SIEMENS

SINUMERIK 840D sl - OEM

Kinematic Transformation Configuration Questions

Configuration Manual

Valid for

Control
SINUMERIK 840D sl
SINUMERIK 840DE sl (export variant)

Drive
SINAMICS S120

Software *Version*

10/2008

SINUMERIK® Documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the "Remarks" columns.

Status code in the "Remarks" column:

A .... New documentation.
B .... Unrevised reprint with new Order No.
C .... Revised edition with new version.

Edition	Order No.	Remarks
10/2008	---	**A**

Registered trademarks

Disclaimer of liability

Preface

SINUMERIK documentation

SINUMERIK documentation is organized in three parts:

- General documentation
- User documentation
- Manufacturer/Service documentation

An overview of publications (updated monthly) indicating the language versions available can be found on the Internet at:

http://www.siemens.com/motioncontrol
Follow menu items "Support" → "Technical Documentation" → "Ordering Documentation" →"Printed Documentation".

The Internet version of the DOConCD (DOConWEB) is available at:
http://www.automation.siemens.com/doconweb

Information about training courses and FAQs (Frequently Asked Questions) can be found at the following web site:

http://www.siemens.com/motioncontrol under menu option "Support"

Reader group

This manual is intended for programmers and service/operating personnel.

Standard version

This Configuration Manual only describes the functionality of the standard version. Extensions or changes made by the machine tool manufacturer are documented by the machine tool manufacturer.
Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

Further, for the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation or maintenance.

Technical support

If you have any questions, please get in touch with our Hotline:

	Europe / Africa
Phone	+49 180 5050 - 222
Fax	+49 180 5050 - 223
Internet	http://www.siemens.de/automation/support-request

	America
Phone	+1 423 262 2522
Fax	+1 423 262 2289
E-mail	mailto:techsupport.sea@siemens.com

	Asia / Australia	
Phone	+86 1064 719 990	
Fax	+86 1064 747 474	
E-mail	mailto:adsupport.asia@siemens.com	

Note

Country telephone numbers for technical support are provided under the following Internet address:

http://www.siemens.com/automation/service&support

Calls are subject to charge, e.g. € 0.14/min on the German landline network. Tariffs of other hone providers may differ.

Questions about the documentation

If you have any queries (suggestions, corrections) in relation to this documentation, please fax or e-mail us:

Fax	+49 9131 98 - 2176
E-mail	mailto:docu.motioncontrol@siemens.com

Fax form: See the reply form at the end of the document.

SINUMERIK Internet address

http://www.siemens.com/sinumerik

Safety information

This manual contains notices that you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. Notices referring to your personal safety are highlighted in the manual by a safety alert symbol; notices referring to property damage only have no safety alert symbol. The warnings are shown below in decreasing order of danger.

Danger

Indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury or in substantial property damage.

Warning

Indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury or in substantial property damage.

Caution

Used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury or in property damage.

Caution

Used without safety alert symbol indicates a potentially hazardous situation which, if not avoided, **may** result in property damage.

Notice

Used without the safety alert symbol indicates a potential situation which, if not avoided, **may** result in an undesirable result or state.

If several hazards of different degrees occur, the hazard with the highest degree must always be given priority. If a warning note with a warning triangle warns of personal injury, the same warning note can also contain a warning of material damage.

Qualified personnel

Start-up and operation of the device/system in question must only be performed using this documentation. The device/system must only be started and operated by **qualified personnel**. Qualified personnel as referred to in the safety guidelines in this documentation are those who are authorized to start up, ground and label units, systems and circuits in accordance with the relevant safety standards.

Correct usage of Siemens products

Note the following:

Warning

Siemens products may be used only for the applications described in the catalog or the technical description, and only in combination with the equipment, components and devices of other manufacturers where recommended or permitted by Siemens. This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

Additional notes

Note

This symbol always appears in this documentation to draw your attention to further information relevant to the subject in hand.

