Application Note

FESTO

Application of Checkbox CHB-C-N with a conveyor belt.

Assembly and setting of basic parameters.

CHB-C-N
Part-No.:3501040

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Content

1 Hardware/Software

Typ/Name	Version Software/Firmware	Manufacturing date
CHB-C-N TN : 3501040	3.6.1.0	
CheckKon	4.3 rel 06	

Table 1.1: Hardware/Software

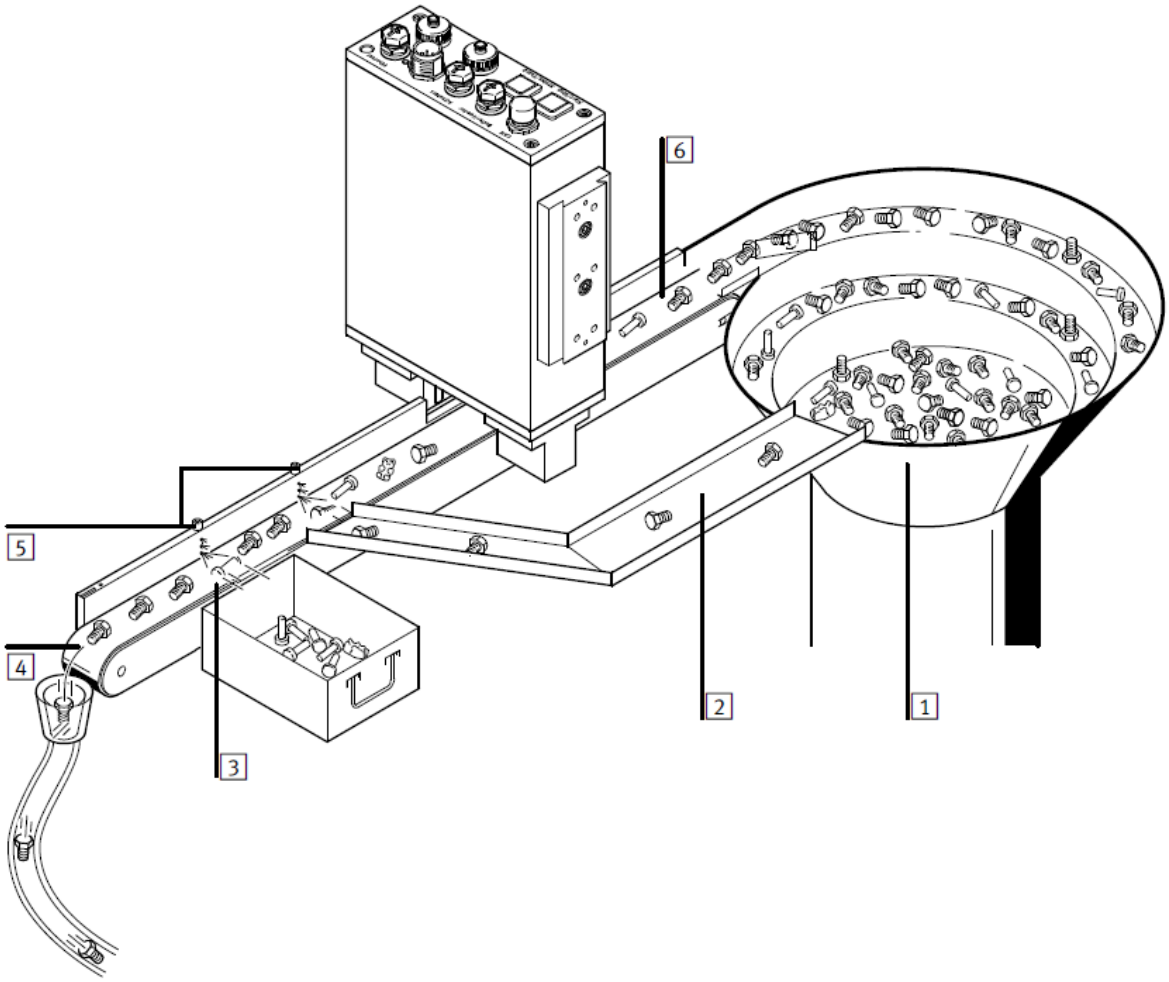
1.1 User Manual

CHB-C-N User Manuals from Support Portal www.festo.com/sp.
DE: 8046181
EN: 8046182

2 Description of the application of a Checkbox on a belt system

The procedure described in the following document shows all necessary settings for the operation of a Checkbox CHB-C-N on a conveyor system.
This application note does not to replace the manual. It describes an approach and shows the meaningful sequence of each step to setup the application. Specific details about the connections or operating modes can be looked in the owner's manual.
The described example stands for the use of the Checkbox as small parts feeding system with sorting function according orientation, type and quality.

Example of a complete solution with vibratory bowl feeder and conveyor belt system.



1: Small parts conveyor, vibratory bowl feeder (other possibilities: centrifuge feeder, step feeder)
2: Return of incorrectly orientated parts to the small parts conveyor
3: Ejecting position for bad parts (faulty parts, wrong part type)
4: Onward transfer of good parts to a buffer zone or the next machine
5: Actuators; blow-off valves with flow controls to adjust ejecting force
6: Transportation device, conveyor belt

The parts are supplied via the small parts conveyor. By a slightly faster speed the parts are delivered separated by gaps. This pull apart (approx. 1 mm and larger) of the parts should be ensured for all possible settings and filling ratios of the small parts feeder. The parts are scanned by the CHB-C-N and categorized according the preset inspection conditions. If parts on the belt touch each other the linked parts can only be evaluated as one cohesive image and cannot be evaluated individually

Categories of the inspection results:

- **Category “Good part”:** A part in this category meets all quality criteria. The part is conveyed to the end of the transportation device and passed to the next station (machine or buffer zone)

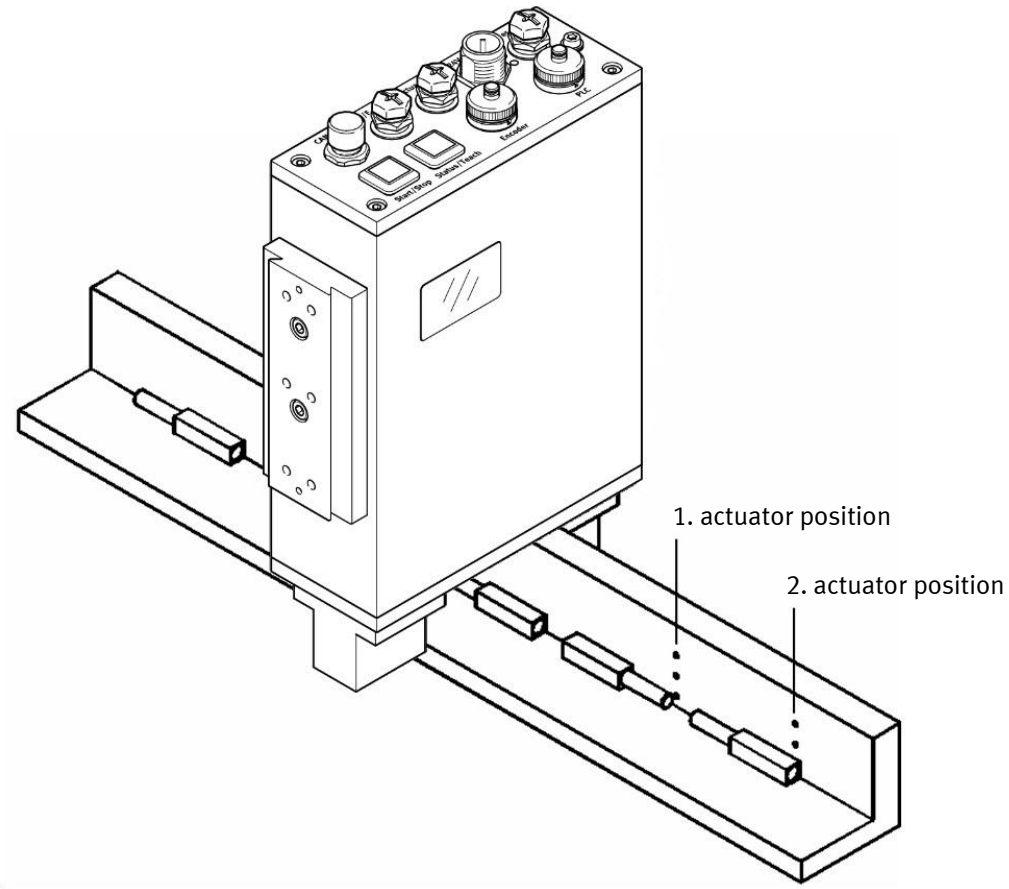
- **Category “Wrongly oriented part”:** A part in this category meets all quality criteria but is wrongly oriented. The part is filtered out and returned to the conveying system for a new inspection.

- **Category “Bad part”:** A part in this category does not meet the quality criteria. The part is filtered out at a separate actuator to be phased out of the feeding process to a bad parts bin.

For each category an actuator is assigned in the parameter settings. The corresponding actuator switches on at the "arrival" of the part at its position.
The parts are usually blown off the conveyor belt with the help of an air impulse.

3 Mounting the Checkbox at the conveyor belt

Install the Checkbox at the conveyor belt at 90 degrees perpendicular to the belt direction and horizontally absolutely parallel to the conveyor belt.
The light beam of illumination should pass the center of the viewing slot of the guiding bar.
The height above the conveyor depends on the part size to be tested or the part geometry. For very small parts the Checkbox prisms should overlap the conveyor belt. For larger parts, it may be necessary that the Checkbox is mounted at a distance to the conveyor belt. In this case only the upper part of the part contour can be inspected.



Acording to the categories, this configuration with 2 discharge positions represents the minimum configuration. Even if no bad parts are to be expected, there is a possibility that the Checkbox will come to a negative result. Possibly caused by poor feeding or non-optimal test settings. These parts are then sorted out at the bad part position.

The distance from the checkbox to the first actuator position is determined by the maximum expected part length of the test pieces. It is not permissible that the first actuator position is reached from the beginning of the part, but the scanning process is not yet completed. The part must be completely scanned! The inspection characteristics are then calculated and the corresponding category is determined as the inspection result.

This calculation time is not a fixed value, it is determined by the test program with the test tools used.
The duration of communication via Ethernet also goes into this time.

