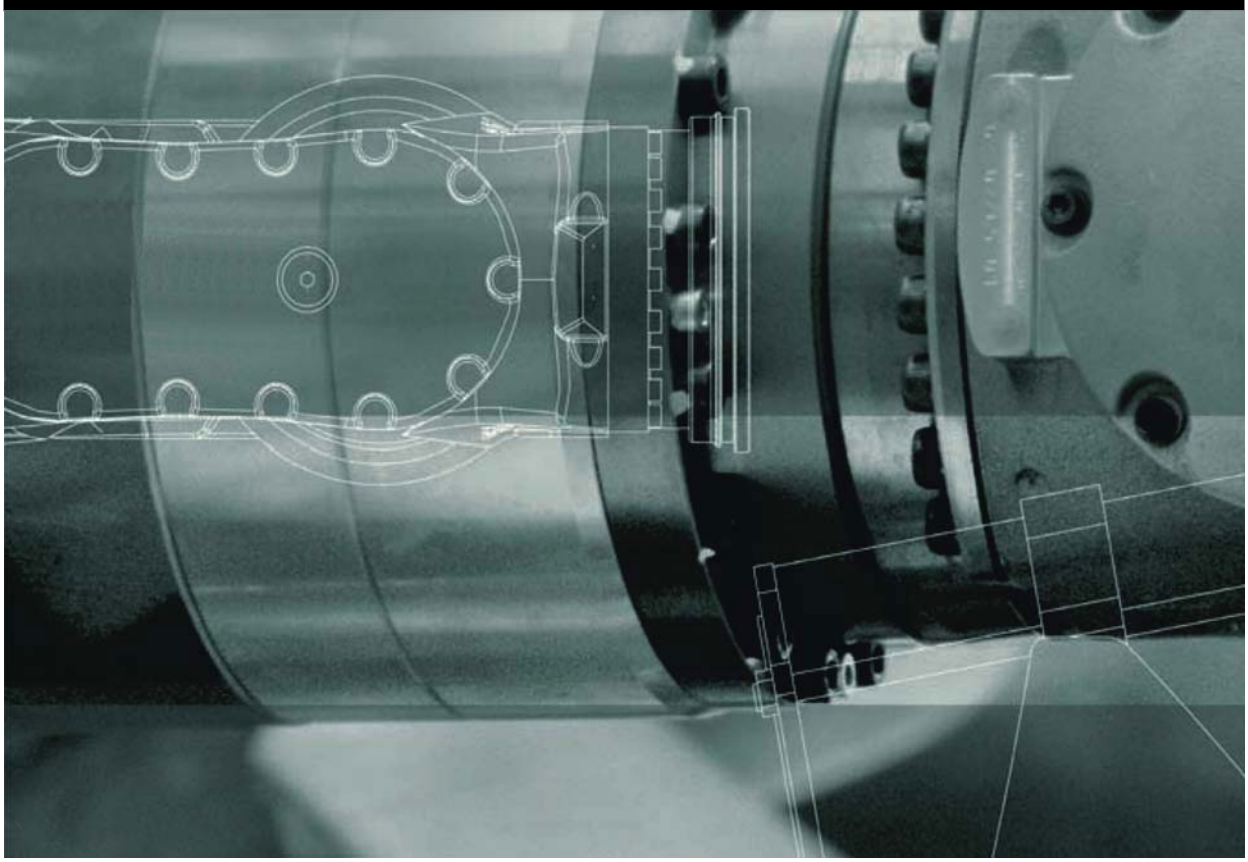
KUKA

KUKA System Technology

KUKA Roboter GmbH

KUKA.TouchSense 2.0

For KUKA System Software 8.3



Issued: 25.07.2013

Version: KST TouchSense 2.0 V1 en (PDF)

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Other functions not described in this documentation may be operable in the controller. The user has no claims to these functions, however, in the case of a replacement or service work.

We have checked the content of this documentation for conformity with the hardware and software described. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. The information in this documentation is checked on a regular basis, however, and necessary corrections will be incorporated in the subsequent edition.

Subject to technical alterations without an effect on the function.

Translation of the original documentation

KIM-PS5-DOC

Publication:	Pub KST TouchSense 2.0 (PDF) en
Book structure:	KST TouchSense 2.0 V1.2
Version:	KST TouchSense 2.0 V1 en (PDF)

Contents

1 Introduction

1.1 Target group

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

- Advanced knowledge of the robot controller system
- Advanced KRL programming skills

For optimal use of our products, we recommend that our customers take part in a course of training at KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

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 KUKA System Software
- Documentation relating to 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 Terms used

Term	Description
Square butt weld	A square butt weld is formed when 2 workpieces, e.g. 2 plates, lie parallel to each other. A square butt weld takes the form of a straight line.
Single-V butt weld	A single-V butt weld is formed when 2 workpieces stand at right angles to each other. A single-V butt weld takes the form of a triangle with two sides of equal length.
Fast Measurement	Fast Measurement interface X33 can be used to program search commands in the robot controller for measuring workpieces using digital sensors. Interface X33 is located on the connection panel of the robot controller.

2 Product description

2.1 Overview of KUKA.TouchSense

KUKA.TouchSense is an add-on technology package e.g. for welding applications that require a high degree of dimensional accuracy. Correction of the originally programmed path is often necessary in order to compensate for deviations in the shape or position of workpieces. This is possible with KUKA.TouchSense.

Functional principle

The original position of the workpiece is detected using the sensor, a live welding wire. This is done by means of search instructions which are programmed via inline forms. When the welding wire touches the workpiece, the current flow is registered. At the same time, the search motion is interrupted by an interrupt signal and the position of the robot when the welding wire touches the workpiece is saved. Depending on the workpiece, one or more search instructions must be programmed.

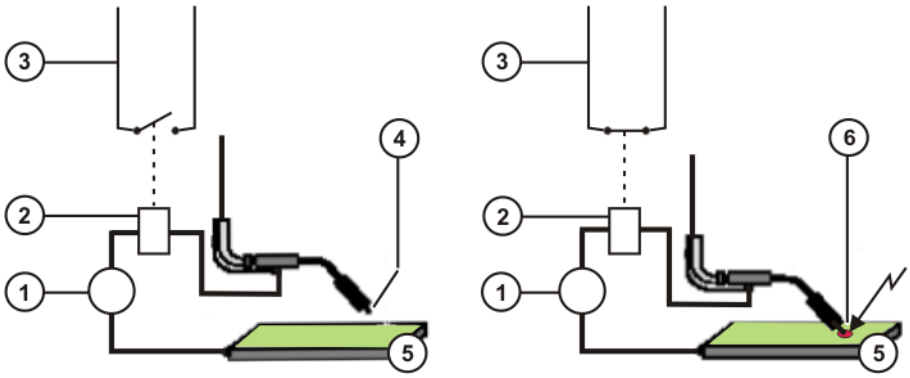


Fig. 2-1: Functional principle

1	Welding power source	4	Welding wire
2	Relay	5	Workpiece
3	“Fast Measurement” cable	6	Current flow on contact

If the workpiece is then offset, the new position of the workpiece is determined using the same program. The robot controller calculates correction data sets from the difference between the original position and the new position.

When making the correction, the programmed path data are offset by the correction data. This is done by means of one or more correction instructions, which are likewise programmed via inline forms.

2.2 Communication

If KUKA.TouchSense is used e.g. for arc welding, a short-circuit between the welding wire and the workpiece causes a 24 volt signal from the robot to be returned to the robot by the welding power source via a floating contact and a fast measuring input and to be evaluated by the robot controller.

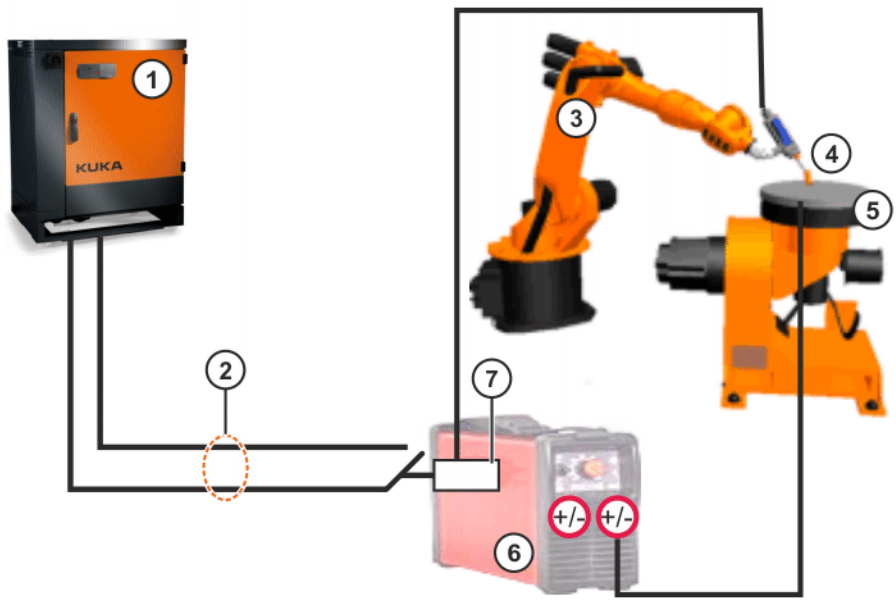


Fig. 2-2: Communication principle

1	Robot controller	5	Workpiece / clamping fixture
2	Fast Measurement input or standard input	6	Welding power source
3	Robot	7	Relay / optocoupler
4	Sensor / welding wire		

KUKA Roboter GmbH does not supply universal touch hardware. When setting up the hardware, observe the specifications of the power source used.