Machine manufacturer

This symbol always appears in this documentation if the machine manufacturer can influence or modify the described function behavior.
Please note the specifications of the machine manufacturer!

■

Table of Contents

1

1 Configuration Questions

Customer

Name	
Address	
Telephone	
Machine type	

(These details are used as transformation designation.)

Contact (support person for the robot design)	
Telephone	
E-mail	

Recipient

The responsible Siemens employee

Software version

The coordinate transformation to be created should be integrated in the following software version (please mark with a cross):

☐ The OEM version of the SINUMERIK 840D sl current at the completion date

☐ In the previously delivered OEM version _____ of the SINUMERIK 840D sl

Note

To simplify the correct answering of the questionnaire, the Appendix contains fully completed examples for an articulated-arm robot, a SCARA robot and a gantry robot.

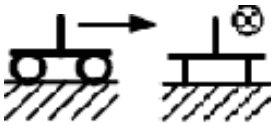
1.1 Machine details

1.1.1 Kinematic equivalent diagram of the robot

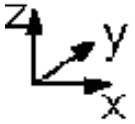
Produce for the robot, including the additional axes or the external axes, a schematic equivalent diagram of the front view. This diagram must clearly show the kinematics. If this is not possible, also provide the side view.

Observe the following notes when you create the kinematic equivalent diagram:

1. Use VDI 2861 symbols to represent the individual joints (as shown below).

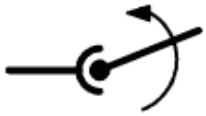


Left traversing axis: In the plane of projection
Right: Perpendicular to the plane of projection
(offset joint)

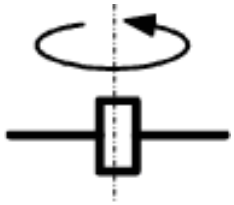


Translation joint, misaligned
(offset joint)

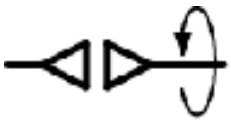
Translation joint, aligned / telescope
(offset joint)



Rotation axis, misaligned / folding axis about y
(folding joint)



Rotation axis, misaligned / folding axis about z
(folding joint)

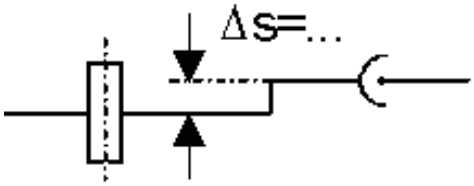


Rotation axis, aligned
(swivel joint)

Flange for fastening the tool

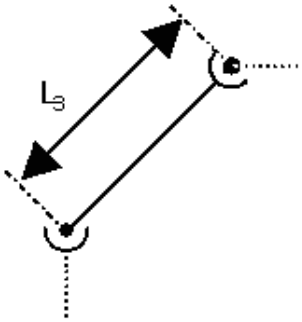
Tool

2. Take account of any offsets between the individual joints of the manual axes.
   The offsets as shown in the following example must be specified in the kinematic equivalent diagram:



3. Enter the lengths L1, L2 ... (as specified in Section 1.2).

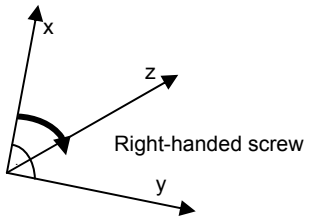
   Example:



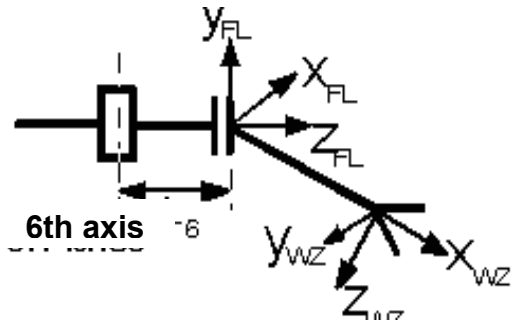
4. Draw the flange for the tool. Also enter the flange coordinate system and specify the separation L6 to the manual point or to the center of rotation of the last axis.
   The tool coordinate system is specified in the flange coordinate system. Except for the following restrictions, the flange coordinate system can be freely selected for the SINUMERIK 840D sl:
   - For a four-axis machine, the x flange coordinate system must be parallel to the fourth axis.
   - For a five-axis machine, the x flange coordinate system may not be parallel to the fifth axis.