Figure 3.1:

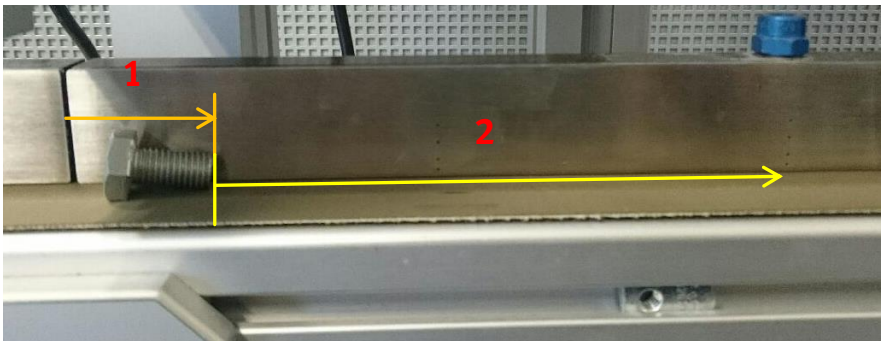


Figure 3.1 shows an example of the situation. The distance 1 describes the position after the scanning process and the calculation time. The distance 2 describes the space to possible discharge position. The distance 2 must never be smaller than 1 mm!

This is especially important for long parts. The calculation time can be determined via the display in the CheckKon software. Normally it lasts only a few ms.

The exact calculation time can only be determined, after all parameters have been set up. See notes in the appendix.

The calculation time can be used to determine the distance 1, via the adjusted belt speed and thus also the position for the first discharge position.

Example: Speed 300 mm / sec, calculation time 10 ms

(Part length + distance computation period E.g. 35 mm + (300 mm / sec x 10 ms) = 38 mm)

If an exact calculation is not possible, an "experience value" can also be assumed.

As an empirical value for the first position, approx. 1.5 x maximum part length can be used as a supposed value.

Caution: Failure to observe the positioning of this first discharge position, will result in an error status that prevents the system from operating!

The 2nd discharge position can be arranged according to the required mechanical conditions. Here, sufficient space should be provided for the installation of discharge slides or collecting trays or similar.

Instructions for blowing off the parts by means of an air pulse

If parts are blown off by means of an air pulse, it should be possible to throttle (pressure/flow) this air pulse. This allows to adjust a well guided blowing of the parts.

Festo recommends using high-speed switching valves, E.g. MHE2-MS1H-3/2G-QS-4 (best. No. 196135 This ensures that the blow-off function is always performed even when the application is highly dynamic.

This also includes a constant supply of compressed air, which is adapted to the air consumption. A separate pneumatic regulator/filter combination is recommended for the checkbox system.

For highly dynamic applications, it is recommended to adjust the air pulse setting, using a high-speed camera. The "flight behaviour" of the parts could be examined and optimized.

Required conveyor belt speed

In order to obtain the required good parts rate in the system following the checkbox, you must calculate and set the conveyor belt speed accordingly.

Use following formula:

Conveyor belt speed = (Part rate required by the system (per second) * possible number of orientations) * (length of part[mm] + distance between parts[mm] * (1 + percentage of bad parts/100)

Example:
3 Good parts/sec
Max. Part length: 35 mm
Average distance between parts: 5 mm
Bolts with 2 orientations
Assumption: Defective part rate 0.5%.

Conveyor belt speed = 3 good parts/sec * 2 orientations * (35 mm + 5 mm) * (1+0.5/100)
Conveyor belt speed = 241,2 mm / sec

Electrical connection of the check box

Wire the checkbox according to the description in the manual.
Basically, it is advisable to connect all offered control options, such as conveyor belt, bowl feeder, jam sensors or counter message and others; directly to the interface of the checkbox.
This ensures the maximum safety of the feeding process.
If, on the other hand, the signals are controlled by an external PLC, signal delays or error states could occur. The consequence would be, that possibly wrong parts could get into the following system.
An overview of the available control signals shows the pin assignment of the 24-pin "PLC" connection in the operating instructions manual.

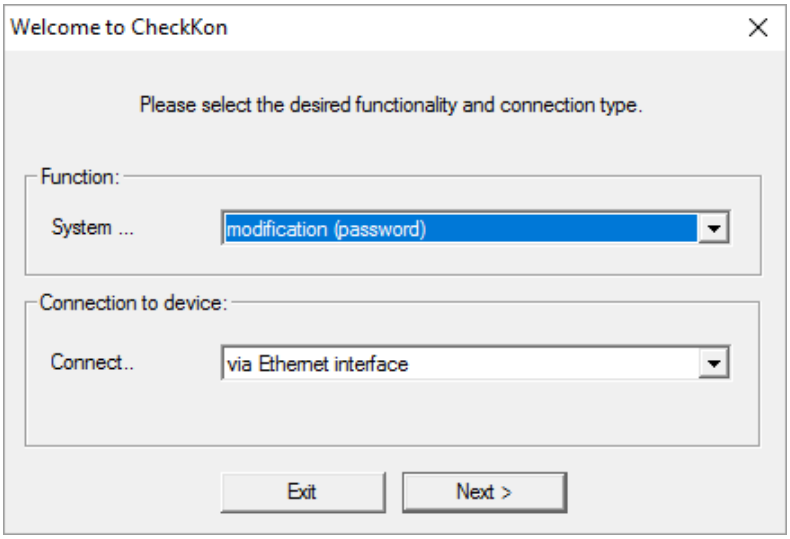
Two connectors are available for the connection of outputs. The outputs of the Checkbox are called actuators.
On the one hand, this is the M12 plug with the marking "Actuators" and a 24-pole socket with the marking PLC".
Both interfaces differ in the permissible current carrying capacity.
When using the recommended fast switching valves, the connection to the M12 plug is mandatory. The load due to the switch-on pulse of the valves is only permissible at these connections!
Detailed technical data can be found in the operating instructions manual.

To be able to perform the following basic settings, at least the 24 VDC power supply must be connected.

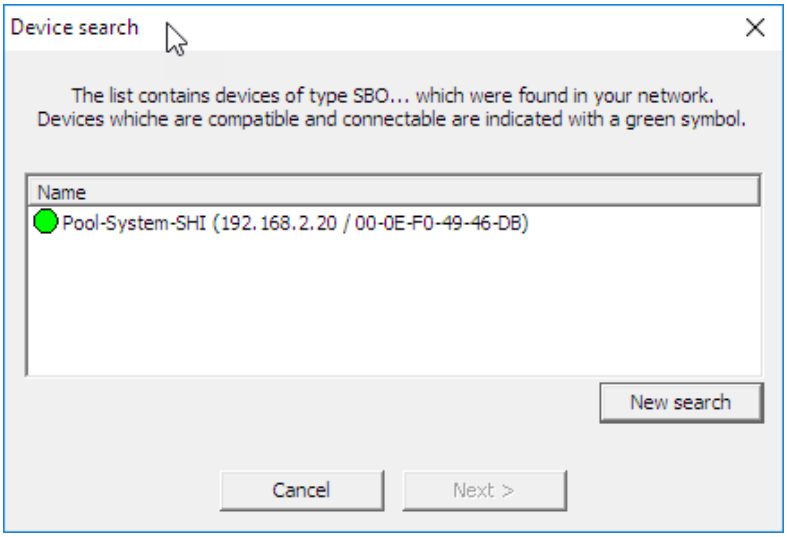
4 Adjustment of viewing range and basic parameters with CheckKon

Prerequisite:
The CheckKon configuration software is required for setting the field of view and other parameters.
Install the software and set your ETH interface on the PC to a fixed IP address range that corresponds to the range of the checkbox in the delivery status.
Checkbox: 192.168.2.20 PC: 192.168.2.99

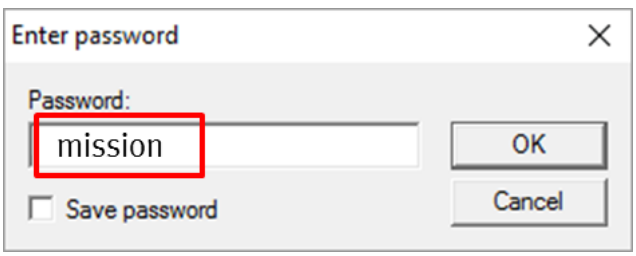
Start CheckKon and proceed with following setting:



Start the search:



Select device



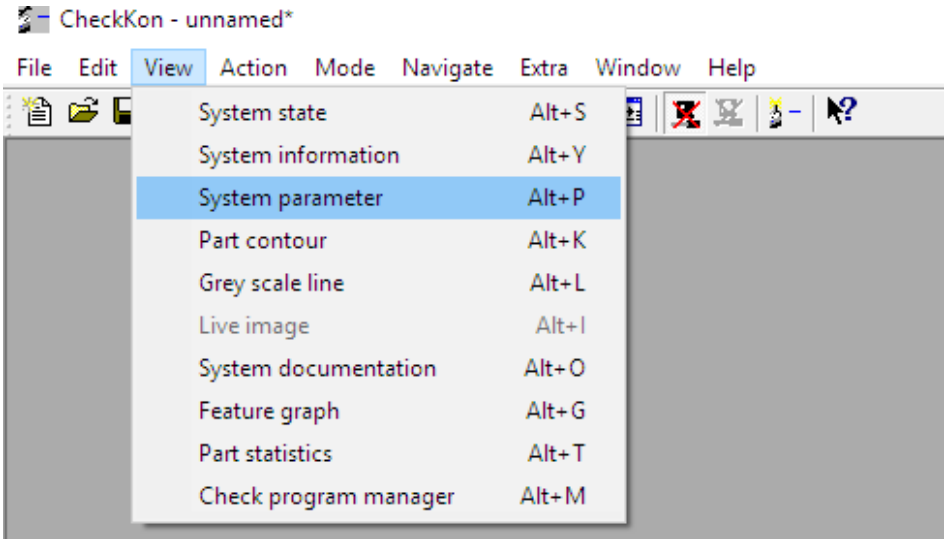
Password: mission

Then the connection and the system status window is displayed.

