Application Note



SBRD use cases for duo camera application



SBRD (pn:8067301)

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1 Hardware/Software

Typ/Name	Version Software/Firmware	Herstellungsdatum
SBRD-DemoCase	98237	
CCS	1.0.19231	

Table 1.1: Hardware/Software

1.1 Available manuals

SBRD

DE: Support Portal > C:\Program Files\Festo\CCS\help EN: Support Portal > C:\Program Files\Festo\CCS\help

2 Description of the use cases

The SBRD is a remote head vision controller with USB 3 interface for 2 cameras. The highlight of the controller is that both cameras are processed simultaneously. This means that with a trigger signal both cameras record simultaneously.

Image processing and evaluation are also carried out together in one inspection program.

Independent use of the two cameras with different trigger inputs is not possible in the described software version. May be available in future developments.

The addressed applications are usually designed to inspect one object in different views or in different positions.

In this Application Note we focus on 2 use cases:

First use case

Inspect an object by 2 different views. One camera will capture the top view of a part and inspect the quality. The second camera inspect a 2D code which is placed on the side of the object.

Top view camera:





Side view camera:



The red marked area must be inspected. It has to be checked whether all 4 screw at the corner of the module are mounted and if only 4 of the maximum of 8 LED are available.(count LED)

The 2D code has to be read, and transmitted to an controller by ETH dataoutput.

Second use case

2 cameras detect the edge position of a wide band. The width of the band should be calculated upon the measures of the 2 cameras. The result is shown in mm values.



3 Basic configuration with software CCS Camera Configuration Studio

The camera at the SBRD controller is configured with the software " CCS Camera Configuration Studio" The software is available on the support portal. Before you connect to CCS you should check you ETH adapter setting on your PC and the camera. The demo work with fix IP addresses for the particular components. So adapt your PC setting to a fix ip-address in the same subnet as the camera. The camera has on default an address 192.168.4.2 255.255.255.0

The IP-setting of the camera could be changed by the software FFT Festo Field Device Tool. > available on Support Portal.

Connect both camera to the controller and supply the I/O_24V . (Both input left and right at the controller see photo)



Remark: The assignment of the cameras in the software is independent of the used USB socket!

Start CCS software:



Select: New job

3	
	New job Create a new job
	New job on device Establish connection, switch device to Configuration mode and create an new job
	Open job from file Open an existing job from a file
	Load job from device (Run mode) Establish connection and load a job from device, device remains in Run mode
	Load job from device Establish connection, load a job from device and then switch device to Configuration mode
<u>۲</u> ۰۰۲	Monitor device operation Establish connection, load active job from device and monitor device operation, device remains in Run mode

Follow the steps on the left column of the CCS software:



Connect or search device:

Click on the ip-address to search for devices on the network.

Connected device	<
[Connection required]	() - \$ - 6
Not connected	Connect
Device mode: [Connection required]	Configure
Job: [Connection required]	8 8

Name	IP	Туре	MAC	
MMT-AS-C4-3A-PN-S1	10.101.64.119		00-0E-F0-12-02-57	
12	10.101.65.120		00-0E-F0-12-08-78	
PX+E-CEC-Pruefstand-MCHJ	10.101.64.46		00-0E-F0-5A-AA-CB	
rehmomentenpr?fstand	10.101.64.188		00-0E-F0-57-72-1C	
é-CT_TEMP_BAR_EBENE1_OFEN	192.168.0.111		00-0E-F0-4C-E4-D9	
E-CT_TEMP_DRUCK_EBENE1_DAUER	192.168.0.112		00-0E-F0-50-97-F3	
BRD-Q	192.168.4.2		86-F2-24-80-8A-7E	
Pool-System-SHI-2	192.168.2.20		00-0E-F0-50-B3-7F	
Pool-System-3H-2	192.168.2.20		00-0E-F0-50-83-7F	



Sonnected device	٢
SBRD-Q, F/W v1.1	— • • • •
Onnected	Disconnect
Device mode: Run mode	Configure
Job: 1. Job 1	≣ 🔒

If connected is confirmed > Enter Configuration mode > press

Configure

If Button appear red > click on button for diagnostic message

Connected device	e	<
SBRD-Q- ^L , F/W v1.0)	0
Connected	Disconnect	t
Run mode	Configure	
Job: 1. Job	iΞ	6

Resolve the Error cause to continue with the project.

Configure Mode:

In configure mode the controller is forced to stop the active job processing. The current setting of the active job is not changed by the following adjustments. The new setting has to be downloaded to the controller, as described in step 8 of the job navigator. To abort you can switch to run mode and disconnect device.

Follow the steps in the Job navigator.

Step 1.: Set up

By the autodetect, the connected camera were shown in the camera selection window. You can edit own name for the particular camera by edit button.

Camera sel	lection	×
Camera 1	Top View 28 S/N: 4103116538)	
	10	
Camera 2	(Siede View R2B S/N: 4103269693)	- (1)
	()	Ŭ

Step 2.: Configure cameras

In the ribbon bar you set up the image parameter. The brightness by the exposure time and gain. The size of the image could be changed by shifting the limits with the mouse.

If needed the Coordinate Calibration could be performed in this step.

