Shapes and Scanning Directions**

Please read the description under binary edge detection (see page 336).

9.10.5 **Result**

The results (see page 336) of gray-value edge detection correspond to those of the binary edge detection.

9.11 Edge Detection Checker with Gray Value Projection

The gray-value projection edge detection checker finds edges in the gray-value image. The system calculates the positions of a maximum of 255 edges.

9.11.1 Algorithm

The "Algorithm" property page contains six parameters by which you define the edge search.

"Algorithm" property page of a checker for gray value edge detection by projection

Execution mode

The list box offers two setting options:

- **Edge position:** If you choose this option, all edges found are processed individually and their edge positions determined.
- **Edge pair:** If you choose this option, the edges found are always grouped in pairs. If only one edge is found no pair can be formed, so no result is delivered. If there is an odd number of edges the last edge is not processed.

Edge type

Here you define which type of edges you wish to detect (Light to Dark or Dark to Light). The list box offers three setting options:

- Dark to light
- Light to dark
- All transitions (from light to dark and from dark to light)

Edge selection

Here you specify which of the edge(s) found is to be processed. The list box offers five setting options:

- **All:** All edges are processed and included in the result list.
- **First:** Only the first edge found is included.
- **Last:** Only the last edge found is processed and delivered as the result.
- **First - Last:** The first and last edges found are processed and delivered as the result.
- **Maximal gradient:** The edge with the largest gradient is output.

Minimal gradient

The minimal gradient defines how high the edge gradient (gray-value difference between a pixel and its neighbors) needs to be at a given pixel in order for it to be accepted as an edge point (see page 345). The minimal gradient is automatically calculated in a first step. The default is 30. If you enter a different value manually, or move the slider, you will see the effect in the gray-value diagram. The minimal gradient is displayed there in green.

☞ ◆**NOTE**

The minimal gradient should be at least ten. With gradients any smaller than this, the edge points will vanish in the image noise.

Noise level
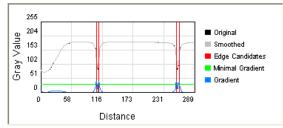
With this value you define the smoothing grade. If the image is very noisy, you can counteract it with a higher value so as to still attain good results. The better the contrast in the image, the lower you can set this parameter value. If you enter a different value manually, or move the slider, you will see the effect in the gray-value diagram. The smoothed edge is displayed there in gray.

Number of edges

Here you specify how many edges as a maximum are to be processed. The default is 255.

Gray value diagram

5 lines in this diagram deliver various items of data from the edge finder.

- **Original:** This line shows the gray value characteristic along the checker from the start point. The start point is always on the left-hand side of the diagram.
- **Smoothed:** This line shows the characteristic of the smoothed gray value along the checker from the start point. The start point is always on the left-hand side of the diagram. The line characteristic is dependent on the preset noise level (see

above).

- **Edge candidates:** These vertical lines show the positions at which edges are found with the current minimal gradient setting.
- **Minimal gradient:** The horizontal line shows the current value of the minimal gradient.
- **Gradient:** This line shows the gradient characteristic along the checker from the start point. The start point is always on the left-hand side of the diagram.

9.11.2 Image Filters

All image filters (see page 246) are available.

9.11.3 Shapes and Scanning Directions

For the edge detection checker with gray value projection, four different shapes are permitted, as opposed to the other edge detection checkers which only permit three:

- Line with scanning direction from start to end point
- Circle with scanning direction clockwise or counterclockwise (ellipse not possible here)
- Rectangle with scanning direction from start to end point
- Doughnut with scanning direction clockwise or counterclockwise

You define the scanning direction when configuring the checker (see page 270).
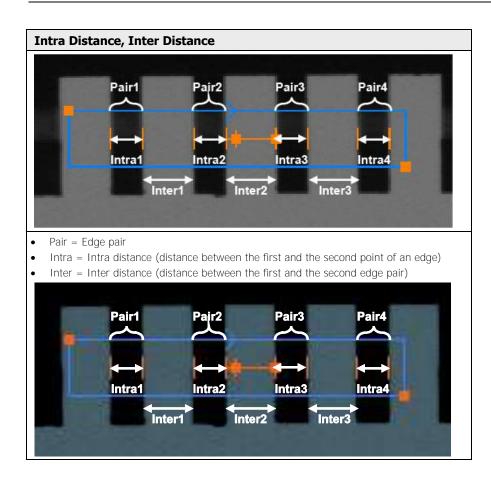
9.11.4 Result
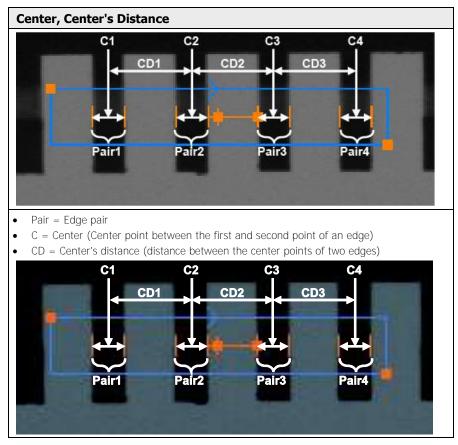
The following tables explain which results are delivered by which edge search and calculation modes.

9.11.4.1 "Edge Pair" Execution Mode

The following figures display results in execution mode "Edge Pair" and the objects they refer to.

Distance, Point, 2nd Point

- Pair = Edge pair
- Dis = Distance (distance between the shape and the first point of an edge)
- P = Point (first point of an edge)
- 2ndP = Second point (of an edge pair)

Intra Distance, Inter Distance

- Pair = Edge pair
- Intra = Intra distance (distance between the first and the second point of an edge)
- Inter = Inter distance (distance between the first and the second edge pair)

Center, Center's Distance

- Pair = Edge pair
- C = Center (Center point between the first and second point of an edge)
- CD = Center's distance (distance between the center points of two edges)

Which results will be output depends on the setting of option "Edge selection".

Result	**Setting under "Edge Selection"**		
	All	**First**	**Last**
Distance	Yes	Yes	Yes
Point	Yes	Yes	Yes
2. Point	Yes	Yes	Yes
Gradient	Yes	Yes	Yes
Gradient 2nd Point	Yes	Yes	Yes
Intra Distance	Yes	Yes	Yes
Inter Distance	Yes	0	0
Center	Yes	Yes	Yes
Center's Distance	Yes	0	0

As with "Edge Selection" = "First" or "Last" only one edge is calculated, no inter distance or distance to the center can be determined. So 0 is output for these results.

9.11.4.2 "Edge Position" Execution Mode

The following figures display results in execution mode "Edge Position" and the objects they refer to.

Distance, Point							

Total number of edges: 8   Number of judged edges: 8

	Point		2	Gradient	G	Intra Distance	Inter Distance
1	43.98	251	-	-58.25	-	-	15.29
2	59.27	251	-	56.92	-	-	25.92
3	85.19	251	-	-46.92	-	-	15.37
4	100.56	251	-	50.73	-	-	25.89
5	126.45	251	-	-49.73	-	-	15.17
6	141.63	251	-	50.79	-	-	26.28
7	167.91	251	-	-49.2	-	-	15.31
8	183.22	251	-	51.35	-	-	0

- P1 - Px = Point 1 to point x (row number in the table)
- Dis1 Disx = Distance (distance from the shape to edge point x)

Inter Distance

Total number of edges 8   Number of judged edges 8

	Point		2	Gradient	G	Intra Distance	Inter Distance
1	43.98	251	-	-58.25	-	-	15.29
2	59.27	251	-	56.92	-	-	25.92
3	85.19	251	-	-46.92	-	-	15.37
4	100.56	251	-	50.73	-	-	25.89
5	126.45	251	-	-49.73	-	-	15.17
6	141.63	251	-	50.79	-	-	26.28
7	167.91	251	-	-49.2	-	-	15.31
8	183.22	251	-	51.35	-	-	0

- P = Edge point
- Int = Inter distance (from one edge point to the next)

Which results will be output depends on the setting of option "Edge selection".

Result	Setting under "Edge Selection"				
	All	**First**	**Last**	**First - Last**	**Max. Gradient**
Distance	Yes	Yes	Yes	Yes	Yes
Point	Yes	Yes	Yes	Yes	Yes
2. Point	No	No	No	No	No
Gradient	Yes	Yes	Yes	Yes	Yes
Gradient 2nd Point	No	No	No	No	No
Intra Distance	No	No	No	No	No
Inter Distance	Yes	0	0	Yes	0
Center	No	No	No	No	No
Center's Distance	No	No	No	No	No

As with "Edge Selection" = "First", "Last", or "Maximum Gradient" only one edge is calculated, no inter distance can be determined. So 0 is output for this result.

9.12 Difference Checker

The difference checker determines the difference between the template just read in and the saved gray-value image by means of image subtraction. The image subtraction result is the difference of the gray values at each pixel:

Current camera image   **Template**   **Result**

Square with gray value 0   **Square with gray value 60**   **Square with gray value -60**

Image   **Result**

Template

	Area Si	Point	
	81	2 5.27	69.99
	60	1 9.12	119.52
	53	1.7	163.15
	8	8.75	102.13

Execution state: OK
Time: 9 ms
Judgement: OK
Number of total objects: 4   Number of judged objects: 4

Pattern Matching Result:
X Coordinate: 231.81
Y Coordinate: 116.54
Angle: 0 °
Average Diff: 6.39

Total Difference: 202

The resulting image is subjected to a type of binarisation, i.e. the thresholding. You may modify the thresholding result with the binary filter. The resulting features of the objects remaining will be calculated.

Typical application examples for the difference checker are:
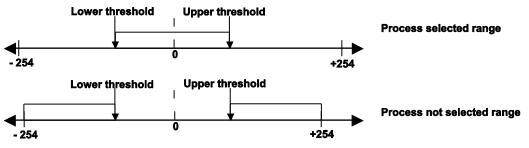
- Flaw detection with cast or molded parts
- Print inspection
- Inspection of punched or stamped parts

| Template | Current (rotated) image | Pseudo differences |

The difference checker displays the size and position of the defects and the total difference in pixels.

9.12.1 Algorithm

The "Algorithm" page contains parameters for "Thresholding", "Object Processing", and "Accuracy". Use these parameters to perform the flaw detection with an optimum of accuracy.

"Algorithm" page of a difference checker with threshold setting

Thresholding

This is where you set the binarisation thresholds, which determine the range of valid differences. Use the sliders (see page 236) to define the thresholds. You may set the difference range anywhere between -254 and +254. When you have selected "Process selected range", the differences within the range of the threshold values (inclusive) determine the objects to be processed. When you select "Process not selected range", the differences outside the selected range are the objects.

In the figure below, the range of differences to be used for the objects is marked in seriph.

Object range with parameter "Process (Not) Selected Range"
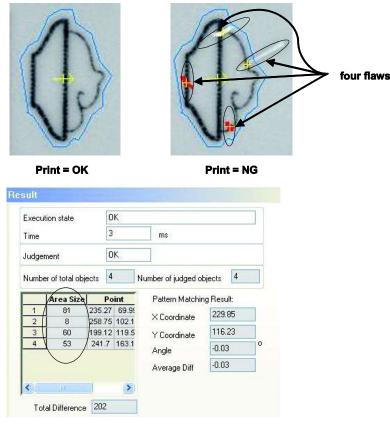
Object Processing

Parameter	Permissible value range	Additional information
Differences	-254 … 254	
Thresholding	Selected / Not selected	
Maximal number of objects	1 … 32767	"Maximal Number" (see page 314) limits the number of objects to be processed.
Area Boundary	ON / OFF	"Area Boundary" defines whether or not an object to be processed may touch the shape. If you set the parameter OFF, then the objects to be processed may not touch the shape. If you select "ON" (see page 314), touching will be permitted.
Output Order		"Output Order" determines the sequence order in which the checker results are displayed. There is no default output order. You may choose between displaying results sorted by size or by coordinates, compare the table for Feature Extraction (see page 314).
Search area	X: 0 … 1296[*] Y: 0 … 1026[*] Full image	This option is not available if the difference checker depends on a position and rotation adjustment checker. It defines the area where Vision Q.400 should carry out the template matching in order to find a matching candidate.

[*]Depends on the selected camera type.

Accuracy

When the difference checker depends on a position and rotation adjustment, **pseudo differences** may occur at the edges of objects.

Print = OK   **Print = NG**   **four flaws**

Pseudo differences

These differences occur not because of real differences between the two images, but because of inaccurate positioning of the template and the current image. Pseudo differences occur to a greater or lesser extent depending on the quality of the position and rotation adjustment process.

The algorithms calculating the position and rotation adjustment offer an accuracy of 1 pixel (x/y) or 0.1 degree, respectively. The accuracy of the algorithms further depends on the inspected object's properties (edges, holes, etc.), which may vary minimally. However, in reality changes in an object's position and rotation happen in the subpixel range.

The accuracy parameters "High", "Medium", and "Standard" let you determine whether pseudo differences will influence the image processing to a lesser or greater extent. Please note that setting a high accuracy factor slows down the algorithms. The following parameter settings are available:

- **High**
  With this setting Vision Q.400 positions the template in the image with the help of a pattern matching process working with subpixel accuracy. This helps to keep the number of pseudo differences at the object edges as low as possible.

The pattern matching process automatically searches a matching candidate within a range of +/- 75 pixels (X,Y) around the template shape.

If you need to perform a rotation adjustment of more than 1.5° degrees, it is necessary to create rotated templates in the expected rotation range. Please note that the settings under "Template Rotation" will influence the accuracy of the pattern matching process, the memory size needed to store the rotated templates, and the speed of the image checking.

☞ ◆NOTE

- **Avoid wasting memory space for rotated templates by setting the angle range in "Min Angle" and "Max Angle" as narrow as possible.**
- **If you expect an object to be misplaced by more than +/- 30 pixels (in x- and/or y-coordinates), use a larger search area or a position and rotation adjustment.**
- **The quality of the matching process deteriorates if the objects contain only white and black pixels but no gray values, or if the objects have no significant structure or texture in either x- or y-direction.**
- **If the image to be checked differs considerably from the template, the pattern matching process may not be successful. In this case, the x- and y-coordinates are usually zero.**
- **Medium**
  This setting works mostly the same as **"High"**. However, there are small differences as far as accuracy and processing speed are concerned.
- **Standard**
  With this setting Vision Q.400 positions the template in the image only with the help of standard algorithms for position and rotation adjustment. This means that the position of the object to be checked is calculated with the help of other checkers. Once the object position has been established, the corresponding rotated template is retrieved from the memory and used to perform the difference check in the appropriate rotated position.

This method is extremely fast because no image rotations have to be performed during inspection. However, the effect of pseudo differences will be more pronounced. To improve the image processing, use a filter method to suppress the object's borders from the difference checking (see paragraph **Filter** (see page 362)).

9.12.2 Template

The template to be used for the difference calculation at hand is displayed to the left. The template is updated as soon as you change the checker shape. You can also force an update of the template with [Refresh Template].

Use [Refresh Template] when Vision Q.400 has read in a new camera image and you wish to use this image to generate a new template. The size of the image area used as a template will be modified so that it fits into the "Template" page.

Setting of the parameter "Accuracy"	Additional parameters
Maximum	Maximal difference
Medium	
Standard	Slider for viewing the rotated templates
	Use filter
	Suppressed border
	Sensitivity
	Delta angle

"Template" page of a difference checker with "Accuracy" = "Medium"

Template rotation

In order to speed up the checker calculation, all template rotations brought about by position and rotation adjustments may be calculated and saved in advance during the initial checker definition. To avoid excessive rotation calculations, we recommend defining the anticipated angle range of the rotations as narrow as possible. In addition, define the increment between the rotations. The confines of the rotation range are defined in the parameters "Min Angle" and "Max Angle", the increment itself in "Delta Angle". The "Min Angle" must always be smaller or equal to "Max Angle", the increment must be greater than zero. The option "Delta Angle" is only available if you have set "Accuracy" to "Standard".

To facilitate specification of the angle range, the value ranges available for "Min Angle" and "Max Angle" have been defined as -180 to 360 degrees, whereby the angle range -180 to 0 degrees is identical to the range 180 to 360 degrees. Let the value ranges -10 to 10 degrees and 170 to 190 degrees (which would be difficult to represent with any other choice of measure) serve to demonstrate the advantages of this approach.

Click [Rotate] to calculate the template rotation with the angle values you have entered. If you have selected the setting "Standard" for parameter "Accuracy" in the "Algorithm" page, some additional parameters appear on the "Template" page: As soon as Vision Q.400 has calculated the rotated templates and stored them in the memory, a slider and a display field appear beneath the [Rotate] button. You can view the rotated templates by moving the slider left and right. The rotation angle as compared to the original template appears in the gray field to the right of the slider.
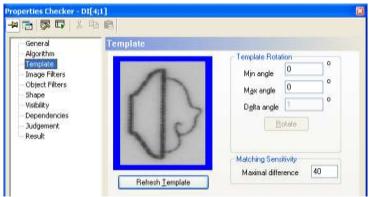
"Template" page of a difference checker with "Accuracy" = "Standard"

☞ ◆NOTE

In order to save storage space, the number of templates which may be calculated and saved in advance is limited. This number is a function of the size of the templates, the limits of the angle range, and the increment (delta angle). The system will issue an error message if the parameters specified exceed the number of templates that can be saved. In that case, you can either reduce the template size or the angle range or else increase the increment.

Maximal difference

If you have selected the setting "High" or "Medium" for the parameter "Accuracy" on the "Algorithm" page, this parameter appears on the "Template" page:

"Template" page of a difference checker with "Accuracy" = "High" / "Medium"

This parameter determines the maximal difference between gray values during matching. This means Vision Q.400 calculates the average of the gray-value differences of all pixels to compare. If this average is bigger than the value entered under "Maximal Difference", Vision Q.400 treats that image area as not matching with the template. The bigger the value you enter here, the more tolerant the matching process is towards differences between the object to be found and the template.

Filter

If you have selected the setting "Standard" for parameter "Accuracy" in the "Algorithm" page, some additional parameters appear on the "Template" page:

These parameters are useful to improve the results of the standard algorithm and help to suppress pseudo differences at the object edges.

Vision Q.400 uses a Sobel filter to calculate the object edges. The user defines the sensitivity of this filter. The result of the Sobel filter operation is then modified by the parameter "Suppressed Border". This parameter causes Vision Q.400 to consider differences within the object edges to be pseudo differences and suppress them.

The result of the parameters "Sensitivity" and "Suppressed Border" appear blue on the screen when you move the slider below the [Rotate] button left and right to display the rotated templates.

Original gray-value image used as a template
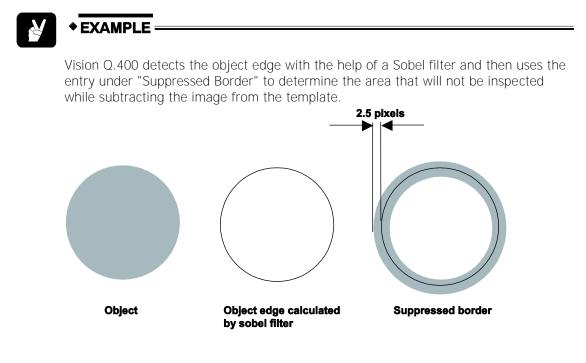
Rotated template with suppressed borders marked in white

Sensitivity

Here you define the sensitivity of the Sobel filter. The smaller the entry, the higher the sensitivity. The highest sensitivity is achieved with 3, the lowest with 13. When you select the highest sensitivity, small differences in the gray values of individual pixels will be detected as edges.

Suppressed border

The value here represents half the width of the area alongside an edge which will not be inspected in order to avoid pseudo differences. The entry signifies the distance between the edge pixel and the edge of the area which will be left out during the inspection. This parameter works with the results of the Sobel filter, i.e. the results of the parameter "Sensitivity". This means that if the Sobel filter does not find an edge, there are no borders to be suppressed.

◆ **EXAMPLE**

Vision Q.400 detects the object edge with the help of a Sobel filter and then uses the entry under "Suppressed Border" to determine the area that will not be inspected while subtracting the image from the template.

2.5 pixels

Object   **Object edge calculated**   **Suppressed border**
                    by sobel filter

9.12.3 Image Filters

Filters which work on the gray-value image are not permissible. All other filters (see page 246) will be applied to the binary image, i.e. the result of the subtraction process.

"Image Filters" page for difference checker

9.12.4 **Judgment**

The criterion for the judgement is the number of objects for which the features have been calculated. This must be within the limits of "Number of judged objects: Lower limit" and "Number of judged objects: Upper limit" (inclusive). You can enter a valid range limit from 0 to 128. The default setting is 0 and 64.

9.12.5 **Dependencies**

In contrast to all other checkers, the difference checker can only depend on ONE exposure adjustment, which will then be used for the lower as well as upper limits of the slice levels.

9.12.6 **Shape**

You may assign one of the following shapes to a difference checker:

- Rectangle
- Ellipse/Circle
- Polygon
- Doughnut

☞ ◆**NOTE**

When creating the checker, make sure to leave at least 6 pixels distance to the image border. The template is always a rectangle, even if you have selected an ellipse or circle as the checker shape. In this case, Vision Q.400 uses the smallest circumscribed rectangle for display. The calculation of differences between the current object and the template, however, takes place only in the checker shape, i.e. the ellipse or circle.

9.12.7 **Result**

The result list displays the area size and center point coordinates of each object processed. The objects are listed in the order specified in the parameter "Output Order".

The "Number of Total Objects" field indicates the number of objects before application of the limit value defined in the "Maximal Number of Objects" parameter on the "Algorithm" property page. The "Number of Judged Objects" field indicates the number of objects for which the features have been calculated.

When you use the setting "High" or "Maximum" for the parameter "Accuracy", you find the results of the pattern-matching algorithm on the "Result" page. These results help to determine the degree of accuracy. The following results are available:

- Location of the highest matching candidate (x-/y-coordinate)
- Angle of the template at the location of the highest matching candidate
- Average gray-value difference

And the total area of all objects found is displayed in "Total Difference".

9.13 Cross-Correlation Matching Checker

The cross-correlation matching checker searches for a predefined template in the current camera image. Only normalized cross-correlations will be considered. Compared with the contour matching checker, the cross-correlation checker has the advantage that the object search also works for objects with slight variations in shape, texture, or in blurry images.

As opposed to other checkers, the checker works with TWO shapes:

- The **template area** is the area where the gray values are defined with the aid of a reference pattern. The comparison is based on the gray values of the reference object.
- The **search area** (shape) is the area within the camera image where you search for gray values matching the gray values defined in the template area.

Create a checker as follows:

1. Set the template area (see page 380) to define the reference object
2. Set the search area (see page 380)
3. Set the model parameters (see page 394)
4. Optimize model parameters (see page 397)

9.13.1 Template Area

The template area is the shape which is set around the image area used to create the correlation model. The template area shape is defined by blue dots connected by a blue-and-orange dashed line. Four different shapes are valid for use with a contour matching checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut (segment)

Use the icons from the shape bar (see page 40) to set the template area. Next, you select the shape of the search area (see page 380).

☞ ◆NOTE

If you have set a polygon as the template area shape and want to change the size by way of the coordinates, identify the polygon nodes by clicking on the points in the table of coordinates. Vision Q.400 marks the selected point by a blue circle. You can use the mouse to drag the polygon node to a different position, thus modifying the polygon size.

9.13.2 Shape

For the cross-correlation matching checker you need to set two shapes:

- The shape of the template area (see page 380) and

- the shape of the search area (called "Shape").

For this reason the following dialog box appears when you have finished setting the template area for the cross-correlation matching checker:

In this dialog box, select the shape you want to use for the search area. The size of the search area is set automatically by Vision Q.400. You can modify it just as you would modify a checker shape, i.e. you can change the size and/or position of the search area.

Because the cross-correlation matching checker works with two shapes (template area and search area), when you create the checker a tool tip is displayed indicating what the shape is used for. The tool tip display is controlled by the "Show tool tip on template creation" check-box.

☞ ◆ NOTE

Selecting [Cancel] in the dialog for defining the search area not only aborts the selection of the search area, but also the creation of the cross-correlation matching checker altogether.

Difference between search and template area

The shape determines the area inside the camera image where the checker will search for matching objects. The template area is set around the object to be searched for. It serves to create the contour model. The shape and the template area are displayed in different colors so it is easier to distinguish them:

- The shape (search area) uses orange dots and a solid blue line and
- the shape of the template area (see page 380) uses blue dots and a blue-and-orange dashed line.

Four different shapes are valid for use with a contour matching checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut (segment)

By default, the search area is created with the maximal size possible in the image range minus a margin. You can decrease the shape of the search area with the keyboard or with the mouse. However, this will slow down the processing speed of the checker.

☞ ◆**NOTE**

> **When you have set a polygon as the search area shape and wish to change the size, identify the polygon nodes by clicking on the points in the table of coordinates. Vision Q.400 marks the selected polygon node with an orange circle. You can use the mouse to drag the polygon node to a different position, thus modifying the polygon size. See the example with the contour matching checker (see page 380).**

9.13.3 **Algorithm**

"Algorithm" page of a cross-correlation matching checker

Minimal correlation
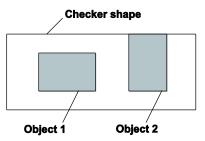
This parameter determines the normalized minimum correlation between template and image. The higher the value, the higher the correlation between template and image and the faster the search for corresponding objects.

Number of matches

Defines how many objects should be found at most. A maximum of 1024 objects can be found. When you set this parameter to "0", Vision Q.400 finds all instances of the object.

Area boundary

Use this parameter to define whether or not an object to be processed will be allowed to touch the shape. If "Area Boundary" is set to OFF, an object to be processed will not be permitted to touch the shape. If the parameter is set to "ON", the object to be processed will be permitted to touch the shape.

Checker shape

Object 1   **Object 2**

Parameter "Area Boundary"

With "Area Boundary" set to "ON", object 1 and object 2 would be processed. With "Area Boundary" "OFF", only object 1 would be processed since object 2 touches the shape.

Output Order

This parameter determines the sequence in which the objects appear in the result list. There is no default output order. You may choose between an ascending or a descending sorting order for the detected objects. You can sort by one of the following criteria:

- X- or Y-coordinate,
- line by line,
- column by column,
- in circular order
- list,
- X- or Y-coordinate of the reference point,
- angle
- correlation or
- Scale

If you have selected "List" (see page 316) as the output order, the object position will be output as the coordinates of the point and not the reference point.

☞ ◆**NOTE**

If you want to use the output order "List", the checker cannot depend on a position and rotation adjustment checker.

Reference point

The cross-correlation matching checker calculates as a result (see page 399) two points: the point and the reference point. As a default, the two points are identical. They refer to the center point of the shape of the cross-correlation matching checker.

If you would like Vision Q.400 to output a different point, e.g. if you would like to output a certain part of an object as the checker result, move the reference point accordingly. You can position the reference point of the object anywhere in the image.

The reference point can be adjusted via the mouse or by clicking buttons marked with arrows. The current coordinates are displayed. Use the button [Reset Reference Point] to reset the point moved to its original position (coordinates of the center point of the checker's shape).

◆ **PROCEDURE**

1. **Execute the cross-correlation matching checker by clicking** **or press <F8>**

   You need to execute the checker first before Vision Q.400 can display the reference point.

2. **Left mouse click on the grip point of the reference point**

   The mouse cursor changes its shapes as soon as you move it near a reference point.

3. **Drop the reference point at the desired position with a left mouse click**

9.13.3.1 Algorithm Advanced

Use the dialog box "Algorithm Advanced" for fine-tuning.

Algorithm advanced for cross-correlation matching

Accuracy

Here you define the accuracy of the search. You can search with pixel or with subpixel accuracy. The default setting is "Subpixel". This method does not require much processing time and allows for maximum accuracy.

◆ **NOTE**

- **The values for run time and errors of measurement depend on the application.**
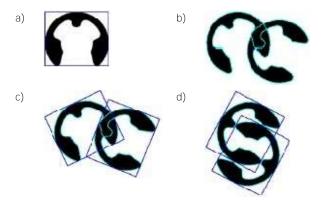
- **The bigger the model, the more accurate Vision Q.400 calculates the position, the scale, and the angle.**

Last compression level

Use this parameter to shorten the search for objects if the application allows for less accuracy when it comes to the objects' position. The cross-correlation matching is performed on several compression levels (see page 391). Enter the level number where you wish to stop searching for objects. The default setting is 1, i.e. the search is performed until the last compression level is reached. How many compression levels are available depends on the template you have used for creating the model. The bigger the template/model (see page 391), the more compression levels (see page 391) are available.

Maximal overlap

Here you determine by how much two objects may overlap (in percent). To achieve a high processing speed, Vision Q.400 does not use the object contour to calculate the overlap, but rather the smallest circumscribing rectangle. This means that you need to enter a comparatively large value even for "small" overlaps. The following pictures illustrate this:
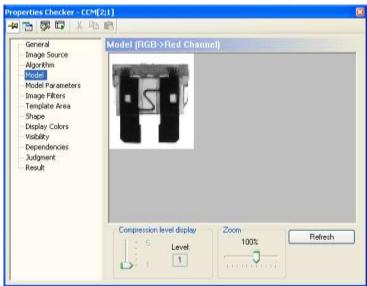
a) Cross-correlation model with circumscribing rectangle, b) overlapping objects (overlap about 8%), c) overlap of the circumscribing rectangles by about 20%, d) worst-case scenario: Although the objects themselves do not overlap, the areas of the circumscribing rectangles overlap by almost 90%. In order to find the objects even in a worst-case scenario, enter a sufficiently high value under "Maximal Overlap".

Max number of area boundary objects

This parameter acts as an offset against the number of objects to be found. If you want to find 5 objects for example, the search is aborted after 5 objects, even if there are 7 objects in the image for example. If 2 of the 5 objects found are then eliminated because they touch the edge of the search area, only 3 found objects are output, even though there are actually 5 valid objects in the image. With this parameter you specify how many more objects are to be sought in order to buffer this problem. The maximum output is the number of objects you specified under "Number of matches" on the "Algorithm" property page.

9.13.4 **Model**

On this property page you see the taught pattern that is used to create the model. You can view the model as a compressed or zoomed image.

"Model" page of a cross-correlation matching checker

Compression level display

Use the slider to select different compression levels. The lowest level (1) shows the uncompressed model image.

Zoom

Use the slider to zoom the selected display image.

Refresh

Use this button to teach Vision Q.400 a new template. First modify the checker shape to surround the area with the object you wish to teach, then click the button to teach the object as a template image.

9.13.5 Model Parameters

Use this property page to create the model and to enter the expected angle range of the objects you wish to find.

"Model Parameters" page of a cross-correlation matching checker

Min Angle/Max Angle

Indicates the angle range in which the object may be rotated compared to the template position. Please note that the bigger the angle range, the longer the processing speed of the checker.

Compression Levels

The model will be created with the help of several image pyramids and compression levels, respectively, and multiple rotations per level. As a default setting, the maximum number of compression levels will be used to speed up the search. However, you can enter a different number under "Use".

Object appearance

This parameter defines which objects will be found against which image background.

Description	Function	Example	
		Template	**Matching objects**
Like template	Finds an object looking like the template.		
Like template or inverted	When you have used a black object with a white background as the template, this setting enables Vision Q.400 to find objects also inverted objects, i.e. white objects with a black background. This slows down the checker's processing speed.		

Apply image filter to model

As a default setting, all image filters applied to the reference image will also be applied for the creation of the model. You can deactivate this option.

Create model

Use this button to create the model with the model parameters you have set.

9.13.6 How to Optimize the Settings

To achieve optimum object recognition make sure to use a representative template image. The template image should reflect typical object features like position and rotation, overlapping and brightness. Carry out two steps to optimize the settings.

1. Stable detection of all objects
2. Optimize the processing speed

Stable detection of objects

◆ PROCEDURE

1. **For teaching, use a template of sufficient size**

    The bigger the contour model, the more accurate Vision Q.400 calculates the position, the scale, and the angle.

2. **Make sure that the objects you wish to detect are all fully within the image**

    Objects "cut off" at the edge of the imaging range cannot be detected.

3. **If you wish to speed up the processing and can tolerate minor errors of measurement, increase the value for parameter "Last Compression Level"**

4. **If two or more objects may overlap and you need to detect them nevertheless, increase the value for parameter "Maximal Overlap"**

    Please refer to the detailed description of the parameter.

5. **If Vision Q.400 detects and displays several objects even though there is only one, this may be due to the symmetry of the object in question. Decrease the value of the parameter "Maximal Overlap" and make the angle range smaller**

Optimize the processing speed

◆ PROCEDURE

1. **Limit the search area as far as possible**

9.13.7 **Judgment**

The judgment criterion is the number of objects found. The number of objects has to fall within the range specified in "Lower limit of objects" and "Upper limit of objects" (inclusive). You can enter a valid range limit from 0 to 1024. The default setting is 0 and 1024.

"Judgment" page of a cross-correlation matching checker

☞ ◆**NOTE**

> **For a more flexible evaluation of the number of objects please use the spreadsheet.**

9.13.8 **Result**
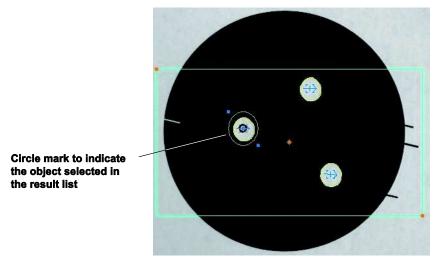
"Result" page of a cross-correlation matching checker

The result list displays the features calculated for each object detected. The objects are listed in the order specified in the parameter "Output Order". In addition, Vision Q.400 displays the "Number of Judged Object" to indicate for how many objects Vision Q.400 calculated the features.

When you click a value in the result list, the center point of the corresponding object is marked by a black circle.

Circle mark to indicate the object selected in the result list

Highlighting the objects detected by the cross-correlation matching checker

When you have moved the reference point (see page 385), Vision Q.400 draws a line connecting the reference and the center point.

Center point

Connecting line between center point and reference point

Moved reference point

Display of a reference point that has been moved from the default position

9.14 Contour Matching Checker

The contour matching checker searches for a predefined template in the current camera image. The search is carried out with the contours of the template. The advantage is that the contour matching checker works independent of changes in lighting conditions and of objects that are misplaced, rotated or overlapping each other.

With a black-and-white camera, the contour matching checker works on the original gray-value image, with a color camera on the color image.

