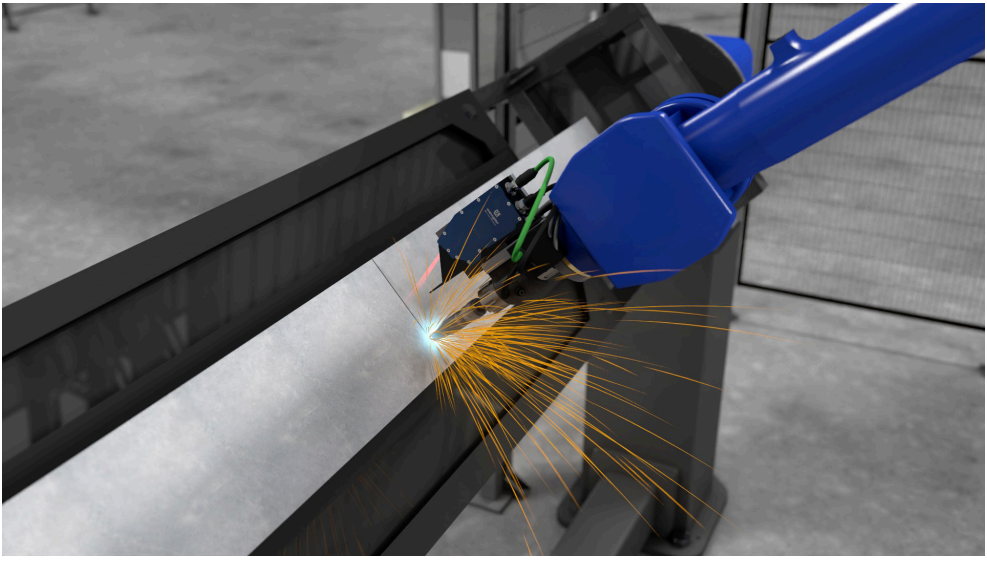
EN

Optical Seam Tracking Solutions



Operating Instructions

Translation of the Original Operating Instruction
Subject to change without notice
Available as PDF version only
Status: 04.09.2026
Version: 2.4.0
www.wenglor.com

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1. Change Index of Operating Instructions

Version	Date	Description/Change
1.0.0	23.03.2022	Initial version of the operating instructions
1.0.1	31.03.2022	Indication of protective foil ZLSE010
1.0.2	13.04.2022	Adaption section 7.9.1 "String Count"
1.0.3	11.07.2022	Update of FANUC system requirements
1.0.4	25.05.2023	Update of changelog for robot weld seam tracking interfaces
1.1.0	13.12.2023	Update with generic robot weld seam tracking interface
1.1.1	23.05.2024	Update with new version 1.0.6 of robot weld seam tracking interface
2.0.0	06.09.2024	Update with integration of robot server for seam tracking on device website of Machine Vision Controller. Compatibility with uniVision 3.3.0 and new Machine Vision Controller MVC.
2.0.1	02.01.2025	Minor changes: • Supported job numbers • List of reserved IP addresses at LAN interface of Machine Vision Controller
2.1.0	16.05.2025	Updated description for uniVision 3.5.0 (and MVC Firmware 1.2.0)
2.2.0	18.08.2025	Updated description for uniVision 3.6.0 (and MVC firmware 1.3.0)
2.3.0	30.03.2026	Updated description for uniVision 3.7.0 (and MVC firmware 1.4.0)
2.4.0	04.09.2026	Updated description for uniVision 3.8.0 (and MVC firmware 1.5.0)

2. General

2.1 Information Concerning these Instructions

The operating instructions describe how to setup an automated welding application using optical seam tracking in combination with the optional uniVision 3 image processing software and the optional wenglor robot server.

NOTE!
Separate extended instructions for each product are available on www.wenglor.com in the download section of each product.

2.2 Explanations of Symbols

- Safety precautions and warnings are emphasized by means of symbols and attention-getting words.
- Safe use of the product is only possible if these safety precautions and warnings are adhered to.

The safety precautions and warnings are laid out in accordance with the following principle:

ATTENTION-GETTING WORD
Type and Source of Danger!
Possible consequences in the event that the hazard is disregarded.
- Measures for averting the hazard.

The meanings of the attention-getting words, as well as the scope of the associated hazards, are listed below.

DANGER!
This word indicates a hazard with a high degree of risk which, if not avoided, results in death or severe injury.

WARNING!
This word indicates a hazard with a medium degree of risk which, if not avoided, may result in death or severe injury.

CAUTION!
This word indicates a hazard with a low degree of risk which, if not avoided, may result in minor or moderate injury.

ATTENTION:
This word draws attention to a potentially hazardous situation which, if not avoided, may result in property damage.

NOTE!
A note draws attention to useful tips and suggestions, as well as information regarding efficient, error-free use.

2.3 Limitation of Liability

- The product has been developed taking into account the state of the art as well as the applicable standards and guidelines.
- We reserve the right to make technical changes.
- A valid declaration of conformity can be found at www.wenglor.com in the download area of the product.
- wenglor sensoric elektronische Geräte GmbH (hereinafter "wenglor") accepts no liability for:
  - » Failure to observe the operating manual,
  - » Unsuitable or improper use of the product,
  - » Excessive use, incorrect or negligent treatment of the product,
  - » Incorrect installation or commissioning,
  - » Use of untrained personnel,
  - » Use of unauthorized spare parts or
  - » Improper or unauthorized changes, modifications or repair work to the products.
- This operating manual does not contain any guarantees/warrantees from wenglor with regard to the processes described or certain product properties.
- wenglor assumes no liability with regard to printing errors or other inaccuracies contained in this operating manual, unless it can be proven that wenglor was aware of the errors at the time the operating manual was created.

2.4 Copyrights

- The contents of these instructions are protected by copyright law.
- All rights are reserved by wenglor.
- Commercial reproduction or any other commercial use of the provided content and information, in particular graphics and images, is not permitted without previous written consent from wenglor.

3. For your Safety

3.1 General Safety Precautions



NOTE!

- In the event of possible changes, the respectively current version of the operating instructions can be accessed at www.wenglor.com in the product's separate download area.
- Read the individual operating instructions carefully before using the product.
- The sensor must be protected against contamination and mechanical influences.

3.2 Laser/LED Warnings

ATTENTION:
For detailed explanation concerning laser safety, please see sensor operating instructions provided on wenglor.com.

Warning labels are included with the products depending on laser class and type of light. The respective warning labels must be attached to the system in a plainly visible fashion.

Laser Class	IEC EN 60825-1	FDA/CFR
Laser Class 1M (EN 60825-1) Applicable standards and safety regulations must be observed.		Not applicable
Laser Class 2M red (EN 60825-1) Applicable standards and safety regulations must be observed.		
Laser Class 2M blue (EN 60825-1) Applicable standards and safety regulations must be observed.		
Laser Class 3R red (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.		
Laser Class 3R blue (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.		
Laser Class 3B blue (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.		

4. System Overview

The system consists of

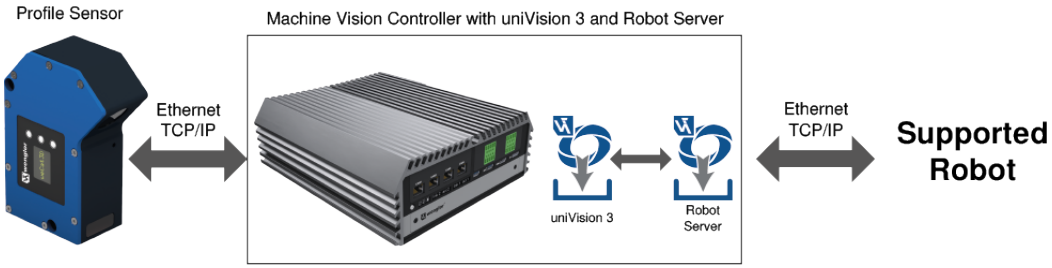
- one 2D/3D Profile Sensor of the weCat3D series
- the optional wenglor software uniVision 3 to find the tracking point, running on the Machine Vision Controller MVC
- the optional wenglor robot server (running on the Machine Vision Controller MVC)

4.1 System with wenglor Software Application

The following options are possible if using the wenglor software application to find the tracking point.

4.1.1 Robot-guided Seam Tracking with Machine Vision Controller

System overview with 2D/3D Profile Sensor and Machine Vision Controller (with wenglor software application and robot server).



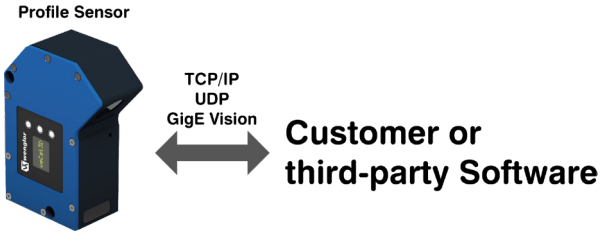
4.1.2 Not Robot-guided Seam Tracking with Machine Vision Controller

System overview with 2D/3D Profile Sensor and Machine Vision Controller (with wenglor software application). The robot server is not used. The communication to any PLC or robot PLC is possible via standard interfaces like PROFINET, EtherCAT, EtherNet/IP, TCP/IP or UDP.



4.2 Sensor without wenglor Software Application

In the case of using only the 2D/3D Profile Sensor hardware without wenglor software application, any customer or third-party software usage is possible. Then the sensor only sends the height profiles (pointclouds) to the customer or third-party software.



NOTE!
Please refer to the sensor operating instructions how to integrate the sensor using the provided SDK, GigE Vision or TCP/IP interface:
https://www.wenglor.com/en/Interfaces-of-2D-3D-Profile-Sensors/s/Themenwelt+weCat3D+Schnittstellen

5. Product Overview

The operating instructions cover several products.

5.1 wenglor weCat3D Sensors

The weCat3D sensors are the 2D/3D Profile Sensors of wenglor. Depending on the application and requirements different sensor series are available:

weCat3D sensors	Properties
MLZLxxx	Optimized sensor for welding applications with integrated cooling and purging different laser classes are available. 10 protective screens (plastic) for replacement included in delivery.
MLSLxxx	Compact housing, different laser classes and measurement ranges are available.
MLWLxxx	High performance sensor with high resolution, different laser classes and measurement ranges are available.

For details and the complete list of accessories see the sensor operating instructions on www.wenglor.com/weCat3D-Manual.

5.1.1 Accessories for weCat3D Sensors

Please find the complete list of all available accessories in the sensor operating instructions on www.wenglor.com/weCat3D-Manual.

Following accessories improve the performance of the sensor at welding applications:

Sensor	Accessories	Comment
MLZLxxx*	• ZLSE010 screening grid (plastic) • ZLSE011 screening grid (glass) • ZLSE012 screening grid retainer • ZLSE015 screening grid retainer • ZLSE018 screening grid (plastic) • ZLSE019 screening grid (glass) • ZLSE013 guard plate	Protects the optical window of the sensor.
MLSL1xx	ZLSS003 protective housing	Combines cooling, protection and purging of the optical window.
MLSLxxx MLWLxxx	Screening grid retainers with exchangeable screens of glass or plastic	Protects the optical window of the sensor.
MLSLxxx MLWLxxx	Cooling units	Allows to use the sensor at higher environmental tempertures.

* The MLZLxxx is equipped with connections for cooling and purging (see section 6.3).

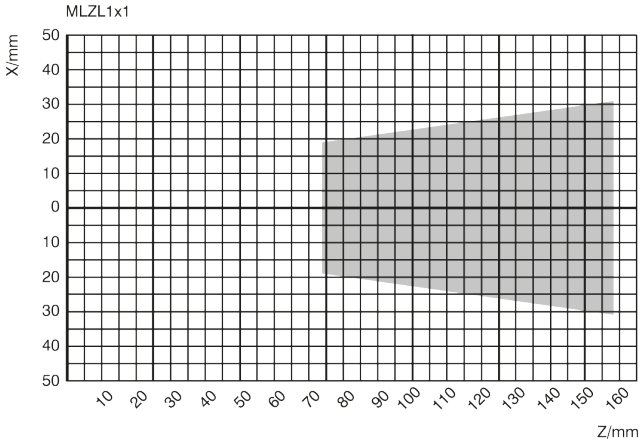
If the sensor is used with a robot there are special torsion resistant cables available:

Ethernet cable:		
ZC1V020	M12x1, 8-pin X-coded, RJ45	5 m
ZC1V021	M12x1, 8-pin X-coded, RJ45	10 m

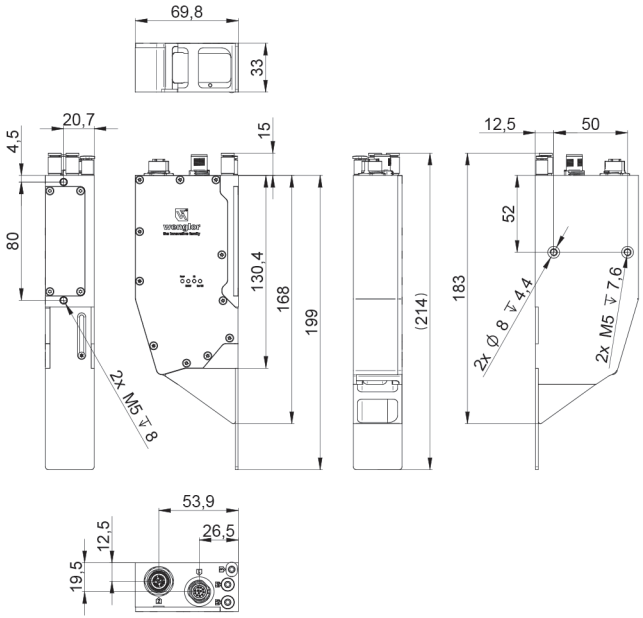
Power supply cable:		
ZDCL001	M12x1, 12-pin to open end	2 m
ZDCL002	M12x1, 12-pin to open end	5 m
ZDCL003	M12x1, 12-pin to open end	10 m
ZDCL007	M12x1, 12-pin to open end	30 m

5.2 MLZLxxx

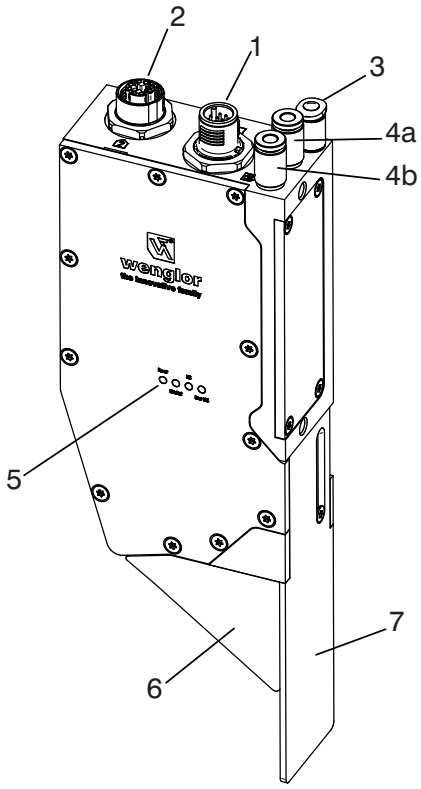
5.2.1 Measuring Field X, Z



5.2.2 Dimensional Drawings



5.2.3 Sensor Construction



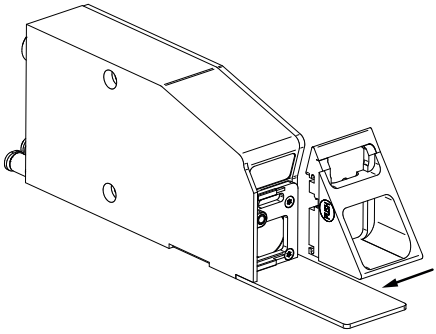
1 = Power supply plug connector, digital I/O
2 = Connection socket Ethernet
3 = Air purging
4a = Air/water cooling IN
4b = Air/water cooling OUT
5 = LED display
6 = Screening grid retainer with screening grid
7 = Guard plate

5.2.4 Installation of Screening Grid Retainer ZLSE012 and Screening Grid ZLSE010 / ZLSE011

NOTE!
Devices up to revision E – delivery condition: ZLSE012 screening grid retainer incl. ZLSE010

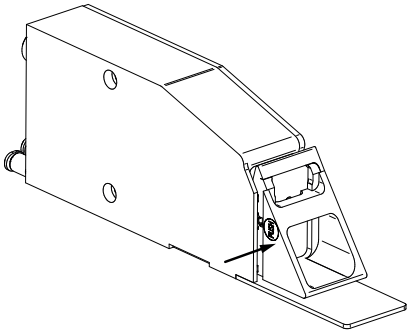
ATTENTION!
Only the ZLSE010 or ZLSE011 screening grids can be used with the ZLSE012 screening grid retainer.

Assembly of the screening grid retainer:



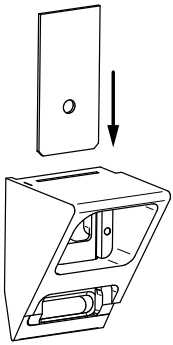
Insert the screening grid retainer into the guide bar of the sensor (see picture above) and slide it to the left until it snaps in.

Disassembly of the screening grid retainer:



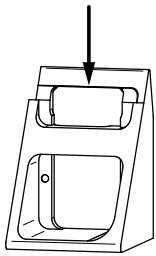
By pressing the push button, the screening grid retainer is removed from the fixation and can be slided out to the right (see picture above).

Inserting the screening grid:



Slide the screening grid into the relevant slot, bevelled edges first (see picture above).

Removing the screening grid:



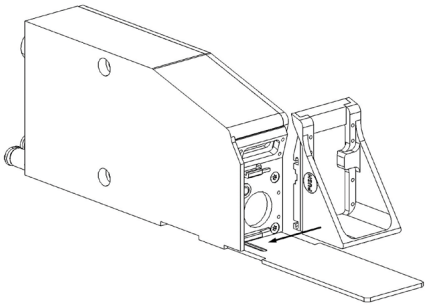
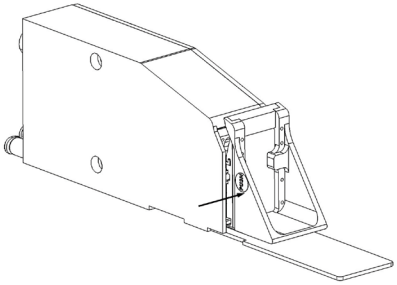
Place a pointed object (e. g. fingernail) on the upper edge of the screening grid and slide it out of the screening grid retainer (see picture above).

NOTE!
Before inserting the plastic screening grid please remove the protective foil on both sides.

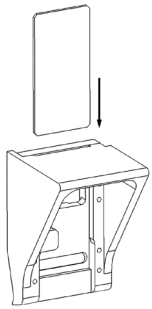
5.2.5 Installation of Screening Grid Retainer ZLSE015 and Screening Grid ZLSE018 / ZLSE019

NOTE!
Devices from revision F onward – delivery condition: ZLSE015 screening grid retainer incl. ZLSE018.

ATTENTION!
Only the ZLSE018 or ZLSE019 screening grids can be used with the ZLSE015 screening grid retainer.

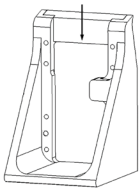
Assembly of the screening grid retainer:	Disassembly of the screening grid retainer:
	
Insert the screening grid retainer into the guide bar of the sensor (see picture above) and slide it to the left until it snaps in.	By pressing the push button, the screening grid retainer is removed from the fixation and can be slided out to the right (see picture above).

Inserting the screening grid:



Slide the screening grid into the relevant slot, bevelled edges first (see picture above).

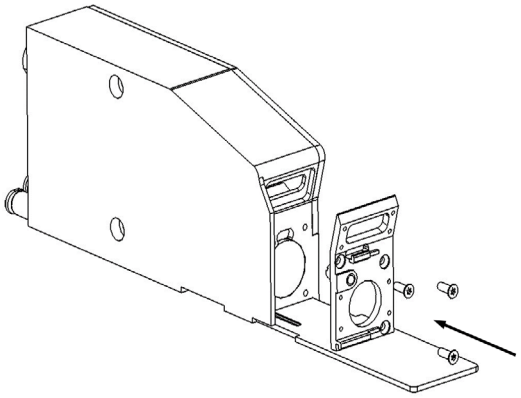
Removing the screening grid:



Place a pointed object (e. g. fingernail) on the upper edge of the screening grid and slide it out of the screening grid retainer (see picture above).

NOTE!
Before inserting the plastic screening grid please remove the protective foil on both sides.

Retrofitting the Screening Grid Retainer (ZLSE015):



If the ZLSE015 screening grid retainer is to be retrofitted and a ZLSE012 is installed, the base plate must be replaced. The appropriate slider plate is included in the scope of delivery of the ZLSE015.

After removing the existing base plate, the new slider plate is mounted on the sensor with three M2.5 × 8 screws. A tightening torque of 0.8 Nm must be observed.

The screening grid retainer can then be mounted.

5.3 Machine Vision Controller

- MVCV001: Machine Vision Controller with included uniVision 3 software package and included license of Device Robot Weld Seam Tracking



NOTE!

- MVCV001 is a Machine Vision Controller which contains the uniVision basic licenses and the licenses for Device Robot Vision and Device Robot Weld Seam Tracking.
- When using another Machine Vision Controller, you can order DNNL026 (License MVC uniVision Robotics) separately. It contains the license for Device Robot Vision and Device Robot Weld Seam Tracking.
- How to generate and activate uniVision 3 licenses is described in the operating instructions of the uniVision 3 software (DNNF023).

5.3.1 Accessories for Machine Vision Controllers

- ZNNG026: Monitor
- Z0044: Keyboard

5.4 Robot Server

The robot server for weld seam tracking is tested with the following hardware and software versions of the robot:

Robot manufacturer	System requirements
ABB	Controller: IRC5 Software RobotWare 6.0 Sensor Interface: Optical Tracking Arc or Controller: OmniCore Software RobotWare 7.21.0 or higher Software ArcWare for OmniCore 1.1.3 or higher Software ArcSeam Tracking for OmniCore 1.1.3 or higher
FANUC	Controller: R-30iB or R-30iA Software ArcTool SW V8.30P/36 Software options: R691 and R648 or Controller: R-30iBPlus or R-30iA Software ArcTool SW V9.40P/27 Software options: R901

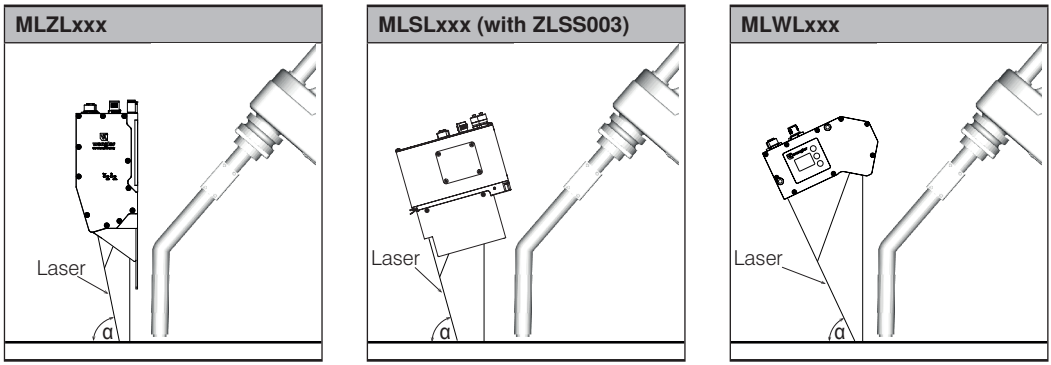
KUKA SeamTech 4 and 5	Controller: KR C5 Operating system: KSS 8.7 Software: KUKA.SeamTech 4 or Controller: KR C5-2 / KR C5-2 micro2 Operating system: iiQKA.OS2 9.2 or higher Software: iiQKA.SeamTech 5 (Finding and Tracking) Further software: iiQKA.UI 3.0, iiQKA.UserTech 8.1, iiQKA.RobotSensorInterface 6.1 and iiQKA.CommonApplicationMessage 1.1 PC Software: iiQWorks.Sim 1.2 to install option packages on the robot
KUKA SeamTech 2 and 3	For KUKA.SeamTech 2.1: • Controller KR C4 with KSS 8.3, RobotSensorInterface 3.3 and Ethernet KRL 2.2 For KUKA.SeamTech 3.1: • Controller KR C4 with KSS 8.6, RobotSensorInterface 4.1 and Ethernet KRL 3.1 • Controller KR C5 with KSS 8.7, RobotSensorInterface 5.0 and Ethernet KRL 3.2
YASKAWA	Controller: DX200, YRC 1000 Software: MotoEyeLT
Kawasaki	Controller: E series Software: Option Laser Tracking

6. Installation

6.1 General Installation Instructions

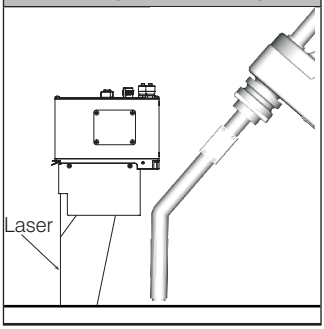
The installation starts with the mounting of the 2D/3D Profile Sensor. The installation depends on the sensor type.
It is very important that the camera of the sensor does not look directly into the welding spot, because this introduces a lot of noise due to the light of the welding process. This requires to mount the sensor tilted for the MLSLxxx and MLWLxxx series with an angleαα to obtain a small or a large forerun.

Mounting of sensor with small forerun:

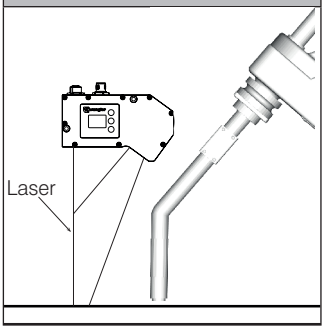


Mounting of sensor with large forerun:

MLSLxxx (with ZLSS003)



MLWLxxx



Angle α for different sensor types: :

2D/3D Profile Sensor	**Minimum** α in °
MLZL1x1*	73.5
MLWL2x5	75.6
MLWL2x4	76.2
MLWL2x3	76.3
MLWL2x2	74.9
MLWL2x1	72.0
MLWL1x5	56.9
MLWL1x4	56.9
MLWL1x3	56.2
MLWL1x2	67.2
MLWL1x1	58.5
MLSL2x6	83.1
MLSL2x5	82.6
MLSL1x4	81.6
MLSL1x3	75.2
MLSL1x2	60.9
MLSL1x1	58.1

* corresponds to vertical mounting of the sensor

6.2 Sensor Mounting

Depending on the configuration, the sensor / protective housing can be mounted in different ways:

Sensor / protective housing	Mounting possibility	Comment
MLSL1xx MLSL2xx	Two mounting points with drilling pattern 80 mm x 35 mm	Two screws M4 (6 mm depth)
MLWL1x1 MLWL1x2 MLWL2x1 MLWL2x2 MLWL2x3	Two mounting points on two sides with drilling pattern 80 mm x 35 mm	Two screws M5 (12 mm depth)
MLWL1x3 MLWL1x4 MLWL1x5 MLWL2x4 MLWL2x5	Mounting with clamp ZLWE011 drilling pattern 83 mm x 54 mm (discontinued) ZLWE012 drilling pattern 80 mm x 54 mm	Four screws M7
Protective housing ZLSS003	Short side drilling distance 59 mm	Two screws M5 (16 mm depth)

NOTE!
For details see the technical drawing in the sensor operating instructions on
www.wenglor.com/weCat3D-Manual

6.3 Connection of Cooling and Purging

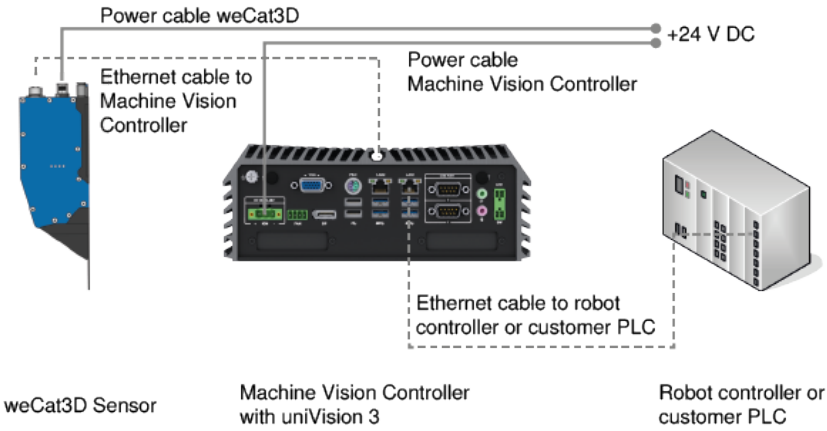
Sensor / Accessories	Medium		Tube dimensions
Cooling unit	Water:	max. 2 bar	Tube with 6 mm outer diameter and 4 mm inner diameter
	Oil free air:	max. 2 bar	
Protective housing ZLSS003	Cooling:		Tube with 6 mm outer diameter and 4 mm inner diameter
	Water:	max. 2 bar	
	Oil free air:	max. 2 bar	
	Purging:		
	Oil free air:	max. 2 bar	
MLZLxxx	Cooling:		Tube with 4 mm outer diameter
	Water:	max. 2 bar	
	Oil free air:	max. 2 bar	
	Purging:		
	Oil free air:	max. 2 bar	

6.4 Connection

This section contains information about electrical and network connections.