The image window show only one camera image. To change between the 2 cameras you have to select the active camera in the drop down box left top corner of the window:



Remark: The numbering of the camera is independent from the USB connector on the device! It is only a definition in the software! The assignment is based on the serial-no. of the camera device. If camera has to be exchanged you have to assign the new device in Set-up, otherwise you get an Error: "Camera type match failed"

When the images of both cameras are adjusted as the inspection demands, go on with the next step.

Step 3.: Acquire records

For the further steps we need to have images for a simulation of the inspection task. The CCS software manage the records in different container. Each container has a different meaning.



Teach records, only records of **GOOD** parts, Base for tolerance calculation



GOOD and Bad parts, Simulation result of the inspection program



Storage container for short period, will be deleted after closing CCS



Records captured online, that are evaluated, for confirming the set up and data logging, will be stored after closing CCS

The ribbon bar offers a button for Trigger. Every click on Trigger will capture an image of both cameras simultaneously. By default setting, the images were recorded in the Temporary records container as a filmstrip. By drop down menu you can see the different image of camera 1 and camera 2. Check both images if the capture is good for the task.

Remark:

Use only captures where both camera show good part images for the sample container! Until step 3 the description fits to both use cases. Also to other use cases where only one camera is in use.

4 Setup the inspection Use case 1

Step 3.: Acquire records

The camera for side view must show the 2D code in all the possible positions. The topview camera should capture the entire part with the details for inspection in all possible positions. At the end, the record list should contain images from Good parts and from Bad parts in all occurring variants.

After all the images recorded we have to drag and drop the image from the Temporary record filmstrip to the record list of Sample records and Inspection records.

At least we need 1 image for the Sample records list. All the other images were pasted in the Inspection record list. Image which are somehow damaged due to wrong operation could be deleted.

At the end of this step the record list should have at least following content.

Use the comment column to identify the parts failure. For multiple parts with the same comment, you can select the group and press F2 to assign comments to the whole group.

Recor	d lists	×	Re	cord v	riew ×					
9-	Ignore	Nº	Ori	Туре	Comments	-	N₽	Ori	Туре	Comments
		1	1	1	io-Part		1	1	1	io-Part
							2	1	1	io-Part
							з	1	1	io-Part
							4	1	1	io-Part
							5	1	1	io-Part
							6	1	1	io-Part
							7	1	1	nio-Part
							8	1	1	nio-Part
							9	1	1	nio-Part
							10	1	1	nio-Part
							11	1	1	nio-Part
							12	1	1	nio-Part
							13	1	1	nio-DM
							14	1	1	nio-DM

Step 4.: Prepare inspection

The meaning of this task is to set up tools, which calculate the position of the object in the image. These position coordinates are used to install the tools to evaluate the quality of the part in step 5.

The position detection for this task is made by xPMATCH tool. This tool search for a "learned" pattern in the image. In this example we learned the FESTO logo on the part for the position reference.

Learning procedure:

(1) Select the xPMATCH icon from Tool library and drag it in the Tool structure window.

(2) Move the search window of the xPMATCH to the area where the pattern could appear.

(3) Open the tab Sample patterns in the Tool setting window. With + you open the pattern wizard. Select the pattern and adjust the window. Use the automatically adjust button. Then define the origin coordinate system of the pattern. > Finish.

In the tab General, you can adjust the performance of the pattern search. E.g. the minimal match score. By default it is 80%, but in some cases it may has to be changed.

Example window and settings:



Before you continue with the next step, you should verify if the pattern is matched properly. Step through all the images in the filmstrip of the inspection records. FESTO has to be found in every record. (no invalid result is allowed!)

Step 5.: Inspect objects

Inspection of the screws

Task is to check the presence of the 4 screws at the corner of the module. This could be done with 4 ROI tools. They have to be placed on the particular screw position.

There are different possibilities to apply and add tools to a job. This Application show only one style!

Select a ROI tool from the Tool library, move and drop it in the image at its supposed position on one screw. We will adjust the necessary setting for the first ROI and afterwards copy the tool 4 times.

Move the ROI to the location of the first screw. Change the shape to circular in Tool setting, tab General. Adapt the size and position by mouse to the screw.

But pay attention to the mouse cursor! Do **not** move the tool by the blue center-point, you will change the offset values of the rotation point!





Look at the arrows at the mouse cursor!

Tab Threshold:

The ROI tool calculate the amount of Pixel in its region, based on the threshold setting of the brightness. In this inspection, we expect the missing screw with dark pixel. So we adjust the threshold to count the dark pixel. Open the Threshold tab and adjust the limit that only the dark pixel are recorded. You can shift the limit by mouse in respect to the shown histogram. In the image you can see the effect of the limit by blue colored pixel.

र्षे Tool results ×	Tool settings ×		A Automatic *	
All Features General I	nfo Position Rotation Threshold			
 Threshold 			A CONTRACTOR OF A CONTRACTOR O	100
Threshold type	Brightness	· ·		
Brightness	Within range	· ·		
Min. brightness	0	· ·		
Max. brightness	70	· ·		
	Brightness			
Level	worken war have been worken and			

IF, shape, position and threshold is adjusted, you have to reference the ROI to the location of the pattern match results. This is made in the Tool structure window:

Select the ROI and move it on the xPmatch tool. A mouse over comment will show: Activate xRun Move into xPmatch.