Further information on connecting the Fast Measurement inputs can be found in the assembly and operating instructions “Optional Interfaces for KR C4”.

2.3 Workpiece search

Overview

There are two methods available for this:

- Single Touch
  (>>> 2.3.1 "Single Touch mode" Page 8)
- Double Touch
  (>>> 2.3.2 "Double Touch mode" Page 9)

2.3.1 Single Touch mode

This method can be used to determine the positional offset of a workpiece.

The robot moves the sensor from the start point along a defined search path. The search direction is defined by the Via point. The search motion is stopped when the sensor touches the workpiece.

The axis values determined during the search are saved as a correction data set. The robot then returns to the start point.

The search path must be programmed in such a way that both the original and new positions of the workpiece lie within the limits of the search motion and

can thus be detected. The search path is dependent on the search distance X, which is set in the **Search Parameter** option window.

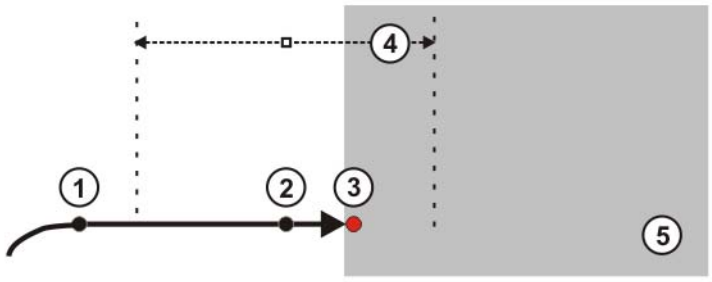


Fig. 2-3: Example: search motion, original position of the workpiece

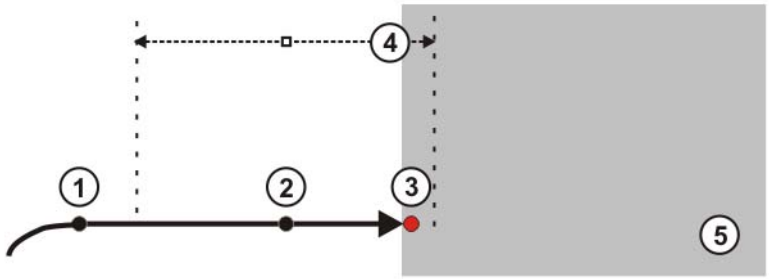


Fig. 2-4: Example: search motion, new position of the workpiece

1	Start point of the search
2	Via point of the search: determines the search direction
3	Touch position: sensor touches workpiece
4	Search distance
5	Workpiece

The number of search instructions needed depends on the possible changes in position of the workpiece. Up to 3 search instructions are generally necessary (for the offset and rotation of each axis) in order to adapt a path to the changed position. In the case of unfavorable geometries or poor accessibility, the number of search motions can be extended as required.

2.3.2 Double Touch mode

This method can be used to determine the center of a gap between 2 workpieces, e.g. for a square butt weld.

The start point of the search lies within the gap. The search direction is defined by the Via point. The search motion is stopped when the sensor touches the side of the gap. The search is then started automatically in the opposite direction. The search motion is stopped when the sensor touches the other side of the gap.

From the axis values determined during the search, the center of the gap is calculated and saved as a correction data set. The robot then returns to the start point.

The start point and the search path must be programmed in such a way that both the original and new positions of the gap lie within the limits of the search motion and can thus be detected. The search path is dependent on the search distance X, which is set in the **Search Parameter** option window.

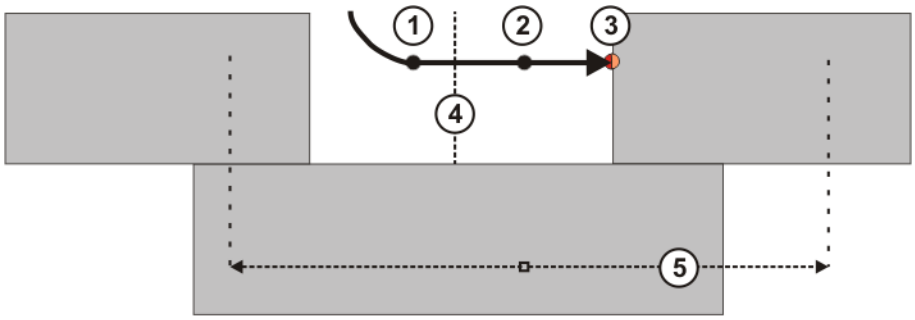


Fig. 2-5: Example of a search motion: center of gap, touch 1

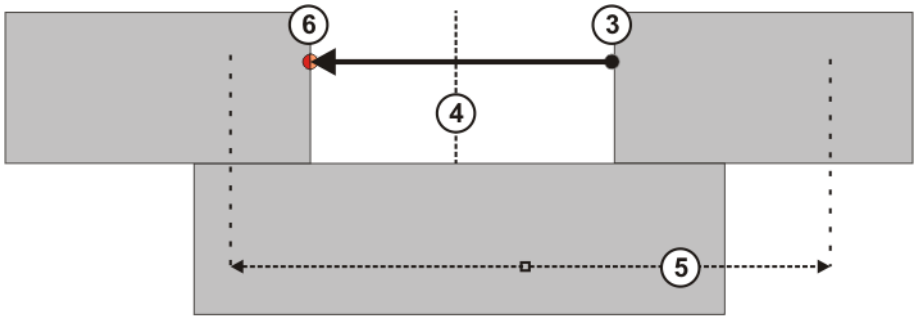


Fig. 2-6: Example of a search motion: center of gap, touch 2

1	Start point of the search
2	Via point of the search: determines the search direction
3	Touch position 1: sensor touches the first side of the gap
4	Center of gap
5	Search distance
6	Touch position 2: sensor touches the second side of the gap

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.

4 Installation

4.1 System requirements

Robot controller

Hardware:

- KR C4 with interface X33

Software:

- KUKA System Software 8.3.2 or higher

Laptop/PC

Software:

- WorkVisual 3.0

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

4.2 Installing or updating TouchSense

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

Precondition

- "Expert" user group
- Software on USB stick

NOTICE Recommendation: Always use KUKA sticks. Data may be lost if sticks from other manufacturers are used.

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 **TouchSense** 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 **Path selection**. 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. Select the entry **TouchSense** 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 TouchSense

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**. All additional programs installed are displayed.
2. Select the entry **TouchSense** 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.

5 Operation

5.1 Menus

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

Main menu:

- **Configuration** > **TouchSense**

Menu sequence:

- **Commands** > **TouchSense**
  - Search
  - Correction
  - Switch off correction
  - Check position correction

5.2 Status keys

Procedure

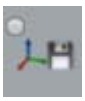
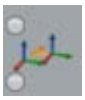
Displaying the status keys:

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

Description

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

- “Expert” user group
- Operating mode T1 or T2
- Program is selected
- Submit interpreter running
- The parameter **TouchSense active** is activated in the configuration
- The enabling switch is pressed (only for status key Sensor On)
- TouchSense is activated via the status key Option Off (only for status key Sensor On)

Status key	Description
	Status key Option Off (not pressed) TouchSense is active. Search and correction are carried out. Pressing the status key deactivates TouchSense.
	Status key Option Off (pressed) TouchSense is not active. Neither search nor correction is carried out.
	Status key Force Mastering (pressed) Remastering is active. At the next search routine, the position data of the workpiece will be saved as reference data. In the case of a reference run, the reference coordinates are recalculated. The reference coordinates of the previous mastering are overwritten.
	Status key Force Mastering (not pressed) Remastering is not active. Pressing the status key activates remastering.
	Status key Corr Off (not pressed) Correction is not active.

Status key	Description
	Status key Corr Off (not pressed) Correction has been switched on and is now active.
	Status key Corr Off (pressed) Correction is deactivated and cannot be switched on via the program. Or, if correction was switched on, it has been deactivated by means of this status key.
	Status key Sensor On (pressed) The sensor is switched on.
	Status key Sensor On (pressed) The sensor is switched on and the welding wire is touching the component.
	Status key Sensor On (not pressed) The sensor is switched off. Pressing the status key switches the sensor on.

6 Configuration

6.1 Configuring TouchSense via the smartHMI

Precondition

- “Expert” user group
- No program is selected.

Procedure

1. In the main menu, select **Configuration** > **TouchSense**.
2. Set the parameters on the tabs as required.
   (>>> 6.1.1 "“General settings” tab" Page 17)
   (>>> 6.1.2 "“Search dynamic” tab" Page 18)
   (>>> 6.1.3 "“Sensor configuration” tab" Page 19)
3. Close the window. Respond to the request for confirmation asking whether the change should be saved by pressing **Yes**.

