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Overview of SCARA robots with the linear axis on the flange

ID	Scara_LinearAxisFlange
Type	Basic transformation
License	SWL-XCx-MOT-KINxLEVEL2xxx-NNNN
Required axes	2 (rotary axes) Additionally optional: 1 (rotary axis) + 1 (linear axis)
Compatible with orientation transformations	No

Overview of SCARA robots with the linear axis at the base

ID	Scara_LinearAxisBase
Type	Basic transformation
License	SWL-XCx-MOT-KINxLEVEL2xxx-NNNN
Required axes	2 (rotary axes) Additionally optional: 1 (rotary axis) + 1 (linear axis)
Compatible with orientation transformations	No

Robot structure

The SCARA robot basically consists of two rotary axes Red1 and Red2 around the Z-axis (also known as joints), which

enable the end effector to be positioned in the XY plane. In addition, a SCARA can optionally have two more axes: A linear axis Lin1 for moving along the Z-axis and an orientation axis Rot3 for achieving a specific rotation of the end effector around the Z-axis. The zero position of a SCARA robot depends on the specified height offset on the linear axis.

Variant

The control provides two different variants of the SCARA, which differ in the arrangement of the linear axis:

- Linear axis for flange (see ↘ Table 19: “Overview of SCARA robots with the linear axis on the flange” and Fig. 77)
- Linear axis at the base (see ↘ Table 20: “Overview of SCARA robots with the linear axis at the base ” and Fig. 78)

Fig. 77: SCARA robot with the linear axis on the flange in the zero position

Fig. 78: SCARA robot with the linear axis at the base in the zero position

Robot parameters

In order for the axis transformation to calculate correctly, information about the distances between the joints and between the joints and the flange is required. These parameters have to be specified when creating the axis transformation.

Fig. 79: Configuration parameters of the SCARA robot with the linear axis on the flange

Fig. 80: Configuration parameters of the SCARA robot with the linear axis at the base

The following table describes the possible parameters of a SCARA. The parameters l1 and l2 are always required and have to be positive. The Z-values l3 to l5 are optional and describe the possible height offsets in the superstructure. The height values always have to be specified in the zero position of all axes.

Parameters	Description	Condition
l1	The length of the connection between Red1 and Red2	l1 > 0
l2	The length of the connection between Rot2 and the flange	l2 > 0
l3	The height difference between the base and the first arm	
l4	The height difference between the first and second arm	
l5	The height difference from the second arm to the flange	

If the axis Lin1 is defined, but the parameters l3, l4 and l5 are not specified, the offset in the z-direction between the base and flange is zero, as can be seen in the following images.

Fig. 81: SCARA robot without configured height parameters (variant: linear axis on the flange)

Fig. 82: SCARA robot without configured height parameters (variant: linear axis at the base)

Singularities of a SCARA robot

There is only one type of singularity in a SCARA robot. This singularity occurs when the joint Rot2 is at 0°, i.e. the robot arm is fully extended. In this position, the end effector lies on the extension of the connection between Rot1 and Rot2 and the robot is at the edge of the workspace, which means it loses one degree of freedom. To move the end effector in the direction of the base, a significant movement of the two axes is first required.

Fig. 83: Singularity of the SCARA robot

Solution selection

Normally, a SCARA robot has two possible solutions to reach a desired position in Cartesian space. Both solutions differ in the positioning of the elbow joint, i.e. the rotational axis Rot2.

Fig. 84: The two solutions of the SCARA robot for a given Cartesian position

In this case, the transformation function determines the optimum solution based on the current axis positions or an additionally specified position. The transformation attempts to avoid changing the solution branch and not to traverse through the singularity. If the start position or the additionally specified position is in or near a singularity, the solution closest to this position is selected. However, there may also be positions that the robot can only reach with one solution or not at all due to axis limitations.

For the SCARA with the linear axis at the base, the singularities are identical.