As opposed to other checkers, the contour matching checker works with TWO shapes:

- The **template area** is the area where the contour is defined with the aid of a reference pattern. The reference object's contour will be used for the matching process.
- The **search area** (shape) is the area within the camera image where you search for contours matching the contour defined in the template area.

Create a contour matching checker as follows:

1. Set the template area (see page 380) to define the reference object
2. Set the search area (see page 380)
3. Set the model parameters (see page 394)
4. Optimize model parameters (see page 397)

9.14.1 Template Area

The template area is the shape which is set around the image area used to create the contour model. The template area shape is defined by blue dots connected by a blue-and-orange dashed line. Four different shapes are valid for use with a contour matching checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut (segment)

Use the icons from the shape bar (see page 40) to set the template area. Next, you select the shape of the search area (see page 380).

☞ ◆ **NOTE**

If you have set a polygon as the template area shape and want to change the size by way of the coordinates, identify the polygon nodes by clicking on the points in the table of coordinates. Vision Q.400 marks the selected point by a blue circle. You can use the mouse to drag the polygon node to a different position, thus modifying the polygon size.

9.14.2 Shape

For the contour matching checker you need to set two shapes:

- The shape of the template area (see page 380) and
- the shape of the search area (called "Shape").

For this reason the following dialog box appears when you have finished setting the template area for the contour matching checker:

Dialog for defining the search area of a contour matching checker

In this dialog box, select the shape you want to use for the search area. The size of the search area is set automatically by Vision Q.400. You can modify it just as you would modify a checker shape, i.e. you can change the size and/or position of the search area.

Because the contour matching checker works with two shapes (template area and search area), when you create the checker a tool tip is displayed indicating what the shape is used for. The tool tip display is controlled by the "Show tool tip on template creation" checkbox.

☞ ◆NOTE
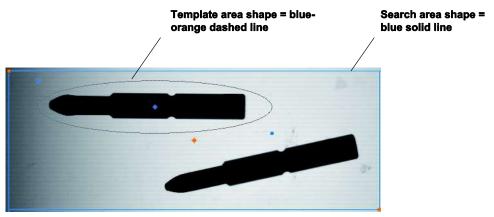
Selecting [Cancel] in the dialog for defining the search area not only aborts the selection of the search area, but also the creation of the contour matching checker altogether.

Difference between search and template area

The shape determines the area inside the camera image where the checker will search for matching objects. The template area is set around the object to be searched for. It serves to create the contour model. The shape and the template area are displayed in different colors so it is easier to distinguish them:

- The shape (search area) uses orange dots and a solid blue line and
- the shape of the template area (see page 380) uses blue dots and a blue-and-orange dashed line.

Template area shape = blue-orange dashed line

Search area shape = blue solid line

Difference between shape and template area for contour matching checker

Four different shapes are valid for use with a contour matching checker:

- Rectangle
- Ellipse (Circle)
- Polygon
- Doughnut (segment)

By default, the search area is created with the maximal size possible in the image range minus a margin.
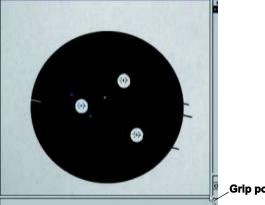
"Shape" page of a contour matching checker

You can decrease the shape of the search area with the keyboard or with the mouse. However, this will slow down the processing speed of the checker.

☞ ◆NOTE

When you have set a polygon as the search area shape and wish to change the size, identify the polygon nodes by clicking on the points in the table of coordinates. Vision Q.400 marks the selected polygon node with an orange circle. You can use the mouse to drag the polygon node to a different position, thus modifying the polygon size.

Grip point selected

✌ ◆EXAMPLE

How to change the rectangular shape of a contour matching checker with a circular template area with the keyboard (first procedure) and with the mouse (second procedure).

Making a shape smaller with the keyboard
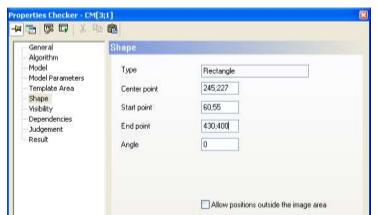
◆PROCEDURE

1. **Enter the new coordinates for the shape under "Start Point" and "End Point"**

   Use the status bar of the main window to retrieve the coordinates with the mouse.

2. Click ⬚ to apply the changes
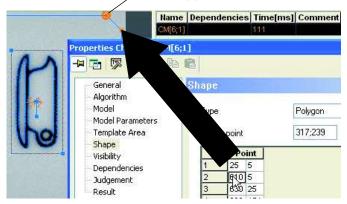
Making a shape smaller with the mouse

◆ PROCEDURE
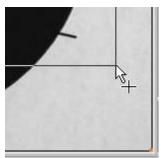
1. Left mouse click on the grip point of the shape and hold the left mouse button down

When you have selected the grip point, the mouse cursor changes to a cross.
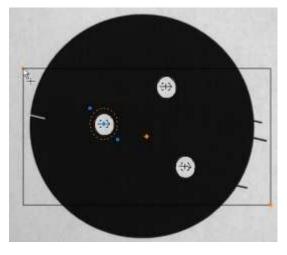
Marked polygon node of the search area

2. Move the grip point of the shape to the desired position and release the left mouse button

3. Select the other grip point of the shape

4. Move the second grip point of the shape to the desired position

9.14.3 Algorithm

"Algorithm" page of a contour matching checker

Minimal correlation
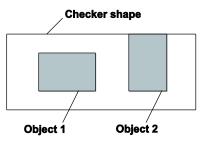
This parameter determines how many matching points Vision Q.400 has to find in the image in order to detect an object. The setting 0.8 means that Vision Q.400 has to find at least 80% of the contour points.

Number of matches

Defines how many objects should be found at most. A maximum of 1024 objects can be found. When you set this parameter to "0", Vision Q.400 finds all instances of the object.

Area boundary

Use this parameter to define whether or not an object to be processed will be allowed to touch the shape. If "Area Boundary" is set to OFF, an object to be processed will not be permitted to touch the shape. If the parameter is set to "ON", the object to be processed will be permitted to touch the shape.

Parameter "Area Boundary"

With "Area Boundary" set to "ON", object 1 and object 2 would be processed. With "Area Boundary" "OFF", only object 1 would be processed since object 2 touches the shape.

Output order

This parameter determines the sequence in which the objects appear in the result list. There is no default output order. You may choose between an ascending or a descending sorting order for the detected objects. You can sort by one of the following criteria:

- X- or Y-coordinate,
- line by line,
- column by column,
- in circular order
- list,
- X- or Y-coordinate of the reference point,
- angle
- correlation or
- scale

The scale is only calculated if you have activated the option "Use Scale" in the "Model Parameters Advanced" dialog box.

If you have selected "List" (see page 316) as the output order, the object position will be output as the coordinates of the point and not the reference point.

◆ **NOTE**

If you want to use the output order "List", the checker cannot depend on a position and rotation adjustment checker.

Reference point

The contour matching checker calculates two points (see page 399), the point and the reference point. As a default, the two points are identical. They refer to the center point of the shape of the contour matching checker.

If you would like Vision Q.400 to output a different point, e.g. if you would like to output a certain part of an object as the checker result, move the reference point accordingly. You can position the reference point of the object anywhere in the image.

The reference point can be adjusted via the mouse or by clicking buttons marked with arrows. The current coordinates are displayed. Use the button [Reset Reference Point] to reset the point moved to its original position (coordinates of the center point of the checker's shape).

◆ PROCEDURE

1. **Execute the contour matching checker by clicking** **or press <F8>**

   You need to execute the checker first before Vision Q.400 can display the reference point.

2. **Left mouse click on the grip point of the reference point**

   The mouse cursor changes its shapes as soon as you move it near a reference point:

3. **Drop the reference point at the desired position with a left mouse click**

9.14.3.1   Algorithm Advanced

Use the dialog box "Algorithm Advanced" for fine-tuning.

Algorithm Advanced

Accuracy

Here you define the accuracy of the search. You can search with pixel or with subpixel accuracy. The default setting is "Subpixel Standard". This method with subpixel accuracy is very fast and suits most applications.

If you would like to perform a more accurate search, change the parameter setting. However, this will slow down the processing speed of the checker. The table demonstrates the influence of the parameter on the calculation accuracy and calculation speed and may serve as a guideline.

◆ EXAMPLE

Last compression level	Subpixel accuracy	Subpixel standard	Subpixel advanced	Subpixel high	Subpixel very high
1	Relative run time	100%	120%	131%	142%
	Max. angle error	0,079°	0,025°	0,014°	0,013°
	Average angle error	0,027°	0,010°	0,006°	0,005°
2	Relative run time	69%	75%	79%	84%
	Max. angle error	0,167°	0,142°	0,133°	0,130°
	Average angle error	0,072°	0,048°	0,051°	0,050°
3	Relative run time	60%	62%	65%	67%
	Max. angle error	0,446°	0,260°	0,253°	0,252°
	Average angle error	0,206°	0,102°	0,101°	0,100°

◆ NOTE

- **The values for run time and errors of measurement depend on the application.**
- **The bigger the model, the more accurate Vision Q.400 calculates the position, the scale, and the angle.**

Search method

Use the parameter "Search Method" to influence the search algorithm by balancing a thorough against a rough but quick search. Use the slider to select a setting between "rough" and "thorough".

To understand the function of this parameter we need to take a closer look at the search algorithm. The checker performs a step-by-step search, starting from a very low image resolution. When the search algorithm detects something that could be possibly be a matching object, the position is stored. This position will be examined more closely at the next (more accurate) search step.

When you have selected a more thorough setting for the "Search Method", Vision Q.400 may also examine objects that are unlikely to match the template. This is because the low resolution at this stage makes it impossible to decide whether the object matches the template or not. This slows down the search process. The basic idea behind this parameter is to stop examining a possible match when it becomes unlikely that the value under "Minimal Correlation" on the "Algorithm" page is reached. In other words, the purpose of this parameter is to avoid wasting time on objects that are unlikely to match the template.

If you set the search method too rough, this may have unwelcome consequences, too: In some cases a perfectly visible object is not detected because the matching process starts "on

the wrong footing", i.e. a possible match is discarded at the low-resolution stage as unlikely and is not pursued.

Please note that the parameters "Search Method" and "Minimal Correlation" work together. This means, enter a lower minimal correlation to perform a rougher search. In general, the processing speed increases if you combine a rough search method with a low minimal correlation. For more tips and tricks read the section on optimizing the settings (see page 397).

Last compression level
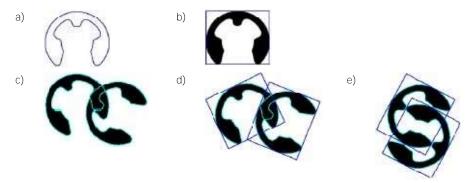
Use this parameter to shorten the search for objects if the application allows for less accuracy when it comes to the objects' position. The contour matching is performed on several compression levels (see page 391). Enter the level number where you wish to stop searching for objects. The default setting is 1, i.e. the search is performed until the last compression level is reached. How many compression levels are available depends on the template you have used for creating the contour model. The bigger the template/model (see page 391), the more compression levels (see page 391) are available.

In poor camera images, i.e. images that are out of focus, deformed, or noisy, it is often not possible to find an instance of the contour model at the lowest compression level because there are not enough edges to be found or the edges are too deformed. On higher compression levels there may be sufficient edge information to find instances of the model, even if the accuracy and robustness are limited. Which compression level to select, i.e. how to determine the lowest level where instances of the model can still be found, depends on the model as well as the camera image. This means the compression level can vary from one image to the next. To facilitate contour matching in poor images, it is possible to determine automatically during contour matching which is the lowest compression level where an instance of the model can be found. To activate this function, the value entered for "Last compression level" needs to be negative.

For example, if you set the parameter to "−2", contour matching will stop at the second but last compression level. Vision Q.400 tries to find an instance of the contour model on compression level 2. If Vision Q.400 cannot find an instance on this compression level, it determines the lowest compression level where instances of the model can still be found. The instances of this compression level will be returned as the result.

Maximal overlap

Here you determine by how much two objects may overlap (in percent). To achieve a high processing speed, Vision Q.400 does not use the object contour to calculate the overlap, but rather the smallest circumscribing rectangle. This means that you need to enter a comparatively large value even for "small" overlaps. The following pictures illustrate this:

a) Contour model, b) contour model with circumscribing rectangle, c) overlapping objects (overlap about 8%), d) overlap of the circumscribing rectangles by about 20%, e) worst-case scenario: Although the objects themselves do not overlap, the areas of the circumscribing rectangles overlap by almost 90%. In order to find the objects even in a worst-case scenario, enter a sufficiently high value under "Maximal Overlap".

Max number of area boundary objects

This parameter acts as an offset against the number of objects to be found. If you want to find 5 objects for example, the search is aborted after 5 objects, even if there are 7 objects in the image for example. If 2 of the 5 objects found are then eliminated because they touch the edge of the search area, only 3 found objects are output, even though there are actually 5 valid objects in the image. With this parameter you specify how many more objects are to be sought in order to buffer this problem. The maximum output is the number of objects you specified under "Number of matches" on the "Algorithm" property page.

Maximal allowed deformation
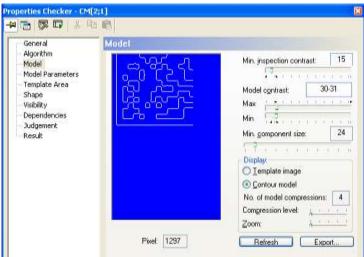
If the shape of the object may differ from the shape saved in the contour model by for example 2 pixels, enter the value "2". Please note that entering higher values for this parameter often lead to higher execution times. In addition, a value set too high increases the risk that the checker finds wrong candidates. Both problems usually occur when objects are small or have a delicate structure. The reason is that objects like that lose their important and characteristic features needed for a reliable detection if you set a value for deformation that is too high. Please also not that the accuracy for detecting partially overlapping objects may decrease with higher deformation values, especially if there are other objects near the object to be detected. This is why it makes sense to set a deformation value that is only as high as necessary and as low as possible.

☞ ◆NOTE

To avoid that wrong objects are detected, we recommend combining the parameter "Maximal allowed deformation" with one of the following settings for the parameter "Accuracy": "Subpixel advanced", "Subpixel high" or "Subpixel very high".

9.14.4 **Model**

This page displays the registered template as an image or as the contour model derived from that image. You can view the template or contour model as a compressed or zoomed image.

"Model" page of a contour matching checker

Minimal inspection contrast

The value determines the minimal contrast for a pixel in order to be compared with the template image during the object search. The minimal contrast helps to separate the object from noise. If due to noise the image contains gray-value differences of up to 10 gray levels, set the parameter to at least 10. Use the slider to set the parameter and move it as far left as possible.

> ☞ ◆**NOTE**
>
> - **This parameter value has to be smaller than the value entered for parameter "Min. Model Contrast". The two parameter values should be as far apart as possible.**
> - **If you wish to find objects that are partially covered, the parameter value has to be slightly bigger than the noise to ensure a stable and accurate position detection.**

Model contrast

The model is extracted with the help of a hysteresis threshold. All pixels in the camera image with a gray-value difference to the neighboring pixels greater than or equal to the value set with the slider "Max Model Contrast" are accepted as "safe" points for the contour model. Accordingly, all pixels with a gray-value difference smaller than or equal to the value set with the slider "Min Model Contrast" will be ignored. "Potential points" with a gray-value difference between the two slice levels will be accepted if they are connected by a path of "potential points" with the "safe" contour model points. That means that "safe" points influence their environment (hysteresis).

If "Min Model Contrast" and "Max Model Contrast" are identical, Vision Q.400 executes a simple segmentation. All pixels with a gray value below the set value are ignored, all pixels with a gray value above the set value are part of the contour model.

Use the sliders "Max Model Contrast" and "Min Model Contrast" to set the thresholds. You can immediately see the effect of changing the parameter in the image on the left.

Min. component size

The value determines the minimal size for a component of the model in order to be considered for selection. Components with less pixels than the minimal size will be suppressed.

Use the sliders to set the value for the threshold. You can immediately see the effect of changing the parameter in the image on the left.

Display template image/contour model

Here you define how the template is displayed in the window to the left: Either as a gray-value image in the different compression levels or as a contour model derived from the gray-value image. The display of the template and contour model is very important because it illustrates the effect of parameter "Min. Model Contrast". First, the parameter influences the quality of the contour model, which is used for the object search. Second, the parameter influences the number of compression (or pyramid) levels, which in turn influence the processing speed of the checker.

No. of model compressions

Vision Q.400 creates so-called image pyramids from the template image and the contour model to speed up the search process. For example, if the original image used for creating the model has a size of 100 x 80 pixels, the image of the first pyramid level is 50 x 40 pixels, the image of the second pyramid level 25 x 20 pixels etc. The more pyramid levels there are, the faster the search for the contour model will be performed in the image. As a template image has to contain at least 15 pixels, the parameter "Min. Model Contrast" directly influences the number of compression levels. When you change the parameter setting, you see the effect immediately on the screen. Especially for large contour models containing many contour points we recommend using the parameter "Optimize Large Models". This parameter is described in the section on "Model Parameters" (see page 394).

Zoom

Use the slider to zoom the selected display image.

Pixel

Here the number of pixels in the contour model is displayed. In the highest pyramid level the model has to contain at least 15 pixels.

Refresh

Use this button to teach Vision Q.400 a new template. First modify the checker shape to surround the area with the object you wish to teach, then click the button to teach the object as a template image.

Export

Use this button to export the contour model as a black-and-white bitmap file. This may be useful when you have only an image of bad quality to create the contour model and it is difficult to extract the object to search for. In such cases it is best to touch up the contour mod-

el created and teach the modified version as a new template. This way you can remove objects created by noise or complete interrupted contour lines.
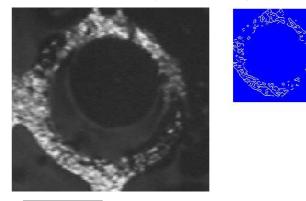
In some cases it is necessary to create a model and use it as a template image. Please see the following example to find out how to proceed in these cases:

◆ **EXAMPLE**

The template is the hole in a soldering eye. Due to poor image quality and variations in the image contrast, the template cannot be extracted by using a slice level. Even when you use the optimal setting for parameter "Model Contrast", the calculated contour model does not yield satisfactory results.

◆ **PROCEDURE**

1. **Export model by choosing** Camera → Save as BMP…

    This enables you to edit the model with any graphics program.

    In this case the model corresponds to the hole. An optimum model would be a black hole with the correct radius.
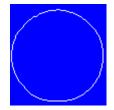
2. **Create a filled circle with a as close to the representation of the hole in the exported image as possible**

    Every edge needs to be represented in the model. When the circle is not filled there are two edges and the model would not fit the requirements.

3. **Save the modified model as a bitmap file.**

4. **Load the bitmap in Vision Q.400 with the command** Camera → Load Image...

5. **Adjust the checker shape to fit the new template**

6. **Select [Refresh] on the property page "Model" to update the template and to calculate a new contour model**

9.14.5 Model Parameters

Use this property page to create the contour model and to enter the expected angle range of the objects you wish to find.

"Model Parameters" page of a contour matching checker

Minimal / Maximal Model Contrast (display only)

The model is created from the pixel which have been extracted from the gray-value image with the help of a hysteresis threshold. The contrast values are only displayed here. To set the values, use property page "Model" (see page 391). You will also find an explanation of the pixel-extraction procedure there.

Minimal Inspection Contrast (display only)

The value determines the minimal contrast for a pixel in order to be compared with the template during the object search. The threshold value is only displayed here. To set the value, use property page "Model" (see page 391).

Min Angle/Max Angle

Indicates the angle range in which the object may be rotated compared to the template position. Please note that the bigger the angle range, the longer the processing speed of the checker.

Create Contour Model

With the button [Create Contour Model] you calculate the contour model on the basis of the parameter values entered.

Model parameters advanced

This button opens a new dialog box where you can fine-tune the settings if one of the following conditions is true:

- You are using a big model and wish to optimize it.
- You wish to find objects of differing appearance,
- you wish to use scaling to find objects of different sizes, or
- you wish to set the gravity center of the template area as the output point.

9.14.5.1   Model Parameters Advanced

Advanced model parameters for contour matching checker

Optimize large models

Use this parameter to optimize large models with very many contour points. The bigger the number of contour points used, the more time the search algorithm needs to find an object. When you select an optimization method, Vision Q.400 reduces the number of contour points used to detect the object. This speeds up the search when you use large models. When you use this parameter, it may be necessary to modify the setting of parameter "Search Method" to make the search less thorough.

Object appearance

This parameter defines which objects will be found against which image background.

Setting	Function	Example	
		Template	**Matching objects**
Like template	Finds an object looking like the template.		
Like template or inverted	When you have used a black object with a white background as the template, this setting enables Vision Q.400 to find objects also inverted objects, i.e. white objects with a black background. This slows down the checker's processing speed.		
Dynamic	This setting enables Vision Q.400 to find objects with changing brightness as compared to the background (e.g. shiny metal parts like screw heads). This means objects may be brighter than the background in parts where the light is reflected and darker in parts where there is no light.		or

Output point

Use this parameter to determine the point to be output. You can choose between "Template Area"" and "Model".

When you select "Template Area", the output point is the center point of the template area you have set. When you select "Model", the output point is the center of gravity of the model.

Pregenerate Model

The pregeneration of the model normally leads to slightly lower run times because the model does not need to be transformed at run time. However, the memory requirements and the time required to create the model are significantly higher. This means loading an application containing a contour matching checker takes longer.

> ◆ **NOTE**
>
> **Please note that the pregenerated model may yield slightly higher correlation values than a model transformed at run time. This is because transforming the model at run time necessarily leads to different internal data for the transformed models than pregenerating the transformed models.**

Scaling

Use this parameter to define whether you wish to find objects of variable size. This parameter heavily influences the memory need for processing and the checker speed. The following options are available:

Option	Description
No	Finds only objects that have the same size as the template.
Proportional	The template will be scaled proportionally by the minimum and the maximum factor. The default settings of 0.9 and 1.1 help to find all objects that are up to 10% bigger or smaller than the template.
Not proportional	The template will be scaled in X and Y direction by the minimum and maximum factor. This parameter heavily influences the memory need for processing and the checker speed.
Minimum/maximum factor	Enter the multiplier to be used for scaling the object's size. For **proportional** scaling the same factors are used in both X and Y direction, for **not proportional** enter factors for each scaling direction separately. When you enter 0.5 in "Minimum Factor" and 2.0 in "Maximum Factor", Vision Q.400 detects object from half the size to double the size of the template object.

☞ ◆**NOTE**

Do not forget to enter the decimal point. If you want to make entering decimals easier, you can reconfigure (see page 78) your keyboard by clicking the [Replace comma with decimal point on numeric keypad] button.

9.14.6 How to Optimize the Settings

To achieve optimum object recognition make sure to use a representative template image. The template image should reflect typical object features like position and rotation, overlapping and brightness. Carry out two steps to optimize the settings.

1. Stable detection of all objects
2. Optimize the processing speed

Stable detection of objects

◆**PROCEDURE**

1. **For teaching, use a template of sufficient size**

   The bigger the contour model, the more accurate Vision Q.400 calculates the position, the scale, and the angle.

2. **Make sure that the objects you wish to detect are all fully within the image**

   Objects "cut off" at the edge of the imaging range cannot be detected.

3. **Choose a rougher rather than a more thorough setting for the parameter "Search Method"**

   When the search method is too "thorough", it is possible that Vision Q.400 will not detect even perfectly visible objects. The more thorough you set "Search Method", the more thoroughly Vision Q.400 searches for objects. When you move the slider to the far right position, Vision Q.400 always detects all objects. How-

ever, this increases the processing time. Try to find a good compromise (see page 394) between the minimal inspection contrast and as thorough a search method as possible.

4. **If you wish to find objects which are partly hidden, decrease the value of parameter "Min Model Contrast"**

5. **If the contrast between object and background is low, decrease the value of parameter "Min. Inspection Contrast"**

    However, make sure to set the value higher than the noise.

6. **If the brightness of an object varies as compared with the image background or even varies within the object itself, change the parameter "Object Appearance" accordingly**

    If only a small part of the object is in front of a variable background, it may make more sense to only decrease the value of "Min Model Contrast".

7. **If you wish to speed up the processing and can tolerate minor errors of measurement, increase the value for parameter "Last Compression Level"**

    Find the optimum combination of the parameters "Accuracy" und "Last Compression Level" to ensure maximum processing speed.

8. **If two or more objects may overlap and you need to detect them nevertheless, increase the value for parameter "Maximal Overlap"**

    Please refer to the detailed description of the parameter.

9. **If Vision Q.400 detects and displays several objects even though there is only one, this may be due to the symmetry of the object in question. Decrease the value of the parameter "Maximal Overlap" and make the angle range smaller**

Optimize the processing speed

♦ **PROCEDURE**

1. **Keep increasing the value of the parameter "Min. Model Contrast" as long as the objects are detected accurately**

    The higher you set this parameter, the faster Vision Q.400 performs the search.

2. **Choose the smallest setting possible for the angle range and the scale parameters "Minimum Scale" and "Maximum Scale"**

3. **Limit the search area as far as possible**

♦ **NOTE**

In order to be able to find the taught model, the selected output point needs to be located inside the search region.

9.14.7 Judgment

The judgment criterion is the number of objects found. This must be within the limits of "Number of judged objects: Lower limit" and "Number of judged objects: Upper limit" (inclusive). You can enter a valid range limit from 0 to 1024. The default setting is 0 and 1024.

"Judgment" page of a contour matching checker

☞ ◆NOTE

For a more flexible evaluation of the number of objects please use the spreadsheet.

9.14.8 Result
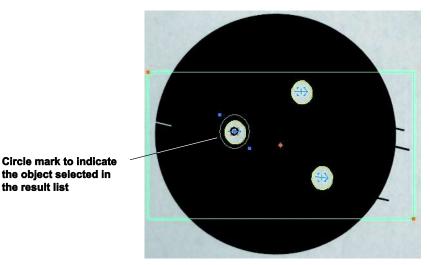
"Result" page of a contour matching checker

The result list displays the features calculated for each object detected. The objects are listed in the order specified in the parameter "Output Order". If the checker has not been working with scaling, the column for the scale factor is highlighted in gray.
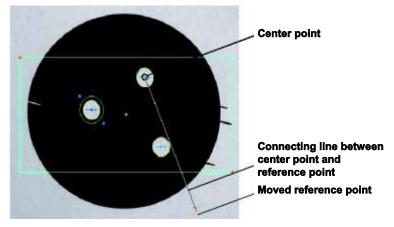
In addition, Vision Q.400 displays the "Number of Judged Object" to indicate for how many objects Vision Q.400 calculated the features.

When you click a value in the result list, the center point of the corresponding object is marked by a black circle.

Circle mark to indicate the object selected in the result list

Highlighting the objects detected by the contour matching checker

When you have moved the reference point (see page 385), Vision Q.400 draws a line connecting the reference and the center point.

Center point

Connecting line between center point and reference point

Moved reference point

Display of a reference point that has been moved from the default position

9.15 OCR Checker

Use the OCR (Optical Character Recognition) to read, identify and check letters, characters, or symbols by teaching.

Inspection task example for OCR checker

9.15.1 Terminology

Label	Name for an object (a letter, cipher, or symbol). A label may consist of up to 255 letters. Blanks are not allowed.
Pattern	A pattern is one representation of an object, e.g. a bold-printed capital "**A**" and a small "**a**" in italics are both patterns of the letter with the label A. The pattern is a gray-value image of the object.
Set of patterns	All patterns of an object combined in a group or set. This group is identified by the label. From the patterns Vision Q.400 obtains the features which help to identify and differentiate between objects.
Font	A kind of image database containing all pattern sets and their labels. For example, there are three different letters, which have been given the labels A, B, and C. Each letter has a set of 5 patterns. All letters and their patterns belong to font "Font 1". A font may also contain symbols like company logos or other characters.
Classifier	Set of data containing the features which help to differentiate between objects. The classifier's features are calculated on the basis of a font and the user's parameter settings. A classifier contains features from object patterns belonging to the same font. However, this does not mean that it contains features for **all** objects belonging to the font.

9.15.2 Distinguishing between Font and Classifier

In order to perform OCR, you need data describing the letters, ciphers, and symbols you wish to inspect. Vision Q.400 has to "learn" the data in order to be able to identify and judge the characters under the camera.

You "train" Vision Q.400 to read by creating a **font**. Working like a database for images, the font stores patterns of letters, ciphers, symbols, etc. together with the label you have assigned for each character.

The font files have the extension *.NFT and are stored in the sub-**folder "fonts" of the insta**llation folder.

In order to be able to compare the images stored in the font database, Vision Q.400 needs a **classifier**. The classifier contains feature information which has been extracted from the patterns saved. These features help Vision Q.400 to differentiate the objects during inspection (see page 411).

Vision Q.400 assigns names to classifiers automatically. The classifier files have the extension *.fnt and are stored in the subfolder "\fonts" of the installation folder.

Once Vision Q.400 has calculated a classifier on the basis of a font, you can decide whether you wish to use the fonts and its options or only the classifier for your OCR checker.

When you set the option "OCR Check Mode" on the "Algorithm" page to "Extended", a file is created in the "\fonts" folder with additional OCR information. The file name is the font name, the file extension is *.ocv.

◆ **EXAMPLE**

If all OCR checkers work with the same font with the same parameter settings, it makes sense to use one OCR checker for pattern training and calculating the classifiers. All other checkers then use the calculated classifier.

Using the font means that the options on the following tabs are available: "Parameters" (see page 411) and "Customize" (see page 415). Using the classifier means that the options on these pages are not available.

◆ **NOTE**

The distinction between font and classifier is very important. The font is the basis, the classifier is derived from the font's data. There can be more than one classifier per font. You need either a font or a classifier to execute an OCR checker.

9.15.3 How to Pass on Applications with OCR Checkers

Font and classifier files contain information which is not saved in the application file *.nav. When you pass on application files to another person or wish to use an application on a different PC Imagechecker, you need to copy the font and classifier files as well.

An OLE client (see page 121) will help you to find out from the application file which font and classifier files you need. Use the function **getDependentFileNames** from the tool **VisionQ.400HelpersControl.ocx** to extract the following information:

- Name of the classifier file: Clf_Name.fnt
- Name of the font file: FontName.nft
- Length of the information in bytes
- Identifier string "Dep_Vision_Q.400"

9.15.4 General

The "General" page contains some additional parameters as compared to the other checkers.

ActiveX name
You need the ActiveX name of a checker if you wish to read or modify the checker's parameters via an ActiveX client. The ActiveX client can only access the checker via its ActiveX name. The ActiveX name is defined by Vision P400 when you create the checker. You can modify the name when you have set the checker.

Force error to NG
In some instances, it makes sense to treat an error as an NG judgment so that an application is executed completely. If Vision Q.400 finds no object for the optical character verification, it generates an error and stops the application. If you know that the optical character recognition will not always work because you are inspecting different objects, but always wish to execute the application completely, set this parameter to "Yes".

Enable execution
Select "No" to stop the checker from being executed. This can be useful, for example, if you do not need the checker for processing the current image, but you do not want to delete it from the sequence list, because you may need the checker again later on. Even if you have disabled the execution of a checker, you can still make all checker settings, as only the execution is disabled.

OCR type
There are two different methods (see page 411) to classify the detected characters: a box classifier and a neural network. In general we recommend to prefer the neural network because the results tend to be more stable. We continue to support the box classifier for reasons of software consistency.

Draw object numbers
Activate this option if you wish to see the number of objects found (letters, symbols, etc.) on the screen. We recommend to activate this option if you wish to use the "Customize" (see page 415) page to group objects.

Draw labels

Activate this option if you want Vision Q.400 to display the labels of the object the system has recognized on the screen.

Display of object numbers and labels with the OCR checker

9.15.4.1   Use Font

Select an existing font or create a new font to perform optical recognition.

Set Font

Click [Set Font] to open the selection dialog box for font files.

☞ ◆NOTE

Before you use the font (see page 185), it is advisable to optimize the file.

Show

Click [View Font] to open the "Font Viewer" (see page 185) dialog. Here you can view and edit existing fonts.
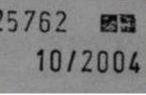
9.15.4.2   Use Classifier

Activate this option (see page 411) if you wish to work with a classifier instead of a font. Vision Q.400 comes with a number of predefined classifiers.

Dot Print

Document

Handwriting

Industrial

MICR, OCRA, OCRB

Pharma

☞ ◆ NOTE

- **This option is not available when you have set the option "OCR Check Mode" (see page 405) to "Extended".**
- **Adding new patterns is only possible when you have selected Use Font.**
- **Selecting a classifier means that you cannot modify the settings on the pages "Parameters" and "Customize" because these parameters are determined by the font.**
- **Please note that the predefined classifiers have been trained with dark writing on a light background. If you want to read light writing in front of a dark background, you need to invert the writing first, for example by preprocessing the gray values of the camera image with the image filter "Invert image" (see page 246).**

9.15.5 Algorithm

Depending on whether you are processing a gray-value image, a color channel of a color image or a color image, you can either use checker-specific slice levels (see page 236) or the checker-specific color selection (see page 243). How to set checker-specific slice levels or perform a checker-specific color selection is described in the chapter about the checker property sheets (see page 246).

"Algorithm" page of an OCR checker

Maximal number of objects
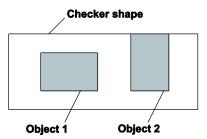
Use this parameter to limit the number of objects to be processed. You may process a maximum of 32767 objects. When there are more objects than the maximal number entered, Vi-

sion Q.400 only calculates and displays the features of the set number of objects in the order specified under "Output Order" on the "Algorithm" page and ignores the rest.

Object type

Here you determine which pixels will define an object. If you choose "Selected", the objects will be generated from the pixels within the specified binarisation range. If you choose "Not Selected", the objects will be generated from the pixels which fall outside the specified range.

Area boundary

Use this parameter to define whether or not an object to be processed will be allowed to touch the shape. If "Area Boundary" is set to OFF, an object to be processed will not be permitted to touch the shape. If the parameter is set to "ON", the object to be processed will be permitted to touch the shape.

Parameter "Area Boundary"

With "Area Boundary" set to "ON", object 1 and object 2 would be processed. With "Area Boundary" "OFF", only object 1 would be processed since object 2 touches the shape.