6.1.1 “General settings” tab

Parameter	Description
TouchSense active	Activate or deactivate TouchSense. ■ **Activated**: TouchSense is active; the TouchSense commands are executed. ■ **Deactivated**: TouchSense is inactive; the TouchSense commands are ignored.
Steps for messaging	Set the messaging level. ■ **Low**: Only the most important messages are displayed, including safety messages. ■ **Medium**: The displayed messages enable a diagnosis to be carried out by the user. ■ **High**: The displayed messages enable a diagnosis to be carried out by the expert. Default setting: Low **Note**: Performance is highest with the setting **Low**, as every message is prepared and logged in the system.
Number of search or measurement repeats after error	If an error (e.g. component not found) occurs during a search or measurement, the robot controller automatically repeats the search up to the specified number of retries (as long as errors still occur). Following the last repetition, and depending on the setting of the parameter **Display dialog in event of error**, either a dialog message is generated or the program stops with an acknowledgement message. ■ **0 … 5** Default setting: 0 **Note**: In the case of a search with welding wire, it is advisable to set this parameter to the value 0. Otherwise, the welding wire may bend in the case of a faulty search. If the search is repeated, this leads to incorrect measurement values.
Wait time before automatic repeat [s]	Before the repetitions configured under **Number of search or measurement repeats after error**, the robot controller waits for the time specified here. ■ **0.3 … 2.00 s** Default setting: 0.3 s

Parameter	Description
Show dialog message in case of error	This parameter determines whether a dialog message is displayed in the case of an error. ■ **No dialog**: No dialog message is displayed; the robot stops the program. ■ **Always**: A dialog message is displayed in all operating modes. ■ **T1|T2**: A dialog message is only displayed in operating modes T1 and T2. ■ **T1|T2|AUT**: A dialog message is only displayed in operating modes T1, T2 and AUT. Default setting: T1|T2
Output number for error	This parameter determines whether an output is set in the event of a correction error, in order to signal the error to the PLC. ■ **0**: No output is set. ■ **≠0**: The output with the specified number is set. Default setting: 0
Interrupt priority characteristic found	Priority of the interrupt for detection of the feature ■ **10 … 32** Default setting: 15 **Note**: The priority of this parameter must be lower than the priority of the parameter **Interrupt priority technology package**. Only alter the default setting if the value is already assigned.
Interrupt priority technology package	Priority of the interrupt for the technology package in the case of an error ■ **11 … 32** Default setting: 16 **Note**: The priority of this parameter must be higher than the priority of the parameter **Interrupt priority characteristic found**.

6.1.2 “Search dynamic” tab

Description

In the option window **Search parameter set** a dynamic profile can be selected for the search (**Fast**, **Medium** or **Slow**).

(>>> 7.3.2 "Option window “Search parameter”" Page 24)

Here on the **Search dynamic** tab, the following velocities and accelerations can be configured for each profile:

Parameter	Description
Search velocity [mm/s]	Velocity for the search ■ **2 … 250 mm/s**
Retract velocity [mm/s]	Velocity at which the robot returns to the start point after the search ■ **2 … 2000 mm/s**
Search acceleration [%]	Acceleration for the search and return motion The value refers to the maximum value specified in the machine data. The maximum value depends on the robot type and the selected operating mode. ■ **1 … 100%**
Return acceleration [%]	

6.1.3 “Sensor configuration” tab

Description

Up to 4 sensors can be displayed on this tab. As standard, 1 sensor is displayed. To change the number of sensors displayed, the value of the variable TSg_NumSensors must be changed via the variable correction function.

The following parameters can be configured for each sensor:

Parameter	Description
Sensor name	Name of the sensor **Note**: The name must not exceed 24 characters.
Output number touch voltage	Number of the output for activating the touch voltage ■ **0**: No input configured Default setting: 0
Input number system ready	Number of the input used by the external system to communicate to the robot that it is ready ■ **0**: No input configured Default setting: 0
Compensation time [s]	Wait time between the setting of the output “Touch voltage” and the start of the search motion. The compensation time ensures that the touch voltage is set by the power source and is stable at the welding wire. ■ **0.0 … 1.0 s** Default setting: 0.1 s
Input number touch signal	Number of the input that is used to signal that the component has been found. This input can be defined as a Fast Measurement input or standard input. Default setting: 1
Kind of the touch input	Type of touch signal ■ **Fast**: The input is defined as a Fast Measurement input. ■ **Standard**: The input is defined as a standard input (via a field bus). **Note**: The stop reaction and the position data acquisition of the robot are fastest and most accurate with a Fast Measurement input. If a standard input is used, the search velocity should not be greater than 10 mm/s.
Switching level of the touch input	Type of touch signal level when the component is found ■ **High active**: The edge from Low to High signals that the component has been found. ■ **Low active**: The edge from High to Low signals that the component has been found.

6.2 Configuring TouchSense with WorkVisual

As an alternative to configuration via the smartHMI, TouchSense can be configured with WorkVisual.

Step	Description
1	Install the **TouchSense** option package in WorkVisual.
2	Transfer the project from the robot controller to WorkVisual. **Precondition**: TouchSense is installed on the robot controller. **Note**: This project should be used for the configuration of TouchSense in WorkVisual, otherwise the entries installed on the robot controller by TouchSense could be lost when the project is transferred back to the robot controller (see step 4).
3	Configure TouchSense in the Editor **TouchSense Configuration**. (>>> 6.2.1 "Setting parameters" Page 20)
4	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.

6.2.1 Setting parameters

Precondition

- A project is open.
- The robot controller has been set as the active controller.

Procedure

1. Open the editor **TouchSense Configuration**: menu sequence **Editors** > **Options packages** > **Configure TouchSense...**.
2. Set the parameters on the tabs as required.
   (>>> 6.1.1 "“General settings” tab" Page 17)
   (>>> 6.1.2 "“Search dynamic” tab" Page 18)
   (>>> 6.1.3 "“Sensor configuration” tab" Page 19)
3. Save the settings.

7 Programming

7.1 Instructions for programming

When a new program is created or an existing program is changed, a test run must be performed in T1 mode.

The programming descriptions refer to a sensor installed on the mounting flange unless stated otherwise. If a fixed sensor is used, the programming must be adapted accordingly.

7.2 Preparation

The following questions must be considered in preparation for programming:

1. In what ways are the workpieces liable to be offset in relation to the reference workpiece?
   - Linear offset along the length, width and/or height
   - And/or: Tilted along the length and/or width, and/or rotated in the plane
2. If only linear offsets are able to occur: Can the reference workpiece be calibrated as a BASE?
3. At what points do measurements have to be carried out in order to detect the offsets?
4. Are these points accessible for the sensor?
5. Which CD*x* data of the measurement register the offset?
6. To what extent are the workpieces liable to be offset in relation to the reference workpiece? Therefore, do the measurements have to be programmed with or without a search?

7.3 Inline form “Search”

Description

This instruction is used to measure the position of the workpiece.

The search is also suitable for robots with mathematically coupled external axes, or robots with a workpiece and a fixed tool (external TCP).

The external axis must be in position before starting the search. It may be moved into new positions for the next search procedure. If teaching with external axes (mathematically coupled or otherwise), these must remain stationary, i.e. only the 6 robot axes may be moved.

A search instruction is also a motion instruction (PTP, LIN, CIRC, SLIN or SCIRC). The search is initiated at the end point of this motion. As soon as the workpiece has been found, the robot is stopped. The position of the workpiece is saved and the robot moves back to the starting point (single touch).

An additional point must be taught for the search (Via point). This Via point defines the search direction. The maximum length of the search motion and other properties of the search are defined using the parameter list.

Programming a search instruction involves the following steps:

- Saving the coordinates of the start point.
- Saving the coordinates of the Via point.
- Setting various parameters, e.g. search velocity.

Precondition

- A program is selected.
- Operating mode T1 or T2

- The welding wire must not be bent.

Preparation

- It is easier to program the search if the workpiece is positioned in the XY plane of a calibrated $BASE or parallel to $WORLD.
- If the welding wire is bent or pushed back on contact with the workpiece, this will falsify the correction data. To reduce the risk of this occurring, it is recommended that the maximum search velocity is determined before programming the search.

NOTICE There is a risk of collisions if differently calibrated positions are used in search instructions. When programming search instructions, it must be ensured that teaching is carried out using either a robot tool or an external tool or an external kinematic system.

Procedure

1. Select the menu sequence **Commands** > **TouchSense** > **Search**.
2. Select the motion type in the inline form.
3. Only if CIRC or SCIRC has been selected as the motion type:
   Move the TCP to the position for the auxiliary point. Press **Teach Aux**.
4. Move the TCP to the position for the end point (= start point for the search). Press **Touchup**.
   The start point must be approached in such a way that the welding wire is not perpendicular to the workpiece during the search, otherwise the resultant correction data will be falsified. Ideally, the welding wire should be positioned at an angle of approx. 45° to the search direction at the start position.