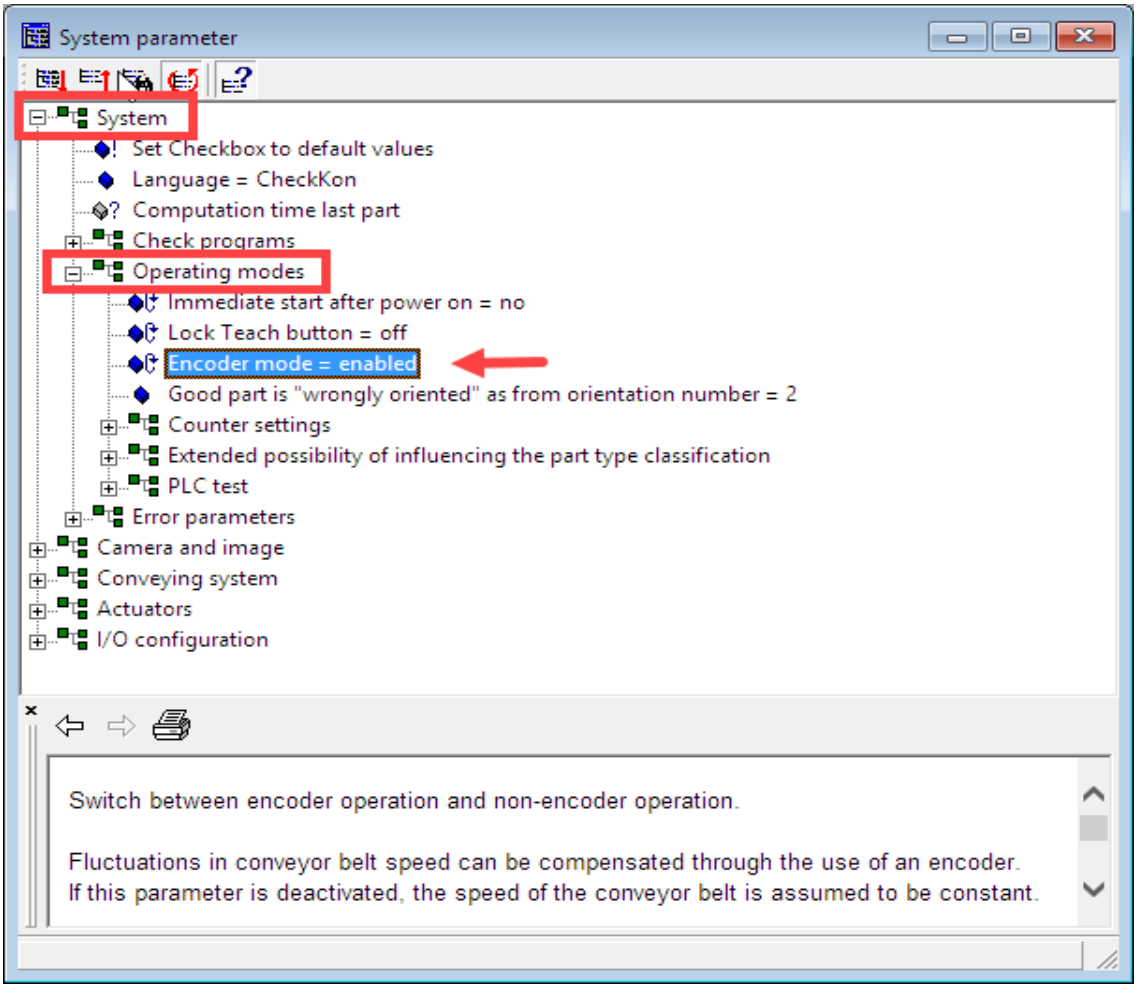
Operating mode

Before the field of view can be set, the system needs to know whether an encoder is used to control the image generation and output circuitry.
If an encoder is used, it must be connected to the "Encoder" interface (RS 485). Mechanically, the encoder should be coupled to a drive roller of the conveyor belt.
As an alternative to the preferred encoder coupling, the process can also be controlled by an internal cycle timer. This is active when the “Encoder mode =disabled”

Select in the menu "View" › system parameters

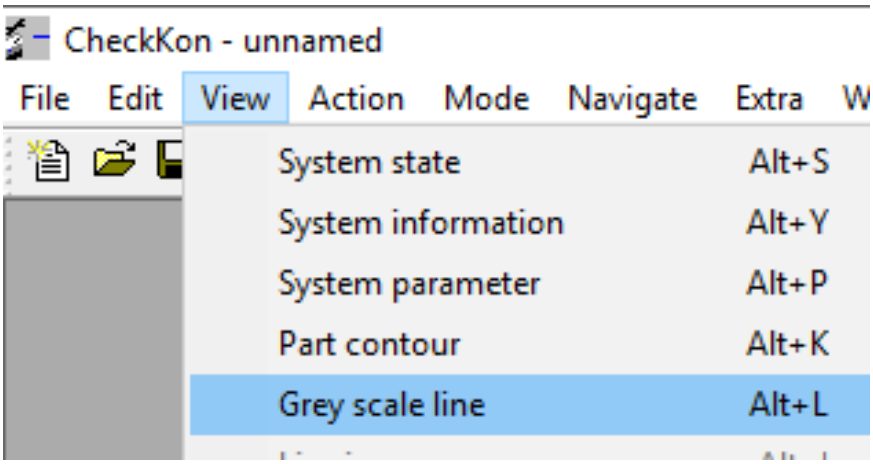


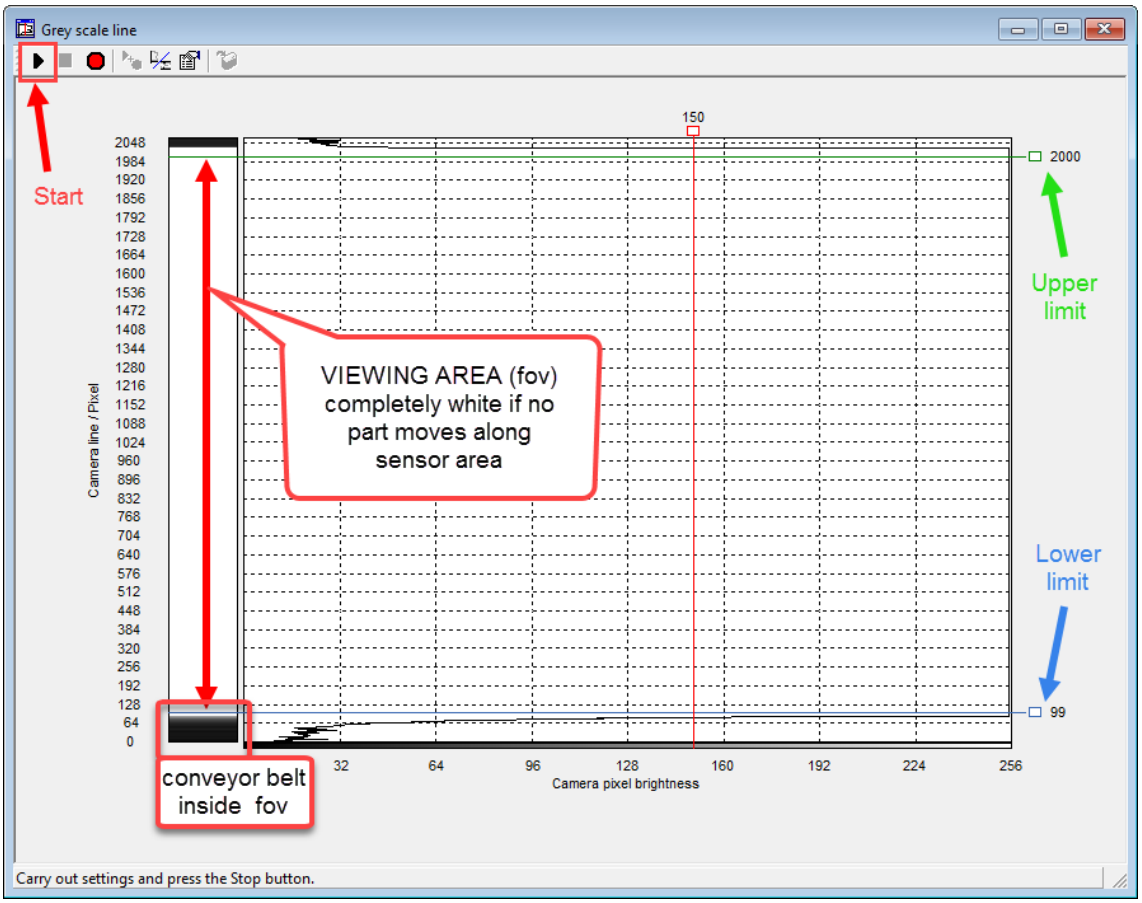
Then they open the path: System › Operating modes



Here, the encoder can be enabled or disabled via a toggle function. Make the selection according to the existing system.

Now open the window of grey value line

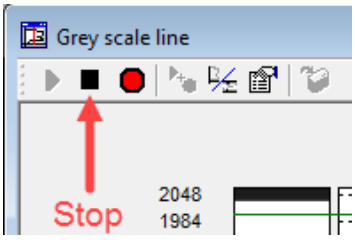




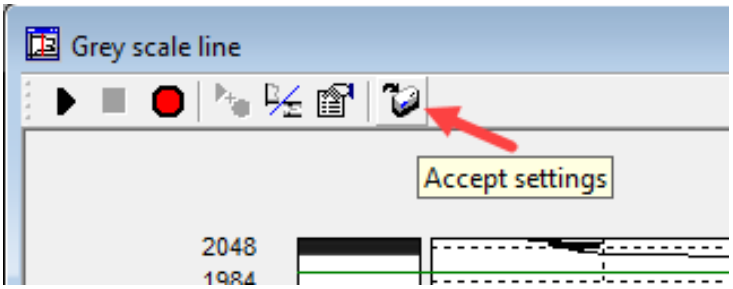
Start the recording with the "play" button. Then the START button on the check box.
Now the checkbox can be adjusted mechanically. Depending on the requirements of the part size (see above) the checkbox is mounted. For many applications, the checkbox should be aligned according to the above shown monitor. Move the checkbox until the bottom area shows the conveyor belt.
Precise adjustments of the viewing area are done with the blue and green boundary lines. The closer the blue line is pushed down to the black area, the less the part is cut off at the bottom of the image.
Depending on the quality (thickness variation) of the conveyor belt, a certain (white) safety distance must be maintained so that the high places of the belt do not reach the visible area and cause pseudo parts.
The upper green line is set so that it runs above the largest part. Maximum up to the upper black area.
It must be ensured that a white area between the blue and green boundary lines is set when there is no part between the prisms.

The boundary lines can be moved with the mouse at the right end of the square. The new value is displayed in brackets. This can be activated when the recording of the gray scale line has been stopped.
To do this, first press the STOP button on the device and second the stop “button” in the window.

1. 

2. 

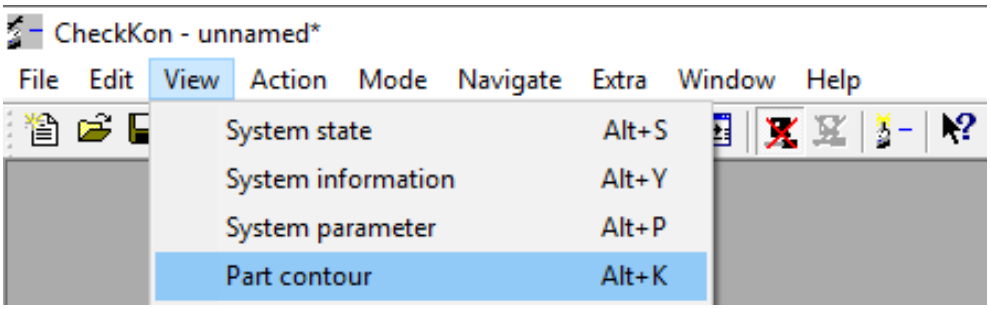
Then, you can apply the new value with the “Accept settings” button active. The brackets at the values will disappear.



