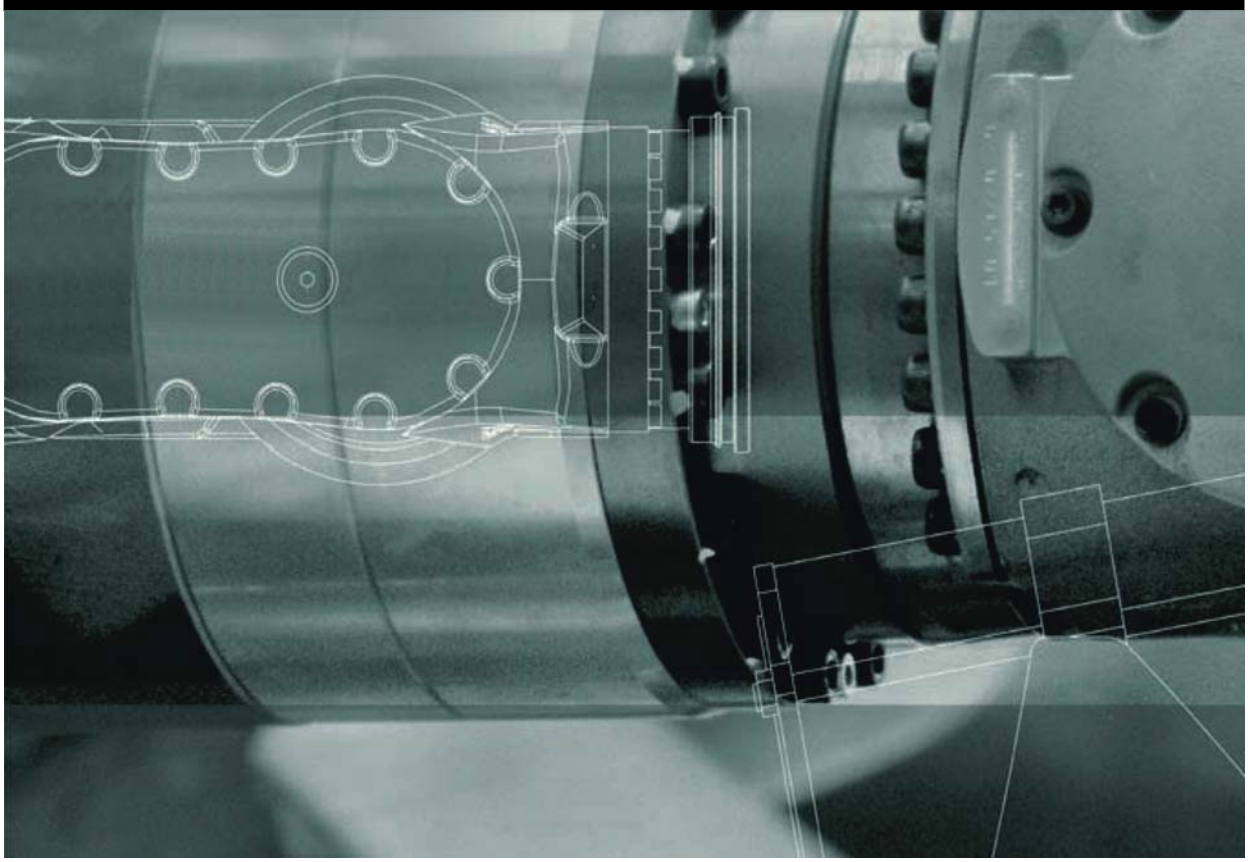
KUKA

KUKA System Technology

KUKA Roboter GmbH

KUKA.SeamTech Tracking 2.0

For KUKA System Software 8.2



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Translation of the original documentation

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Contents

1 Introduction

1.1 Target group

This documentation is aimed at users with the following knowledge and skills:

- Advanced KRL programming skills
- Advanced knowledge of the robot controller system
- Advanced knowledge of the sensor controller system
- Advanced knowledge of the controller system for the application used, e.g. weld controller

1.2 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the control software
- Instructions for options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

These warnings are relevant to safety and **must** be observed.

DANGER	These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.
WARNING	These warnings mean that death or severe injuries **may** occur, if no precautions are taken.
CAUTION	These warnings mean that minor injuries **may** occur, if no precautions are taken.
NOTICE	These warnings mean that damage to property **may** occur, if no precautions are taken.
	These warnings contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

This warning draws attention to procedures which serve to prevent or remedy emergencies or malfunctions:

SAFETY INSTRUCTIONS	Procedures marked with this warning **must** be followed exactly.

Notes

These hints serve to make your work easier or contain references to further information.

Tip to make your work easier or reference to further information.

1.4 Trademarks

WeldCom is a trademark of Servo-Robot.

1.5 Terms used

Term	Description
Sensor advance run	The sensor advance run is the distance between the laser line projected onto the workpiece by the sensor and the TCP of the tool. The tool must be in the work position (e.g. the welding position in the case of a welding torch).
Seam	Feature on a workpiece which has a course, e.g. an edge or a groove.
Seam search	The sensor searches for the seam.
Seam tracking	The sensor has already found the seam and is tracking its course.

2 Product description

2.1 Overview of SeamTech Tracking

Functions

SeamTech Tracking is a program for seam tracking. It can be used together with a light section sensor for numerous different applications, e.g. for arc welding, laser welding, etc.

The seam is not always identical from one workpiece to the next. SeamTech Tracking allows the original path to be corrected in such a way that the robot can follow the current path of the seam. In order to ensure that the corrected seam cannot deviate more than the desired amount from the original path, limit values can be defined.

SeamTech Tracking is an add-on technology package.

Characteristics:

- Simple coupling via Ethernet
- Communication with the sensor controller and correction of the path are carried out in a 12 ms cycle, in parallel with the robot motion.
- KRL instructions for seam tracking (inline forms)
- KRL instructions for additional functions, e.g. searching for the start of seam; interrupting and resuming seam tracking (inline forms)
- Seam tracking and additional functions can be executed in the operating modes T2, AUT and AUT EXT.

Areas of application

- Laser welding (only after consultation with KUKA Service)
- Laser hybrid welding
- Arc welding
- Gluing (only after consultation with KUKA Service)
- Numerous other applications for which seam tracking is appropriate

SeamTech Tracking supports the following systems:

- Sensor controllers supplied by Servo-Robot
- Sensor controllers supplied by Meta-Scout

More detailed information about the suitability of the individual sensor controllers can be obtained from Servo-Robot or Meta-Scout.

For information about adaptation for systems from other manufacturers, please contact KUKA Roboter GmbH. (>>> 12 "KUKA Service" Page 61)

WorkVisual

The following software is required for configuring sensors:

- WorkVisual 3.0

2.2 Typical sensor system

The robot controller communicates with the sensor controller via Ethernet.

Overview

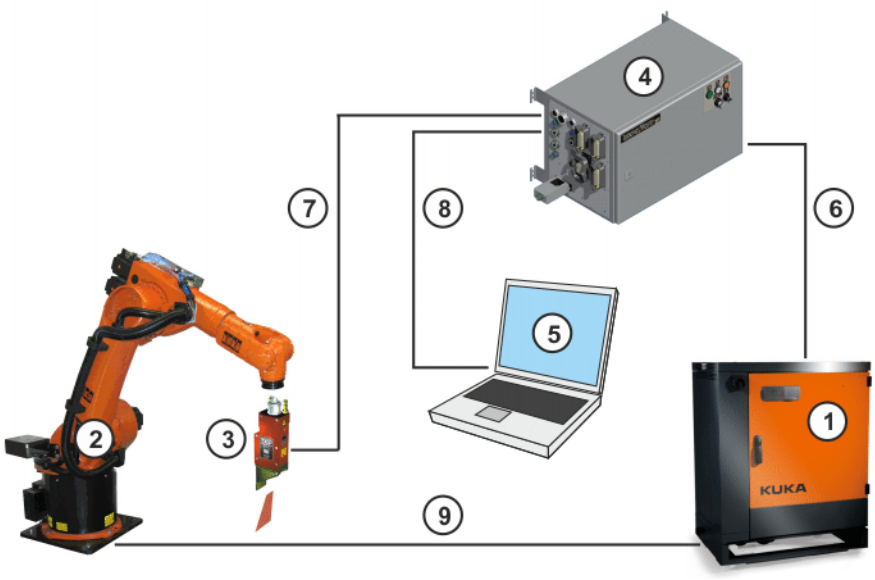

Fig. 2-1: Schematic overview

Item	Description
1	Robot controller
2	Robot
3	Sensor
4	Sensor controller
5	External PC **Note**: Administrator rights are required on the external PC.
6	Ethernet connection between the robot controller and sensor controller
7	Connection between the sensor controller and the sensor
8	Ethernet connection between the external PC and the sensor controller
9	Connection between the robot controller and the robot

3 Safety

This documentation contains safety instructions which refer specifically to the software described here.

The fundamental safety information for the industrial robot can be found in the “Safety” chapter of the Operating and Programming Instructions for System Integrators or the Operating and Programming Instructions for End Users.

The “Safety” chapter in the operating and programming instructions of the KUKA System Software (KSS) must be observed. Death to persons, severe injuries or considerable damage to property may otherwise result.

The safety standards must be observed when working with the laser. Injuries may otherwise result. For further information and specification of the laser class, please refer to the documentation of the laser manufacturer.

Incorrect operation of the laser can cause injuries. The laser must be properly operated. Information on operator control can be found in the documentation of the laser manufacturer.

4 Installation

After initial installation, it is not yet possible to use the inline forms, the status keys and the configuration pages on the smartHMI. To complete the installation of SeamTech Tracking, a WorkVisual project with the configuration of the sensor must be transferred to the robot controller. (>>> 6.1 "Configuring the sensor with WorkVisual" Page 17)
If SeamTech Tracking is updated, the **SeamTechTracking** option package in WorkVisual must also be updated. The previously used WorkVisual project must be updated with this version and then transferred to the robot controller.

4.1 System requirements

Hardware

- KR C4
- Sensor system supplied by Servo-Robot or Meta-Scout

Software

- KUKA System Software 8.2.20
- KUKA.RobotSensorInterface 3.1.3
- KUKA.Ethernet KRL 2.1.3

We recommend installing the technology packages in the following order:

1. KUKA.RobotSensorInterface
2. KUKA.Ethernet KRL

Laptop/PC

Software:

- WorkVisual 3.0

  The requirements for installation of WorkVisual are contained in the WorkVisual documentation.

KRL resources

As standard, SeamTech Tracking uses the following KRL resources:

KRL resource	Number
Interrupts	28 … 32
Flags	91, 92, 98, 99
Cycflags	29

The numbers can be configured.

(>>> 6.2.2 "“Communication” tab" Page 20)

(>>> 6.2.9 "“Resources” tab" Page 23)

SeamTech Tracking makes use of the function generator for seam tracking. This can affect compatibility with other technology packages.

4.2 Installing or updating SeamTech Tracking

It is advisable to archive all relevant data before updating a software package.

Preparation

- Copy software from CD to KUKA USB stick.
  The software must be copied onto the stick with the file Setup.exe at the highest level (i.e. not in a folder).

> **NOTICE** Recommendation: Use a KUKA stick. Data may be lost if any other stick is used.

Precondition

- "Expert" user group

Procedure

1. Connect the USB stick to the robot controller or smartPAD.
2. In the main menu, select **Start-up** > **Additional software**.
3. Press **New software**: The entry **SeamTechTracking** must be displayed in the **Name** column and drive **E:** or **K:** in the **Path** column.
   If not, press **Refresh**.
4. If the specified entries are now displayed, continue with step 5.
   If not, the drive from which the software is being installed must be configured first:
   - Press the **Configuration** button. A new window opens.
   - Select a line in the **Installation paths for options** area.
     Note: If the line already contains a path, this path will be overwritten.
   - Press **Browse**. The available drives are displayed.
   - Select **E:**. (If stick connected to the robot controller.)
     Or select **K:**. (If stick connected to the smartPAD.)
   - Press **Save**. The window closes again.