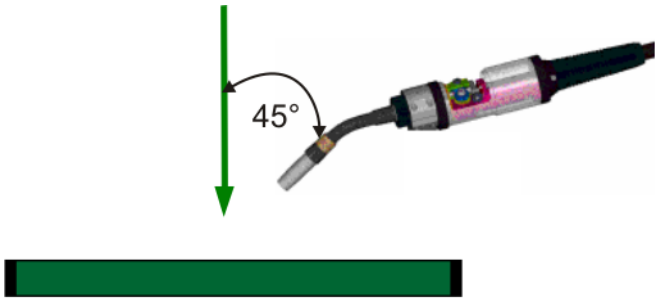


Fig. 7-1: Start position for search

5. Set the other parameters in the inline form.
6. Move the TCP to the position that is to be taught as the Via point. Press **Touchup Via**.
7. If the search instruction is to detect the original position of the workpiece (instead of the deviation from the original position), set the parameter to **Yes** in the option window **Set new reference**. The data are saved as reference data.
   (>>> 7.3.1 "Option window “Set new reference”" Page 23)
8. Set the desired parameters in the option window “Search parameter”.
   (>>> 7.3.2 "Option window “Search parameter”" Page 24)
9. Save instruction with **Cmd OK**.

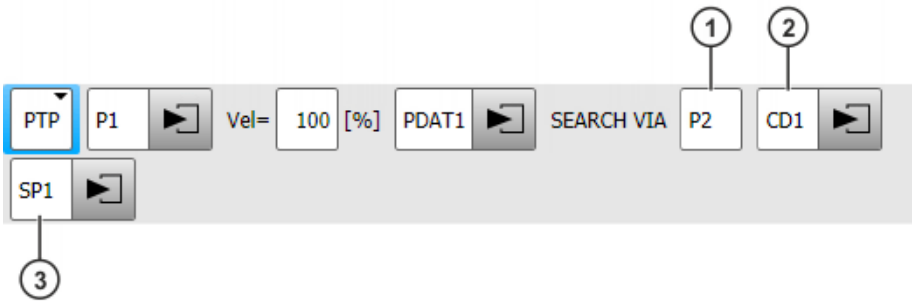


Fig. 7-2: Inline form “Search”

NOTICE Define the Via point and search distance so there is no risk of a collision if the component is not found and the robot therefore has to cover the full length of the search distance. Damage to property may otherwise result.

Item	Description
1	Via point The Via point defines the direction of the search. It does not specify the end point of the search. (This is derived from the search distance.) The system automatically generates a name. The name can be changed.
2	Name of the feature. The system automatically generates a name. The name can be changed. Touch the arrow to edit the data. The corresponding option window is opened. (>>> 7.3.1 "Option window “Set new reference”" Page 23)
3	Search parameter The system automatically generates a name. The name can be changed. Touch the arrow to edit the data. The corresponding option window is opened. The search distance and the velocity profile for the search are defined here. (>>> 7.3.2 "Option window “Search parameter”" Page 24)

7.3.1 Option window “Set new reference”

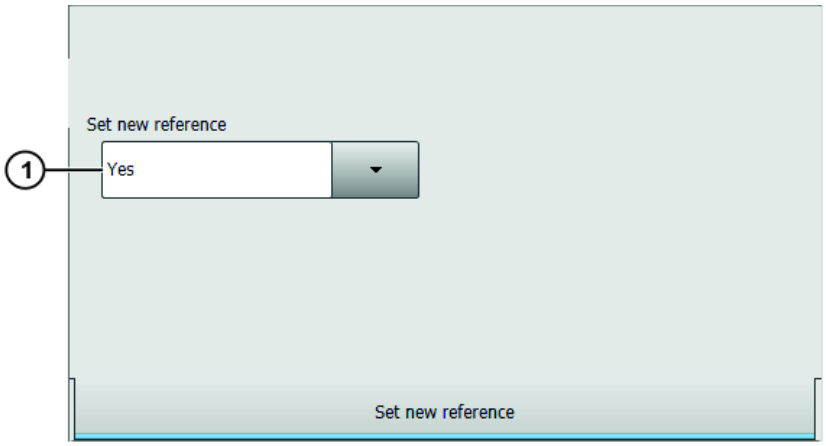


Fig. 7-3: Option window: Set new reference

Item	Description
1	Set new reference ■ **Yes**: The position of the reference workpiece is referenced again for the search. Once referencing has been carried out, this parameter is automatically set to **No** so that the referencing is not overwritten. ■ **No**: The position of the reference workpiece is not referenced again for the search.

7.3.2 Option window “Search parameter”

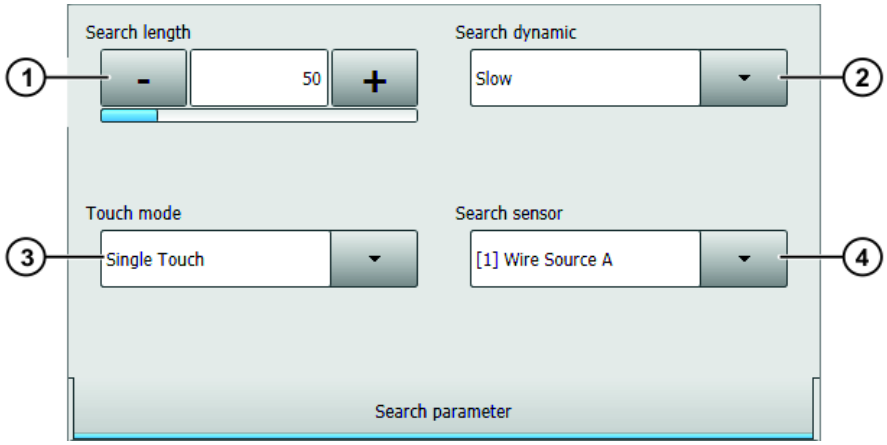


Fig. 7-4: Option window: Search parameter

Item	Description
1	Enter the search distance. ■ **5 … 250 mm** Default value: 50 mm
2	Set the velocity and acceleration for the search. ■ **Slow**, **Medium** or **Fast** The exact values can be configured on the **Search dynamic** tab. (>>> 6.1.2 ""Search dynamic” tab" Page 18)
3	Select the Touch mode. ■ **Single Touch** (>>> 2.3.1 "Single Touch mode" Page 8) ■ **Double Touch** (>>> 2.3.2 "Double Touch mode" Page 9)
4	Select the sensor to be used for the search.

NOTICE Define the Via point and search distance so there is no risk of a collision if the component is not found and the robot therefore has to cover the full length of the search distance. Damage to property may otherwise result.

The stop reaction and the position data acquisition of the robot are fastest and most accurate with a Fast Measurement input. If a standard input is used, the search velocity should not be greater than 10 mm/s.

7.4 Linked search

Description

With searches consisting of more than one search motion, there may be such a large deviation in one direction that a further search instruction no longer locates the workpiece. This can be avoided by linking searches as illustrated in the following diagrams.

Linking the searches leads to a higher hit rate and greater accuracy. The linked search is suitable for all linear offsets and slight rotations.

Example

```
...
LIN P1 TouchSense SEARCH VIA P2 CD1
LIN P3 TouchSense SEARCH VIA P4 CD2
TouchSense Corr 2D CD1 CD2
...
```

Fig. 7-5: Original position

The second search command no longer locates the workpiece:

Fig. 7-6: New position, without linked search

Remedy: Program a linked search. The second search command then takes into account the first change in position.

```
...
LIN P1 TouchSense SEARCH VIA P2 CD1
TouchSense Corr 1D CD1
LIN P3 TouchSense SEARCH VIA P4 CD2
TouchSense Corr 2D CD1 CD2
...
```

Fig. 7-7: New position and linked search

7.4.1 Example of a linked search: searching for the position of a single-V butt weld

Description

A single-V butt weld may be subject to a linear offset in 2 directions:

- Horizontally to the right or left
- Vertically up or down

In order to determine the position of the single-V butt weld, a linked search is carried out, combining a search in Single Touch mode with a search in Double Touch mode.

1. Single Touch: search for the upper edge of the weld
2. Double Touch: search for the center of the weld

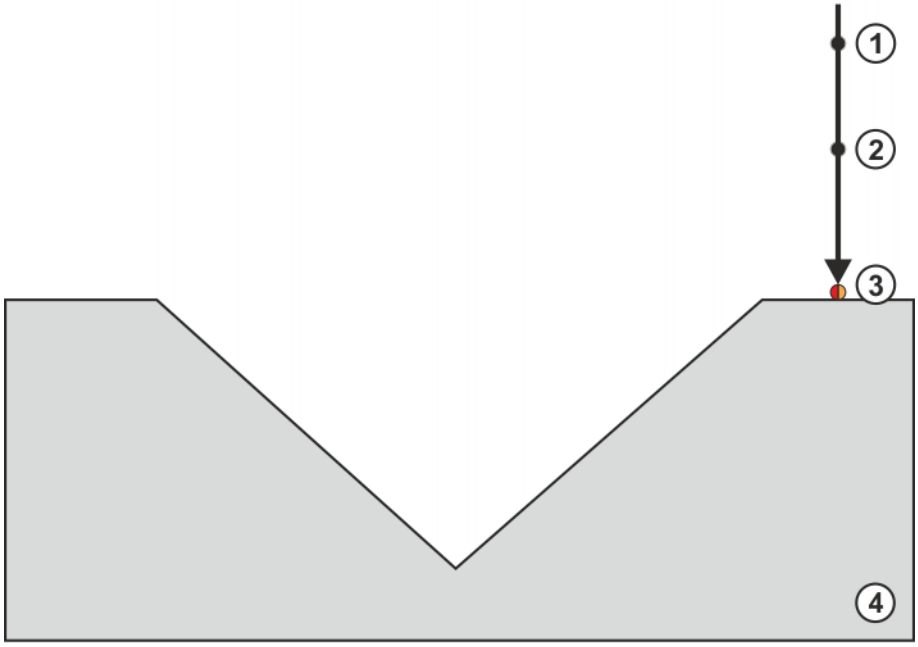


Fig. 7-8: Search for upper edge of weld, Single Touch

Item	Description
1	Start point P1 of the search
2	Via point P2 of the search: determines the search direction
3	Touch position: upper edge of the weld
4	Workpiece