Tool structure			×
Name	Refs.		
過 xPMATCH: xPMATCH	8		
🕭 ROI: ROI	8	Activate xRun: Move into xPMATCH: xPI	MATCH

If you release the mouse button the ROI is referenced to the xPmatch and the Tool structure look like:

Two structure						
Name	Refs.					
a xPMATCH: xPMATC	сн в					
🕒 🕒 ROI: ROI	Ø					
Tool results ×	Tool settings ×					
All Features General Info	Position Rotation Threshold					
 Position 	\smile					
Diameter	66.681	*				
X center	-413.45 + xPMATCH: X coord.	-				
Y center	290.9 + xPMATCH: Y coord.	*				
Z coordinate	Z-value of job properties	*				

In the tool settings tab Position you can see the reference and the offset for the ROI. As well in the tab Rotation the xPmatch references are connected.

Now the first ROI is configured and it could copied 3 times. Select the ROI and click right mouse button for context menu. Select Copy

ol structure			
Name	Refs.		
뤎 xPMATCH: xPMATC	сн 🖉		Tool structure
L 🕑 ROI: ROI		01.0	
	Сору	Ctrl+C	Name Refs.
	Cut	Ctrl+X	B DUNTOU DUNTOU P
	Paste	Ctrl+V	and xpmaich: xpmaich of
	Delete	Del	
	Select All	Ctrl+A	🗘 🖓 ROI: ROI
	Reset feature r	names	
	Reset tool(s) n	ame	
			Paste direct on the ROI!

Now you get an exact copy of ROI with the name ROI 1. If The "Enter" symbol is like shown above, the copy of the Roi is also referenced to the xPmatch tool.

Repeat this sequence 3 times to get 4 ROI entries in the Tool structure.

Now all ROI located on the same screw. As next step move each ROI to the specific positions. (Record view)



If you multi select in Tool structure, all ROI were displayed.

To get a better overview for the different ROI, it is possible to give them separate names in the Tool settings "Name" field.

Two structure					>		
Name		Refs.					
🔴 🚠 xPMATCH: xPM	ATCH	S					
🖵 🕒 🕼 ROI: ROI							
↓ 🛑 🕲 ROI: ROI left-top							
4 🔵 🕑 ROI: ROI	-right bottom						
↓ ● (學 ROI: ROI-left bottom							
Tool results ×	Tool setti	ngs ×					
All Features General	nfo Position	Rotation Th	reshold				
 General 			_				
Name	ROI-righ	nt top					
Calculate on	☆ Ca	mera image	1: R5B (S/N: 410325526	-			
Shape	Circul	Circular region					
Threshold type	Bright	ness		-			
Brightness	Withir	Within range					
Min. brightness	0			*			

Inspection of the LED

The next inspection is done by xSBLOB tool. The availability of the status LED were checked. The xBLOB will count the amount of blobs. Every blob represent 1 LED.

Select the xSBLOB tool from the Tool library, move and drop it in the image at its supposed position. Adapt the region of the tool to cover the mounted status LED by mouse. Select the xSBLOB in Tool structure and move it on the xPmatch tool. A mouse over comment will show: "Activate xRun Move into xPmatch"



Then adjust the Tool settings as shown:

J settings ×	That settings	×
Feature Filter internal Info Position Rotation Selection		
eshold	All Features Filte General nfo Position Rotation Selection Threshold	
Filter	 General 	
/hen tool region is to	ocheral	
/hen other objects in	Name xSBLOB	
Filter feature Area 💌 =	Calculate on 🖄 Camera image 1: R5B (S/N: 4103 💌	1
Range min. value 200 -	Shana Bastana Incorting	
Bange max value 500	Shape Rectangular region	11
Elhan fanture aff	Blob-Type Contour blobs (8-neighborhood)	1.
Filter leature on		
ettings		
tures Filter General Info Position Rotation Selection Threshold	a loor settings	<u>^</u>
shold	All Features Filter General Info Position Rotation Selection Inreshold	
hold type Brightness *		
tness Within range	 Selection 	
brightness 0		
Brightness	Number of result blobs	r.,
l l l l l l l l l l l l l l l l l l l	Stop evaluation when	۰.
· · · · · · · · · · · · · · · · · · ·		
• <u>1</u>	 Sort feature Area 	н.,
I A	Sort feature Area	÷.
	Feature Filter Feneral Info Position Rotation Selection shold iiller hen tool region is to Image mark Filter feature Area Range max. value 200 Filter feature off Brightness Within range prightness 0 prightness 110	Freatures Info Position Rotation Selection All Features Filte General nfo Position Rotation Selection hen tool region is to Image Image General nfo Position Rotation Selection Threshold Filter feature Area Image Image Calculate on Image Calculate on Image Calculate on Image Shape Rectangular region Image Shape Rectangular region Image I

After the setting you can step through the images and check in Tool results, if always 4 Blob were found.

Quality classification setting

If all tools are adjusted it is necessary to set the quality classification. By default every tool is **not** used for a God/BAD decision. So the tools, that should check the quality, have to defined in the window Tolerance ranges.

Every tool can offer multiple feature results. But only some features were determined for the inspection of the quality. In this example the feature "**Area**" of the particular ROI's are responsible for the quality. (the amount of pixel is called area, and a missing screw will cause a bigger area. This difference could be used for the quality inspection)

The area of **each** ROI must be assigned to use for the quality classification. So hook (1) the checkbox "Use for classification" in every ROI!