   The drive only needs to be configured once and then remains saved for further installations.
5. Mark the entry **SeamTechTracking** and click on **Install**. Answer the request for confirmation with **Yes**.
6. Confirm the reboot prompt with **OK**.
7. Remove the stick.
8. Reboot the robot controller.

LOG file

A LOG file is created under C:\KRC\ROBOTER\LOG.

4.3 Uninstalling SeamTech Tracking

> It is advisable to archive all relevant data before uninstalling a software package.

Precondition

- "Expert" user group

Procedure

1. In the main menu, select **Start-up** > **Additional software**.
2. Mark the entry **SeamTechTracking** and click on **Uninstall**. Reply to the request for confirmation with **Yes**. Uninstallation is prepared.
3. Reboot the robot controller. Uninstallation is resumed and completed.

LOG file

A LOG file is created under C:\KRC\ROBOTER\LOG.

4.4 Defining the IP address of the robot controller

> Do not make any changes to an existing network!

Procedure

1. In the main menu, select **Start-up** > **Network configuration**. The **Network configuration** window is opened. The active Windows interface is displayed. (Default: “virtual5”)
2. Select the type **Fixed IP address** in the **Address type** box.
3. Enter the IP address of the robot controller in the **IP address** box.

> The IP addresses of the robot controller and the sensor must be in the same IP network.

4. Press **Save**.
5. Reboot the robot controller so that the change takes effect.

> Further information about network configuration is contained in the operating and programming instructions for the KUKA System Software (KSS).

5 Operation

5.1 Menus

The following menus and commands are specific to this technology package:

Main menu:

- **Configuration** > **Status keys** > **SeamTech Tracking**

Menu sequence **Commands** > **SeamTech Tracking**

- Initialize sensor
- Switch sensor on
- Switch sensor
- Switch sensor off
- Deactivate sensor
- Sensor commands
  - Search for start of seam
  - Search for feature
  - Search for end of seam
  - Freeze sensor
  - Reactivate sensor

5.2 Status keys

Procedure

Displaying the status keys:

- In the main menu, select **Configuration** > **Status keys** > **SeamTech Tracking**.

Description

The status keys are only available if the following conditions are met:

- WorkVisual project with the sensor configuration has been transferred to the robot controller
- “Expert” user group
- Operating mode T1
- Enabling switch is pressed
- Submit interpreter running

Status key	Description
	Seam tracking is activated. Correction is active. Pressing the status key deactivates seam tracking.
	Seam tracking is deactivated. Correction is not active. Pressing the status key activates seam tracking. When seam tracking is deactivated, the commands are passed through, but not executed. **Note**: Since no measurement or correction is performed, it is possible for the sensor to collide with the workpiece.
	Pressing the status key activates or deactivates the laser light. Seam tracking must be deactivated to make the status key available for use after installation. **Note**: It may take up to 5 seconds before the laser light is activated.

6 Configuration

6.1 Configuring the sensor with WorkVisual

Step	Description
1	Install the **SeamTechTracking** option package in WorkVisual.
2	Transfer the project from the robot controller to WorkVisual. **Precondition**: SeamTech Tracking is installed on the robot controller. **Note**: This project should be used for configuration of Seam-Tech Tracking in WorkVisual, otherwise the entries installed on the robot controller by SeamTech Tracking could be lost when the project is transferred back to the robot controller (see step 6).
3	Insert the **SeamTechTracking** catalog in the currect project.
4	Insert the sensor in the project. (>>> 6.1.1 "Inserting a sensor in a project" Page 17)
5	Configure the sensor in the **SeamTechTracking Editor**: ■ Make the settings for the sensor. (>>> 6.1.2 "Configuring the sensor" Page 17)
6	Transfer the project from WorkVisual to the robot controller. **Note**: During project transfer, the technology-specific files are copied to the robot controller and activated. If an earlier project has already been transferred, the files of this project are overwritten. It is therefore recommended to archive the files of the earlier project before transferring the new project.

Information about installing and managing option packages can be found in the **WorkVisual** documentation.

Information about bus configuration and project deployment can be found in the **WorkVisual** documentation.

6.1.1 Inserting a sensor in a project

Precondition

- A project is open.
- The **SeamTechTracking** catalog is inserted in the project.
- A robot controller has been added and set as active.

Procedure

1. Select the **Hardware** tab in the **Project structure** window.
2. In the **Catalogs** window, select the **SeamTechTracking** catalog and mark the sensor.
3. Drag the sensor into the **Project structure** window: into the **Hardware** tab, onto the robot controller there.
4. Change the name of the sensor in the **Properties** window (optional).

6.1.2 Configuring the sensor

Precondition

- The project is open.
- The sensor is inserted in the project.

- The robot controller has been set as the active controller.

Procedure

1. Select the sensor in the project (**Hardware** tab).
2. Open the **SeamTechTracking Editor**:
   - Select the menu sequence **Editors** > **Options packages** > **Open SeamTechTracking Editor**.
   - Alternatively: Click on the  button.
3. Define the parameters for the sensor.
4. Save the project and answer the request for confirmation with **Yes**.

Description

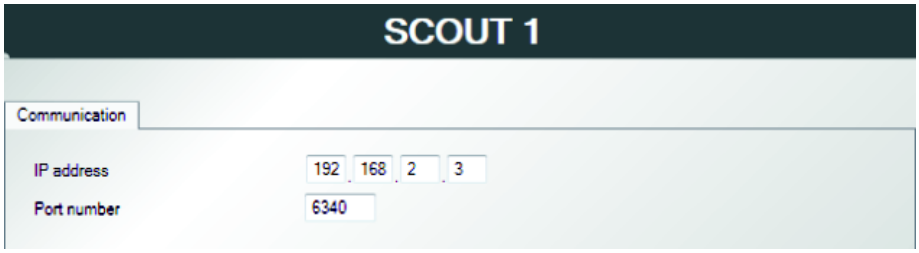

Fig. 6-1: SeamTechTracking Editor – Overview

Parameter	Description
IP address	The predefined IP address of the sensor can be changed here.
Port number	The predefined port number of the sensor can be changed here.

6.2 Configuring SeamTech Tracking via the smartHMI

Precondition

- The sensor has been configured with WorkVisual.
- The project has been transferred from WorkVisual to the robot controller.
- “Expert” user group

Procedure

1. In the main menu, select **Configuration** > **Seamtech Tracking**.
2. Set the parameters on the configuration pages as required.
   (>>> 6.2.1 "“General” tab" Page 19)
   (>>> 6.2.2 "“Communication” tab" Page 20)
   (>>> 6.2.3 "“Outputs” tab" Page 20)
   (>>> 6.2.4 "“Inputs” tab" Page 20)
   (>>> 6.2.5 "“Control behavior” tab" Page 21)
   (>>> 6.2.6 "“I/O via Ethernet” tab" Page 22)
   (>>> 6.2.7 "“Adaptive parameters” tab" Page 22)
   (>>> 6.2.8 "“Temporary data” tab" Page 22)
   (>>> 6.2.9 "“Resources” tab" Page 23)
3. Press **Save** and close the window. The configuration is saved.

Description

The navigation bar can be used to switch between the individual configuration pages.

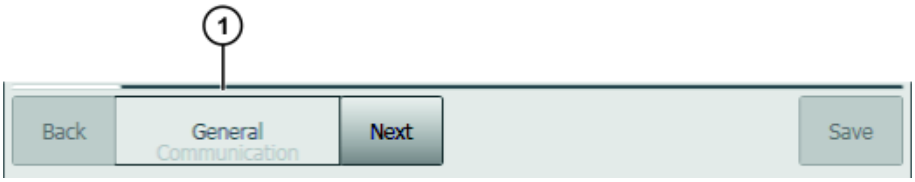

Fig. 6-2: Navigation bar – Configuration

Item	Description
1	Name of the configuration page currently being displayed. Pressing the display opens a menu. In this menu, the user can select the pages individually. Precondition: “Expert” user group

The following buttons are available:

Button	Description
Next	Switches to the next page.
Back	Switches to the previous page.
Save	Saves the configuration.

6.2.1 “General” tab

Parameter	Description
Error reaction	
Stop on seam search error	■ **Activated**: If, in the case of **Switch sensor on**, the seam is not found within the seam search length defined in the option window **Sensor adjustments (Switch sensor on)**, the robot stops.
Stop on “Search seam start” error	■ **Activated**: If the start of the seam is not found in the case of **Search for start of seam**, the robot stops.
Stop on “Search on seam” error	■ **Activated**: If the defined shape is not found in the case of **Search for feature** or if the end of the seam is not found in the case of **Search for end of seam**, the robot stops.
Stop on freeze error	■ **Activated**: If an error occurs in the case of **Freeze sensor** or **Reactivate sensor**, the robot stops.
Stop on loss of seam	■ **Activated**: If the sensor loses the seam, the robot stops.
Reaction on seam loss	After losing the seam, the sensor is switched off. What happens next is defined here: ■ **Off**: The sensor remains switched off. ■ **Restart**: The sensor is switched on again.
Sensor search parameter	
Maximum base correction [mm]	The maximum permissible value for the base correction carried out on **Search for start of seam**. If this value is exceeded, the robot stops and an acknowledgement message is displayed. Once the message has been acknowledged, the robot motion is resumed on the original path. The value always relates to the originally taught path. ■ **0 … 50 mm**

6.2.2 “Communication” tab

Parameter	Description
Real-time communication lost ($FLAG[…])	Flag that is set if communication between the robot controller and sensor controller is interrupted during seam finding or seam tracking ■ **1** … **999** Default value: 92
Number of lost or delayed data packages	The maximum number of lost data packets in succession. If this number is exceeded, a communication error is displayed by the SeamTech object. The connection must then be re-established using **Initialize sensor**. After every **Initialize sensor** command, the lost data packet counter is reset to 0. ■ **0** … **100** Default value: 5
Status key communication lost ($FLAG[…])	Flag that is set if seam tracking has been activated with the status key. ■ **1** … **999** Default value: 91

6.2.3 “Outputs” tab

Parameter	Description
Enable sensor option	This output defines whether the sensor is enabled or not (see “Enable sensor”).
No communication possible	This output signals whether the communication to the sensor was correctly established or failed.
Sensor not ready	This output signals that the communication to the sensor was established correctly, but that no ready signal has been received from the sensor.
Seam not found	This output signals that no seam has been detected within the maximum seam search length.
Loss of seam	This output signals that the sensor has lost the seam during the motion.
Correction out of limit	This output signals that the correction window has been violated during execution of the seam with the sensor.

6.2.4 “Inputs” tab

Parameter	Description
External sensor enable ($IN[...])	This input enables the PLC to decide whether to carry out motions with or without the sensor. ■ Input set: KRL program is executed with sensor. ■ Input not set: KRL program is executed without sensor. On **Initialize sensor**, an acknowledgement message is generated, indicating that the sensor is deactivated. Default value: 1025
Activate external sensor enable ($IN[…])	The input is assigned by the sensor controller. Default value: 1025

6.2.5 “Control behavior” tab

The parameters should only be changed by persons with specialist knowledge of the application.

Parameter	Description
Gain Cartesian controller loop Gain rotatory controller loop	These parameters describe the dynamic response of the system. The higher the value, the more dynamically the corrections are controlled. The lower the value, the less responsive the system becomes. Recommendation: Retain the default value. It must be adapted if the control time (correction time) taken by the robot before it is moving on the path determined by the sensor is too long. If the value is too great, this can result in the robot controller generating an error message (e.g. torque monitoring). In this case, the robot cannot follow the specified control values. Range of values for Cartesian correction: ■ **0** … **150,000** Default value: 50 Range of values for rotational correction: ■ **0** … **100,000** Default value: 40
Sensor - robot path relationship	This parameter changes the relationship between the taught path and the sensor values. ■ **Mapping** ■ **Direct I** ■ **Direct II** ■ **Velocity_map** ■ **Velocity_rad**

6.2.6 “I/O via Ethernet” tab

Parameter	Description
Input byte	The robot controller can send up to 8 digital signals to the sensor controller. **ANOUT**: Analog outputs ■ **1 … 32** **ANIN**: Analog inputs ■ **1 … 32** **DIGOUT**: Digital outputs ■ **1 … 4096** **DIGIN**: Digital inputs ■ **1 … 4096** **PINT**: Global KRL variable $SEN_PINT ■ **1 … 20** **Off**: Deactivated
Output byte	The robot controller can receive up to 8 digital signals from the sensor controller. **ANOUT**: Analog outputs ■ **1 … 32** **DIGOUT**: Digital outputs ■ **1 … 4096** **PINT**: Global KRL variable $SEN_PINT ■ **1 … 20** **Off**: Deactivated

6.2.7 “Adaptive parameters” tab

This tab is only displayed if a sensor system supplied by Servo-Robot is used.