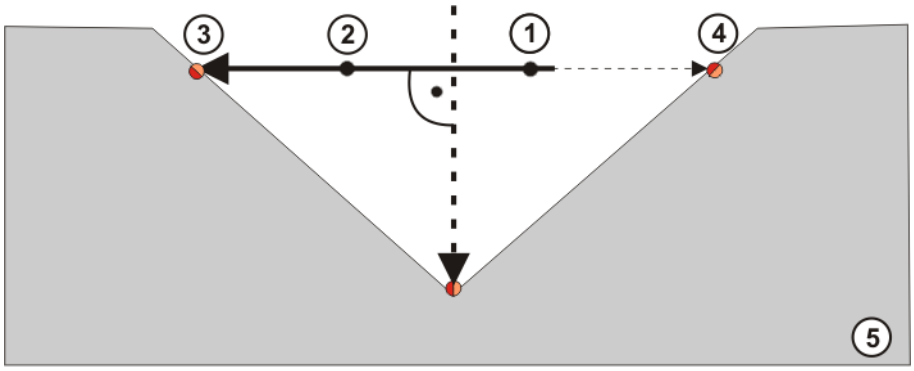


Fig. 7-9: Search for center of weld, Double Touch

Item	Description
1	Start point P3 of the search
2	Via point P4 of the search: the search direction must be programmed so that it is perpendicular to the upper edge of the weld.
3	Touch position 1: from this point, the search motion is started in the opposite direction.
4	Touch position 2
5	Workpiece

Example

```
1  ...
2  LIN P3 TouchSense SEARCH VIA P4 CD1
3  TouchSense Corr 1D CD1
4  LIN P1 TouchSense SEARCH VIA P2 CD2
5  TouchSense Corr 2D CD1 CD2
6  ...
```

Line	Description
2	Search instruction for determining the center of the weld (Double Touch)
3	Correction instruction **1 dimensional**: Correction of the horizontal offset of the weld
4	Search instruction for determining the upper edge of the weld (Single Touch)
5	Correction instruction **2 dimensional**: Correction of the horizontal offset of the weld, linked to correction of the vertical offset of the weld
6 …	Weld program

7.5 Programming a correction instruction

NOTICE If the workpieces are possibly inclined and/or rotated in relation to the reference workpiece, the correction instruction **Corr Free** must be used. The correction instructions **Corr 1D**, **Corr 2D** and **Corr 3D** can only be used to determine or correct linear offsets and not rotations or inclinations.

7.5.1 Inline form “Corr” (1-dimensional)

Description

This correction instruction is used if the workpiece has a linear offset in **one** direction:

- Length
- Width
- or height

A correction instruction overwrites the data of a previous correction instruction.

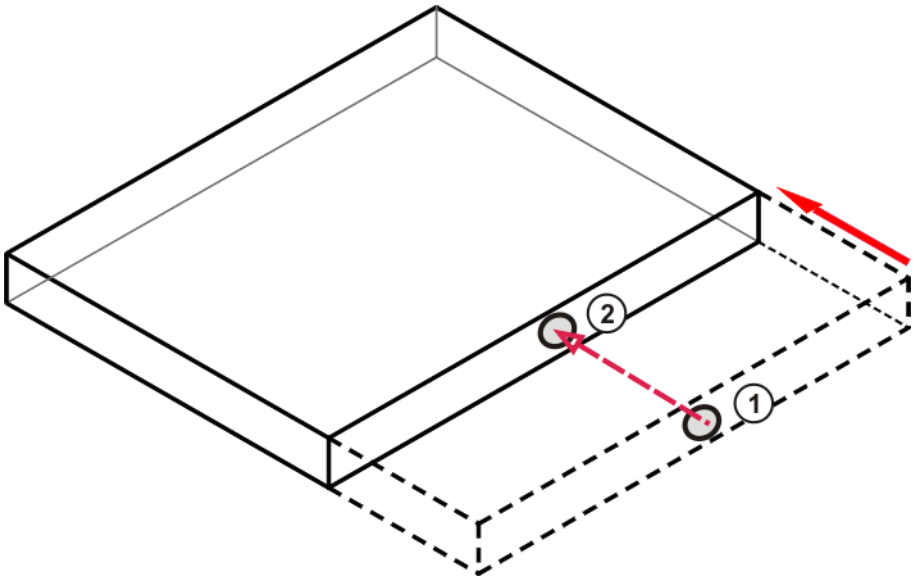


Fig. 7-10: Example: 1-dimensional offset

1 Original position 2 Offset position

Precondition

- All search instructions have been programmed.

Procedure

1. Select the menu sequence **Commands** > **TouchSense** > **Correction**.
2. Select **1D** in the inline form.

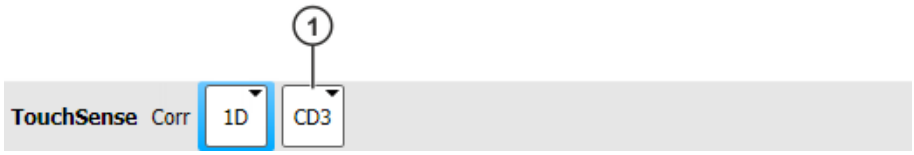


Fig. 7-11: Inline form: Corr (1D)

Item	Description
1	Enter the correction data set. All correction data sets created in the current program can be entered.

7.5.2 Inline form “Corr” (2-dimensional)

Description

This correction instruction is used if the workpiece has a linear offset in **two** directions:

- Length
- Width
- or height

A correction instruction overwrites the data of a previous correction instruction. The following example is valid for an unlinked search.

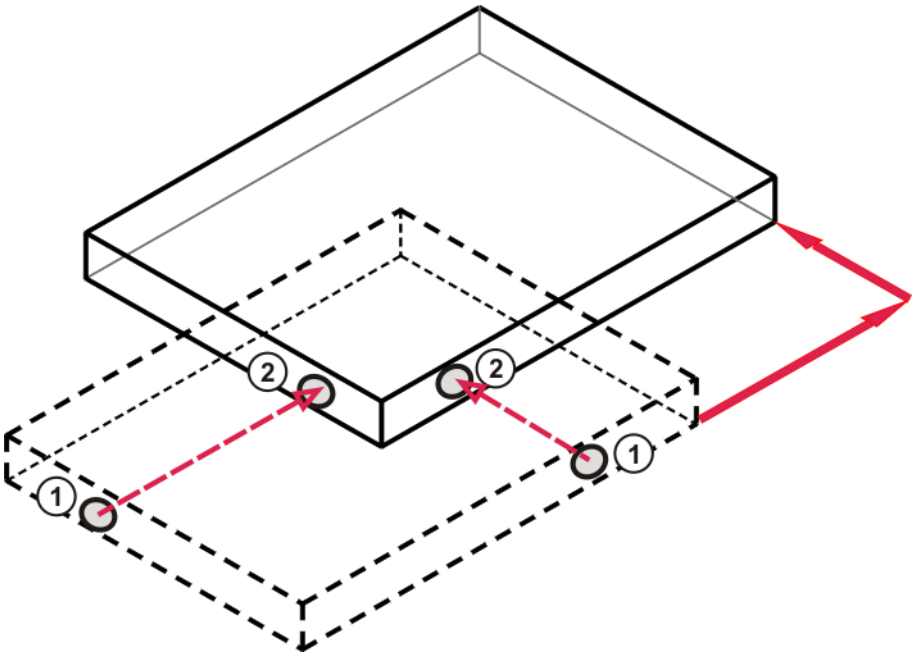


Fig. 7-12: Example: 2-dimensional offset

1 Original position 2 Offset position

Precondition

- All search instructions have been programmed.

Procedure

1. Select the menu sequence **Commands** > **TouchSense** > **Correction**.
2. Select **2D** in the inline form.

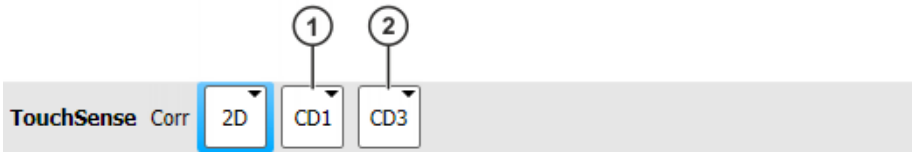


Fig. 7-13: Inline form: Corr (2D)

Item	Description
1, 2	Enter the correction data set. All correction data sets created in the current program can be entered.

7.5.3 Inline form “Corr” (3-dimensional)

Description

This correction instruction is used if the workpiece has a linear offset in **all** directions:

- Length
- Width
- and height

A correction instruction overwrites the data of a previous correction instruction. The following example is valid for an unlinked search.