Then select the "Manual" mode in Advanced settings. After that, you can adjust in Tolerance range(2), the upper and lower limits for "Good-part".





Every "used for classification" feature has to be within the limits, which is displayed in the column Effect. Min and Effect. Max. values.(3) This limits are calculated on the general tolerance(4): Default 5% All measures out of this limits were classified as BAD-part.

You have to check if all parts were classified correctly. In Record list of the inspection parts, the result must be correct as the record of good and bad part are. Good part must have a green hook, bad parts will get a red cross. If not, then you have to adjust the tolerance range of the affected tool. (Results overview show the result of every single feature.

TCH > RC
nments
Part
-Part
-Part
-Part

Additionally the Graph window support to evaluate the results of every feature. Every point respect one part. The limit of the values are shown with the green bar. Good-parts have to stay within that range. Every part out of this range is rated as a Bad-part.

		(10015 > XFIMIATCH	. AFIMIMICTI > NOI	. KOI-fight top > *	i. Area > value) ×								
Ø 📕 Object orientation:	All 🔻 Object type:	All 🔻 Data to di	splay: 📈 •										
1000 -													
900 -			Å ba	d part out									
800 -			/ \	or mine									
700 -													
600 -													
500 -													
400 -													
300 -			\\								upper	limit	
200 -			/									↑	
100	0-0-				00	0 0	• •	•	0	0	•		1/1
0													
-100 -											lower	limit	
1 2	3 4	5 6	7	8 9	10 11	12 1	3 14	15	16 17	18	19	20	

To change the value for the display, you can select another feature in the Tool structure or in any other window. Or do a selection in the "Data to display" drop down menu.

Code reading with the second camera

Drag and drop a xDATACODE tool from the Tool library to the end of the Tool structure. (or double click on the tool icon)

Record view ×	Tolerance ranges ×	Results overview ×			Tool structure	
Automatic	*		Xiprej Viprej Brightess Hue	673 950 45 🖬 0 🖿	Name Name	Refs. H ht top -top ht bottom
		CPX-CMAX-C1-1 548932 D702 Rev 07		<	Col results ×	tbottom LOB AccoDE Fool settings ×
	f.T	00000010328015		¢	All Features General Info Ceneral Name Calculate on Shape Usage of color image Code type	Position Rotation >DATACODE \$\therefore Camera image 2: R58 (S/N: 4103255267) Rectangular region Colour to grey image ECC 200
	11	88.2		— 65%	Number of result codes Variable matrix size Features Code data > All features Testinon	v
Tool library ×	Graph (Tools > xDATAC	ODE : xDATACODE > 13. Code data > Val	ue) ×			
▲ Chainspection tools Chainspect detection Chainspect detection Chainspect detection	on tools tools	ROI Calculates area-based features of a single object.	xBLOB HALCONI Calculates area and contour-based features in a tool region. The pixel c	ODE Reads Data Matrix d at the same time eir quality (reada	xPMATCH [HALCON] Searches th region for matches wi previously taught pat	he tool th a tern. xSBLOB Calculates area and contour- based features in a tool region. The pixel coherenca

Select the side view camera image in Tool settings tab. The record view is updated immediately when the Automatic option is activated.

Move the xDATACODE tool to the region where the 2D code is expected.

In the Tool settings the code type and number of expected codes can be adjusted

Tool settings						
All Features General Info Position Rotation General						
Name	xDATACODE					
Calculate on	☆ Camera image 2: Siede View (R2B S/N:	*				
Shape	Rectangular region	*				
Usage of color image	Colour to grey image	*				
Corle type	ECC 200	-	-			
Number of result codes		1	-			
Variable mauix size		_				

After the setting you can step through the images and check in Tool results, if all datacodes were readable.

If no other feature have to be inspected then next step.

Step 6.: Configure I/O

In this step the I/O assignment is adjusted. In this example we use the digital I/O for the trigger and result communication.

By default there is a basic setting for inputs and outputs. For this example we accept the default setting. If any change is necessary, it could be proceeded by drag and drop the function on the column. The pin assignment is also given. E.g. X2.4 Trigger signal.

I/O settings × I/O results ×			1/O structure
Digital inputs General Description Digital inputs			Digital I/O: Type Assigned value Digital inputs Digital outputs
Assignment Drag Available functions Drag Att Trigger signal 전문 Acknowledge error 객문 Acknowledge error, apply inputs ion 관문 Apply inputs signal	Assigned fu Digital X2.2 X2.3	nctions (12) ^ 쉽 Not assigned	
4 <u>t</u> Job number	X2.4	같! Trigger signal	Protocol-based I/O:
	X2.6 X2.7	≹¶ Apply inputs sig ≹¶ Jc ۱ of n ▼ 7 ♀	
	X3.0 X3.1	같 Job number - → ∦ 같 Job number - → ∦	D Add protocol-based
	X3.2 X3.3		

I/O settings × I/O results ×		I/O structure
Digital outputs General Description Digital outputs Assignment		Digital I/O: Type Assigned value Digital inputs Digital outputs
Available functions and data Digital functions and results	Assigned functions and data Digital (8) ^ X4.0 X4.1 X4.1 X4.2 X4.3 ZE Inspection result Not OK X4.4 ZE Inspection result Not OK X4.5 Not assigned X4.6 Not assigned X4.7 Not assigned	Protocol-based I/O:

To use the result of the 2D code, we need to set up a dataoutput for the communication to a PLC controller. There are different protocols available. In this example we use the telnet protocol. This protocol is supported by the Festo Codesys controllers. The SBRD deliver the results in a so called "Telnet Data Collection". This allows to send a couple of results by one access. Details are described in a Codesys library for the particular Festo controllers. Other telnet commands are described in the manual of the SBRD controller.