6.4.1 Cabling of System Components

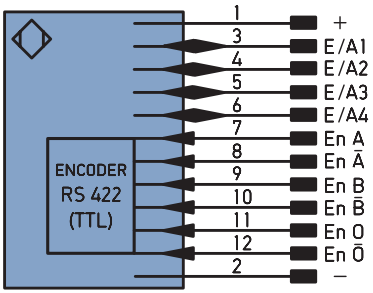
weCat3D - Machine Vision Controller - PLC:



6.4.2 Electrical Connection

6.4.2.1 Electrical Connection of 2D/3D Profile Sensor

The connection is made via a 12x1 12-pin connector.



Pin	Description
1	+ 24 V DC (18-30 V DC)
2	Ground
3	Digital In/Out 1
4	Digital In/Out 2
5	Digital In/Out 3
6	Digital In/Out 4
7	Encoder Input A
8	Encoder Input Ā
9	Encoder Input B
10	Encoder Input B̄
11	Encoder Input O
12	Encoder Input Ō

6.4.2.2 Electrical connection of Machine Vision Controller

The Machine Vision Controller is equipped with a 3-pin feed-through header for the power connection

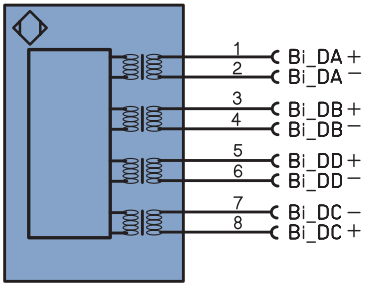
6.4.3 Network Connection

The communication between the 2D/3D Profile Sensor, the optional Machine Vision Controller and the robot controller or PLC works via a TCP/IP Ethernet connection.

NOTE!
Cabling must be capable of 1 GBit/s throughout the entire network.

6.4.3.1 Ethernet Connection of 2D/3D Profile Sensor

The Ethernet connection is made via a 12x1 8-pin x-coded connector.



Pin	Description
1	Bi DA+
2	Bi DA –
3	Bi DB+
4	Bi DB –
5	Bi DD+
6	Bi DD –
7	Bi DC –
8	Bi DC+

NOTE!
The network settings of the 2D/3D Profile Sensor can be adjusted via the OLED display (MLSL and MLWL only) or the sensor website if using no wenglor software application (see section 4.2).

6.4.3.2 Ethernet Connection of Machine Vision Controller

The Machine Vision Controller is equipped with four CAM ports and two LAN ports.

- Connect the 2D/3D Profile Sensor to one of the CAM ports.
- Connect the robot controller or the PLC to one of the LAN connectors of the Machine Vision Controller.



NOTE!

- Cabling must be capable of 1GBit/s throughout the entire network.
- Keep the networks for LAN, CAM and RTE separated on the MVC in order to optimize the performance of the Machine Vision Controller.
- Use unique network configurations for each network adapter within its network.
- Use different network configurations for the LAN, RTE and CAM adapters on the MVC. The network configuration of the CAM ports on the MVC is fix and reserved. Trying to use one of the reserved IP addresses results into an error message. The following IP addresses are reserved for the CAM Ethernet adapters of the MVC:
  - » 192.168.90.1 - 192.168.90.255
  - » 192.168.91.1 - 192-168.91.255
  - » 192.168.92.1 - 192.168.92.255
  - » 192.168.93.1 - 192.168.93.255
- Furthermore, the following IP addresses are reserved and not allowed at the LAN port of the Machine Vision Controller:
  - » 169.254.0.0/16
  - » 0.0.0.0/8
  - » 1.0.0.0/8
  - » 127.0.0.0/8
  - » 224.0.0.0/4
  - » 233.252.0.0/24
  - » 240.0.0.0/4
  - » 255.255.255.255/3

7. Settings in wenglor Software Application

NOTE!
This section describes the configuration of the system with wenglor software application (see section 4.1). In the case the sensor is not used with wenglor software application please refer to the documentation of the sensor interfaces (see section 4.2).

If using the wenglor software application (uniVision 3) for finding the tracking point, it is necessary to configure the project via the software wenglor uniVision 3.

The software wenglor uniVision 3 is available directly on the Machine Vision Controller if connecting a monitor, a keyboard and a mouse.
The software wenglor uniVision 3 for Windows is available for any 64 bit Windows 10 or 11 PC (download from https://www.wenglor.com/product/DNNF023)

7.1 Network Configuration for Optical Seam Tracking with Machine Vision Controller

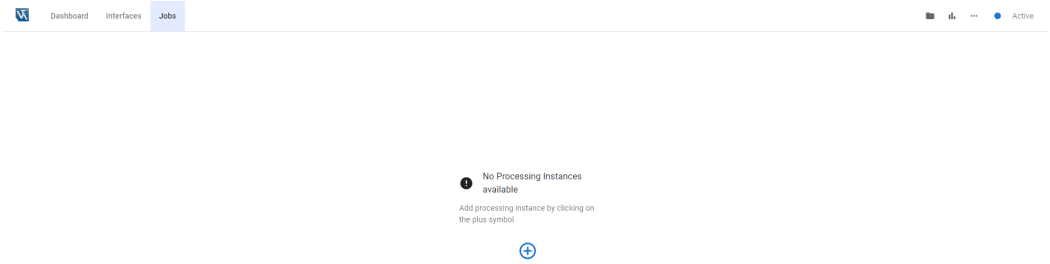
Example configuration:

- 2D/3D Profile Sensor (gets network configuration from Machine Vision Controller)
- Machine Vision Controller (LAN adapter):
  - » IP address: 192.168.100.1
  - » Subnet mask: 255.255.255.0
- PC with software wenglor uniVision 3 for Windows:
  - » IP address: 192.168.100.200
  - » Subnet mask: 255.255.255.0
- Robot Controller or PLC:
  - » IP address: 192.168.100.100
  - » Subnet mask: 255.255.255.0

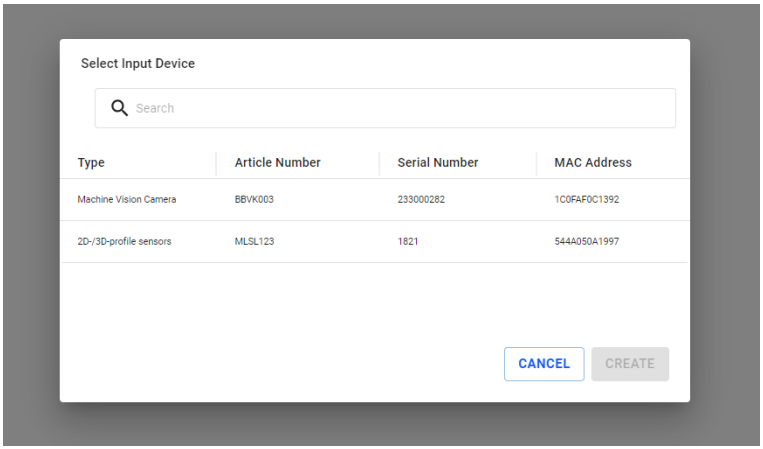
7.2 Device Website of Machine Vision Controller

Access the device website of the Machine Vision Controller MVC via entering the IP address in any supported browser or via clicking on “Open Device” at the software wenglor Discovery Tool. For details, see operating instructions of Machine Vision Controller and of wenglor Discovery Tool (DNNF022).

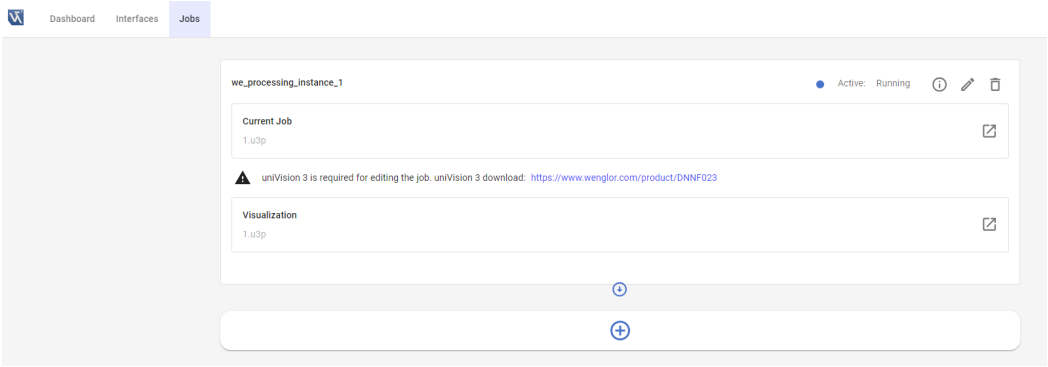
Click on the tab “Jobs” in order to create a processing instance for the 2D/3D Profile Sensor. For details, see operating instructions of Machine Vision Controller.



Click on the “plus” symbol to find the 2D/3D Profile Sensor that is connected to one of the CAM ports.

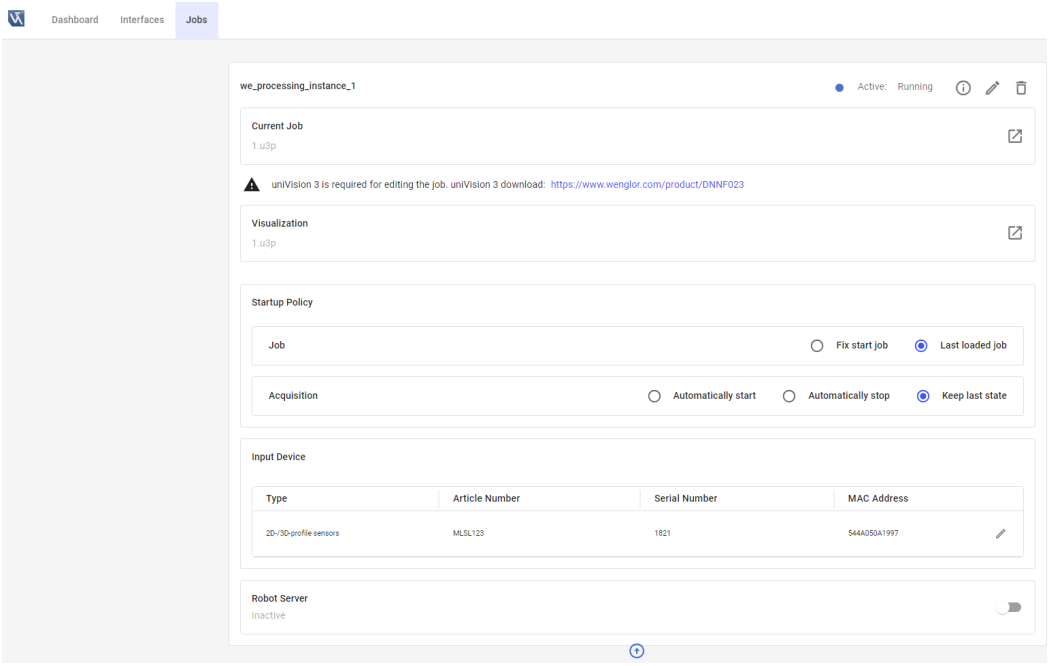


Selecting the 2D/3D Profile Sensor creates a processing instance



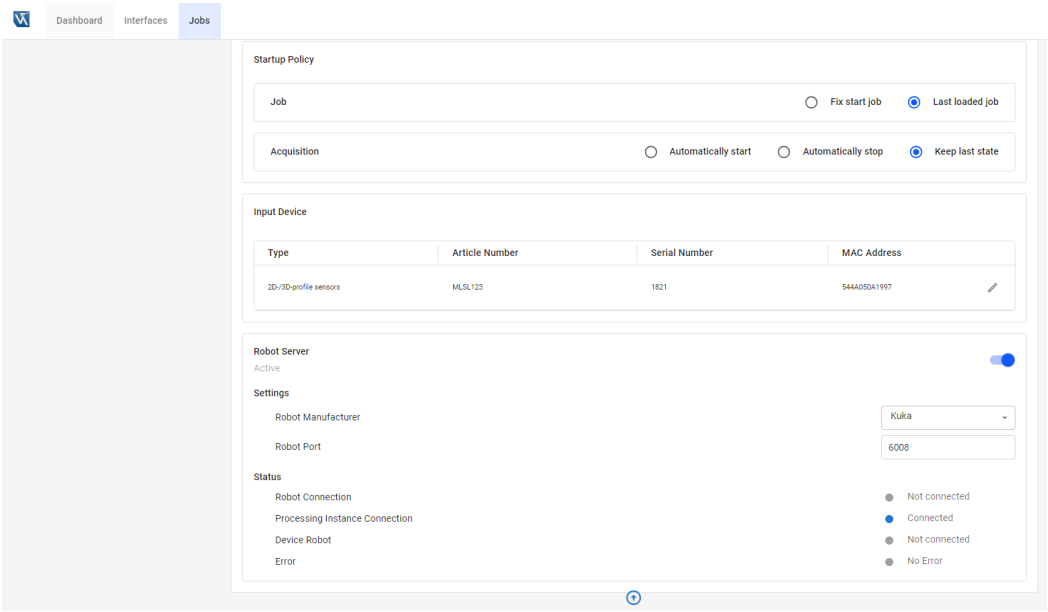
Define in the extended settings the startup policy for the job and the acquisition. When starting the processing instance, it loads the defined job (fix or last loaded job) and sets the acquisition status accordingly (started, stopped or keeps last status). For details, see operating instructions of Machine Vision Controller.

NOTE!
When loading a job from the robot, the processing instance keeps the previous acquisition status. If acquisition was off before the job change, it keeps acquisition off after loading another job. If acquisition was on before the job change, it keeps acquisition on after loading another job allowing welding on the fly.



Activate the robot server at the processing instance of the 2D/3D Profile Sensor.

NOTE!
A separate robot server is available for each processing instance.



The following settings appear at the robot server:

- Robot Manufacturer: Select the relevant robot manufacturer (KUKA SeamTech 4 and 5, KUKA SeamTech 2 and 3, ABB, FANUC, YASKAWA or Kawasaki)
- Robot Port: Shows the default port (depending on the robot manufacturer). Edit the port, if needed. Make sure to use a unique port. The following ports are used as default:
  - » KUKA SeamTech 4 and 5: 6008
  - » KUKA SeamTech 2 and 3: 6008
  - » ABB: 5020
  - » FANUC: 5020
  - » YASKAWA: 5020
  - » Kawasaki: 5000

NOTE!
At the robot manufacturer "KUKA SeamTech 2 and 3" further settings appear. For details, see section „8.6 KUKA SeamTech 2 and 3“.

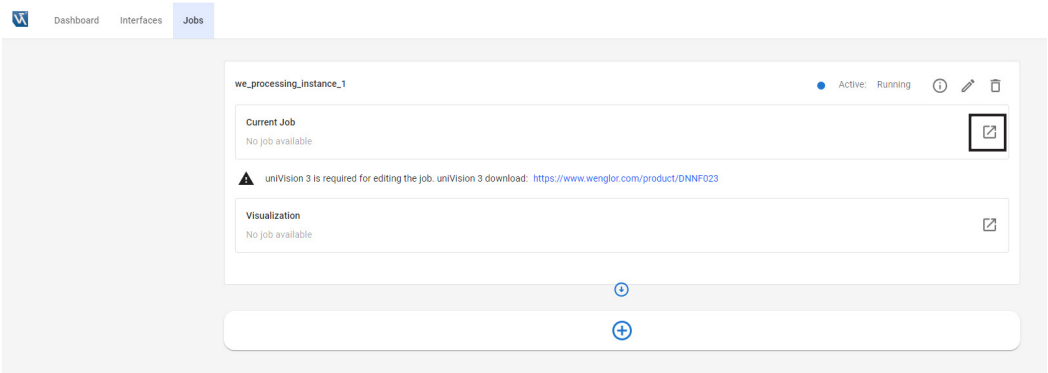
The robot server shows the following status:

- Robot Connection: Shows if the robot is connected to the robot server or not.
- Processing Instance Connection: Shows if the robot server is connected to the processing instance via the LIMA Read/Write Limited port or not.
- Device Robot: Shows if the robot server is connected to Device Robot Weld Seam Tracking or not.
- Error: Shows if there is any error (e.g. if port is already in use).

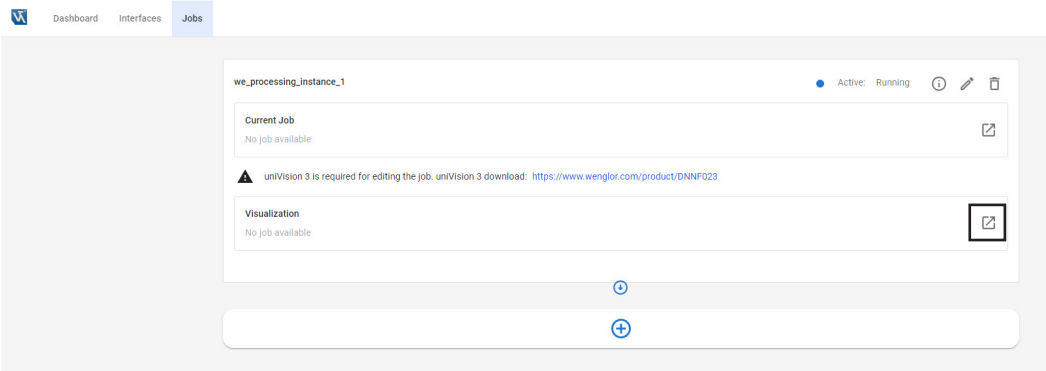
Click on “Edit job” in the section “Current job” in order to open the uniVision 3 software for editing the uniVision job.

NOTE!

- Make sure that the suitable version of the software wenglor uniVision 3 is installed on the PC.
- Click on the link to open the product detail page of the software wenglor uniVision 3 (DNNF023) in order to download the suitable software version at “Downloads” → “Soft and Firmware” (only available with internet access).
- The uniVision 3 software is described in detail in the operating instructions of DNNF023.

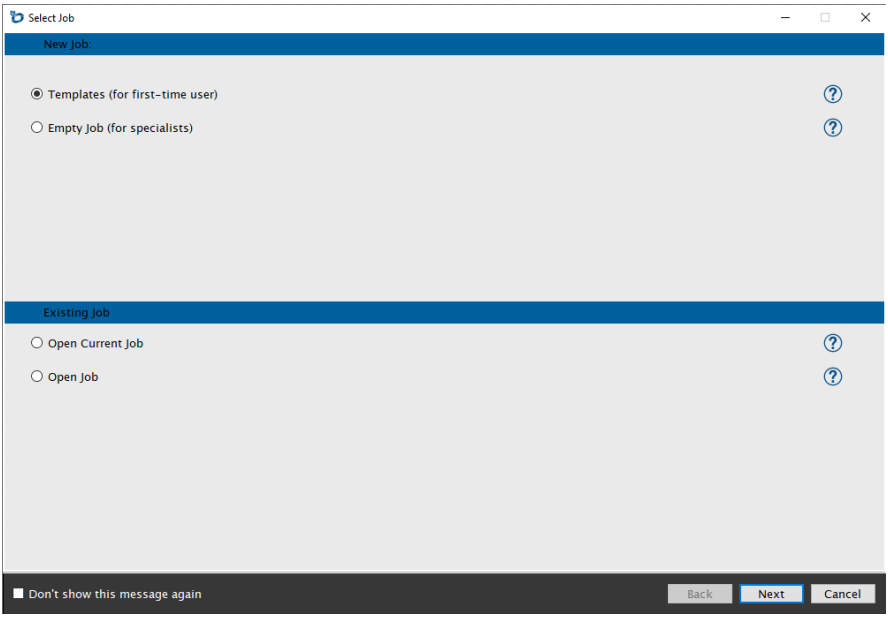


Click on “Open visualization” in the section “Visualization” in order to open the webbased visualization. It allows showing all results sent from Device Robot Weld Seam Tracking to the robot server. Furthermore, it allows starting or stopping the acquisition of the 2D/3D Profile Sensor.



7.3 uniVision Templates for Seam Tracking Applications

Select “Templates” and click on “Next” to select a pre-configured uniVision 3 job for seam tracking applications.



Select the relevant template for seam tracking. The following seam tracking templates are available:

- Find butt joint
- Find lap joint
- Find T joint
- Find dent
- Calibrate robots (edge)
- Calibrate robots (calibration plate)

The templates for seam tracking applications contain at least the following modules:

- Device weCat3D
- Module Profile Seam Tracking
- Device Weld Seam Tracking



NOTE!

- For details about the uniVision 3 software, check the operating instructions of DNNF023.
- Activate the “Extended View” on the top right part of the software to see all parameters for complex applications.

7.4 Setup Device weCat3D

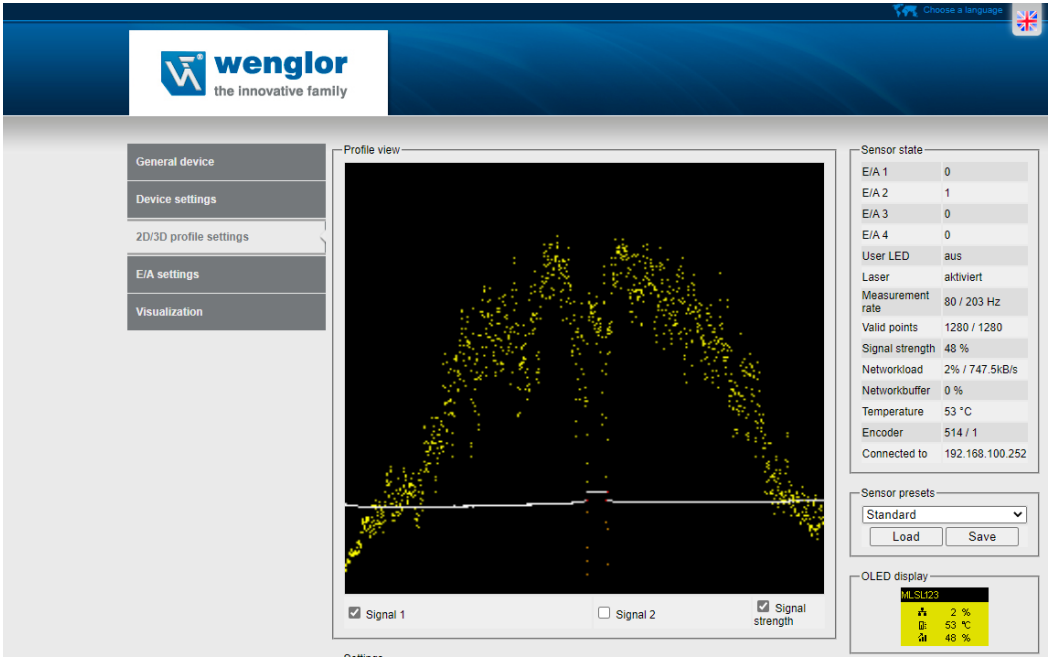
Device weCat3D contains all sensor settings. For seam tracking applications, the settings described in the sections 7.4.1, 7.4.2 and 7.4.3 are important.

NOTE!
All sensor parameters are described in detail in separate manuals of the sensor. The manual for seam tracking applications contains only the most relevant parameters with some welding specific explanations.

7.4.1 Acquisition Control: Exposure Time

Select a suitable value for the exposure time in µs so that the intensity of the measuring points is not too low and not too high. In general, the exposure time should be as short as possible at seam tracking applications to reduce the impact of the welding process on the profile quality as much as possible.

- Move the mouse position on single measuring points to see the intensity value at the bottom right part of the uniVision 3 software. The intensity of the measuring points has a range from 0 to 1024 and should be in the middle for an optimal profile quality.
- Open the website of the weCat3D sensor via entering the IP of the sensor in a browser for detailed analysis of the intensity (default: http://192.168.90.10 if connected to CAM1 → “2D/3D profile settings”).



7.4.2 Acquisition Control: Acquisition Line Rate

The acquisition line rate defines the number of captured profiles per second. For slow movements of the welding process, slow acquisition line rates are sufficient. For fast movements of the welding process, select high values of the acquisition line rate.

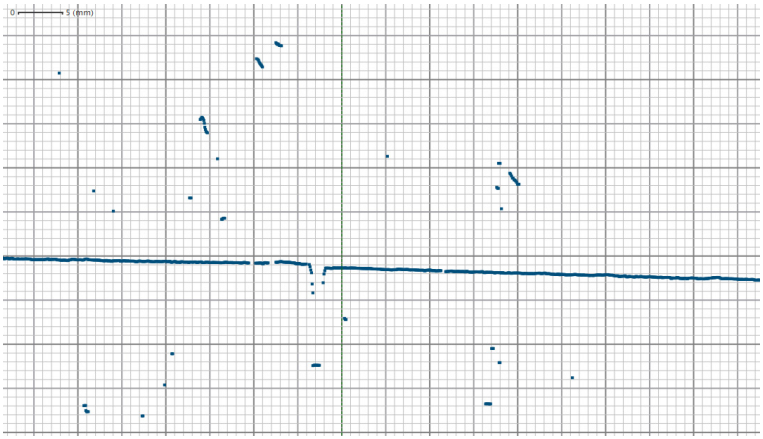
NOTE!
Typical seam tracking applications require acquisition line rates between 50 and 100 Hz.

7.4.3 Signal Control

Open the “Extended View” to see the “Signal Control”, if during the welding process the impact on the profile quality is still too high for a stable joint detection.

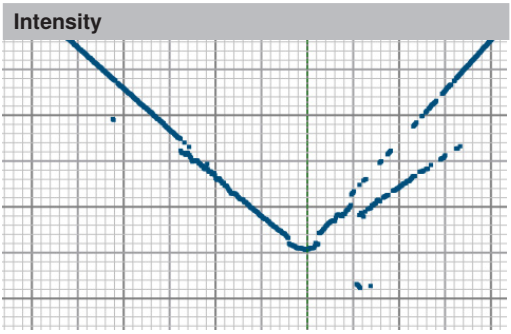
“Signal Enable” with the “First” (default) signal is suitable for typical seam tracking applications.

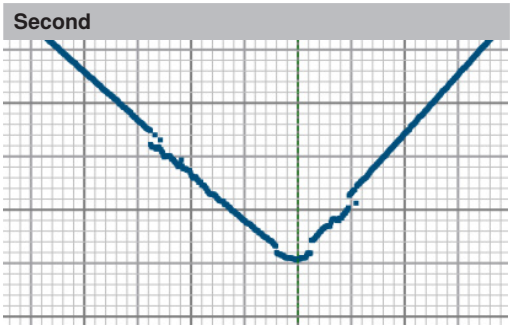
NOTE!
At butt joints with very small joint widths (only some mm) it might be helpful to select “First and Second” if unwanted gaps of the same size appear because of the noise during the welding process that have stronger signals than the real profile. With “First and Second” signals such unwanted gaps are closed and only the real small gap of the joint remains.