5 Setting contour image and resolution

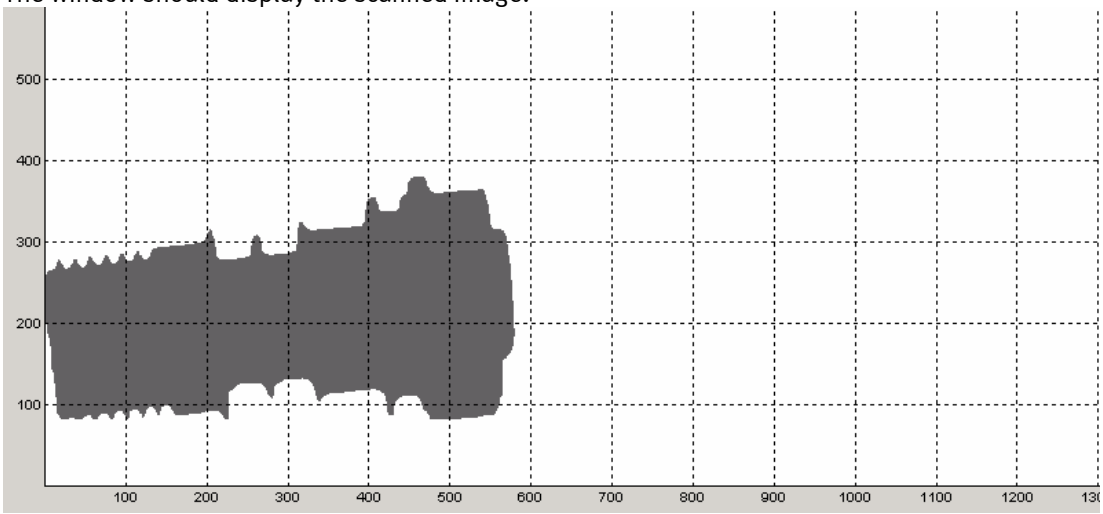
After adjustment of the viewing area, check the contour image.

Open the window: menu › view › part contour



Start the Checkbox and place a part on the conveyor belt.

The window should display the scanned image:

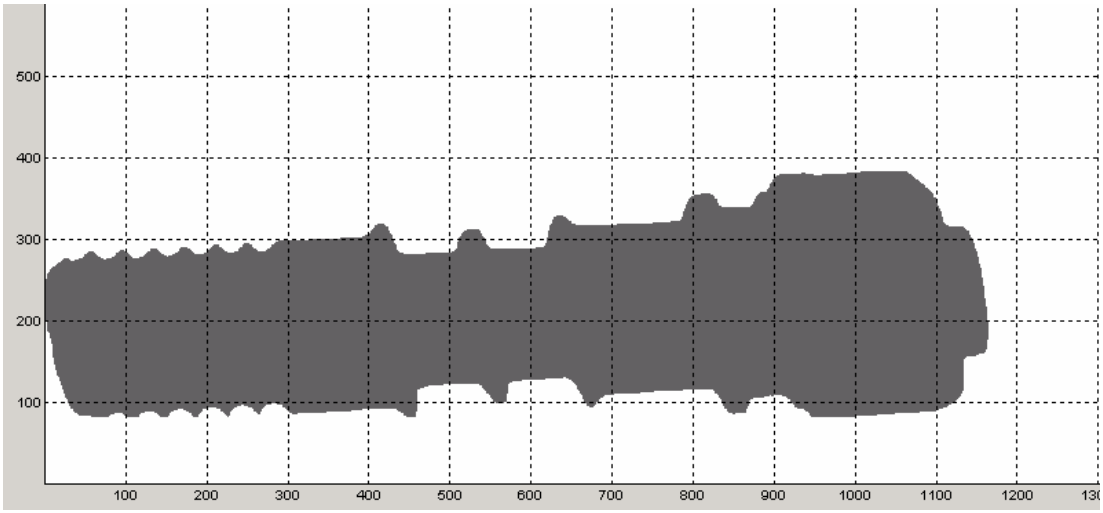


All relevant details should be visible in the picture. For position orientation tasks, differences in the contour of the different feed layers should be visible.
The details, to be inspected, should be mapped appropriately large, especially for quality inspections. (Thread or punctures or chamfers)
The resolution can be increased, if the image capture should be improved with regard to details.

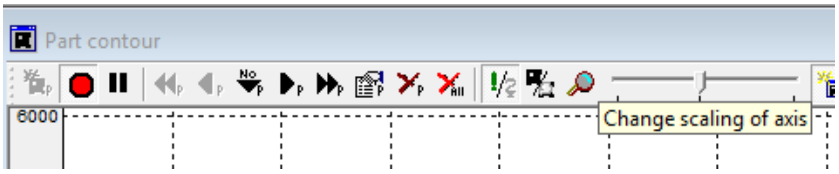
Resolution

The resolution of the checkbox differs from conventional camera systems. The vertical and horizontal resolution can be set separately. This is also the reason why the image of the parts can appear "distorted".

Here an image of the same part but with higher horizontal resolution included:



Note: with the slider "Change scaling of axis" the display can be adapted to the real appearance of the parts. This does not change the resolution, only the representation of the image on the screen!



The resolution in horizontal direction results from the number of scanned lines per parts. If scanning is performed more often per unit of time, a more detailed image of the part is obtained. And vice versa, a "smaller" representation.
The specified length in pixels corresponds to the number of scanned lines.
The number of lines results from the settings in the system parameters. The parameter differs from encoder-controlled and time-controlled systems.

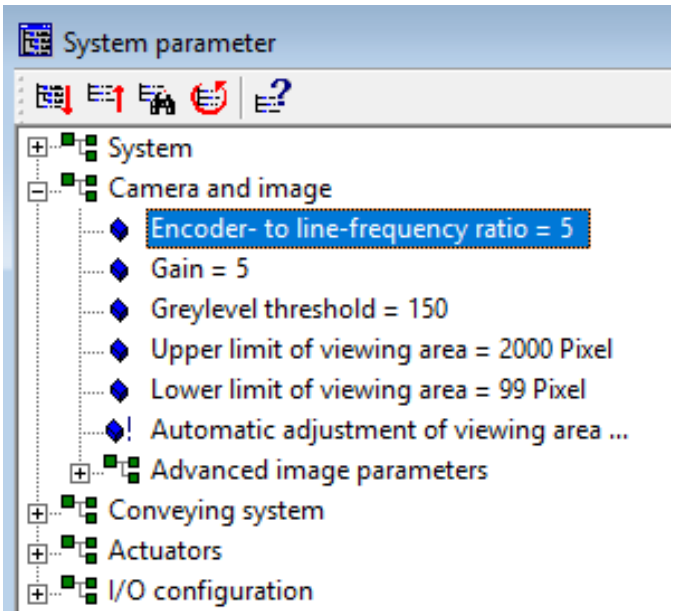
Resolution encoder-controlled systems:

For encoder-controlled systems, the resolution is set in the "Encoder to line-frequency ratio" parameter. The factor describes how many encoder pulses must be detected before one line is scanned. The value 6 means that, all 6 pulses of the encoder are scanned one line of the image. If the factor is doubled, e. g. 12, the part moves twice as long before a line is scanned. The resolution becomes "coarser".
If the factor is reduced to 3, then all 3 encoder pulses are scanned one line. This means that the image will be more detailed.
The belt speed has no influence, as the pulses are counted and the exposure time remains constant. The length of the part in the picture always remains the same. This coupling to the encoder impulses causes that the influence of fluctuation of the belt speed cannot affect the image and therefore not the results of the test procedure.

Limits:
The higher the conveyor speed, the more often the camera has to scan one line. If the encoder's pulse frequency reaches the camera's maximum scan frequency of 8.5 kHz, the system can no longer follow.
Then error 14 "Belt speed too high" is caused. To avoid error 14, the conveyor speed can be reduced or the parameter " Encoder to line-frequency ratio" can be increased. This reduces the frequency of the pulses relevant for recording.

Note:
During commissioning, the relationship between the part rate, resolution and belt speed must be brought into harmony.

Relevant system parameter:

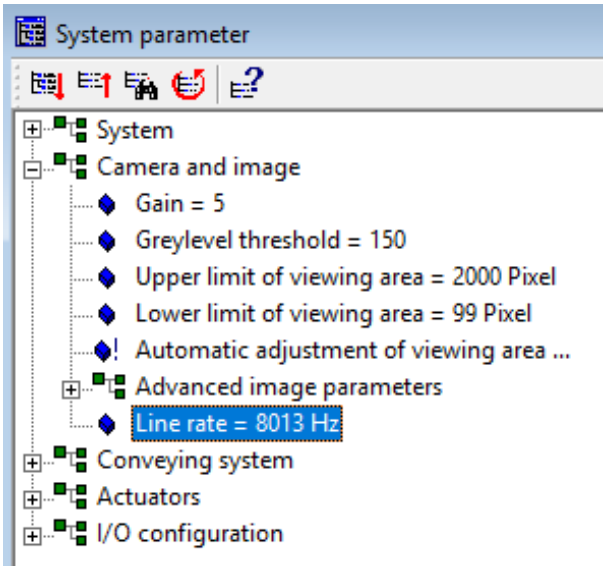


Resolution for time-controlled systems (Encoder mode = disabled)

For time-controlled systems, the resolution is determined via the "Line rate" parameter. The line rate is a frequency in Hz, that controls the scanning process.
The camera always scans one line at the set frequency. The higher the line rate, the better the resolution and vice versa. The maximum line rate is 8.5 kHz.
In addition to the line rate, the belt speed has also an influence on the resolution and image. The faster the conveyor runs, the fewer lines are scanned by the part. The resolution will be more "coarser".
Conversely the image becomes more detailed.

Note:
Because the number of lines directly reflects the length of the part in the image, a change in speed also causes a change of the part length!
The inspection procedure and its reliability is therefore highly dependent on the constant speed of the conveyor belt used. The learning of parts (teach process) is only valid a one specific conveyor speed.
If the conveyor speed change after the teach process, the images and thus also the inspection result will change. If the change is greater than the permitted tolerance, then all good parts are also recognized as bad, and discharged. The teach process must then be repeated!