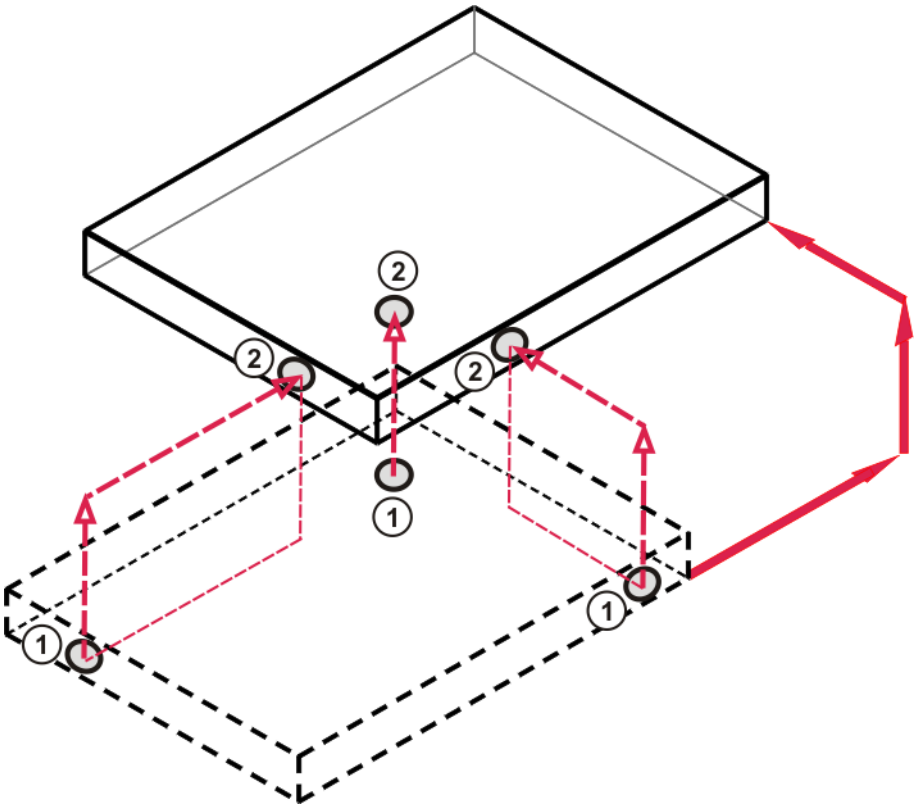


Fig. 7-14: Example: 3-dimensional offset

1 Original position 2 Offset position

Precondition

- All search instructions have been programmed.

Procedure

1. Select the menu sequence **Commands** > **TouchSense** > **Correction**.
2. Select **3D** in the inline form.

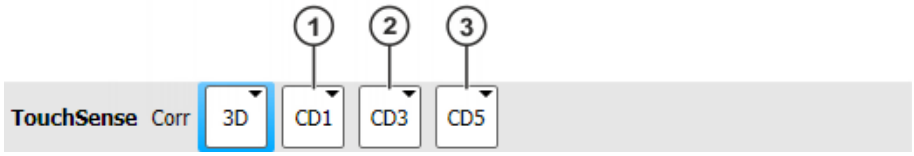


Fig. 7-15: Inline form: Corr (3D)

Item	Description
1 … 3	Enter the correction data set. All correction data sets created in the current program can be entered.

7.5.4 Inline form “Corr” (freely programmable)

Description

This correction instruction is used if the workpiece is rotated in one or more directions:

- Length
- Width
- Height

The workpiece may additionally have a linear offset in the other directions.

A correction instruction overwrites the data of a previous correction instruction.

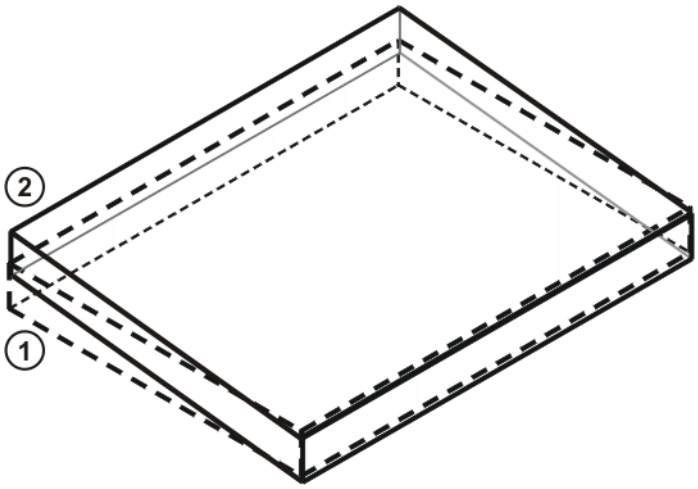


Fig. 7-16: Example: Angular offset

1 Original position 2 Offset position

Precondition

- All search instructions have been programmed.

Procedure

1. Select the menu sequence **Commands** > **TouchSense** > **Correction**.
2. Select **Free** in the inline form.

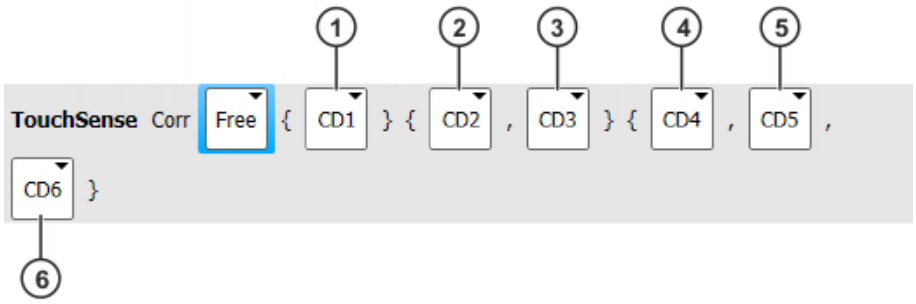


Fig. 7-17: Inline form: Corr (freely programmable)

Item	Description
1 … 6	Enter the correction data set. All correction data sets created in the current program can be entered.

7.5.4.1 Freely programmable correction – detailed explanation

Description

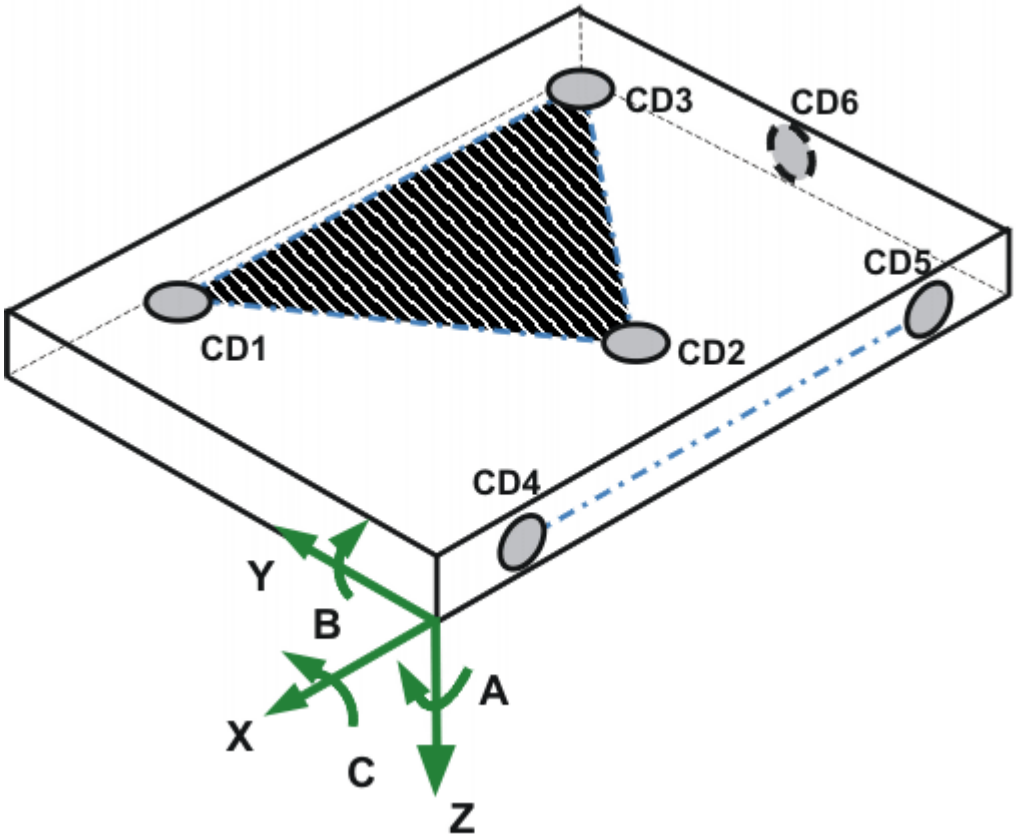


Fig. 7-18: Freely programmable correction, dimensions

- Boxes 1, 2 and 3 in the inline form define a plane between dimensions CD1, CD2 and CD3.

  The dimensions can be freely assigned to the boxes. (Dimension CD1 does not have to be entered in box 1. It could also be entered in box 2 or 3.)
- Boxes 4 and 5 in the inline form define a line between dimensions CD4 and CD5.