The “Signal Selection” is by default set to “Strength” which is most suitable for most seam tracking applications.

NOTE!
If annoying reflections (e.g. at very reflective T joints) have a stronger signal than the real profile, then it is possible to set the signal enable to “Top” or “Bottom” to make sure that the real profile is detected by the sensor. The settings "Top" and "Bottom" are not related to the distance to the sensor, but to the orientation of the image chip within the sensor.





7.5 Setup Module Profile Seam Tracking

With Module Profile Seam Tracking it is possible to detect common joint types in height profiles of 2D/3D Profile Sensors. Results of the module are the tracking point and further joint specific results needed for sensor-guided seam tracking applications at robots or linearization tables.

The following step by step procedure shows how to adjust the module.

7.5.1 Basic Parameters

This section gives a description of the parameters which appear in multiple types.

7.5.1.1 Link "Input Pointcloud"

In the templates, the link of the “Input Pointcloud” is preset to the output pointcloud of Device weCat3D.

NOTE!
If adding Module Profile Seam Tracking from the toolbox to the uniVision 3 project, it is necessary to select the input pointcloud (e.g. output pointcloud of Device weCat3D).

7.5.1.2 Select the "Type" of the joint

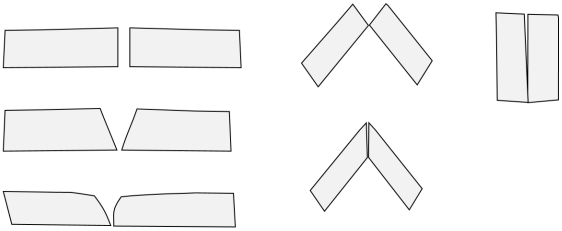
In the templates the joint type is preset depending on the selected template.

NOTE!
If adding Module Profile Seam Tracking from the toolbox to the uniVision 3 project, it is necessary to select the joint type.

Following joint types are available:

- **Butt joint:**
  Two metal sheets are on a similar height with a small gap. A necessary condition for the detection is that an edge is observable to the left and right of the gap. Possible tracking points are the left, the right and the midpoint between these points. This type also fits for the calibration of the robot and the sensor system via the calibration plate.



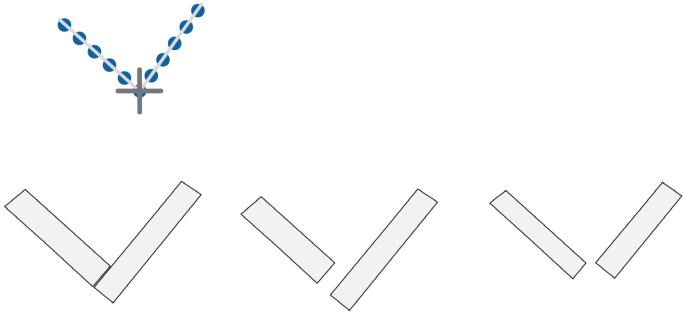


- **Lap joint:**
  One metal sheet is on top of the other with a certain height difference. Possible tracking points are the top, the middle and the bottom point.
  This type also fits for the calibration of the robot and the sensor system via an edge.





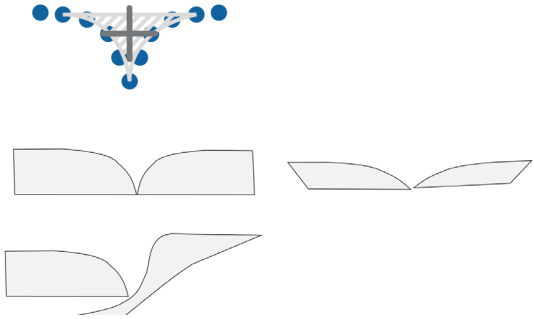
- **T joint:**
  Two metal sheets are in a certain angle (e.g. 90°). Gaps to left and/or right are considered. Tracking point is the intersection point.



- **Edge:**
  Only one metal sheet on the left or right side has a clear and consistent shape – the other metal sheet not.



- **Dent:**
  Two metal sheets are on the same or similar height level, but in comparison to the butt joint, there is no clear and sharp edge visible - only a dent. This algorithm is most suitable for welding at tanks or barrels for example. Tracking point is the centroid, the left, the right and the bottom point of the found area.

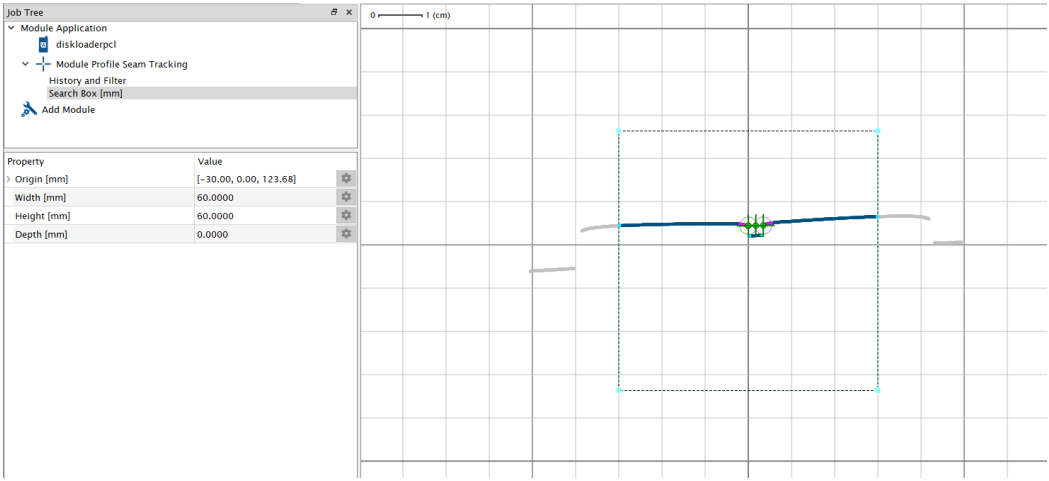


- **Input Point:**

Link a point from another module (e.g. from Module Profile Measure) as input point in order to use the history and filter settings of Module Profile Seam Tracking.

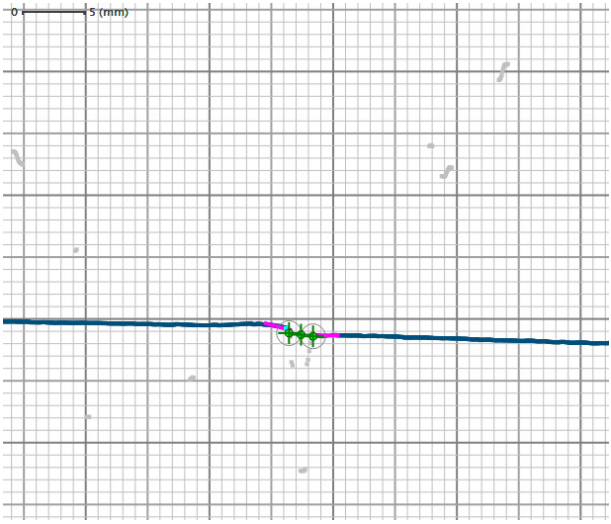
7.5.1.3 Define "Search Box"

Move the Search Box to the relevant area within the field of view of the sensor. The Search Box should cover all possible areas where the joint can appear.



7.5.1.4 Filtering

In order to eliminate noise during the welding process, the algorithm tries to find connected groups in the height profile. Small groups are considered as noise – consequently they are filtered and not used anymore for the next steps.



Profile data dismissed, due to filtering, are visualized in grey color. The profile points used for tracking have blue color.

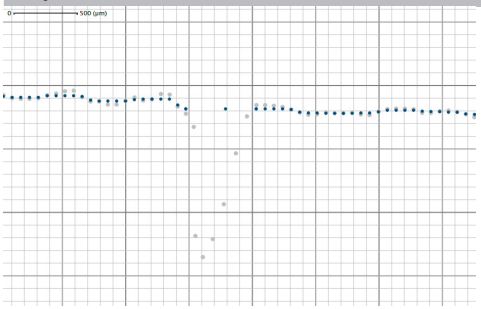
Following parameters are relevant for the filtering:

- **Gap Closure:**
  Defines the maximum distance between measuring points in order to group points together. Noise can also create gaps where actually no gap exists. Optimize the sensor settings to avoid such unwanted gaps (see section „7.4 Setup Device weCat3D“).

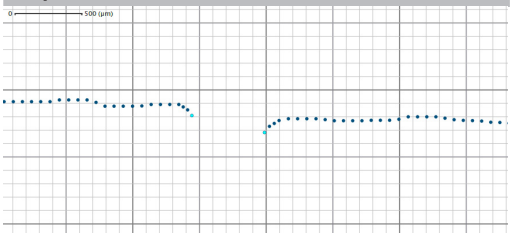
NOTE!
It is not possible to detect a joint, if the gap width is smaller than the Gap Closure. On the other hand, if the Gap Closure has a very small value, every gap which is wider than this, creates candidates for tracking points (see section 7.5.1.5) and therefore the risk of false-positives increases.

Example:
Decrease the Gap Closure to find the Points of Interest (cyan points). On the left side no Point of Interest is found because of the too big gap closure value of 0.6 mm. On the right side Points of Interest are found because of the smaller gap closure value of 0.2 mm.

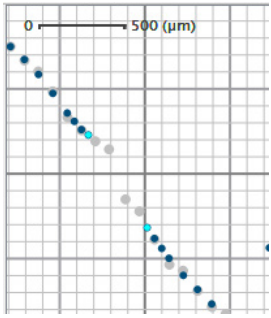
Gap Closure: 0.6 mm



Gap Closure: 0.2 mm



Due to a smoothing step before computing connected components the Gap Closure value needs to be chosen slightly larger than the gaps that are visible in the raw data. For example, the original profile (grey) has a gap that is smaller than 500 μm, but in the smooth profile (blue) it is larger. In order to connect the cluster set a Gap Closure value that is larger than the distance between the Points of Interest (cyan points , see section 7.5.1.5 for details). Compare also following figure:

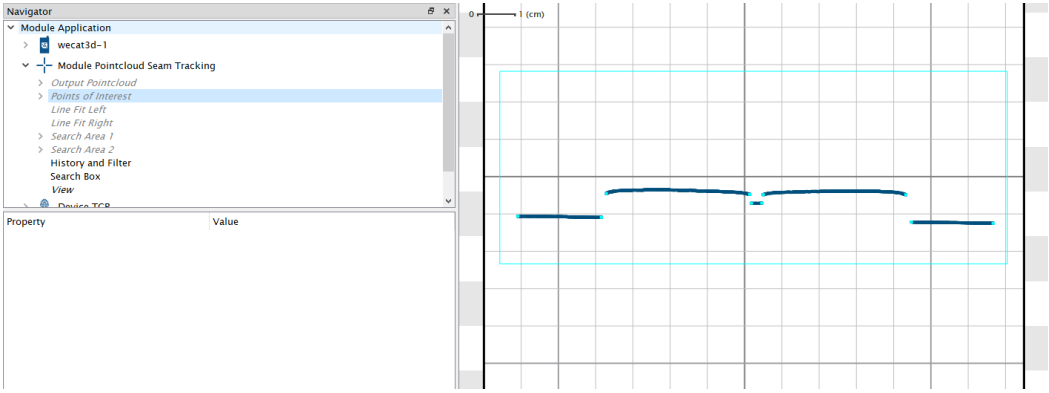


- **Min Cluster Size:**
  Defines the minimum number of measuring points that is necessary to consider the cluster as valid profile. The Min Cluster Size helps to ignore small reflections and to filter them out. This parameter rarely needs adjustment.

7.5.1.5 Points of Interest

For the joint types “Butt joint”, “Lap joint”, “T joint” and “Edge” the algorithm tries to find Points of Interest. These points are the candidates for tracking points. Joint specific checks apply in the following to determine if these points (or point pairs) are the tracking point(s) we are searching for. On the other hand this means, if the algorithm does not find Points of Interest at a certain position, it cannot find a tracking point there!

Points of Interest (cyan color) are the start and end points of a cluster (profile group) and edges within clusters.



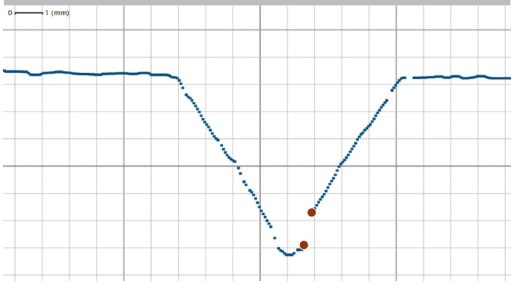
The relevant parameter for finding edges is

- **Edge Detection:**
  The algorithm finds more edges if using a high value for Edge Detection. If edges are not sharp, it might be necessary to increase the value.

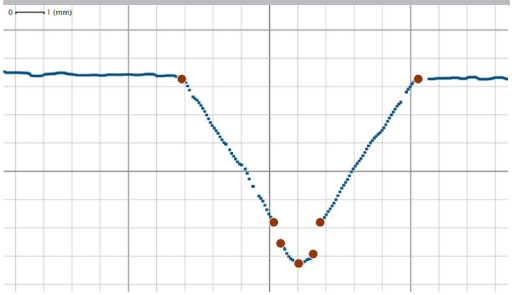
NOTE!
Avoid unnecessary high values, as every edge is a Points of Interest and every Point of Interest is a tracking point candidate. Hence, a high value may increase process time and the risk of false-positives.

Example:
At edges without significant corner point, the algorithm finds no Point of Interest. Increasing the Edge Detection value resolves the problem.

Edge Detection: 50

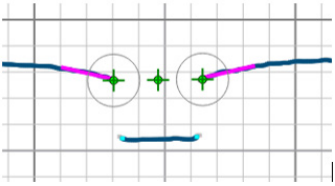


Edge Detection: 70



7.5.1.6 Straight Line Left/Right

Defines the length of line segments fitted next to the tracking points. These line segments (magenta color) have the purpose to determine how the profile looks like at the tracking point.



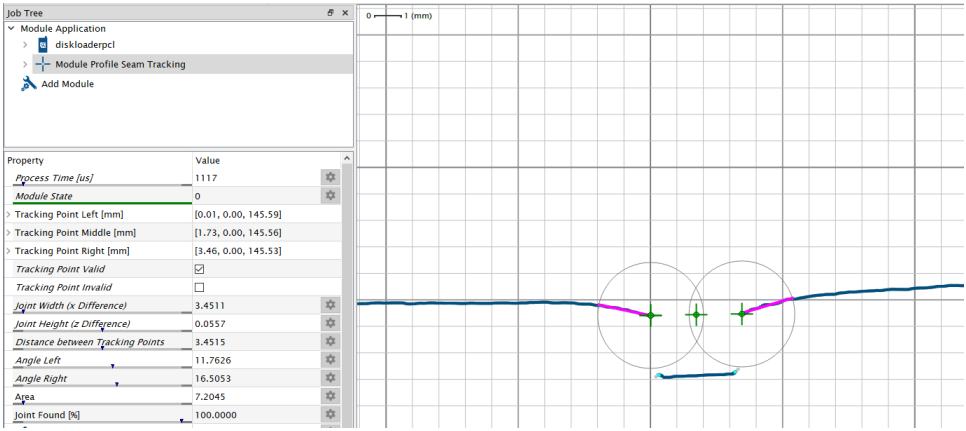
The algorithm uses the line fits for plausibility checks. Make sure that it is possible to fit a straight line at this part of the profile – otherwise adjust the length of the lines.

On rough surfaces, it is often helpful to use long line segments.

At least a certain percentage of the line has to be covert with points of the profile - otherwise no line fit is possible and, hence, it is not possible to find a tracking point at such position. Adjust if needed the parameter "Min Line Fit Quality" in order to allow fittings at profiles with many reflections (especially at T joints).

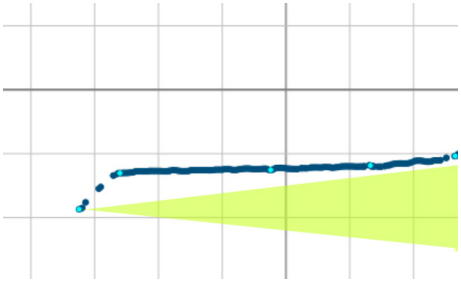
7.5.1.7 Angle Left/Right Min/Max

Defines the tolerated minimum and maximum angles of the left/right straight lines. If the angles of the straight lines are out of the allowed angle range, the algorithm finds no tracking points. Use the results of Angle Left and Angle Right to adjust the angles accordingly.



NOTE!

Do not set the allowed range to tight. The algorithm uses Angle Left/Right Min/Max not only to restrict the line results, but also to restrict the search area for the line fit! For example, in the picture below, it is not possible to find a line fit at the left point if the angles are restricted as illustrated with the green area.



7.5.2 Basic Outputs

The algorithm calculates for most joints types the results described in the following sections.

7.5.2.1 Process Time

Indicates the process time in μs for Module Profile Seam Tracking

7.5.2.2 Module State

Following numbers indicate the module state:

0: Filtered tracking points found successfully
1106: No filtered tracking points found

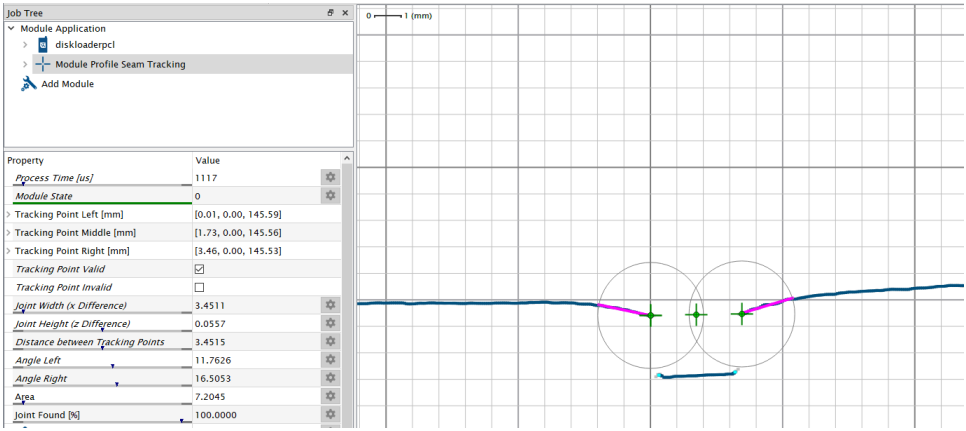
The module state makes no statement about the current tracking points, only about the filtered tracking points! It is possible that the current tracking points are invalid (in this case, entries are in error state), but the module state is 0.

7.5.2.3 Joint Found [%]

Percentage of profile evaluations with successful joint detection. The result provides an information on how good the settings are for the joint detection on a certain part. The history is reset with system start, project loading and acquisition start commands. If the acquisition is started before the joint detection or the acquisition is continued after the joint detection, the percentage will decrease accordingly.

7.5.2.4 Angle Left and Angle Right

Angle of left and right straight lines. Angles are measured with respect to the horizontal axis. Starting from the tracking point, if the line points upwards, the sign is positive and if it points downwards, the sign is negative.



7.5.2.5 Tracking Points Valid

Boolean Flag that indicates if valid tracking points are found.

7.5.2.6 Tracking Points Invalid

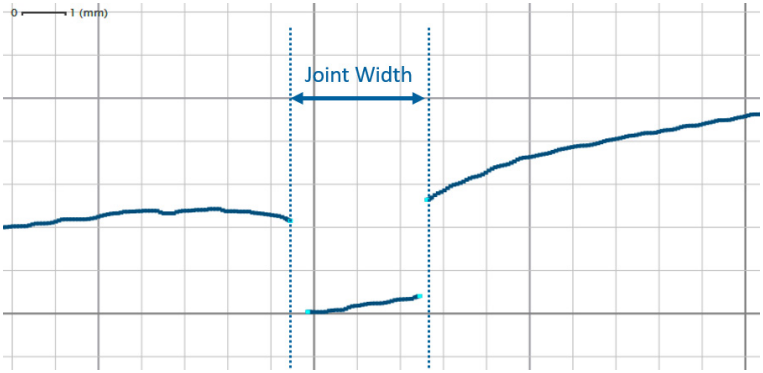
Boolean Flag that indicates if valid tracking points are not found.

7.5.3 Butt Joints

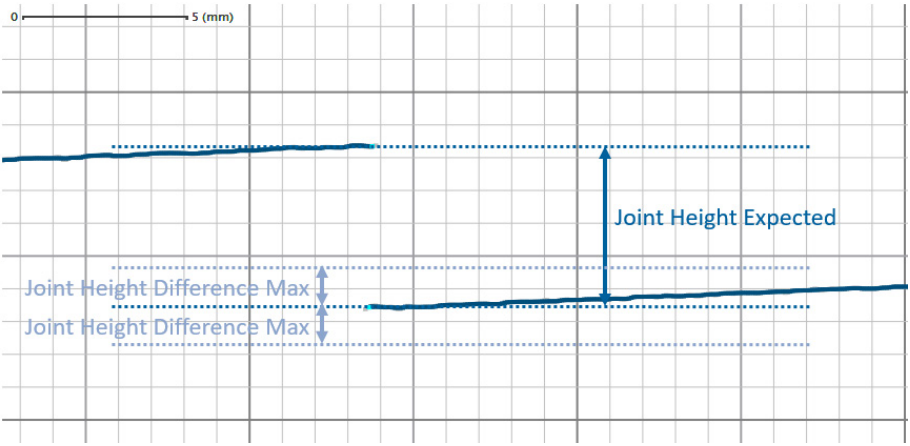
7.5.3.1 Parameters

The following parameters are relevant for butt joints:

- **Input Pointcloud:**
  See Basic parameters
- **Joint Width Min:**
  Defines the minimum difference of the x values of the left and right tracking points. If the real butt joint has a smaller width than Joint Width Min, no tracking point is found.
- **Joint Width Expected:**
  Defines the expected difference of the x values of the left and right tracking points. If several potential tracking points are within the limits, the algorithm choses the one with the better Joint Width Expected value.
- **Joint Width Max:**
  Defines the maximum difference of the x values of the left and right tracking point. If the real butt joint has a bigger width than Joint Width Max, no tracking point is found.

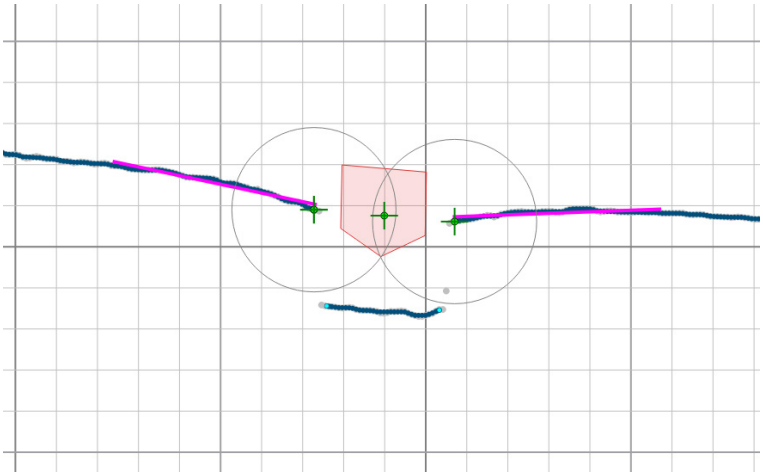


- **Joint Height Expected:**
  Defines the expected difference of the z values of the left and right tracking points. If the left tracking point is lower than the right one (step up), enter positive values for Joint Height Expected. If the left tracking point is higher than the right one (step down), enter negative values for the Joint Height Expected. By default, Joint Height Expected is set to 0 mm.
- **Joint Height Difference Max:**
  Defines the maximum height difference (positive and negative) that is accepted for left and right tracking points around the Joint Height Expected. If the real butt joint is out of the Height Difference Max window, no tracking point is found.



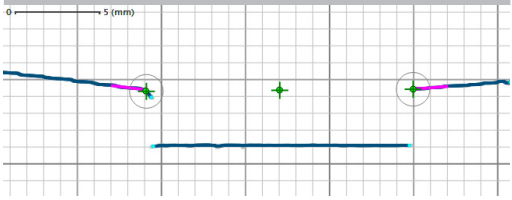
- **Gap Closure:**
  See Basic parameters
- **Cluster Size Min:**
  See Basic parameters
- **Edge Detection: + more / - less edges**
  See Basic parameters
- **Straight Line Left/Right:**
  See Basic parameters
- **Min Line Fit Quality:**
  See Basic parameters
- **Angle Left/Right Min/Max:**
  See Basic parameters

- **Forbidden Area Width [%]:**
  Defines the width of the forbidden area (by default 60 %). Activate or deactivate the forbidden area in the scene via the parameter "Forbidden Area" below the sub category "View". The forbidden area should not contain measuring points. The parameter is ignored if the parameter Depth Min is set to 0 mm (The forbidden area check is then ignored). The example shows Depth Min set to 1 mm and Forbidden Area Width to 60%.

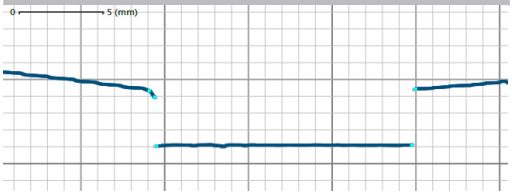


- **Depth Min:**
  Defines the minimum depth between left and right tracking points that should not contain measuring points. The amount of points in the area between left and right tracking point and slightly beneath and above is used as an indicator for welding tacks. Hence, if the number of points in this area is high, no tracking point is found. Activate or deactivate the forbidden area in the scene via the parameter "Forbidden Area" below the sub category "View".

Depth Min: 2 mm (tracking points are found)

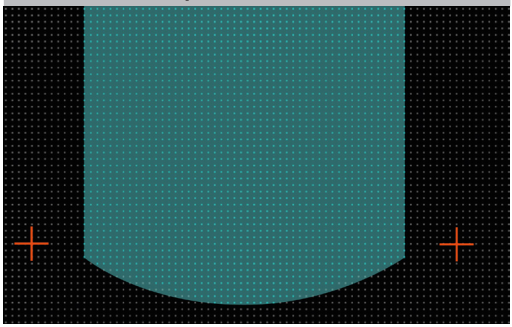


Depth Min: 5 mm (tracking points are not found)

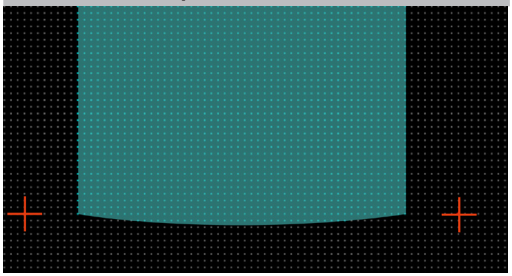


The images show the area to search for welding tacks (cyan) between two Points of Interest (red):

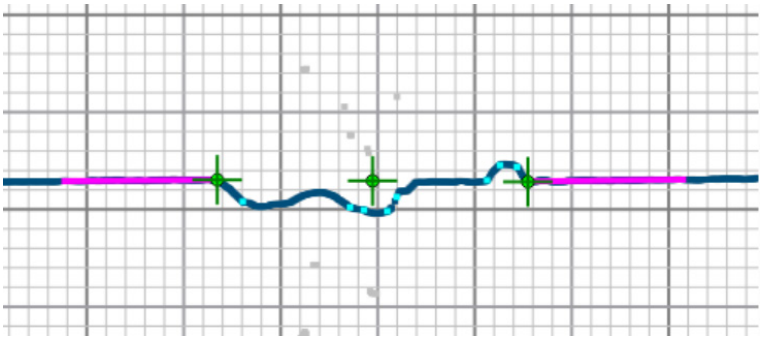
Width 20 mm, depth 3 mm



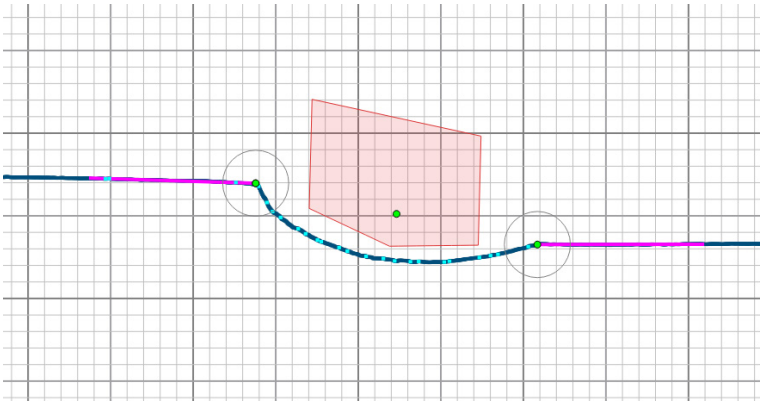
Width 20 mm, depth 1 mm



It is even possible to set Depth Min to value zero. In this case, the welding tack detection is disabled completely. A use case for this setup is the tracking of an already welded seam.