System parameters screen:



6 Calibration of the conveyor belt system to camera parameters

In some parameter settings, values in mm specifications are used. To ensure that these values correspond to the actual values of the existing system, the camera system must be calibrated to the mechanics of the conveyor belt system.
This is particularly important for actuator control, since they are referenced via the mm values. Incorrect calibration causes an incorrect activation moment and thus a bad discharge behaviour.

This calibration hardly differs whether it is a time- or encoder-controlled system.

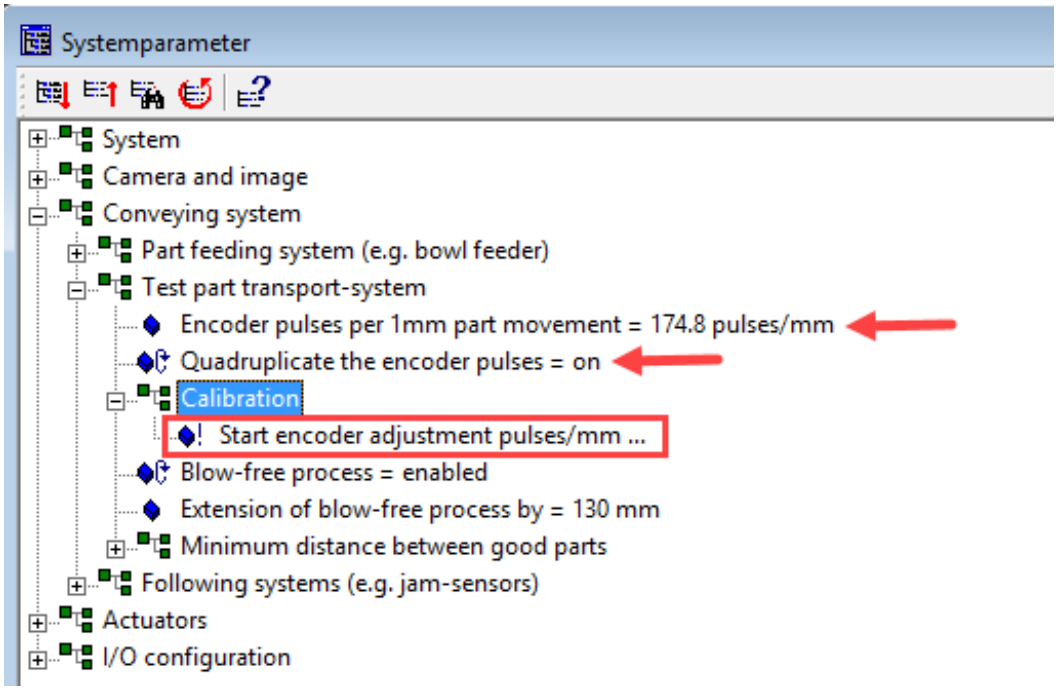
Calibration encoder-controlled systems:

Adjust the belt speed according to the needs and requirements.

Open the Wizard "Start encoder adjustment pulses/mm" for calibration in the system parameters.

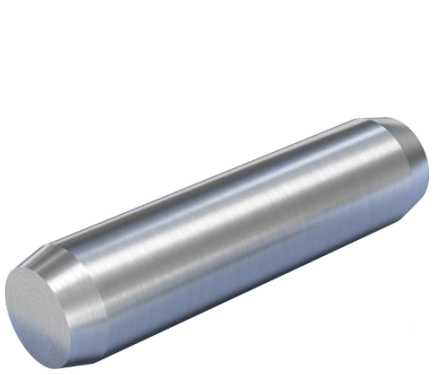
The wizard guides you through the process.

After successful completion of calibration, the current pulses/mm value is entered in the parameter tree.
(174,8 pulses/mm is a default value by Festo)



Follow the wizard's instructions. Almost every test piece can be used as a "calibration object".
The edges of the contour should be clearly mapped and measured.
The calibration object should also be able to be transported on the conveyor belt in a stable manner.

Example:

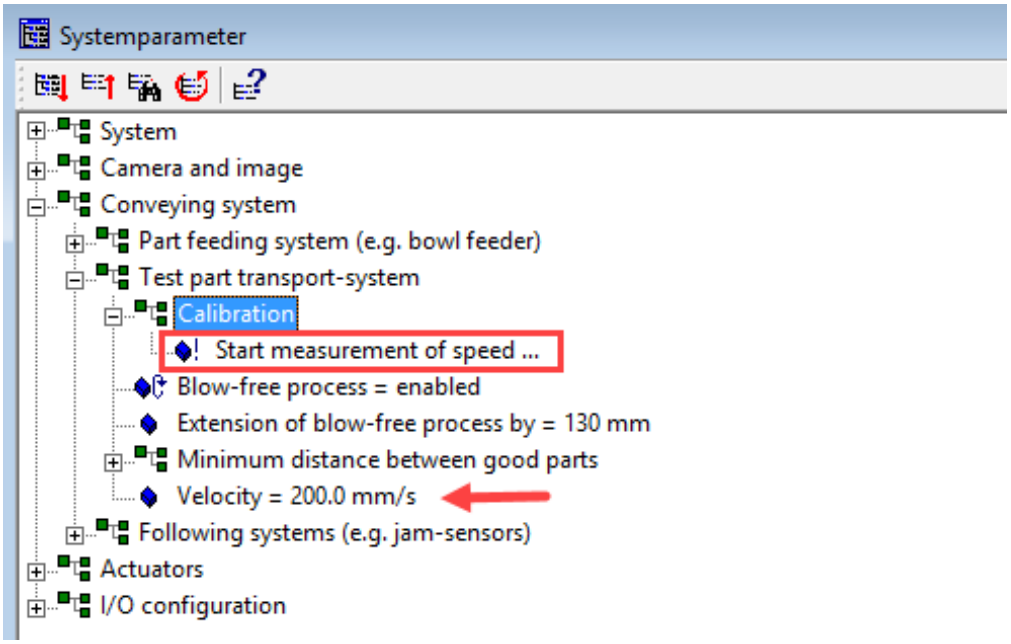


Calibration for time-controlled systems:

Adjust the belt speed according to the needs and requirements.
Important point:
A change of speed requires a new calibration!

Open the Wizard "Start measurement of speed…" for calibration in the system parameters.
The wizard guides you through the process.

After successful completion of calibration, the velocity value is entered in the parameter tree.
(300mm/sec is a default value by Festo)



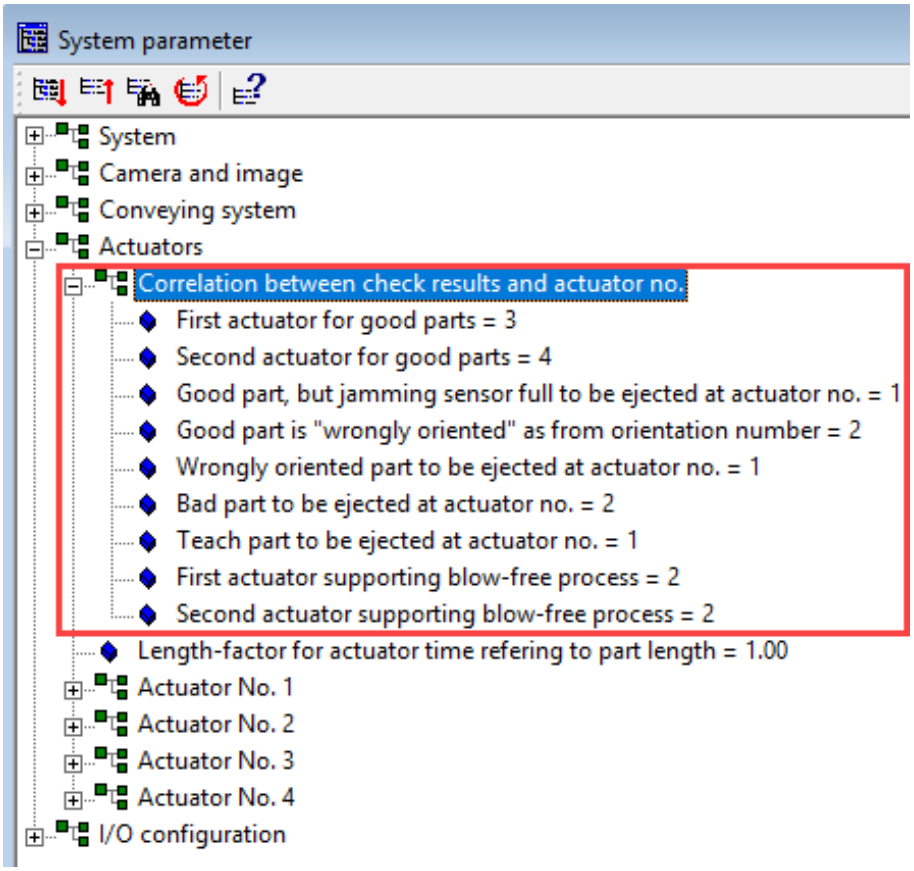
Follow the wizard's instructions. Almost every test piece can be used as a "calibration object".
The edges of the contour should be clearly mapped and measured.
The calibration object should also be able to be transported on the conveyor belt in a stable manner.

7 Actuator settings

Assignment

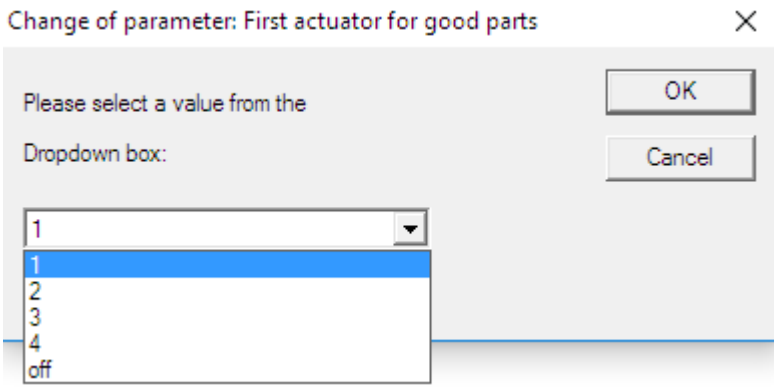
Depending on the parameter setting, the checkbox has 3 or 4 outputs. These are designated in the software as actuators.

The assignments of the actuators to the corresponding function are configured in the system parameters. Double-clicking on the parameter opens a menu.



Each category of parts is assigned to an actuator, according to the available hardware.
Several assignments to an actuator are permissible and common.