The parameters should only be changed by persons with specialist knowledge of the application.

Parameter	Description
Free parameters p(1) … p(8)	The parameters refer to parameters in the sensor controller. ■ **1** … **20**
Predefined parameters p(1) … p(15)	

6.2.8 “Temporary data” tab

The parameters should only be changed by persons with specialist knowledge of the application.

Additional REAL array

Parameter	Description
Sen:(double1), Rob:$SENPREA[…] … Sen:(double6), Rob:$SENPREA[…]	The parameters refer to parameters in the sensor controller. ■ **1** … **20**

Additional INTEGER array

Parameter	Description
Sen:(int1), Rob:$SENPINT[…] … Sen:(int6), Rob:$SENPINT[…]	The parameters refer to parameters in the sensor controller. ■ **11** … **20**

6.2.9 “Resources” tab

Sensor search

Parameter	Description
Result memory in $SEN_PINT[…]	Defines the array element of $SEN_PINT. This variable is assigned as its value the event numbers defined in the option windows **Search parameters** and **Search for end of seam**. ■ **1** … **20**

The following parameters specify which KRL resources are used by SeamTech Tracking. The default settings can be changed.

Every cycflag number and every interrupt priority may only be used once in the entire robot controller. In the case of overlaps (e.g. due to a different technology package that uses the same number), the default settings must be modified.

Allocated KRC resources

Parameter	Description
Flag number ($FLAG[…])	Number of the flag ■ **1** … **256** Default value: 98
Cyclical flag (1)	Cyclical flag number (1) ■ **1** … **256** Default value: 28
Cyclical flag (2)	Cyclical flag number (2) ■ **1** … **256** Default value: 27
Interrupts	Priorities of the interrupts used. ■ **1** … **128** Default values: 28 to 32 **Note:** Priorities 1 to 3 and 40 to 80 are reserved for use by the system. They must not be assigned by the user.

7 Programming

7.1 Programming tips for SeamTech Tracking

NOTICE The process (e.g. welding process) must not be started until the seam has been found and the correction build-up distance has been executed. Otherwise there is a risk that the robot will damage the workpiece, e.g. if it stops after an unsuccessful seam search with the process still running.

- It is advisable to create a KRL program without sensor instructions first and then to insert the sensor instructions.
- The selected TOOL and BASE coordinate systems must remain identical throughout the entire program.
- The last motion before **Switch sensor on** must be a LIN or CIRC motion (in the same direction as the subsequent motion).
- In T1 mode, the robot controller cannot execute sensor instructions.

  To execute a program that already contains sensor instructions in T1, deactivate the sensor using the status key.
- When teaching the path, there must be no corrections present from the sensor computer. This can be ensured by terminating the communication with the sensor controller.

  Ways of terminating the communication with the sensor controller:
  - Deactivate seam tracking using the status key.
  - Reset program.
  - Deselect program.
  - Block selection to **Deactivate sensor**
- In a running program, no block selection may be carried out after **Initialize sensor**.
- The sensor can only carry out corrections for LIN and CIRC motions. If the robot remains stationary or executes a PTP or spline motion, no corrections can be made.
- Avoid exact positioning points. Program points as approximate positioning points in order to achieve a constant path velocity.
- Program override: The program override that is valid for the last motion before **Switch sensor on** remains valid throughout the entire seam tracking operation.

  Exception: Motions between **Freeze sensor** and **Reactivate sensor**. No seam tracking occurs here and a different program override can be selected.

  Manual modification of the program override is not possible during seam tracking. The program override must not be influenced in any other way, either (e.g. by means of a Submit program).

In the case of correction distances that are shorter than the original seam, the sensor may get ahead, with the result that the robot, with its taught path, is unable to keep up. This may be manifested by triggers that are triggered in the wrong place, for example.
The cause of this is frequently that a program override of 100% has been programmed. The robot controller, which internally has to execute the longer original seam, thus has no way of accelerating.
Remedy: Reduce the program override. To compensate for this, increase the velocity programmed in the motions so that the desired velocity is maintained on the rest of the path.

7.2 Position of triggers on the original and the corrected path

Switching points of triggers are transferred at right angles from the original path to the corrected path. (This behavior is the default setting and can be changed by the start-up technician.)

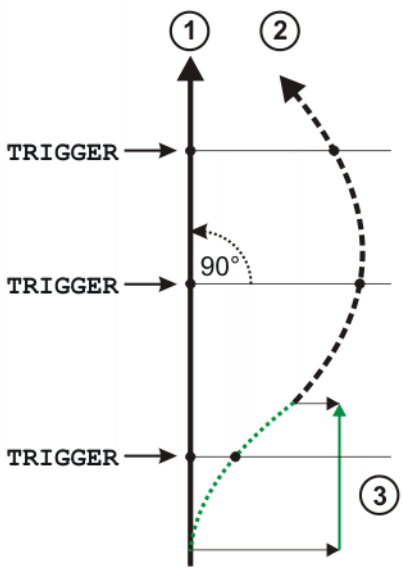

Fig. 7-1: Position of triggers

Item	Description
1	Original path
2	Corrected path
3	Correction build-up distance

Exception: With the instruction **Search for start of seam**, the base is adapted to the current start of the seam. In this case, the switching points of the triggers are also shifted according to the new base.

7.3 Inline form “Initialize sensor”

Precondition

- The connection to the sensor system is established.

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Initialize sensor**.

Description

The instruction establishes communication with the sensor controller. The robot controller then waits for a response from the sensor controller. (If communication with the sensor controller is interrupted, it can only be re-established using the **Initialize sensor** instruction.) **Initialize sensor** sets the laser to standby. It resets the flags, outputs, etc. where this is necessary and assigns the required flags and interrupts.

This instruction triggers an advance run stop.

If seam tracking has been deactivated using the status key, an acknowledgement message is generated on **Initialize sensor**, indicating that the sensor is deactivated.

When **Initialize sensor** is first executed after the sensor controller is switched on, a wait time of up to 3 s may occur. This only applies the first time it is executed.

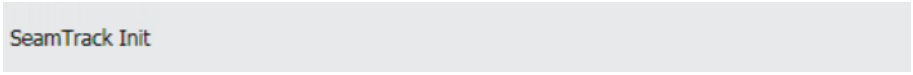

Fig. 7-2: Inline form “Initialize sensor”

7.4 Inline form “Switch sensor on”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Switch sensor on**.

Description

This instruction switches the sensor on. It is relative to the end point of the current motion instruction. Due to the sensor advance run, the seam search starts only after the end point. The switch-on point can be shifted.

The last motion before this instruction must be LIN or CIRC.

The instruction **Switch sensor on** detects whether the seam has been shifted up, down or sideways relative to the original path. The instruction **Switch sensor on** does not detect whether the seam has been shifted longitudinally along the path, however. In this case, the instruction **Search for start of seam** must be used in addition to **Switch sensor on**.

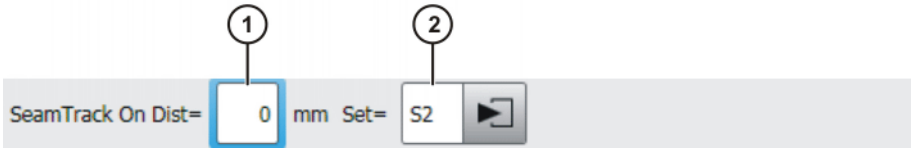

Fig. 7-3: Inline form “Switch sensor on”

Item	Description
1	■ Range of values: **-100** … **+100 mm** ■ Negative value: The switching point lies before the end point. ■ Positive value: The switching point lies after the end point. ■ **0**: The switching point lies at the end point. The end point is generally approximated. The switching point then lies at the position on the approximation arc which is nearest to the end point.
2	Name of the data set containing the sensor parameters. The system automatically generates a name. The name can be overwritten. Place the cursor in the box and the relevant option window opens. (>>> 7.4.1 "Option window: Sensor adjustments (Switch sensor on)" Page 28)

Further information on offsetting the switching point and on the offset limits can be found in the following documentation: Operating and Programming Instructions for System Integrators, section TRIGGER WHEN PATH.

Example

```
...
LIN P2 CONT
LIN P3 CONT
SeamTrack On Dist=3 mm
LIN P4 CONT
LIN P5 CONT
...
```

P4 is approximated. The seam search starts when the TCP is 3 mm after the position nearest to P4 on the approximation arc. Due to the sensor advance run, the laser line is already further ahead on the path!

7.4.1 Option window: Sensor adjustments (Switch sensor on)

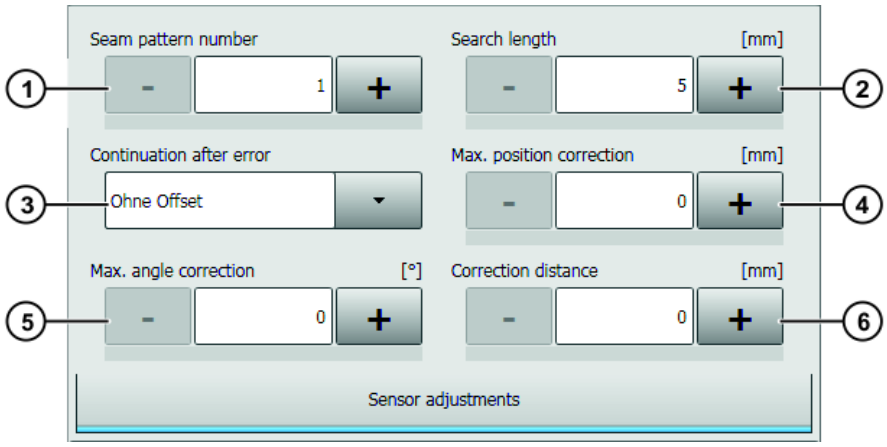

Fig. 7-4: Option window: Sensor adjustments (Switch sensor on)

Item	Description
1	Number on the sensor controller in which the seam type is defined
2	Distance after which the search is aborted if no seam is found. If the search is aborted, the robot controller issues a message. The robot stops if this has been defined in the configuration.
3	Defines whether or not the robot retains the correction following a sensor error (e.g. loss of seam) ■ With offset: Only useful with a straight seam, if it can be assumed that the correction along the seam remains constant to the end of the seam. ■ Without offset: The correction is eliminated over the correction elimination distance, and the robot returns to the taught path.
4	Maximum path deviation If the sensor sends a seam point that is outside the defined limits, the robot only moves the maximum permissible correction distance towards the seam point. A message is generated. The robot does not stop. If a point on the seam is found again within the defined limits, the corrections are immediately carried out in full once again. This also applies to corrections for A, B or C
5	Maximum correction for angle
6	Corrections are eliminated or built up over this distance.

7.5 Inline form “Switch sensor”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Switch sensor**.

Description

This instruction can be used to change the sensor parameters.

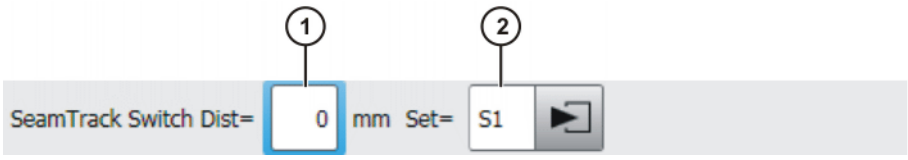

Fig. 7-5: Inline form “Switch sensor”

Item	Description
1	Switch the sensor parameters: ■ Range of values: **-100** … **+100 mm** ■ Negative value: The switching point lies before the end point. ■ Positive value: The switching point lies after the end point. ■ **0**: The switching point lies at the end point. The end point is generally approximated. The switching point then lies at the position on the approximation arc which is nearest to the end point.
2	Name of the data set containing the sensor parameters. The system automatically generates a name. The name can be overwritten. Place the cursor in the box and the relevant option window opens. (>>> 7.5.1 "Option window: Sensor adjustments (Switch sensor)" Page 29)

Further information on offsetting the switching point and on the offset limits can be found in the following documentation: Operating and Programming Instructions for System Integrators, section TRIGGER WHEN PATH.