  The dimensions can be freely assigned to the boxes.
- Box 6 in the inline form defines the dimension CD6.

The amount of input required depends on the specific correction. If, for example, only a rotation of the surface needs to be corrected, it is only necessary to enter correction data sets in boxes 1 to 3. The default value -1 is entered in boxes 4 to 6.

Point	Description
CD1	Defines the surface.
CD2	1st rotational dimension of the surface
CD3	2nd rotational dimension of the surface
CD4	Defines the line.
CD5	1st rotational dimension of the line
CD6	Defines the offset.

Example

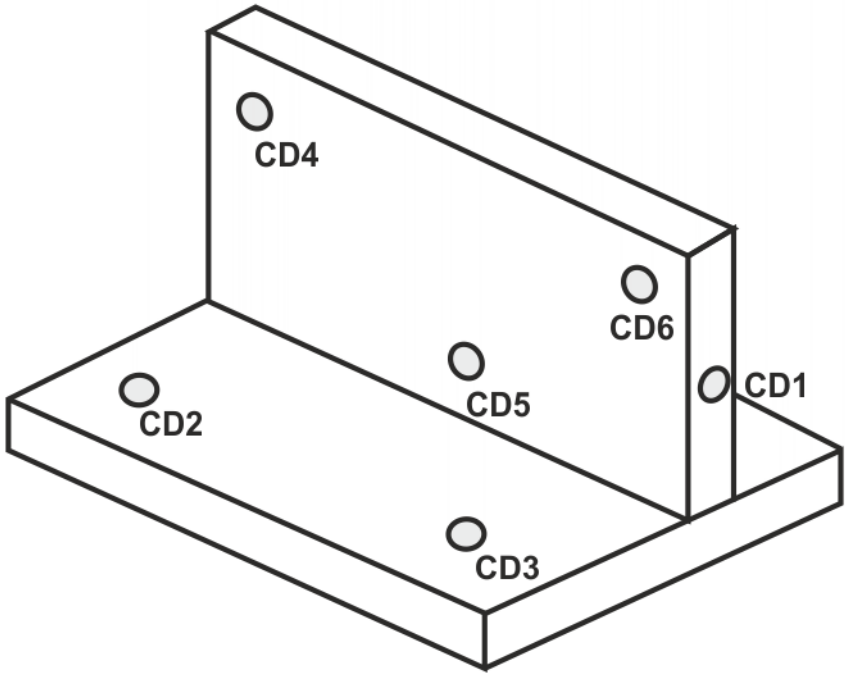


Fig. 7-19: Example: Freely programmable correction, dimensions

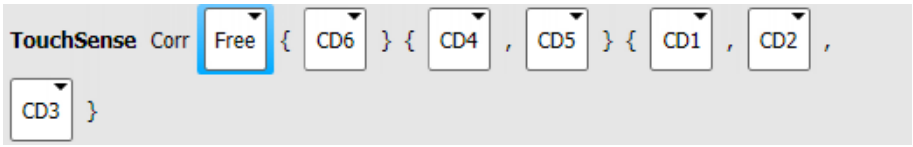


Fig. 7-20: Example: Freely programmable correction, inline form

7.5.5 Inline form “Corr Off”

Description

Each correction instruction switches the correction mode on. This instruction switches the correction mode off. This means that all following motion commands are executed without correction.

NOTICE If correction mode is switched off and the position of the workpiece does not correspond to the reference position, collisions may result.

Procedure

- Select the menu sequence **Commands** > **TouchSense** > **Switch off correction**.

Fig. 7-21: Inline form: Corr Off

7.5.6 Inline form “Check Point”

Description

This instruction checks whether a point is still within certain limits after the correction. If the limits are exceeded, a message is displayed. This enables incorrectly loaded workpieces to be detected, for example.

Recommendation: Always check corrections with the instruction **Check Point**.

The instruction **Check Point** should be programmed directly after the correction instruction. It may be inserted at any distance before the point to be checked.

The limits can be defined as a sphere about the original point, or as X, Y, Z and angle values.

Procedure

- Select the menu sequence **Commands** > **TouchSense** > **Check position correction**.

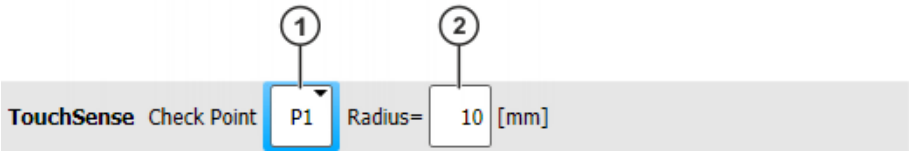


Fig. 7-22: Inline form: Check Point (Radius)

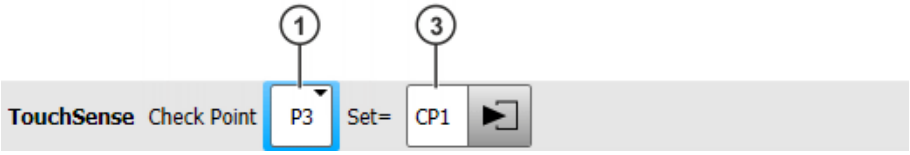


Fig. 7-23: Inline form: Check Point (Set)

The **Set** box can be displayed by pressing the **Parameter** button. The **Radius** box can be displayed by pressing the **Radius** button.

Item	Description
1	Point whose position is to be checked. All points created in the current program are available for selection.
2	The system checks whether the point is still within a sphere of this radius. ■ **0.1 … 200 mm**
3	The system checks whether the point lies within the defined limits. Name of the data set containing the limit values. The system automatically generates a name. The name can be overwritten. Touch the arrow to edit the limits. The corresponding option window is opened. (>>> 7.5.6.1 "Option window “Position evaluation criteria”" Page 35)

7.5.6.1 Option window “Position evaluation criteria”

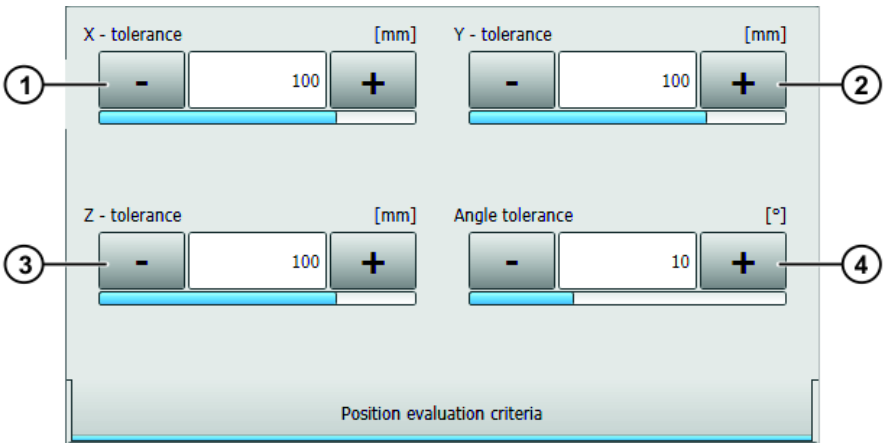


Fig. 7-24: Option window: Position evaluation criteria

Item	Description
1	Permitted deviation in the X values
2	Permitted deviation in the Y values
3	Permitted deviation in the Z values
4	Permitted deviation in the angle values

8 Example programs

8.1 Example program with 3-dimensional correction

Program

```
1   DEF Example( )
2   INI
3
4   PTP HOME  Vel= 100 % DEFAULT
5
6   PTP P1 CONT Vel=100 % PDAT1 Tool[1]:Torch1 Base[0]
7   PTP P2 CONT Vel=100 % PDAT2 Tool[1]:Torch1 Base[0]
8   LIN P3 Vel=2 m/s CPDAT1 TouchSense SEARCH VIA P4 CD1 SP1
    TOOL[1]:Torch1 BASE[1]:Table
9   PTP P5 Vel=100 % PDAT3 Tool[1]:Torch1 Base[0]
10
11  TouchSense Corr 1D CD1
12
13  TouchSense Check Point P8 Radius=3 mm
14
15  PTP P6 CONT Vel=100 % PDAT4 Tool[1]:Torch1 Base[0]
16  PTP P7 CONT Vel=100 % PDAT5 Tool[1]:Torch1 Base[0]
17  LIN P8 Vel=2 m/s CPDAT2 TouchSense SEARCH VIA P9 CD2 SP2
    Tool[1]:Torch1 BASE[1]:Table
18
19  TouchSense Corr 2D CD1 CD2
20
21  TouchSense Check Point P13 Radius=3 mm
22
23  PTP P10 Vel=100 % PDAT6 Tool[1]:Torch1 Base[0]
24  LIN P11 Vel=2 m/s CPDAT3 TouchSense SEARCH VIA P12 CD3 SP3
    Tool[1]:Torch1 BASE[1]:Table
25  PTP P13 Vel=100 % PDAT7 Tool[1]:Torch1 Base[0]
26
27  TouchSense Corr 3D CD1 CD2 CD3
28
29  TouchSense Check Point P17 Set=CP1
30  TouchSense Check Point P18 Radius=5 mm
31
32  PTP P14 CONT Vel=100 % PDAT8 Tool[1]:Torch1 Base[0]
33  LIN P15 CONT Vel=2 m/s CPDAT4 Tool[1]:Torch1 Base[0]
34  PTP P16 Vel=100 % PDAT9 Tool[1]:Torch1 Base[0]
35  LIN P17 Vel=0.2 m/s CPDAT5 Tool[1]:Torch1 Base[0]
36  LIN P18 Vel=0.2 m/s CPDAT6 Tool[1]:Torch1 Base[0]
37  PTP P19 CONT Vel= 100% PDAT10 Tool[1]:Torch1 Base[0]
38
39  PTP HOME  Vel= 100 % DEFAULT
40
41  END
```