The I/O library show the available protocols. The Telnet data collection is installed by drag and drop from the I/O library to the window of I/O structure. (1)

After this, the result data have to be assigned to the data collection.(2) Therefore the available Tool results can be assigned, by drag and drop, to the necessary data format. E.g. the code data has string format, so it has to be assigned to the "string 64x8 bit field".

Other results, as coordinates of the code, can be assigned to the "float 32 bit" field.

If feature result is assigned, there is a possibility to change the dataformat of the particular value. (3). "Value(trans)" will transmit the result value in mm converted coordinates.

The addressing for communication to the controller is done by a "Id". This Id is a name for the particular data collection. (4) In the example it is **RDC**. Details for possible names are described in the SBRD manual.

See the settings:

Settings × I/O) results ×	I/O structure
Available functions and data Tool results Available functions and data Tool results Available functions and data Tool results Market AparacoDe: xDATACC Market AparacoDe: xDATACCDE: xDATACCDE	Oresults × ollection ription Teinet - Data Coll Byte order: Utitie-Endian Big-Endian Streaming (send data a MATCH Big-Endian ODE XDATACODE: XDATACODE Value (trans. String: 64 x 8 bit Big. String: 64 x 8 bit	I/O structure Digital I/O: Type Assigned value Digital inputs Digital outputs Digital outputs Protocol-based I/O: Type Id Description Type Id Description Type Id Description
Advanced settings //O library @ IVO E Digital I/O E Protocol-based I/O E My I/O	13. Code data Code (ccl) 14. Code (ccl) Code (ccl) 15. Code data Code (ccl) 16. Code (ccl) Code (ccl) 16.	sult Flagwords gra data and functions he Result Flagwords I/O

Step 7.: Perform test run

This step allows to evaluate the inspection program by the performance of the controller. In other steps the results were calculated on PC-CPU. In test run the results were calculated in the SBRD controller CPU. So we can get the real processing time of the inspection program.

Optimize steps

Step 8.: Finish job

All settings which are done in the first 7 steps are only stored on the PC in CCS software. To get the data on the device you have to download the job settings to a job memory.

Connected device «	Job manager		x
SBRD-Q, F/W v1.1	Festo Camera Configuration Studio		2 Device
Connected	Job 1	82.4 kB	1. Job 1 82.3 kB
Device mode: Run mode	edit job description by righ	Drag and Drop	Case /
Job navigator «	mouse click on the icon	_	3. Job 14.6 kB empty job
1. Set up ~			4. Job 14.6 kB
3. Acquire records ~			5. Job 14.6 kB empty job
4. Prepare inspection 👻			6. Job 14.6 kB empty job
5. Inspect objects ~ 6. Configure I/O ~			7. Job 14.6 k8
7. Perform test run ~			8. Job 14.6 kB empty job
8. Finish job			9. Job 14.6 kB empty job
Adjust job name and description Transfer job to the device Add project documentation, save project			10. Job 14.6 kB
The Edit current job name			11. Job 14.6 kB
save job to me			12. Job 14.6 kB

By drag on the job on left side and drop it on a memory on right side, the setting are stored on the device. The "play" button show the selected job which is processed in run mode.

Last action before you save and close the software: switch the device into run mode and disconnect.



First use case is finished.

5 Setup the inspection use case 2

For the second use case follow the step as described in the first use case until step 2 Configure cameras.

As in the task description mentioned we have to measure the width in mm-values. This demands to calibrate the cameras. We need to enable the cameras to do a coordinate transformation from the pixel values in the image to the mm value in real world format.

This procedure is supported by the "Coordinate transformation Calibration" wizard in step 2.

But before the wizard can be executed, it is necessary to get the calibration pattern available. In the start menu of windows you can find 2 files with the standardized pattern. The difference of the patterns are based on the z-direction, based on the "right hand rule" for x,y,z-handlings.

For this use case we work on 2D, so you are free to use one of the enclosed patterns.



Find the 2 calibration pattern in start menu:

Based on the idea, that we use 2 cameras for the width measurement of a band, we achieve a good resolution. So we adjust the field of view that each camera cover the edge of the band. The area has to be as big as the movement of the band is possible.

Left: Principle of the application



Right: Set-up of the DemoCase



If the field of view is determined, you can print the calibration pattern, that it fits to that size. It should not be smaller than 80% of this area.

All the 20 black dots of the pattern should fit in the camera image! Print a pattern for each of the camera. Put the pattern to the object area where the band is expected. Align the pattern to each other and check in the live image that the pattern fit into the image.



It is not possible to have a view of both cameras simultaneously! So in this example, a ruler help for the alignment process!

Photo of the object area:



If both pattern aligned well, the calibration process could be done.

Remark!

Be sure that both cameras are adjusted in sharpness and brightness. Secure the lens setting by the available fixture screw. Any changes of the lens setting or position of the camera need a new calibration process!