7.5.1 Option window: Sensor adjustments (Switch sensor)

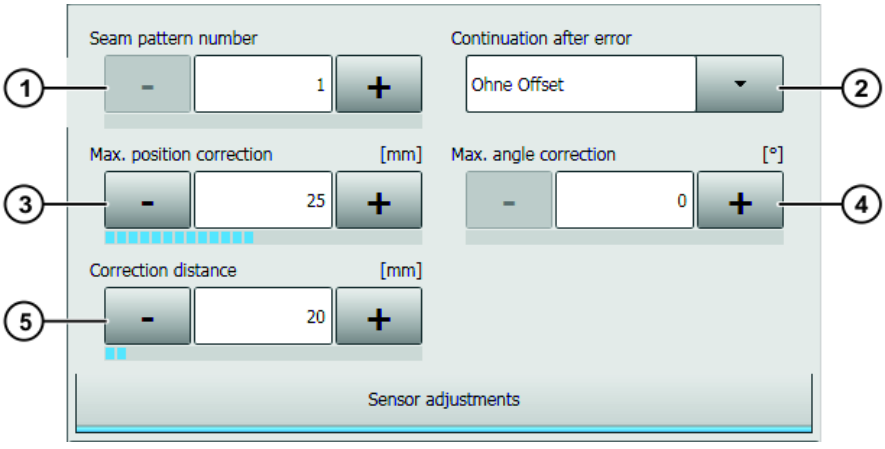

Fig. 7-6: Option window: Sensor adjustments (Switch sensor)

Item	Description
1	Number on the sensor controller in which the seam type is defined
2	Defines whether or not the robot retains the correction following a sensor error (e.g. loss of seam) ■ **With offset**: Only useful with a straight seam, if it can be assumed that the correction along the seam remains constant to the end of the seam. ■ **Without offset**: The correction is eliminated over the correction elimination distance, and the robot returns to the taught path.
3	Maximum correction for linear offset If the sensor sends a seam point that is outside the defined limits, the robot only moves the maximum permissible correction distance towards the seam point. A message is generated. The robot does not stop. If a point on the seam is found again within the defined limits, the corrections are immediately carried out in full once again. This also applies to corrections to angles.
4	Maximum correction for angle
5	Corrections are eliminated or built up over this distance.

7.6 Inline form “Switch sensor off”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Switch sensor off**.

Description

This instruction switches the sensor off. It is relative to the end point of the current motion instruction. Due to the sensor advance run, seam tracking ends only after the end point. The switch-off point can be shifted.

Switch sensor off does not reset any base correction that may have been carried out.

After **Switch sensor off**, an additional LIN or CIRC motion is required in order to be able to eliminate any outstanding corrections before a PTP motion is executed. The LIN or CIRC motion must be at least as long as the correction elimination distance defined for **Switch sensor on** or **Switch sensor**.

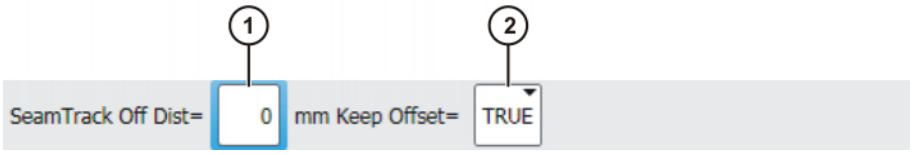

Fig. 7-7: Inline form “Switch sensor off”

Item	Description
1	Switch sensor off: ■ Range of values: **-100** … **+100 mm** ■ Negative value: The switching point lies before the end point. ■ Positive value: The switching point lies after the end point. ■ **0**: The switching point lies at the end point. The end point is generally approximated. The switching point then lies at the position on the approximation arc which is nearest to the end point.
2	Defines whether the robot continues motion with or without correction: ■ **TRUE**: With correction ■ **FALSE**: Without correction

Further information on offsetting the switching point and on the offset limits can be found in the following documentation: Operating and Programming Instructions for System Integrators, section TRIGGER WHEN PATH.

Example

```
...
LIN P9 CONT
LIN P10 CONT
SeamTrack Off Dist=3 mm
LIN P11 CONT
LIN P12 CONT
...
```

P11 is approximated. The sensor is switched off when the TCP is 3 mm after the position nearest to P11 on the approximation arc. Due to the sensor advance run, the laser line is already further ahead on the path!

7.7 Inline form “Deactivate sensor”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Deactivate sensor**.

Description

This instruction terminates communication with the sensor controller. This switches off the sensor. (It is not set to standby.)

```
SeamTrack Clear
```

Fig. 7-8: Inline form “Deactivate sensor”

7.8 Sensor commands

7.8.1 Inline form “Search for start of seam”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Sensor commands** > **Search for start of seam**.

Description

With this instruction, the sensor searches for the start of the seam. If it is found, the base is adapted to the current start of the seam. The precondition is that a point has been taught at the original start of the seam. The vector from the original start of seam to the current start of seam defines the base correction.

Search for start of seam is a motion of its own. Unlike other motions, however, no end point is taught. Instead, the direction of motion is determined by the original start of seam and one further point.

Base corrections are written to the variable M_BASE_CORR. ($BASE remains unchanged.) The maximum permissible value for the base correction is defined via the configuration parameter ‘Maximum base correction’.

(>>> 6.2.1 "“General” tab" Page 19)

A base correction is reset to the value before **Search for start of seam** in the following cases:

- **Initialize sensor** (with a message that must be acknowledged)
- **Deactivate sensor** (without message)

As a rule, there is then no further correction present, and $BASE applies again. Exception: If M_BASE_CORR was already assigned a value before **Search for start of seam**, e.g. via the variable correction function, then this value applies!

Sequence for ‘Search for start of seam’ if start of seam is found:

1. The sensor finds the start of the seam.
2. The search motion is terminated and the robot stops briefly.
3. The base is adapted to the position of the start of seam.
4. The robot moves to the start of the seam. It does not stop there.
5. Seam tracking commences at the start of the seam.

Sequence for ‘Search for start of seam’ if start of seam is not found:

1. The sensor does not find the start of the seam within the search length.
2. The search motion is terminated. (The robot stops if this has been defined in the configuration.)
3. The program is resumed from the next instruction after **Search for start of seam**. The robot moves to the first point after **Search for start of seam**. It does not stop there.

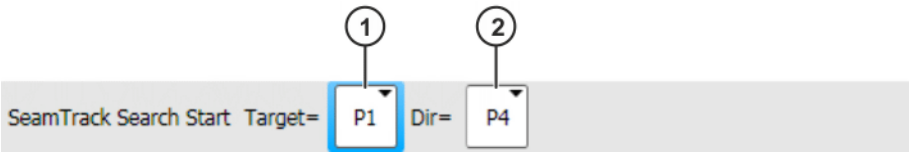

Fig. 7-9: Inline form “Search for start of seam”

Item	Description
1	Point at which the original start of seam is located ■ Range of values: All end points **Note**: Only those points are available for selection which were created with a LIN motion.
2	If the TCP reaches the original start of seam without the sensor having found the current start of seam, this point specifies the direction in which the search motion should be continued. ■ Range of values: All end points situated after the end point specified in item 1. **Note**: Only those points are available for selection which were created with a LIN motion.

Example

```
...
LIN P1 CONT
SeamTrack On
LIN P2 CONT
SeamTrack Search Start Target=P4 Dir=P6
LIN P3 CONT
LIN P4 CONT
PROCESS ON
LIN P5 CONT
LIN P6 CONT
...
```

Key to the illustrations:

Item	Description
1	Workpiece
2	Original path
3	Position of the TCP
4	Position of the sensor
5	Corrected path
6	Position at which the TCP leaves the original path

Original position of the workpiece and original path. The start of seam is at P4. This is also where the process begins (e.g. gluing process).

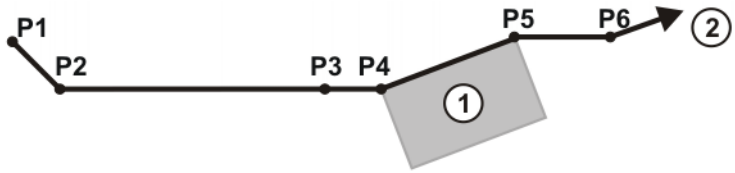

Fig. 7-10: Original position of the workpiece and original path

The position of the workpiece has changed. The search motion starts at P2. The sensor finds the current start of seam.

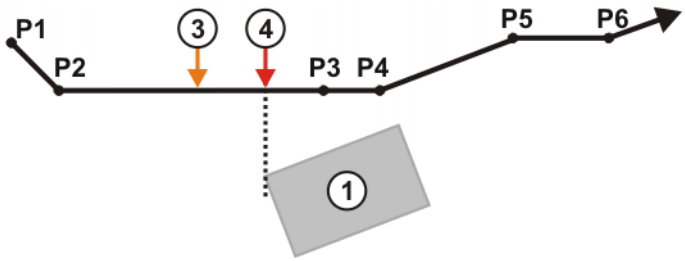

Fig. 7-11: New position of the workpiece, start of seam found

The vector from P4 to the current start of seam defines the base correction.

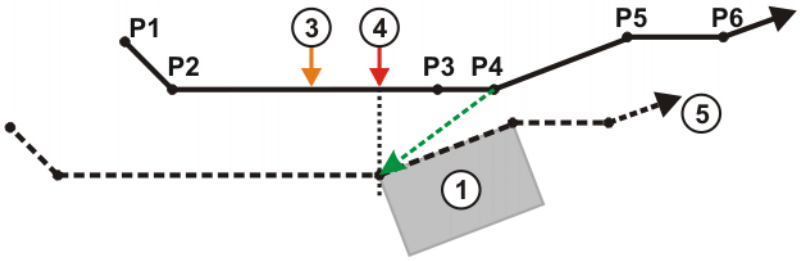

Fig. 7-12: Base correction

The TCP leaves the original path and moves to the current start of seam P4'. Triggers assigned to P3 are switched at P3".

The following distances are the same:

- P3 -> P4
- P3" -> P4'
- P3' -> P4'

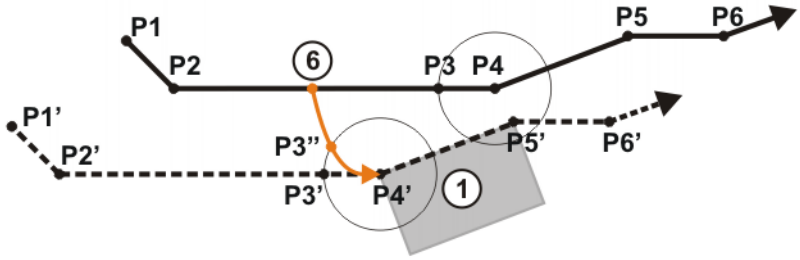

Fig. 7-13: Motion to the current start of seam

Example of a programming error:

At position (6), there are 2 motions to be executed:

- Move to the current start of seam P4'.
- Move to P3' with an approximated motion.

In the first example, these two motions were compatible due to the extremely short distance between P3' and P4'. (The motion to P3' lay within the tolerance range of the motion to P4'.)

As a rule, the two motions are not compatible, however, which leads to an error message.

Do not teach any point between **Search for start of seam** and the original start of seam. If a point is absolutely necessary, it must lie very close to the original start of seam.