Labeling

If "Labeling" is "OFF", all pixels within the selected range will be gathered into an object. If, however, "Labeling" is set to "ON", only pixels linked to one another within the 8-fold neighboring relationship (see page 314) will be gathered into one object.

OCR check mode

You can choose between "Standard" and "Extended" check mode. The "Extended" check mode uses an additional algorithm to compare the gray-value projections of the detected object with a reference pattern. Vision Q.400 determines the grade of similarity between the two and calculates a result named "Quality", which helps to evaluate the printing quality of a label. The options for "Extended" check mode are described elsewhere (see page 414).
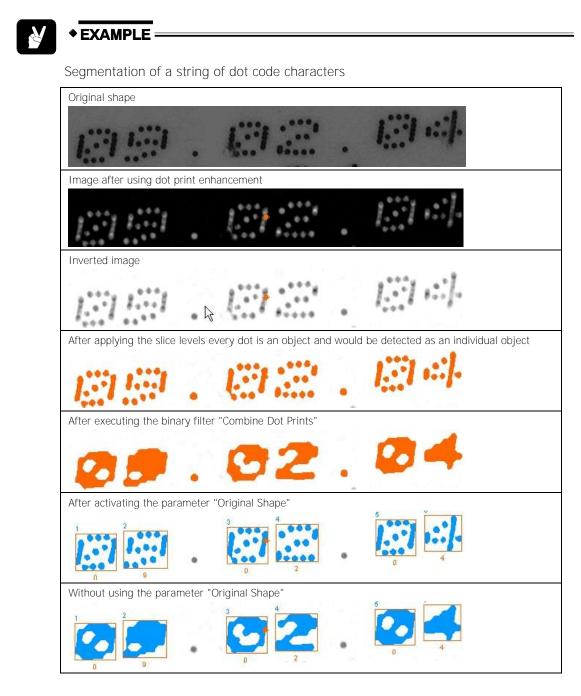
Connect OCR objects

This parameter is used for letters consisting of two or more parts like "ö", "i", and "j". By default, this parameter is activated in order to stop Vision Q.400 from treating each part as an individual object. Instead, Vision Q.400 treats objects which are very close to and positioned on top of each other as one single OCR object.

◆ **NOTE**

Deactivate this parameter if you need to check print in a direction other than the usual reading direction, i.e. from top to bottom.

Original shape

If you activate this parameter, the parameters "Labeling" and "Connect OCR Objects" will no longer be available. This parameter is designed for dot code fonts. It makes Vision Q.400 use the originally detected characters for teaching the font and not the characters possibly modified by filters you have set.

◆**EXAMPLE**

Segmentation of a string of dot code characters

Original shape

Image after using dot print enhancement

Inverted image

After applying the slice levels every dot is an object and would be detected as an individual object

After executing the binary filter "Combine Dot Prints"

After activating the parameter "Original Shape"

Without using the parameter "Original Shape"

NG symbol for unrecognized characters

Enter the character here that is output as the result of an object when the object does not have the expected correlation value. If "NG symbol output for NG" is set to "On", this character is also output on the result page under "String" if the judgment of the checker is "NG".

NG symbol output for NG

If this parameter is set to "On", on the result page under "String" the characteristic specified under "NG symbol for unrecognized characters" is output if the judgment of the checker is "NG", because too few letters were found for example.
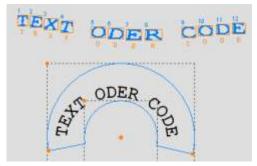
Output Order

This parameter determines the sequence order in which the checker results are displayed. The default output order is Character Mode and assumes that objects should be read like European writing, i.e. from left to right and from top to bottom.

You may also choose to display results sorted by size or by coordinates: If you need to check print in a vertical direction, we recommend setting this parameter to "Ascending/Descending Y-Coordinate".

Use polar transformation

If you have created a doughnut-shaped code reader checker, you use this option to "straighten out" the selected ring segment. This will make the code appear to be written in a "straight" line. The straightened-out checker result will be displayed in the image area of Vision Q.400. Set the display position for the checker result with the parameter "Result Display Offset".
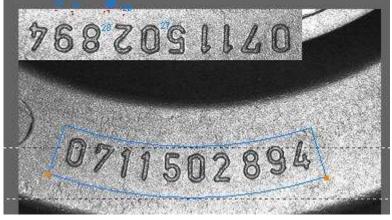
Effect of the parameter "Use Polar Transformation"

Assign object size

This parameter allows you to change the size of objects that should be output line by line. For example, if characters touch the line of characters above or below them, it is necessary to make the smaller. The larger the factor, the smaller the character size. In most cases this will be sufficient to prevent overlapping of lines. This parameter only effects the sorting of objects and is only used if you have select "Line-by-Line Adv" as the output order.

Rotate transformed image

This parameter permits the image to be rotated 180° following transformation. This can be of interest, for example, when the text - as here - is readable not from the center of the circle but from the outside of the circle.
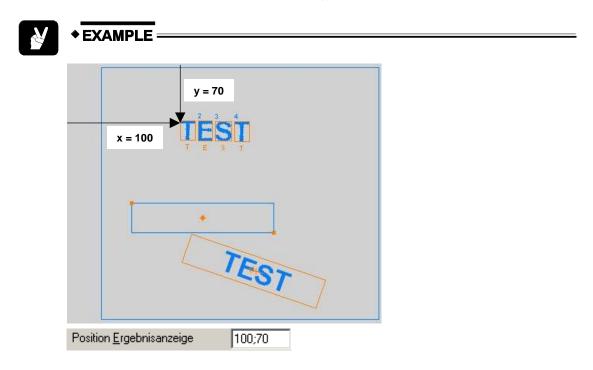
"Rotate transformed image" checkbox not activated

If the "Rotate transformed image" checkbox is activated

Result display offset

This parameter is only available if you have activated the option "Use Polar Transformation" or if the checker depends on a position adjustment. Vision Q.400 displays at this position images which have been transformed or rotated back to their original position. The position coordinates refer to the top left corner of the displayed checker result.

◆ **EXAMPLE**

9.15.6 Image Filters

All image filters (see page 246) are available.

◆ **NOTE**

The filter operators are used for the segmentation of characters only! They do not influence the object and pattern features with which Vision Q.400 calculates the classifier.

9.15.7 Judgment

The "Judgment" (see page 266) page works exactly like with the other checkers.

9.15.8 Shape

You may assign one of the following shapes to an OCR checker:

- Rectangle
- Ellipse/Circle
- Polygon
- Doughnut
- Object Shape

9.15.9 **Parameters**

Use this page to determine the features that the classifier should use to differentiate the different objects (letters, ciphers, symbols, etc.). When you have selected "Extended" as the "OCR Check Mode" on the "Algorithm" page, the options for the OCR extension at the bottom of the property page become available.

"Parameters" page of an OCR checker

Bear in mind that the more features you select, the better Vision Q.400 will be able to distinguish between different objects. However, selecting more features also means that it takes longer to calculate the classifier and to execute the checker. Rule of thumb: The higher the number of objects, the more similar the objects will be. Therefore, you need more features to ensure a reliable recognition.

The features available for calculation of the classifier can be sorted into groups. They are described in the following sections.

9.15.9.1 **How Does the Classifier Work?**

The Vision Q.400 classifier is a so-called box classifier. For each pattern Vision Q.400 calculates the selected features (see page 413). The characteristics used are as follows:

- Ratio of the character's height and width
- Width
- Height
- Relative number of pixels in the foreground
- Form feature anisometry
- Form feature compactness

- Scaled 2nd geometric moment of the region
- Scaled 3rd geometric moment of the region
- Scaled central geometric moment of the region
- Angle of the principle axis of inertia
- Number of connected components
- Number of holes
- Gray value of each individual pixel found in the character
- Horizontal / vertical projection of the gray values

Vision Q.400 determines the characteristics of all patterns and obtains a range or box of characteristic values for each label. It then averages the values to obtain the set of features which will help to distinguish one label from another. The correlation factor is the average of all characteristics used for the classifier calculation.

◆ EXAMPLE

In order to differentiate between A, B, and C, you first teach Vision Q.400 by adding different patterns of the letter to the font.

Label	Pattern
A	A A A A **A** A A
B	**B** B B *B* ℬ
C	C **C** **C** C C

Vision Q.400 calculates the box classifier, in this case for the features "Area Size", "Width", and "Number of Holes".

Pattern	Box: Area size No. of pixels	Box: Width No. of pixels	Box: Holes Number of holes
All A			
All B			
All C			

The next step is to calculate an average from the box and use the averaged characteristics to differentiate the objects, e.g. for letter B the average characteristics would be: area size = 75 pixels, width = 10 pixels, number of holes = 2.

9.15.9.2 Used Characteristics for Standard OCR

Fixed Size

This feature uses the pattern dimensions in X and Y directions. Select this feature if there is no difference in the dimensions of the trained patterns and the objects to be inspected.

Gray Value Standard/Extended

These two features use all available information on the pattern's gray values (gray values, histogram, gray-value projections in vertical and horizontal directions, etc.). As a rule, gray-value features are a safe means of differentiation. However, it takes longer to calculate them. The trained patterns are made uniform in size with the help of "Pattern Size in Pixel" (see page 413), i.e. Vision Q.400 keeps the height/width ratio to avoid distortions. The calculation time depends on the setting of "Pattern Size in Pixel".

Binary Standard/Extended

These two features use all available information on the pattern's binary properties (number of holes, perimeter, number of pixels, etc.). Select this feature if you have a limited number of characters to inspect or if the patterns have some unmistakable characteristics. In such a case the binary features are usually enough and should be given preference before the gray-value features to save calculation time.

Rotation Invariant

This feature uses all pattern properties that do not change if the object is rotated (number of pixels, etc.).

☞ ◆**NOTE**

Use this feature by itself. You cannot combine it with the other features.

9.15.9.3 Pattern Size in Pixel for Standard OCR

Use this parameter together with the gray-value features (standard / extended) to determine the pattern size. Remember that the bigger the size, the longer it takes Vision Q.400 to calculate the classifier.

☞ ◆**NOTE**

Set this parameter in such a way that it reflects the height/width ratio of the object(s) to be inspected. The current size of an object is displayed in the result list (see the values in the "Height" and "Width" columns).

If you read characters in the vertical instead of horizontal direction, activate the check box "Invert" to adapt the pattern size to the reading direction. Vision Q.400 uses the size in X-direction for the Y-direction and vice versa.

9.15.9.4 Average Confidence for Standard OCR

This field is only displayed if you select the option "Box Classifier" (see page 403) on the "General" page. The field displays a factor indicating the reliability of the character-recognition process so far. After recalculating the box classifier, Vision Q.400 uses the calculated features to reclassify all patterns which have been taught so far. In doing so, the system calculates for each object a correlation factor indicating how reliably this object is recognized during inspection. The factor displayed here is the average of all correlation factors obtained during the pattern reclassification.

☞ ◆NOTE

Like the "Correlation" factor on the "Result" page, this factor depends on the number of objects to be distinguished. The smaller the number, the higher the "Average Confidence" and "Correlation". If more objects need to be distinguished, the values decrease. However, Vision Q.400 is still able to distinguish reliably between different objects. The factors only give an indication about the quality of the recognition process.

9.15.9.5 Mean Error

If you have selected the option "Neural Network" (see page 403) on the "General" page for classification, you will find here not the average confidence, but the mean error. This is the error that occurs when you apply the classifier to the letters taught during the training.

As opposed to the box classifier, the mean error should be as low as possible to ensure a successful training.

Displaying the mean error of the OCR checker

9.15.9.6 OCR Extension Options

The options in this part of the screen are only available if you have set the option "OCR Check Mode" to "Extended" on the "Algorithm" page.

The extended mode uses a reference pattern in order to classify an object detected in the checker shape as "good" or "bad".

☞ ◆NOTE ═══════════════════════════════════

The reference pattern is always the first pattern of each label in the font file.

The comparison between the reference pattern and the object in the OCR checker shape is based on gray-value projections. For every trained pattern as well as the detected object, Vision Q.400 calculates the horizontal and vertical gray-value projections by adding the gray values in the rows and columns of the pattern. The gray-value projection of the reference is stored in the buffer and is compared with the projection of the detected objects. The similarity of the two projections is expressed in the "quality" value (from 0.00 = very low, to 1.00 = very high). This value is displayed in the "Quality" column on the "Result" (see page 419) property page.

Parameters for "Extended" check mode

Scaling Invariant/Translation Invariant
These two options refer to the geometry of the detected object and specify whether the size and/or position should be adapted automatically.

Exposure adjustment
This option determines whether the gray values of the detected object should be modified according to changes in the lighting conditions.

Slice level
This option specifies how large the difference between two gray values needs to be in order to be considered an error. If the difference exceeds the threshold, Vision Q.400 reduces the "Quality" value on the "Result" page. Therefore, the higher the threshold, the less sensitive Vision Q.400 reacts to small differences in gray values.

9.15.10   Customize

Use the "Customize" page to optimize the classifier calculation.

Main Groups
The more objects you have to distinguish, the longer the inspection time will be. If you are using a font with many patterns, say the alphabet, but you only need to inspect the word "date", that is the letters "D", "A", "T", and "E", there is a way to reduce the inspection time. Activate the option "Use Mask" to use this parameter group.

In the Main Group box you can limit the inspection to capitals, numbers, small characters, symbols, or user labels or any combination of these five. In the "Edit" box you see all patterns

belonging to the selected group (e.g. the letters "A", "D", "I", etc. are capitals, see figure below). Reduce the inspection time further by selecting only the items that need to be inspected.

There are two buttons available to speed up the selection process. By clicking [Select All], you select all items belonging to the main group; with [Select None], you deselect all.

Using main groups to customize an OCR checker

Object Groups

Use this option to combine several recognized objects into one "result" (see page 419). When inspecting characters, each character appears as a recognized object in the result list. If you are inspecting an 8-digit date, it makes more sense to inspect the data as a string of digits rather than check each digit individually. It also means you can reduce data input in the spreadsheet.

◆ **EXAMPLE**

The result list displays the recognized objects numbers 1 to 13 on the spreadsheet as individual results with a spreadsheet row for each result. The procedure below explains how you combine the objects into a group and have only one result in the spreadsheet.

◆ **PROCEDURE**

1. **Double click on the OCR checker to open the property page**

2. **Select the register tab "Customize"**

3. **Select "Use mask"**

Under "Main Groups:" the different character groups are displayed. For the example we only need capital letters and numbers.

4. Select "Capitals" and "Numbers" under "Main groups"

5. Click [Select All]

Now all capitals and numbers are available.

6. Click [New] to create an object group

A row with the column headings "Label" and "Content" appears.

7. Click into the white field below "Label"

8. Type in "DATE"

9. Click into the white field below "Content"

10. Type in the object numbers separated by commas

If you cannot see any object numbers in the camera window, check whether the option "Draw Object Numbers" is activated on the "Algorithm" page of the OCR checker.

11. Click [icon] to apply your modifications

The "Customize" page should now look like this.

12. Click [icon] to execute the checker

At the bottom of the spreadsheet you find the object group "Date" as a new result. Use it for data transfer and further processing like all other spreadsheet data.

9.15.11 Character Separation

Use this page to separate characters which are or appear joined by accident. This is useful if you need to inspect print and there is a danger of Vision Q.400 mistaking two or more letters for a single character.

[icon] ◆ **NOTE**

This feature only works if the characters have the same size.

In the figure below the letters D and A are attached to each other. In order to separate them, activate Use Separation. Then use the "Adjust Size" options to determine the position and size of the separation box (the green rectangle surrounding the letter D).

The character-separation algorithm checks an area of +/- 2% around the separation box to find the thinnest part of the object. This is where Vision Q.400 separates the characters joined and treats them henceforth as two individual objects.

"Character Separation" page of an OCR checker

Use separation

Click here to activate the character separation tool.

> **NOTE**
>
> **If you are using character separation, an additional "Select separated objects" object filter (see page 258) is available as an additional filter.**

Adjust Size

Click on the cursor keys to position and adjust the green separation box around the character you wish to separate from another character.

Zoom

Move the slider to zoom in and out of the image.

9.15.12   Result

The top half of the "Result" page for the OCR checker contains the same information on execution state, time, number of total and judged objects and judgments as for the other checkers. The bottom half contains the result list and some additional options. For best results with the OCR checker you need to train (see page 423) Vision Q.400.

The result list contains the following columns:

Column title	Contents
Label	Here you assign a label to the detected object. This is important for the training phase.
	When you have grouped the characters into a result by setting up an object group (see page 415), the label you assigned for the object group is shown here.
Result	Here Vision Q.400 displays the label of the object it has recognized.
	When you have set up an object group (see page 415), the result composed from all characters is shown here.
Export	Activate this option to export the result as a new pattern into the font.
Correlation	Factor indicating the reliability of the character recognition.
Quality	Quality of the detected object determined by the grade of similarity between the object and the reference pattern (from 0.00 = very low to 1.00 = very high).
Area size	Number of pixels used in determining the label (useful for filter settings).
Surrounding rectangle	Coordinates of the rectangle surrounding the object.
Width	Width of the rectangle surrounding the object.
Height	Height of the rectangle surrounding the object.
Similar class	Label with the next best correlation factor.

Vision Q.400 displays the results in the order selected under "Output Order". For OCR checkers the standard output order "Character Mode" means the order of detection from top left to bottom right. All objects that Vision Q.400 does not recognize receive the label "not_set". Assign the correct label by clicking into the field and typing in the label. Alternatively, type all object names into the String field (see below).

"Result" page of an OCR checker in "Extended" check mode

Correlation threshold

Here you can enter a value for the correlation threshold. An object needs to equal or exceed this value in order that Vision Q.400 automatically assigns the most similar label. If the result

of the OCR checker is below the correlation threshold, the object is labeled "#" in the "Result" column and the "String" field.

String
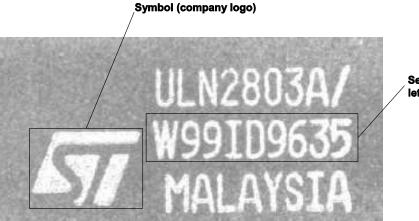
Additionally, you find all results in the field "String" combined together in one word. This string is also available for further processing in the spreadsheet: Click [Apply String] to enter the characters from the "String" field in the "Label" column of the result list.

If you enter more characters than there are objects detected by Vision Q.400, the system displays a warning message.

◆ **EXAMPLE**

To assign the correct labels to the detected characters D, A, T, and E, enter DATE in the "String" field and click [Apply String]. The labels appear in the Labels column of the result list.

If you want to label the objects with names consisting of more than one character, use a blank to separate the labels. As a consequence, a blank cannot be used as part of a label name.

◆ **EXAMPLE**

To assign the labels Delta, Alfa, Tango, Echo to the detected characters D, A, T, and E, enter the labels separated by blanks in the "String" field and click [Apply String]. The labels appear in the "Labels" column of the result list.

Auto label

If you train Vision Q.400 with objects where the text or sequence of letters vary, activate this option to transfer the result automatically into the Label column. All you have to do is change the label for objects which have not been detected successfully and where Vision Q.400 assigned a wrong label.

If you have not activated the option "Auto Label", the entry in the "Label" column remains unchanged unless you edit it manually. This is useful if you are working with identical objects: As soon as there is a difference between the label and the result after executing the checker, Vision Q.400 marks the first row with such a difference by shading it red and scrolling it to the top of the result list.

Export to font

Once a label has been entered (either manually or automatically with "Auto Label"), Vision Q.400 activates the check box "Export". This indicates that this result (pattern) and its label will be added to the font during the next export process. Results with an inactive Export box are not eligible for export to the font.
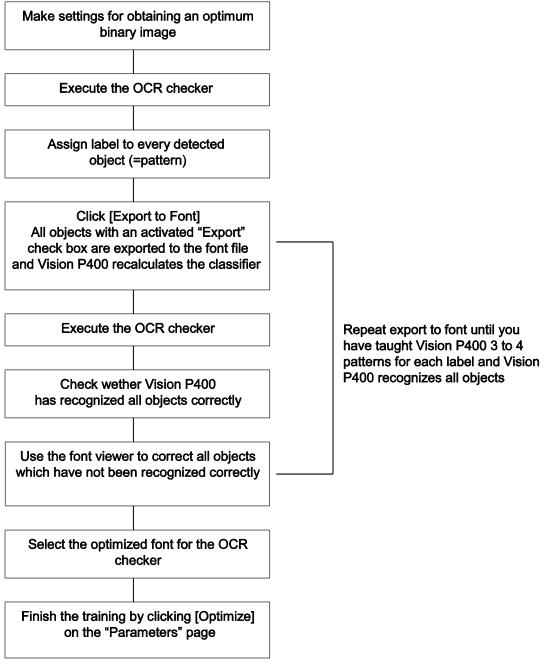
Click on the column header Export to activate/deactivate all patterns for export. Start the export of new patterns and labels to the font by clicking [Export to Font]. By default, Vision Q.400 exports all results with a cross in the "Export" box and recalculates the classifier with the parameters you have set on the "Parameters" page.

Always recalc classifier

The more patterns you teach (see page 423), the longer it takes to calculate the classifier. By deactivating the option "Always recalc classifier" you can prevent Vision Q.400 from recalculating the classifier for every new pattern and thus speed up the training phase. Please note that you must recalculate the classifier after the teach-in phase. To do so, click on [Optimize] under "Parameter" and see how the taught-in patterns have improved the character recognition rate.

9.15.13 Training Vision Q.400 in Optical Character Recognition

In order to train Vision Q.400 in optical character recognition, open the OCR checker's property page and follow the steps in the diagram below.

```
┌─────────────────────────────────────┐
│   Make settings for obtaining an     │
│         optimum binary image         │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│        Execute the OCR checker       │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│      Assign label to every detected  │
│          object (=pattern)           │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│         Click [Export to Font]       │
│   All objects with an activated      │
│   "Export" check box are exported    │
│   to the font file and Vision P400   │
│     recalculates the classifier      │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│        Execute the OCR checker       │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│      Check wether Vision P400        │
│   has recognized all objects         │
│           correctly                  │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│  Use the font viewer to correct all  │
│  objects which have not been         │
│      recognized correctly            │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│   Select the optimized font for the  │
│            OCR checker               │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│  Finish the training by clicking     │
│  [Optimize] on the "Parameters" page │
└─────────────────────────────────────┘
```

Repeat export to font until you have taught Vision P400 3 to 4 patterns for each label and Vision P400 recognizes all objects

OCR training diagram

The first step is to make all settings to obtain an optimum binary image. This is necessary to separate the objects you wish to recognize from the image background. Once Vision Q.400

displays the objects you wish to recognize in the result list, you can start exporting the objects as patterns for the font file. This is where the actual training begins.

Execute the checker to obtain a first recognition result. If Vision Q.400 does not recognize an object correctly, use the font viewer (see page 185) to check the patterns you have stored so far. Delete wrong patterns and find out how many patterns have been stored for that label. Teach the font more patterns and repeat the process until the recognition result is reliable.

Speed up the training process by setting the parameters "Auto Label" and "Always Recalc Clf" appropriately (see page 419).

☞ ◆ **NOTE**

- **To obtain reliable recognition results, make sure to teach Vision Q.400 2 to 3 patterns for each label (characters in thin and thick print, if possible). The higher the correlation factor, the more reliable the character recognition will be.**
- **Teaching patterns should have a size of at least 20 x 30 pixels!**

9.15.13.1   Training Tips

To optimize the optical character recognition training, please follow the recommendations below:

- Depending on the way the printed characters may vary, add two or three variations of the pattern (for example, in thick and in thin print).
- Then select the taught font in the Font Viewer (see page 185) and optimize it. Select the optimized font for the OCR checker (see page 402).
- Finally, select [Optimize] for the classifier.
- Use a rotation adjustment if the characters to be read may vary in position and orientation. We recommend to use the contour matching checker for rotation adjustment.

9.15.14   Result Handling in the Spreadsheet

Use drag & drop to transfer the results from the OCR checker to the spreadsheet for further processing. However, the result in the "Result" column differs from other checker results. This result is not a figure, but a string and therefore needs special handling in the spreadsheet.

That is why the spreadsheet contains a new column (see page 466), "String Reference", containing the actual string as a template for the checker result. Vision Q.400 compares the reference string with the checker result and forms an OK/NG judgment.

	Result Name	Result (Calib.)	String Reference	Judgement	Scans
Results	Start				
	OCR[1;1]resut_13	DATE30122020	DATE30122020	OK	2
	End				

OCR checker result in the spreadsheet

☞ ◆NOTE ─────────────────────────────────────

- **As the OCR checker result is a string and not a figure, output to the parallel interface is not available.**
- **If you are checking figures with the OCR checker, you can use the result in formulas.**

9.16 Code Reader Checker

The code reader checker (code reader for short) searches the camera image for 1D or 2D codes and interprets them according to the selected type.

The code reader works reliably even if the light conditions vary and if the objects appear misadjusted, with differing orientations or are partially covered.

Create a code reader checker as follows:

1. Set the search area
2. Define the code type to search for
3. Optimize the parameters (see page 397) if the default settings do not yield a satisfactory result

---

☞ ◆**NOTE** ═══

> **If you have selected "Color image" as the image source for the code reader, the checker automatically uses the red channel of the image for further processing.**

9.16.1 Algorithm

Code type

Select the type of code you want to read. You can read the following code types or use the setting "auto" to have the system determine the code type to be read:

1D Code (Bar Code)	2D Code
2/5 Industrial	Data Matrix ECC200
2/5 Interleaved	QR Code
Code 39	PDF417
Codabar	Aztec
Code 128	GS1 DataMatrix
Code 93	GS1 QR Code
EAN-13	GS1 Aztec Code
EAN-13 Add-On 2	Micro QR Code
EAN-13 Add-On 5	
EAN-8	
EAN-8 Add-On 2	
EAN-8 Add-On 5	
UPC-A	
UPC-A Add-On 2	
UPC-A Add-On 5	
UPC-E	

1D Code (Bar Code)	2D Code
UPC-A Add-On 2	
UPC-A Add-On 5	
PharmaCode	
GS1 DataBar Omnidir	
GS1 DataBar Truncated	
GS1 DataBar Stacked	
GS1 DataBar Stacked Omnidir	
GS1 DataBar Limited	
GS1 DataBar Expanded	
GS1 DataBar Expanded Stacked	
GS1-128	
MSI	

☞ ◆NOTE

- **Pay careful attention to the polarity of the 1D barcode to be read: Only codes with a "black on white" polarity can be read. To ensure that a code consisting of light print on a dark background can be read, you must first invert the code polarity by means of the filter "Invert Image."**

- **With the setting "auto", the system recognized to code type to be read automatically. In this case the result will display the type of code detected. However, the execution time for "auto" is longer than for other settings where the code type is specified in advance.**

When you select a code type, an example is displayed at the bottom of the property page with information on how many and which data items can be displayed with this code.

Reverse

This option is only available if you have selected "PharmaCode" under "Code Type". The option sets the correct reading direction, which cannot be determined automatically for this type of code. For all other types of code, this parameter is hidden.

Check digit

This option is available for all 1D codes except "PharmaCode". It is not available for 2D codes. Any 1D barcode can contain a checksum, which can be used to verify the consistency of the code read. You must set this parameter manually, because Vision Q.400 cannot automatically detect whether the code contains a checksum.

Number of codes

Enter the number of codes to be read.

Number of search loops

This parameter enables you to define the sensitivity of the search algorithm. The smaller the value, the faster the search. The greater the value you enter, the more thoroughly Vision Q.400 searches the image for possible codes – which increases processing time, however.

☞ ◆ **NOTE**

This parameter only applies to 2D codes.

Output Order

Use this parameter to define the sequence in which the detected codes will appear in the results list.

Quality

This parameter activates or deactivates the calculation of quality values. When you activate the parameter, you can choose between the following two quality standards:

- ISO/IEC 15415
- AIM DPM-1-2006

Depending on which code you have selected, you will get different results for the code quality (see page 436).

If you wish to evaluate the code based on the standard AIP DPM-1-2006, you need to perform a calibration first in order for the resulting values to conform to the standard. Please proceed as follows:

◆ **PROCEDURE**

1. **Select button [Calibration]**

   The dialog box with the calibration wizard appears. As a first step, the calibration wizard helps you to optimize the image quality regarding homogeneity and contrast.

The gray values are displayed below the image. Ideally, the gray values cover the complete range from 0 – 255. If not, the lighting is either too dark or too bright. The image is displayed in false colors so that you can see the homogeneity of the inspection area better. The lighting should be as homogenous as possible over the complete image area. If you change the lighting, you need to capture the image again with the button [Grab Image].

2. **Select [Next]**

   For the second step, use a calibration target, if available. Calibration targets are available from GS1 US, Inc. (http://www.gs1us.org).

3. **Enter the reference data from the calibration target in the fields "(Ref Aperture)" and "(X Dimension)**

   or, if you do not have a calibration target,

   leave the default values and put a reference code of good quality under the camera

Make sure that the reference code is in the middle of the image. Use the yellow circles overlaying the image as a help. The circles must be made to overlap. Then the bigger circle becomes green.

4. **Select [Calibrate] to grab a new image**

5. **Modify the mean gray value until it is between the upper and lower limit defined by the hardware configuration**

Change the mean gray value by modifying the lens aperture, the camera gain, or the lighting. As soon as the mean gray value is within the limits defined, the detected code is surrounded by a green frame (otherwise red). The slider should be right in the middle of the scale now.

> **◆NOTE**
>
> - **The calibration depends on the camera gain you have set as well as the shutter speed - if you change either of the values, you need to repeat the calibration process.**
> - **If during measurement the values exceed the limits set by the calibration, a warning message is output.**
> - **Activating "Quality" results in a lengthier run time.**

Use polar transformation

If you have created a doughnut-shaped code reader checker, you use this option to "straighten out" the selected ring segment. This will make the code appear to be written in a "straight" line. The straightened-out checker result is then displayed (see page 405) in the image area of Vision Q.400.

Result display offset

This parameter is only available if you have activated the option "Use Polar Transformation" with a doughnut-shaped code reader. Here you define where, i.e. in which part of the image, the straightened-out checker result is to be displayed. The position coordinates refer to the top left corner of the displayed checker result.

> **◆NOTE**
>
> **This parameter is available only for 1D codes.**

9.16.2 Shape

Four different shapes are available for a code-reading checker:

- Rectangle
- Ellipse/Circle
- Polygon
- Doughnut
- Object Shape

9.16.3 Code Model Parameter

The property page looks different depending on whether you have selected a 1D code or a 2D code on the "Algorithm" (see page 426) page.

Standard
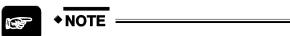
Default setting to detect clearly printed black-on-white codes. When you have selected a 2D code, a note explains the limitations of using the setting.

Enhanced

Use this setting if you need to detect black-on-white or white-on-black codes under difficult conditions. When you have selected a 2D code, a note explains the limitations of using the setting. With 1D codes, the parameter is grayed out.

Maximum

Use this parameter for codes of very bad quality, i.e. when the finder pattern is disturbed or for codes with very small modules.

☞ ◆**NOTE**

- **This parameter only applies to 2D codes.**
- **Note: This mode can lead to very long execution times!**
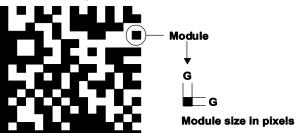
Manual

This option allows you to set every parameter individually. The parameters will be explained below. In general, the execution time for the code reader is decreased if the individual parameters have been set optimally for the code to be read.

☞ ◆**NOTE**

If you wish to use the number of decoding errors on the "Result" (see page 436) page to judge the quality of the code, we recommend setting the option to "Manual" and setting the parameters "Minimal Module Size" and "Maximal Module Size" to fit the code to be read as closely as possible or to train Vision Q.400 on the code to be read.

Module size in pixels

There are two possibilities of training the code with the current image:

Button	Description
New training	In this case, you need to select the basis for the new training under "Based on:" - the parameter set you select influences the execution time of the code reader. For simple codes, we recommend using the default set of parameters - codes of minor quality usually need "Enhanced" or "Maximum". When you execute the checker, Vision Q.400 tries to find the code. If Vision Q.400 manages to find the code with the default set of parameters, the parameters are adjusted automatically so that this code will be found with the best performance possible. You can add further sample codes with [Continue Training].

Button	Description
Continue training	If you want to use additional codes for training, select this button. Then the parameter limits based on the previously trained codes will be modified so that the current code can be read.

9.16.3.1 1D-Code Parameters

This is what a 1D code or bar code looks like:

Bar code

Black bars = elements   **White bars = gaps**
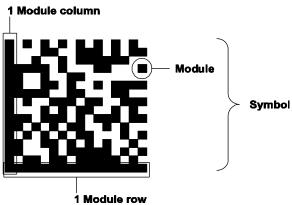
Sample 1D code

Parameter name	Description
Minimum element size	Minimum size of an element – that is, the minimum width of all elements and gaps. The standard value is 2.0. For very narrow bar codes, this value should be reduced to 1.5. For very wide bar codes, the value can be increased accordingly, which reduces processing time.
Maximum element size	Maximum size of an element – that is, the maximum width of all elements and gaps. The standard value is 16. This value should be set high enough to ensure that two-part bar codes – that is, those comprising add-ons – will be recognized as distinct inspection units. However, the value must not be too high; otherwise, two neighboring codes will be treated as one.
Minimum element height	Minimum bar code height. The standard setting -1 signifies that the height will be adjusted automatically in accordance with the other settings. In the case of very small bar codes that are less than 16 pixels high, it is advisable to define code height manually, to ensure that the bar code can be detected and read. The minimum height is 8 pixels. In the case of very large bar codes that are 70 or more pixels high, you can reduce processing time by defining code height manually.
Orientation angle	Expected orientation angle. The elements belonging to a bar code candidate are all aimed in a similar direction – that is, their average orientation angle falls within a certain range of values. You can use the parameters "Orientation angle" and "Orientation tolerance" to define this range of values. As a result, only those codes will be detected whose elements are aimed in a similar direction. If the majority of bar codes in a set of processed images are aimed in a similar direction, the range of values can be defined accordingly. In this way, candidates that were erroneously inspected can be recognized at an early stage, which reduces processing time. This strategy is particularly advisable for processed images showing a heavy background texture filled with bar code candidates aiming in the wrong direction. For codes of the type "PharmaCode" – which do not have a distinct reading orientation, and therefore usually yield two decoded results with a value range of [-180.0 ... . 180.0] – you can use this parameter to define a distinct reading orientation and thus obtain a single definitive result.
Orientation tolerance	Permissible orientation tolerance. See "Orientation angle." A value of 90.0 deactivates any restrictions on the orientation.