Description

Line	Description
8	First search instruction with correction data set CD1
11	Correction instruction **1 dimensional**
13	The instruction checks that point P8 is no more than 3 mm away from the original position following the correction.
15 … 17	These motions are executed with the data from the 1-dimensional correction instruction.
17	Second search instruction with correction data set CD2
19	Correction instruction **2 dimensional**
21	The instruction checks that point P13 is no more than 3 mm away from the original position following the correction.
23 … 25	These motions are executed with the data from the 2-dimensional correction instruction.
24	Third search instruction with correction data set CD3
27	Correction instruction **3 dimensional**

Line	Description
29	The instruction checks that point P17 is within the limits defined in the **Correction set** option window.
30	The instruction checks that point P18 is no more than 5 mm away from the original position following the correction.
32 … 37	These motions are executed with the data from the 3-dimensional correction instruction.
39	The HOME position is not affected by the correction.

9 Messages

9.1 Error messages

No.	Message	Description
1003	Power source or the control of touch sensing is not ready or is off.	Remedy: ■ Check whether the weld power source or controller is switched on. ■ Or: Check the configuration of the input system and modify if necessary. ■ Or: Check “Compensation time - Relay” if readiness is coupled with the “Touch voltage” output.
1007	Calculation of the motion frame for dynamic measurements is not possible! Check the taught positions of the search motion.	Cause: The distance between the start point and the Via point is too small. Remedy: Increase the distance by reteaching the start point and/or the Via point.
1008	The motion could not be initialized, since the process state does not permit this.	Remedy: Analyze previous messages and restart program.
1011	The search will not be done, because option TouchSense is not active	Cause: TouchSense is not active. Remedy: Activate TouchSense via the status key or by means of the configuration.
1015	The measurement could not be carried out, since the process state does not permit this.	Cause: The sensor is not initialized. Remedy: Check the configuration of the sensor.
1017	Error on sensor switch-off!	Cause: The sensor is incorrectly configured. Remedy: Check the configuration of the sensor.
1018	Correction data is not set, because option TouchSense is not active	Cause: TouchSense is not active. Remedy: Activate TouchSense via the status key or by means of the configuration.
1020	Correction data cannot be calculated or set!	Cause: The interpolation mode in which the measuring instructions are executed is incorrect. Remedy: Check the interpolation mode at the start position and repeat the measurement.
1021	Correction data cannot be set, because Process state not fulfilled	Cause: The process state is not #MeasureOkSenOffMovOff. Remedy: Repeat the measurement.
1022	The correction will not be calculated, because option TouchSense is not active	Cause: TouchSense is not active. Remedy: Activate TouchSense via the status key or by means of the configuration.
1038	Function "Check Point" will not be executed, because option TouchSense is not active	Cause: TouchSense is not active. Remedy: Activate TouchSense via the status key or by means of the configuration.
1057	Process state #SenInitializedMoveNot not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1058	Process state #SensorAndMoveInitialized not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1059	Process state #SensorOn not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.

No.	Message	Description
1060	Process state #SensorOnMeas-MovementOn not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1061	Process state #SensorFound-Workpiece not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1062	Process state #ErrorSearchLimit not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1063	Process state #ErrorStopAtMeas not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1064	Process state #ErrorStopAtMeas-Movement not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1065	Process state #MeasureOkSe-nOffMovOff not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1066	Process state #SetCorrData-DoneFirstDoub not possible!	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1067	Unknown state of state machine	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1500	The via-position is the same as the start position or the distance is too short. The search, measurement will be aborted.	Cause: The start point corresponds to the Via point or the distance between the two points is too small. Remedy: Re-teach the Via point at a distance far enough away (min. 5 mm) from the start point.
1502	Search direction cannot be determined. Calculation of Start and destination position not possible!	Cause: The distance between the start point and the Via point is too small. Remedy: Increase the distance by reteaching the start point and/or the Via point.
1503	Unknown motion type on preparing search motion	Remedy: 1. Open the inline form **Search**, check the entries and close the form again with **Cmd OK**. 2. Execute the search instruction again. 3. Contact KUKA Support if the message occurs again.
1506	Unknown touch type in TSM_SearchLoop().#Single or #Double expected.	Cause: An inadmissible touch type has been used. Remedy: Check the entries in the inline form.
1508	Unknown motion type in subroutine BFM_SearchLoop(), "#MoveWithLin" expected	Remedy: Reset the program and contact KUKA Support if the message occurs again.
1509	Search vector is too short to define a search direction	Cause: The calculated search vector is too short to define a search direction. Remedy: Re-teach the Via position. Check the entries in the inline form. Check the variable “TSM_MinSearchVectorLen”.
1511 1512 1536	Start of the search not possible, because the fast input "touch signal" is already active before searching is started.	Cause: ■ The welding wire is touching the component. ■ Or: The switching level of the touch input is incorrectly set. Remedy: ■ Move the robot so that the welding wire is no longer touching the component. ■ Or: Set the switching level of the touch input differently.

No.	Message	Description
1514 1515 1537	Start of the search not possible, because the standard input "touch signal" is already active before searching is started.	Cause: ■ The welding wire is touching the component. ■ Or: The switching level of the touch input is incorrectly set. Remedy: ■ Move the robot so that the welding wire is no longer touching the component. ■ Or: Set the switching level of the touch input differently.
1519	Unknown touch type in TSM_SearchLoopCP(). "#Single", "#FirstDouble" oder "#SecondDouble" expected.	Cause: An inadmissible touch type has been used. Remedy: Check the entries in the inline form.
1526	Calculated target position reached but workpiece not recognized	Cause: The complete search distance was covered without the workpiece being detected. Many possible reasons, including: The workpiece is located outside the search window of the sensor. Or fouling in the field of view of the sensor. Remedy: Depends on the reason, for example: Reprogram the search with a longer search path.
2000	The selected sensor is Null	Cause: There is no valid sensor selected. Remedy: Check the selection of the sensor in the inline form and the configuration of the sensor.
2001	The selected sensor is not configured	Cause: A sensor that is not configured has been selected in the inline form. Remedy: Either configure the selected sensor or select a configured sensor in the inline form.
2002	Input for "Touch signal" exceeds the system input range.	Cause: The value for the touch signal input is greater than the number of inputs. Remedy: Enter a value for the touch signal input that is lower than the number of inputs.
2500	No correction is calculated. Individual data sets are incorrectly preset.	Cause: For some CD*x* either no measurement or no successful measurement has been performed. Remedy: Repeat all the measurements.
2501	No correction calculated. Correction data set type mismatch.	Cause: The CD*x* originate from measuring instructions that are executed partly with interpolation mode = TRUE and partly with FALSE. This mixture is not permissible. Remedy: Execute all measuring instructions in the same mode. (The interpolation mode is defined in the **Frames** option window.)

No.	Message	Description
2530	Calculation of normalized vector cross product from [Y] or [Y-A.1] is not possible!	Cause: ■ Unsuitable CD*x* were selected in the correction instruction. The required values cannot be calculated from them. ■ Or: CD*x* were selected in the correction instruction whose directions meet at an angle of 90°. Remedy: ■ Check the correction instruction and select suitable CD*x*. ■ Or: Repeat the measurements, altering the angle of the sensor slightly between measurements.
2541	The current interpolation mode (TCP) differs from IPO mode of measurement data. A mixture is not allowed and can not be calculated.	Cause: The interpolation mode in which the measuring instructions were executed differs from the current interpolation mode. This mixture is not permissible. Remedy: Change the modes so that they match. The current interpolation mode can be changed using the system variable $TCP_IPO.
2542	No frame correction can be calculated with the current coordinate system ($ACT_TOOL smaller 0).	Initial situation: The sensor is defined as a fixed tool (= BASE), the workpiece is moving (= TOOL). Cause: Before the correction instruction a motion must have been carried out with the moving workpiece. This is not the case. Therefore the robot controller cannot determine the current TOOL. Remedy: Program a motion with the workpiece before the correction instruction.
2543	Current interpolation mode (BASE) differs from IPO mode of measurement data. A mixture is not allowed and can not be calculated.	Cause: The interpolation mode in which the measuring instructions were executed differs from the current interpolation mode. This mixture is not permissible. Remedy: Change the modes so that they match. The current interpolation mode can be changed using the system variable $TCP_IPO.

10 KUKA Service

10.1 Requesting support

Introduction

The KUKA Roboter GmbH documentation offers information on operation 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 applicable)
- Model and serial number of the energy supply system (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software
- Application used
- Any external axes used (if applicable)
- Description of the problem, duration and frequency of the fault

10.2 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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