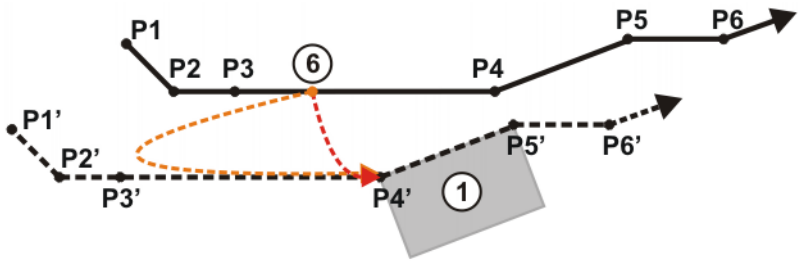

Fig. 7-14: Programming error

7.8.2 Inline form “Search for feature”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Sensor commands** > **Search for feature**.

Description

This instruction can be used to search for a particular feature on the path. The precondition is that the feature has been configured in the sensor controller.

The search is relative to the end point of the motion instruction. The search range is dependent on the settings in the option window **Search parameters**

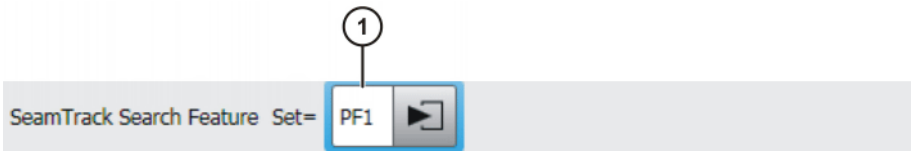

Fig. 7-15: Inline form “Search for feature”

Item	Description
1	Name of the data set containing the parameters for the search. The system automatically generates a name. The name can be overwritten. Place the cursor in the box and the relevant option window opens. (>>> 7.8.2.1 "Option window: Search parameters" Page 36)

Example

A search is to be carried out for a shape in the area of P4. The search instruction is therefore programmed between P3 and P4.

```
...
LIN P2 CONT
LIN P3 CONT
SeamTrack Search Feature
LIN P4 CONT
LIN P5 CONT
LIN P6 CONT
...
```

If the limit value is defined in millimeters:

- The value describes the radius of a circle. The center of the circle is the end point. If the end point is approximated, the center lies at the position on the approximate positioning arc that is closest to the end point.
- The search area lies between the points at which the circle intersects with the path. The search begins and ends when the sensor (not the TCP) enters and leaves the circle.

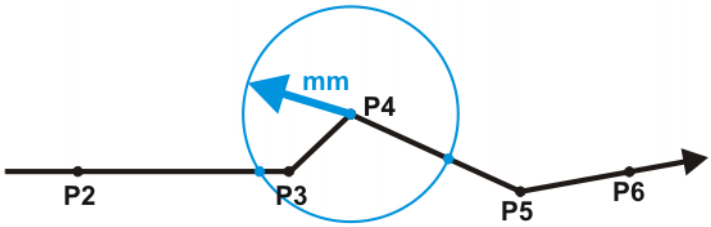

Fig. 7-16: Search on Seam, limit value in millimeters

If the limit value is defined in seconds:

- The search begins at the end point plus sensor advance run. If the end point is approximated, the position on the approximate positioning arc that is closest to the end point is taken for this purpose.
- The search ends after the defined time.

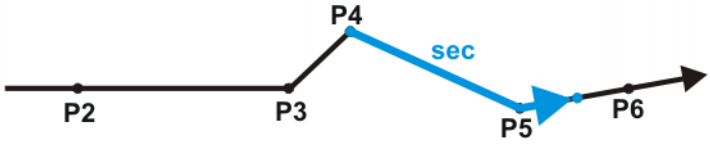

Fig. 7-17: Search on Seam, limit value in seconds

7.8.2.1 Option window: Search parameters

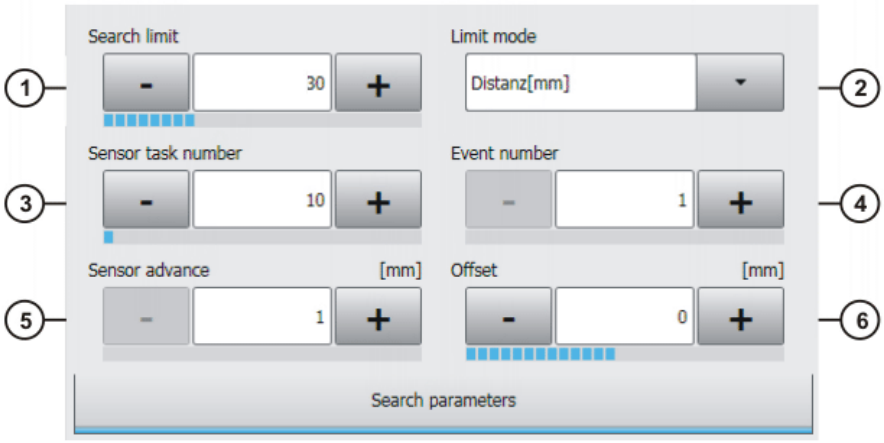

Fig. 7-18: Option window: Search parameters

Item	Description
1	Limit value for the search. Unit: ■ For **Distance[mm]**: mm ■ For **Time[s]**: s
2	Limit mode for the search: ■ **Distance[mm]**: Limitation by distance ■ **Time[s]**: Limitation by time
3	Number of the shape in the sensor controller
4	Number of the event that is triggered when the shape is found. The number is assigned as the value of the system variable $SEN_PINT[x]. [x] is defined on the **Resources** configuration page. (>>> 6.2.9 ""“Resources” tab" Page 23)
5	The sensor advance run must be entered here. **Note:** To measure the sensor advance run, the tool must be in the work position.
6	Offset Example: The sought shape is detected. Due to long transmission times, however, the process (e.g. welding or gluing process) only stops 20 mm after the shape. This can be compensated with an offset of -20 mm.

7.8.3 Inline form “Search for end of seam”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Sensor commands** > **Search for end of seam**.

Description

This instruction can be used to search for the end of the seam. The search is relative to the end point of the motion instruction. The search range is dependent on the settings in the option window **Search for end of seam**.

Once the end of seam has been found, the sensor is switched off. (At the latest, however, when the end of the search range is reached.) It is therefore not necessary to program a separate **Switch sensor off**. After **Search for end of seam**, an additional LIN or CIRC motion is required in order to be able to eliminate any outstanding corrections before a PTP motion is executed. The LIN or CIRC motion must be at least as long as the correction elimination distance defined for **Switch sensor on** or **Switch sensor**.

Fig. 7-19: Inline form “Search for end of seam”

Item	Description
1	Name of the data set containing the parameters for the search. The system automatically generates a name. The name can be overwritten. Place the cursor in the box and the relevant option window opens. (>>> 7.8.3.1 "Option window: Search for end of seam" Page 38)

Example

In the area of the point END, a search is to be carried out for the current end of seam. The search instruction is therefore programmed between P9 and END. After END, P10 is programmed as LIN in order to eliminate the correction. After P10, PTP motions can be carried out again.

```
...
LIN P9 CONT
SeamTrack Search End Set=PF1
LIN END
LIN P10 CONT
PTP P11 CONT
...
```

Example of the limit values for the search range: (>>> 7.8.2 "Inline form “Search for feature”" Page 35)

7.8.3.1 Option window: Search for end of seam

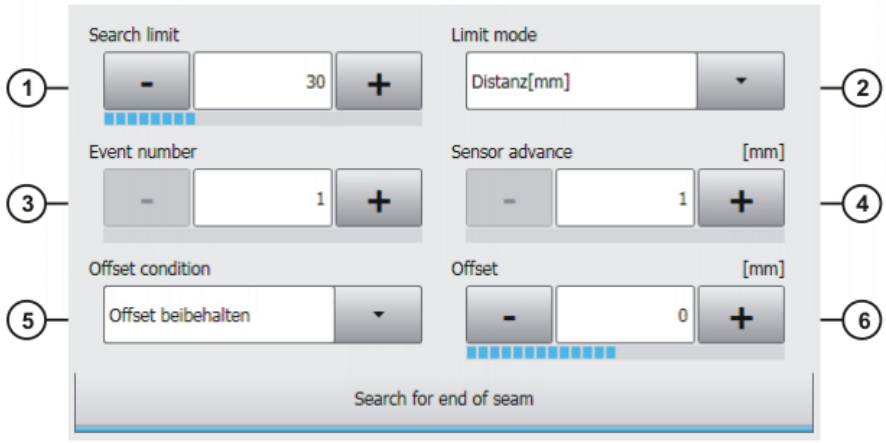

Fig. 7-20: Option window: Search for end of seam

Item	Description
1	Limit value for the search. Unit: ■ With **distance**: mm ■ With **time**: s
2	Limit mode for the search: ■ **distance**: Limitation by distance ■ **time**: Limitation by time
3	Number of the event that is triggered when the end of seam is found. The number is assigned as the value of the system variable $SEN_PINT[x]. [x] is defined on the **Resources** configuration page. (>>> 6.2.9 ""Resources" tab" Page 23)
4	The sensor advance run must be entered here. **Note:** To measure the sensor advance run, the tool must be in the work position.
5	Defines whether the robot continues motion with or without correction: ■ **Keep offset**: With correction ■ **Remove offset**: Without correction
6	Offset Example: The end of seam is detected. Due to long transmission times, however, the process (e.g. welding process) only stops 20 mm after the end of seam. This can be compensated with an offset of -20 mm.

7.8.4 Inline form "Freeze sensor"

Call

■ Select the menu sequence **Commands** > **SeamTech Tracking** > **Freeze sensor**.

Description

This instruction interrupts seam tracking. It can be used to address points without correction, e.g. a station for cleaning the welding torch.

Freeze sensor saves the current correction. Robot motion is continued without correction. Seam tracking is deactivated: the sensor continues to supply

data, but these are ignored. Seam tracking can then be reactivated and resumed using **Reactivate sensor**.

Freeze sensor triggers an advance run stop.

```
SeamTrack Freeze
```

Fig. 7-21: Inline form “Freeze sensor”

7.8.5 Inline form “Reactivate sensor”

Call

- Select the menu sequence **Commands** > **SeamTech Tracking** > **Reactivate sensor**.

Description

If seam tracking has been interrupted using **Freeze sensor**, it can be resumed using **Reactivate sensor**.

Reactivate sensor is a motion of its own. Unlike other motions, however, no end point is taught. Instead, the end point is selected as the point at which **Freeze sensor** was executed.

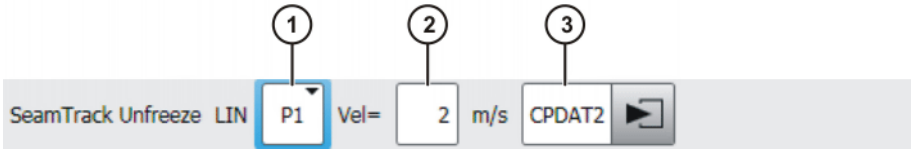

Fig. 7-22: Inline form “Reactivate sensor”

Item	Description
1	The point at which **Freeze sensor** was executed is selected here. (CIRC auxiliary points cannot be selected.) The saved correction and seam tracking are reactivated at this point. The point is addressed with LIN, even if it was originally taught as a CIRC end point.
2	Velocity No seam tracking takes place in the case of **Reactivate sensor**. The velocity can therefore be freely selected and does not have to correspond to the velocity at **Switch sensor on**. ■ **0.001** … **2 m/s**
3	Name of the data set containing the motion data. The system automatically generates a name. The name can be overwritten. Place the cursor in the box and the relevant option window opens. **Note:** Information about the option window can be found in the operating and programming instructions for the KUKA System Software.

Example

```
...
LIN P1 CONT
LIN P2 CONT
SeamTrack Freeze
LIN P3
PTP P4
SeamTrack Unfreeze LIN P2
LIN P5 CONT
LIN P6 CONT
...
```

Despite CONT, P2' is addressed with exact positioning. When the TCP reaches P2', the current correction is saved. The correction is eliminated on the way to P3. The robot then continues the path without correction. After P4, the correction is built up again. At P2', the correction is reached and seam tracking is reactivated.

P2' -> P3 and P4 -> P2' must each be at least as long as the defined correction elimination distance (‘Leave correction distance’).