Parameter name	Description
Maximum orientation difference	Permissible angle of deviation expressed in degrees. Defines the degree to which the orientation angle of neighboring edges is permitted to deviate from the reference orientation angle. A potential bar code consists of elements, and thus of edges with a uniform direction. The value "Maximum orientation difference" indicates how much neighboring edges may differ as far as their orientation is concerned. If a bar code is frayed at the edges, that is, if its bars are defective, it is advisable to set a high value. You can use a lower value to reduce the number of bar code candidates detected erroneously.
Slice level	Within scan rows, edges are detected by means of relative slice levels. If a bar code is defective, or the background noise level is high, it is advisable to set the slice level to a higher value.
Composite code	EAN.UPC bar codes can comprise a 2D composite code component. If "Composite Code" has been set to "CC-A/B," the composite component will be localized and decoded. The standard setting "none" signifies that the composite component next to the bar code will be ignored. If a bar code of this type does not comprise a composite component, the inspection result will be limited to the main bar code. Composite codes are only supported in conjunction with bar codes of the type RSS-14 Stacked or RSS-14 Stacked Omnidirectional.
Zoom for reading	You can zoom the code to improve readability. Use this parameter to switch the zoom on and off.
Image zoom factor X	Factor for zooming the image in X direction.
Image zoom factor Y	Factor for zooming the image in Y direction.
Start stop pattern tolerance	Set a high or low tolerance for the search for start and stop patterns within a scan line. A high tolerance will improve readability especially for low-contrast images. On the other hand, a high tolerance may lead to invalid decoding in noisy images or in images containing symbols from other bar code types. A low tolerance is less likely to result in wrong decoding, but may decrease overall readability.
Absolute threshold	This parameter is designed to prevent the detection of false edges. If the scan line reaches a part of the image with little dynamic, e.g. a predominantly white area with gray values near 255, the threshold value for edge detection will be calculated too small. This may lead to a large number of false edges detected. If the threshold based on the parameter "Slice Level" is smaller than the value in "Absolute Threshold", the absolute threshold value will be used. By default, "Absolute Threshold" is set to 5.0. If you are processing noisy images, it may be helpful to increase the value. For noiseless images with low contrast the parameter may prevent the correct detection of edges. In such cases, select a smaller value or deactivate the parameter by entering 0.0.
Encodation method This parameter is available only for UPC-E code types.	UPC-E bar codes can be output in different output formats. By default, "Encodation Method" is set to "ucc-12". The decoded string is output in UCC-12 format, i.e. as 12 ciphers. If "Encodation Method" is set to "zero-suppressed", zeros will be suppressed at defined places in the result. This format consists of a leading zero, six coded ciphers and an implicitly coded check character. The format conforms to the standard ISO/IEC 15420.

9.16.3.2   2D-Code Parameters

This is what a 2D code looks like:

Sample 2D code

The table lists the available model parameters in the order in which they appear in the dialog box. For 2D codes such as QR Code and ECC200 additional parameters are available.

Parameter name	Description
Minimal contrast	Minimal contrast between the foreground and the background of the symbol (this corresponds with the Minimal gradient between the symbol's foreground and the background).
Minimal symbol columns	Minimal number of module columns in the symbol.
Maximal symbol columns	Maximal number of module columns in the symbol.
Minimal symbol rows	Minimal number of module rows in the symbol.
Maximal symbol rows	Maximal number of module rows in the symbol.
Minimal module size	Minimal size of the modules in the image in pixels.
Maximal module size	Maximal size of the modules in the image in pixels.
Symbol shape	Possible restrictions of the module shape (rectangle and/or square).
Mirrored	This parameter describes whether the symbol is or may be mirrored (which is equivalent to swapping rows and columns of the symbol).
Polarity	Possible restrictions of the polarity of the modules, i.e., if they are printed dark on a light background or vice versa.
Maximal module gap	Determines whether there is a gap between neighboring modules. Maximal gap size in symbol columns.
Minimal module gap	Determines whether there is a gap between neighboring modules. Minimal gap size in symbol columns.
Minimal module gap row	Determines whether there is a gap between neighboring modules. Minimal gap size in symbol rows.
Maximal module gap row	Determines whether there is a gap between neighboring modules. Maximal gap size in symbol rows.
Strict Model	Defines whether symbols must be exactly the same size as the taught-in model code or may deviate from the rules. If "yes" is set, only symbols precisely corresponding to the model are found and read, even if there are other readable symbols with different dimensions in the camera image. If "no" is set, codes may also be found which differ in size from the taught-in model.

Parameter name	Description
Persistence	Defines whether interim results are saved during symbol searching. By default (0) the interim results are not saved, owing to the high memory requirement. If you need the interim results from the symbol search for error fixing or for a display, set the parameter to 1.
Small module robustness	Setting the parameter to "high" increases the probability that you can read codes with very small modules. Please note that the setting "high" may take up significantly more internal memory!

9.16.3.3 QR Code and Micro QR Code Parameters

Parameter name	Description
QR model type	The old QR Code Model 1 and the newer Model 2 are supported.
Minimal symbol version	The minimal size of the symbol in modules.
Maximal symbol version	The maximal size of the symbol in modules.
Position Pattern Min	The search aids in the QR code are the nested light and dark squares in the three corners. Define how many search aids are to be found as a minimum (2 or all 3)

9.16.3.4 ECC200 Code Parameters

Parameter name	Description	Usage
Maximal Angle Variation	Maximal variation of the angle of the L-shaped finder pattern from the (ideal) right angle (the angle is returned in radians and corresponds to the distortion that occurs when the symbol is printed or during the image acquisition).	Image pre-processing and candidate search

9.16.4 Image Filters

All filters (see page 246) except for binary filters are available.

9.16.5 Judgment

"Judgment" page of a code reader

The judgment criterion is the number of objects found. This must be within the limits of "Number of judged objects: Lower limit" and "Number of judged objects: Upper limit" (inclusive). You can enter a valid range limit from 0 to 1024. The default setting is 0 and 1024.

9.16.6 Dependencies

In contrast to all other checkers, the code reader checker can only depend on a position adjustment (see page 282).

9.16.7 Result

"Result" property page of a code reader checker

Vision Q.400 outputs a list with the following results for each object detected:

Result name	Description
Code	Decoding result output as ASCII text. If the code cannot be read, the result is output as "-".
Position	Position of the code in the image.
Area size	Size of the detected code in pixels.
Decoding errors	Number of errors that have been corrected during decoding. To a certain degree, this value can be used to judge the quality of the inspected code (see notes). The more errors Vision Q.400 had to correct, the lower the quality of the printed code. This result is only available for 2D codes.
Angle	Angle of the code within the image. This result is only available for 1D codes.
Parity	For the result to be of any use, the code to be inspected must contain a check digit. If the code does not contain a check digit, please ignore the result. This result is only available for 1D codes.
Cumulative quality	Compiles all further results into a cumulative result. The values for each quality criterion can range from 1 to 4 (see notes). The cumulative value cannot be better than the worst individual value.
Contrast	Determines the modules' degree of optical contrast versus their respective backgrounds.
Modulation	Determines the ratio of light to dark modules within the data field.
Fixed Pattern Damage	Evaluates print deficiencies that are causing problems in the three fixed code elements – that is, in the finder and alternating pattern as well as in the quiet zone. If these print deficiencies are causing gaps or leaving residues in places that should be ink-free, legibility will be impaired.
Decode	Tests code syntax.
Axial Nonuniformity	Evaluates the fixed ratio of code length to width.
Grid Nonuniformity	Evaluates the position of individual modules within the code.
Unused Error	Checks the utilization of correction resources. The code data is saved with redundant data

Result name	Description
Correction	overhead; in this way, errors can be recognized, and ca. 25% can be corrected. Error correction is performed byte-by-byte. Thus, the utilization of error correction bytes is an indirect quality criterion: The fewer the bytes consumed, the higher the code quality. However, the result does not provide any information on the reasons for poor legibility.
Start Stop Pattern	Checks whether the code's Start and Stop Patterns are in good condition.
Codeword Yield	Counts and checks the proportion of correctly decoded codewords.
Decodability	Measures the precision of element width as well as the gaps between elements.
Defects	Evaluates the greatest difference in brightness within an element or a gap.
Cell contrast	Measures the difference between the average brightness of the black and the white modules (cells). The value indicates how close the black and the white modules are in the histogram.
Cell modulation	Measures the distribution and differences of brightness of all the modules of one color (all white or all black modules).
Mean Light	The degree of reflection from the calibration target will be compared with the degree of reflection from the current part. The value gives a ratio from reflection of the part and the calibration target (or reference code). Every part has to have a certain degree of minimal reflection.
Calibration	Indicates whether the code is within the calibration limits.
Number of characters	Indicates the number of characters in the code.
Code type	Displays the type of the code detected. This result is only displayed of you have set "Code type" to ""auto" (see page 426) on the property page "Algorithm".

In addition, the field "Number of Judged Objects" specifies the number of objects for which features have been calculated. "Total Number of Objects" displays the number of objects counted before the limit defined by the parameter "Maximum Number of Objects" was applied.

To highlight an object's center of gravity, use the left mouse button to click on a result in the results list.
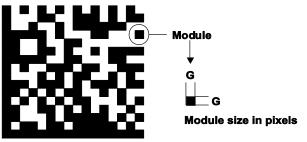
☞ ◆**NOTE**

- **Depending on the quality assessment standard you have selected, only the corresponding results will be displayed.**
- **The code quality results are only displayed if the corresponding option was selected when the algorithm settings were defined. These results are based on ISO 15416 and 15415 for 1D and 2D respectively. The calculations of the quality level are performed on the basis of a black code on a white label — that is, a high-contrast standard. Depending on the code type, the results displayed will also differ.**
- **The quality results are assessed with a numeric system. However, sometimes letters are used to indicate the quality level.**

Quality	Numeric system	Letter system
Very good	4	A
Good	3	B
Average	2	C

Quality	Numeric system	Letter system
Acceptable	1	D
Bad	0	F

- **The result in the "Decoding Errors" column may vary considerably, depending on whether you have selected "Standard" or "Enhanced" on the "Code Model Parameters" property page. These parameters have been optimized to enable detection of all codes presented, if possible. If you want to use the number of decoding errors to judge code quality, we recommend setting the option to "Manual" and setting the parameters "Minimum Module Size" and "Maximum Module Size" to fit the code that will be inspected as closely as possible.**

- **If you have selected the ring as the checker shape and you are reading a 1D code, the selected image area is "straightened out" (see "Use Polar Transformation" for the OCR checker (see page 405)). Set the display position for the straightened-out image part in the camera image on the "Algorithm" property page with the parameter "Result Display Offset" (see page 426).**

9.17 Geometry Checker

In contrast to all other checkers described, the geometry checkers are not image-processing routines in the ordinary sense. That is to say they do not extract their results directly from the current camera image but instead rely on results provided by other checkers and calculate additional features from these results.

Geometry checkers may use the result from any checker as a reference as long as two conditions are fulfilled:

- The reference checker result provides the coordinates of a point
- The reference checker is executed BEFORE the geometry checker depending on it, i.e. the reference checker must be positioned above the depending checker in the sequence.

Geometry checkers have no shapes and do not use filters. There are no parameters that need setting. The only thing users need to define is the dependencies (see page 443). Consequently, the Properties window is limited to the following pages:

- General
- Dependencies
- Result

You have three different geometry checkers at your disposal, all of which will be described in the sections to follow:

Geometry Point-Point (G_PP)

Geometry Point-Line (G_PL)

Geometry Line-Line (G_LL)

9.17.1 **Geometry Point-Point (G_PP)**

This geometry checker calculates the distance between two points (point A and point B) as well as the center point (M) and the angle between the horizontal line and the line defined by these two points.

"Dependencies" page of a geometry point-to-point checker

☞ ◆**NOTE**

You set the dependencies with drag & drop (see page 443).

You will find the results on the "Result" page:

"Result" page of a geometry point-to-point checker

- **Distance**
  Distance between point A and point B
- **Center point**
  coordinates of the center point M lie on the line connecting point A and point B
- **ALPHA**
  Angle ALPHA (counterclockwise) between the line connecting point A and point B and the horizontal. Base point for this angle is always the point listed on the "De-

pendency" page under Point A.
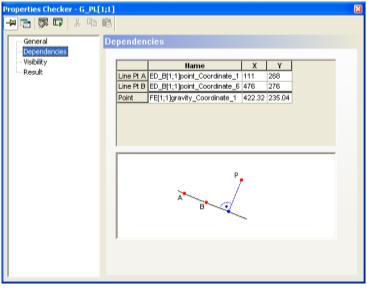
9.17.2 Geometry Point-Line (G_PL)

This geometry checker calculates the distance between a point P and a virtual line which is defined by two additional points (line point A and line point B) and the anchor or foot point (L) of the perpendicular created by the point dropping to the line.

"Dependencies" page of a geometry point-to-line checker

 ◆NOTE

You set the dependencies with drag & drop (see page 443).

You will find the results on the "Result" page:

"Result" page of a geometry point-to-line checker

- **Distance**
  Distance between point and line
- **Foot Point**
  Coordinates of the foot point

9.17.3 Geometry Line-Line (G_LL)

This geometry checker calculates from two virtual lines (L1 and L2), created by two points each (Line 1 Point S1 - Line 1 Point E2 + Line 2 Point S2 - Line 2 Point E2) the point of intersection Z and the two enclosed angles (ALPHA, BETA). The points of line 1 and the points of line 2 could, for example, be the results of edge detection checkers.

"Dependencies" page of a geometry line-to-line checker

☞ ◆ NOTE

You set the dependencies with drag & drop (see page 443).

You will find the results on the "Result" page:

"Result" page of a geometry line-to-line checker

- **Intersection point**
  coordinates of the intersection point. The intersection point is the result of the 2 lines L1 and L2 which are determined by Line 1 Point S1 + Line 1 Point E2 and Line 2 Point S2 + Line 2 Point E2.
- **ALPHA**

Angle Alpha is that angle which is defined by the two points (point S1 of Line 1 and point S2 of Line 2) as well as the intersection point Z of the two virtual straight lines, counterclockwise (see figure above)

- **BETA**
  Angle BETA = 360° - Angle ALPHA

☞ ◆**NOTE**

- **The objects used for defining the virtual lines need to be different. Otherwise the system will try to create a line from a single point.**
- **If you would like to use only three objects for a geometry checker type G_LL, i.e. if the two virtual lines have an intersection point in common, please make sure to enter the intersection point as Line 1 Point E2 and Line 2 Point E2 on the "Dependencies" page.**

9.17.4 Entering Checkers in the Dependency List

The dependency on the checker providing the results for the geometry checker is entered on the "Dependencies" page. Depending on the type of checker you use for reference, the procedure is different.

☞ ◆**NOTE**

- **You can remove a checker value you inserted in the "Dependencies" property page by right-clicking on the value you want to remove and choosing "Remove" from the pop-up menu.**
- **When you click on an inserted checker value from the list, the object from which the value originates is highlighted in the camera image. When you press the [spacebar] the object remains highlighted for as long as you hold it down.**
- **With the [Up arrow] and [Down arrow] keys you switch to the next checker value up or down in the list respectively. The object remains highlighted for as long as you hold down the arrow key.**

9.17.4.1 Drag & Drop Inspection Checkers

All inspections checkers, i.e. all checkers apart from geometry checkers, can be entered in the dependency list with drag & drop.

◆**PROCEDURE**

1. **Select the geometry checker icon you wish to create with a left mouse click**
2. **Select the inspection checker you wish to use in the dependency list**
3. **Execute the checker by pressing <F8>**

4. Select a result providing coordinates, e.g. from the "Gravity" column, with a left mouse click and hold the mouse button down

	Area Size	Gravity		Angle
1	4324	32	235.04	177.75
2	1340	201.61	282.63	88.12
3	1320	238	283.84	88.36

5. Drag the result to the "Dependencies" page of the geometry checker you have created in step 1

6. Release the left mouse button in the desired row

9.17.4.2 Entering Geometry Checkers

A different procedure is needed to enter geometry checker results in the dependency list of a geometry checker because it is not possible to have two geometry checker property windows open at the same time.

◆ PROCEDURE
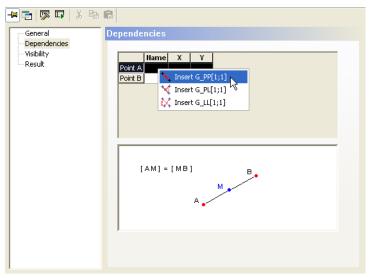
1. Select the geometry checker icon you wish to create with a left mouse click

This example will show how to create a G_PP checker and make it depend on the results from a G_PL and G_LL checker, which have been created previously.

2. Click the right mouse button on the "Point A" row

A pop-up menu appears. If you previously defined a maximum of 10 geometry checkers, this menu contains the names of all them. Select a geometry checker which you want to use as a reference.

The selected geometry checker is inserted onto the "point A" row. Do the same for "Point B".
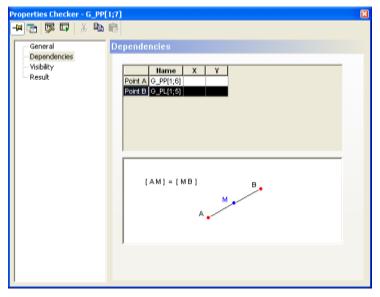
If you have defined more than 10 geometry checkers and the one you want is not in the list of the 10 most recent geometry checkers defined, from the pop-up menu choose "Select Checker". A dialog box appears. The pull-down list contains all available geometry checkers which can be referenced.
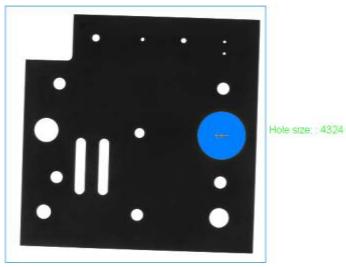
3. **Left-click to select a geometry checker**

4. Click [OK]

9.18 Indicators

With indicators you can highlight results and analyses (NG/OK) of spreadsheet results on screen with the aid of geometric figures, images or freely definable texts. The visibility settings of indicators are independent of those of the checkers. This means you can suppress the display of checkers in run mode while the indicators are all drawn.

Example of a text indicator with display of the result of a spreadsheet row

There are 6 different types of indicators:

Type	Description
Text	Display of a user-defined text and/or a spreadsheet result.
Line	Display of a line between two points optionally with or without arrow tips. Additional display of a user-defined text and/or a spreadsheet result.
Rectangle	Display of a rectangle, e.g. to mark an area in the image.
Ellipse	Display of an ellipse, e.g. to mark an area in the image.
Marker	Highlighting of a specific point in the image by selectable marker.
Bitmap	Display of any image in *.bmp format.

All indicators use the same properties pages, which may offer different setting options depending on indicator type:

- General: Contains a field for the comments as for the checkers (see page 241)
- Basic settings (see page 449)
- Position settings (see page 451)
- Display settings (see page 453)
- Result (see page 463)

Selecting and positioning indicators in the camera window

Select an indicator in the camera window by pressing <Ctrl> and simultaneously clicking the indicator with the left mouse button in the camera window.

You can reposition a selected indicator in the camera window. Again, press <Ctrl> and select the indicator in the camera window with a left mouse-click. As long as you hold down the left mouse button, you can move the indicator. Releasing the left mouse button determines the new position of the indicator.

If the indicator has been set to "Fixed Position" in the position settings, the new position will be entered as the fixed position. If the indicator has been set to "Depends on Results", the X-offset and Y-offset will be recalculated according to the new position of the indicator.

9.18.1 Basic Settings

The "Basic Settings" property page is used to define the indicator type, the error display method and other properties dependent on the indicator type.

"Basic Settings" property page of a line indicator

Type

Here you determine which indicator type (see page 448) you want to use. Additional settings are displayed depending on type, such as for line types and widths etc.

Scale on zooming

Here you specify whether the indicator is scaled when zooming the image segment in or out.

Error settings

Here you define how an error during execution of the indicator is displayed. You can define the error text, the color, the position, the font size and a color for the transparent back-ground. Note, however, that "Transparent Background" is not selected by default. This means that by default the error text you entered under "Text" is displayed in black on a rectangle in the selected color. If you have activated "Transparent Background", it is the text itself which is displayed in the selected color and not the background.

Error display with the preset values

☞ ◆ **NOTE**

- **The text entered under "Error Settings" is used In the event of all indicator errors and displayed in the camera window. The exact cause of the error is indicated on the "Result" property page under "Messages:".**

- **Every time you create an indicator, Vision Q.400 creates a standard text in the "Text" field under "Error Settings". This standard text consists of the indicator name, ":", and the word "Error". When you copy an indicator, the text is only copied along if it has been changed by the user. Otherwise Vision Q.400 creates a new standard text containing the name and number of the copied indicator.**

- **If you do not want errors to be displayed in the camera window, enter an empty character string under "Text".**

- **The position set under "Error Settings" is only used if the error occurred in position calculation. Otherwise the error text is displayed at the calculated indicator position.**

- **If you cannot see an indicator in the image, there may be a number of reasons:**

Possible reason	Explanation	Remedy
Preset color	A black indicator in front of a black object only becomes visible when you click on the [Highlight] button. The indicator is inverted and so made visible.	Select a different color for the indicator.
Preset position	The indicator is outside of the displayed image segment. Double-click the [Highlight] button on the "Result" property page to move the displayed image segment so that the indicator is inside it and then click the [Highlight] button to highlight it.	Change the position settings, e.g. set a lower offset
No calculation or not yet drawn	The indicator has not been calculated or not yet drawn. In this case the [Highlight] button is deactivated.	Execute the indicator with ⬛ or click ▶ to draw it.

Possible reason	Explanation	Remedy
Error occurred	An error has occurred when calculating or drawing the indicator, and you have entered no error text under "Error Settings".	Check whether an error is entered on the "Result" property page under "Messages".

Available buttons

| Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.2 Position Settings

The position of the indicator is defined on the "Position Settings" property page. Different settings are possible depending on the indicator type.

For all indicator types you can choose between a fixed (= unchanging) position and a variable position (that is, dependent on spreadsheet or checker results) in the image. To distinguish between spreadsheet and checker results, checker results are marked by a "*" in front of their names.

For a spreadsheet or checker result dependent position, enter the results in the relevant field by drag & drop.

◆ SHORTCUTS

When you drag checker results into a field, you can transfer two related checker results at once like X and Y coordinates of a point by pressing the <Ctrl> key while releasing the mouse button over a field. This is useful, for example, when you want to transfer the coordinates of a result point onto the "X position" and "Y position" rows. This function is only available for checkers, not for spreadsheet results.

For checker results it is possible to check whether the "Type" of the result being entered matches the "Type" of the field in which it is to be inserted. It is not possible, for example, to transfer an angle result into the "X position" field. Vision Q.400 will not insert a non-matching result in the field, and outputs a message telling you so.

In the case of spreadsheet results, though, it is generally not possible to check whether the "Type" of the result and the "Type" of the field match. You can enter the result of a formula in the "X position" field for example, but it is not possible to check whether the formula result actually represents an X coordinate. Be sure to drag logical spreadsheet results into a field.

Position settings for a text indicator with a fixed position

Position settings for a text indicator with a variable position

Parameter	Available settings
Position	**Fixed Position:** The indicator is always displayed at the same location, which you define by entering the coordinate values under "X position" and "Y position".
	Depends on Results: Drag & drop the coordinates of a checker or spreadsheet result into the blue colored "X result" and "Y result" fields to define the position variably. You can then additionally move the indicator by the entered offset values starting from the inserted result in X and/or Y direction.
Angle type	**Fixed Angle:** The indicator is always displayed rotated by the same value entered under "Angle".
	Depends on Results: Drag & drop an angle result of a checker or a spreadsheet result into the blue colored field to define the display angle variably. Note that Vision Q.400 cannot check whether a spreadsheet result is really an angle value.

Descriptions of the further setting options on this property page are given for the respective indicator types.

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.3 **Display Settings**

The display mode of the indicator is defined on the "Display Settings" property page. The settings are identical for all types apart from the text (see page 454) indicator, the line indicator with text and the borderless bitmap indicator (see page 462). The text indicator and the line indicator with text require additional settings for text output. For the borderless bitmap indicator all the settings are covered by the basic and position settings.

Display settings of an indicator not dependent on any judgment

Example of a line indicator dependent on a judgment

Parameter	Available settings
Color	Select the color in which the indicator is displayed. The default color is green. To the right of the color field you see the RGB values of the selected color.
Depend on spreadsheet row	Activate this parameter when you want to make the display dependent on the judgment of a spreadsheet row. Then you can style the display differently depending on whether the judgment is OK or NG.
Judgment is OK/NG	Select the color in which the indicator is to be displayed In the event of an OK or NG judgment of the entered spreadsheet row. The default is green for OK and red for NG.

Descriptions of the further setting options on this property page are given for the respective indicator types.

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.4 **Visibility**

Please read the description under Visibility (see page 262) for the checkers.

9.18.5 Text Indicator

Here you will find all the setting options which the text indicator needs in addition to the settings shared by all indicator types.

Display settings

Here you define which text is displayed, and how.

Text indicator with fixed text (default settings)

By activating the "Depend on Spreadsheet Row" option you can define different texts whose display is dependent on the judgment (OK/NG) of a spreadsheet row. In this case you must drag & drop the desired row from the spreadsheet into the blue field next to the "Spreadsheet Row".

Settings for a text indicator dependent on the judgment of a spreadsheet row

> **NOTE**
>
> **When you have selected "Depend on Spreadsheet Row" and drag a spreadsheet row into the "Spreadsheet Row" field, that spreadsheet row is automatically also entered in the "Spreadsheet Row" fields under "Judgment is OK" and "Judgment is NG", provided those fields are still empty. This also applies when you only retrospectively configure the text type so that it is dependent on a spreadsheet result and consequently needs a spreadsheet row as its reference.**

**The spreadsheet rows for "Judgment is OK" and "Judgment is NG" influ-
ence each other mutually, as long as they are both empty. When a spread-
sheet row is dragged into the field under "Judgment is OK", it automatical-
ly also appears under "Judgment is NG".**

Parameter	Available settings
Color	Specify the text color.
Text type	**Fixed Text:** Under "Text" specify which (fixed) text is to be displayed. **Spreadsheet Row Result:** The result of the spreadsheet row entered under "Spreadsheet Row" is displayed. **Name of the spreadsheet row + result:** The name and result of the spreadsheet row entered under "Spreadsheet Row" are displayed. **Text + result of the spreadsheet row:** The (fixed) text entered under "Text" and the result of the spreadsheet row entered under "Spreadsheet Row" are displayed. **Text + coordinates:** Under "Text" specify which (fixed) text is to be displayed. Drag & drop an X and Y coordinate result from the spreadsheet onto the blue rows underneath. Note that the coordinate value is delivered by the spreadsheet and cannot come directly from the checker results.
Text	This option is available for all text types for which you can predefine texts. Enter the text to be displayed.
Spreadsheet row	This option is only available for the text types linking to a spreadsheet result. Drag & drop here the spreadsheet row whose result is to be displayed.
Font size	8 - 72 Point (default: 18 Point)
Transparent background	If you deactivate this parameter, the text is displayed in black inside a rectangle filled out in the selected color.

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.6 Line Indicator

Here you will find all the parameters which the line indicator needs in addition to the settings shared by all indicator types.

Basic settings

Basic settings for the line indicator

Parameter	Available settings
Line type	The following line types are available: — ↔ ← >—< ← ▸—◂ ↔
Line width	1 - 5 pixels (default: 1 pixel)
Additional text	Can be activated to label the line. The "Text Alignment" option is additionally displayed. The text itself is entered on the "Display Settings" property page under "Text".
Text alignment	**Centered, Line End:** When these two settings are set the Text is oriented to the angle of the line and is displayed either centered or right-justified with the line. **Centered and Horizontal, Line End and Horizontal:** When these two settings are set the text is displayed horizontal at the selected line position.

Position settings

There are two methods for drawing line indicators:

- With a start point and an auxiliary point
- With a start point and angle/length data

You must set different parameters depending on the setting you select for the "Line is defined by" parameter. As for the other indicators, the values may be either fixed or dependent on spreadsheet or checker results (for examples see below).

Line is defined by	Parameter	Additional setting options
Auxiliary point	Position	Fixed Position or Depends on Results

Line is defined by	Parameter	Additional setting options
Angle and length	Angle type	Fixed Angle or Depends on Results The angles are translated as follows: 130° 49° 0° 240°
	Length type	Fixed Value or Depends on Results

Example of a vertical line indicator in the center of the image (636x480)

Line indicator defined by angle, length, and a result-dependent point

Example of a line indicator defined by result-dependent points

Display settings

Here you specify how the indicator is to be displayed and whether the display is to be dependent on a spreadsheet row. If you have activated the "Additional Text" parameter under "Basic Settings", the parameters for text type, text, font size and transparent background familiar from the text indicator (see page 454) are displayed.

Display settings when "Additional Text" under "Basic Settings" is activated

Parameter	Available settings
Color	Here you define the color of the line.

Parameter	Available settings
Text type	**Fixed Text:** Under "Text" specify which (fixed) text is to be displayed.
	Spreadsheet Row Result: The result of the spreadsheet row entered under "Spreadsheet Row" is displayed.
	Name of the spreadsheet row + result: The result and name of the spreadsheet row entered under "Spreadsheet Row" are displayed.
	Text + result of the spreadsheet row: The (fixed) text entered under "Text" and the result of the spreadsheet row entered under "Spreadsheet Row" are displayed.
	Text + coordinates: Under "Text" specify which (fixed) text is to be displayed. Drag & drop an X and Y coordinate result from the spreadsheet onto the blue rows underneath. Note that the coordinate value is delivered by the spreadsheet and cannot come directly from the checker results.
Text	This option is available for all text types which use user-definable text. Enter the text to be displayed with the line. It is displayed in the same color as the line.
Spreadsheet row	This option is available for all text types which use spreadsheet rows. Drag & drop here the spreadsheet row whose result and name is to be displayed.
Font size	8 - 72 Point (default: 18 Point)
Transparent background	If you deactivate this parameter, the text is displayed in black inside a rectangle filled out in the selected color.

☞ ◆**NOTE**

When you have selected "Depend on Spreadsheet Row" and drag a spreadsheet row into the "Spreadsheet Row" field, that spreadsheet row is automatically also entered in the "Spreadsheet Row" fields under "Judgment is OK" and "Judgment is NG", provided those fields are still empty. This also applies when you only retrospectively configure the text type so that it is dependent on a spreadsheet result and consequently needs a spreadsheet row as its reference.
The spreadsheet rows for "Judgment is OK" and "Judgment is NG" influence each other mutually, as long as they are both empty. When a spreadsheet row is dragged into the field under "Judgment is OK", it automatically also appears under "Judgment is NG".

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.7 Marker Indicator

Marker type indicators have a number of additional parameters in their basic settings.

Basic settings

Basic settings for the marker indicator

Parameter	Available setting options
Marker Type	The following marker types are available: ╬ ╳ ⊡ ■ ● + ✕ □ ○
Line width	1 - 5 pixels (default: 1 pixel)
Marker Size	5 - 17 pixels (odd values)

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.8 Ellipse and Rectangle Indicators

Rectangle and ellipse indicators have a number of additional parameters in their basic and position settings.

Basic settings

Basic settings for the rectangle indicator

In the "Area Properties" under "Line Width" select the line width in which the rectangle or the ellipse is to be drawn.

Position settings

There are two methods for drawing ellipse and rectangle indicators:

- From the top left corner point to the bottom right corner point (the system internally assumes a virtual rectangle surrounding the ellipse)

- From the center point outward

You must set different parameters depending on the setting you select for the "Area is defined by" parameter. As for the other indicators, the values may be either fixed or dependent on checker or spreadsheet results.

Area is defined by	Parameter	Available settings
Top left and bottom right point	Top Left Corner	Fixed Position or Depends on Results
	Bottom Right Corner	
	Angle	Fixed Angle or Depends on Results
Center point and extension	Center point	Fixed Position or Depends on Results
	Extension: • Width • Height	Fixed Value or Depends on Results
	Angle	Fixed Angle or Depends on Results

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✗	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.
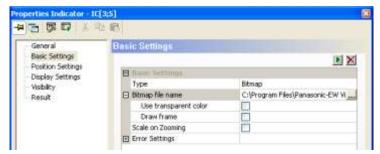
9.18.9 Bitmap Indicator
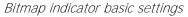
Here you will find all the setting options which the bitmap indicator needs in addition to the settings shared by all indicator types.

Basic settings

Here you define which bitmap is displayed, and how.

Parameter	Available settings
Bitmap file name	Select a bitmap file in *.bmp format by clicking the [...] button at the right.
Use transparent color	You can hide part of the bitmap if you activate this parameter and select the color which is to appear transparent.
Draw frame	Activate this parameter when you want to draw a border round the bitmap, and select a line width of 1 - 5 pixels. The border color is defined on the "Display Settings" property page. The default color is green.

Bitmap indicator basic settings

☞ ◆ **NOTE**

- **The bitmap must be saved in *.bmp format.**
- **The bitmap is shown in 1:1 scale.**
- **If you want to update the bitmap defined under "Bitmap file name" (new image, same file name), you must first delete the bitmap file name, then click on the ▨ icon and re-insert the bitmap file by choosing "Bitmap file name".**
- **The borderless bitmap indicator requires no display settings, because they are covered by the basic and position settings.**

Available buttons

Button	Functionality
▶	Draws the indicator with the current settings on the camera image.
✕	Only available if you have selected a parameter that depends on a result. Deletes the result in the fields with blue shading.

9.18.10　Result

An indicator has no results in the sense that a checker does. So here only the **execution state**, the **time** the **judgment** and - if an error has occurred - under "Messages:" a detailed error message, are output.

"Result" property page of an indicator which could not be executed

By clicking the [Highlight] button you can mark the indicator on screen. Then the indicator is displayed inverted in the image for as long as you hold down the button. The [Highlight] button is only active when the indicator has been calculated or already drawn.

If an indicator is outside the segment, but still within the camera image (because you have zoomed a different area of the camera image for example), you can double-click the [Highlight] button to move the displayed segment so that the indicator is in the middle of it.

If the indicator is outside the camera image, it is usually not possible to move the current image segment so that the result is positioned in the middle of it. In this case a warning message appears on the screen.