- **Min Angle Edge:**
  Defines the minimum angle difference between left and right line fits at one single point of interest to consider it as edge point. The following example shows a successful butt joint detection with "Min Angle Edge" set to 5° (especially relevant for the right point of the butt joint).



7.5.3.2 Results

The following results are relevant for butt joints:

- **Tracking Point Left/Middle/Right:**
  x and z coordinates of found points
- **Joint Width (x difference):**
  x difference between left and right tracking points
- **Joint Heigth (z difference):**
  z difference between left and right tracking points
- **Distance between Tracking Points:**
  Direct distance between left and right tracking point
- **Angle Left/Right:**
  See Basic outputs
- **Area:**
  Area between tracking points and the points between them. If there are no points between Tracking Point Left and Right, the area is zero.

NOTE!
The filtered Area in History and Filter is the mean of the last results. How many results are used depends on the smoothing parameter Mean of Last N Results. If the Filtered Tracking Point is the result of the keep valid or extrapolation setup, the value is repeated. If the filtered tracking point is invalid, the area is zero.

- **Joint Found (%):**
  See Basic outputs
- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.5.4 Lap Joints

7.5.4.1 Parameters

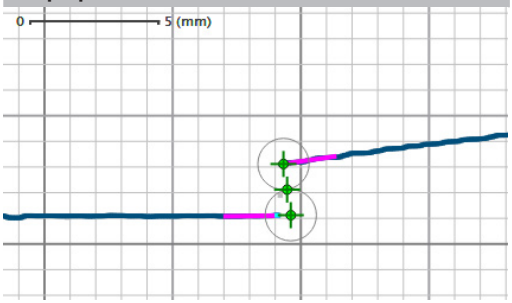
The following parameters are relevant for lap joints:

- **Input Pointcloud:**
  See Basic parameters
- **Lap Shape:**
  Defines if the lap joint is step up or step down. The algorithm only finds lap joints with such orientations.

Step down

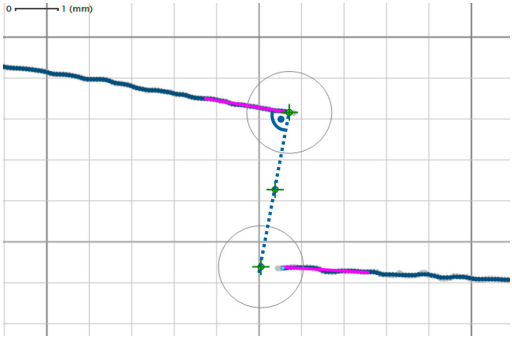


Step up

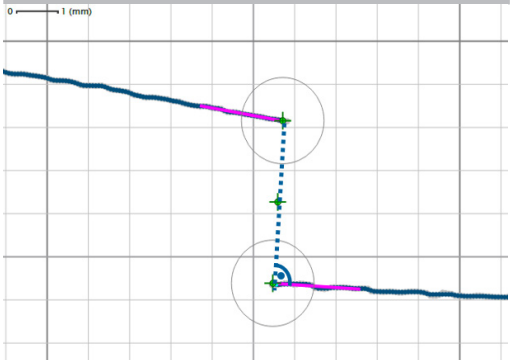


- **Right Angle Correction:**
  Defines the position where the right angle is set. This setup has influence on the position of the bottom tracking point. If it is possible to assume that there is a right angle, the detection of manual welding tacks is supported.
  - » **Right Angle Top:** The Tracking Point Bottom is the intersection point of the projection at the Tracking Point Top with the bottom straight line. The right angle is at the Tracking Point Top.
  - » **Right Angle Bottom:** The Tracking Point Bottom is the intersection point of the projection from the Tracking Point Top with the bottom straight line. The right angle is at the Tracking Point Bottom.

Right Angle Top

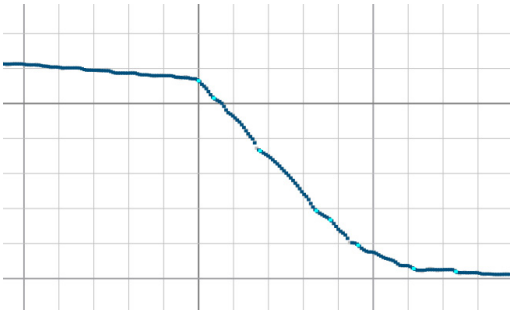


Right Angle Bottom

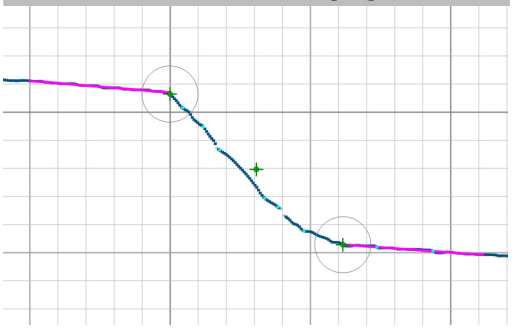


» **None (No Right Angle):** The Tracking Point Top and Bottom are equal to the Point of Interest (no alignment). In this case, it is not possible to detect manual welding tags.

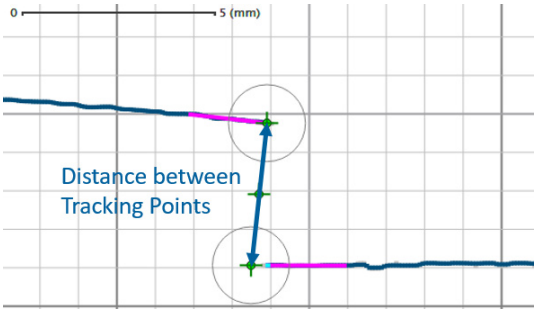
Right Angle Top/Bottom: No tracking point is returned at manual welding tags



None (No Right Angle): Tracking Point is returned even at manual welding tags

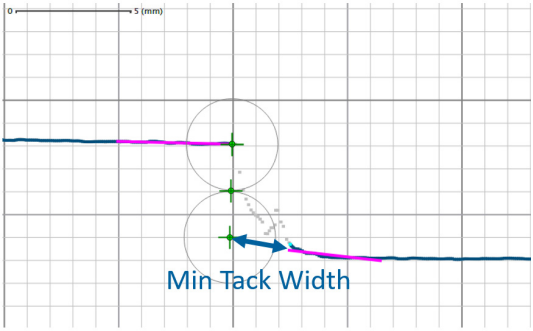


- **Tracking Points Distance Min/Max:**
  Defines the minimum and maximum (direct) distance between top and bottom tracking points. If the real distance of the lap joint exceeds the limits, the algorithm finds no tracking point.



The maximal distance is an important result as it may indicate that the metal parts are not in the proper position. The limits help to stop the welding process when Tracking Point Distance Max is exceeded.

- **Min Tack Width:**
  If the Right Angel Correction value is not set to None, the bottom tracking point is not necessary at the same position as the Point of Interest, which helped finding the tracking point pair. If the distance between Tracking Point Bottom and original Point of Interest is larger than Min Tack Width, a manual welding tag is assumed and no valid result is returned. In other words, a manual welding tack has to have at least a width of Min Tack Width to be recognized.



- **Straight Line Left/Right:**
  See Basic parameters
- **Min Line Fit Quality:**
  See Basic parameters
- **Angle Left/Right Min/Max:**
  See Basic parameters
- **Gap Closure:**
  See Basic parameters
- **Edge Detection:**
  See Basic parameters
- **Cluster Size Min:**
  See Basic parameters

7.5.4.2 Results

The following results are relevant for lap joints:

- **Tracking Point Top/Middle/Bottom:**
  x and z coordinates of found points
- **Joint Width (x difference):**
  x difference between top and bottom tracking points
- **Joint Heigth (z difference):**
  z difference between top and bottom tracking points.
- **Distance between Tracking Points:**
  Direct distance between top and bottom tracking points.

- **Angle Left/Right:**
  See Basic outputs
- **Joint Found (%):**
  See Basic outputs
- **Tracking Point Valid/Invalid:**
  See Basic outputs

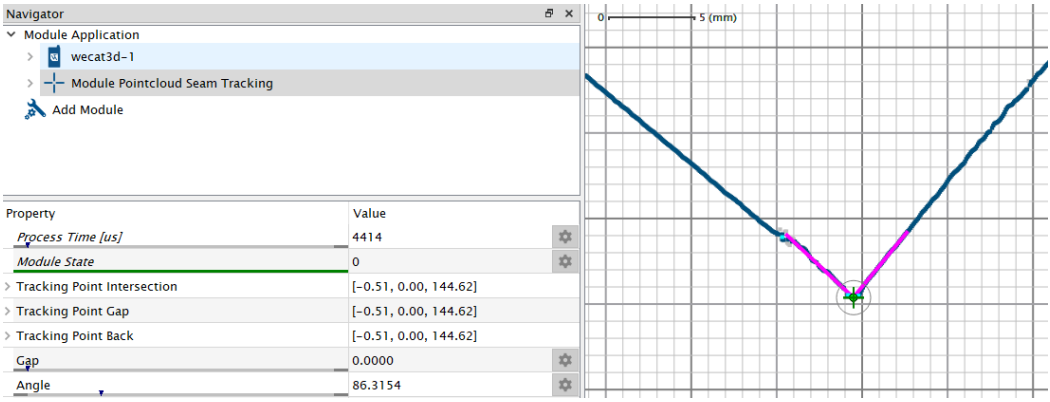
7.5.5 T Joints

7.5.5.1 Parameters

The following parameters are relevant for T joints:

- **Input Pointcloud:**
  See Basic parameters
- **Angle Min:**
  Defines the minimum angle between the left and right straight lines. If the real angle is smaller than Angle Min, no tracking point is found.
- **Angle Expected:**
  Defines the expected angle between the left and right straight lines. If several potential tracking points are within the limits, the algorithm chooses the one with the better Angle Expected value.
- **Angle Max:**
  Defines the maximum angle between the left and right straight lines. If the real angle is bigger than Angle Max, no tracking point is found.

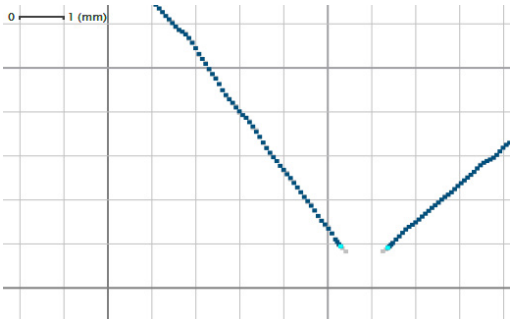
NOTE!
Use the result Angle to optimize the settings for Angle Min, Angle Expected and Angle Max.



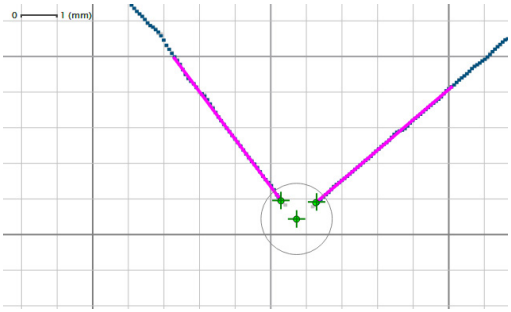
- **Gap Left/Right Max:**
  Defines the maximum gap between the left or right tracking point to the intersection point. If the real gap between the left or right tracking point to the intersection point is bigger than Gap Left Max or Gap Right Max, the algorithm finds no tracking point.

NOTE!
Use suitable values for Gap Left Max and Gap Right Max to find also T joints with a certain gap. The Gap Left/Right Max values help to stop the welding process when the metal parts are misaligned.

Gap Left/Right Max: 0 mm (No tracking point found)



Gap Left/Right Max: 3 mm (Tracking point found)

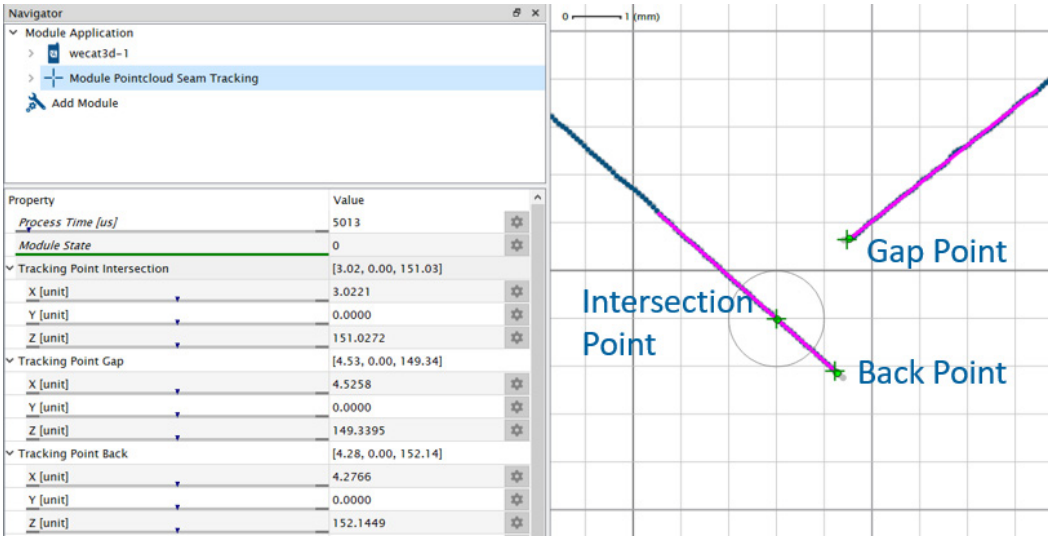


- **Straight Line Left/Right:**
  See Basic parameters
- **Min Line Fit Quality:**
  See Basic parameters
- **Angle Left/Right Min/Max:**
  See Basic parameters
- **Gap Closure:**
  See Basic parameters
- **Edge Detection:**
  See Basic parameters
- **Cluster Size Min:**
  See Basic parameters

7.5.5.2 Results

The following results are relevant for T joints:

- **Tracking Point Intersection:**
  x and z coordinates of intersection point between left and right straight line fits. This is the only point that is used for plausibility check of future results to prevent jumping results.
- **Tracking Point Gap:**
  x and z coordinates of end point of “higher” straight line. In case of no gap, Tracking Point Gap has the same coordinates as Tracking Point Intersection.
- **Tracking Point Back:**
  x and z coordinates of end point of “lower” straight line. In case of no gap, Tracking Point Back has the same coordinates as Tracking Point Intersection.



- **Gap:**
  Distance from Gap Point to Intersection Point.
- **Angle:**
  Angle between left and right straight line fits.
- **Angle Left/Right:**
  See Basic outputs
- **Area:**
  Area between Intersection, Back and Gap Point.

NOTE!
The filtered Area in History and Filter is the area between the filtered Intersection, Back and Gap Points.

- **Joint Found (%):**
  See Basic outputs
- **Tracking Point Valid/Invalid:**
  See Basic outputs

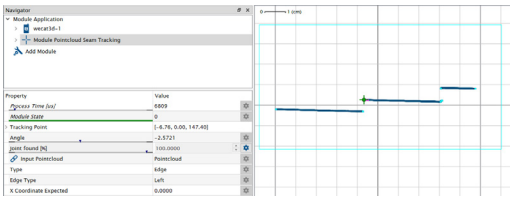
7.5.6 Edge

7.5.6.1 Parameters

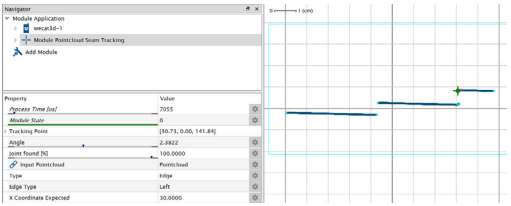
The following parameters are relevant for edges:

- **Input Pointcloud:**
  See Basic parameters
- **Edge Type:**
  Defines if looking for edges on the left or on the right side.
- **X Coordinate Expected:**
  Defines the expected x coordinate of the edge point. If several potential tracking points are within the limits, the algorithm chooses the one with the better X Coordinate Expected.

X Coordinate Expected: 0

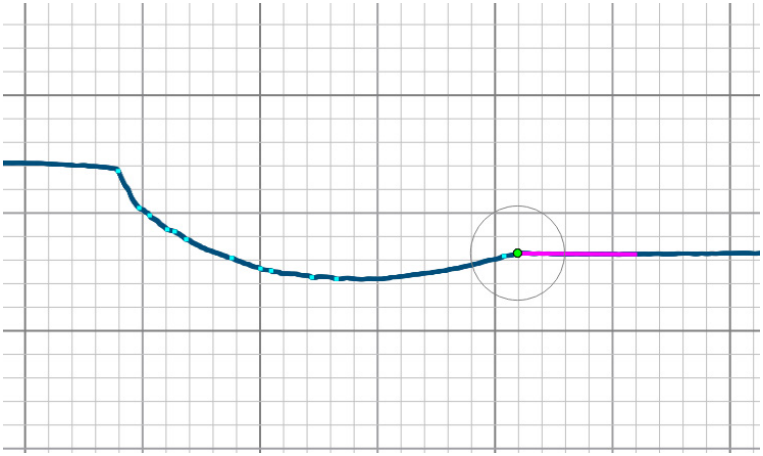


X Coordinate Expected: 30



- **Straight Line Left/Right:**
  See Basic parameters
- **Min Line Fit Quality:**
  See Basic parameters
- **Angle Left/Right Min/Max:**
  See Basic parameters
- **Gap Closure:**
  See Basic parameters
- **Edge Detection:**
  See Basic parameters
- **Cluster Size Min:**
  See Basic parameters

- **Min Angel Edge:**
  Defines the minimum angle difference between left and right line fits at one single point of interest to consider it as edge point. The following example shows a successful left edge detection with "Min Angle Edge" set to 5°.



7.5.6.2 Results

The following results are relevant for edges:

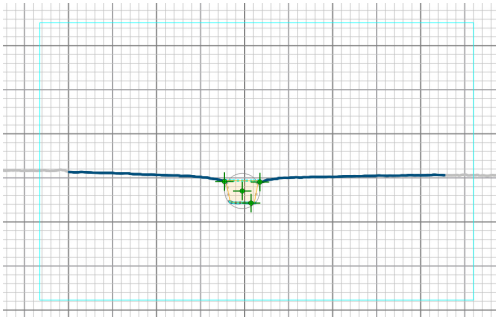
- **Tracking Point:**
  x and z coordinate of the edge point.
- **Angle:**
  See Basic outputs.
- **Joint Found (%):**
  See Basic outputs
- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.5.7 Dent

7.5.7.1 Parameters

The following parameters are relevant for dents:

- **Input Pointcloud:**
  See Basic parameters
- **Filter Width:**
  Dents are detected by comparing the profile with a strongly smoothed version of it. Depending on the intensity of the smoothing, dents are almost gone in the smooth version. The difference to the original profile is used to detect dents. The intensity of the smoothing is adjusted with the parameter Filter Width.
  As smoothing destroys information, the area near the boundary of the search box is not usable for dent detection. The larger the filter width, the more profile is lost. This is visible in the UI by the greyed out profile. Cyan points visualize the boundary of the dent approximation. The dent area is marked with yellow color.



- **Area Min/Max:**
  Defines the range of the allowed area which the found dent is allowed to have.
- **Compactness Min:**
  Compactness is defined as the ratio of the area of an object to the area of a circle with the same perimeter. The maximal compactness value (for a perfect circle) is 1 and the minimal value is 0. The Compactness Min parameter helps to exclude false-positives with long and thin shape.

$$\text{compactness} = (4\pi \times \text{area}) / (\text{perimeter})^2$$

- **Compactness Max:**
  Defines the maximal compactness value.
- **Gap Closure:**
  See Basic parameters
- **Cluster Size Min:**
  See Basic parameters

7.5.7.2 Results

The following results are relevant for dents:

- **Tracking Point Centroid:**
  x and z coordinate of the centroid of the dent area.
- **Tracking Point Left/Right:**
  x and z coordinate of the leftmost/rightmost point in the dent area.
- **Tracking Point Bottom:**
  x and z coordinate of the lowest point in the dent area
- **Area:**
  Area covered by the dent approximation.



NOTE!
The filtered Area in History and Filter is the man area of the last results. How many results are used depends on the smoothing parameter Mean of Last N Results. If the Filtered Tracking Point is the result of the keep valid or extrapolation setup, the value is repeated. If the filtered Tracking Point is invalid, the area is zero.

- **Compactness:**
  Compactness of the dent approximation.
- **Joint Found (%):**
  See Basic outputs
- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.5.8 Input Point

7.5.8.1 Parameters

The following parameters are relevant for the input point:

- Input Pointcloud: See Basic parameters
- Input Point: Link a point from another module (e.g. from Module Profile Measure) as input point. If the input point is in error state, all results of Module Profile Seam Tracking are in error state (also the results of the sub-module "History and Filter")

7.5.8.2 Results

The following results are relevant for the input point:

- Output Point: Shows coordinates of the input point.
- Tracking Point Valid/Invalid: See Basic outputs
- Joint Found [%]: See Basic outputs

7.5.9 History and Filter

For safe and smooth tracking, the last results are stored and used to generate an artificial tracking point, the Filtered Tracking Point. This point is supposed to be more reliable, stable and less affected by noise.



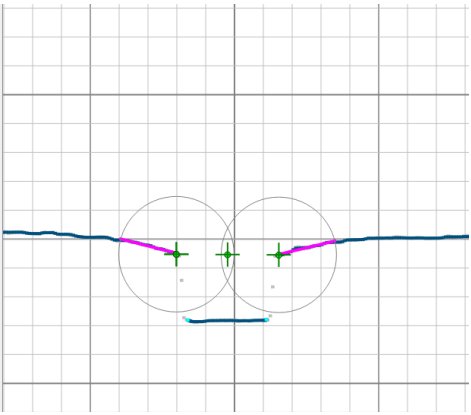
NOTE!
It is not possible to use the filtering in case of too fast acquisition frequencies for the input device. In case of overflowing data buffers, also the Filtered Tracking Points go in error state.

7.5.9.1 Parameters

The following parameters are relevant for History and Filter:

- **History Reset:**
  Manual reset of the history. In offline mode, when working with teach-plus files, it is sometimes necessary to reset the history manually. Whenever parameters change, the history is reset, too. When working online, with real sensor data, the following actions trigger a history reset automatically:
  - » Booting the system
  - » Loading a project
  - » Starting the acquisition via software Acquisition Start command
  - » Stopping the acquisition via software Acquisition Stop command
- **Prevent Jumping Results:**
  New results of the filtered tracking points are only allowed in a specific search area around the last filtered tracking points.
  - » **Applied Max Distance to Last Tracking Points:** This output shows the applied maximal distance around the last found tracking points. If “Search Area” is activated in “View”, the search areas around the last valid tracking points are also visualized in the UI. It is not possible to set this value, as it is computed from the following parameters.
  - » **Initial Max Distance to Last Filtered Tracking Points:** Defines the initial radius of the search area, centered at the last Filtered Tracking Points.
  - » **Increment Max Distance to Last Filtered Tracking Points:** Defines the increment that is added to the radius each time no tracking point is found in order to take into account the movement of the joint position.

Property	Value
Filtered Tracking Point Left	[-2.02, 0.00, 185.53]
Filtered Tracking Point Middle	[-0.24, 0.00, 185.54]
Filtered Tracking Point Right	[1.54, 0.00, 185.55]
Filtered Tracking Point Valid	☑
Filtered Tracking Point Invalid	☐
Joint Width Filtered Tracking Points (x Difference)	3.5525
Joint Height Filtered Tracking Points (z Difference)	0.0210
Distance between Filtered Tracking Points	3.5525
Area	7.1243
Joint Found [%]	100.0000
History Reset	☐
Prevent Jumping Results	☑
Applied Max Distance to Last Filtered Tracking Point [mm]	2.0000
Initial Max Distance to Last Filtered Tracking Point [mm]	2.0000
Increment Max Distance to Last Filtered Tracking Point [mm]	0.2000
Smooth Results	☑
Fill Gaps in Results	☑
Safe Joint Localization	☑



- **Smooth Results:**
  For stable and smooth results, the last valid tracking points can be filtered. If this option is activated, the Filtered Tracking Points are the smoothed version of previous results.
  - » **Mean of Last N Results:** Defines how many previous tracking points are considered to compute the mean. Only valid tracking points of the last N results are used.

- **Fill Gaps in Results:**
  It is possible to fill gaps if not every tracking point is found and no errors should be sent to the communication partner. Consequently, Filtered Tracking Points can become valid, even if no current Tracking Points are found.
  - » **Runs Without Tracking Point:** Shows the number of evaluations without a valid Tracking Points. This result is reset whenever a valid result is found.
  - » **Keep Valid for N Runs:** If no current Tracking Point is found, the last valid Filtered Tracking Points are reused for N runs. Once, no Tracking Point is found for N+1 runs, the Filtered Tracking Points become invalid.
  - » **Trend Using Last N Results:** Defines how many steps between consecutive previous Filtered Tracking Points are considered to extrapolate, in case of a missing result. Only the valid Filtered Tracking Points of the last N +1 results are used for this calculation. The target is to preserve the movement of Tracking Points even if there are gaps in the results. By default, the value is set to 1, which means that no trend is applied (only the last result is considered, and therefore there is no movement in these data).

- **Safe Joint Localization:**
  This option reduces the risk of false-positive results when localizing joints. Problems arise for example, if the sensor moves towards the joint and detects structures in the surface, which look similar to the joint. In general, there is a risk, that false-positive Filtered Tracking Points set the Search Area at an unsuitable position. This risk is reduced by comparing the current result with previous ones and by only accepting the Filtered Tracking Points, if there is a certain amount of previous results at a similar location. For this purpose, the distances between the current result and the previous ones are measured. Every previous result that has a distance smaller than the search radius S is considered as a match. Search radius S is computed as the search radius at the Filtered Tracking Point. It starts with the value set for Initial Max

Distance to Last Filtered Tracking Point and increases when going back in time with the value of Increment Max Distance to Last Filtered Tracking Point. The mechanism does not apply if immediately a valid result is received after starting the acquisition. In this case, the sensor is usually at the proper position and the delayed seam recognition can be avoided. So every valid tracking point result produces a valid filtered tracking point result (even if the overall number of received results is smaller than "Relocate Buffer Size").

» **Relocate Matches:** This output shows the current number of similar results in history.

» **Relocate Buffer Size:** Defines the number of results stored for comparison.

» **Relocate Matches Min:** Defines the minimal number of matches within the Relocate Buffer that have to be found in order to consider the Filtered Tracking Points as valid.