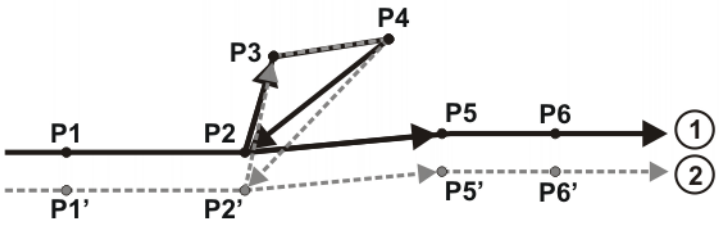

Fig. 7-23: Path with sensor instructions

Item	Description
1	Path executed with sensor deactivated (Seam tracking deactivated using the status key)
2	Path executed with sensor activated (Seam tracking activated using the status key)

Program without sensor instructions:

If the sensor instructions are removed from the program, the path changes. P2 is now approximated. After P4, P5 is addressed.

```
...
LIN P1 CONT
LIN P2 CONT

LIN P3
PTP P4

LIN P5 CONT
LIN P6 CONT
...
```

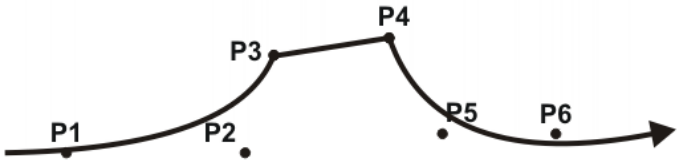

Fig. 7-24: Path, without sensor instructions

7.9 Names in inline forms

Names for data sets can be entered in inline forms. These include, for example, point names, names for motion data sets, etc.

The following restrictions apply to names:

- Maximum length 24 characters
  Individual boxes may be restricted to fewer than 24 characters.
- No special characters are permissible, with the exception of _.

- The first character must not be a number.

The restrictions do not apply to output names.

7.10 System integration

Description

The sensor system can be integrated into the system using one of the following methods:

- Use of global KRL variables
- Use of inputs and outputs

Global KRL variables

Variable	Description
STTg_FlagComm_Okay	**TRUE**: Communication with the sensor is active.
STTg_FlagSensorActiv	**TRUE**: Sensor is switched on.
STTg_FlagTargetFound	**TRUE**: Seam found
STTg_FlagMaxCorrReached	**TRUE**: Correction too great – limit value reached
STTg_FlagSeamLost	**TRUE**: Seam lost
STTg_FlagBeginNotFound	**FALSE**: The start of the seam was not found during a search for start of seam.
STTg_FlagSensedSeam	**TRUE**: Seam being tracked
STTg_FlagSensorReady	**TRUE**: Sensor is initialized

Inputs and outputs

The inputs and outputs can be configured on the configuration pages **Inputs** and **Outputs**.

(>>> 6.2.4 "“Inputs” tab" Page 20)

(>>> 6.2.3 "“Outputs” tab" Page 20)

8 Example programs

8.1 Example 1

Program

```
 1  DEF trackingtest( )
 2  INI
 3  PTP HOME  Vel= 100 % DEFAULT
 4  SeamTrack Init
 5  PTP P1 CONT Vel=100 % PDAT1 Tool[1]:wire Base[0]
 6  LIN P2 CONT Vel=0.1 m/s CPDAT1 Tool[1]:wire Base[0]
 7  SeamTrack On Dist= 0 mm Set= S1
 8  LIN P3 CONT Vel=0.1 m/s CPDAT2 Tool[1]:wire Base[0]
 9  LIN P4 CONT Vel=0.1 m/s CPDAT3 Tool[1]:wire Base[0]
10  LIN P5 CONT Vel=0.1 m/s CPDAT4 Tool[1]:wire Base[0]
11  SeamTrack Switch Dist=0 mm Set= S2
12  LIN P6 CONT Vel=0.1 m/s CPDAT5 Tool[1]:wire Base[0]
13  LIN P7 Vel=0.1 m/s CPDAT7 Tool[1]:wire Base[0]
14  SeamTrack Freeze
15  LIN RED_CORR CONT Vel=2 m/s CPDAT14 Tool[1]:wire Base[0]
16  PTP CLEAN_TORCH Vel=100 % PDAT2 Tool[1]:wire Base[0]
17  SeamTrack Unfreeze LIN P7 Vel=2 m/s CPDAT13
18  LIN P8 CONT Vel=0.1 m/s CPDAT8 Tool[1]:wire Base[0]
19  LIN P9 CONT Vel=0.1 m/s CPDAT10 Tool[1]:wire Base[0]
20  SeamTrack Search End Set= PF1
21  LIN END CONT Vel=0.1 m/s CPDAT11 Tool[1]:wire Base[0]
22  LIN P10 Vel=0.1 m/s CPDAT12 Tool[1]:wire Base[0]
23  SeamTrack Clear
24  PTP HOME  Vel= 100 % DEFAULT
25  END
```

Description

Explanation of the program:

Line	Description
4	The sensor is initialized.
5	Motion to a point near the workpiece
6	The last motion before **Switch sensor on** must be LIN or CIRC.
7	The sensor is switched on, thereby starting the seam search. As **Switch sensor on** is used with “Dist= 0 mm”, the seam search starts when the TCP is at the end point of the motion block, i.e. P3. Due to the sensor advance run, the search distance thus only starts after P3!
11	Change of sensor parameters at P6
13 … 18	The cleaning station CLEAN_TORCH is addressed between P7 and P8. The cleaning station is to be addressed without correction. For this reason, the seam tracking is interrupted at P7' with **Freeze sensor**. **Freeze sensor** saves the current correction at this point.
15 … 17	The same velocity must be programmed throughout seam tracking. The motions in lines 15-17 are without seam tracking, which means that different velocities are possible here.
15	The correction is eliminated on the way from P7' to RED_CORR. At RED_CORR, the TCP has reached the original path.
16	Cleaning station CLEAN_TORCH

Line	Description
17	The robot moves from CLEAN_TORCH to P7'. On the way, the correction is built up again. The correction saved with **Freeze sensor** applies. At P7', the TCP has reached the corrected path and seam tracking is resumed.
20, 21	In the area of the point END, a search is carried out for the current end of seam. Once the end of seam has been found, the sensor is switched off. A separate **Switch sensor off** command is no longer required after **Search for end of seam**. The switching points of triggers are transferred at right angles from the original path to the corrected path, e.g. also switching points referring to the point END. The switching points are therefore **not** transferred to the new end of seam.
22	The LIN motion P10 is necessary in order to eliminate the correction after END. (CIRC would also be possible instead of LIN.) After P10, PTP motions can be carried out again.
23	Communication with the sensor controller is terminated.

Key to the illustration:

Item	Description
1	Workpiece
2	Corrected path (red dotted line)
3	Original path (black)

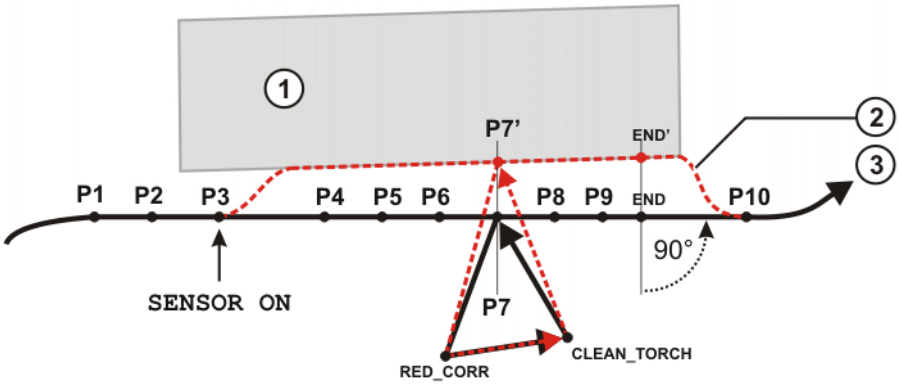

Fig. 8-1: Example program

8.2 Example 2 (with ARC instructions)

Program

```
 1  DEF k3_n2_test( )
 2  INI
 3
 4  SeamTrack Init
 5
 6  PTP P1  Vel=100 % PDAT2 Tool[1] Base[1]
 7
 8  ;----- sensor on -----
 9  LIN P2  Vel=0.01 m/s CPDAT15 Tool[1] Base[1]
10  SeamTrack On Dist=0 mm  Set= S42
11  LIN P3  Vel=0.01 m/s CPDAT11 Tool[1] Base[1]
12
13  ;----- arc on -----
14  LIN P4 Vel= 0.01 m/s CPDAT7 ARC_ON  Pgno= 42 S42 Seam2 Tool[1]
Base[1]
15
16  LIN P5 CONT CPDAT17 ARC  Pgno= 42 W5 Tool[1] Base[1]
17  LIN P6 CONT CPDAT17 ARC  Pgno= 42 W5 Tool[1] Base[1]
18
19  ;----- sensor & arc off -----
20  SeamTrack Off Dist=-1 mm Keep Offset=FALSE
21  LIN P7 CPDAT12 ARC_OFF  Pgno= 43 E42 Seam2 Tool[1] Base[1]
22
23  LIN P8  Vel= 0.1 m/s CPDAT13 Tool[1] Base[1]
24
25  PTP P9  Vel= 100 % PDAT2 Tool[1] Base[1]
26  SeamTrack Clear
27  END
```

Description

Explanation of the program:

Line	Description
4	The sensor is initialized.
9	The last motion before **Switch sensor on** must be LIN or CIRC.
10	The sensor is switched on, thereby starting the seam search.
14	Activate welding.
20	Switch sensor off.
21	Deactivate welding. The first motion after **Switch sensor off** must be LIN or CIRC.
26	Terminate communication with the sensor controller.

When programming ARC applications, remember that the velocity for most ARC instructions is programmed in m/min, and not in m/s as for motions.

Key to the illustrations:

Item	Description
1	TCP with sensor
2	Workpiece
3	Path

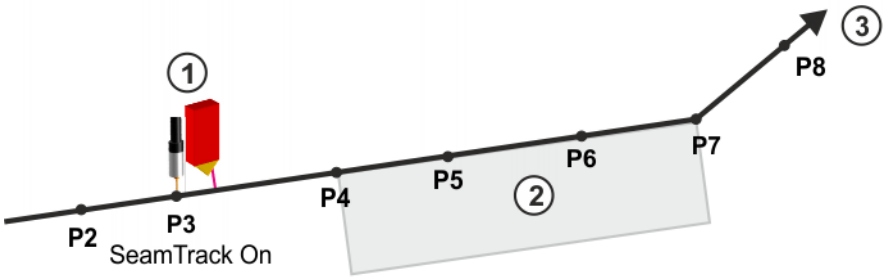

Fig. 8-2: Switch sensor on

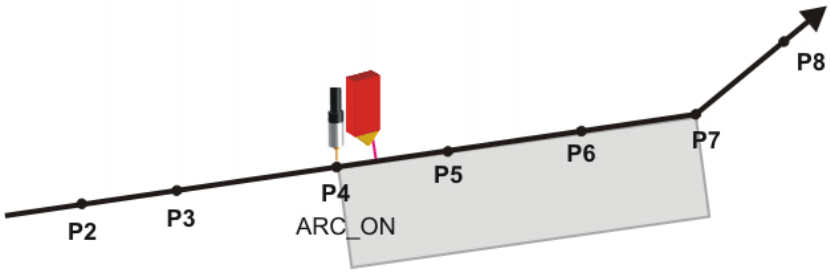

Fig. 8-3: ARC_ON

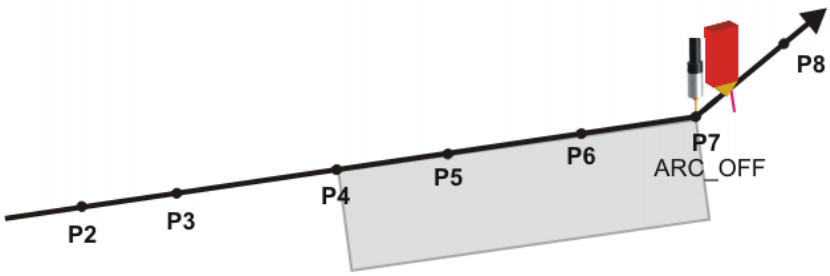

Fig. 8-4: ARC_OFF

9 Diagnosis

9.1 Displaying diagnostic data

The diagnostic data can also be displayed in WorkVisual. Information about procedures in WorkVisual is contained in the WorkVisual documentation.