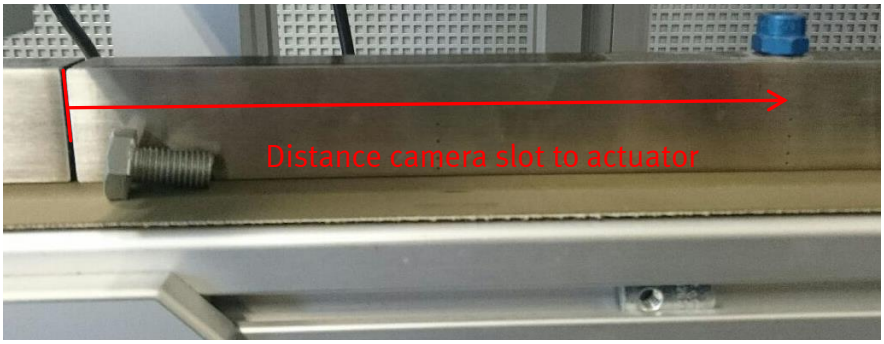
Example of menu:



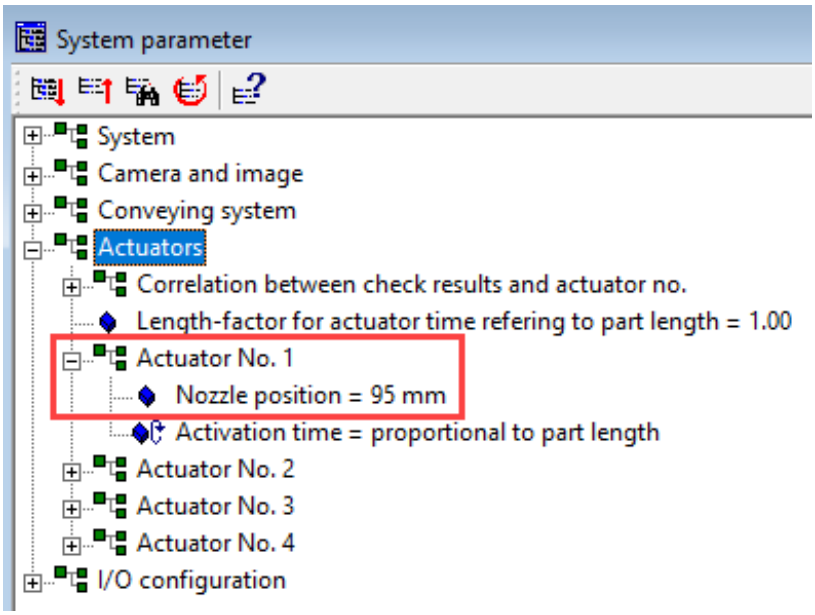
Position

In order to reliably discharge the parts, the checkbox must know the correct position of the actuators in relation to the camera slot.
Parameter: "Nozzle position = XX mm".

All dimensions refer to the camera position with the slot in the guiding bar.



The appropriate dimension must be entered for each actuator used.



When using valves to blow off parts, the setting "Activation time = proportional to part length" must be set. (default value)
By changing the nozzle position the activation moment can be influenced!

Blow-free process

If the STOP button on the checkbox is pressed, the conveyor system is stopped immediately. As a result, there are parts on the conveyor belt that have not yet been blown out.
These parts can no longer be reliably treated. That's why the air blow-free process exists. This ensures that when the START is renewed, all existing parts are discharged from the conveyor belt.
Therefore, the blow-free parameter is switched to active by default.

This is set in the system parameters for conveying system › test part transport-system.
By increasing the value of the parameter "Extension of blow-free process by = xx mm", you can reduce or increase the activation time of the actuators after the START of the checkbox. To determine the correct value, make sure that all parts located between the camera and the actuators are reliably blown out. This applies to long parts lying on the conveyor belt and still protruding into the camera slot.
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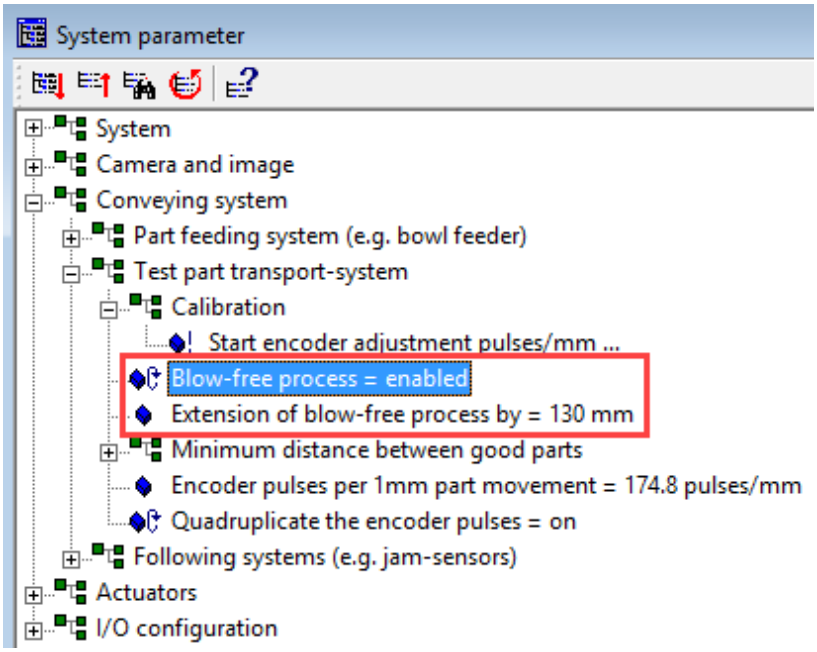
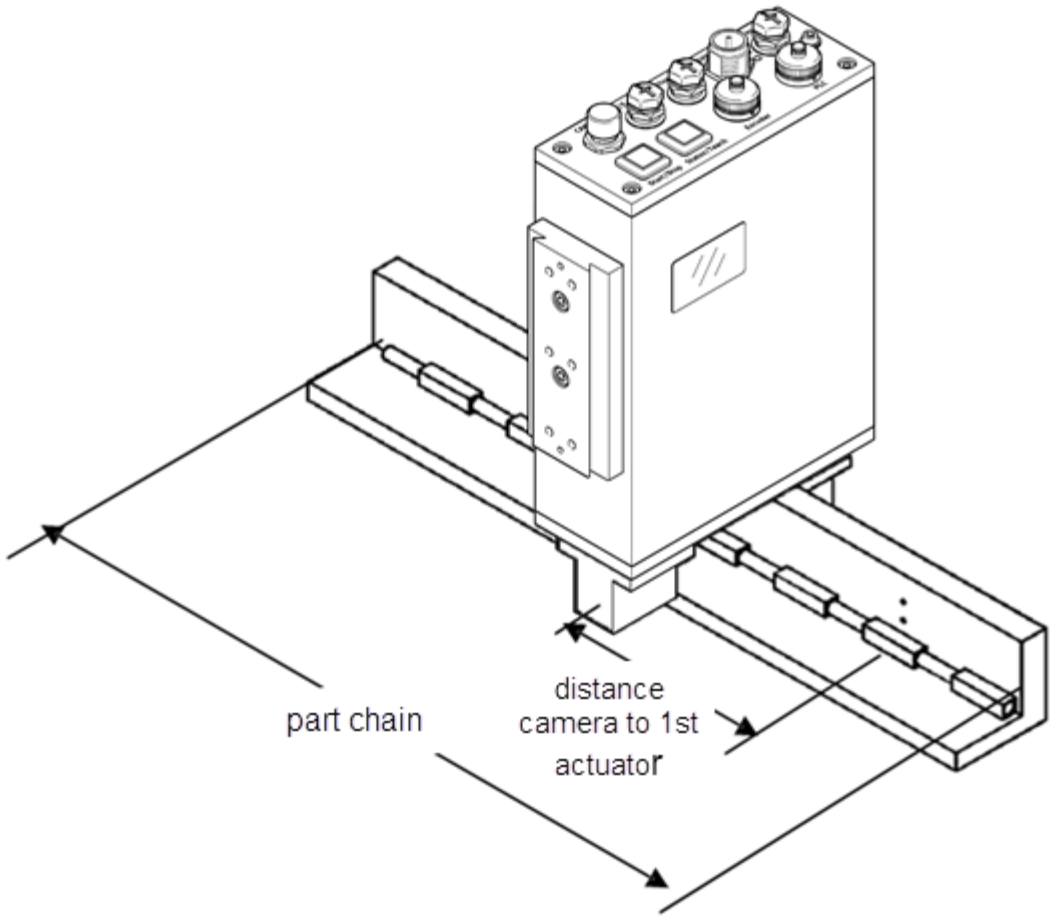