7.5.9.2 Results

Depending on the joint type, further results appear.

7.5.10 View

Activate /deactivate or adjust one of the following overlays within the profile:

- **Current Tracking Points:**
  Shows the tracking points for the current profile.
- **Filtered Tracking Points:**
  Shows the filtered tracking points.
- **Input Pointcloud:**
  Shows the original and not filtered input pointcloud with grey points.
- **Points of Interest:**
  Shows the Points of Interest with cyan color.
- **Line Fits:**
  Shows the line fits for the tracking points.
- **Search Area:**
  Shows the search area for the filtered tracking points. The next filtered tracking point is only allowed within the search area, otherwise no tracking point is found in order to avoid jumping tracking points (see section 7.5.9).
- **Area:**
  Shows the area of found joints (only supported at some of the joint types).
- **Forbidden Area:**
  Shows the forbidden area (only available at butt joints).
- **Filtered Tracking Point Cross Size:**
  Defines the size of the cross for the filtered tracking points.
- **Tracking Points:**
  Shows all or only specific tracking points (depending on parameter type).

7.6 Setup Device for Outputs

The relevant device for outputs within the uniVision project depends on the use case:

- wenglor robot server (on Machine Vision Controller): Device Robot Weld Seam Tracking
- No wenglor robot server (on Machine Vision Controller): Any available interface of the device is possible (PROFINET, EtherNet/IP, EtherCAT, TCP/IP or UDP)



NOTE!
This manual contains all info about Device Robot Weld Seam Tracking for the communication to the wenglor robot server. Check the product page of the relevant device for further info about all other interfaces like PROFINET, EtherNet/IP, EtherCAT, TCP/IP, UDP or LIMA.

7.7 Setup Device Robot Weld Seam Tracking (for Robot Server)

In the templates, Device Robot Weld Seam Tracking is already part of the project and preset with the relevant defaults for the robot interfaces.



NOTE!
If creating an empty project, it is necessary to add Device Robot Weld Seam Tracking from the toolbox to the project to work with the wenglor robot server. If not using the robot server, Device TCP or any other interface (e.g. PROFINET, EtherNet/IP) can be used to send the data to the communication partner (e.g. PLC).

Process Time [µs]	Process time to run the module in µs
Module State	Shows state of module: • 0: No error • Different to 0: Error (for details, see operating instructions of DNNF023).
Output	Returns a preview of the output sent to the robot server.

The Sub-Module “Main Results” contains the following mandatory parameters:

Tracking Point Invalid	Link with a boolean value which provides information concerning the validity of the measured value (e.g. Filtered Tracking Point Invalid). If the result of “Tracking Point Invalid” provides a valid tracking point, all other values (e.g. Tracking Point x and z) must be valid. Otherwise, wrong values are sent to the robot. **NOTE!** The linked value is interpreted as follows: • Boolean false: The ascertained value is valid. • Boolean true: The ascertained value is invalid. The robot ignores the measured value.
Tracking Point x [mm]	Link to the x coordinate of the tracking point.
Tracking Point z [mm]	Link to the z coordinate of the tracking point.

The Sub-Module “Optional Results” contains the following optional parameters.

Gap (x Difference) [mm]	Link to the width difference (e.g. the x value difference at a butt joint).
Height (z Difference) [mm]	Link to a height difference (e.g. the z value difference at a lap joint).
Area [mm²]	Link to an area (e.g. the area from joint type "Dent").
Inclination Angle [°]	Link to inclination angle of calibration plate to the x-axis of the sensor (only necessary for calibration template via calibration plate at ABB robots).
2nd Tracking Point x [mm]	Link to x-coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB).
2nd Tracking Point z [mm]	Link to z-coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB).

7.8 Save Project and Setup Startup Behavior

Save the project with a project number and make sure that it is defined as start job in the device website of the Machine Vision Controller (see operating instructions of Machine Vision Controller).

Example:

- Job number on robot side: 1
- Matching name of the uniVision project: 1.u3p

8. Robot Manufacturer

Connect the Machine Vision Controller with the robot controller via network (TCP/IP).



NOTE!
For details about robot and calibration, check the operating instructions of the robot manufacturer.

8.1 ABB

8.1.1 Robot Controller IRC5

System requirements

- Controller: IRC5
- Software: RobotWare 6.0
- Sensor Interface: Optical Tracking Arc

Use port X4 (LAN2) or X5 (LAN3) on the ABB robot controller for connecting the Machine Vision Controller.

Adjust the default configuration of the software “Optical Tracking Arc” accordingly:

Parameter	Description
Name	Enter the name of the sensor (e.g. MLZL121)
Type	Select LTAPPTCP
Serial port	Not used
Remote address	Enter IP address of Machine Vision Controller (default: 192.168.100.1)
Remote port	Enter port (default: 5020)

Enter properties of the sensor (e.g. with sensor MLZL121):

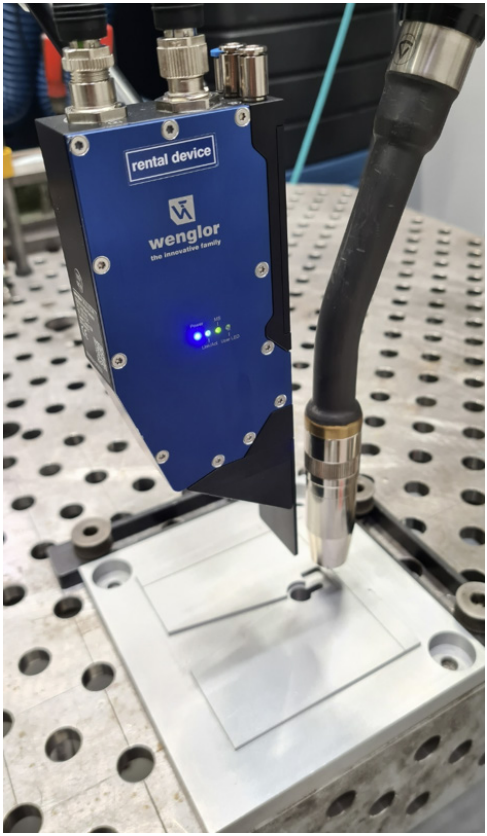
ABB property name	wenglor property value (datasheet)	Property value*
Name	MLZL121	MLZL121
Dimension		2
Angle camera to laser		16,5
Frequency		20
Close width of field Y**	Measuring range X (small value)	38 (field width X start, recommended: 30)
Far width of field Y**	Measuring range X (large value)	62 (field width X end, recommended: 50)
Close width of field X		0
Far width of field X		0
Close StandOff*	Working range Z (small value; must be converted to negative value)	-74 (working range Z start)
Depth of Field	Measuring range Z	84 (working range Z)
Far StandOff*	Working range Z (large vlaue; must be converted to negative value)	-158 (working range Z end)

Optimal TCP Stand-Off*		-115 (working range Z at center of field of view)
Frame alignment		Camera aligned
Frame Z orientation		Into camera
Brand		wenglor
Camera compensates X measurement		false

* Some values must be negative values because the coordinate system of the sensor is different to the coordinate system of the ABB robot.
** For some sensor properties, use smaller values than described in the sensor datasheet. The ABB controller uses the sensor properties for the calibration. Limiting the range makes the calibration more stable.

Calibration

Calibrate robot and sensor via the calibration plate. The following image shows the orientation of sensor, robot and calibration plate .



Load the template “Calibrate robots (calibration plate)” in the uniVision software, adjust the settings and save the project with the name “90.u3p”. Make sure that the left tracking point is the first tracking point and that the right tracking point is the second tracking point in Device Robot Weld Seam Tracking (see „7.7 Setup Device Robot Weld Seam Tracking (for Robot Server)“).

Apart from the "Main results", also the following "Optional results" need to be linked at Device Robot Weld Seam Tracking for calibration via the calibration plate:

- Inclination Angle [°]
- 2nd Tracking Point x [mm]
- 2nd Tracking Point z [mm]

The robot requests the coordinates of the left and right tracking points and the inclination angle to the x axis at a very high frequency.

- Left joint: Job number 90 on robot side
- Right joint: Job number 91 on robot side
- Butt joint: Not used

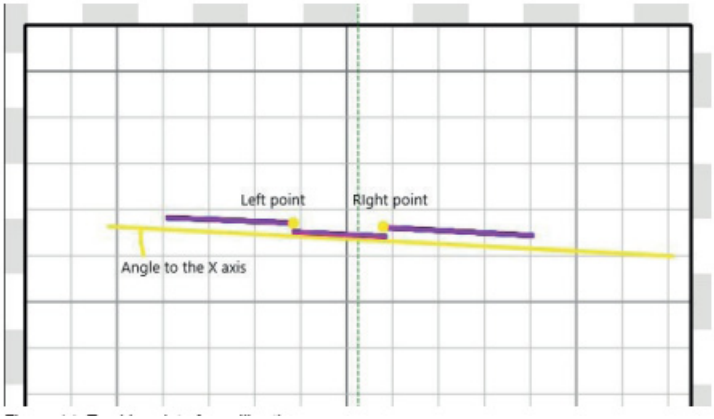


Fig. 1: Tracking data for calibration

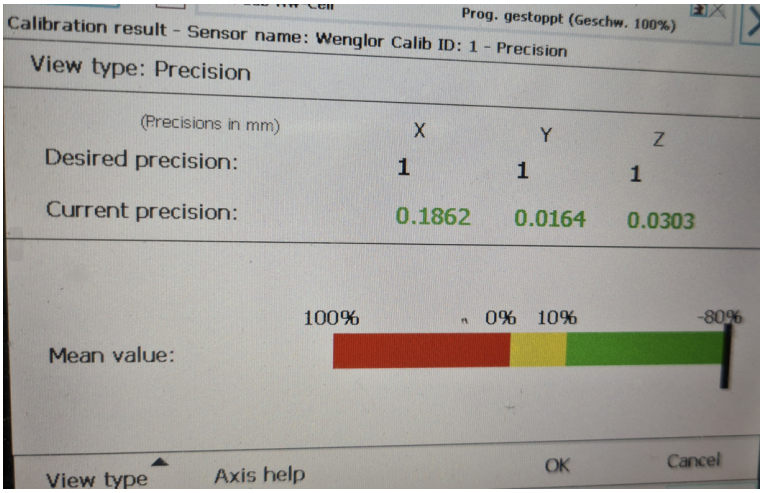
NOTE!

- In order to change left and right joints, open the developer page on the Machine Vision Controller (default 192.168.100.1/#/developer) and set the parameters accordingly.
- Use job number 90.u3p only for the calibration project and do not save any project with the job number 91 (91.u3p).

For the ABB robot, job 90 for the left joint and job 91 for the right joint are different jobs. The weld seam tracking interface remains at job 90 for performance reasons. It uses either the coordinates of the left or the coordinates of the right tracking point. Requesting data during calibration is at a very high frequency and every result must be valid. So make sure that the uniVision job is set correctly for all orientations. Directly use the relevant job 90.u3p as start job to avoid an additional job change at the beginning of the calibration process.

NOTE!
In case of calibration error 80001 at the ABB robot, mount the sensor nearer to the calibration plate and check the sensor properties.

Check the calibration results at the ABB robot.



Tracking
Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g.1.u3p).

8.1.2 Robot Controller OmniCore

System requirements

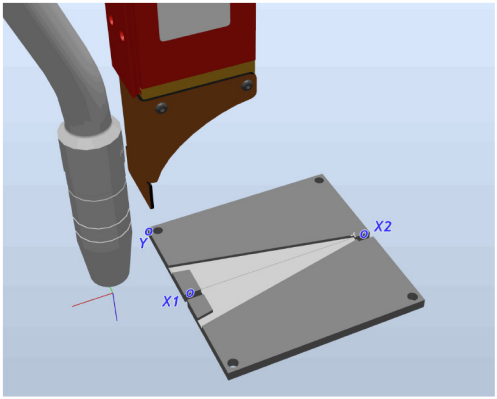
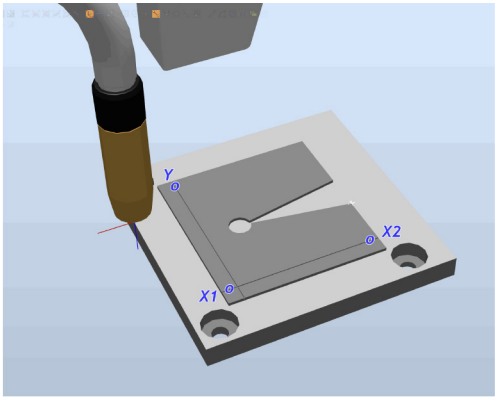
- Controller: OmniCore
- RobotWare 7.21.0 or higher
- ArcWare for OmniCore 1.1.3 or higher
- ArcSeam Tracking for OmniCore 1.1.3 or higher

License requirements
3416-3 Arc Welding Premium+ (used for ArcSeam Tracking for Omnicore with optical sensor based tracking)

Network cable connection
Use one of the Ethernet ports on the ABB OmniCore robot controller for connecting the Machine Vision Controller.

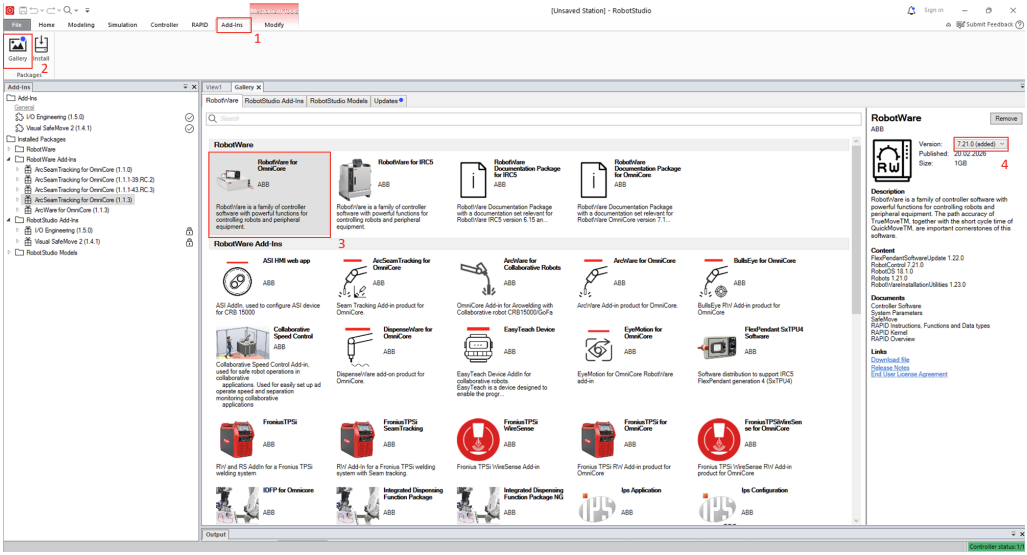
Calibration plate

The following calibration plates are compatible

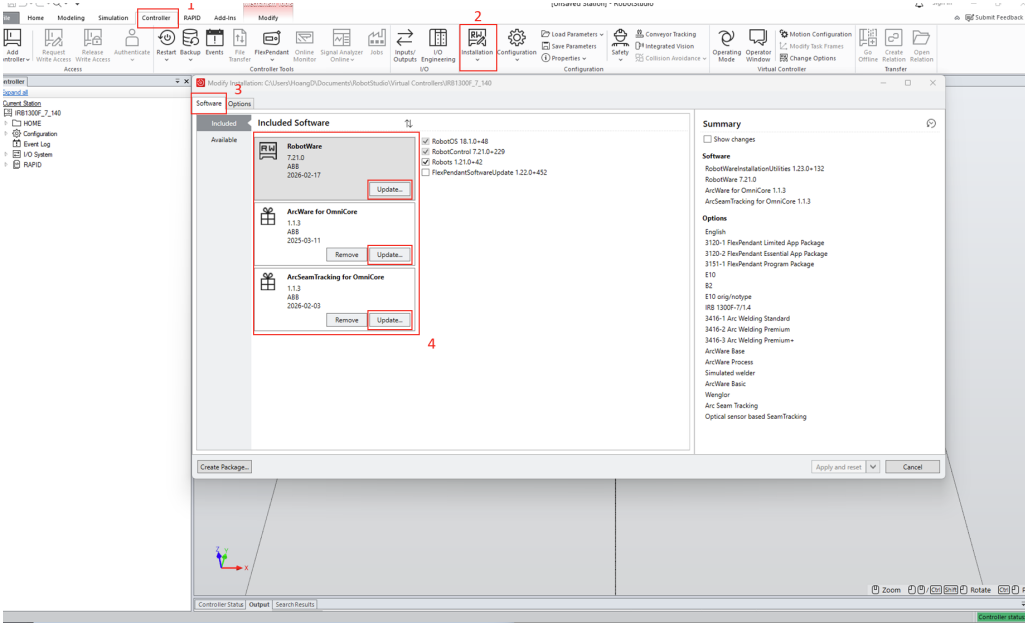
ABB0 (recommended, must be ordered from ABB	scansonic1
	

Installation and configuration

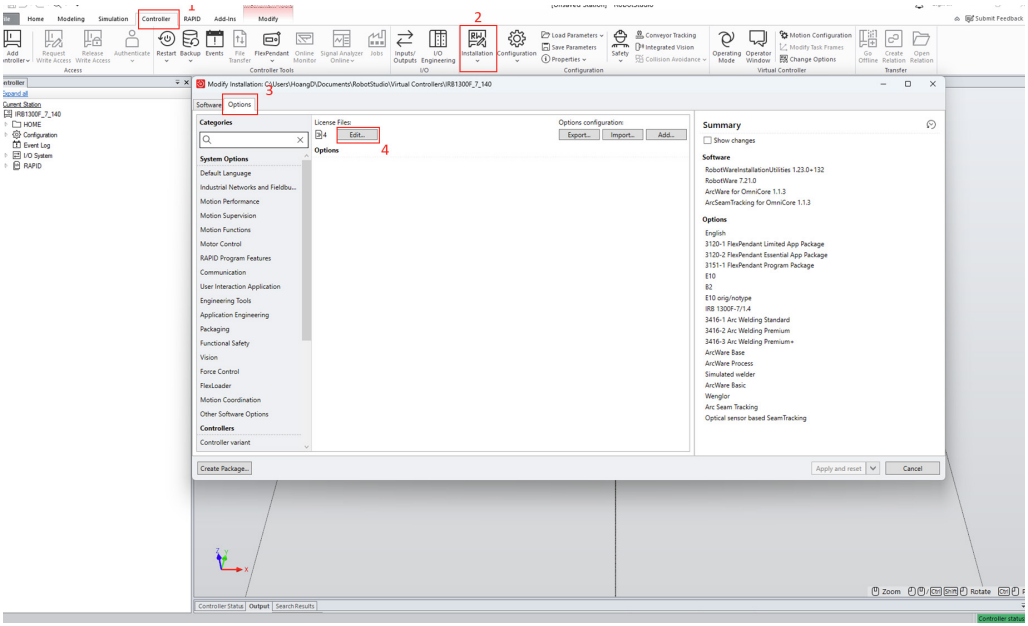
Add required ABB Add-Ins (see system requirements), e.g. RobotWare for OmniCore.



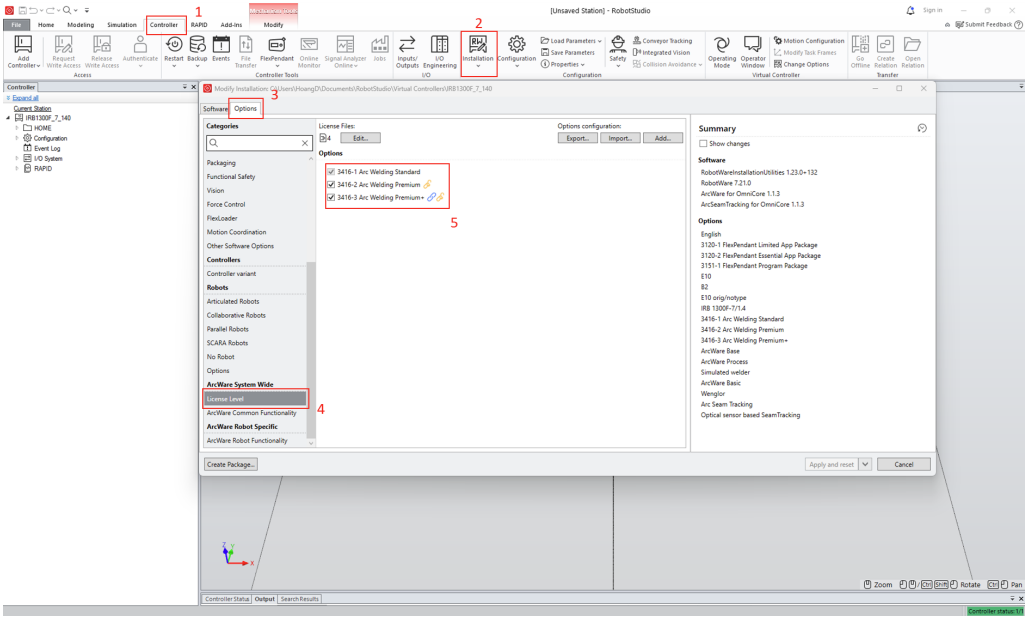
Install or update the added software packages.



Import the license from ABB.



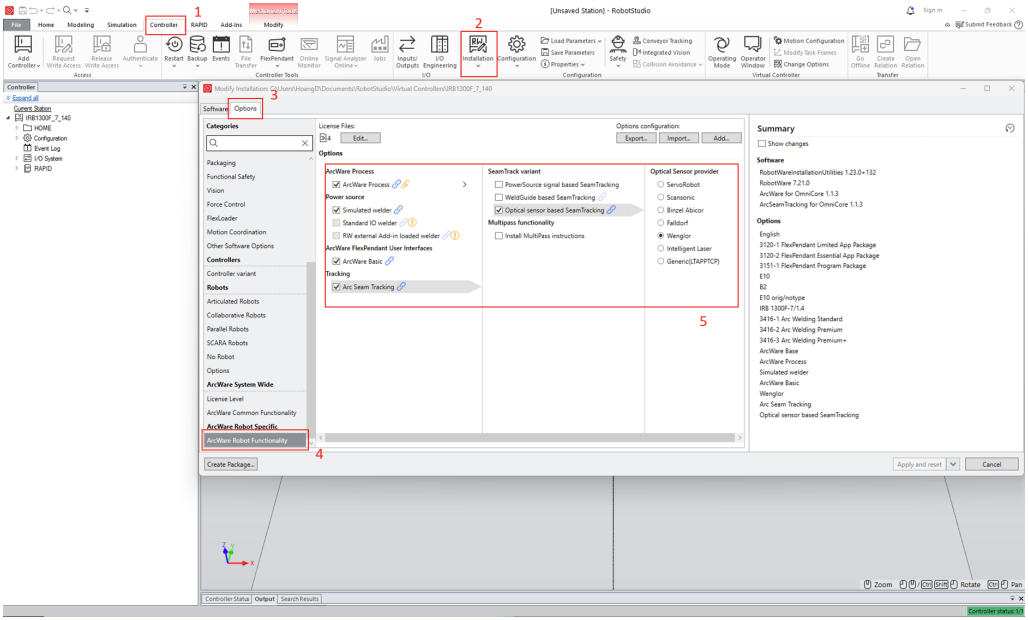
Move to “License Level” and activate all licenses.



Activate Arc Seam Tracking

Move to “ArcWare Robot Functionality” and select

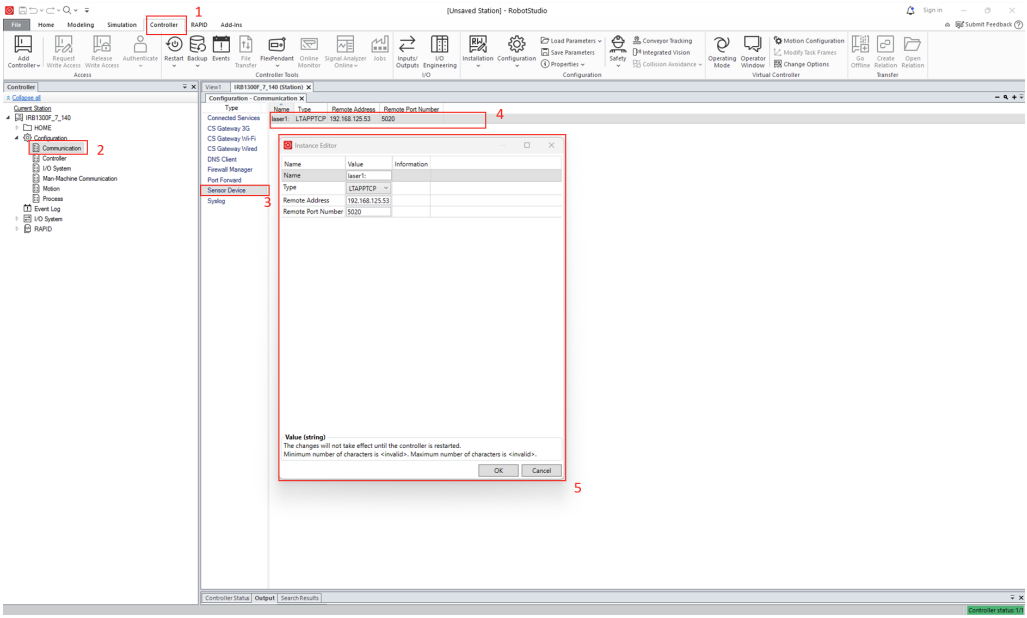
- Tracking: Arc Seam Tracking
- SeamTrack variant: Optical sensor based SeamTracking
- Optical Sensor provider: Wenglor



Configure communication

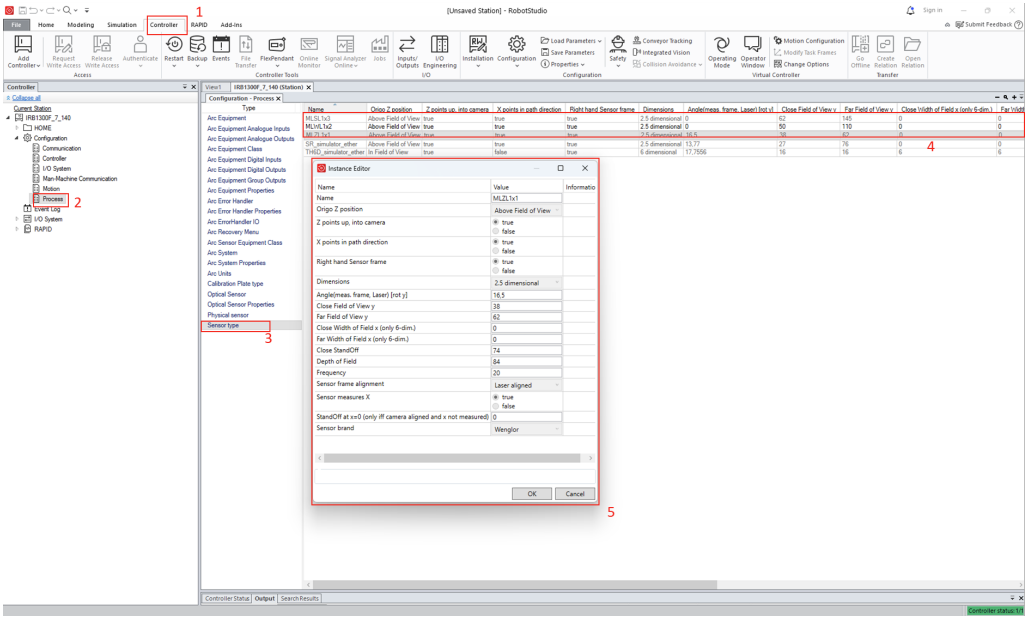
Configure the communication with the wenglor robot server:

- Name: laser1:
- Type: LTAPPTCP
- Remote Address: wenglor device (Machine Vision Controller MVC) IP address (by default 192.168.100.1)
- Remote Port Number: wenglor device robot server port (by default 5020)

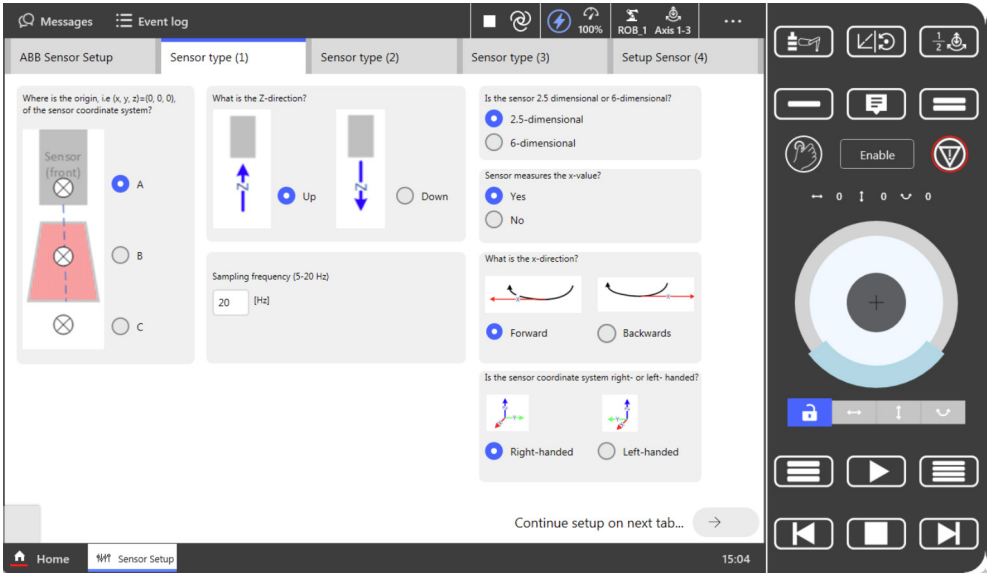


Check default configuration wenglor sensor

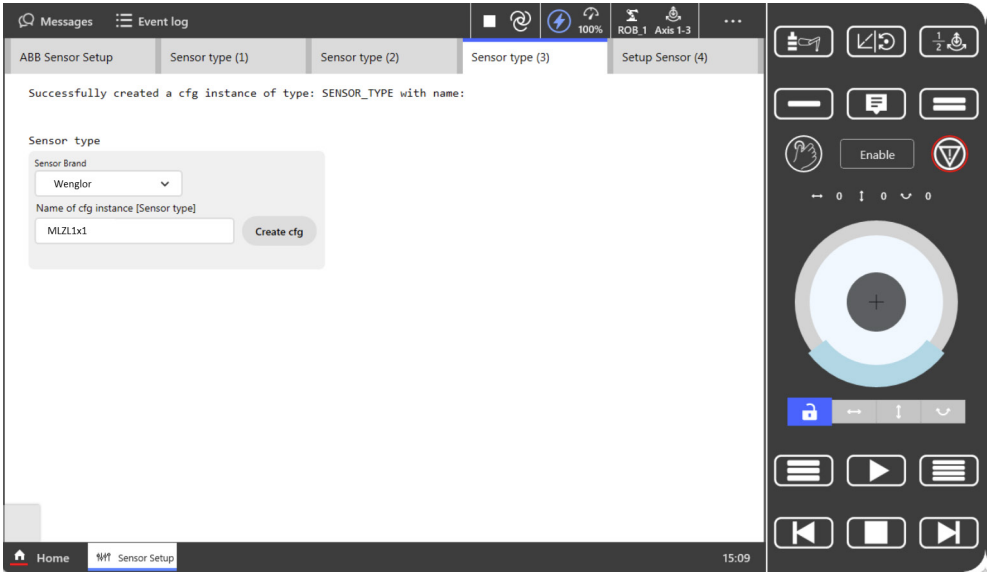
If using RobotStudio, check the parameters.