Procedure

1. Select the menu sequence **Diagnosis** > **Diagnostic monitor**.
2. In the **Module** box, select the entry **Seamtech Tracking (STT)**.
   Diagnostic data are displayed.

Description

Name	Description
Sensor activated	■ **1**: sensor is activated. ■ **0**: sensor is not activated.
Sensor on	■ **1**: sensor is switched on. ■ **0**: sensor is switched off.
Seam type recognized	■ **1**: seam type was recognized. ■ **0**: no seam type was recognized.
Tracking seam	■ **1**: sensor is tracking the seam. ■ **0**: sensor is inactive.

10 Messages

Remedy in the case of acknowledgement messages, unless stated otherwise: eliminate the cause, acknowledge the message and restart the program.

No.	Message	Description
2	Tracking not allowed in T1 mode.	Cause: Mode T1 is selected. In this mode, the robot controller cannot execute sensor instructions.
3	Error on “Deactivate sensor”.	This message is preceded by a notification message containing information about the cause of the error.
17	Error while switching sensor on	Cause: The instruction **Switch on sensor** could not be executed. Remedy: Contact KUKA Service.
25	Seam tracking deactivated	Cause: Seam tracking was deactivated using the status key. Remedy: Activate seam tracking using the status key.
26	Start of seam found, but distance exceeds value configured	Possible causes: ■ The start of seam lies outside of the offset tolerance. ■ The start of the seam was found in the case of **Search for start of seam**. The maximum distance defined in the configuration parameter ‘Maximum base correction’ has been exceeded, however. Remedy: Increase the tolerance or move the workpiece inside the tolerance.
27	No network connection to the sensor	Cause: The Ethernet connection to the sensor could not be established.
28	“Enable sensor on KRC” is inactive, or PLC has not enabled the sensor.	Cause: The input ‘External sensor enable’ is not set. Remedy: Set the input ‘External sensor enable’ via the PLC.
30	Sensor start not possible.	Cause: Communication with the sensor controller has been established. The sensor controller signals that it is not ready, however.
32	Communication with sensor interrupted. Sensor instruction cannot be executed.	Cause: The current sensor instruction cannot be executed because communication with the sensor has been interrupted.
33	Correction value exceeds maximum value. Robot only moves by maximum value.	Cause: The maximum correction values defined in the option window **Sensor parameter** have been exceeded. The robot only executes the maximum permissible correction towards the seam point. If a point on the seam is found again within the defined limits, the corrections are immediately carried out in full once again.
34	Error on “Search on seam” or “Search for end of seam”.	This message is preceded by a notification message containing information about the cause of the error.
35	Error on “Freeze sensor”.	The message type depends on the configuration parameter “Stop on freeze error”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message This message is preceded by a notification message containing information about the cause of the error.

No.	Message	Description
36	Error on “Sensor Init”.	Cause: Communication with the sensor controller could not be established.
37	“Sensor Init” detected a base correction and reset it.	Cause: **Initialize sensor** detected that there was still a base correction active and reset it. A base correction may still be active, for example, if it was not reset by means of **Deactivate sensor** at the end of the last program run.
38	Sensor initialization failed.	This message is preceded by a notification message containing information about the cause of the error.
39	Shape on seam or end of seam not found.	The message type depends on the configuration parameter “Stop on ‘Search on seam’ error”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message Cause: In the case of **Search for feature**, the feature could not be found within the limit values defined in the option window **Search parameters**. Or: In the case of **Search for end of seam**, the end of seam could not be found within the limit values defined in the option window **Search for end of seam**.
41	Error on “Sensor Off”.	This message is preceded by a notification message containing information about the cause of the error. Whether the robot continues with or without correction after the message is acknowledged depends on which option has been selected in the inline form **Switch sensor off**.
42	Error on “Sensor On”.	This message is preceded by a notification message containing information about the cause of the error.
43	Error on “Reactivate sensor”.	The message type depends on the configuration parameter “Stop on freeze error”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message This message is preceded by a notification message containing information about the cause of the error.
44	Seam already found! Start of seam cannot be detected.	Cause: With the instruction **Search for start of seam**, it turns out that the sensor has already found the seam before this instruction.
45	Seam lost during motion.	The message type depends on the configuration parameter “Stop on loss of seam”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message Cause: The sensor has lost the seam during the motion.
46	Error on “Sensor Switch”.	This message is preceded by a notification message containing information about the cause of the error.

No.	Message	Description
47	Start of seam not found.	The message type depends on the configuration parameter “Stop on ‘Search seam start’ error”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message Cause: In the case of **Search for start of seam**: the sensor has not found the seam within the seam search length defined in the option window **Sensor adjustments (Switch sensor on)**.
48	Error on “Search for start of seam”: base correction is already present.	Cause: **Search for start of seam** has detected that there is already a base correction active. This may be the case, for example, if **Search for start of seam** has already been executed earlier in the program and the correction has not subsequently been reset.
49	Seam not found.	The message type depends on the configuration parameter “Stop on seam search error”: ■ **Activated** = acknowledgement message ■ **Deactivated** = notification message Cause: The sensor has not found the seam within the seam search length defined in the option window **Sensor adjustments (Switch sensor on)**.
50	Sensor type not defined	Cause: No identifier could be found for the sensor system. Remedy: Set the sensor type in WorkVisual.
52	Error while setting base correction	Cause: The BASE offset could not be executed.
54	Error during velocity control	Cause: A change in the command velocity could not be processed.
69	Time limit exceeded on “Freeze sensor”	Cause: The sensor is not reacting to the instruction **Freeze sensor**.
70	Time limit exceeded on “Reactivate sensor”	Cause: The sensor is not reacting to the instruction **Reactivate sensor**.
72	Initialization of communication for the status keys not possible	Cause: The communication with the sensor cannot be established. Remedy: Check IP address and port settings.
73	Sensor not responding to request of laser beam	Cause: The flag that is configured in the configuration parameter **Real-time communication lost ($FLAG[...])** is already used by another parameter. Remedy: Modify the value.
74	Unexpected response of the sensor in PID variable	Cause: The communication with the sensor does not correspond to the implementation. Remedy: Deselect the Submit interpreter and reselect it.

11 Appendix

11.1 Servo-Robot sensor system

The robot controller communicates with the sensor controller via Ethernet.

Overview

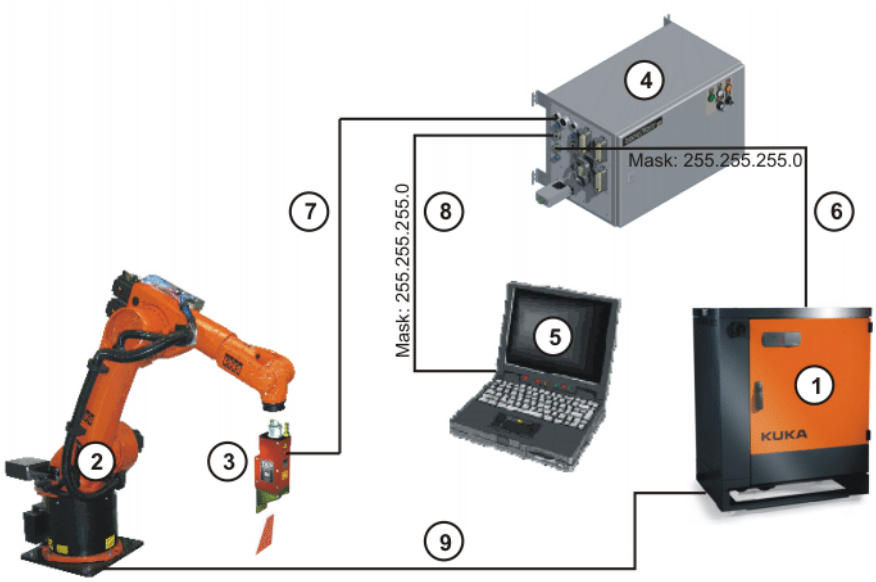

Fig. 11-1: Schematic overview

Item	Description
1	Robot controller **Note**: The IP address must be entered in the **Network configuration** window. (>>> 4.4 "Defining the IP address of the robot controller" Page 12)
2	Robot
3	Sensor
4	Sensor controller; default IP address: 192.168.2.3 If a different IP address is required, it must be entered at the following locations: ■ In the SeamTechTracking Editor in WorkVisual ■ On the sensor itself. Information on this can be found in the documentation of the sensor manufacturer. Robot port: Connector: CN6 User port: Connector: CN5
5	External PC The external PC must be located in the same network.
6	Ethernet connection between the robot controller and the robot port of the sensor controller (TCP/IP-CAT5)
7	Connection between the sensor controller and the sensor; measuring cable, max. 40 m
8	Ethernet connection between the external PC and the the user port of the sensor controller
9	Connection between the robot controller and the robot

11.1.1 Sensor coordinate system

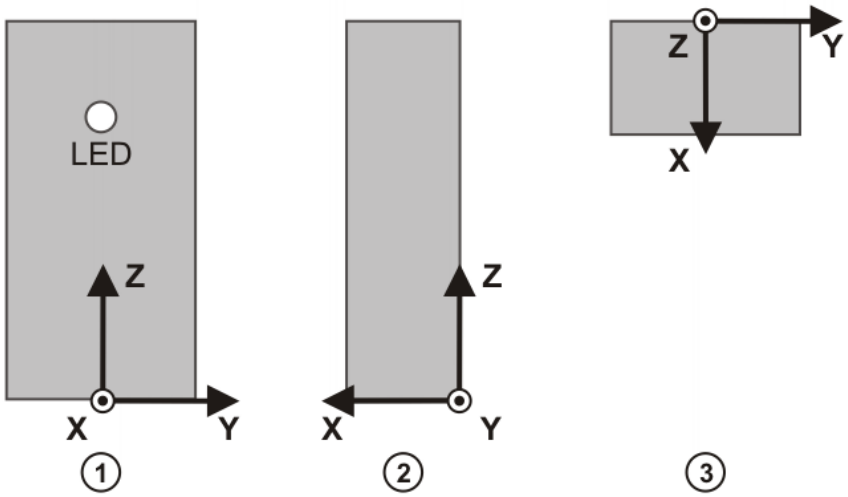

Fig. 11-2: Sensor and sensor coordinate system

1 Front view
2 Side view
3 Top view

The alignment of the sensor coordinate system cannot be changed.

Further information about the sensor is contained in the documentation supplied by the manufacturer of the sensor.
The angle designations in the sensor manufacturer documentation may vary from those of the robot coordinate systems!

11.1.2 Calibrating the sensor

Precondition

- The alignment of the TOOL coordinate system of the tool (e.g. the welding torch) is known.
- WeldCom displays the window for sensor calibration.
  (>>> "Description" Page 55)
- The laser line is displayed. Preconditions for this:
  - The sensor controller is switched on and operational.
  - The sensor is enabled by the sensor controller.
  - The sensor is not being addressed or requested by the robot.

Preparation

NOTICE Before executing the motions, ensure that there is sufficient space available. Damage to property may otherwise result.

- Compare the Z axes of the TOOL coordinate system and the sensor coordinate system.
  To do so, move the tool in the positive Z direction of the TOOL coordinate system. Note whether this direction corresponds to the positive or negative Z direction of the sensor coordinate system.
- Compare the X axis of the TOOL coordinate system with the sensor coordinate system.
  To do so, move the tool in the positive X direction of the TOOL coordinate system. Note whether this direction corresponds to the X or Y axis of the sensor coordinate system.

- Measure the sensor advance run (in mm). The tool must be in work position for this.
- Determine the angle of inclination of the sensor relative to the torch. This can be done visually or with the aid of an angle meter. The positive directions of the angles are indicated on the WeldCom interface.