☞ ◆**NOTE**

- **When an error has occurred in calculating an indicator, it can only be highlighted if an error text is entered on the "Basic Settings" property page under "Error Settings".**
- **A borderless bitmap indicator is marked by a green surround; on a bordered bitmap indicator the surround is inverted.**

9.19 Print

When you select this option, you print out the parameters of the selected checker, object shape or indicator, together with information on the application, the camera, the frame grabber, and the date and time.

9.20 Properties

With **Properties** you can call up the property page of a selected checker, the object shape or the indicator and make changes.

9.21 Execute

With this function you can execute the selected checker, object shape or indicator as a test. It does not scan a new image. Instead, it works exclusively with the memory image.
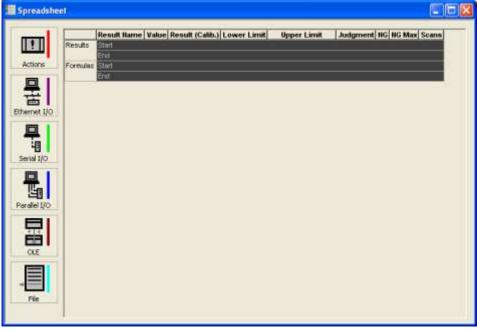
Chapter 10

Spreadsheet

10.1 Introduction

The spreadsheet is the pivotal interface in Vision Q.400. To display the spreadsheet, use

View → **Spreadsheet** or click .

Spreadsheet (Use scrollbar to display additional columns)

Here you can:

- View checker results
- View statistics
- Assign checker results a user-defined name
- Define data output to the interfaces
- Execute arithmetical and Boolean calculations
- Combine individual results into a cumulative result
- Calibrate values
- Define system actions when certain events occur
- Set judgment limits
- use IfCase formulas to execute a checker sequence conditionally

10.1.1 Spreadsheet Columns

The following data can be displayed in the spreadsheet. You define which columns in the spreadsheet should be displayed or hidden (see page 552).

Column title	Description
Name	Name of the checker or formula result, can be modified by user
Value	Checker or formula result in pixels
Factor	Factor used for calibration. The factor can be calculated by Vision Q.400 or entered manually.
Result (Calib.)	Calibrated checker or formula result, or input of the reference value (see page 485) for calibration. The value in this column is used for: • Data output via the interfaces • In the formulas • of indicators which display spreadsheet results If the result is not calibrated, the same value is displayed in the "Value" and "Result (Calib.)" columns.
Unit	Unit used for calibration
String reference	Reference value (see page 468) to verify a checker result of type string (OCR result, for example). Enter this value manually or via the serial or OLE interface.
Lower limit	Lower limit (see page 492) used for judging the checker or formula result. Enter this value manually or via the serial or OLE interface.
Upper limit	Upper limit used for judging the checker or formula result. Enter this value manually or via the serial or OLE interface.
Min result	Lowest checker or formula result measured
Max Result	Highest checker or formula result measured
Range	Greatest difference of all maximum and minimum results
Average	average checker or formula result (calculation formula: am = a1 + a2 + ... + an / n) + an / n)
Sigma	$$\sigma = \sqrt{\sum \frac{x_i^2}{n} - \left(\frac{x_i}{n}\right)^2}$$ Standard deviation
Judgment	OK/NG judgment of the checker or formula result (depending on the lower/upper limit (see page 492), or messages like "Error", "not executed". You can connect this cell with an Action (see page 518) which will be triggered every time the judgment fulfills one or more user-definable conditions.
NG	Number of NG judgments
NG Max	User-defined maximal number of permissible NG judgments. This number can be linked to an Action (see page 518), which will be triggered either every time the number of NG judgments can be divided by NG Max, or every time there have been "NG Max" successive NG results. User-defined maximal number of permissible NG judgments. This number can be combined with an Action (see page 518), which will be triggered every time the number of NG judgments can be divided by NG Max.
Error	Number of errors which occurred during execution (execution state error)
Scans	Number of times the application has been executed
Comment	Here you can enter a comment for the spreadsheet row.

☞ ◆**NOTE**

An error is treated as a NG judgment, i.e. whenever an error occurs, the value under "NG" is increased by 1.

10.1.1.1 Special Features of the String Reference

The "String Reference" column is only available for the OCR checker, and performs the function of a comparative rather than a limit value, meaning the column decides whether the result of the OCR checker is judged OK or NG. There are two ways of specifying a string reference:

- You enter a template text manually, e.g. "Copyright". This option is advisable when the same text always has to be checked.

	Result Name	Result (Calib.)	String Reference	Judgement
Results	Start			
	OCR[5;1]result_10	COPYRIGHT	COPYRIGHT	OK
	End			

- You refer to another checker result on the spreadsheet. This option is advisable when varying texts have to be checked and the text in question can be identified by way of other checkers.

	Result Name	Result (Calib.)	String Reference	Judgement
Results	Start			
	CR[2;1]decodedString	PANASONIC	PANASONIC	OK
	OCR[5;2]result_10	PANASONIC	PANASONIC	OK
	End			

◆ EXAMPLE

In the example, the code reader checker of camera 3 delivers the text for the string reference of the OCR checker of camera 1.

	Result Name	Result (Calib.)	String Reference	Judgement
Results	Start			
	CR[2;1]decodedString	PANASONIC	PANASONIC	OK
	FE[1;1]areaSize_1	1105		OK
	FE[1;1]areaSize_2	395		OK
	FE[1;1]areaSize_3	280		OK
	FE[1;1]areaSize_4	277		OK
	FE[1;1]gravity_X_Coordinate_1	148.89		OK
	FE[1;1]gravity_Y_Coordinate_1	226.15		OK
	OCR[5;2]result_10	PANASONIC	=CR[2;1]decodedString	OK
	End			

Function

The content of the "String Reference" column is interpreted by Vision Q.400 as follows:

Method	Entry in "String Reference"	Response of Vision Q.400
Referring to a fixed default	Does not begin with "="	Vision Q.400 interprets the entry as a fixed character string and compares it with the current checker result. You can use wildcards in the string reference to exclude one or more characters from the inspection. The following wildcards are available: • ? serves as a wildcard for a single character. • * serves as a wildcard for several consecutive characters.

Method	Entry in "String Reference"	Response of Vision Q.400
Referring to another checker result	Begins with "="	Vision Q.400 assumes that the string reference without the "=" contains the name of a spreadsheet row. The current checker result from this row is used as a comparative value when: • the string reference without the '=' contains the valid name of a spreadsheet row; • the checker result from that spreadsheet row is a string result; and • the spreadsheet row delivering the checker result was defined **before** the current spreadsheet row. If one of these conditions is not met, the string reference including the '=' is interpreted as a character string by way of a fixed default, and the checker result in the current spreadsheet row is always compared against it.

☞ ◆ **NOTE**

As for checker dependencies, the spreadsheet row whose result is to be used as a string reference must be ABOVE the row on the spreadsheet which needs the result as an entry in the "String Reference" column.

To link a string reference to a checker result:

◆ **PROCEDURE**

1. **Enter the result of the checker on the spreadsheet which is to deliver the comparative value**

   As the referenced spreadsheet row has to be above the row with the OCR checker on the spreadsheet, this result is inserted first. Right-click on the result in the checker result list and from the context menu choose "Insert Into Spreadsheet".

2. **Enter the result of the OCR checker on the spreadsheet**

3. **Open spreadsheet**

The quickest way is to right-click on the OCR result you just entered on the spreadsheet and then choose "Show in the Spreadsheet".

By default, Vision Q.400 applies the last valid checker result as the reference value when inserting a checker result.

Next the name of the spreadsheet row 1 is copied to the clipboard with the code reader checker whose result is to be used as a string reference.

4. Left-click in the "Name" field of the CL result

5. Select the complete name and press <Ctrl>-<c> to copy

6. Left-click in the "String Reference" field of the OCR result

7. Select the complete existing text

8. Enter =

9. Press <Ctrl>-<v> to paste copied name <Enter>

10. Start the application with <F5>

The spreadsheet column widths are automatically adjusted to the entry length, enabling you to see the full entry in the "String Reference" column.

	Result Name	Result (Calib.)	String Reference	Judgement
Results	Start			
	CR[2;1]decodedString		PANASONIC	Never Executed
	OCR[5;2]result_10		=CR[2;1]decodedString	Never Executed
	End			

☞ ◆NOTE ───────────────────────────

- **As long as a string reference is linked to a spreadsheet row, the row cannot be deleted.**
- **When moving spreadsheet rows, ensure the correct order is maintained, so that the rows to which others refer appear first. Otherwise an entry such as "=CL[3;1]DecodedString" will be taken literally by Vision Q.400 (interpreted as a manual text template).**
- **When a string reference is linked to a spreadsheet row, you can view the current value from that row. To do so, click in the "String Reference" field so the cursor starts flashing. If you leave the cursor where it is for a moment, the tool tip appears showing the current value of the row to which the string reference is linked.**

10.1.2 Available Options

Spreadsheet commands can be accessed either via the **Spreadsheet** menu or via the pop-up menu. The pop-up menu is context-sensitive, i.e. depending on where the cursor is positioned, the pop-up menu contains different options. Most options are available both in the **Spreadsheet** menu and in the pop-up menu. Some, however, are only available from either of the two, see table below.

Option	Explanation	Available in
Insert formula	**Spreadsheet** menu: Inserts a formula (arithmetic, Boolean, or IfCase) in the bottom section of the spreadsheet Pop-up menu: Inserts a formula (arithmetic, Boolean, or IfCase) at the position of the mouse cursor	both **Spreadsheet** and pop-up menu
Delete row(s)/contents	Deletes the currently selected row(s)/the complete spreadsheet	both **Spreadsheet** and pop-up menu
Reset statistics	Resets statistical values in the spreadsheet to zero (see page 551)	both **Spreadsheet and pop-up menu**
Properties	Opens the property window (see page 552) of the spreadsheet. Here you define which values should be displayed	both **Spreadsheet** and pop-up menu
Hide row(s)	Hides selected rows (see page 497)	both **Spreadsheet** and pop-up menu
Show row(s)	Shows hidden rows again (see page 497)	both **Spreadsheet** and pop-up menu

Option	Explanation	Available in
Lock row(s)	Activates the protection against editing (see page 500) for the selected row(s) in the spreadsheet. Locked rows are indicated by text in italics and a small red padlock symbol to the left of the result name.	both **Spreadsheet** and pop-up menu
Save as text file	Saves the contents of the spreadsheet in a text file.	both **Spreadsheet** and pop-up menu
Unlock row(s)	Deactivates the protection against editing (see page 500) for the selected row(s) in the spreadsheet. Locked rows are indicated by text in italics and a small red padlock symbol to the left of the result name.	both **Spreadsheet** and pop-up menu
Lock spreadsheet	Protects the spreadsheet against changes in setup mode by locking it (see page 497)	**Spreadsheet** menu only
Password	Sets a password (see page 502) for locking the spreadsheet	**Spreadsheet** menu only
Insert into ... <Interface name>	Marks the item for output to the selected interface (see page 527)	Pop-up menu only
Copy	Copies the selected item to the clipboard, e.g. for entering limits and editing formulas (see page 536)	Pop-up menu only
Paste	Pastes the selected item from the clipboard, e.g. for entering limits and editing formulas (see page 536)	Pop-up menu only
Quote	Copies (modified) values from the columns "Min Result/Max Result" or "Average" to the selected cells in the column "Lower Limit" and "Upper Limit" (see page 485), respectively	Pop-up menu only
Print	Prints the spreadsheet as well as the objects selected for transfer to the interfaces	in the pop-up menu and under **Application → Print →Spreadsheet**
Add delta value	Modifies the selected cells from the columns "Lower Limit" resp. "Upper Limit" with the selected operator and the input value (see page 494)	Pop-up menu only
Calibrate	Opens the dialog box with the calibration options for results (see page 485)	Pop-up menu only
Edit all cells	Inserts the value entered (see page 495) in the selected cells (only for cells from the columns "Unit", "String Reference", or "NG Max")	Pop-up menu only
Background color	Displays the selected cells with a background color (see page 501)	Pop-up menu only
Spreadsheet controller	By selecting an item you limit the spreadsheet display to the selected checker and formula results (see page 176)	Pop-up menu only

10.1.3 Selecting Items in the Spreadsheet

You select items in the spreadsheet in the same way as in other Windows applications:

- Left mouse click for individual items
- Left mouse click and <Shift> key for multiple connecting objects
- Left mouse click and <Ctrl> key for multiple objects

Please note that the options (see page 471) available in the pop-up menu vary depending on which cells, rows, or columns you have selected.

Select what	Mouse and/or keyboard operation
One cell	Left mouse click
Multiple con-necting cells	Left mouse click and hold the <Shift> key down
Multiple non-connecting cells	Left mouse click and hold the <Ctrl> key down
One column	Left mouse click

Select what	Mouse and/or keyboard operation
Multiple con-necting columns	Left mouse click and hold the \<Shift> key down
Multiple non-connecting columns	Left mouse click and hold the \<Ctrl> key down
One row	Left mouse click
Multiple con-necting rows	Left mouse click and hold the \<Shift> key down

Select what	Mouse and/or keyboard operation
Multiple non-connecting rows	Left mouse click and hold the <Ctrl> key down
All spreadsheet cells	Left mouse click in the top Left area

☞ ◆NOTE ——————————————

When you have selected an individual cell, Vision Q.400 treats the whole row as selected.

10.2 Transfer Checker Results to the Spreadsheet

This section informs you about which checker results can be transferred to the spreadsheet and how this transfer is done. Furthermore, you learn how to modify the (automatically created) name of the checker result in the spreadsheet according to your requirements.

10.2.1 Available Checker Results

Not all checker results are available for further processing. There are two groups of results which can be transferred to the spreadsheet for further processing:

- Individual results (usually gray-shaded results from the last two boxes on the "Result" page)
- Calculated results from the result list (results with white or light-gray background from the table on the "Result" page)

Results available for the spreadsheet

> **NOTE**
>
> - **Spreadsheet results are displayed to two decimal places.**
> - **The value entered in the "Calibration" column can have up to three decimal places.**
> - **After you have executed the application, the new checker results will be transferred to the spreadsheet and the statistics will be recalculated, i.e. the spreadsheet is updated.**

Highlighting results in the camera image

When you click a result from the list, the corresponding object is highlighted in the camera image. With the keys at the bottom you can leave the highlighting as it is or highlight different results:

Key	Highlighted result
Spacebar	The result selected with the left mouse button is highlighted as long as you hold down the key.
Up arrow	The result above the result selected with the left mouse button is highlighted as long as you hold down the key.
Arrow left	The result left of the result you have selected with a left mouse click will be highlighted as long as you press this key.
Down arrow	The result below the result selected with the left mouse button is highlighted as long as you hold down the key.
Arrow right	The result right of the result you have selected with a left mouse click will be highlighted as long as you press this key.

Only the results within the current displayed image segment are highlighted in the camera image. If a result is outside the segment, but still within the camera image (such as because only part of the complete image is visible after zooming), you can move the current image segment so that the result is positioned in the middle of it. To do so, double-click on the result.

If the result is outside the camera image (this is often the case with indicators), it is usually not possible to move the current image segment so that the result is positioned in the middle of it. In this case a warning message appears on the screen.

10.2.2 Selecting Checker Results

In order to transfer checker results to the spreadsheet, you need to select them first.

Select what	Click at position of mouse cursor				
One checker result	Left mouse click				

	Area Size	Gravity		Angle
1	57600	246.87	252.79	156.43
2	115	173.48	74.45	24.44
3	52	325.5	74.5	0
4	24	254.42	74.67	20.82
5	13	396.38	74.62	45
6	11	396.36	95.09	164.93

Select what	Click at position of mouse cursor
One column of checker results (for more columns, repeat on desired columns)	Left mouse click
One or more rows of checker results (for more rows, repeat on desired rows)	Left mouse click
Multiple checker results in different columns and rows	Press <Shift> to select multiple results from the same column Press <Ctrl> to select multiple results from different columns

☞ ◆**NOTE**

Any result you click on is color-highlighted in the camera image for as long as you hold down the mouse button.

10.2.3 Inserting Checker Results into the Spreadsheet

There are two ways of inserting checker results into the spreadsheet once you have selected one or more results. Depending on the method you choose, the selected checker results are inserted at the end of the spreadsheet or at a certain position.

Using the right mouse button

◆PROCEDURE

1. **Select the checker results you wish to insert into the spreadsheet**

2. Click the right mouse button

or, if you have selected more than one result,

Press <Ctrl> and then click the right mouse button

If the result has not yet been entered in the Spreadsheet, or if you have selected multiple results, a pop-up menu appears. For results already entered on the spreadsheet, the pop-up menu only offers the "Show in the Spreadsheet" option.

3. Select "Insert into Spreadsheet" and click the left mouse button

All selected checker results are added at the end of the list of values already inserted into the spreadsheet.

☞ **◆NOTE**

Please note that the option "Insert into Spreadsheet" is only available for checker results which can be inserted into the spreadsheet.

Using the drag & drop function

◆PROCEDURE

1. Select the checker results you wish to insert into the spreadsheet

or, if you have selected more than one result,

Hold down the <Ctrl> key

2. Click the left mouse button somewhere in your selection and hold it down

The mouse cursor changes to a circle with a diagonal bar.

3. Drag the selection to the spreadsheet

4. Drop the selection at the desired position in the spreadsheet

Drop as shown below to add the selected checker results at the end of the spreadsheet.

	Result Name	Result (Calib.)	Lower L
Results	Start		
	FE[1;1]areaSize_1		0
	FE[1;1]areaSize_2		0
	FE[1;1]areaSize_3		0
	FE[1;1]areaSize_4		0
	End		
Formulas	Start		
	End		

Drop as shown below to insert the selected checker results right below the mouse cursor.

	Result Name	Result (Calib.)	Lower Limit	Upper
Results	Start			
	FE[1;1]areaSize_1		0	4324
	FE[1;1]areaSize_2		0	1340
	FE[1;1]areaSize_3		0	1329
	FE[1;1]areaSize_4		0	1105
	End			
Formulas	Start			
	End			

	me	Result (Calib.)	Lower L
Results	Start		
	FE[1;1]areaSize_1		0
	FE[1;1]areaSize_2		0
	FE[1;1]gravity_X_Coordinate_3		0
	FE[1;1]gravity_Y_Coordinate_3		0
	FE[1;1]gravity_X_Coordinate_4		0
	FE[1;1]gravity_Y_Coordinate_4		0
	FE[1;1]areaSize_3		0
	FE[1;1]areaSize_4		0

☞ ◆ **NOTE**

- **With both methods of inserting checker results into the spreadsheet, the sequence order can be modified by drag & drop.**
- **You have to drag the value only once into the spreadsheet. The values will be updated automatically.**
- **Newly inserted checker results are judged with "Never Executed" (with light blue background color) until you execute the application and a new judgment is made.**
- **When inserting the checker results, limit values are set (see page 492) at the same time. In this, 0 is entered as the lower limit and the current result as the upper limit.**
- **All checker results you have inserted into the spreadsheet are displayed with a background color in the checker's result list. The default color is a light blue. You can change the default color under** System Settings → Vision Q.400 Settings **on the "Extras" page with the "Color for Results Inserted in Spreadsheet button (see page 78).**

- **To find checker results already inserted into the spreadsheet quickly, right-click on the checker result and from the pop-up menu choose "Show in the Spreadsheet".**

10.2.4 Changing Result Names in the Spreadsheet

When you transfer a checker result to the spreadsheet, Vision Q.400 automatically assigns a result name. This name can be changed if you wish to make the spreadsheet display easier to read (see procedure below).

◆**EXAMPLE**

The figure below shows part of a spreadsheet with a result name as assigned by Vision Q.400. The result name helps to identify the checker result and can be interpreted as follows:

FE[2;3]areaSize_1
FE   Feature extraction checker
2   Number of the camera to which the checker belongs
3   Number of the feature extraction checker in the camera
AreaSize_1   Area size of object No. 1

	Result Name
Results	Start
	FE[2;3]areaSize_1

◆**NOTE**

Please note that each checker result has its unique name consisting of the checker abbreviation and numbers and labels.

You can change either an individual result name or many (connecting) result names simultaneously.

10.2.4.1   Change Individual Result Names

If you wish to change individual result names or the names you wish to change are not positioned in connecting spreadsheet cells and cannot be moved until they are connected, please proceed as follows:

◆PROCEDURE

1. **View → Spreadsheet**

2. **Click on the checker result name you wish to change**

   Click into the cell name so that the cursor starts flashing.

3. **Overwrite part or all of the name**

4. **Press <Enter> to confirm the new name**

If you click into the cell with the changed result name and wait a bit, a tool tip appears and displays the original result name (see figure below).

☞ ◆NOTE

The cursor in the "Result Name" cell must be flashing in order for you to be able to change the name or to see the original result name displayed!

10.2.4.2   Changing Multiple Result Names Simultaneously

With this function it is possible to change multiple checker result names in one step. However, the function is only available for neighboring results and you need an open editor to copy the result name to the clipboard.

Please proceed as follows:

Store New Result Name in the Clipboard

◆PROCEDURE

1. **Open an editor on the PC, e.g. Notepad**

2. **In the editor window, write the result name you wish to paste later**

    In this example, we want to rename all area results with "Object".

3. **Select the name and copy it to the clipboard with <Ctrl>+<c>**
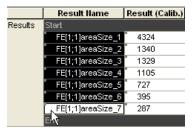
Paste New Result Name into the Spreadsheet

◆PROCEDURE

1. **View → Spreadsheet**

2. **Select the first checker result name to be changed with a left mouse click**

3. **Press <Shift>**

4. Select the last checker result name to be changed with a left mouse click

	Result Name	Result (Calib.)
Results	Start	
	FE[1;1]areaSize_1	4324
	FE[1;1]areaSize_2	1340
	FE[1;1]areaSize_3	1329
	FE[1;1]areaSize_4	1105
	FE[1;1]areaSize_5	727
	FE[1;1]areaSize_6	395
	FE[1;1]areaSize_7	287
	End	

Make sure to click the "empty" space to the left or right of the result name. Because if you click the letters of the result name, the cell will be activated for editing and the pop-up menu will not appear when you click the right mouse button. Instead, the cursor is flashing inside the result name cell.

5. Click the right mouse button

If the cell you clicked last has been activated for editing, the pop-up menu will not appear. In this case, point the cursor to any cell from the selected area marked in black and click the right mouse button again.

6. Select "Paste"

The text from the clipboard is inserted in the name column. Vision Q.400 automatically adds a number after the name to ensure that the result name is unique.

	Result Name	Result (Calib.)
Results	Start	
	Object_1	4324
	Object_2	1340
	Object_3	1329
	Object_4	1105
	Object_5	727
	Object_6	395
	Object_7	287
	End	

10.2.5 Finding Checker Results in the Spreadsheet

If you have entered a large number of checker results on the spreadsheet, you can make it easier to find them again by right-clicking on a blue-backgrounded checker result and from the pop-up menu choosing "Show in the Spreadsheet". Then the following happens automatically:

- The spreadsheet window is placed in the foreground.
- The spreadsheet row belonging to the result is selected and moved into the visible area of the spreadsheet. Any previously existing selection of spreadsheet rows on the spreadsheet is deleted.
- The "Spreadsheet Controller" (see page 176) window is displayed, and in it the "Toggle display of all hidden rows" option is activated.

10.2.6 Jumping from the Spreadsheet to the Checker Result

When you have inserted a checker result in the spreadsheet, you can jump directly from the spreadsheet result to the "Result" page of the checker. There are two possibilities to do that:

- Right mouse-click on a cell in the select spreadsheet row and select "Highlight in checker results" from the pop-up menu.
- Double-click left of the selected spreadsheet row in the gray area below "Results".

This is what happens:

- Vision P400 brings the camera window to which the selected checker result belongs forward
- Vision P400 highlights the sequence to which the selected checker result belongs
- The property page of the checker to which the checker result belongs is displayed.
- The checker result you have selected is highlighted on the checker's "Result" page (if the result exists, that is). If the checker from which you have selected the result works with a list, the object belonging to the selected result is moved into the visible area of the "Result" page.

10.3 Editing Functions

Vision Q.400 offers some special options in the spreadsheet. The following functions are available:

- Calibrate Values (see page 485)
- Quote (see page 492) and/or modify (see page 494) several limits simultaneously
- Edit (see page 495) several cells simultaneously
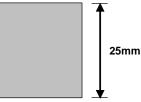
10.3.1 Calibrate Values

In the spreadsheet you can automatically calculate the calibrated value of any result.
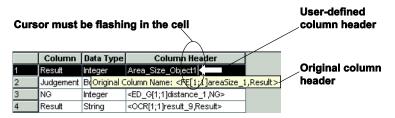
◆**EXAMPLE**

Use a reference object that you have measured accurately. In this example we chose a square with a side length of 25 mm.

25mm

Put the object in the view range of the camera and measure the distance with two edge detection checkers and a geometry checker

Cursor must be flashing in the cell

User-defined column header

Original column header

	Column	Data Type	Column Header
1	Result	Integer	Area_Size_Object1
2	Judgement	Bo...	Original Column Name: <FE[1;1]areaSize_1,Result>
3	NG	Integer	<ED_G[1;1]distance_1,NG>
4	Result	String	<OCR[1;1]result_9,Result>

These are the options for entering the values of the reference object for calibration:

- Enter them manually in the cells.
- Enter them simultaneously in multiple cells.
- Quote from an already calibrated spreadsheet row.

◆**NOTE**

- **You can only calibrate a spreadsheet row if there is a value not equal to 0 in the "Result (Calib.)" field.**
- **When a spreadsheet row is calibrated, the calibrated result is displayed in the "Result (Calib.)" field and the pixel value of the result in the "Value" field.**

- **When a spreadsheet row is not calibrated, the pixel value of the result is displayed both in the "Value" field and in the "Result (Calib.)" field.**

- **For a calibrated spreadsheet row the calibration factor is always not equal 1.0; for an uncalibrated row it is always equal to 1.0.**

- **The calibration factor is displayed by Vision Q.400 in the "Factor" field. If that spreadsheet column is hidden, you can still view the factor by clicking in the "Result (Calib.)" field so that the cursor starts flashing (!). If you leave the cursor where it is for a moment, the tooltip appears showing the calibration factor.**

- **The "Lower Limit", "Upper Limit", "Min Result", "Max Result", "Range", "Average", and "Sigma" columns always refer to the value in the "Result (Calib.)" column.**

- **When a spreadsheet row is calibrated, the "Min Result", "Max Result", "Range", "Average" and "Sigma" columns are automatically calibrated too. For the "Lower limit" and "Upper limit" columns you can choose whether this happens or not.**

- **The interfaces always transmit the value from the "Result (Calib.)" column.**

- **In formulas the value from the "Result (Calib.)" column is always used.**

- **Indicators displaying the result of a spreadsheet row always use the value from the "Result (Calib.)" column.**

10.3.1.1   Entering the Reference Value for Calibration Manually

◆ PROCEDURE

1. **First measure a reference object with the accuracy demanded**

2. **Inspect it with Vision Q.400**

3. **Enter the precisely measured value as a reference in the "Result (Calib.)" field of the spreadsheet <Enter>**

   A dialog box appears asking whether the lower and upper limits for judgment of the checker or formula result should be adjusted to the new calibration factor or not.
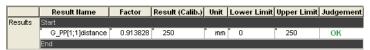
4. **Confirm if you want the limit values to be adjusted accordingly**

   The calibration factor is automatically calculated by Vision Q.400 and displayed in the "Factor" field. The cursor is now in the "Unit" field.

5. **Enter the unit (e.g. mm) in the "Unit" field <Enter>**

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	G_PP[1;1]distance	0.913828	250	mm	0	250	OK
	End						

When you execute the application with ⬚ or <F5>, you see the value, e.g. in millimeters, in the "Result (Calib.)" field.

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	G_PP[1;1]distance	0.913828	250	mm	0	250	OK
	End						

☞ ◆ **NOTE**

- **Confirm each entry in the spreadsheet either with <Tab> or <Enter>.**
- **The calibration is only valid for this spreadsheet row. It does not serve as a reference calibration for other rows.**
- **If you enter an empty characteristic string or the value 0.0 in the "Result (Calib.)" column, the row calibration is removed.**
- **You can also enter the factor manually, if you know it. A dialog box appears asking whether the lower and upper limits for judgment of the checker or formula result should be adjusted to the new calibration factor or not. Confirm if you want the limit values to be adjusted accordingly.**

10.3.1.2 Entering Multiple Calibration Values Simultaneously

If you wish to calibrate multiple rows simultaneously with the same calibration value, please proceed as follows:

◆ **PROCEDURE**

1. **Select the fields in the "Result (Calib.)" column or in the "Factor" column for which you want to enter the reference**

   Click on the column header or, depending on the positions of the fields, press the <Shift> or <Ctrl> key (see page 472).

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	ED_B[1;1]distance_1	1	20		0	20	OK
	ED_B[1;1]distance_2	1	103.52		0	103.52	OK
	ED_B[1;1]distance_3	1	118.2		0	118.2	OK
	ED_B[1;1]distance_4	1	140		0	140	OK
	End						

2. **Click the right mouse button in one of the selected cells**

   This field must not be calibrated, meaning its calibration factor must be 1.

3. **Select "Calibrate..."**

A dialog box appears in which "Use calibrated value" is preset by default and in the input box the value of the "Result (Calib.)" column of the last selected spreadsheet field is entered.

4. Enter the new reference

5. Choose "Adjust the lower and upper limit according to the new calibration factor" if you want to adjust the limit values according to the new calibration factor

6. Click [OK]

Make sure that the option "Use Calibration" remains activated. All selected fields in the "Result (Calib.)" column now contain the entered reference. For each calibrated row Vision Q.400 calculates an individual calibration factor from the current result and the entered reference and outputs it in the "Factor" column. If under 5. you selected "Adjust the lower and upper limit according to the new calibration factor", Vision Q.400 also adjusts the lower and upper limit values.

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	ED_B[1;1]distance_1	10	200		0	200	OK
	ED_B[1;1]distance_2	1.93	200		0	200	OK
	ED_B[1;1]distance_3	1.69	200		0	200	OK
	ED_B[1;1]distance_4	1.42	200		0	200	OK
	End						

☞ ◆ NOTE

When you right-click on an already calibrated field, in the dialog box which then appears "Use calibration factor" is preset by default, because when a row is calibrated Vision Q.400 assumes that you want to apply the calibration factor of that row to the other rows. In this case, apply the procedure described in the section headed "Quote an Existing Calibration Value".

10.3.1.3 Quote an Existing Calibration Value

If you want to apply an existing calibration as the benchmark for the other rows, you have two options:

- You apply the calibrated value
- You apply the calibration factor

The procedures are virtually identical. The example below demonstrates how to apply a calibration factor:

◆ PROCEDURE

1. **Select still uncalibrated fields in the "Factor" column**

   Depending on the cells' position, use the <Shift> or <Ctrl>key (see page 472).

2. **Right-click on the "Factor" field of the row from which you want to transfer the calibration factor**

   This field must be calibrated, meaning its calibration factor must be unequal to 1.

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	ED_B[1;1]distance_1	1	20		0	200	OK
	ED_B[1;1]distance_2	1	103.52		0	200	OK
	ED_B[1;1]distance_3	1	118.2		0	200	OK
	ED_B[1;1]distance_4	1	140		0	200	OK
	ED_B[1;1]distance_5	0.61	94.379		0	94.379	OK
	ED_B[1;1]distance_6	0.6	198.666		0	198.666	OK
	ED_B[1;1]distance_7	1	385		0	385	OK

3. **Select "Calibrate..."**

The following dialog box is displayed:

The calibration factor of the row in which you pressed the right mouse button has already been entered and the "Use calibration factor" option activated. If the cursor was positioned on an uncalibrated row when the pop-up menu was opened, the dialog box shows other settings. In that case Vision Q.400 suggests that you apply the calibrated value of the row in which you pressed the right mouse button.

4. Choose "Adjust the lower and upper limit according to the new calibration factor" if you want to adjust the limit values according to the new calibration factor

5. Click [OK]

Make sure the "Use calibration factor" option remains activated. Vision Q.400 applies the calibration factor of the selected row for the other rows, enters it in the "Factor" column and recalculates the value in the "Result (Calib.)" column. If you selected "Adjust the lower and upper limit according to the new calibration factor", Vision Q.400 also adjusts the lower and upper limit values.

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	ED_B[1;1]distance_1	0.61	12.2		0	122	OK
	ED_B[1;1]distance_2	0.61	63.147		0	122	OK
	ED_B[1;1]distance_3	1	118.2		0	200	OK
	ED_B[1;1]distance_4	1	140		0	200	OK
	ED_B[1;1]distance_5	0.61	94.379		0	94.379	OK
	ED_B[1;1]distance_6	0.6	198.666		0	198.666	OK
	ED_B[1;1]distance_7	1	385		0	385	OK

☞ ◆**NOTE**

• **A calibrated value is applied in the same way as detailed in this procedure: If the right mouse button click is made in a field of an uncalibrated row, the dialog box suggests you apply the calibrated result:**

If you confirm with [OK], Vision Q.400 applies the reference of the selected row for the other rows, enters it, calculates from it an individual calibration factor for each row and outputs it in the "Factor" column. If you selected "Adjust the lower and upper limit according to the new calibration factor", Vision Q.400 also adjusts the lower and upper limit values.

	Result Name	Factor	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
	ED_B[1;1]distance_1	1	17.08		0	17.08	OK
	ED_B[1;1]distance_2	1.98	200		0	200	OK
	ED_B[1;1]distance_3	1.73	200		0	200	OK
	ED_B[1;1]distance_4	1	137		0	137	OK
	ED_B[1;1]distance_5	1.31	200		0	200	OK
	ED_B[1;1]distance_6	0.60	200		0	200	OK
	ED_B[1;1]distance_7	1	382.19		0	382.19	OK
	End						

- **You can edit the value in the input box before clicking [OK]. Please note, however, that the modified input value will also be entered in the row you have selected with a right mouse click, i.e. the row with the original input value.**

10.3.1.4 Removing a Calibration

To remove a calibration, please proceed as follows:

◆ PROCEDURE

1. **Select the fields from which you want to remove the calibration**

   You can select the fields either in the "Result (Calib.)" column or in the "Factor" column. Depending on the cells' position, use the <Shift> or <Ctrl>key (see page 472).

2. **Select "Calibrate..."**

3. **Deactivate "Use Calibration"**

4. **Click [OK]**

The calibration is deleted.