If using FlexPendant, enter the parameter of the sensor. But as the default configuration is available, nothing to do here. Select “Sensor Setup” -> “Setup a new sensor type”



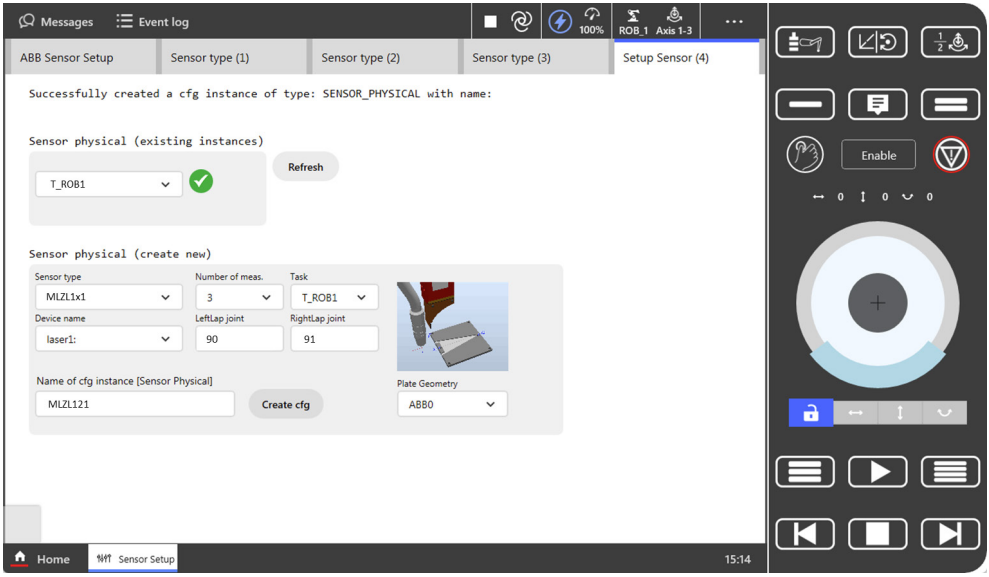

Messages
Event log
100%
ROB_1
Axis 1-3
ABB Sensor Setup
Sensor type (1)
Sensor type (2)
Sensor type (3)
Setup Sensor (4)
Sensor (front)
Close Stand-off
74
[mm]
38
[mm]
Close FoV
Field of View (FoV)
Depth of field
84
[mm]
Far FoV
62
[mm]
Sensor (front)
Sensor (side)
Angle Camera to Laser (rot y)
16,5
[°]
Stand-off with x=0
0
[mm]
Continue setup on next tab...
Home
Sensor Setup
15:06
Enable


Messages
Event log
100%
ROB_1
Axis 1-3
ABB Sensor Setup
Sensor type (1)
Sensor type (2)
Sensor type (3)
Setup Sensor (4)
Successfully created a cfg instance of type: SENSOR_TYPE with name:
Sensor type
Sensor Brand
Wenglor
Name of cfg instance [Sensor type]
MLZL1x1
Create cfg
Home
Sensor Setup
15:09
Enable

Add physical sensor with wenglor configuration

Since the sensor type is available, we can set it and the other parameters to add the sensor. Both options lead to the same result.

- Name of the sensor, e.g.: MLZL121
- Sensor Type: MLZL1x1
- RAPID Task: T_ROB1 (default)
- Device Name: laser1
- LeftLap joint: 90 (defined by wenglor)
- RightLap joint: 91 (defined by wenglor)
- Calibration Plate type: ABB0 or Scansonic1
- Number of Measurements: 5 (for accuracy during calibration)



Calibration job in uniVision

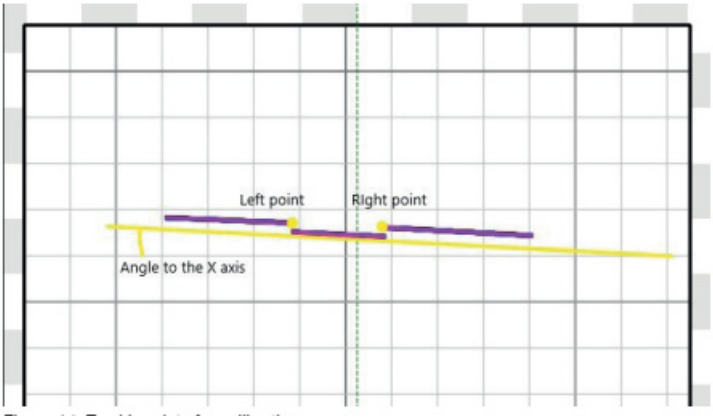
Load the template “Calibrate robots (calibration plate)” in the uniVision software, adjust the settings and save the project with the name “90.u3p”. Make sure that the left tracking point is the first tracking point and that the right tracking point is the second tracking point in Device Robot Weld Seam Tracking (see „7.7 Setup Device Robot Weld Seam Tracking (for Robot Server)“).

Apart from the “Main results”, also the following “Optional results” need to be linked at Device Robot Weld Seam Tracking for calibration via the calibration plate:

- Inclination Angle [°]
- 2nd Tracking Point x [mm]
- 2nd Tracking Point z [mm]

The robot requests the coordinates of the left and right tracking points and the inclination angle to the x axis at a very high frequency.

- Left joint: Job number 90 on robot side
- Right joint: Job number 91 on robot side



NOTE!

- In order to change left and right joints, open the developer page on the Machine Vision Controller (default 192.168.100.1/#/developer) and set the parameters accordingly.
- Use job number 90.u3p only for the calibration project and do not save any project with the job number 91 (91.u3p).

For the ABB robot, job 90 for the left joint and job 91 for the right joint are different jobs. The weld seam tracking interface remains at job 90 for performance reasons. It uses either the coordinates of the left or the coordinates of the right tracking point. Requesting data during calibration is at a very high frequency and every result must be valid. So make sure that the uniVision job is set correctly for all orientations. Directly use the relevant job 90.u3p as start job to avoid an additional job change at the beginning of the calibration process.

Rapid program

Calibration: Use the provided Rapid code from ABB to run the calibration.

```
MODULE calib

    TASK PERS tooldata tWelder:=[TRUE,[[0,0,0],[0,0,0,0]],[1,[1,0,0],[1,0,0,0],0,0,0]];

    ! Result of the sensor calibration is necessary for tracking with ArcWare
    ! - the names have to match the configured names in the Optical Sensor Properties
    TASK PERS pose laser1_cal_pose := [[0,0,0],[1,0,0,0]];
    TASK PERS pos laser1_cal_pos := [0,0,0];

    ! Work object for the calibration plate
    ! - Needs to be calibrated before sensor calibration
    TASK PERS wobjdata CalibPlate_laser1:=[FALSE,TRUE,"",[[0,0,0],[1,0,0,0]],[[0,0,0],[1,0,0,0]]];

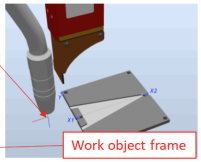
    ! robtargets need to be updated before sensor calibration
    CONST robtarget p_calibApproach:= [[0,0,0],[1,0,0,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget p_calibStart := [[0,0,0],[1,0,0,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];

    ! Name of the physical sensor defined in the process configuration
    ! - Needs to be set to the actual name before sensor calibration
    CONST string physSensor := "MLZL121";

    PROC sensorCalib()
        MoveJ p_calibApproach, v1000, z50, tWelder\WObj:=CalibPlate_laser1;
        MoveOptCalibL physSensor, p_calibStart, v500, fine, tWelder\WObj:=CalibPlate_laser1\CreateLogFile;
        MoveJ p_calibApproach, v1000, fine, tWelder\WObj:=CalibPlate_laser1;
    ENDPROC

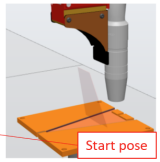
ENDMODULE
```

Tool

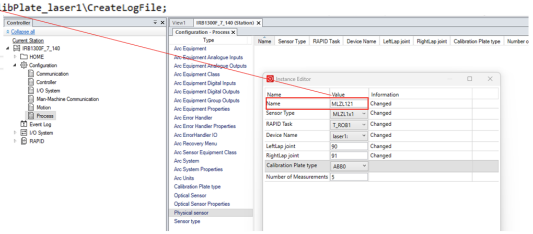


Work object frame

Pose to approach start pose



Start pose



→ Run *sensorCalib()* to calibrate sensor with robot

NOTE!
For best results, align the y and z axis of the sensor measurement frame with that of the calibration plate in the start position.

The calibration movement can be adjusted using the parameter of the function (see operating instructions of ABB):

```
MoveOptCalibL SensorName ToPoint Speed Zone RobotTool
[\WObj] [\TLoad] [\AlignY] [MaxMoveDistX] [\MaxMoveDistZ] [\CreateLogFile]
```

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g.1.u3p). Do not use the number 90 and 91 for tracking jobs as they are required for the calibration.

Use the provided Rapid code from ABB to track the seam.

```
MODULE track

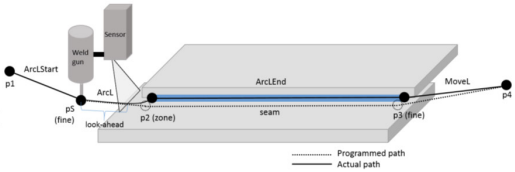
    TASK PERS seamdata sm1:=[0,0,0,0,[0,0,0,0,0,0,0,0,0,0],0,0,0,0,[0,0,0,0,0,0,0,0,0,0],0,0,0,0,[0,0,0,0,0,0,0,0,0,0],0,0,[0,0,0,0,0,0,0,0,0,0],0];
    TASK PERS welddata wd1:=[10,0,[0,0,0,0,0,0,0,0,0,0],[0,0,0,0,0,0,0,0,0,0]];
    TASK PERS trackdata tr1:=[1,FALSE,20,[0,0,0,0,0,0,0,0,0,0],[2,0,0,0,0,0,0,0]];

    TASK PERS robtarget p1:=[[0,0,0],[1,0,0,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]];
    TASK PERS robtarget pS:=[[0,0,0],[1,0,0,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]];
    TASK PERS robtarget p2:=[[0,0,0],[1,0,0,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]];
    TASK PERS robtarget p3:=[[0,0,0],[1,0,0,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]];
    TASK PERS robtarget p4:=[[0,0,0],[1,0,0,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]];

    PROC tracking()
        MoveJ p1, v1000, z50, tWelder;
        ArcLStart pS, v1000, sm1, wd1, fine,tWelder\Track:=tr1;
        ArcL p2, v1000, sm1, wd1, z50,tWelder\Track:=tr1;
        ArcLEnd p3, v1000, sm1, wd1, fine,tWelder\Track:=tr1;
        MoveL p4, v1000, z50, tWelder;
    ENDPROC

ENDMODULE
```

joint_no → uniVision project



→ Teach points and run *tracking()*

NOTE!
The defined “trackdata” handles the job number.

8.2 FANUC

System requirements

- Controller: R-30iB or R-30iA
- Software ArcTool SW V8.30P/36
- Software options: R691 (Universal Sensor Interface) and R648 (User Socket Messaging)

Or

- Controller: R-30iBPlus or R-30iA
- Software ArcTool SW V9.40P/27
- Software options: R901

Use one of the Ethernet ports on the FANUC robot controller for connecting the Machine Vision Controller. Enter IP address of Machine Vision Controller (by default 192.168.100.1) and port (by default 5020) on FANUC robot side. Press “Menus”, select “Setup” and press [F1]. Select “Host Comm” and “TCP/IP” to configure the network settings of the host (Machine Vision Controller). Test the connection from the robot to the Machine Vision Controller by pressing the ping [F4] in the robot controller .

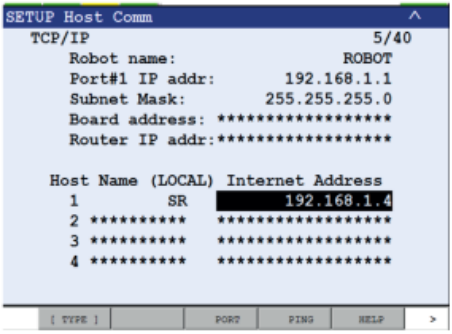


Fig. 2: Setup host communication

Calibration

Calibrate robot and sensor via an overlap joint with two positions at a certain distance (Ten Point Teaching Method).

Load the template “Calibrate robots (edge)” in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u3p).

For details, see Ten Point Calibration Method at FANUC operating instructions.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g. 1.u3p).

8.3 KUKA SeamTech 4 and 5

8.3.1 KUKA.SeamTech 4

System requirements

- Controller: KR C5
- Operating system: KSS 8.7
- Software: KUKA.SeamTech 4

Use one of the Ethernet ports on the KUKA robot controller for connecting the Machine Vision Controller.

Enter IP address of Machine Vision Controller (by default 192.168.100.1) and port (by default 6008) on KUKA robot side.

Calibration

Calibrate robot and sensor via an overlap joint with one position.

Load the template “Calibrate robots (edge)” in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u3p).

For details, see operating instructions of KUKA.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 999 are supported (e.g. 1.u3p).

The error codes at the KUKA robot have the following meaning:

Error code on KUKA robot	Error description	Possible solution
420	No connection to uniVision	Make sure that the robot weld seam tracking interface can connect to the LIMA Read/Write Limited port of the Processing Instance. Check that IP and port are set correctly.
520	Job number out of range	Load a job with a valid number (1...999).
610	Seam not detected	Adjust the uniVision project so that Module Profile Seam Tracking detects the seam and that correct results are linked to Device Robot Weld Seam Tracking.
710	Laser is off	Send start acquisition command in order to set the laser to on.
820	No new data	Check that acquisition line rate at Device weCat3D is fast enough for the frequency the robot asks for new results.

8.3.2 iiQKA.SeamTech 5

System requirements

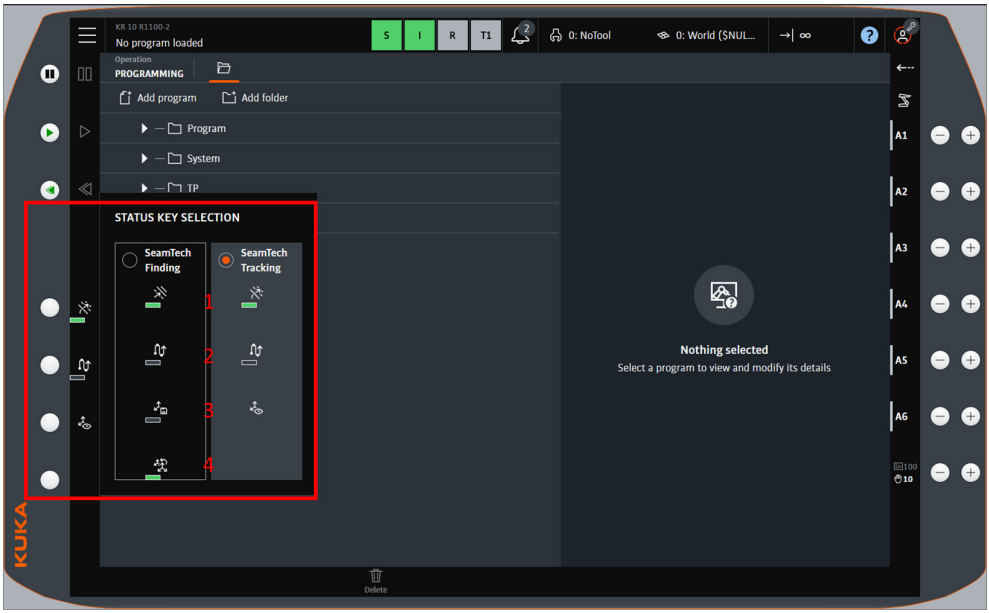
- Controller: KR C5-2 or KR C5 micro-2
- Operating system: iiQKA.OS2 KSS 9.2 or higher
- Software: iiQKA.SeamTech 5 (Finding and Tracking)
- Further software: iiQKA.UI 3.0, iiQKA.UserTech 8.1, iiQKA.RobotSensorInterface 6.1 and iiQKA.CommonApplicationMessage 1.1
- PC software: iiQWorks.Sim 1.2 to install option packages on the robot

Use one of the Ethernet ports on the KUKA robot controller for connecting the Machine Vision Controller.

Calibration

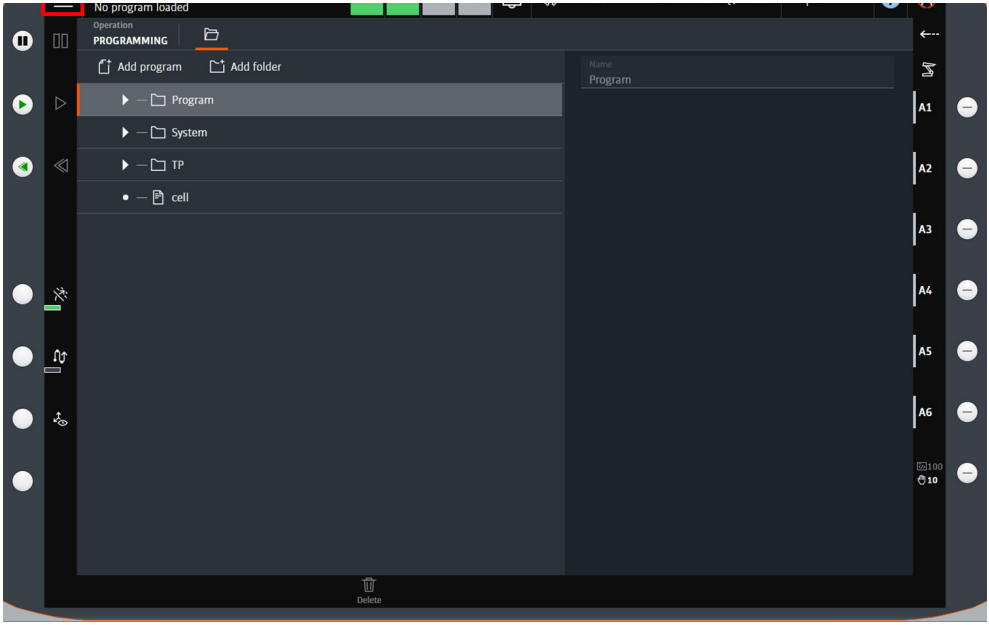
Calibrate robot and sensor via an overlap joint with one position.
Load the template “Calibrate robots (edge)” in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u3p).

Useful function at robot

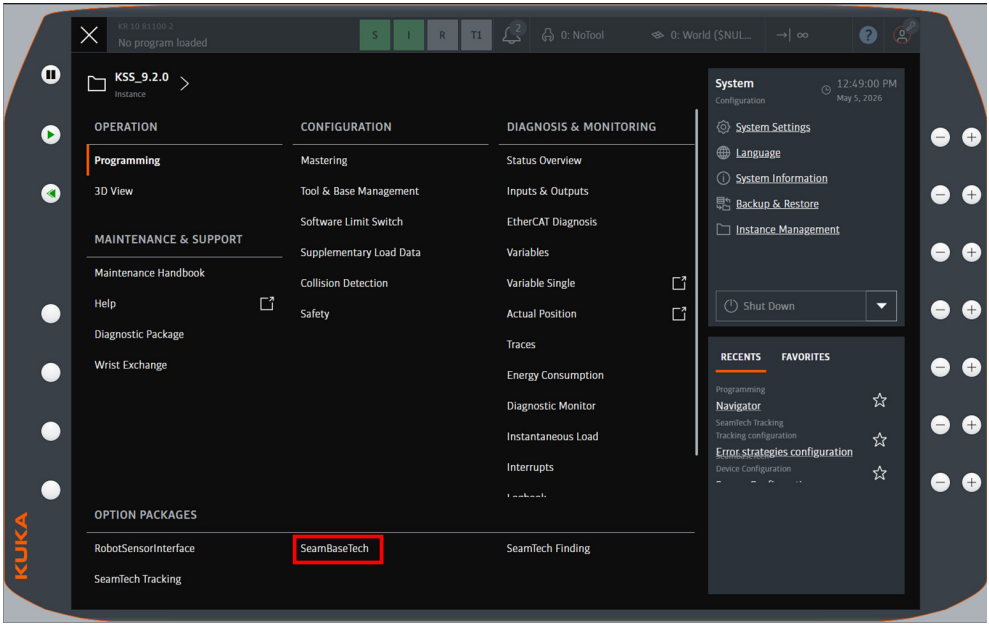


Symbol	SeamTech Finding	SeamTeck Tracking
1	Activate Finding	Activate Tracking
2	Turn on/off laser	Turn on/off laser
3	Activate new reference measurement	Get sensor data
4	Activate base correction	

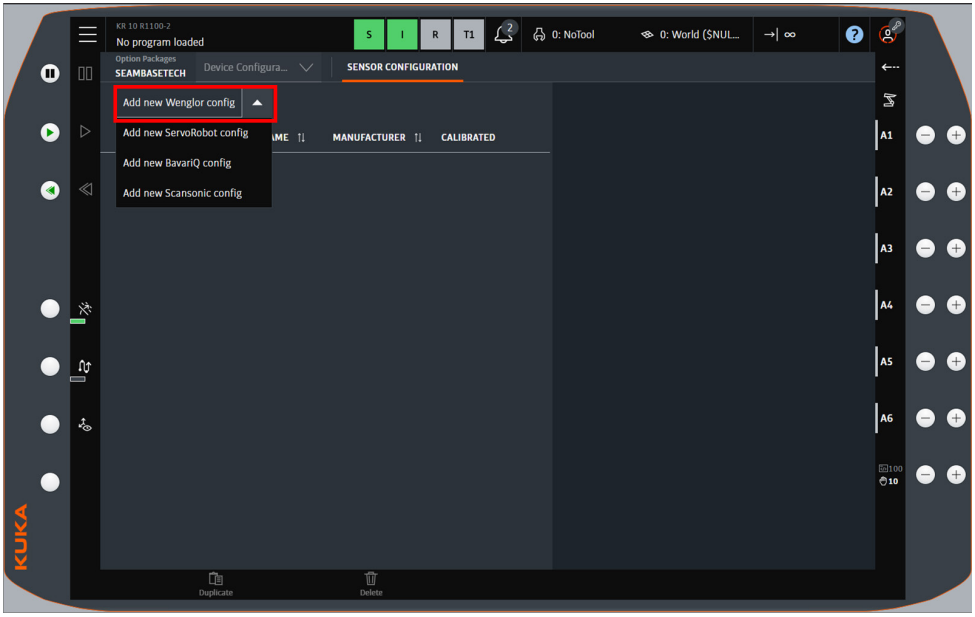
Navigate to the menu.



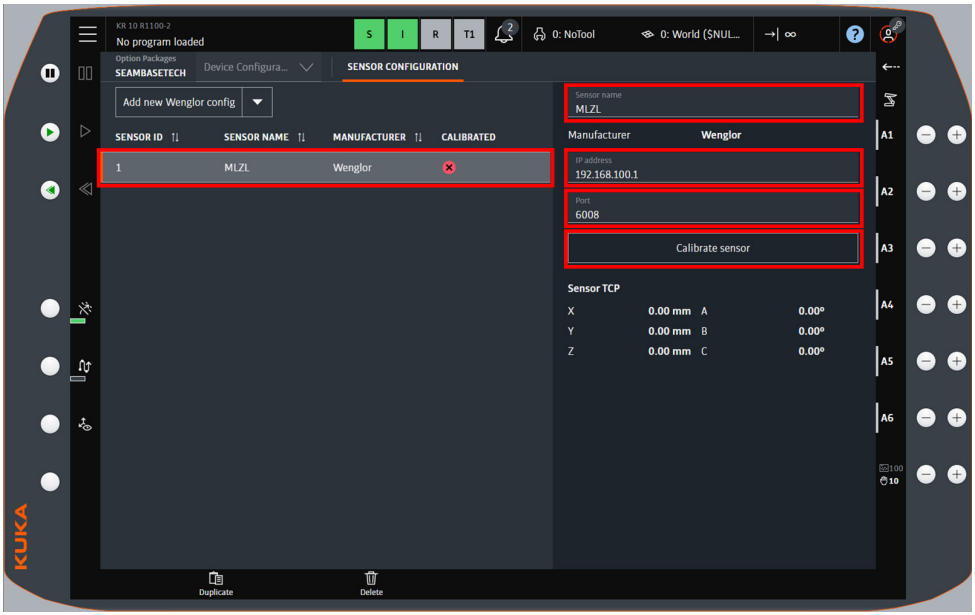
Navigate to SeamBaseTech.