Part feeding

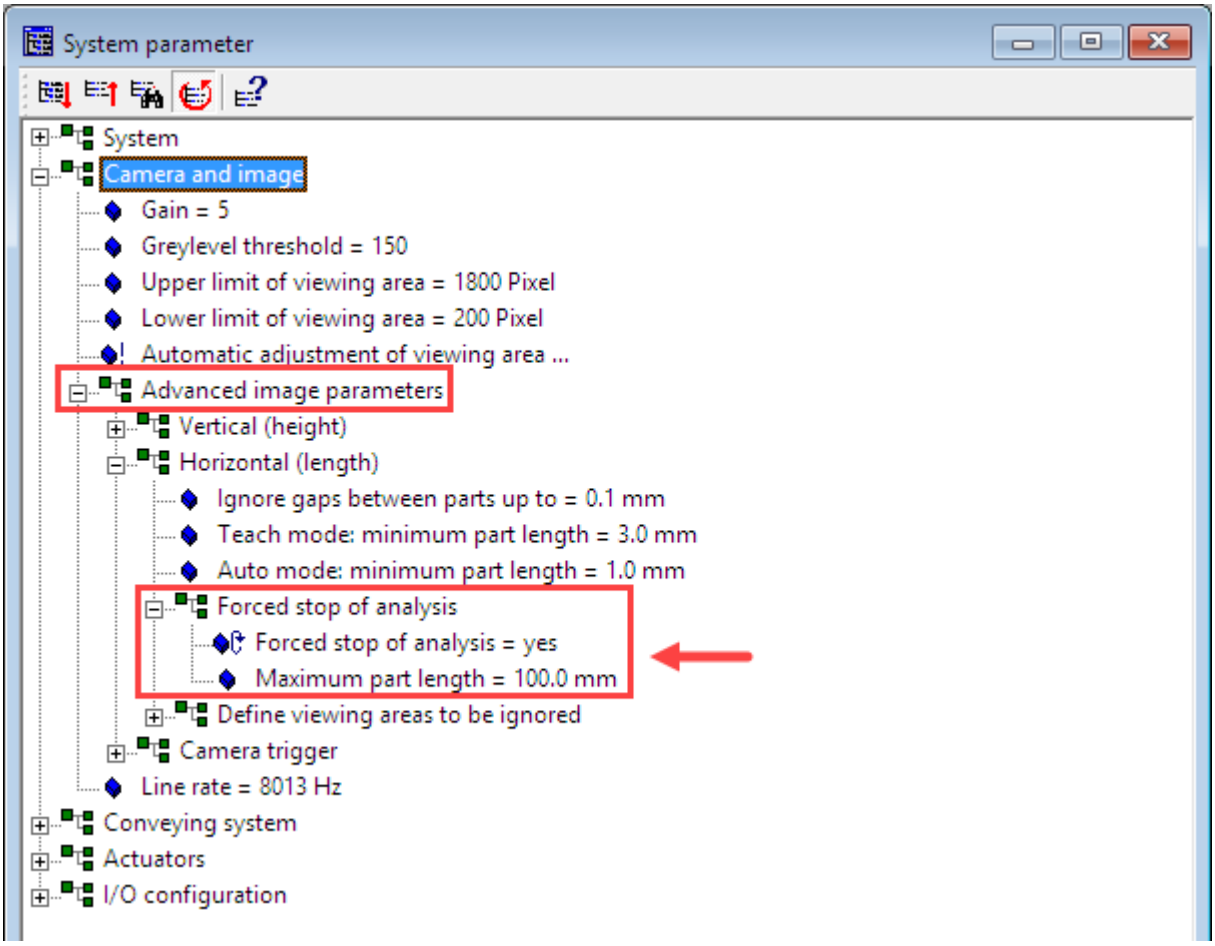
In some applications, it cannot be guaranteed that the test parts are always singled out in front of the camera, i. e. chains of parts can occur, for example, due to interlocked parts. These part chains are seen by the checkbox as one part and they are analyzed until they have passed the checkbox completely (i. e. no object is visible in the viewing area of the checkbox). The complete chain is then ejected as a wrong part on the bad part actuator. In the worst case, this chain of parts is longer than the distance between the camera and the first actuator. This leads to an illegal operating state and would cause the error "Error 18". (according to the following figure) This situation must be prevented!



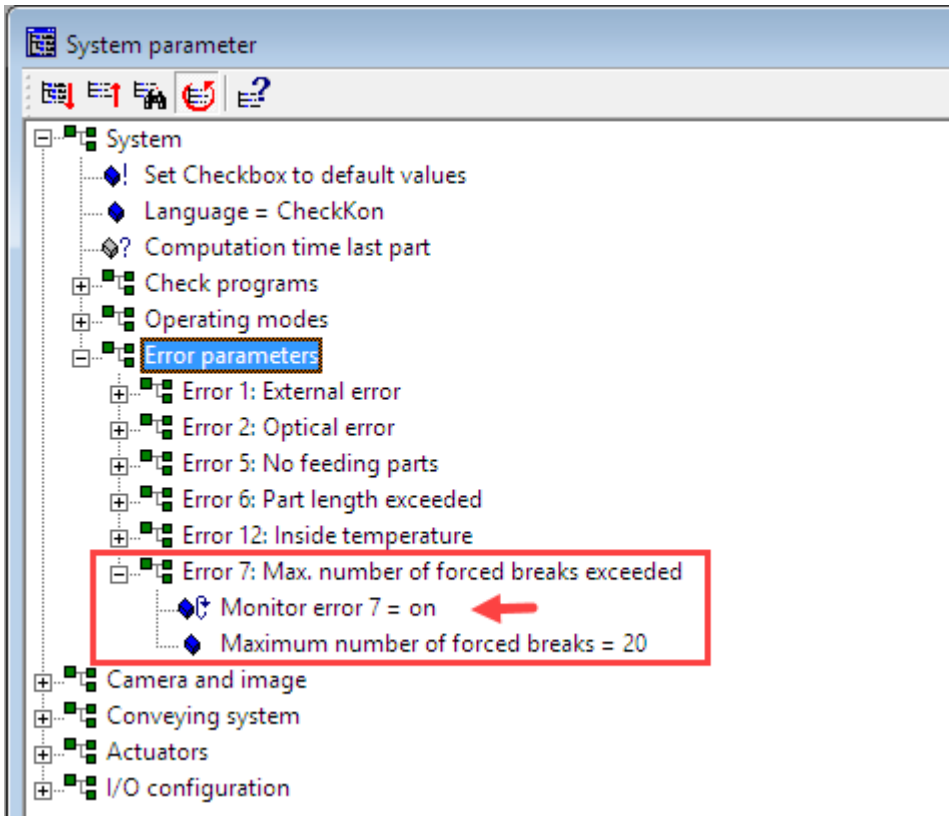
To prevent this situation, the parameter "Forced stop of analysis =" is used. This causes that the analysis will be interrupted and a new scan is started. The point of interruption is adjusted by the mm-value in the parameter “Maximum part length”. This causes several "artificial parts" which were discharged accordingly to the parameter setting of actuators.

For the value of the “Maximum part length”, enter a value smaller than the distance of the shortest distance of the first actuator. E.g. Actuator 1: Distance to the camera = 120 mm › requires a value of the part length of max. 100 mm when the analysis is forced to stop. Since the "fragments" are also calculated, the calculation time must be taken into account.

Setting the forced stop of analysis in System parameters



The number of “aborts” can be configured so that this state does not occur permanently.
E.g when a part gets stuck in the in the viewing area of the checkbox.



When the maximum number of forced breaks is reached, an error Error 7 is generated and the system stops.

Note:

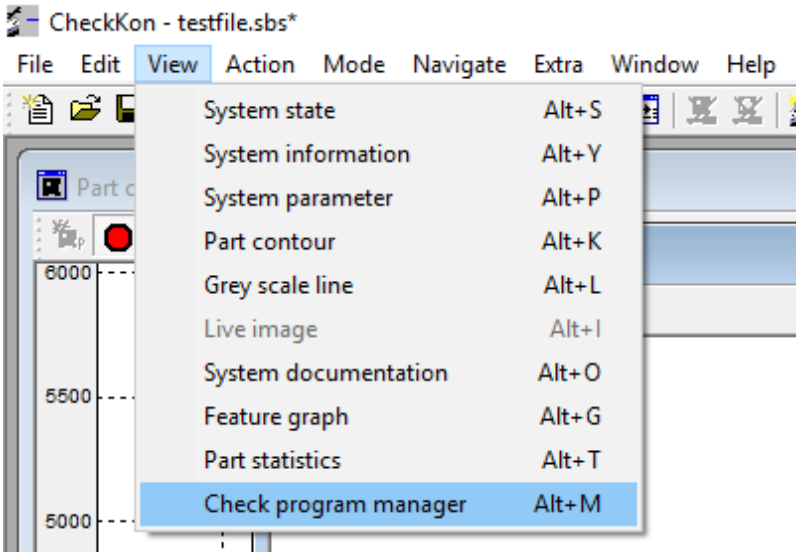
At this point, the parameterization of the system is completed. You can now begin learning the parts. This can be done directly via the teach-in function or using the software CheckOpti.

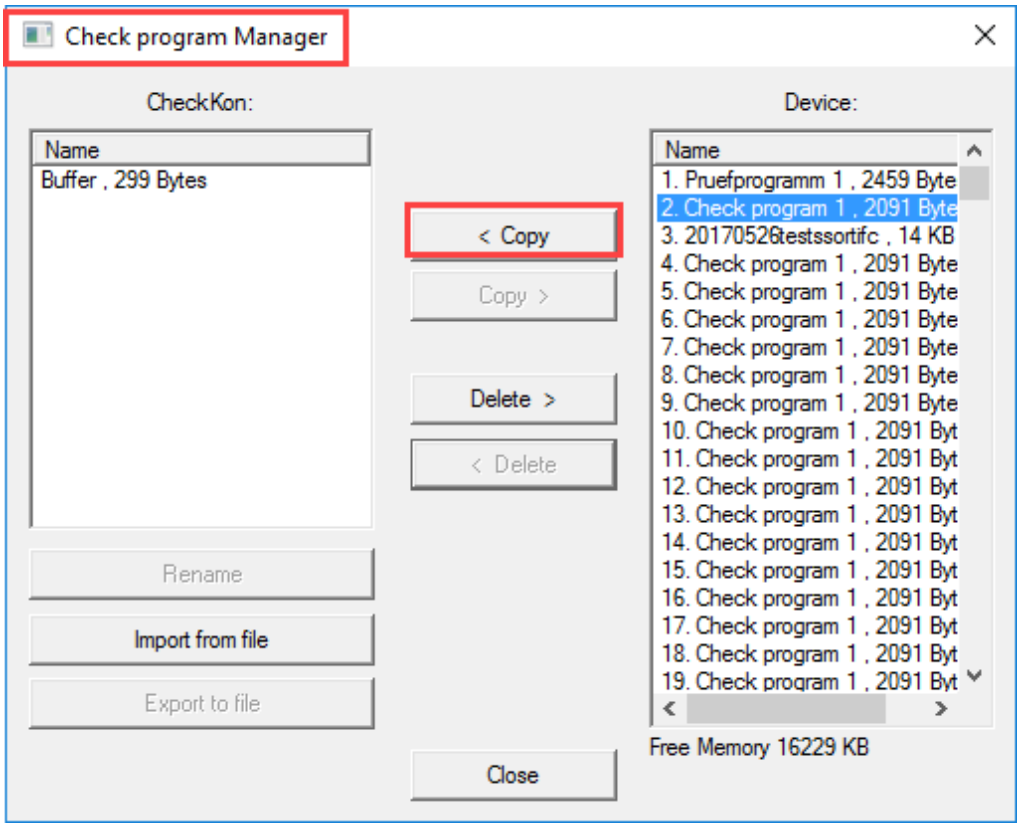
8 Data backup

If the system is working reliably, you should save the selected settings as a backup file.

To get a complete data backup you have to load the existing data from the Teach-in memory into the software CheckKon. These data files are called “Checkprogram”.