Select the 1. Camera and click on the wizard icon in ribbon bar:



Then select the first option for Measurement application:

Prepare calibration
The cl_bration is only required if tools of the type 'Coordinate transformation' are used. The calibration requires a calibration image with know shape and size. From this image the coordinate transformation parameters are calculated.
The calibration can be done automatically with the supplied calibration pattern. If the supplied calibration pattern can not be used please select the manual calibration.
All calibration points are expected at $Z = 0$ e.g. [mm].
Select application / type of calibration. Enter calibration values when using the automatic calibration.
Units of the world coordinate system (for display only) mm 💌
 Measurement application calibration uses the calibration pattern with a reference length
O Robot / handling application - calibration uses the calibration pattern with 2 reference points
O Manual entry of calibration points - without automatic detection of calibration points
The calibration image must contain at least the 9 main calibration points of the file 'Calibration Pattern' in same order and proportion. The file can be used by printing out in suitable size.
Measure the required coordinates in reference to the center of the world coordinate system and enter here:
Reference point 1 (big point): 50.00 🔿 X-coordinate e.g. [mm]
50.00 🗢 Y-coordinate e.g. [mm]
Measure the length Lip the calibration pattern and enter here. The axis of the calibration pattern have to be parallel to the axis of the world coordinate system:
53.00 🔿 e.g. [mm]

Now enter the value x,y-coordinate for Reference point 1. For this application with the measurement it is not very relevant which value is entered, because the width is measured relatively, not absolutely. So it could be the position of the reference point 1 in the field of view.

But important is the length L in the print of the pattern. In this example it is 53mm.

(The length L is indicated in the pattern, and it describe the distance from center reference point 1 and the reference point 2.)

> Next



Press the "Record new calibration pattern image"-button. Then an image is captured and evaluated. If the green dot appear, the calibration was successful. If the dot is red: Try different setting of the threshold sliders to achieve a better image until the dot get green.

Then press Finish. The 1st camera is calibrated.

Select the 2nd camera in the Live image and start calibration wizard again.

Edit the value for the reference point 1. For the x-coordinate we add the distance between the two reference points to the value edited in the first camera.

First camera reference point 1 = 50mm + distance 111mm measured with ruler (see photo of object area above) equals to 161mm for reference point 1 2^{nd} camera.

As the y-coordinate is on the same line we keep the same value as in 1st camera.

The size of the pattern is also the same, so the length L is also the same.

Prepare calityration
The calibration is only required if tools of the type 'Coordinate transformation' are used. The calibration requires a calibration image with know shape and size. From this image the coordinate transformation parameters are calculated.
The calibration can be done automatically with the supplied calibration pattern. If the supplied calibration pattern can not be used please select the manual calibration.
All calibration points are expected at Z = 0 e.g. [mm].
Select application / type of calibration. Enter calibration values when using the automatic calibration.
Units of the world coordinate system (for display only) mm
Measurement application - calibration uses the calibration pattern with a reference length
O Robot / handling application - calibration uses the calibration pattern with 2 reference points
O Manual entry of calibration points - without automatic detection of calibration points
The calibration image must contain at least the 9 main calibration points of the file 'Calibration Pattern' in same order and proportion. The file can be used by printing out in suitable size.
Measure the required coordinates in reference to the center of the world coordinate system and enter here:
Reference point 1 (big point): X-coordinate e.g. [mm]
50.00 Y-coordinate e.g. [mm]
Measure the length 'L' in the calibration pattern and enter here. The axis of the calibration pattern have to be parallel to the axis of the world coordinate system:
53.00 🚔 e.g. [mm]

Next

Press the "Record new calibration pattern image"-button. Then an image is captured and evaluated. If the green dot appear, the calibration was successful. If the dot is red: Try different setting of the threshold sliders to achieve a better image until the dot get green.

Then press Finish. The 2nd camera is calibrated.

Now the pattern could be removed from the object area.

Place the band into the object area and continue with step 3 Acquire records.



Step 3.: Acquire records

As in the first use case we capture records into the temporary records container. Then drag and drop one record to the sample record list and some other records into the Inspection record list.

Record lists	
S ▼ Ignore № Ori Type Comme	Service Vorianter Service Ser
1 1 1	1 1 1
	2 1 1
	3 1 1
	4 1 1
	5 1 1
	6 1 1
	7 1 1
	8 1 1

Step 4/5: Prepare inspection / Inspect objects

As we do in this use case 2 no quality inspection, we can proceed the set up of the tool in one of the step 4 or 5.

For the detection of the edge we can use different tool. In this example we focus on the edge tool.

Connected device <	Record view × Results overview ×	Tool structure
SBRD-Q, F/W v1.1 🗇 🕆 🗘 🛪 🕤	Ministry Texel 1173	Name Refs.
Connected Disconnect	A Automatic * v [proej 963 Brightness 37	i⊚edge: edge ∅
Device mode: Configuration mode	2	
Job: «Configuration» 🗄 😗	DEPERTURATE CONTRACTOR OF A CONT	
Job navigator <		
1. Set up 👻		
2. Configure cameras 👻		Tool results X Tool settings X
3. Acquire records 🛛 👻	Thims Print and a second se	Name Value Transformed Unit Dev. Refs.
4. Prepare inspection	120101204520-0442014510-0444	10 EDGE: EDGE
Add tools for image preprocessing Add tools for object localization	A DAMAGE AND A DAMAG	1. X edge invalid invalid (unset) 0.00 % 🔗
5. Inspect objects ~		2. Y edge invalid invalid (unset) 0.00 %
6. Configure I/O ~	UTERROW AND	3. Angle of edge invalid invalid (unset) 0.00 %
7. Perform test run 🗸		
8. Finish job 🗸 🗸 🗸	##₩©!≣49	
	Tool library × Record lists ×	
	▲ (a) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and location tools CRCLE and ords ▲ (b) Preprocessing and ords CRCLE and	Le staanse konne the contour of al Conclusters are not contour of al Conclusters are toruchaster faire conclusters are conclusters are