Add sensor by choosing “wenglor config”.

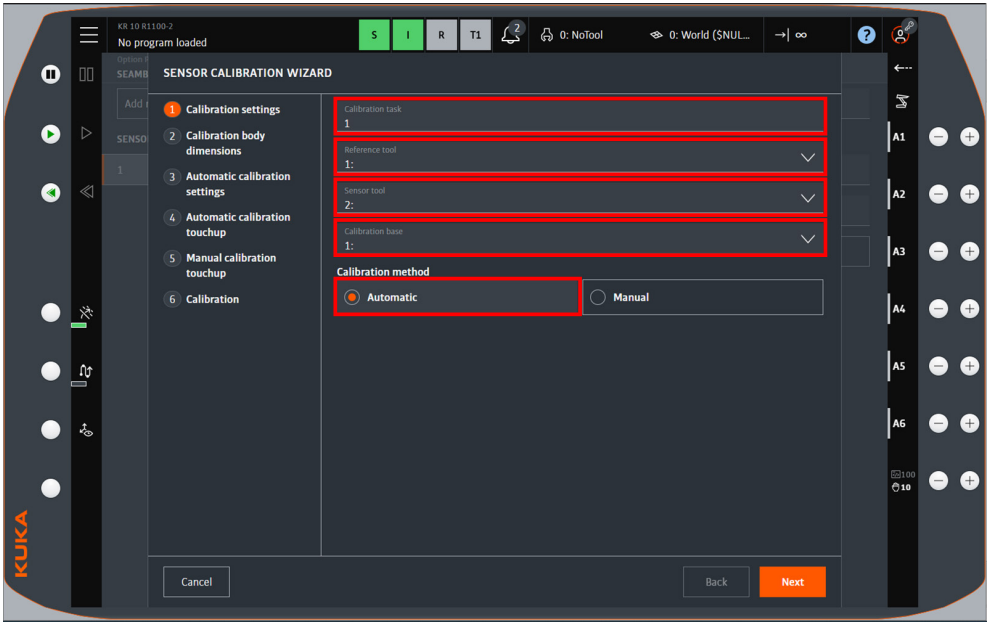


Enter name of the device, IP address of Machine Vision Controller (by default 192.168.100.1), port (by default 6008) and press “Calibrate sensor” to continue.

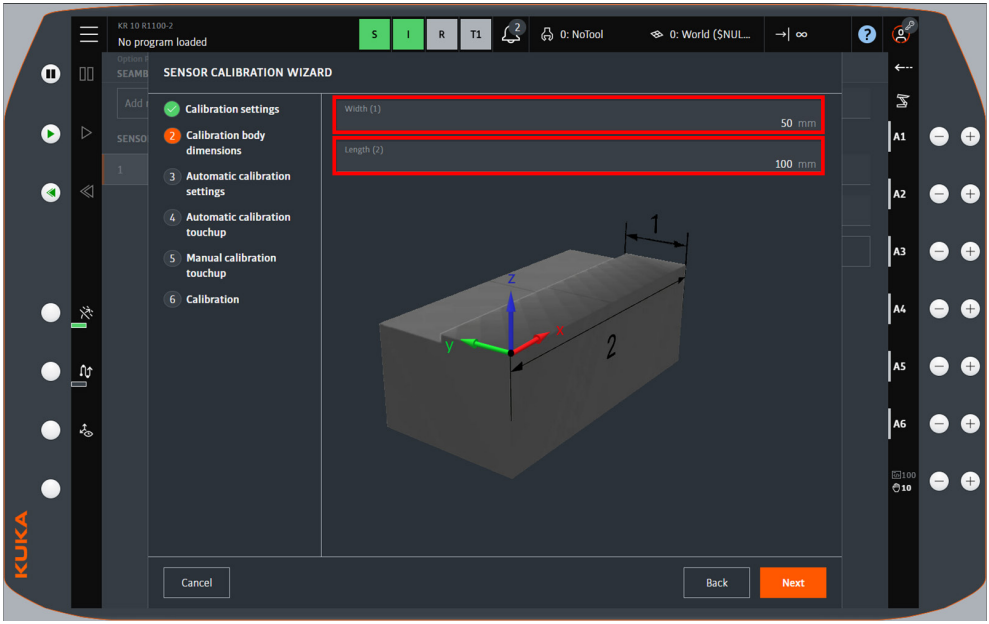


Choose between the option to calibrate “Automatic” (with defined calibration object) or “Manual” (with any lap joint).

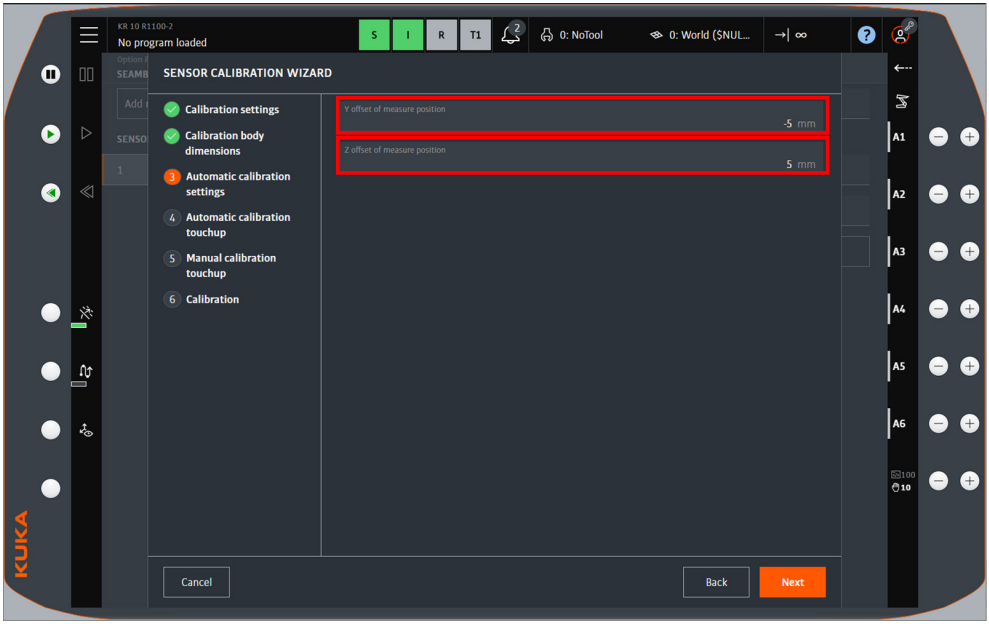
- “Calibration task” -> uniVIsion job number
- “Reference tool” -> e.g. welding torch
- “Sensor tool” -> Calibration will be saved there
- “Calibration base” -> base frame on calibration object

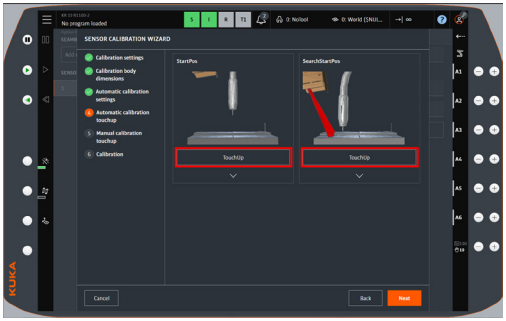
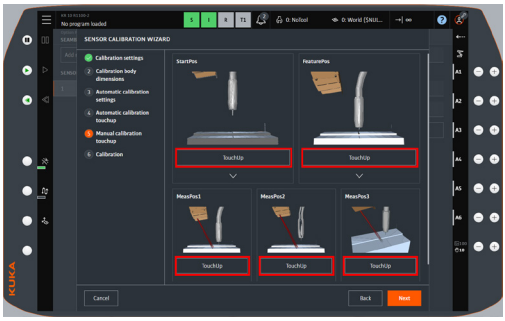


In case of “Automatic”, enter Width and Length of the calibration object.



In case of “Automatic”, set offsets (default values are good).



In case of “Automatic”, teach the start and a pose where the lap joint can be detected.	In case of “Manual”, teach the calibration poses.
	

Start the calibration.

Finding

Use the uniVision templates (e.g. Find butt joint) to create projects for finding. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 999 are supported (e.g. 1.u3p).

NOTE!
For details, see operating instructions of KUKA.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 999 are supported (e.g. 1.u3p).

NOTE!
For details, see operating instructions of KUKA.

The error codes at the KUKA robot have the following meaning:

- 420: No connection to processing instance
- 520: Job number out of range (1...999 are valid)
- 610: Seam is not detected
- 710: Laser is off
- 820: No new data

8.4 YASKAWA

System requirements

- Controller: DX200 or YRC 1000
- Software: MOTOEYE-LT
- Function specification D2-D2013-028
- DX 200 software version DN1.83.00A(--)-00
- Macro Job's and MACRO.DAT fitting to the application
- Sensor-app / motoPlus-interface LTRACK-DX200.out

Use one of the Ethernet ports on the YASKAWA robot controller for connecting the Machine Vision Controller.

Enter IP address of Machine Vision Controller (parameter SXE160-163; by default 192.168.100.1) and port (parameter SXE164; by default 5020) on robot side.

Select sensor model 1 in MOTOEYELT-SETTING-JOB.

Calibration

Calibrate robot and sensor via an overlap joint. Create JOB calibration [LT-CALIB] and teach six reference positions at the robot.

Load the template "Calibrate robots (edge)" in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u3p).

For details, see operating instructions of YASKAWA.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g. 1.u3p).

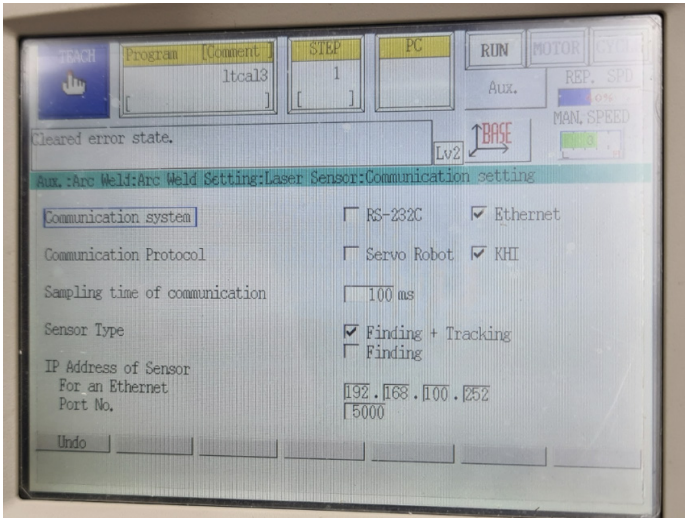
8.5 Kawasaki

System requirements

- Controller: E series
- Software: Option Laser Tracking

Use port LAN 1 on the KAWASAKI robot controller for connecting the Machine Vision Controller.

- Communication system: Ethernet
- Communication Protocol: KHI
- Sampling time of communication: 120 ms (increase default value to 120 ms!)
- Sensor Type: Finding + Tracking
- IP Address of Sensor: Enter IP address of Machine Vision Controller (by default 192.168.100.1)
- Port No.: Enter port (by default 5000)



Calibration

Calibrate robot and sensor via an overlap joint.

Load the template “Calibrate robots (edge)” in the uniVision software, adjust the settings and save the project with a number “30.u3p”.

Use calibration jobs 30 and 40 on KAWASAKI robot side. In reality, the robot uses only the project 30.u3p including only one tracking point at an overlap joint.

For details, see operating instructions of Kawasaki.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g. 1.u3p).

The error codes at the Kawasaki robot have the following meaning:

- 420: No connection to processing instance
- 520: Job number out of range (1...127 are valid)
- 710: Laser is off (warning)

8.6 KUKA SeamTech 2 and 3

System requirements

For KUKA.SeamTech 2.1:

- Controller KR C4 with KSS 8.3, RobotSensorInterface 3.3 and Ethernet KRL 2.2

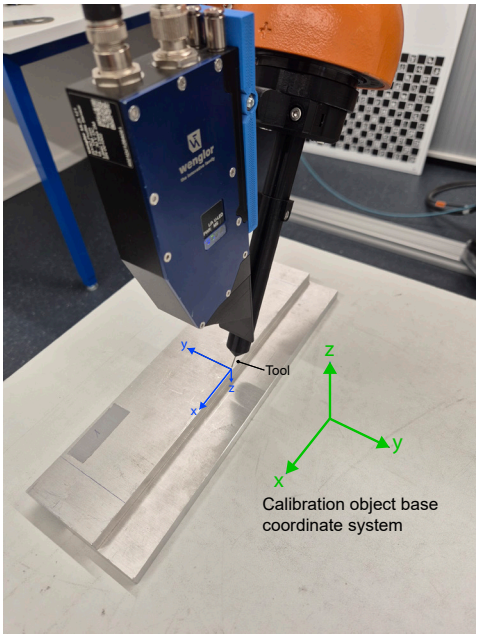
For KUKA.SeamTech 3.1:

- Controller KR C4 with KSS 8.6, RobotSensorInterface 4.1 and Ethernet KRL 3.1
- Controller KR C5 with KSS 8.7, RobotSensorInterface 5.0 and Ethernet KRL 3.2

Use one of the Ethernet ports on the KUKA robot controller for connecting the Machine Vision Controller MVC.

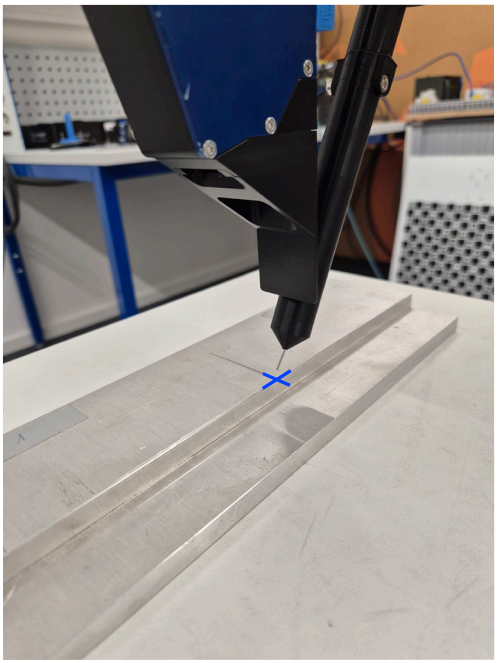
Teach the calibration object base coordinate system of the robot so that the x axis points in the welding direction and the z axis points upwards (towards the 2D/3D Profile Sensor).

Mount the 2D/3D Profile Sensor in front of the tool. Teach the tool coordinate system so that the +x axis points in the welding direction and that the +z axis points downwards. During the teach-in process, pay attention to the orientation of the tool coordinate system. The x axis defines the tracking and welding direction.



Calibration

Calibrate robot and sensor via an overlap joint. Mark any point on the top side of the lap joint in order to use it for the calibration process.



Load the template "Calibrate robot (edge)" in the uniVision software, adjust the settings and save the project with a number (e.g. 1.u3p).

Download the example calibration program for KUKA from the wenglor website. It consists of the following files:

- wenglorCalibration.dat
- wenglorCalibration.src
- wenglorCalibration.xml
- wenglorUser.dat
- wenglorUser.src

Copy the files to the KUKA controller. Edit the file "wenglorCalibration.xml":

- Adjust the IP address of the Machine Vision Device (by default 192.168.100.1).
- Adjust the port of the robot server (by default 6008).

[KRC4(WINDOWS-BIDO66S)] - KRC:\R1\Program\wenglorCalibration\wenglorCalibration.xml

```
<ETHERNETKRL>
   <CONFIGURATION>
      <EXTERNAL>
         <IP>192.168.100.1</IP>
         <PORT>6008</PORT>
         <TYPE>Server</TYPE>
      </EXTERNAL>
      <INTERNAL>
         <ENVIRONMENT>Program</ENVIRONMENT>
         <BUFFERING Mode="FIFO"/>
         <TIMEOUT Connect="60000"/>
         <ALIVE Set_Flag="1" Ping="200"/>
         <PROTOCOL>TCP</PROTOCOL>
         <MESSAGES Logging="error" Display="error"/>
      </INTERNAL>
   </CONFIGURATION>
   <RECEIVE>
      <XML>
         <ELEMENT Tag="sensor/reply/command" Type="STRING"/>
         <ELEMENT Tag="sensor/reply/return_code" Type="INT"/>
         <ELEMENT Tag="sensor/reply/job_name" Type="STRING"/>
         <ELEMENT Tag="sensor/reply/calib_results/@XMAX" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_results/@YMAX" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_results/@ZMAX" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@X" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@Y" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@Z" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@RX" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@RY" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_validate/@RZ" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@X" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@Y" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@Z" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@RX" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@RY" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_data/@RZ" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/calib_state" Type="STRING"/>
         <ELEMENT Tag="sensor/reply/laser_state" Type="STRING"/>
         <ELEMENT Tag="sensor/reply/sensor_state" Type="STRING"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@X" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@Z" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@GAP" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@HEIGHT" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@AREA" Type="REAL"/>
         <ELEMENT Tag="sensor/reply/sensor_data/@ANGLE" Type="REAL"/>
         <ELEMENT Tag="sensor/reply" Set_Flag="42"/>
      </XML>
   </RECEIVE>
   <SEND/>
</ETHERNETKRL>
```

IP address of device

Port of robot server

Copy the file "wenglorCalibration.xml" on the robot controller in the file location:
C:\KRC\ROBOTER\Config\User\Common\EthernetKRL\

Edit the file "wenglorUser.src"

- Adjust the tool numbers (only necessary if using KUKA.SeamTech Finding)

```
GLOBAL DEF readToolNumbers(tcp_tool_number:out, sensor_tool_number:out)
    DECL INT tcp_tool_number
    DECL INT sensor_tool_number
    ; Adjust the number of the tool which is used for the calibration.
    tcp_tool_number = 1   <- Adjust TCP tool number
    ; Adjust the number of the tool where the sensor tcp data can be saved.
    sensor_tool_number = 16   <- Adjust sensor tool number
END
```

- Adjust the calibration job number
- Teach the start pose
- Teach the reference pose
- Teach the calibration poses one to four

```
GLOBAL DEF callCalibrationJob()
    ; Set Calibration job
    sendSimpleCommand("job:change [1.u3];")   <- Edit calibration file name
END

GLOBAL DEF startPoint()
    ; Add a movement to a Start point to
    ; start with the calibration
    ;   <- Teach pose

END

GLOBAL DEF referencePoint()
    ; Add a movement to Reference point
    ;   <- Teach pose

END

GLOBAL DEF calibPoint1()
    ; Add a movement to Calibration point 1
    ;   <- Teach pose

END

GLOBAL DEF calibPoint2()
    ; Add a movement to Calibration point 2
    ;   <- Teach pose

END

GLOBAL DEF calibPoint3()
    ; Add a movement to Calibration point 3
    ;   <- Teach pose

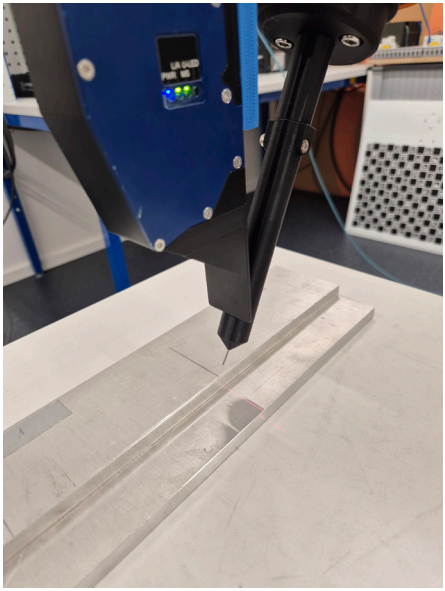
END

GLOBAL DEF calibPoint4()
    ; Add a movement to Calibration point 4
    ;   <- Teach pose

END
```

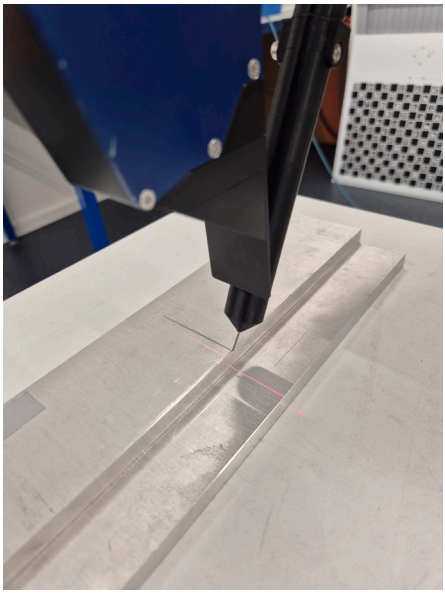
Start point

Teach any start point for the calibration process where the robot tool is above the lap joint.



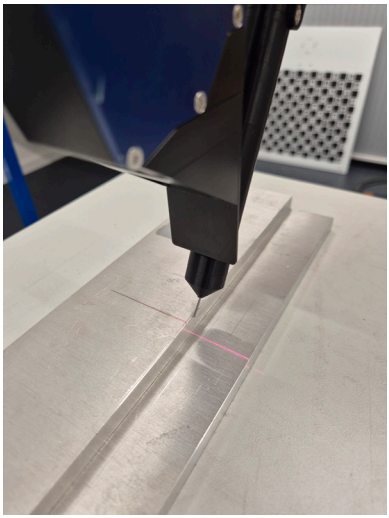
Reference point

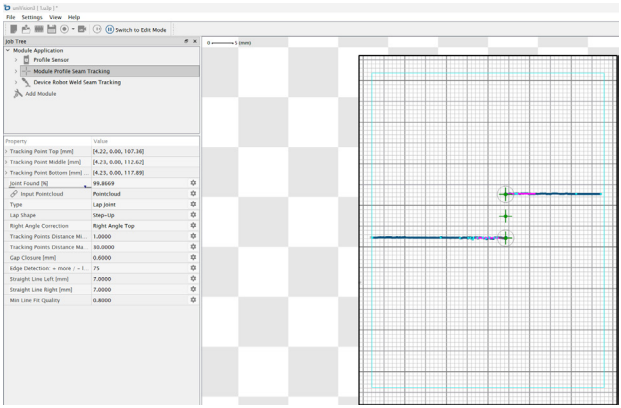
Jog the robot tool to the marked point on the top side of the lap joint and teach the position as reference point.



Calibration point 1

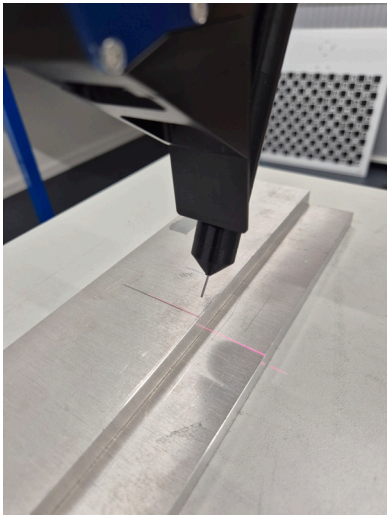
Jog the robot tool in the -x direction of the tool coordinate system (without changing the 3D orientation of the tool) until the laser line is located exactly on the marked point. Make sure that the uniVision job detects the tracking point. Teach the position on robot side as calibration point 1.

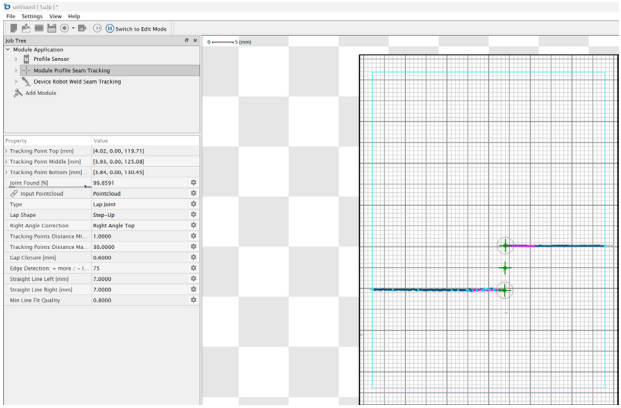




Calibration point 2

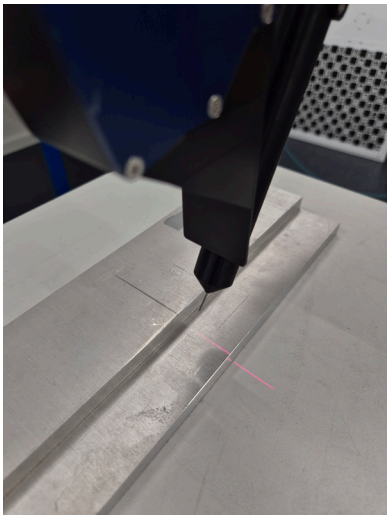
Jog the robot tool in the -z direction of the tool coordinate system. Jog the robot tool forward or backward (in x direction of the tool coordinate system) until the laser line matches the marked point on the lap joint. Make sure that the uniVision job detects the tracking point. Teach the position on robot side as calibration point 2.

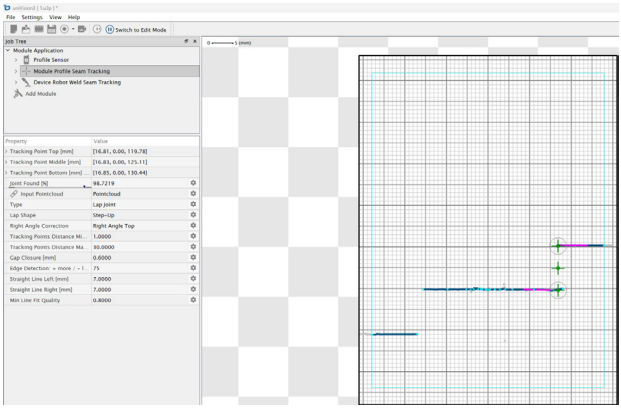




Calibration point 3

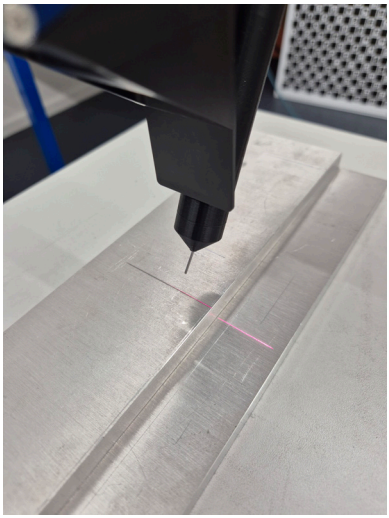
Jog the robot in the -y direction of the tool coordinate system. Jog the robot tool forward or backward (in x direction of the tool coordinate system) until the laser line matches the marked point on the lap joint. Make sure that the uniVision job detects the tracking point. Teach the position on robot side as calibration point 3.

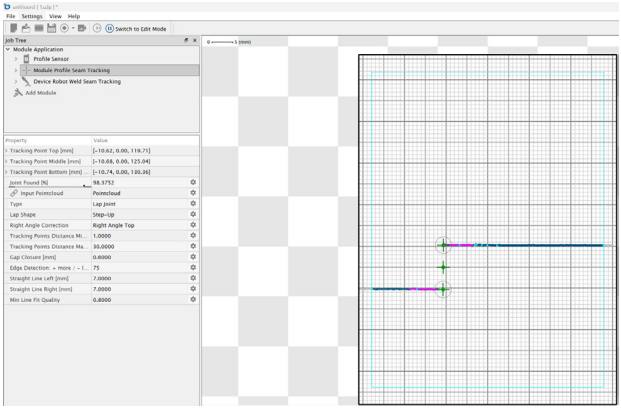




Calibration point 4

Jog the robot in +y direction of the tool coordinate system. Jog the robot tool forward or backward (in x direction of the tool coordinate system) until the laser line matches the marked point on the lap joint. Make sure that the uniVision job detects the tracking point. Teach the position on robot side as calibration point 4.