To do this, open the “Check program Manager”: Menu › View › Check Program Manager

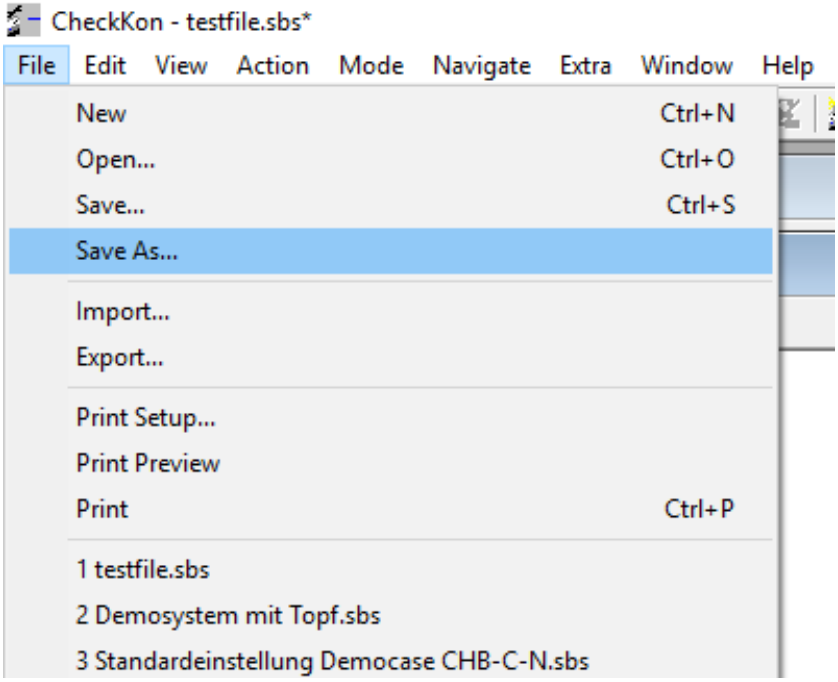




Mark the memory locations with the taught-in parts in the "Device" column on the right-hand side. Then press the "‹ Copy" button.

Then the checkprogram files in the column CheckKon appear. Here it is possible to name the file or to change the names. This name is also shown on the display of the Checkbox, and gives the user an helpful feedback about the selected checkprogram.
Then, the window can be closed.

Now the completed backup file can be stored by the “Save...” menu of the file actions.
The file extension is xx.sbs.



Finish!

This completes a basic commissioning.

Further settings for the detection of quality defects or counter settings can be carried out with the CheckOpti software package.

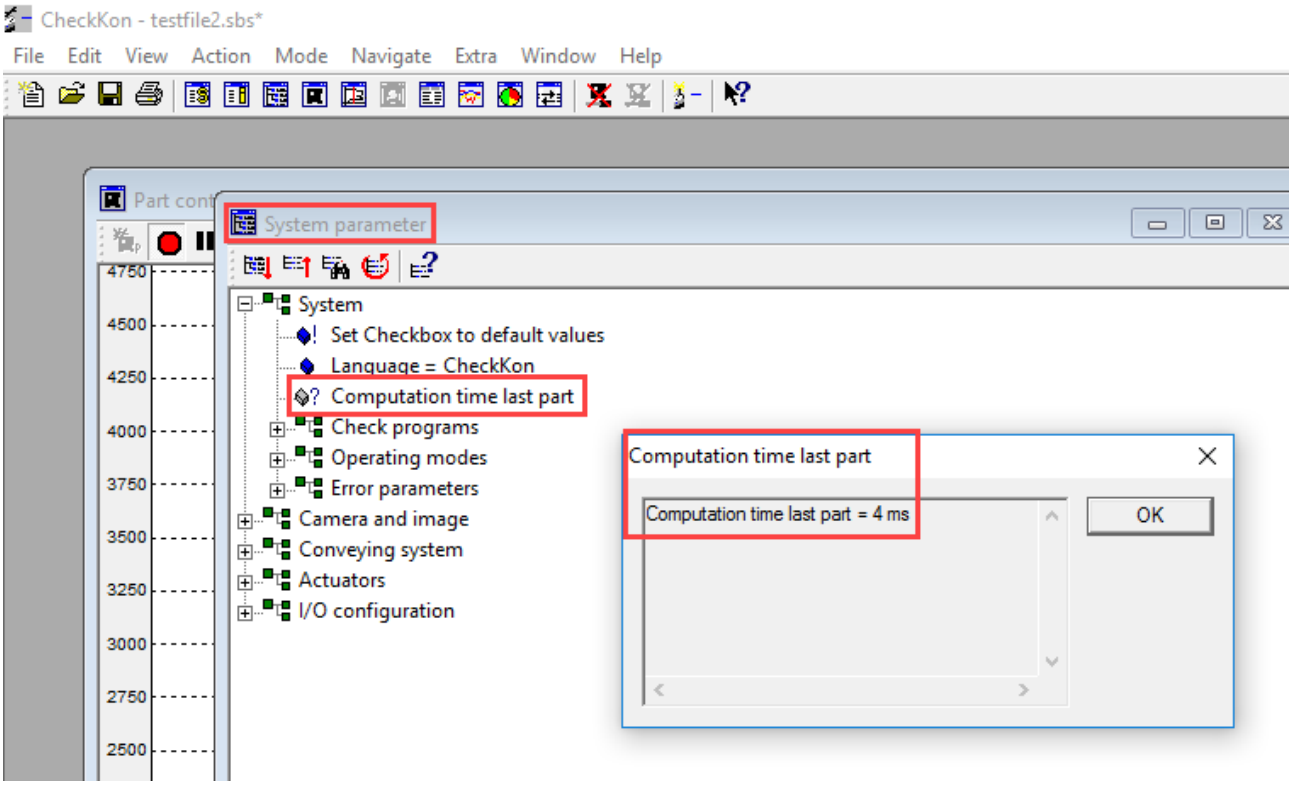
The current version of CheckOpti is available for free download in the Festo Support Portal at www.festo.com/sp

9 Appendix

Determining the processing time

To evaluate the exact time of calculation, the calculation time of the last part can be queried in the system parameters.

CheckKon displays the calculation time which is named as “Computation time last part”



The dialogue window shows the required processing time. It includes also the duration of the data/image transmission to the connected PC.

The calculation of the actual required distance for the position of the first actuator can thus be carried out according to the actual conditions.

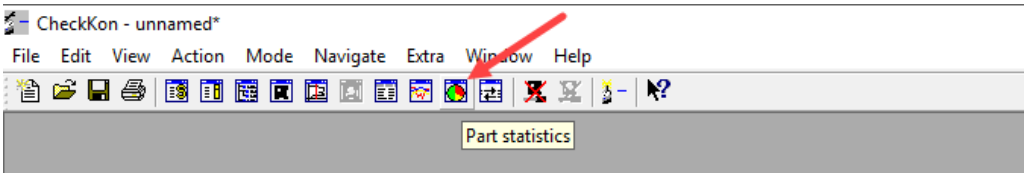
Please note, however, that this time may change for different parts. It therefore makes sense to add a safety factor to the calculation

Calculation example see chapter 3.

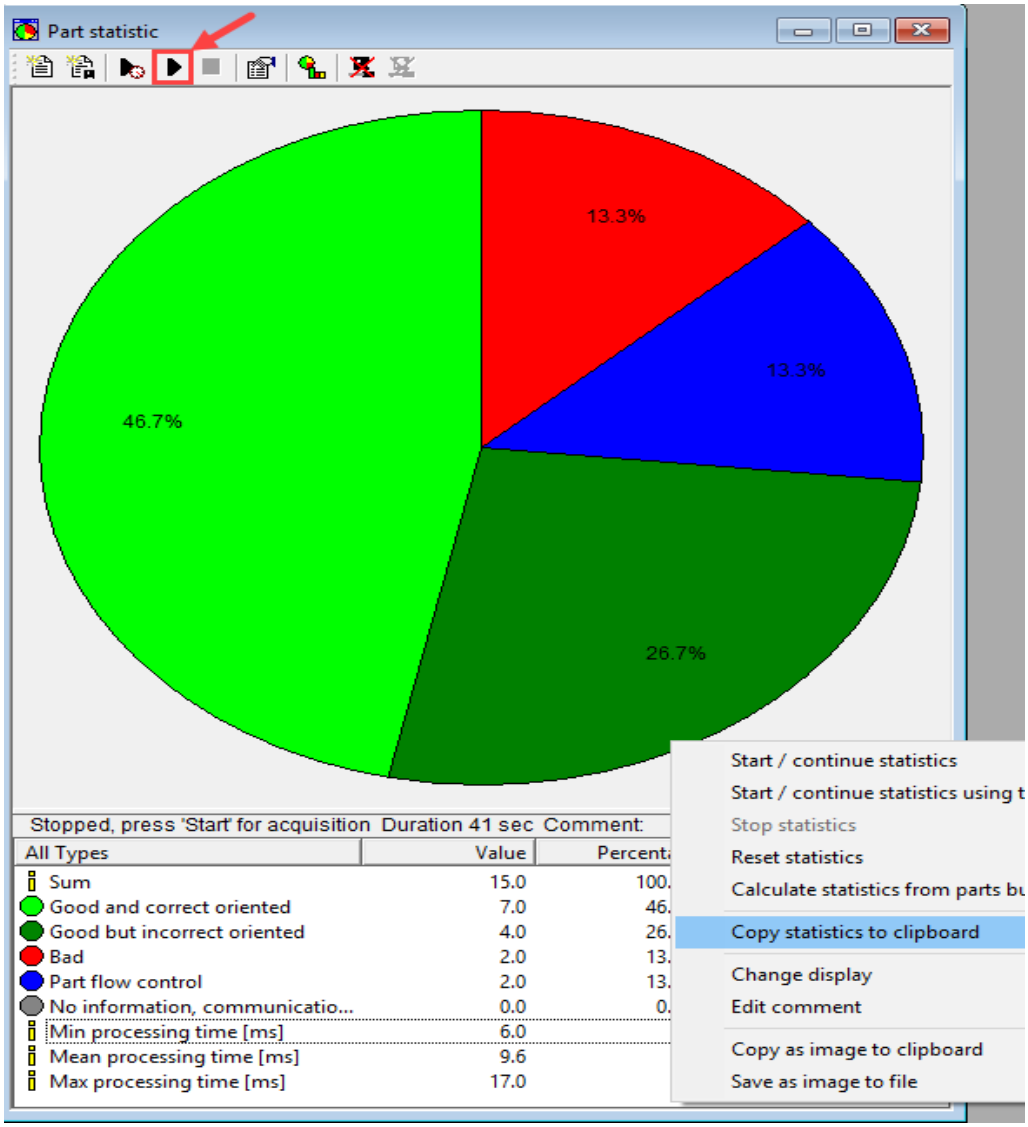
Statistics functionality

The CheckKon software offers the possibility to create statistics about the part processing of the system. This allows to evaluate the inspection results and the part output of the feeding system in operation mode.

This data can be exported via the clipboard (right mouse button) to Excel and further processed.



Visualization of statistics in CheckKon:
The recording can be started/stopped with the "Play" button.



The blue “pie” represents the parts, that have been ejected by the part flow control. This includes parts, that were fed during jam sensor was active or in counter mode, when the preset counter value is reached.