(1) Drag and drop edge tool into the record view window(2) Turn the tool to 90 degree at the blue point at tool frame

Record view ×	Results overview ×	
A Automatic -		X [pixe] 4 Y [pixe] 4 Y [pixe] 4 193 193 193 193 193 193 193 193
1		

(3) Adapt the size of the tool to an appropriate position in the middle of the camera view.

Then the tool settings have to be adjusted. For the measure of the band width and position we need only the x-coordinate of the edge. So we can disable the not used feature **y** and **angle**. And the angle of the tool region could be adjusted and verified.

Vitool results × Tool settings ×	GTool results ×	Tool settings ×
All Features General Info Measure Position Rotation Threshold	All Features General I	nfo Measure Positic Rotation Inreshold
▼ Features	▼ Rotation	
X edge	X rotation	0
Y edge	Y rotation	0
All features	Angle of rotation	0
	Angle of turning	90

For a better description of the "meaning" from the edge tool in this program, we can give the tool an own name. In this case we use this edge tool for the position of the band left side. So we can name it like: x-Pos left

Tool results × Tool	ool settings ×
All eatures General Info	Measure Position Rotation Threshold
 General 	
Name 🤇	x-Pos left
Calculate on	☆ Camera image 1: R5B (S/N: 4103255267)
Shape	Parallel search lines
Number of search lines	15
Outliers	Fast removal
Allowed deviation	

Now we can copy and paste the tool in Tool structure for the right edge of the band.

Tool structure			Tool structure	
Name	Refs.		Name Refs.	
i DGE: x-Pos left	R		il EDGE: x-Pos left	
	Сору	Ctrl+C	IO EDGE: x-Pos left 1	
	Cut	Ctrl+X	Сору	Ctrl+C
	Paste	Ctrl+V	Cut	Ctrl+X
	Delete	Del	Paste	Ctrl+V
	Select All	Ctrl+A	Delete	Del
	Devet for her service	Current	Select All	Ctrl+A
	Reset feature names		Tool results X Tool settings X Reset feature n	ames
Tool results × To	Reset tool(s) name		All Features General Info Measure Position Rotation	ame -

The copied tool has to be adjusted for the right side. There we select the second camera, adapt the tool name and the search direction of the edge detection:

Tool settings ×	Tool results × Tool settings ×
All jeatures General Info Measure Position Rotation Threshold	All Features General In Measure Osition Rotation Threshold
▼ General	✓ Measure
Name x-Pos right	Search direction End -> begin
Calculate on 🖄 🛱 Camera image 2: R5B (S/N: 4103255268)	Transition type all edges
Shape Parallel search lines	Transition number
Number of search lines 15	Subpixel calculation m No subpixeling
Outliers Fast removal	
Allowed deviation	

In the image we should see the tool now on the right side of the band. And the search lines starting from right side.



The edge tool offers a lot of different adjustments. For further explanation of the tool refer to the CCS manual.

Now we have the position of the two edges in two separate tool, due to the separate images. We can not measure with one tool the width of the band, because a measure tool can not operate with 2 images. So we have to do the calculation by Math/Logic tool. You can find this tool in Tool library "All tools". The idea is to subtract the x-Pos left from the x-Pos right coordinate. The difference equals the width of the

band.

If we do the subtraction with the results of the edge tools we get the width in pixel value. The task is to have the width in mm value. So we have to do the subtraction with the mm result of the edge tools.

To get the mm value in the calculation we have to use a function, which shift the internal mm value into feature value. This function is available also in the Math/Logic tool. It is called:

"Exchange for F1 "Value with Value(trans.)

Apply a Math/Logic tool to the tool structure.

Record view × Results overview ×	Tool structure
A Automatic *	Name Refs. 1© EDGE: x-Pos left 𝒫 1© EDGE: x-Pos right № MATH/LOGIC: MA' 𝒫
Minimum distance and a second se	Tool results × Tool ettings ×
อาร์ตอากสุนอาการการการการการการการการการการการการการ	Name Value Transformed Unit Dev. Refs.
Contraction of the Contraction o	3. Exchange for F1 'Value' with 'Value (trans.)' 86.64 mm 0.00 % 🔗
# ₽ © = -0 40%	
Tool library Record lists ×	
September 2015 Septembe	COLOUR Development of the individual paties in the the individual paties in the optic
All tools All tool All tool	MATH/LOGIC MATH/LOGIC MATH/LOGIC CALL AND A CONTRACT AND A CONTRAC
CustomTTC CREATING CONTROL RAY TO CONTROL RAY TARA TARAY TARA TARA TARA TARA TARA	Rol Recher die Markmale Rol Recher die Recher die Recher Rol Recher Rol Recher die Recher Rol
PATACODE PALCON Reads Data Matrix PALCON Reads Pachage Pachag	SBLOB Calculates area and contour- ing transmission of the second