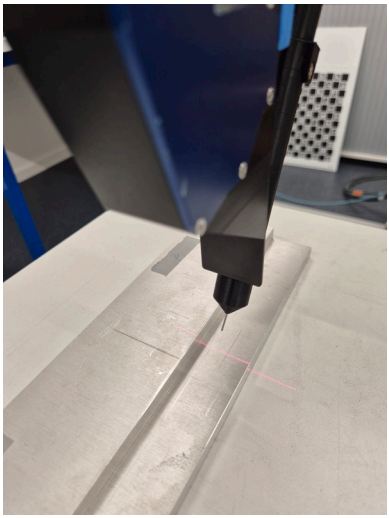


Optional step

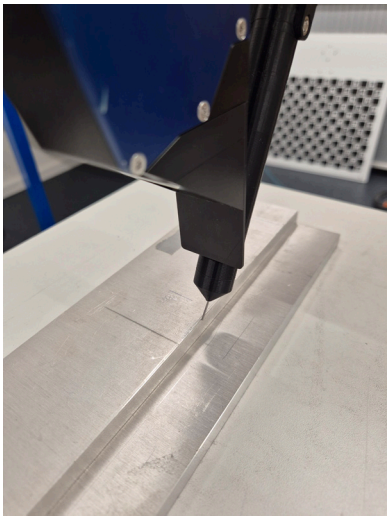
The program performs a validation step after the calibration. A point is approached. At this point, the sensor sends the detected point (the laser line on the lap joint) to the robot. The robot then moves its TCP to this point. It requires to teach "poseToBeValidated".

```
88
89  GLOBAL DEF poseToBeValidated()
90      ; Add a movement to a pose, where the seam can
91      ; be detected.
92      ;   <= Teach pose
93
94  END
```

Point to be validated

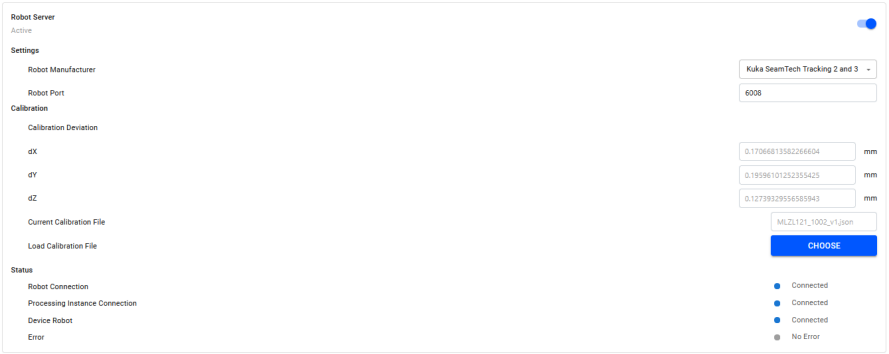


Validated point



Run "wenglorCalibration.src" to start the calibration procedure. After finishing the calibration, the robot shows the deviation of the calibration. Make sure that the program has run completely. The robot connection should be disconnected at the end.

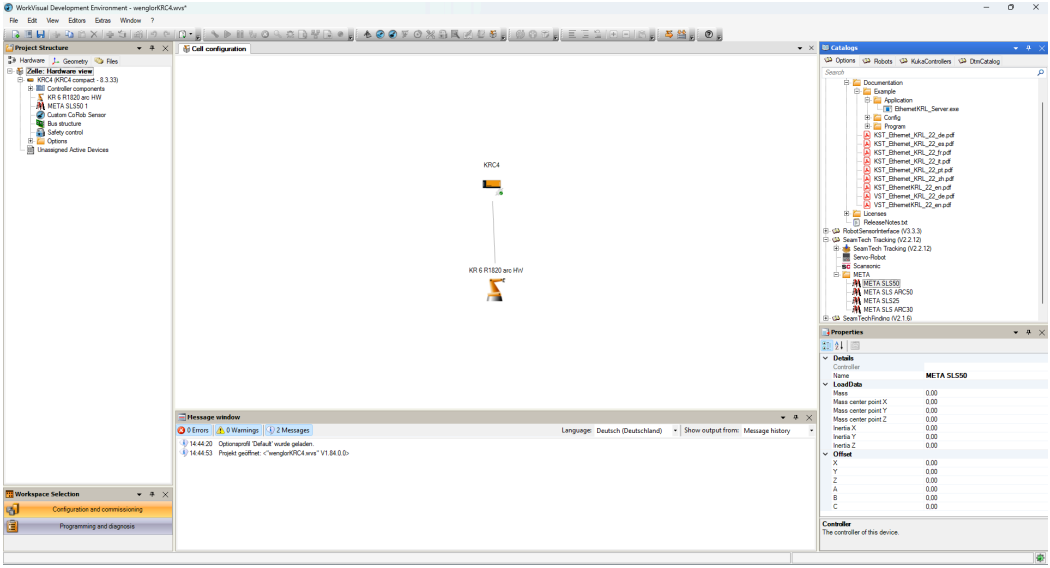
Furthermore, the device website of the Machine Vision Controller shows the calibration deviations and the current calibration file. In case of several available calibrations, load another calibration file (if needed). The smaller the calibration deviation, the better the accuracy (recommended are deviations smaller than 0.5 mm).



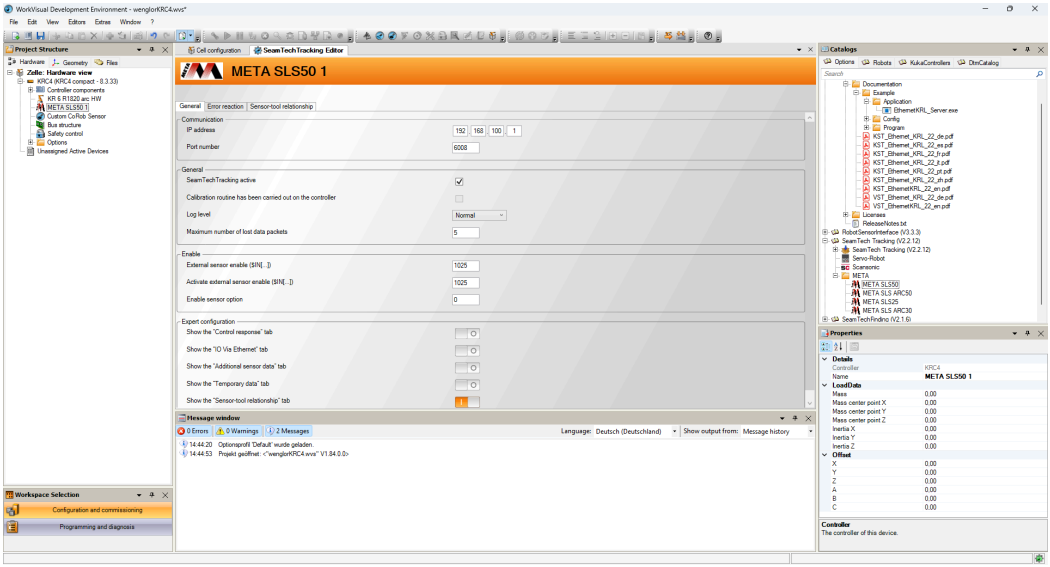
Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g. 1.u3p).

Install the software package “SeamTech Tracking” on the robot controller. Open the current robot configuration in the KUKA software WorkVisual. Select the sensor “META SLS50” from the catalogue in order to work with 2D/3D Profile Sensors from wenglor.



Add the sensor to the robot controller. Enter the IP address of the Machine Vision Controller (by default 192.168.100.1) and the port (by default 6008) in the tab "General". Transfer it to the robot.

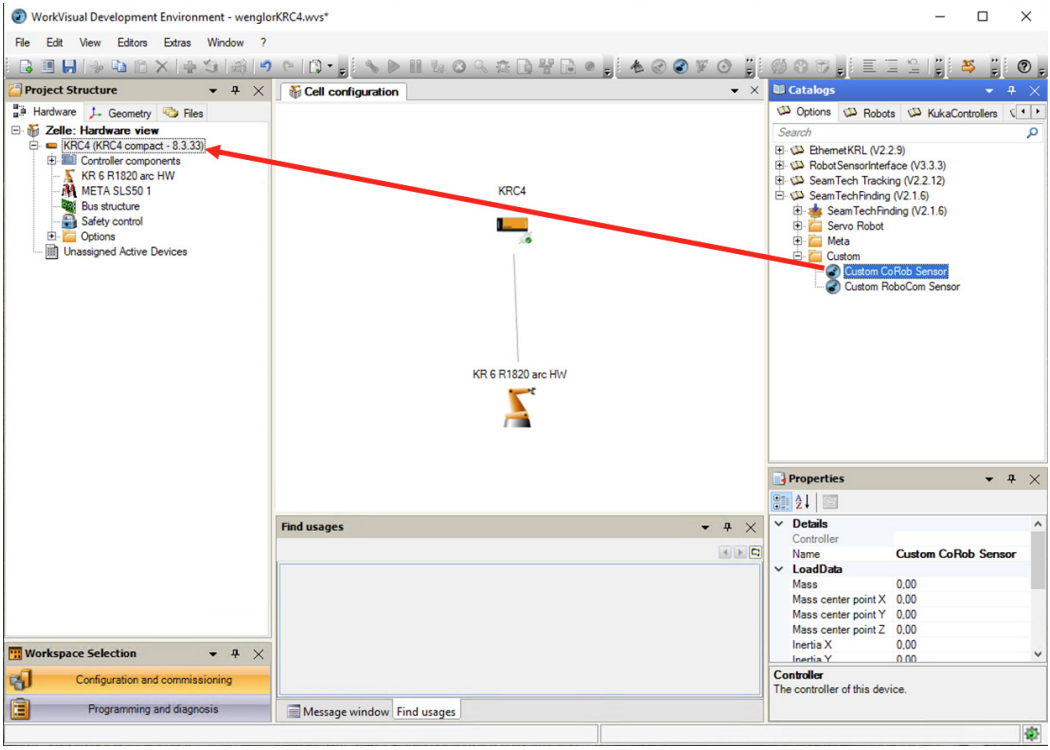


Create the tracking project on robot side according to the KUKA tracking documentation.

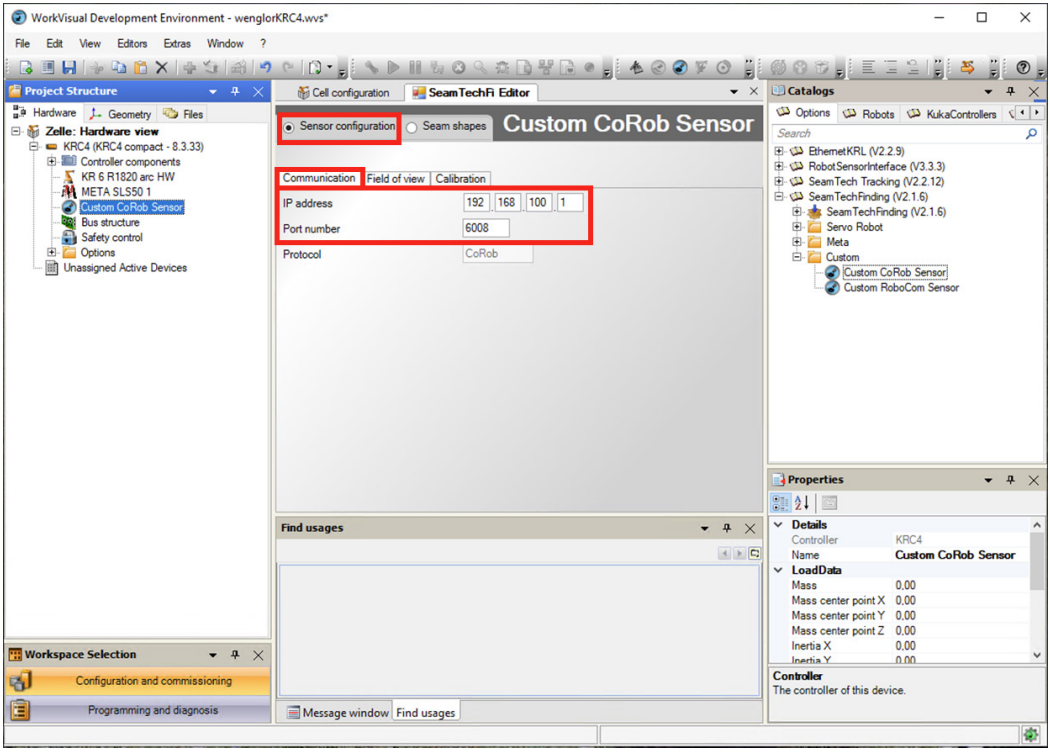
Finding

Use the uniVision templates (e.g. Find butt joint) to create projects for seam finding applications. Save the project files with numbers in order to load them from robot side. Only job numbers from 1 to 127 are supported (e.g. 1.u3p).

Install the software package “SeamTech Finding” on the robot controller. Open the current robot configuration in the KUKA software WorkVisual. Select "SeamTechFinding/Custom/Custom CoRob Sensor" from the catalogue and add it to the controller. CoRob is the protocol name of KUKA.

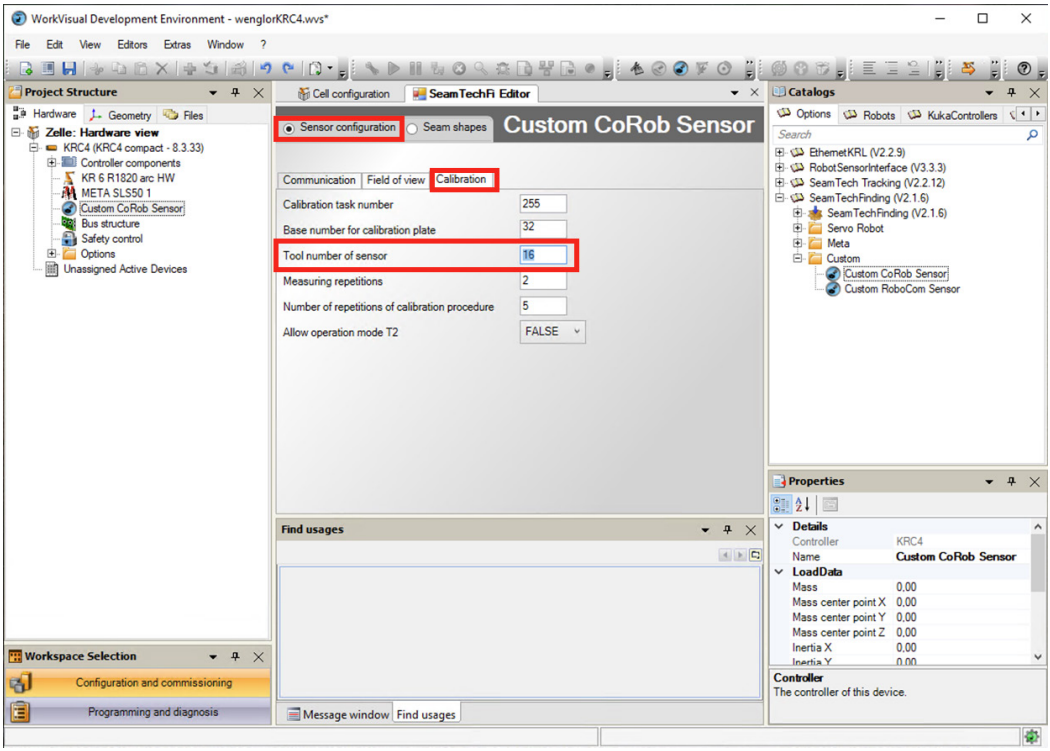


Open the "SeamTechFi Editor" and select the communication tab. Enter the IP address of the Machine Vision Controller (by default 192.168.100.1) and the port (by default 6008).

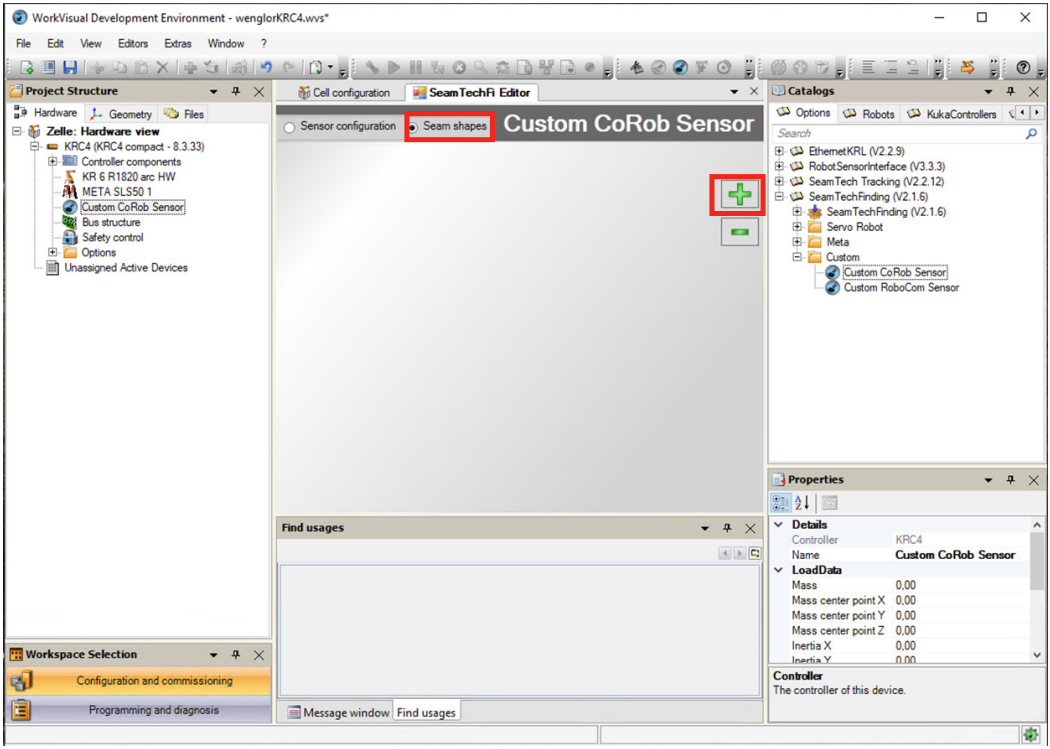


Select the tab "Calibration" and edit the tool number of the sensor. Use the number where the sensor tcp is saved (sensor_tool_number of wenglorUser.src).

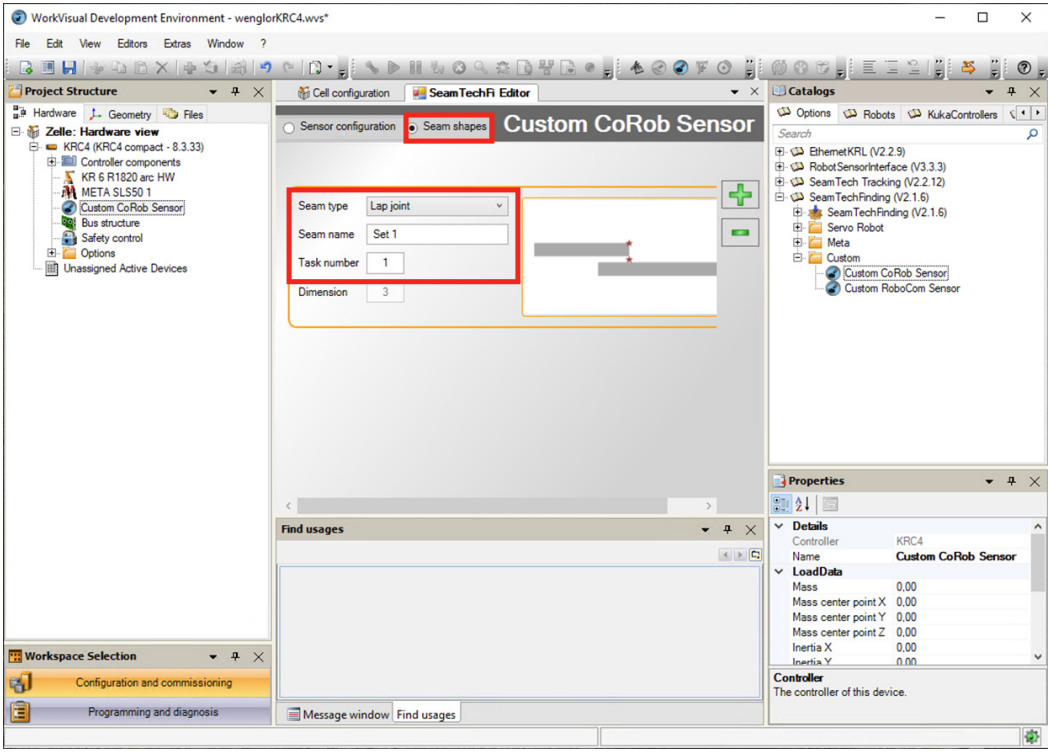
```
GLOBAL DEF calibration_tool_numbers(tcp_tool_number:out, sensor_tool_number:out)
    DECL INT tcp_tool_number
    DECL INT sensor_tool_number
    ; Adjust the number of the tool which is used for the calibration.
    tcp_tool_number = 1
    ; Adjust the number of the tool where the sensor tcp data can be saved.
    sensor_tool_number = 16
END
```



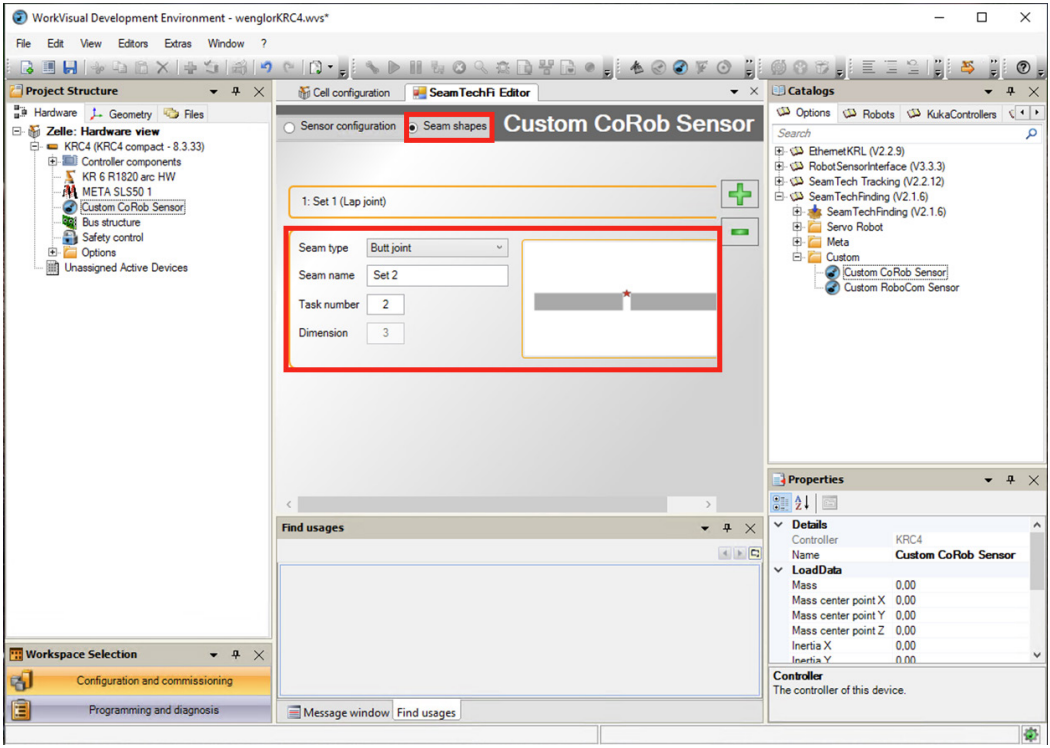
Add seam shapes by pressing "+".



Define the seam type and set the uniVision project number (project name) as task number.



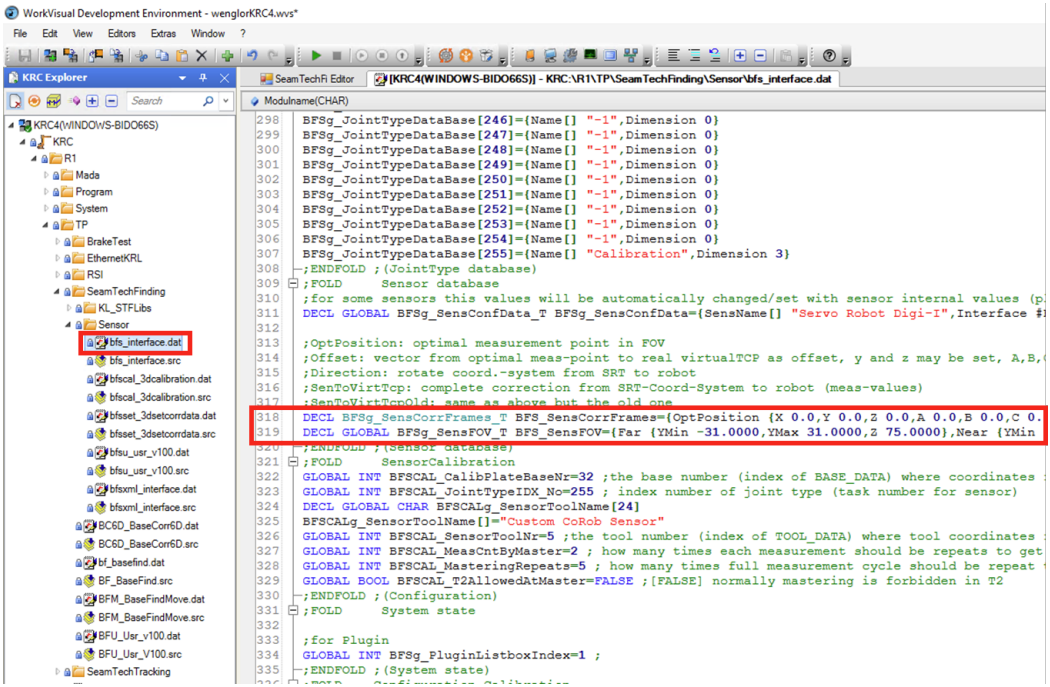
Each set has one uniVision project number assigned to it. Create separate sets for each uniVision job in order to switch between jobs.



Transfer the configuration to the robot controller.

Check these values in WorkVisual or on the robot panel for this file:

KRC:\R1\TP\SeamFinding\Sensor\bfs_interface.dat



DECL BFSg_SensCorrFrames_T BFS_SensCorrFrames={OptPosition {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 0.0},
Offset {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 0.0},
Direction {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 180.000},
SenToVirtTcp {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 0.0},
SenToVirtTcpOld {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 0.0},
ToolData {X 0.0,Y 0.0,Z 0.0,A 0.0,B 0.0,C 0.0},
ToCalibrate FALSE,
Calibrated TRUE}

BFS_SensCorrFrames has the variables “ToCalibrate” and “Calibrated”. Set it to:

- ToCalibrated FALSE
- Calibrated TRUE

DECL GLOBAL BFSg_SensFOV_T BFS_SensFOV={Far {YMin -31.0000,YMax 31.0000,Z 75.0000},
Near {YMin -19.0000,YMax 19.0000,Z 158.000},
OptPos {X 0.0,Y 0.0,Z 84.0000},
AngleLimit 180.000}

BFS_SensFOV defines the field of view of the sensor. Enter the parameters of the sensor (e.g. for MLZL):

- Far {YMin -31.0000,YMax 31.0000,Z 75.0000}
- Near {YMin -19.0000,YMax 19.0000,Z 158.000}
- OptPos {X 0.0,Y 0.0,Z 84.0000}



NOTE!
Z-Far and Z-Near are swapped.

Save it and configure a SeamFinding process (see operating instructions of KUKA).