   Note that the coordinate systems in the SINUMERIK 840D sl are always right-handed systems.

The rotation of the positive x-axis after the positive y-axis subject to the simultaneous offset in positive z-axis represents a right-handed screw.



Example:



Enter here the front view of the robot.

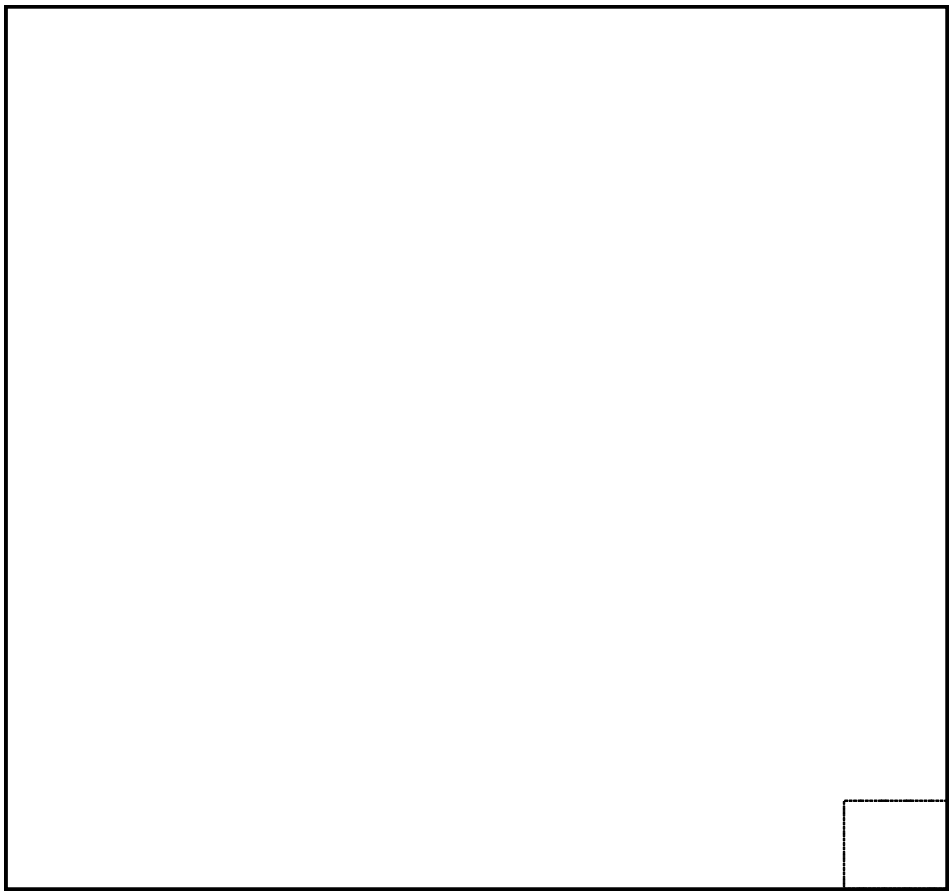


Figure 1-1: Kinematic equivalent diagram of the robot from the **front**
Lower right figure element: Details of the directions of the coordinate system in the robot base point

Between which joints do offsets occur? (please mark with a cross)

	yes	no
Offset between axis 1 and axis 2	☐	☐
Offset between axis 2 and axis 3	☐	☐
Offset between axis 3 and axis 4	☐	☐
Offset between axis 4 and axis 5	☐	☐
Offset between axis 5 and axis 6	☐	☐

If necessary, enter here the side view of the machine.