☞ **◆NOTE**

You can also remove the calibration of a spreadsheet row manually. To do so, enter an empty character string or the value 0.0 in the "Result (Calib.)" column.

10.3.2 Judgment Limits

On the spreadsheet limit values are used for logical evaluation (OK/NG) of the result values. When inserting the checker results in the spreadsheet, limit values are set at the same time. In this, 0 is entered as the lower limit and the current result as the upper limit.

If the result lies in between these limits, the judgment will be OK, if not it will be NG (not good). The result is displayed in the field "Judgment". OK is displayed in green, NG in red.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	ED_B[1;1]distance_2	103.52	102	104	OK
	End				

Spreadsheet judgment

☞ **◆NOTE**

- **You need to enter the upper limit first as Vision Q.400 does not accept an upper limit that is lower than the lower limit: Lower limit < = upper limit. Bear this also in mind if you change the limit settings manually or via the interface.**
- **Confirm each entry in the spreadsheet either with <Tab> or <Enter>.**
- **If you calibrate values, the upper and lower limit always refer to the calibrated value, not to the pixel value.**

10.3.2.1   Quote Values for Both Limits

You may quote the current values from the columns "Min Result", "Max Result", or "Average" to be used as limits. The quickest method is to quote the values for the lower and upper limits simultaneously. Please proceed as follows:

◆PROCEDURE
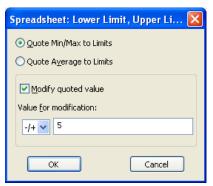
1. **In the columns "Lower Limit" and "Upper Limit" select the cells for which you wish to quote the values**

   Make sure you select both limits for each row because otherwise an error may occur when you try to quote the values.

2. **Position the cursor on any of the selected cells and click the right mouse button**

3. **Select "Quote..."**

If the dialog box displayed looks different, it probably means you have selected cells only from the column "Lower Limit" or "Upper Limit".

4. **Select "Quote Min/Max to Limits" if you wish to take over the values from the columns "Minimum" and "Maximum" or select "Quote Average to Limits" if you wish to take over the average values**

5. **Activate "Modify Quoted Value" if you wish to modify the values to be taken over**

6. **Under "Value for Modification", enter the value to be used for modifying the values to be taken over**

   The default operator is "-/+" when you take over values for the lower and the upper limits. In this case, the modification value is subtracted from the lower limit and added to the upper limit. However, if you select "-" or "+", the modification value will be subtracted from or added to BOTH limits.

7. **Select [OK]**

10.3.2.2   Quote Values for One Limit

If you wish to quote values for the upper and lower limit separately, you should begin with the upper limit. Otherwise an error may occur because Vision Q.400 does not tolerate it if you enter a lower limit that is above the upper limit. Please proceed as follows:

◆ PROCEDURE

1. **Select the cells from the column "Upper Limit" for which you wish to quote values from other columns**

2. **Position the cursor on any of the selected cells and click the right mouse button**

3. **Select "Quote..."**

If you have selected cells only from the column "Upper Limit", the following dialog box is displayed:

If the dialog box displayed looks different, you have selected cells also from columns other than "Upper Limit".

4. Select "Quote Max to Limits" if you wish to take over the values from the column "Maximum" or select "Quote Average to Limit" if you wish to take over the average values

5. Activate "Modify Quoted Value" if you wish to modify the values to be taken over

6. Under "Value for Modification", select the arithmetic operator and the value you want to use to modify the applied values

Select "+" or "-" as the operator, depending on whether you wish to add or subtract the value for modification.

7. Select [OK]

10.3.2.3   Modify Existing Limits

You can modify all limits by adding or subtracting values. Please proceed as follows:

◆ PROCEDURE

1. In the columns "Lower Limit" and/or "Upper Limit" select the cells for which you wish to modify the values

2. Position the cursor on any of the selected cells and click the right mouse button

3. Select "Add Delta Value..."

4. Enter the value for the modification and select one of the operators "+", "-", or "-/+"

It depends on the cells selected under "Lower Limit" and/or "Upper Limit" which operators are available and which operator is selected by default. With "-/+", the value you enter will be subtracted from the lower limit and added to the upper limit. With "-" or "+", however, the value will be subtracted from or added to BOTH limits.

5. Select [OK]

10.3.3 Editing Multiple Cells

It is possible to change the contents of multiple cells simultaneously in the columns "Unit", "String Reference" und "NG Max".

◆ PROCEDURE

1. Select several spreadsheet cells from one of the columns listed above

Please use the multiple selection keys (see page 472) or select complete columns. In this example we want to enter "mm" in all cells from the "Unit" column.

		Result Name	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start						
		ED_B[1;1]distance_1	20		0	20	OK
		ED_B[1;1]distance_2	103.52		0	103.52	OK
		ED_B[1;1]distance_3	118.2		0	118.2	OK
		ED_B[1;1]distance_4	140		0	140	OK
	End						

2. Click the right mouse button

3. Select "Edit All Cells"

A dialog box appears with the name of the column in which you have selected the cells.

4. Enter the text for the cells

```
Spreadsheet: Unit                    [×]

Unit:

[ mm|                              ]

   [    OK    ]        [   Cancel   ]
```

5. Click [OK]

Vision Q.400 pastes the text you have entered in the dialog window into all selected cells.

	Result Name	Result (Calib.)	Unit	Lower Limit	Upper Limit	Judgement
Results	Start					
	ED_B[1;1]distance_1	20	mm	0	20	OK
	ED_B[1;1]distance_2	103.52	mm	0	103.52	OK
	ED_B[1;1]distance_3	118.2	mm	0	118.2	OK
	ED_B[1;1]distance_4	140	mm	0	140	OK
	End					

10.4 Locking, Hiding, and Display Functions

You can lock or hide individual rows of the spreadsheet or lock the complete spreadsheet to protect it against changes.

10.4.1 Locking the Complete Spreadsheet

In setup mode, you can lock the spreadsheet with **Spreadsheet → Lock Spreadsheet** so that users cannot modify the entries in any way (changing limits, selecting different data for interface output, etc.). The lock can be combined with a password (see page 502).

When the spreadsheet has been locked, the word "[Locked]" appears in the blue title bar of the spreadsheet window. To unlock the spreadsheet, use **Spreadsheet → Lock Spreadsheet** again so that the check mark disappears.

☞ ◆**NOTE**

Locking the spreadsheet affects ALL applications.

10.4.2 Hide Rows and Show Hidden Rows

It is possible to hide individual spreadsheet rows in order to have a better overview over large spreadsheets.

When a row is hidden, certain functions can no longer be executed via the user interface:

Available	Not available
Update contents by executing the application	Change properties of cells in the row, e.g. result name, limits, background color
Reset statistics	
Use row in a formula (copy name beforehand or enter it manually)	

☞ ◆**NOTE**

This does not apply to functions executed by the interfaces, e.g. changing limits.

If you wish to hide spreadsheet rows, please proceed as follows:

◆**PROCEDURE**

1. **Select one or more spreadsheet rows**

   Depending on the rows' position, use the <Shift> or <Ctrl> key (see page 472) if you wish to select more than one row.

2. **Click the right mouse button**

3. Select "Hide Row(s)"

When a row is hidden, the separating line between the rows above and below the hidden row is thicker than usual (it represents the "missing" row). In this example the row with the 5th result is hidden.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_1	4324	0	4324	OK
	FE[1;1]areaSize_2	1340	0	1340	OK
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
→	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

When you hide the topmost row(s), a thick **blue** separation line appears above the first non-hidden row.
In this example the rows with the 1st, 2nd and 5th result are hidden.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
→	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

To display a hidden row again, proceed as follows depending on the position of the row in the spreadsheet:

Show hidden middle rows

◆ PROCEDURE

1. Select the row right above the thick blue separation line

It suffices to select one cell in the row (a selected cell is displayed with a black frame).

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

2. Click the right mouse button

3. Select "Show Row(s)"

The formerly hidden row will be displayed again.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_5	727	0	727	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

Show hidden top rows

 PROCEDURE

1. **Left mouse click on "Results"**

   The cursor turns into an arrow.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_5	727	0	727	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

2. **Click the right mouse button**

3. **Select "Show Row(s)"**

   If you have positioned the cursor in the first visible row above the thick blue sep-
   aration line and use the show function, all hidden rows below the selected row
   will be displayed. In the example the rows 1 and 2 are no longer hidden.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_1	4324	0	4324	OK
	FE[1;1]areaSize_2	1340	0	1340	OK
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_5	727	0	727	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK
	End				

 NOTE

- **If you have hidden spreadsheet rows, you can temporarily display them
  again by clicking on the ⚙ icon in the Spreadsheet Controller. Then
  the 🗖 icon is displayed on the spreadsheet to the left of the actually
  hidden but temporarily visible rows.**

	Result Name	Value	Result (Calib.)	Judgement
Results	Start			
	FE[1;1]areaSize_1	47482	47482	OK
🗖	FE[1;1]gravity_X_Coordinate_1	205.88	205.88	OK
🗖	FE[1;1]gravity_Y_Coordinate_1	266.68	266.68	OK
	FE[1;1]angle_1	165.27	165.27	OK
	End			

- **Hidden rows remain hidden when you save the application, close it, and
  then open it again. This is different from the spreadsheet controller (see
  page 176), which you can use to limit the display of checker and for-
  mula results when creating an application. However, the limits you
  make with the spreadsheet controller are lost when you save the appli-
  cation, close it, and then open it again.**

- **When you have hidden several rows at the top of the spreadsheet and
  there are also hidden rows below the first visible row in the spread-**

sheet, the show function will unhide both the top rows and the rows below the first visible row.

- **If you have selected several neighboring rows with the <Shift> key and there are hidden rows among them, the hidden rows will be displayed when you choose "Show" from the pop-up menu.**

10.4.3 Lock Individual Rows

It is possible to lock individual rows of the spreadsheet. When a row is locked, certain functions can no longer be executed via the user interface:

Available	Not available
Update contents by executing the application	Change properties of cells in the row, e.g. result name, limits, background color
Reset statistics	
Use row in a formula (copy name beforehand or enter it manually)	

☞ ◆**NOTE**

This does not apply to functions executed by the interfaces, e.g. changing limits.

Locked rows are marked with a small red padlock symbol to the left of the result name. The text in the cells is displayed in italics.

If you wish to lock spreadsheet rows, please proceed as follows:

◆**PROCEDURE**

1. **Select one or more spreadsheet rows**

   Depending on the row position, use the <Shift> or <Ctrl>key (see page 472).

2. **Click the right mouse button**

3. **Select "Lock Row(s)"**

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_1	4324	0	4324	OK
	FE[1;1]areaSize_2	1340	0	1340	OK
🔒	*FE[1;1]areaSize_3*	*1329*	*0*	*1329*	OK
	FE[1;1]areaSize_4	1105	0	1105	OK

   To unlock a row, proceed in the same way, but select "Unlock Row(s)".

☞ ◆**NOTE**

Locked rows remain locked when you save the application, close it, and then open it again.

10.4.4 Changing the Background Color of Cells

Use this function to change the background color of spreadsheet cells. However, please note that user-defined colors will be ignored if the cell color is used to convey a certain information. For example, the background color for cells in the "Judgment" columns is always red, if an error has occurred during result calculation. The red color will appear no matter what color you may have selected for the cell.

When you define a new background color, make sure it is different from the text color. For example, black as a background color will prove impractical.

♦ PROCEDURE

1. **Select one or more spreadsheet cells**

    Please use the multiple selection keys (see page 472) or select complete rows.

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_1	4324	0	4324	OK
	FE[1;1]areaSize_2	1340	0	1340	OK
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_5	727	0	727	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK

2. **Click the right mouse button**

3. **Select "Background color..."**

    The color selection dialog appears.

4. **Click the left mouse button on a basic color or on any of the colors on the right**

5. **Use the arrow on the far right to adjust the color brightness**

6. Click [OK]

	Result Name	Result (Calib.)	Lower Limit	Upper Limit	Judgement
Results	Start				
	FE[1;1]areaSize_1	4324	0	4324	OK
	FE[1;1]areaSize_2	1340	0	1340	OK
	FE[1;1]areaSize_3	1329	0	1329	OK
	FE[1;1]areaSize_4	1105	0	1105	OK
	FE[1;1]areaSize_5	727	0	727	OK
	FE[1;1]areaSize_6	395	0	395	OK
	FE[1;1]areaSize_7	287	0	287	OK

The selected cells appear in the background colors you have chosen.

10.4.5 Setting a Password

Use this option to set a password for locking the spreadsheet. If you do not define a password, the spreadsheet can be locked/unlocked by any user.

◆ PROCEDURE

1. System Settings → Spreadsheet Password

Change Spreadsheet Password

Current [   ]

New password: [   ]

Confirm new [   ]

[OK]   [Cancel]

If you have not assigned a password yet, proceed to step 3.

2. If you have already assigned a password to the spreadsheet, enter it under "Current Password"

3. Enter your new password under "New Password"

If you make no entry, the access to locking/unlocking the spreadsheet is not protected.

4. Enter your password again under "Confirm New Password"

5. Click OK

◆ NOTE

This password only applies to locking/unlocking the spreadsheet. The application is protected by a dedicated password (see page 62).

10.5 Interface Settings

Depending on the interface you have selected for output, you can make additional settings. This enables you to customize the results file and data format to obtain a layout tailored to your requirements.

Interface	Data Format Settings	Settings for the Results File	Additional Settings
Ethernet I/O (see page 92) Ethernet I/O	Column separator Decimal separator CR and LF in the data	---	---
Serial (see page 505) Serial I/O	Column separator Decimal separator CR and LF in the data	---	---
Parallel I/O (see page 115) Parallel I/O	---	---	Define whether data transfer should be controlled by handshake or, if not, whether the system should perform a forced reset on the strobe signal after the reset time entered on the digital I/O property page.
OLE (see page 518) OLE	Data container index Execution group numbers	---	---
FILE (see page 510) File	Column separator Extra columns File header Additional file header text Decimal separator CR and LF in the data	File settings Append to file name Number controlling Limited file size	---

The following sections deal with the available setting options for all the interfaces in the same order as the interface buttons appear on the left side of the spreadsheet.

10.5.1 Ethernet and Serial Interfaces

The Ethernet and serial interfaces have data format settings that enable you to define the layout of the results output. Some of these options are also used for the FILE interface.

Data format for Ethernet or serial interfaces when using a separator

Depending on whether you want to output data with a fixed length or separated by a separator character, there are different settings available:

- Data separation using a separator:
  - Column separator (see page 505)
  - Decimal Separator (see page 505)
  - CR and LF in the data (see page 505)
  - Format for digits after the decimal separator (see page 505)

- Sending data with fixed data length:
  - Prefix for numerical data output (see page 506)
  - Decimal Separator (see page 506)
  - CR and LF in the data (see page 505)
  - Length and format of the data types (digits before and after the decimal separator) (see page 506)

10.5.1.1 Data Separation Using a Separator

Here you define the character which separates the columns in the result file from each other. By default, Vision Q.400 uses a comma to separate the columns.

☞ ◆**NOTE**

If you wish to use the comma as the decimal separator, you must select a different separator here.

User-Defined Separator
You may enter up to 22 characters in the list of available separators, then click [OK]. Use the [Delete] button to remove the character or string from the list of column separators. In this case, Vision Q.400 reverts to the comma as the default column separator, unless it is already in use as the decimal separator. In this case the semicolon is the default.

10.5.1.2 Decimal Separator

This option acts as a toggle switch and lets you define the character used to display decimal numbers. You can choose between a full stop (period) and a comma.

☞ ◆**NOTE**

This option is only available when the option "Use Separator" does not use a comma or full stop to separate the data columns!

In addition, you need to set the number of decimal digits after the decimal separator on the right side of the dialog box under "Format Decimal Digits".

10.5.1.3 CR and LF in the Data

The result of the code reader may contain line breaks (CR / LF = Carriage Return / Line Feed). In this case you need to define how Vision Q.400 should output the line breaks to the interfaces:

Setting	Functionality
Remove	If the result contains line breaks, these will be removed.
Replace by	Enter a character (or a string of characters) to be output instead of the line break.

| CR[2;1]decodedString | This text comprises several lines | This text comprises several lines | | | OK |

Code reader result with several lines

10.5.1.4 Sending Data with Fixed Data Length

When you decide to send data with a fixed data length, some further options in the dialog box become available:

Data format for RS232 interface when working with a fixed data length

Prefix for numerical data output

Use this option to define how to handle unused digits. You can fill unused digits with zeros or with blanks when a result has less digits than defined on the right side of the dialog box. When outputting text data, Vision Q.400 automatically adds blanks to reach the fixed data length for text.

Format decimal digits for the different types of data

The right side of the dialog provides options to set the number of digits for the different data types available. For decimal numbers you also need to define the number of pre-decimal digits and digits following the decimal separator.

10.5.1.5 Data Format for Transfer with MEWTOCOL

When transferring data with MEWTOCOL, you can assign the transferred data various data types. You can, for example, transfer a number as an integer or real value.

Data register

Here you select the start register. The transferred data are filed starting with this register. The end register is automatically determined from the volume and the data types of the results being transferred. The start register is application-specific, and is saved with the application.

MEWTOCOL Settings

Start Register for Data | D00001

OK | Cancel

The start register is structured as follows. The first letter indicates the register type. The fifth digit specifies the start register number.

Memory area	Description
D	Data register
F	File Register
L	Communication flag

Change format

Here you select the desired data type for all marked rows from the list under "Selected spreadsheet cells".

☞ ◆**NOTE**

The transfer speed and transfer commitment can vary across different data types. So select a data type which makes sense for the application!

The following data types are available:

Data type	Value range	Properties
BOOL	0 and 1 (1 bit)	The state 0 corresponds to FALSE and signifies that the switching variable is disabled/not set. The state 1 corresponds to TRUE and signifies that the switching variable is enabled/set.
INT	From -32768 to 32767 (decimal, 16 bits)	Variable values of data type INTEGER are whole natural numbers without decimal places.
DINT	From -2147483648 to 2147483647 (decimal, 32 bits)	Variable values of data type DOUBLE INTEGER are whole natural numbers without decimal places.
REAL	From -3.402823*E38 to -1.175494*E-38, 0.0, +1.175494*E-38 to +3.402823*E38	Variables of data type REAL are real numbers, or floating-point constants. There are seven effective numbers. The mantissa has 23 bits and the exponent 8 bits (based on IEEE754).
WORD	16 bit	A variable of data type WORD comprises 16 binary states.
DWORD	32 bit	A variable of data type DOUBLE WORD comprises 32 binary states.
STRING	Character string of variable length [0-255]; see notes	A variable of data type STRING comprises a string of up to 255 characters.
ARRAY OF	Character string of variable	In the data type ARRAY OF WORD [0..] the size of the range

Data type	Value range	Properties
WORD	length [0-9999]; see notes	is given from zero to a maximum of 9999. This data type is suitable for transferring character strings and, as opposed to the STRING data type, has no data header.

☞ **◆NOTE**

- **An ARRAY OF WORD with the number ARRAY OF WORD [0..1] can accommodate four characters; a String[2] can only accommodate two characters. If the result of an OCR or code reader checker is longer than the predetermined length for the configured STRING or ARRAY OF WORD data type, an execution result error is output and the result cut off.**

- **In the case of the BOOL data type, the order of results in the "Objects for Data Transfer" dialog box influences the data volumes and so also the transfer speed. If four BOOL values are always entered in succession in "Objects for Data Transfer" instead of alternating BOOL and INT values for example, the number of characters to be transferred is reduced. The reason for this is that four characters are always required to transfer a single BOOL value. But when several BOOL values are sent in direct succession, up to four BOOL values are always sent with four characters.**

Always send the data of all execution groups

This option has effects on the choice of destination registers, and should be used with due caution. The examples illustrate how the setting of this option affects the choice of destination registers when using execution groups.

✌ **◆EXAMPLE**

Case 1: "Always send the data of all execution groups" is not activated. Only the results of the selected execution group are written to the registers as from the start address.

Advantage	Disadvantage
Shorter transfer time	If then a different execution group is selected, the registers are overwritten as from the same start address. On the one hand, this can be useful if the same data type is always written to a register for example, so as to have some influence on the control. On the other hand, dies can also easily result in an error if different data types are written to the same register.

Case 2: "Always send the data of all execution groups" is activated. All results of all execution groups are always transmitted, even if only the results of one execution group were calculated. For the results of the execution groups which were not calculated, the preset defaults (see page 99) are transmitted.

10.5.2 Parallel I/O Interface

The "Objects for Data Transfer" window offers two settings concerning the transfer. Here you may define whether the data transfer should be controlled by handshake (see page 115) and, if it is, whether the Strobe signal should act as a forced reset. In addition, you can change the data type that has been automatically assigned by Vision Q.400 with the button [Change Data Type].

If the settings "Handshake" and "Forced reset" are not activated, you can use the button [System Settings] to select whether the data signals are never reset or are reset at the start of the next application (see page 109). If you activate "Data signals are never reset", data signals will only change if the execution result of the application changes. For example, if you use one data signal to output whether the inspection result was OK, the signal remains unchanged as long as the inspection result is OK. Only when there is an NG result will the data signal state change.

10.5.3 File Interface
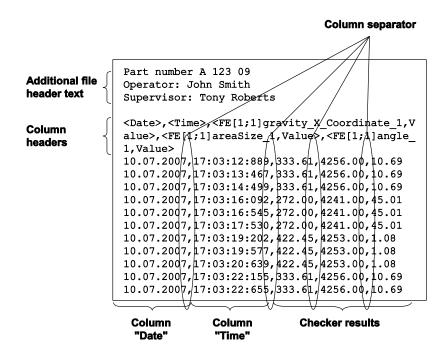
All checker results selected for output via the File interface are written to file in the sequence defined in the "Objects for Data Transfer" (see page 530) window. They are separated by a separator character and form orderly rows and columns.

For each application start, the system begins a new line in the file. Use applications like Microsoft Excel or Microsoft Access to read and process the data file.

The example below shows a typical data file, as it is created when you transfer spreadsheet data to a file and execute the application several times.

◆EXAMPLE

This example file shows three checker results (x-coordinate, area size, angle) and the number of scans (13 altogether). The individual results are separated by commas. Each data record is preceded by the exact time. In the beginning, a comment has been entered.

```
Part number A 123 09
Operator: John Smith
Supervisor: Tony Roberts

<Date>,<Time>,<FE[1;1]gravity_X_Coordinate_1,V
alue>,<FE[1;1]areaSize_1,Value>,<FE[1;1]angle_
1,Value>
10.07.2007,17:03:12:889,333.61,4256.00,10.69
10.07.2007,17:03:13:467,333.61,4256.00,10.69
10.07.2007,17:03:14:499,333.61,4256.00,10.69
10.07.2007,17:03:16:092,272.00,4241.00,45.01
10.07.2007,17:03:16:545,272.00,4241.00,45.01
10.07.2007,17:03:17:530,272.00,4241.00,45.01
10.07.2007,17:03:19:202,422.45,4253.00,1.08
10.07.2007,17:03:19:577,422.45,4253.00,1.08
10.07.2007,17:03:20:639,422.45,4253.00,1.08
10.07.2007,17:03:22:155,333.61,4256.00,10.69
10.07.2007,17:03:22:655,333.61,4256.00,10.69
```

10.5.3.1   File settings

Saving checker results to a file works similar to outputting them to the interfaces (see page 530). However, there are additional settings necessary for the file creation.

◆ PROCEDURE

1. **Click**

   The "Objects for Data Transfer" window appears with the "File" property page open. You see the list of all checker results selected for file export.

2. **Click in the field next to "File Name" and enter the path and name for your data file**

   When you change the file or folder name, Vision Q.400 checks whether the entry is valid. If the selected folder does not exist, a message appears and asks wheth-

er you really want to use the file name and the folder you have entered. If you confirm, you can also use applications which are normally executed on a different PC with a different folder structure. However, when you switch to run mode, an interface error will occur because Vision Q.400 will not be able to create the result file in the folder you have entered (because it does not exist).

3. **Select [File Settings]**

   The "File Settings" dialog window appears.

4. **Set the options as necessary (for more information see below)**

5. **Click [OK]**

☞ ◆ **NOTE**

- **Always enter the name of the folder where you want Vision Q.400 to save the result file. This makes it easier for you to find and access the result file on the PC. If you do not enter a folder name, a message asks whether you really want to use the file name without indicating a folder.**

- **If you allow an invalid folder to be entered and try to switch to run mode, an interface error occur because Vision Q.400 cannot create the file in which you try to save the results.**

10.5.3.2   File Modes

The options under "File Modes" help to regulate the access to the data file and how to handle new data when there already is a data file. As long as Vision Q.400 is in run mode, the system writes all results selected for file output into a file.

☞   ◆**NOTE**

> **Please note that the access options are only relevant as long as Vision Q.400 is in run mode. At all other times there are no access restrictions for the data file. It is very important that no other application tries to access the data file while Vision Q.400 is writing checker data into the data file.**

Read Only

This ensures that other applications like Microsoft Excel or Microsoft Access can only read the file, but not delete it or overwrite it with different data.

Read/Write

Use this setting if you wish to allow other applications like Microsoft Excel or Microsoft Access to change or delete the data.

Append

Use this option if you do not want Vision Q.400 to overwrite existing data files. Instead, Vision Q.400 adds checker results from a new scan to the list of last results. Please note that this option is only available if you have activated "Date" or "None" under "Append to File Name" (see page 512).

Overwrite

Here you define whether you wish to overwrite the existing data file after leaving and restarting run mode or changing the application. Please note that this option is only available if you have activated Date or None under Append to File Name.

Always Overwrite

This setting appears when you have activated "Time" or "Number" under "Append to File Name". In this case, Vision Q.400 overwrites an existing data file if a new file has the same time or number included in the file name. Otherwise Vision Q.400 creates a new file.

10.5.3.3   Append to File Name

These options define the layout of the file name. Use these options if you wish to create a new data file every time Vision Q.400 switches to run mode.

Date

When you activate this option, every time you leave and restart run mode or change the application, the system switches to run mode or to another application Vision Q.400 checks whether the system date has changed. If the system date has changed, a new file is created. The file name follows the pattern: <User-defined name>_<two-digit day>.<two-digit month>.<year>.<user-defined extension>.

◆EXAMPLE

We assume that the user has entered TEST.DAT as the generic file name for the data file. If you have activated the option "Date" and Vision Q.400 has switched to run mode on three days in January 2001, the following files will have been created:

TEST_05.01.2001.dat
TEST_06.01.2001.dat
TEST_07.01.2001.dat

Time

When you activate this option, every time the system switches to run mode or to another application Vision Q.400 checks whether the system time has changed. If the system time has changed, a new file is created. The name follows the patter (24-hour clock mode):
<user-defined name>_<hour>.<minute>.<second>.<user-defined extension>

◆EXAMPLE

We assume that the user has entered TEST.DAT as the generic file name for the data file. If you have activated the option "Time" and Vision Q.400 has switched to run mode on three different occasions, the following files will have been created:

TEST_07.12.20.dat = at 7:12:20 a.m.
TEST_14.05.09.dat = at 02:05:09 p.m.
TEST_21.34.54.dat = at 09:34:54 p.m.

Number

When you activate this option, Vision Q.400 appends a number (beginning with the number displayed under "Next Number") to the user-defined file name every time the system switches to run mode or to another application and creates a data file. The next free number is saved and used when the next start occurs in run mode or the application is changed. Reset the number with option "Number Controlling - Next Number" (see page 514).

◆EXAMPLE

We assume that the user has entered TEST.DAT as the generic file name for the data file. If you have activated the option "Number" and entered 100 under "Next Number", the following files will be created:

TEST_100.dat
TEST_101.dat
TEST_102.dat and so on.

None

Vision Q.400 always writes data into the same file. Whether new data is appended to the existing data or overwrites the file content depends on the settings under "Options".

☞ **◆NOTE**

> **Please be aware when you activate options which entail the creation of files on your hard disk that the hard disk may be full after some time of continuous operation.**

10.5.3.4   Number Controlling

When you have activated the option "Append to File Name - Number", Vision Q.400 appends a number (beginning with the number displayed under Next Number) to the user-defined file name every time the system switches to run mode or to another application and creates a data file.

Next Number

Use this field to enter the number to be used for the first data file which the system creates. When you save the application, Vision Q.400 stores the last number here and starts counting from this number when you activate run mode again.

When you enter a new number, Vision Q.400 starts with this number when you leave and restart run mode or when you change to another application. You can also use this option to reset the file numbering.

10.5.3.5   Limited File Size Options

When you enter a size limit for the data file, Vision Q.400 writes into a data file until the size limit is reached and then creates a new data file. The files are numbered by attaching the next free number to the generic or modified file name. Whenever you switch to run mode or change to another application, Vision Q.400 resets the file number to 0.

Use Limit / Size

Activate this field and use the arrow buttons next to "Size (MB)" to enter the size limit in megabytes. Alternatively, you can simply type in a figure.

✌ **◆EXAMPLE**

> We assume that Vision Q.400 creates 4,5MB data in a work shift with 355,000 starts and that you have entered 1MB as the size limit. So 5 data files are created:
>
> TEST_~0.dat (size: 1MB)
> TEST_~1.dat (size: 1MB)
> TEST_~2.dat (size: 1MB)
> TEST_~3.dat (size: 1MB)
> TEST_~4.dat (size: 0.5MB)

10.5.3.6 Data Formatting

This dialog box allows you to add some application-specific information to the data file, e.g. information on the project, shift information, supervisory staff, etc.

◆PROCEDURE

1. **In the "Objects for Data Transfer" window, click [Format Data]**

The "Data Formatting" dialog box appears.

2. **Make your settings (see sections below)**

3. **Click [OK]**

10.5.3.7 Column Separator

This option works exactly like for the RS232 interface (see page 505).

10.5.3.8　　Extra Columns

When you activate this option, Vision Q.400 includes up to three additional columns in the result file. Click the corresponding checkbox to include the time, date and/or group number of the execution group in the result file. You can change the header text if you have checked the checkbox.

10.5.3.9　　File header

With this option, Vision Q.400 includes the headers of the result columns in the file header of the result file.

Column headers

When you activate this option to include a header for each data column in the file header, an additional column appears in the "Objects for Data Transfer" window (see figure below). By default, this header includes the checker and result name. However, you can change the column header text in the "Objects for Data Transfer" window, if required. Simply click into the cells below "Column Headers" and type in the text you wish to use as a header.

◆**EXAMPLE**

The column header for the first result has been changed from the default <WI[2;1]areaSize,Result> to "Area Object 1". The results 2 - 6 still display the default column header text.

Once you have changed a column header, you can see the original (default) column header if you click into the cell (the cursor must be flashing and the mouse cursor must be positioned in the cell) and wait. The system displays the default column name in the tool tip.

Changing the column headers also affects the pop-up menu: You find a new item "Default Column Header". Use this to reset the user-defined header to the default column header.

10.5.3.10   Additional File Header Text

Here you can enter a comment. Vision Q.400 prints the text before the data (excerpt from result file (see page 509)).

10.5.3.11   Decimal Separator

This option works exactly like for the RS232 interface (see page 505).

10.5.3.12   Handling of CR and LF in the Data

The result of the code reader may contain line breaks (CR / LF = Carriage Return / Line Feed). In this case you need to define how Vision Q.400 should output the line breaks to the interfaces:

Setting	Functionality
Leave as is	All line breaks are output.
Delete	If the result contains line breaks, these will be removed.
Replace by	Enter a character (or a string of characters) to be output instead of the line break.

Code reader result with several lines

10.5.4 OLE Interface

The OLE interface offers two data format settings to determine the layout of the result output.

Data formatting for the OLE interface

10.5.4.1 Data Container Index

When you activate this option, for each result the index from the list of object for data transfer is also sent to the interface. For more information, please read the PDF document "Vision Q.400 ActiveX Controls.pdf", which has been stored in the Vision Q.400 installation folder.

10.5.4.2 Execution Group Numbers

When you work with execution groups, activate this option if you wish to output the number of the execution group which has been used to start the application.

10.5.5 Action

The [Actions] button allows you to associate a "Judgment" result or "NG Max" with an Action by dragging it from the spreadsheet to the button. The Action options allow you to specify various actions that are performed when the Action is triggered.

- An Action associated with **"Judgment"** can be triggered with any of NG, OK, Forced NG, Error or Not Executed results.
- An Action associated with **"NG Max"** can be triggered when the value in the "NG" column is equal to or a multiple of the value in "NG Max", i.e. when "NG" modulo "NG Max" = 0. If you select "Count with reset", the value of "NG Max" will be reset after triggering the Action.

It should be noted that an Action can only be triggered by a single spreadsheet value, and a spreadsheet value can only trigger one Action. After you have associated a spreadsheet cell with an Action, it will be marked with a red bar.

◆NOTE

- **If you drag "NG Max" to the [Actions] button, but do not enter a value and leave the default entry 0, the Action will always be executed.**

- **When you are working with execution groups, an action is only execut-
  ed when the trigger cell "NG Max" belongs to one of the execution
  groups that has been executed.**
- **You can use Actions to control data output (see page 525) to the inter-
  faces.**

Using the right mouse button

◆ PROCEDURE

1. **Click the "NG Max" cell you wish to associate with an action with the
   right mouse button**

   The pop-up menu appears.

2. **Select** Insert Into → Actions

Using the drag & drop function

◆ PROCEDURE

1. **Decide how you want the Action to be triggered and then select the ap-
   propriate trigger cell "Judgment" or "NG Max"**

Judgement	NG Max	Scans
OK	20	8
OK	20	8
OK	20	8

2. **Click and hold down the left mouse button**

3. **Drag the selected cell to the [Actions] button**

		Result Name	Value	Result (Calib.)	Lower Limit	Upper Limit	Judgment	NG	NG Max	Scans
	Results	Start								
		FE[1;1]areaSize_1	4253	4253	4243	4253	OK	0	20	15
Actions		FE[1;1]areaSize_2	1261	1261	1251	1261	OK	0	20	15
		FE[1;1]areaSize_3	1259	1259	1249	1259	OK	0	20	15
		FE[1;1]areaSize_4	1070	1070	1060	1070	OK	1	20	15
		End								

4. **Release the left mouse button**

   The cell is marked with a red bar to indicate the association with an Action.