Adjust the tool setting for Calculation and the value F1 and give a name:

Nool results ×	Tool settings ×					
All Features General In	1 <u>fo</u>					
▼ General						
Name	left edge mm					
Calculation	Exchange for F1 'Value'	with 'Value (tr	rans.)'			
Ignore invalid features						
Value F1	1. x-Pos left: X edge					
Result factor	1					
▼ Features						
Exchange for F1 'Value	🔽					
In Tool results we	see the value in mm					
Tool results ×	Tool settings 🗙					
5	Name	Value	Transformed	Unit	Dev.	Ref
MATH/LOGIC: lef	t edge mm					
3. Exchange f	for F1 'Value' with 'Value (trai	ns.)' 86.64		mm	000 %	S

Then we do a second tool which exchange the value of the x-right.

If both coordinates are shifted to the mm value we can apply another Math/Logic tool for the subtraction.

Tool results ×	Tool settings ×
All eatures General Ir	fo
▼ General	
Name	Width in mm
Calculation	F1 - F2
Ignore invalid features	
Value F1	4. right edge mm: Exchange for F1 'Value' with 'Value (trans.)'
Value F2	3. left edge mm: Exchange for F1 'Value' with 'Value (trans.)'
Result factor	1
▼ Features	
F1 - F2	

Result:

Tool results ×	Тос	ol settings ×				
Name	Value	Transformed	Unit	Dev.	Refs.	
MATH/LOGIC: Width in mm						
5. F1 - F2	85.77		mm	0.00 %	S	

Step 6.: Configure I/O

The results for such application are used in PLC for alignment process. So the left edge position and the value of the width should be transferred by data output.

I/O settings × I/O results ×		I/O structure
I/O settings × I/O results × Profinet General Description Print Assignment Available functions and data Tool results ● @EDGE sePos left ● @EDGE sePos right ● @EDGE sePos right ● @EDGE sePos right ● @EDGE sePos right ● @EDGE sePos right	Assigned data byte: 8 bit () float 32 bit () MATH/LOGIC.left edge mm 3 Evrebane (51 Mblaid with Malas Image V) Value (trans.)	I/O structure Digital I/O: Type Assigned value Digital inputs Digital cutputs 0)v 2)
P (BMATH/LOGIC: tiplit edge mm ▲ (BMATH/LOGIC: Width in mm Mistrie Carl and the mm	3. Exchange for F1 Value with Value (trans.) Walke (trans.) Walke Value int: 32 bit string: 64 x 8 bit (Protocol-based I/O: Type Id Description Data Profinet Data Profinet
Advanced settings		*
I/O library	Result Flagwords Lange data and functions Flagge to the Result Registration UP Colling to the Table - Data Colling to the Table	Teinet - Result output Auges data and functions Respingtor Digo

In principle the same procedure as in use case 1. Assign the data by drag and drop.

Step 7.: Perform test run

This step allows to evaluate the inspection program by the performance of the controller. In other steps the results were calculated on PC-CPU. In test run the results were calculated in the SBRD controller CPU. So we can get the real processing time of the inspection program.

Sprocessing times ×		es ×	Results overview 🗴		
Total time			(160 ms	
	Title	Duration	Category	\smile	
1 94 ms Image recording					
:0	x-Pos left	34 ms	Tool processing		
:0	x-Pos right	32 ms	Tool processing		
2	left edge mm	0 ms	Tool processing		
2	right edge mm	0 ms	Tool processing		
2	Width in mm	0 ms	Tool processing		
ß		0 ms	Result classification		
B		0 ms	I/O (digital)		
B	PN	0 ms	I/O Streaming (protocol-based)		
ß		0 ms	Communication		

Also the particular processing times of each tool can be evaluated.

Step 8.: Finish job

All settings which are done in the first 7 steps are only stored on the PC in CCS software. To get the data on the device you have to download the job settings to a job memory.

Connected device <	Job manager		x
SBRD-Q, F/W v1.1	Festo Camera Configuration Studio	μ μ	Device
Connected Disconnect	Job 1	82.4 kB	1. Job 1 82.3 kB
Device mode: Run mode	edit job description by right	Drag and Drop	Case 1 2. Job 1 82.3 kB
Job: 1. Job 1 🗄 🚺	mouse click on the icon		Case 1
Job navigator <		1	3. Job 14.6 kB empty job
1. Set up 👻		1	4. Job 14.6 kB
2. Configure cameras ~ 3. Acquire records ~			5. Job 14.6 kB
4. Prepare inspection ~		1	6. Job 14.6 kB empty job
5. Inspect objects ~			T. lob 14.6 k8 empty job
6. Configure I/O ~ 7. Perform test run ~		-	a. Job 14.6 kB 14.6 kB
8. Finish job 🔹		1	9. Job 14.6 k8 empty.job
Adjust job name and description Transfer job to the device Add project documentation, save project		1	10. Job 74.6 k8 empty job
tile Edit current job name Coursish to Ele		1	11. Job 74.6 kB empty job
Save job to file			12. Job 14.6 kB

By drag on the job on left side and drop it on a memory on right side, the setting are stored on the device. The "play" button show the selected job which is processed in run mode.

End of document