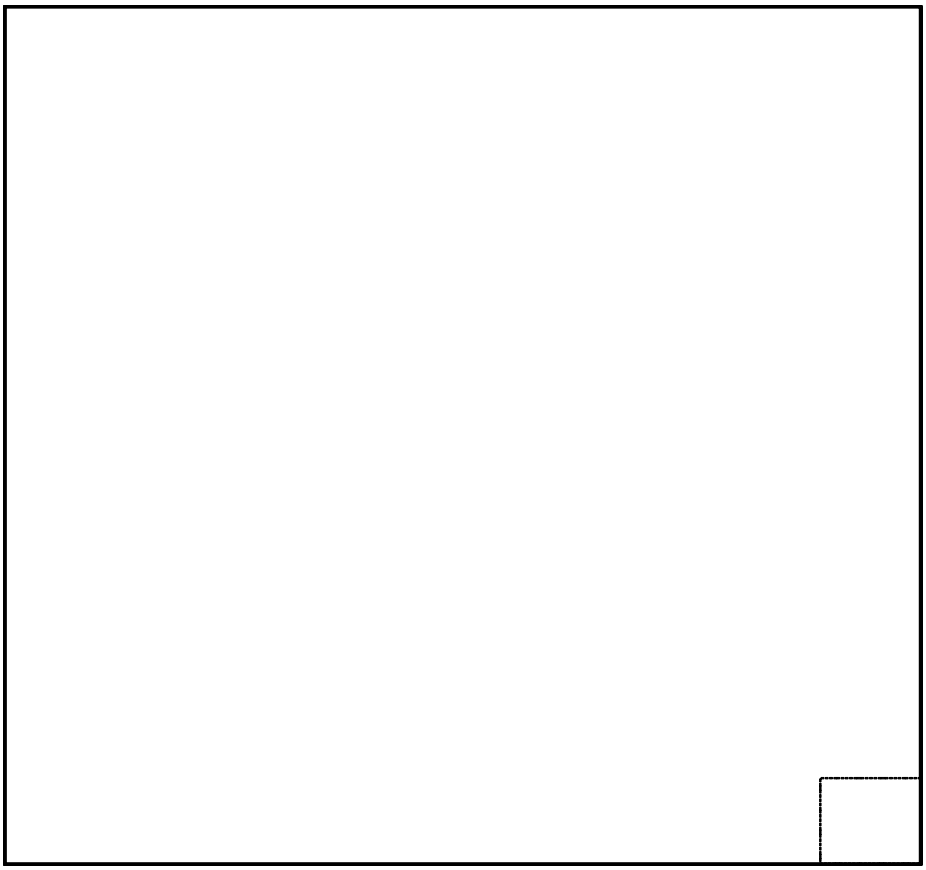


Figure 1-2: Kinematic equivalent diagram of the robot from the **side**
Lower right figure element: Details of the directions of the coordinate system in the robot base point

1.2 Robot arm lengths

Specify the arm lengths between the individual kinematic elements.

L_1: _____ [mm]
L_2: _____ [mm]
L_3: _____ [mm]
L_4: _____ [mm]
L_5: _____ [mm]
L_6: _____ [mm]
L_7: _____ [mm]
L_8: _____ [mm]

Important

Enter the designations of the arm lengths also in the kinematic equivalent diagrams Figure 1-1 and Figure 1-2. If the details are incomplete, there is the danger that the coordinate transformation is incorrectly configured and so cause additional costs.

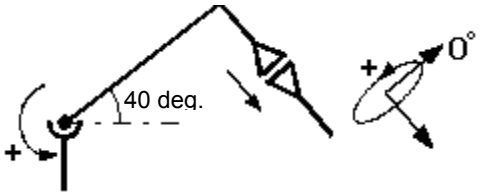
Note

Intentional changes of arm lengths (e.g. other model variants) can also be specified in parentheses here.
To the extent possible, these length details are also used for creating the coordinate transformation or the machine data.
If after completion of the transformation, additional arm lengths and offsets are used, this will cause additional efforts.