		Result Name	Value	Result (Calib.)	Lower Limit	Upper Limit	Judgment	NG	NG Max	Scans
	Results	Start								
		FE[1;1]areaSize_1	4253	4253	4243	4253	OK	0	20	15
Actions		FE[1;1]areaSize_2	1261	1261	1251	1261	OK	0	20	15
		FE[1;1]areaSize_3	1259	1259	1249	1259	OK	0	20	15
		FE[1;1]areaSize_4	1070	1070	1060	1070	OK	1	20	15
		End								

   Next you define the trigger and actions Vision Q.400 should perform when the
   Action is triggered.

5. **Select [Actions]**

6. **Select the spreadsheet cell you have just dragged to the [Actions] but-**

ton from the list

7. Select the actions to be performed when the Action is triggered

10.5.5.1 Description of the Available Actions

This section describes the actions available on the "Actions" page. The top half shows a list of defined Actions. The bottom half shows the properties of a selected Action on different property pages, for details see below.

List of Actions and general properties of the selected Action

The following options are available in the top half of the property page.

- When you select an Action and click the right mouse button, a context menu allows you to either show the line associated with the Action in the spreadsheet or to delete the Action. Alternatively, you can delete a selected Action by simply pressing <Del>.
- The column with the exclamation mark in the header contains a checkbox to enable or disable an Action. This can be useful for testing purposes.
- The column "Condition" indicates under which condition (see page 518) the Action will be triggered. The column contents varies depending on which spreadsheet cell triggers the Action.

The bottom half of the dialog box shows the properties of a selected Action on different property pages.

> ☞ ◆ **NOTE**
>
> - **The options marked with * may trigger time-consuming processes. We recommend that you check carefully whether the actions you have selected are impeding the execution of your application.**
> - **Actions are only triggered in run mode.**

Page	Option	Description
General	Stop Vision Q.400	Vision Q.400 will be stopped if the Action is triggered. The system will ignore all further start signals as well as signals for changing the application. When you activate this option, the option "Send action error to All Output Devices" is also activated.
	Send action error to all output devices	If the Action is triggered, Vision Q.400 sends an action error to the parallel and the OLE interface and a PCError to all other interfaces.
	Numerate file names (see note 1)	When you select this check box, Vision Q.400 automatically appends a numerical suffix (preceded by an underscore character) to an image or spreadsheet file name. The counter starts from 1 and is stored in the application. When the maximum number of files is reached, the counter is reset to 1. Please note that for images the effect of this option will depend on how you have set the images option "Buffer images". For the file name pattern see under the following table. **Note:** When this option is not checked, Vision Q.400 saves the image or spreadsheet file name under the user-defined file name, overwriting without warning any files of the same name. If you have activated the option "Numerate file names", you can enter the maximum number of files to be saved. When the number of spreadsheet and image files Vision Q.400 has been requested to save exceeds the maximum entered here, the system resets the file number and starts again with 1. This prevents Vision Q.400 from filling the hard disk with spreadsheet and image files. Whether you should enter a high or low figure in this field depends on your current requirements. On the one hand, the figure should be high enough that files with contents you may need are not overwritten; on the other hand the figure should be as low as possible so that you have enough disk space to run Vision Q.400 and the operating system reliably.
Images	*Save images	When you activate this option, camera images of the selected cameras are saved to the specified file name and location. Note: If you activate this option and delete the folder selected here, Vision Q.400 will not save the images. Rather, it writes a warning to the error log. Caution: You cannot resolve this problem by simply creating a new folder in the Explorer. You must exit run mode, go back to the "Action" page, and once again select the folder and path. The file name can be edited with the "File Name Editor" by clicking on the [...] button next to the displayed name.
	Buffer images	When you activate this option, all images are saved in a ring buffer. Each Action has its own ring buffer, but the ring buffer size is the same for all Actions. The ring buffer size is set under **System Settings → Action**. The default ring buffer size is 12 images. If you switch from run to setup mode or change applications, and if an Action has been triggered, the images are saved in the folder specified under "Location:". Writing images in a ring buffer is quicker than writing to disk, so that Vision Q.400 resumes processing the application faster when you use this option. Please note that you can only access the images after having switched from run to setup mode, or after having changed applications, and that the buffer has a limited size. If you deactivate this box, Vision Q.400 writes all images as bitmaps directly to the hard disk. You can access the images immediately after they have been saved. Vision Q.400 will not continue processing the application until after the images have been written to disk.
	File name	The file name can be edited with the "File Name Editor" by clicking on the [...] button next to the displayed name.
	Location	Specify the location where the camera image files should be saved.
	For cameras	From the "Choose cameras" dialog, select those cameras whose images you want to save when the Action is triggered. The option "Buffer images" defines the point in time at which Vision Q.400 saves the camera images.

Page	Option	Description
Spread-sheet:	*Save spread-sheet (see note 2)	Enter the path and file name for the spreadsheet contents to be saved when the Action is triggered.
	File name	**The file name can be edited with the "File Name Editor" by clicking on the [...]** button next to the displayed name.
	Location	Specify the location where the spreadsheet files should be saved.
	*Print spread-sheet to default printer	Activate this check box if you want the spreadsheet to be printed when the Action is triggered. If you have no printer installed, the option is grayed out.
Display	*Display mes-sage	Activate this check box if you want a message to be generated when the Action is triggered.
	Freeze display at NG image (see note 3)	With "Freeze display at NG Image" you define whether Vision Q.400 should freeze – that is, display – the images that have triggered an Action. Vision Q.400 continues executing the application normally, but only displays the frozen images, not the images it is currently processing.
		When you have activated "Freeze NG Images," the images that have triggered an Action will be displayed even if you have disabled the option "Image" in the "Update" box on the "General" page of the application properties.
		Image "freezing" only works in run mode. When you return to setup mode and execute the application or select "Grab Image + Execute," the images that are currently being processed will be displayed.
		The following options are available:
		• **Do not freeze:** None of the images that have triggered an action will be frozen.
		• **Freeze first:** The first image that has triggered an action will be frozen.
		• **Freeze last:** The last image that has triggered an action will be frozen.

☞ ◆**NOTE**

1. **Please note that the effect of this option depends on how you set the options "Buffer images" and "Numerate file names". If "Buffer images" is activated, Vision Q.400 writes the images into the buffer and only saves them to disk when you**
   - change the application or
   - switch from run mode to setup mode and then back to run mode.

Buffer images	Numerate file names	Effect of the entry in "Maximum count"
No	Yes	When the maximum number of files is reached, Vision Q.400 resets the file number and overwrites the first file.
No	No	Vision Q.400 creates one file and overwrites the file every time the Action is triggered.
Yes	Yes	When you switch to run mode or change the application, Vision Q.400 creates temporary files with the first free number. When you switch back to setup mode or change the application, the files are saved. As soon as you switch to run mode again, new temporary files with the next free number are created. When the maximum number of files is reached, Vision Q.400 resets the file number and overwrites the first file.
	No	When the buffer content is written to disk, any existing files with the same name will be overwritten.

2. **If you have activated the option "Save spreadsheet" option and deleted the folder selected here, Vision Q.400 will not save the spreadsheet. Rather, it writes a warning to the error log. Caution: You cannot resolve this problem by simply creating a new folder in the Explorer. You must exit run mode, go back to the "Actions" page, and once again select the folder and path.**

3. **If you want to save frozen images to a file in setup mode, be sure to save them before executing the application or selecting "Grab Image + Execute."**

File name conventions

By default, images are saved in BMP format. The images' file name follows the pattern:

Numerate file names	Buffer images	Files names of the camera images saved
Yes	No	<file name>_<index>.<extension>
	Yes	<file name>_<index ring buffer>_<index>.<extension>
No	No	<file name>.<extension>
	Yes	<file name>_<index ring buffer>.<extension>

The spreadsheet file name follows the pattern:

Numerate file names	File name for the saved spreadsheet
Yes	<file name>_<index>.txt
No	<file name>.txt

File name editor dialog

The file name is formatted as a template in the format window at the top of the dialog. Un-limited text string tokens (e.g. %CAMNR%) can be used and these are replaced by content data when formatting to a file name occurs. An example below the edit field shows the cur-rently formatted file name.

Tokens are presented in groups as follows:

- Camera and Sequence
- Date and Time

Tokens can be added to the template via the [Insert] button, being added at the cursor posi-tion in the format window. You can also manually add tokens to the template if you prefer.

In addition to the listed tokens, spreadsheet values can be inserted as tokens via drag & drop from the spreadsheet window, being added at the cursor position in the format window. **Spreadsheet values are denoted by being in between two '|' characters.**

Formatting of the template to a file name will occur once only when constant text string to-kens are used, and on each trigger of the Action if variable data tokens are used. Any result-ing illegal file name characters :*?"<>| will be replaced with an underscore ('_') character.

The example string is shown as an aid to formatting. It may contain one or more numerical suffixes that are not present in the formatting window. This will depend on the Action options "Buffer images" and "Save data for more than one action".

The standard format for camera images is BMP. However, by appending the file name with the appropriate extension, PNG, JPG or TIF can be specified as image formats to save in.

☞ ◆**NOTE**

Please note that the image formats PNG, JPG, and TIF compress the image. This may lead to a situation where the execution of checkers on a different image format than BMP will yield different results than a BMP file.

10.5.5.2   Using Action to Control Result Output to the Interfaces

When you have defined an action, you can use the action to control whether and when Vision Q.400 outputs result data to the interfaces or not.

◆PROCEDURE

1. **Drag the selected cell to the [Action] button (see page 518)**

2. **Select the actions to be performed**

   Next you define how the action controls (see page 520) the data output to the interfaces. In this example, Vision Q.400 will control the output to the serial interface.

3. **Select the page "Serial I/O"**

   Vision Q.400 displays the properties of the serial interface.

4. **Activate "Controlled by Actions"**

A dialog for selecting which Actions control the interface, together with the condition for sending the data, is displayed.

5. In the column "Controlled" select the checkbox(es) of the Actions you wish to use for controlling the result output to the serial interface

Configure one or more Actions that control the interface.

6. In the column "Condition for sending data" select when the data should be sent

In the "Condition for sending data" column, choose whether to send data when the Action is triggered, or when the Action is NOT triggered.

☞ ◆ **NOTE**

When you are working with execution groups, the action can be assigned to one or more camera/execution groups, depending on the result the action is based on. When you execute the application, the Action only controls the interfaces if it is assigned to one of the EXECUTED execution groups. If the Action is assigned to an execution group which is not executed by the application, the setting in "Controlled by Actions" is ignored for all interfaces: The interfaces will work as if they are not controlled by the action, i.e. all data is always transferred.

10.6 Results Output to the Interfaces

There are 5 interfaces (see page 527)/file types available (see below). For data output to interfaces and/or to a file, proceed as follows:

◆ **PROCEDURE**

1. **Select one or more results from the spreadsheet for the output**

2. **Configure data type**

3. **Define settings for the interfaces/file**

10.6.1 Available Interfaces

On the left side of the spreadsheet window you see buttons representing the available interfaces. Use these buttons to determine which results from checkers or formulas should be transferred to which interface.

Icon	Interface name
Actions	Actions (see page 518)
Ethernet I/O	Ethernet (see page 92)
Serial I/O	Serial (see page 472)
Parallel I/O	Parallel I/O (see page 472)
OLE	OLE (see page 472)
File	FILE (see page 510)

When you click the button, the "Objects for Data Transfer" window belonging to the interface opens up with the spreadsheet results you want to output to the interface. For the following interfaces, additional basic settings are required for communication:

- Ethernet (see page 92)
- Serial (see page 94)
- Parallel I/O (see page 109)
- OLE (see page 121)

10.6.2 **Selecting Results for Output**

All values from spreadsheet cells that are calculated when you execute the application can be output to the interfaces. Please note that depending on the type of spreadsheet row, not all cells in the row will undergo calculation. For example, in a row containing a Boolean formula, Vision Q.400 does not calculate the values in the columns "Min Result" and "Max Result". All cells with data for calculation have the default color white.

Data types in spreadsheet cells

Depending on the data type, the contents of a cell can be output to different interfaces:

Data type in cell	Serial	Parallel I/O	File	OLE
Numeric results (integer, double/string[*])	X	X	X	X
Boolean results	X	X	X	X
Textual string results	X		X	X

[*]All numeric results of type "integer" or "double" can also be output as a string.

For the individual cells and their data type, please refer to the table:

Cell (column)	Data type
Result name	String
Value	Numeric or string
Factor	Numeric
Result (Calib.)	Numeric or string
Unit	String
String reference	String
Lower/upper limit	Numeric
Min/max result	Numeric
Range	Numeric
Average	Numeric
Sigma	Numeric
Judgment	Boolean
NG	Numeric
NG Max	Numeric
Errors	Numeric
Scans	Numeric

Output of results to an interface

To transfer multiple results from a spreadsheet to an interface, use the right mouse button or drag & drop.

If you start Vision Q.400 in run mode, the selected results are transmitted automatically.

☞ ◆NOTE

- **If you are attempting to transfer multiple results to an interface simul-taneously, Vision Q.400 only accepts the values from those cells with a data type that is valid for the selected interface. The remaining values will be ignored.**
- **Results that are not recalculated at program startup, such as the name of a checker result or a formula, are always output. The following re-sults are output only if they can be recalculated at program startup:**
  - **Value**
  - **Result (Calib.)**
  - **Judgment**

If these three results cannot be calculated, the interface handles them as described under "Interface Reaction to Errors (see page 570)".

- **If you are using execution groups, only the values that can be calculat-ed are output, that is:**
  - **Data that was calculated during the current program startup, or**
  - **Data from formulas that are either global or otherwise independent of execution groups**

Please note the limitations described in the chapter "Execution Groups" under"Result output (see page 137)".

Using the right mouse button

1.2.3. ◆PROCEDURE

1. **Select one or more values you want to output to an interface**

   For multiple values, please use the multiple selection keys (see page 472).

2. **Click the right mouse button in one of the selected spreadsheet cells**

   A context menu appears. The data type of the cell where you clicked the right mouse button determines which interfaces will be displayed in the context menu.

3. **Select an interface with the left mouse button**

	Result Name	**Result (Calib.)**	**Lower Limit**	**Upper Limit**	**Judgement**	**NG Max**	**Scans**
Results	Start						
	FE[1;1]areaSize_1	4324	0	4324	OK	20	8
	FE[1;1]areaSize_2	1340	0	1340	OK	20	8
	FE[1;1]areaSize_3	1329	0	1329	OK	20	8
	FE[1;1]areaSize_4	1105	0	1105	OK	20	8
	FE[1;1]areaSize_5	727					
	FE[1;1]areaSize_6	395					
	FE[1;1]areaSize_7	287					

Insert Into ▶ Ethernet I/O / Serial I/O / Parallel I/O / OLE / FILE
Delete Row(s)
Copy
Paste
Calibrate...

The transferred spreadsheet values appear in a color matching the color code for the interface to which they will be output.

◆ NOTE

The right mouse button works only as described if you have selected the field with the mouse (the field has a black border). The function is not available when the cursor is IN the field (flashing bar-style cursor).

Using the drag & drop function

◆ PROCEDURE

1. **Select the values you want to output to an interface**

   For multiple values, please use the multiple selection keys (see page 472).

2. **Hold the left mouse button in one of the selected fields and drag the cell to the interface button**

   If you transfer multiple values to the interface, you must hold down not only the mouse button but also the <Ctrl> or <Shift> key. Depending on the data type in the cell where you clicked, different interfaces may be available.

   The transferred values will be marked in the spreadsheet with a small bar in the corresponding interface color coding, e.g. green for the serial and blue for the parallel interface.

The next step is to configure the objects you have marked for interface output in the "Objects for Data Transfer" window.

10.6.3 Configuring Checker Results for Data Transfer

All results you have selected in the spreadsheet for output to the interfaces need to have a data type (see page 531) assigned. Vision Q.400 automatically assigns a default data type. However, you can change both the output sequence and the data type manually.

10.6.3.1   Setting the Data Type

When you configure the result output to the interfaces, Vision Q.400 automatically assigns a data type:

Result	Property of output value	Default data type for interface			
		RS232 in ASCII mode and file	RS232 in MEWTOCOL mode	Parallel I/O	OLE
NG NG Max Errors Scans	Numeric and integer	Integer	INT	INT16 INT 8	Integer
Result (Calib.) of all checkers except OCR checker and code reader Value Factor Lower/upper limit Min result Max result Range Average Sigma	Numeric and decimal	Decimal value	REAL	IEEE float	Double
Result name Result (Calib.) OCR checker and code reader Unit String reference	Text	Text	STRING[16]	Not available	String
Judgment	Boolean	Boolean	BOOL	INT1	Boolean

For numeric values Vision Q.400 decides whether the transferred result will always be integer (e.g. the number of scans) or whether it may be a decimal figure, e.g. the result of a spreadsheet row. If it is integer, Vision Q.400 uses the largest integer data type available for that interface. If it is a decimal value, the data type will be "Decimal Value" or "Double", depending on the interface.

If the current result for a numeric data type is too big or too small, Vision Q.400 writes an overflow message to the error log and outputs an error. Please note that the overflow signal is only sent to the parallel interface if you have activated the sending of the signal on the P I/O's property page (see page 109).

The value ranges for numeric data types are given in the "ASCII Communication Protocol" (see page 97):

Data type	Value range
INT1	0 or 1
INT8	0 to 255 or -127 to +127
INT16	0 to 65,535 or -32,767 to +32,767
INT32	0 to 4,294,967,295 or -2,147,483,647 to +2,147,483,647

Data type	Value range
Integer	-2^{13} to 2^{13}
Double	1.7E -308 to 1.7E +308
IEEE float	3.4E -38 to 3.4E 38

It depends on the application whether a value is interpreted positively or negatively. Checker and calculation results can be negative/positive.

When outputting data to the parallel interface you need to consider not only the data type but also data representation and the value range, respectively:

Data type	Representation
Numerical data	INT8 = 1 byte; INT16 = 2 byte; IEEE float = 4 byte
Boolean data (OK/NG)	INT1 = 1 bit, 8 Boolean data in a row require 1 byte

The serial interface in PLC mode (MEWTOCOL) produces the value ranges below. If a result value exceeds the value range of the preset data type, Vision Q.400 outputs an execution result error (provided the "Execution Result Error" option on the property page of the RS232 interface is activated) and transmits the predefined error value (see page 99).

Data type	Representation
BOOL	0 or 1 (1 bit)
INT	From -32,767 to +32,767 (decimal, 16 bits)
DINT	-2.147.483.648 to +2.147.483.647 (decimal, 32 bits)
REAL	-3,402823E38 and -1,175494E38 also 0.0 and between +1,175494E38 and +3,402823E38
WORD	0 to 65535
DWORD	0 to 4294967295
STRING[..]	1 to 255 characters, programmable (e.g. with STRING[2] two characters can be transferred)
ARRAY OF WORD [0..]	1 to 9999 character pairs, programmable (e.g. with ARRAY OF WORD [0..1] four characters can be transferred)

☞ ◆**NOTE**

- **If no data type is selected (column entry: "not set" (see page 531)), the system outputs an execution result error to the interface regardless of the selected communication protocol.**
- **If a result of data type STRING[..] or ARRAY OF WORD[0..] exceeds the predefined number of characters, the system transmits the preset maximum number of characters and outputs an execution result error to the interface.**

There are two ways of manually changing the data type assigned automatically by Vision Q.400:

Data type changing via the pop-up menu

◆ PROCEDURE

1. **Click the corresponding interface button**

   The window "Objects for Data Transfer" appears (in this example, the serial in-
   terface has been selected).

2. **Select the row(s) to be edited with the mouse**

3. **Click the right mouse button**

   A pop-up menu appears. The menu will look different depending on which data
   types are available for the selected value.

4. **Select a data type**

   If you have selected several rows, Vision Q.400 displays only those data types
   (see page 528) which are common to all selected rows.

Data type changing via the "Change Data Type" window

◆ PROCEDURE

1. **Click the corresponding interface button**

The window "Objects for Data Transfer" appears (in this example, the RS232 interface has been selected).

2. **Select the row(s) with the mouse you wish to edit and then select [Change Data Type]**

   or

   Double-click one of the selected rows

   Please note that you need to hold down the <Shift> or <Ctrl> key during the double-click when you have selected several rows. The "Change Data Type" window appears.

3. **Click the drop-down list to see all available data types**

   If you have selected several rows, Vision Q.400 displays only those data types (see page 528) which are common to all selected rows. The fields "Result Name" and "Column" display "Multiple Selection".

4. **Select a data type**

5. **Confirm your choice with [OK]**

10.6.3.2   Deleting Checker Results from the Result Output List

◆ PROCEDURE

1. **Click the corresponding interface button**

2. **Select the row(s) to be deleted**

3. **Select [Delete]**

   or

   press <Del>

   or

   Click the right mouse button and select "Delete" from the pop-up menu

10.6.3.3   Changing the Transfer Sequence

Normally, the checker results from the spreadsheet are transferred in the same sequence order as they were selected for the interface. You can change the transfer sequence to meet your requirements.

◆ PROCEDURE

1. **Click the corresponding interface button**

   The "Objects for Data Transfer" window appears.

2. **With the left mouse button, click on a row and keep the button pressed**

3. **Drag the row to the required position in the list**

4. **Release the left mouse button**

   This alters the sequence in which the objects are transferred to the interface.

10.7 Formulas

Use the formula function to make further calculations on the basis of the checker results. The entry under "Result Name" helps the system to find the result needed for the formula. Use this result name in the formula to perform calculations with the value under "Result". In case you defined a calibration, the calibrated value is used.

You may use arithmetic, Boolean or IfCase formulas:

- Arithmetic formulas let you perform mathematical operations on checker/formula results

- Boolean formula let you work with the OK/NG judgement of checkers/formulas

- IfCase formulas let you use judgement results of any number of checkers or formulas in order to identify an object and/or conditionally execute certain execution groups

Below find an explanation of arithmetic/Boolean and IfCase formulas as well as the procedures for setting up new formulas in the spreadsheet and working with them.

10.7.1 Arithmetic or Boolean Formulas

Arithmetic or Boolean formula (to IfCase formulas (see page 540)) can be inserted by selecting the menu command **Spreadsheet → Insert Formula → Arithmetic/Boolean**. Or you can use the right mouse button in the spreadsheet:

◆ PROCEDURE

1. **Click on or between the "Start" or "End" row in the "Formulas" section of the spreadsheet**

2. **Click the right mouse button**

   The spreadsheet pop-up menu appears. If it looks different, it is because your cursor is not positioned on or between the "Start" or "End" row of the formulas.

Insert Formula	▶	Arithmetic
Delete Contents		Boolean
		IfCase
Copy		
Paste		
Reset Statistics		
Properties...		
Print...		
Save as Text File...		
Spreadsheet Controller...		

3. **Select "Insert Formula"**

4. **Select "Arithmetic" or "Boolean"**

   A new formula row is added before the row you have selected with the cursor. If your cursor has been positioned on the start row, the new formula row is added behind this row.

5. Open and edit the formula

For opening and editing formulas you need the Formula Editor (see page 537).

☞ ◆NOTE ════════════════════════════════════

- **The name cell of a new formula is shaded in red as long as nothing has been entered in the formula editor.**
- **The result of the formula is displayed only after you have used** Application → Start **.**

10.7.1.1 Editing a Formula and Entering Checker Results

Vision Q.400 is equipped with a functional formula editor for arithmetic and Boolean formulas. When you open a formula, the corresponding formula editor (arithmetic or Boolean) appears in a separate window. In order to edit the formula the following symbols and options are available:

Arithmetic editor	Symbol	Boolean editor	Symbol
Addition	+	**AND**	&
Subtraction	-	**OR**	|
Multiplication	x	**XOR**	^
Division	/	**NOT**	~
Cosinus	cos( )	**1**	TRUE
Sinus	sin( )	**0**	FALSE
Absolute value	abs( )		
Square root	sqrt( )		
Arcus tangens	atan2( )		
Tangens	tan( )		
Arcus cosinus	acos( )		
Arcus sinus	asin( )		
Square	sqr()		
Minimum of x and y	min(x,y)		
Maximum of x and y	max(x,y)		
Constant pi (3.1415)	pi		

Options for both editors	Description
Operators - Insert always	If you activate this option, the corresponding operator is inserted before each checker result which you insert with drag & drop into the editor.
Others - Insert blank	If you activate this option, a blank is inserted before each item which you insert with drag & drop into the editor.
Properties - Global formula	This option is useful when you work with execution groups. If you activate this option, the current formula is treated as a global formula (see page 547). This means that the results of this formula can be used by other formulas, even if they belong to a different execution group.
Properties - Force error to NG	In some instances, it makes sense to treat a faulty formula as a NG judgment. For example, when an arithmetic formula cannot be calculated because it uses an object that has not been detected by Vision Q.400. If the judgment of the faulty formula is used by another formula, the second formula cannot be calculated either and is considered faulty. If you wish to calculate the second formula nevertheless, activate this option to convert the judgment of the first formula from error to NG.
OK	Use this button to save the changes and close the formula editor. Note that this option is only executed when you have entered a correct formula. Otherwise you will get a warning message.
Apply	Use this button to accept all changes to the formula. The editor window stays open. Note that this option is only executed when you have entered a correct formula. Otherwise you will get a warning message.
Undo	Use this button to undo all changes you made since you have last clicked [Apply] to save.
Cancel	Use this button to leave the formula editor without saving any of the changes made since you have last clicked [Apply].

♦ PROCEDURE
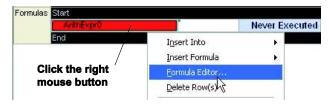
1. **To open the formula, double-click in the textless area of the formula's name field**

Double-click here

or

click the right mouse button on any cell of the formula row and select "Formula Editor"

Click the right mouse button

The "Edit Arithmetic/Boolean Formula" dialog box appears. This procedure uses an arithmetic formula as an example.

2. **Insert a checker result from the spreadsheet into the formula by**

   drag & drop

   or

   by typing in the result name

   or

   click on the result name so that the cell is surrounded by a frame, click the right mouse button and select "Copy" from the pop-up menu. Then click in the white area in the formula editor, click the right mouse button and select "Paste"

   Use drag & drop to insert multiple results or judgments into the formula simultaneously. For arithmetic formulas, select cells from the column "Result", for Boolean formulas from the column "Judgment" or select rows completely, when you wish to use their results or judgment in an arithmetic or Boolean formula.

3. **Use the operator and function buttons for calculation operations**

   If you are not sure about the meaning of an operator symbol, position the cursor on the button and wait until the tool tip appears. If want to insert multiple results or judgments simultaneously into the Formula Editor, first select "Insert always" for one of the operators.

4. **Enter the rest of the formula in the same manner**

5. **Click [Apply] or [OK]**

   The formula is checked for consistency and, if correct, is saved. Errors will be shown in the field "Parse Results". If you click [OK] the Formula Editor is then closed; click [Apply] and it remains open.

10.7.2 IfCase Formulas

The IfCase formula uses the judgment results of any number of checkers or formulas essentially for two tasks:

- identify an object and/or
- Conditionally execute certain execution groups

The IfCase formula contains a list of judgment results, which is processed completely from top to bottom. The aim is to find one (and - depending on the definition of the formula - **only** one) entry that is judged OK (see page 546) and act accordingly, for example by execution an execution group. The figure below gives an example.

◆ EXAMPLE

The example below shows how to execute a specific execution group if a condition is true. If the judgment of the first checker result is judged as true = OK, Vision Q.400 is to run execution group 15.

Result name

This column contains the name(s) of checker or formula results. The judgment of these results is the basis for the condition of the IfCase formula. Insert a result name from the spreadsheet with drag & drop. The sign "~" means that the judgment result will be negated and then judged (see description of "Judgment" column).

Judgment

This column informs you on how the IfCase formula evaluates the judgment of this checker or formula result. By default, the IfCase formula uses the same judgment as the spreadsheet. However, if there is a "~" before the entry in the "Result Name" column, the judgment is negated, i.e. OK becomes NG and vice versa.

If the judgment of a checker or formula result in the spreadsheet is neither OK nor NG, the IfCase formula displays "Error" or "Not executed" when you open the editor.

Output value

Here you define the output value, which will be used as the result of the IfCase formula. The output value will appear in the formula editor in the "Result" field and in the "Result" column of the spreadsheet. The result of the IfCase formula is the output value of the first row to be judged with OK. Vision Q.400 always starts evaluating the judgments from row number 1 in ascending order. In the example above, the IfCase formula result as shown in the spreadsheet would be 1, as the row with this output value is the first row in the editor to be judged with OK. If no row is judged OK, the result of the IfCase formula in the spreadsheet will be 0.

The following entries are permitted in the "Output Value" column:

Input	Description
Any number	To do this you can also click on the [Set Output Values] button. Vision Q.400 automatically assigns output values to all rows starting with value 1 for row 1. Please note that this will overwrite any manual entries you may have made in the "Result" (see page 545) column.
The "*" sign.	The calibrated result of the checker/formula entered in the "Name" column is used as the output value.
The name of a checker or formula result	The calibrated result of the checker/formula entered in the "Output Value" column is used as the output value. You can drag & drop a result of this kind into the column: To do so, select the result from the spreadsheet, drag it over the "Output Value" column into which you want to insert it and press the <Ctrl> key while releasing the mouse button.

☞ ◆**NOTE**

- **If you want to use a checker result of the String type (such as the result of an OCR checker) as the output value, it must be possible to convert it into a number. If it is not, "Error" is displayed in the "Judgment" column when calculating the IfCase formula.**
- **If you want to use a formula result as the output value, the associated formula must be positioned in the spreadsheet before the IfCase formula which it uses as its output value.**
- **When you click either the [OK] or [Apply] button, the IfCase formula can only be saved if each row contains a valid value in the column "Output Value".**

- **While you are editing the "Output Value" column the [Set Output Values] button is deactivated.**

Execution group

In the "Execution Group" column you can enter the name of an execution group. To do so, click in the column on the [...] button and a dialog box appears in which you can select the name of the group from a list box. If you choose "None", no name is entered or an already entered name is deleted.

When you enter an execution group name in the "Execution Group" column, you link a judgment with an execution group. When Vision Q.400 has judged all formula rows, Vision Q.400 executes the execution group assigned to the first row judged with OK. (This is the same row determining the output value and thus the result of the formula.) If you have not assigned an execution group to the row, Vision Q.400 will not execute any execution group. In the example above, Vision Q.400 executes group number 15 (the preset name "Execution Group No.: 15" has not been changed), because the judgment connected to the execution group is the only one judged OK in the formula editor.

If an execution group is triggered by an IfCase formula, you can activate a check box in the column "Grab" for Camera Link and GigE Vision cameras so that the cameras used in the execution group grab a new image before the execution group is executed.

	Result Name	Judge	Output Value	Execution Group
1	CM[4;1]numberOfTotalObjects	OK	1	No. 15: Execution Group No.: 15 [...]
2	CM[1;1]numberOfTotalObjects	NG	2	No. 16: Execution Group No.: 16 [...]

In order to ...	Do the following:
Enter a group name	Click the [...] button to open the "Available Execution Groups" dialog box and from the list box in it select the execution group.
Remove a group name	Click on a row in the Formula Editor and click the [Delete Execution Group] button or click [...] to open the "Available Execution Groups" dialog box and from the list box in it select "None".

☞ ◆ **NOTE**

- **The execution group triggered by an IfCase formula will be executed without the camera grabbing a new image - unless you are using Camera Link or GigE Vision cameras and you have activated the checkbox in the column "Grab". Then all cameras used in the execution group will grab a new image. Please note that image capture with these cameras should be started by Vision Q.400 directly to make sure the images are captured immediately and to avoid synchronization problems.**

- **If the calculation of an IfCase formula leads to the execution of an execution group, Vision Q.400 executes the assigned group IMMEDIATELY after calculating the IfCase formula, i.e. BEFORE calculating the next formula in the spreadsheet.**
- **To avoid infinite loops, Vision Q.400 executes each execution group only once. If several IfCase formulas use the same execution group, the group will only be executed once, after the first IfCase formula with the execution group is triggered.**
- **If a triggered execution group contains a checker sequence which has been executed before, Vision Q.400 will not execute the sequence again to avoid infinite loops.**
- **IfCase formulas cannot be global formulas.**

10.7.2.1   How to Create IfCase Formulas

You can create an IfCase formula in the spreadsheet with the menu command **Spreadsheet** → **Insert formula** → **IfCase**. Or you can use the right mouse button in the spreadsheet:
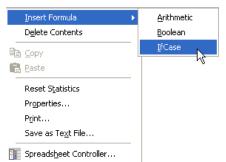
◆PROCEDURE

1. **Click on or between the "Start" or "End" row in the "Formulas" section of the spreadsheet**

2. **Click the right mouse button**

   The spreadsheet pop-up menu appears. If it looks different, it may be because your cursor is not positioned on or between the "Start" or "End" row of the formulas.

Insert Formula ▶	Arithmetic
Delete Contents	Boolean
	IfCase
Copy	
Paste	
Reset Statistics	
Properties...	
Print...	
Save as Text File...	
Spreadsheet Controller...	

3. **Select "Insert Formula", then "IfCase"**

   A new formula row is added before the row you have selected with the cursor. If your cursor has been positioned on the start row, the new formula row is added behind this row.

4. **To open the formula, double-click in the formula's name field**

   or

click the right mouse button on any cell of the formula row and select "Formula Editor"

5. **Click a checker or formula judgment in the spreadsheet and hold the mouse button down**

   It is possible to drag several judgments into the IfCase formula at once. Select the cells in the "Judgment" column or select the spreadsheet rows containing the judgments completely.

6. **Drag the checker/formula judgment(s) into the IfCase formula**

   Please remember to use the <Ctrl> or <Shift> key if you try to drag multiple checker/formula judgments into the formula.

7. **Drop the checker/formula judgment(s) in the table**

   The judgment(s) will be dropped at the mouse cursor position. When you press the <Shift> key while dropping the checker/formula result, the "~" sign is inserted in front of the result name and negates the result judgment.

8. **In the "Output Value" column, assign an output value for the IfCase formula**

   When you drop the judgment(s) in the row, Vision Q.400 assigns the row number as the output value. If that number is already used, Vision Q.400 automatically assigns the next free row number. You can change the output value any time. It is possible to have the same output value for different rows.

9. **Enter an output value manually**

   or

   click on [Assign Output Value]

   Vision Q.400 automatically assigns output values to all rows starting with output value 1 for row 1, thus overwriting all previous entries.