  (>>> "Description" Page 55)

  The angles can be seen in the following views:

  - Alpha: front view of the sensor
  - Beta: side view of the sensor
  - Gamma: top view of the sensor

The angles must not exceed ±90°.

Procedure

1. Position the tool on the seam in the work position (e.g. the welding position in the case of a welding application).
2. Mark the position on the seam in which the TCP is located.
3. In the TOOL coordinate system, move backwards along the seam until the laser line is located at the marked point.
4. Enter the values determined during preparation in WeldCom.
5. Transfer the values. Do this by pressing the **Calibration** button.

   Once calibration has been successfully completed, this is immediately indicated by a message. Confirm the message with **OK**.

Description

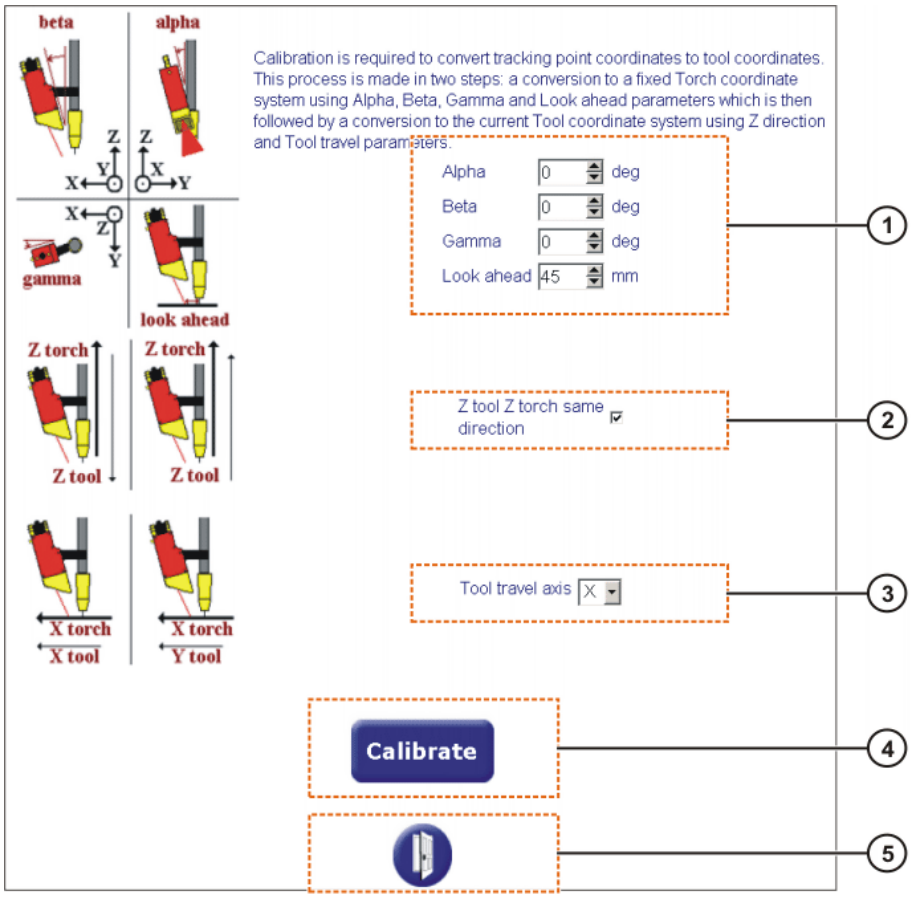

Fig. 11-3: WeldCom: calibrating the sensor

The term “tool” in WeldCom refers to the sensor, not the robot tool! The term “look ahead” refers to the sensor advance run.

Item	Description
1	Enter the angle of inclination and the sensor advance run. The angles must not exceed ±90°.
2	Specify the direction of $+Z_{TOOL}$. ■ $+Z_{TOOL}$ identical with $+Z_{SENSOR}$: check mark ■ $+Z_{TOOL}$ identical with $-Z_{SENSOR}$: no check mark ■ $+Z_{TOOL}$ identical with $+/-X_{SENSOR}$ or $+/-Y_{SENSOR}$: no calibration possible!
3	Specify the direction of $+X_{TOOL}$. ■ $+X_{TOOL}$ identical with $+/-X_{SENSOR}$: enter **X** ■ $+X_{TOOL}$ identical with $+/-Y_{SENSOR}$: enter **Y** ■ $+X_{TOOL}$ identical with $+/-Z_{SENSOR}$: no calibration possible!
4	Transfer the values.
5	Close the window.

11.2 Meta-Scout sensor system

The robot controller communicates with the sensor controller via Ethernet.

Overview

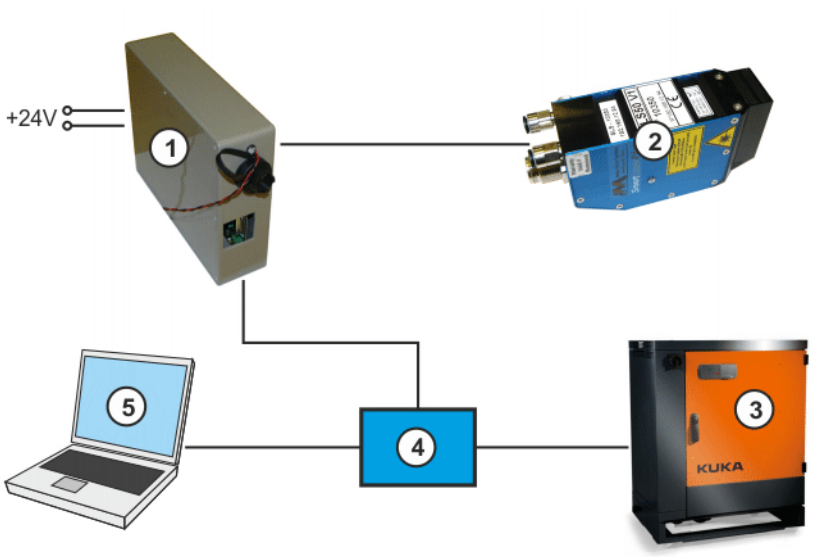

Fig. 11-4: Schematic overview

Item	Description
1	Power box
2	Sensor; default IP address: 192.168.12.94
3	Robot controller; IP address: 192.168.12.50 (example) **Note**: The IP address must be entered in the **Network configuration** window. (>>> 4.4 "Defining the IP address of the robot controller" Page 12)

Item	Description
4	Switch
5	External PC; IP address: 192.168.12.100 (example)

11.2.1 Sensor coordinate system

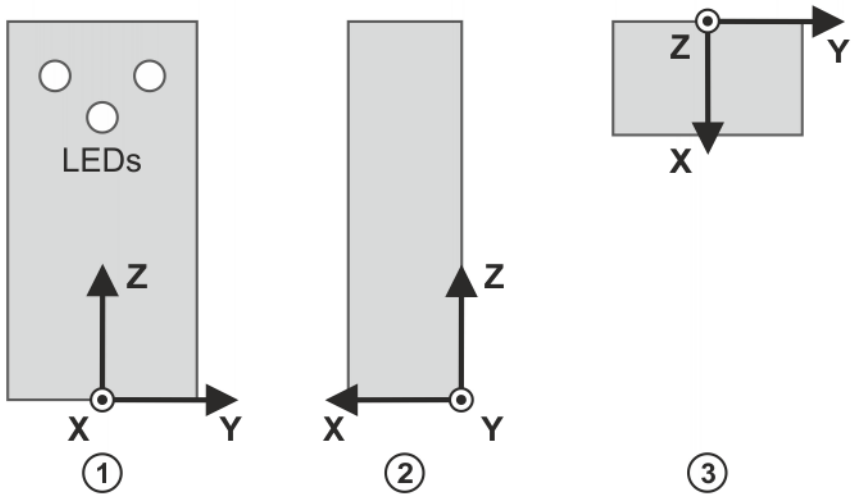

Fig. 11-5: Sensor and sensor coordinate system

1 Front view
2 Side view
3 Top view

The alignment of the sensor coordinate system cannot be changed.

Further information about the sensor is contained in the documentation supplied by the manufacturer of the sensor.
The angle designations in the sensor manufacturer documentation may vary from those of the robot coordinate systems!

11.2.2 Calibrating the sensor

Precondition

- The tool is aligned with the sensor.

Procedure

1. Align the calibration plate so that the open V points in direction +X of the BASE.
2. Align the sensor and TOOL coordinate system so that the TCP moves along direction +X of the BASE.
3. In the file STT_Calibration.src, teach the following points:
   - P1: Position above the calibration plate
   - P2: Start point with TCP on the cross of the plate
   - P3: Sensor line above 3/4 of the V opening
   - P4: Sensor line above 1/2 of the V opening
   - P5: Sensor line above 1/4 of the V opening

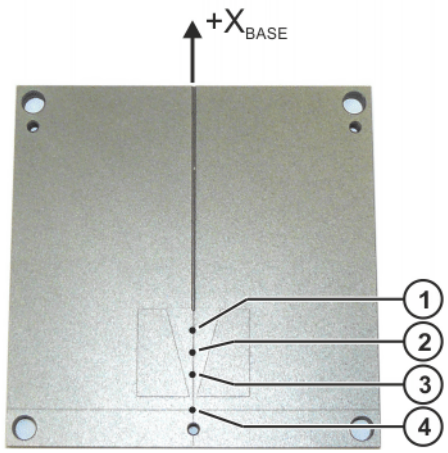

Fig. 11-6: Calibration plate

1	Point P3	3	Point P5
2	Point P4	4	Point P2

4. Create a new program.
5. Enter the function STT_Calibrate().
6. Start the program. The sensor is calibrated.

11.2.3 Changing the IP address of the sensor

Procedure

1. In the Smart Laser Tools program, select the menu sequence **System Setup** > **System** > **Network**.
2. Enter the IP address and confirm with **Save**.
3. Restart the sensor.

> Further information about Smart Laser Tools can be found in the documentation for this software.

11.3 Changing the IP address of the sensor controller

11.3.1 Entering a new IP address via Telnet

Precondition

- The network connection to the sensor controller is established.

Procedure

> In all Telnet entries: observe upper/lower case!

1. Click on the Windows **Start** button.
2. Select the menu option **Run...**.
3. In the **Open** box, enter “telnet *[IP address of the user port]*”, e.g. “telnet 192.168.3.3”.
4. Click on **OK**. The Telnet window is opened.
5. Enter the login name **sriadmin** and press the Enter key.
6. Enter the password **sriadmin** and press the Enter key.

> For security reasons, the password is not displayed on the screen when it is entered!

If login is successful, a message is displayed (e.g. with information about the last login, or similar).

7. Enter **./netconfig** and press the Enter key.

   The current address of the user port may now be displayed. A selection of possible actions is always displayed.
8. Enter “2” (for the action “Manual entry of the new IP address”) and press the Enter key.
9. Enter the new IP address of the user port and press the Enter key.

   The current number of the subnetwork mask is displayed.
10. Enter the current number of the subnetwork mask again and press the Enter key.

    The new address of the user port and the number of the subnetwork mask are displayed.

    The current address of the robot port may now be displayed. A selection of possible actions is always displayed.
11. Enter “2” (for the action “Manual entry of the new IP address”) and press the Enter key.
12. Enter the new IP address of the robot port and press the Enter key.

    The current number of the subnetwork mask is displayed.
13. Enter the current number of the subnetwork mask again and press the Enter key.

    The new address of the robot port and the number of the subnetwork mask are displayed.
14. A request for confirmation is displayed, asking if the changes are to be accepted or rejected. Accept the changes with “y”. Press Enter.
15. To log out, enter **exit** and press the Enter key.
16. Reboot the sensor controller.

12 KUKA Service

12.1 Requesting support

Introduction

This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Information

The following information is required for processing a support request:

- Model and serial number of the manipulator
- Model and serial number of the controller
- Model and serial number of the linear unit (if present)
- Model and serial number of the energy supply system (if present)
- Version of the control software
- Optional software or modifications
- Archive of the software
- Application used
- External axes used
- Description of the problem, duration and frequency of the fault

12.2 KUKA Customer Support

Availability

KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.

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