10. **Link an execution group with the [...] button in the "Execution Groups" column if you want**

☞ ◆**NOTE**

- **There are two ways to negate a condition, i.e. insert "~" in front of the condition:**
  - **Press <Shift> when storing the checker/formula judgment(s) in the Formula Editor**
  - **Select the row and click [Negate Row]**
- **Every checker/formula judgment from the spreadsheet can be used twice in any given IfCase formula: Once as is and once negated.**
- **If you wish to change the sequence order of conditions in your IfCase formula, select a row with a left mouse click and drag it to the right position.**

10.7.2.2 Available Options

Some of the options described below require you to select a row first by clicking the left mouse button on any cell in the row so that the row background turns to black.

Button/Option	Description	Select a row first?
Set output values	Vision Q.400 automatically assigns the row number to each row as the output value. All previous entries will be overwritten.	No
Delete execution group	Vision Q.400 deletes the entry in the "Execution Group" column.	Yes
Delete row	Vision Q.400 deletes the selected row.	Yes
Negate row	Vision Q.400 negates the selected row by inserting the character "~" in front of the result name.	Yes
Multiple OK rows are allowed	Use this option to control the judgment of the IfCase formula. Define whether only one or more than one rows may be judged OK.	No
Force error to NG	When an error occurs, the judgment of the formula is converted to NG.	No
OK	Use this button to save all changes and close the formula editor. Please note that this is only possible if the entered formula is correct. Otherwise you will get a warning message.	No
Apply	Use this button to accept all changes to the formula. The editor window stays open. Please note that this is only possible if the entered formula is correct. Otherwise you will get a warning message.	No
Undo	Use this button to undo all changes which you have made since you have last clicked [Apply].	No
Cancel	Use this button to leave the formula editor without saving any of the changes made since you have last clicked [Apply].	No

10.7.2.3 Calculating IfCase Formulas

How Vision Q.400 calculates an IfCase formula is demonstrated in the example below.

IfCase formula for identifying circles of different size

◆**EXAMPLE**

This IfCase formula is designed to identify an object. There are 5 different kinds of circles, which may vary from one camera image to the next. The IfCase formula result relates to the size of the circle detected.

Vision Q.400 uses 5 checkers to evaluate the size of the circle arithmetically. All checkers have been set up to provide the circle size, but each has different limits. This way, only one checker result (and in turn, one condition) can be true = OK.

10.7.2.4   Judgment of IfCase Formulas

Vision Q.400 evaluates the IfCase formula beginning from row number 1 in ascending order. The first row in the list with judgment = OK determines the formula result and (if defined) which execution group will be executed. In the example above, this is the normal-sized circle condition from row 3. The result "3" is displayed in the formula editor and output to the spreadsheet.

Vision Q.400 always evaluates ALL rows in an IfCase formula. The judgment of the IfCase does NOT judge the result, but rather the number of rows judged as OK. How an IfCase formula is judged is determined by the option "Multiple OK Rows Are Allowed" (see table below).

Setting	Number of rows judged OK	Judgment of the IfCase formula	Result of the IfCase formula
Multiple OK rows are allowed = OFF	0	NG	0.0
	1	OK	As defined under "Output Value"
	More than 1	NG	0.0
Multiple OK rows are allowed = ON	0	NG	0.0
	1	OK	As defined under "Output Value"
	More than 1	OK	As defined under "Output Value"

Leave the option "Multiple OK Rows Are Allowed" OFF if you wish to identify objects unambiguously. If more than one condition is OK, the object evidently cannot be identified unambiguously.

If a row/condition in the IfCase formula is judged with "Error" or "Not executed", then this row is ignored and does not influence the result and the judging of the formula. Again, this is to help with object identification. If the object to be detected is not present in the camera image, then all formulas dealing with that object will fail and produce "Error". The fact that something is missing is not necessarily an error for the object identification, e.g. when you wish to detect an object with the characteristic "no holes".

IfCase formula judgment in the spreadsheet is	If
"Error"	The list of conditions is empty
	All rows are judged with "Error"
	At least one row is judged with "Error" and the rest of the rows is judged with "Not executed"

IfCase formula judgment in the spreadsheet is	If
"Not executed"	All rows are judged with "Not executed"
"Forced NG"	Any of the conditions under "Error" is fulfilled and you have activated the option "Force Error to NG"

10.7.3 Global Formulas

Global formulas are useful when you use execution groups. In order to calculate a formula, Vision Q.400 needs all checker results included in a formula. However, with execution groups only the checkers belonging to the currently active execution group are executed.

In order to be able to use checker results from other execution groups, mark a formula as a "global formula". This way, Vision Q.400 uses the last result calculated for the formula checkers, regardless of whether the checker has been executed with the active execution group or belongs to a different group which has been executed earlier. The only condition is that all checkers used in the formula have been executed correctly once.

◆ **EXAMPLE**

When you work with execution groups and need the same calibration factor for all execution groups, create a global formula in one execution group to calculate the calibration factor, thus making it available for all other execution groups.

Global formulas can easily be recognized by the orange shading of the name cell in the spreadsheet.

Global formula in the spreadsheet

◆ **NOTE**

Please note that global formulas are recalculated every time you execute the execution group in which the global formula belongs. This is why it is not possible to use global formulas to access old results from the global formula's execution group.

10.7.4 Switching to Another Formula in the Formula Editor
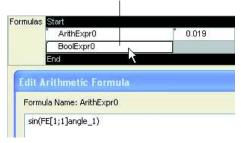
Vision Q.400 lets you switch to another formula when the "Formula Editor" window is open under the condition that the currently active formula is free of errors.

◆ PROCEDURE

1. To open the formula, double-click in the formula's name field
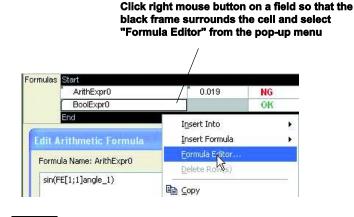
Double-click here to switch in the formula editor from the arithmetic to the Boolean formula

or

click the right mouse button on any cell of the formula row and select "Formula Editor"

Click right mouse button on a field so that the black frame surrounds the cell and select "Formula Editor" from the pop-up menu

◆ NOTE

Please note that you can only switch to another formula if the currently displayed formula is correct. Otherwise you need to parse it and correct the errors.

10.8 Delete

With **Spreadsheet → Delete**, you can delete a single row or the entire spreadsheet contents. The same functionality is also available from the pop-up menu.

Delete spreadsheet rows/contents

Deleting Selected Rows

◆ PROCEDURE

1. **Select the rows to be deleted**

   For multiple rows, please use the multiple selection keys (see page 472).

2. **Spreadsheet → Delete → Row(s)**

   or

   right-click and select the option "Delete Row(s)" from the pop-up menu

   or

   press <Del>

   The selected rows will be deleted.

Deleting the Whole Spreadsheet via the Menu

◆ PROCEDURE

1. **View → Spreadsheet**

2. **Spreadsheet → Delete → Contents**

   The entire spreadsheet is deleted.

Deleting the Whole Spreadsheet via the Pop-up Menu

◆PROCEDURE

1. **Right-click in the gray area at the very top left of the spreadsheet**

   or

   right-click in the gray area at the bottom left

2. **Select "Delete Contents"**

   The entire spreadsheet is deleted.

◆NOTE

The undo function is not available after Spreadsheet → Delete → Row(s) **or** Spreadsheet → Delete → Contents**.**

10.9 Reset Statistics

Use **Spreadsheet** → **Reset Statistics** to reset the following statistical values in the spreadsheet to zero:

- Min result
- Max result
- Range
- Average
- Sigma
- Number of NG judgments
- Errors
- Scans

◆PROCEDURE
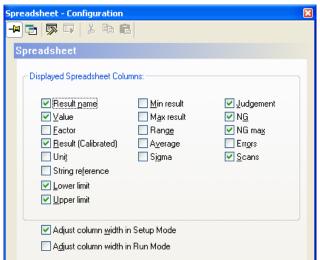
1. **Spreadsheet → Reset Statistics**

   or

   Click into the spreadsheet, click the right mouse button and select "Reset Statistics"

10.10   Properties

With **Spreadsheet** → **Properties** you specify which values are to appear on the spread-sheet.

Spreadsheet property page

Please note that you can assign the results in the columns "Judgment" and "NG Max" (upper limit for the number of NG judgments) to Actions (see page 518). Actions will be performed if the selected judgment is true or when the value for "NG Max" or a multiple thereof is reached.

All values displayed on the spreadsheet can be transferred to the interfaces. But only the results from "Judgment" and "NG Max" can be linked to the [Actions] button.

Adjust Column Width in Run Mode / Setup Mode
When you activate the option(s), Vision Q.400 recalculates the column width in the selected mode every time after you have executed the application so that the longest entry in the column determines the column width. When the option is not activated, the column width remains the same after executing the application. In this case it is possible that not all results are completely visible.

Chapter 11

Run Mode

11.1 Introduction

The system's operational mode from Vision Q.400 is called run mode. You will switch to run mode only after you have defined all your settings in the setup mode and are ready for Vision Q.400 to start work on the applications.

The setup mode is used for creating/editing applications.

NOTE

- **Once you have defined a password with** System Settings → Password**, start/stop run mode will be protected by a password. Only exception: If you have activated the check box "Activate Run Mode at Startup" on the property page "Application" under** System Settings → Vision Q.400 Settings**, the password is bypassed when activating run mode.**

- **You will not be able to define settings (checker, application, interfaces) in run mode.**

- **It is not possible to change the windows' size and display order in run mode because this would negatively affect the time response of the system. Make sure to size and position your windows as desired while you are in setup mode.**

- **In run mode, the execution times displayed refer to the entire application. That means, the display shows the maximal image processing time for the sum of all cameras selected. Image processing takes place exclusively on the PC.**

- **Results marked in the spreadsheet can only be transferred to the interfaces in run mode.**

- **As the Monitor: Parallel Interface display affects the performance in run mode, we recommend leaving it switched off. If you need to change the settings, quit run mode and open the parallel interface monitor again.**

- **Application-specific settings from** Application → Properties **only take effect in run mode.**

- **Data or commands sent by the serial, parallel or OLE interface are only processed by Vision Q.400 in run mode.**

- **Windows 2000/Windows XP is not a real-time operating system. Please test the time response of your application extensively in run mode before installing the PC at its destination.**

- **When you exit run mode, the application is saved automatically unless it is write-protected. In this case the application is not saved and Vision Q.400 writes a warning into the error log file.**

11.2 Start/Stop

You can activate the run mode with **Run Mode → Start**. **Run Mode → Stop** will return you to setup mode.

Run mode menu

Another alternative is to click to switch to run mode and to switch to setup mode.

 ◆**NOTE**

When you quit run mode and use camera/execution groups, the sequence list displays the checkers from the last executed sequence.

Chapter 12

Window and Help Menu

12.1 Window

With **Window** you can move one of the windows listed to the front of the screen. Listed are all windows which you opened but have not yet closed during your Vision Q.400 session. The window marked with a bullet is the active window you see in front on the screen.

Show list of open windows

You can switch to a different window using the window menu, the icon on the standard tool bar or the camera bar (see page 193).

Using the icon from the standard tool bar

You can click to switch to the next camera window. This also works if the last active

windows was for example spreadsheet window. By clicking several times you can "scroll" through all the camera windows. Windows that have been minimized, will be visible again and display with the standard size.

Using the camera bar

The camera bar shows thumbnail images from all connected cameras in ascending order. The camera bar is started by default with Vision Q.400 and docked in a fixed position at the bottom of the screen above the status bar. Click on the next thumbnail view to switch from one camera to the next.

12.2 Help

Vision Q.400 offers you sophisticated online help. The following submenus are available:

Help menu

Use **Help** → **Contents** to open the help window. There you find three property pages: "Contents", "Index", and "Search". The contents of the online help is the same as in this book.

12.2.1 Contents

With the "Contents" tab you open a list of books, which by and large correspond to the individual menus in Vision Q.400. Open the book about the menu you wish to know more about. A list of submenus will appear from which you can choose any topic with a mouse click.

12.2.2 Index

The "Index" tab displays an alphabetical list of all available topics described in the online help.

 PROCEDURE

1. **Help → Index**

2. **Click on a subject, e.g. "Checker", or type it in**

    You either see the explanation and/or a further index item you can click.

12.2.3 Find

The "Find" tab enables you to perform a full-text search of the help file. This way, you can find individual keywords and topics directly. Enter the keyword or select it from the list with the mouse.

12.2.4 About...

When you select **Help** → **About...**, you will see version information and the copyright of Vision Q.400. You can also check whether a new version is available and get an overview of the versions of all installed files.

Option	Description
Version	Vision Q.400 version number and type
FGAL version	Version number of the frame grabber software

Option	Description
FGAL type	Installed version of Vision Q.400: either **Standard** or **Simulation**
Frame grabber type	Type of frame grabber installed in the PC Imagechecker
Serial number	Serial number which has been entered during the installation of Vision Q.400. You can find this number also on the inside of the front door of the PC Imagechecker and on the packaging label.
Dongle ID	The identification number of the dongle. You need this number if you wish to update the software.
Dongle serial number	The identification number of the dongle. You need this number if you wish to update the software.

Check for update

With this button you check whether a new version of the software is available, provided you are connected to the Internet.

File info

With this button you open a dialog box listing version information for all installed files. This information can be very helpful for troubleshooting.

12.2.5 About Vision Q.400 Plug-Ins...

When you select **Help → About Vision Q.400 Plug-Ins...**, you will see information about the Vision Q.400 plug-ins installed on your computer. Plug-ins provide extended functionality for Vision Q.400. Please contact your distributor for more information about plug-ins.

When you select a plug-in on the left side, you will see details on the plug-ins on the right side.

Information on the plug-ins installed

Option	Description
Plug-in version	Version of the plug-in
Company	Manufacturer of the plug-in
The plug-in is a HDevelop script.	Only is displayed if the plug-in has been implemented with the help of an HDevelop scripts.
The plug-in needs a license	Only is displayed if the plug-in requires a license. How the plug-in is licensed is determined by the manufacturer of the plug-in.
Path	The location of the plug-in on your computer.

☞ ◆**NOTE** ─────────────────────────────

In the Essentials version there are no plug-ins available.

Chapter 13

Appendix

13.1 Error Handling and System Diagnosis

This chapters contains information about how you can diagnose and fix errors when operation Vision Q.400. You find information on the following topics:

- List of possible types of error (see page 564)
- List of possible error messages (see page 569)
- List of possible mistakes when setting or executing checkers (see page 570)
- Possible reactions of the interfaces (see page 570)
- System diagnosis (see page 571)
- Feedback form (see page 572)

13.1.1 Error Types

In Vision P400 six different error types can occur:

1. Unexpected error
2. Fatal error
3. Warning
4. Interface error
5. Action error (user-defined error)
6. Status message

13.1.1.1 Unexpected Error

After an unexpected error has occurred, it is impossible to continue image processing with Vision Q.400, not even in a limited way. When an unexpected error occurs, the only possibility is to save the current state of Vision Q.400 and to exit Vision Q.400 immediately.

If an unexpected error occurs, the Vision Q.400 session has to be stopped immediately and an error message appears on the screen. The system writes a detailed description in the window "Error Logging" and in the file "error.txt". A user-defined size limit for the file will be ignored. In addition to this, the error message will be sent to all available interfaces. It is not possible to start another application execution.

As soon as you have confirmed the error message about the unexpected error, Vision Q.400 terminates as there is no way of continuing.

☞ ◆**NOTE**

- **Whenever a fatal or an unexpected error occurs, Vision Q.400 automatically transfers the contents of the error file "error.txt" in a file with the name "errorfatal.txt". New contents will be added at the beginning of "errorfatal.txt". This way, existing entries in "errorfatal.txt" will not be overwritten.**
- **Whenever a fatal or unexpected error occurs, Vision Q.400 creates a new subfolder in its installation folder. This subfolder is called "Q.400Diagnostic<internal number>" and contains important infor-**

mation for analyzing the error. Please do not rename this subfolder and do not change its contents.

- **Vision Q.400 creates up to 10 subdirectories with the name "Q.400Diagnostic<internal number>". After that, existing subdirectories will be overwritten when new subdirectories with the same name are created.**

13.1.1.2   Fatal Error

After a fatal error has occurred, it is possible to continue image processing with Vision Q.400 to a limited extent. However, when a fatal error has occurred it is no longer possible to switch from setup to run mode, for example.

If a fatal error occurs, the Vision Q.400 session has to be stopped immediately and an error message appears on the screen. The system writes a detailed description in the window "Error Logging" and in the file "error.txt". A user-defined size limit for the file will be ignored. In addition to this, the error message will be sent to all available interfaces. It is not possible to start another application execution.

☞   ◆ NOTE

- **Whenever a fatal or an unexpected error occurs, Vision Q.400 automatically transfers the contents of the error file "error.txt" in a file with the name "errorfatal.txt". New contents will be added at the beginning of "errorfatal.txt". This way, existing entries in "errorfatal.txt" will not be overwritten.**
- **Whenever a fatal or unexpected error occurs, Vision Q.400 creates a new subfolder in its installation folder. This subfolder is called "Q.400Diagnostic<internal number>" and contains important information for analyzing the error. Please do not rename this subfolder and do not change its contents.**
- **Vision Q.400 creates up to 10 subdirectories with the name "Q.400Diagnostic<internal number>". After that, existing subdirectories will be overwritten when new subdirectories with the same name are created.**

13.1.1.3   Warning

Warnings usually have no impact on the running session except that a certain time is needed to write the warning into the file error.txt and into the "Error Logging" window (can be switched off in run mode).

You will receive a warning if a **calculation error** occurs in the spreadsheet or when **executing a checker**.

Calculation errors of checkers are for example dependency errors and land overflow errors. If such an error occurs, the checker will not be executed. The results are invalid and must not be processed further.

If a calculation errors occurs in the spreadsheet, for example when the system tries to divide a result by zero, the word "Error" is displayed in the "Judgement" column and the number of NG judgements is increased by one. In addition, a warning is displayed on the "Result" page of the checker in question. If other checkers use the result of a faulty checker, these checkers too display a warning (execution error, dependency error) on their "Result" pages.

13.1.1.4 Action Error

An action error is a signal issued by an Action. An action error will only occur in run mode and only if an Action is triggered.

13.1.1.5 Status Message

Status messages are no errors in the true sense of the word. They provide information on the status of a checker, when the execution of this checker leads to a result differing from what the user expected. The status message will help you to adjust the checker parameters to obtain the best results.

For example, the status message "no object after binarizing" informs you that there were no objects after the binarization procedure and that you need to change the binarization thresholds and to execute the checker again. Status messages only appear in the field "Execution State" on the checker's "Result" page. They are not written to the "Error Logging" window or into the "error.txt" file.

13.1.1.6 Interface Error

Interface errors are errors occurring in the course of communication between Vision Q.400 and external devices. You can resolve interface errors without exiting Vision Q.400.

Interface errors have two main causes:

- Vision Q.400 and the external device are using different settings for the interface parameters, for example if the baud rate settings differ.
- The external device is not responding within the expected interval, for example if the parallel interface is transferring data via handshake and the external device is not acknowledging the data transfer on time, thus causing a timeout.

This is what happens when an interface error occurs:

	Interface causing the error	All other interfaces
Reaction when the interface error occurs	Displays error dialog box (see below)	A warning is issued
Accept signal reception?	No	Yes
Data and signal output?	No	Yes
PCReady output?	No	Yes

Example of an error dialog box when an interface error has occurred

The error dialog box provides an error description and suggestions for troubleshooting. If more than one error has occurred in an interface, you can toggle between the errors. If errors have occurred in several interfaces, you can select each interface on the left side of the dialog box.

Depending on whether the error was caused by settings in Vision Q.400 or by settings in the external device, you proceed differently to resolve the error:

Resolving interface errors caused by Vision Q.400 settings

To change the settings, you must first switch to setup mode. Please proceed as follows:

◆ PROCEDURE

1. **Select [Setup Mode] in the error dialog box**

2. **Change the settings in Vision Q.400**

   Also check the interface settings in the external device.

3. **Select [OK] in the error dialog box**

4. **Switch to run mode**

Resolving interface errors caused by settings in the external device

You do not need to exit run mode. Please proceed as follows:

◆PROCEDURE

1. **Change the interface parameters of the external device so that they correspond to the Vision Q.400 settings**

2. **Select [OK] in the error dialog box**

◆NOTE

- **Ensure that you have resolved all interface errors before you select [OK] in the error dialog box. Otherwise the interface error will reoccur the next time you execute the application.**
- **If you are in run mode when you choose [OK], Vision Q.400 resumes transmitting the next set of data and signals to all interfaces affected by the error. If an error has not been properly resolved, the error dialog box will reappear the next time you execute the application.**
- **When you are in setup mode, all interface errors must first be resolved before you can switch to run mode.**
- **If an interface error and a fatal error have occurred simultaneously, the fatal error takes precedence. This means that you must first resolve the fatal error by switching to setup mode and/or exiting Vision Q.400.**
- **If a fatal error in Vision Q.400 remains unresolved, no interface errors are output.**

13.1.2 Error Messages in "error.txt"

Every time the program starts up a new section with the current date and time is created at the end of the file. Each error or warning is written in a new line.

```
----- 2007-06-25 15:04:02.451 -----

1 2007-06-25 15:06:22.545 Error: (Warning BASE)

Execution of G_PP[1;1] has failed;

Error: dependency error.

Error number: (major: 6141; minor: 0)

(C:\P400Source\IPDSource V4.0\base\cichecker.cpp: 1767)


----- 2007-04-25 14:24:04 -----


1 2007-04-25 14:35:19.877 Error: (Fatal BASE)

Inconsistent data structure (major failure)

Error number: (major: 6095; minor: 0)

C:\P400Source\IPDSource V4.0\base\cidrvhw.cpp <4.0.0.0>: 3920)

[C:\InstallationPath\P400Diagnostic01]
```

Commentated extract from file "error.txt"

1	Date and time when Vision Q.400 was started
2	Entry number
3	Date
4	Time
5	Error type
6	Location of error
7	Faulty object
8	Error text
9	Error number
10	Information on the source code. In case of unexpected and fatal errors the version number is stored here.
11	Only for unexpected and fatal errors: Name of the subfolder in the Vision Q.400 installation folder with information for the error diagnosis

Below you find a list of all possible error types and locations where fatal errors or warnings may occur.

Error type	Meaning
Unexpected	Unexpected error, Vision Q.400 session will be terminated
Fatal	Fatal error, Vision Q.400 session will be stopped
Warning	Warns you that for example the execution of a checker has failed

Location of error	Meaning
GUI	An error occurred in the user interface
BASE	An error occurred in the "Base Classes"
Driver access error	System failed to access a driver
FGAL	An error occurred while the system tried to grab the image
Other files	Other causes

13.1.3 Errors When Setting or Executing a Checker

Errors which occur during the setting or execution of a checker can be divided into two categories: error occurring during the calculation of the checker/spreadsheet result or errors occurring when setting the checker.

Calculation errors are always displayed as warnings and appear in the "Error Logging" window (in run mode only if you have activated this option). Errors occurring during the setting of a checker are displayed as a status message in the field "Execution State" on the "Result" page of a checker. Status messages are displayed if the checker does provide a result, but this result is different from the expected result.

13.1.4 Interface Reaction to Errors

Depending on the error type, the interfaces react differently if an error occurs.

Parallel interface

Error type	Reaction
Unexpected/fatal error	The output "Error" will be set.
Spreadsheet error	If an error (see page 564) occurs during calculation of the spreadsheet data, the output "Execution Result Error" will be set.
Action error	The output "Action Error" will be set.
Byte overflow	If a selected value is not within the range of the selected data type, the output "Byte Overflow" will be set. This error is equivalent to a fatal error.

Ethernet and serial interfaces

Error type	Reaction
Unexpected/fatal error	"%?" will be sent.
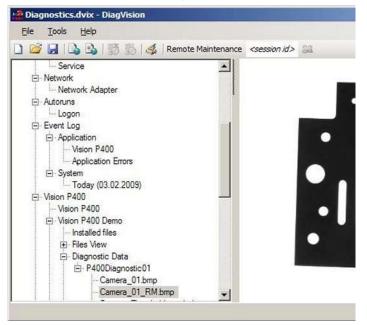
Error type	Reaction
Spreadsheet error	If an error (see page 564) occurs during the calculation of the spreadsheet data, the result in the data package is marked with a character, e.g. an exclamation mark: 1,!,10,4. The character is user-definable (see page 94).
Action error	"%?" will be sent.
Invalid application number	If an invalid application number was used for an application change, the error code "%z" will be transferred.

OLE

Error type	Reaction
Unexpected/fatal error	Signal PCError will be sent
Action error	Signal Action_Error will be sent if the action (see page 518) is triggered

13.1.5 System Diagnosis with DiagVision.exe

The English-language diagnosis tool "DiagVision.exe" is located in your Vision Q.400 installation directory. You can use this tool to retrieve a wide range of information about your hardware and software, which may help solve problems with Vision Q.400.

"DiagVision.exe" diagnosis tool

DiagVision: Available functionality

Menu	Description
File → New	Performs a new system diagnosis. The information displayed here is derived exclusively from the PC running the program.
File → Open...	Opens a diagnosis file with the extension *.dvi.
File → Save.../Save As...	Saves all the available information in a file with the extension *.dvi. This file can be viewed with the DiagVision software.

Menu	Description
File → Exit	Exits DiagVision.
Tools → Generate a report view of the current diagnostics...	Displays a report dialog box for the entire analysis.
Tools → Generate a report view of selected item...	Displays a report dialog box for the current analysis selection.
Tools → Install Vision Q.400 Drivers	Installs Vision Q.400 drivers.
Tools → Uninstall Vision Q.400 Drivers	Uninstalls Vision Q.400 drivers. Note: The standard procedure is via **Control Panel→ Add/Remove Programs**
Tools → System clean of Vision Q.400 Software...	Use this option to remove all installed versions of Vision Q.400 from your PC. This is useful if you have installed several versions of Vision Q.400 on your PC and the standard deinstallation routine for the setup is no longer working. Before the installation directories of Vision Q.400 and Vision Q.400 Demo are deleted, the system backs up all files with the extensions *.nav, *.fnt, *.nft, and the file "License.dat" in a user-defined file. All other files in the Vision Q.400 and Vision Q.400 Demo installation directories will be deleted together with the directories.

Remote maintenance

You can also use DiagVision for remote maintenance purposes.

♦PROCEDURE

1. **Enter the remote maintenance session ID number, which is generated automatically, in the input field**

2. **Start remote maintenance by clicking the adjacent icon**

13.1.6 User Feedback

When producing the Vision Q.400 software we did everything possible to detect and remove software errors by highly sophisticated quality checks. As you know, it is nearly impossible to produce a flawless software product. That is why we kindly ask you for your support if a software error occurs in spite of all our efforts.

♦NOTE

If you wish to report an error, please send or fax a print-out of the file "error.txt" together with the report sheet on the next page. Alternatively, use the tool DiagVision.exe (see page 571) to create a *.dvi file and mail it to us. This will speed up the trouble-shooting process.

Thank you very much in advance for your help and understanding.

☐ **Software Error Report**

☐ **Change Request/Suggestion for Improvement**

From

Name:	Date:
Address:	Q.VITEC GmbH
Phone:	
Facsimile:	Facsimile: +49-5031-697 29 76

Error description

Vision Q.400 version number:
Vision Q.400 software serial number: Vision Q.400 Imagechecker number: Imagechecker serial number: (see label on casing or behind front door)
Environment (version number of the operating system, service pack installed, system configuration (network card, etc.)):
System behavior (C = Crash, P = Program failure, M = Miscellaneous):
Description of the problem or change request (in case of a software problem please attach a print-**out of the file "error.txt", a print**-out of the faulty application (*.nav), and a screen-shot to document the problem):
Explain step by step what you have been doing before the problem appeared so we can reproduce the system behavior:

13.2 Recommended Literature

Title	Author	Published by
Fundamentals Of Digital Image Processing	Anil K. Jain	Prentice Hall Englewood Cliffs 1989
Digitale Bildverarbeitung	Bernd Jähne	Springer Verlag Berlin Sechste überarbeitete und erweiterte Auflage 2005
Bildverarbeitung in der Praxis	R. Steinbrecher	Oldenbourg Verlag München 1993
Methoden der digitalen Bildsignalverarbeitung	P. Zamperoni	Vieweg Verlag Braunschweig Zweite überarbeitete Auflage 1991
Einführung in die digitale Bildverarbeitung	Wolfgang Abmayr	B.G. Teubner Verlag Stuttgart Zweite Auflage 2002
Digitale Bildverarbeitung: Grundlagen und Anwendungen	Peter Haberäcker	Hanser Verlag München 1991
Praxis der Digitalen Bildverarbeitung und Mustererkennung	Peter Haberäcker	Hanser Verlag München 1995
Das Handbuch der Bildverarbeitung. Methoden, Programme, Anwendungen.	Rolf-Jürgen Ahlers	Expert-Verlag Renningen 2000
Industrielle Bildverarbeitung. Wie optische Qualitätskontrolle wirklich funktioniert.	Christian Demant et al.	Springer Verlag Berlin Zweite Auflage 2001
Einführung in die industrielle Bildverarbeitung	Gerhard Weißler	Franzis Verlag Poing 2006
Machine Vision Algorithms and Applications	Carsten Steger, Markus Ulrich, Christian Wiedemann	Wiley-VCH Verlag Erste Auflage 2007

13.3 ASCII Codes

Dec.	Hex.	Charac-ter	Dec.	Hex.	Character	Dec.	Hex.	Character	Dec.	Hex.	Charac-ter
0	00	(NUL)	32	20	Space	64	40	@	96	60	`
1	01	(SOH)	33	21	!	65	41	A	97	61	a
2	02	(STX)	34	22	"	66	42	B	98	62	b
3	03	(ETX)	35	23	#	67	43	C	99	63	c
4	04	(EOT)	36	24	$	68	44	D	100	64	d
5	05	(ENQ)	37	25	%	69	45	E	101	65	e
6	06	(ACK)	38	26	&	70	46	F	102	66	f
7	07	(BEL)	39	27	'	71	47	G	103	67	g
8	08	(BS)	40	28	(	72	48	H	104	68	h
9	09	(HT)	41	29	)	73	49	I	105	69	i
10	0A	(LF)	42	2A	*	74	4A	J	106	6A	j
11	0B	(VT)	43	2B	+	75	4B	K	107	6B	k
12	0C	(FF)	44	2C	,	76	4C	L	108	6C	l
13	0D	(CR)	45	2D	-	77	4D	M	109	6D	m
14	0E	(SO)	46	2E	.	78	4E	N	110	6E	n
15	0F	(SI)	47	2F	/	79	4F	O	111	6F	o
16	10	(SLE)	48	30	0	80	50	P	112	70	p
17	11	(CS1)	49	31	1	81	51	Q	113	71	q
18	12	(DC2)	50	32	2	82	52	R	114	72	r
19	13	(DC3)	51	33	3	83	53	S	115	73	s
20	14	(DC4)	52	34	4	84	54	T	116	74	t
21	15	§ (NAK)	53	35	5	85	55	U	117	75	u
22	16	(SYN)	54	36	6	86	56	V	118	76	v
23	17	(ETB)	55	37	7	87	57	W	119	77	w
24	18	(CAN)	56	38	8	88	58	X	120	78	x
25	19	(EM)	57	39	9	89	59	Y	121	79	y
26	1A	(SIB)	58	3A	:	90	5A	Z	122	7A	z
27	1B	(ESC)	59	3B	;	91	5B	[	123	7B	{
28	1C	(FS)	60	3C	<	92	5C	\	124	7C		
29	1D	(GS)	61	3D	=	93	5D	]	125	7D	}
30	1E	(RS)	62	3E	>	94	5E	^	126	7E	~
31	1F	(US)	63	3F	?	95	5F	_	127	7F	

Dec.	Hex.	Character	Dec.	Hex.	Character	Dec.	Hex.	Character	Dec.	Hex.	Charac-ter
128	80	Ç	160	A0	á	192	C0	└	224	E0	Ó
129	81	ü	161	A1	í	193	C1	┴	225	E1	ß
130	82	é	162	A2	ó	194	C2	┬	226	E2	Ô
131	83	â	163	A3	ú	195	C3	├	227	E3	Ò
132	84	ä	164	A4	ñ	196	C4	─	228	E4	õ
133	85	à	165	A5	Ñ	197	C5	┼	229	E5	Õ
134	86	å	166	A6	ª	198	C6	ā	230	E6	µ
135	87	ç	167	A7	º	199	C7	Ã	231	E7	þ
136	88	ê	168	A8	¿	200	C8	╚	232	E8	Þ
137	89	ë	169	A9	®	201	C9	╔	233	E9	Ú
138	8A	è	170	AA	¬	202	CA	╩	234	EA	Û
139	8B	ï	171	AB	½	203	CB	╦	235	EB	Ù
140	8C	î	172	AC	¼	204	CC	╠	236	EC	ý
141	8D	ì	173	AD	¡	205	CD	═	237	ED	Ý
142	8E	Ä	174	AE	«	206	CE	╬	238	EE	¯
143	8F	Å	175	AF	»	207	CF	¤	239	EF	´
144	90	É	176	B0	░	208	D0	ð	240	F0	─
145	91	æ	177	B1	▒	209	D1	Ð	241	F1	±
146	92	Æ	178	B2	▓	210	D2	Ê	242	F2	=
147	93	ô	179	B3	│	211	D3	Ë	243	F3	¾
148	94	ö	180	B4	┤	212	D4	È	244	F4	¶
149	95	ò	181	B5	Á	213	D5	€	245	F5	§
150	96	û	182	B6	Â	214	D6	Í	246	F6	÷
151	97	ù	183	B7	À	215	D7	Î	247	F7	¸
152	98	ÿ	184	B8	©	216	D8	Ï	248	F8	°
153	99	Ö	185	B9	╣	217	D9	┘	249	F9	¨
154	9A	Ü	186	BA	║	218	DA	┌	250	FA	·
155	9B	ø	187	BB	╗	219	DB	█	251	FB	¹
156	9C	£	188	BC	╝	220	DC	▄	252	FC	³
157	9D	Ø	189	BD	¢	221	DD	▌	253	FD	²
158	9E	×	190	BE	¥	222	DE	Ì	254	FE	■
159	9F	ƒ	191	BF	┐	223	DF	▀	255	FF	

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Record of Changes

Manual No.	Date	Description of changes
MANSWQ400V0713AE	June 2013	First edition

Q.VITEC