1.3 Maximum traversing range of the axes (starting from the mechanical zero position)

The definition of the maximum axis traversing ranges is based on the mechanical zero position of the machine.
Please enter the mechanical zero position with angle specifications in the following frame.
The length of the spindle s ( ) at the adjustment point must be specified for spindle drives.
Also specify the positive direction of the axis traversing range of the individual axes. This definition applies for the axis-specific traversing in JOG mode.

Example:



For swivel joints, to uniquely specify the axis rotation, also specify the direction of the vector used for the rotation (corresponding to a right-handed screw).

This is the front view ☐ Side view ☐

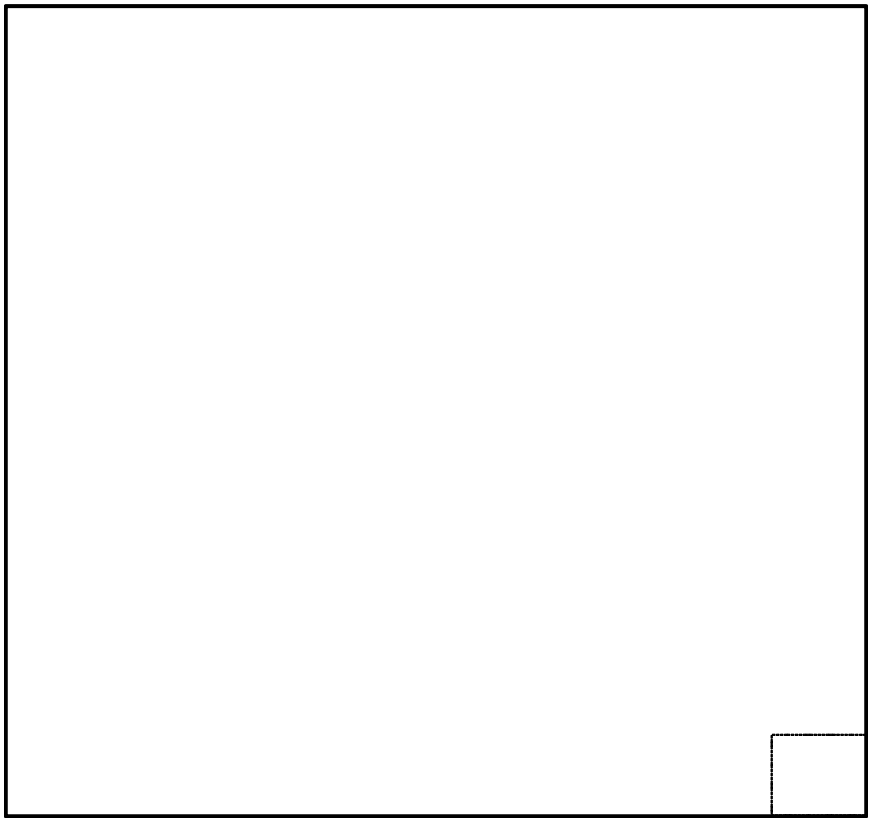


Figure 1-3: Mechanical zero position of the robot and axis traversing direction
Lower right figure element: Details of the directions of the coordinate system in the robot base point.

Now enter, starting from the mechanical zero position specified above, for translatory axes, the maximum traversing range (length), and for rotary axes, the maximum rotational angle in both directions.

	Maximum negative traversing range		Maximum positive traversing range
Traversing range axis 1:	_____	to	_____
Traversing range axis 2:	_____	to	_____
Traversing range axis 3:	_____	to	_____
Traversing range axis 4:	_____	to	_____
Traversing range axis 5:	_____	to	_____
Traversing range axis 6:	_____	to	_____
Traversing range ext. axis 1:	_____	to	_____
Traversing range ext. axis 2:	_____	to	_____
Traversing range ext. axis 3:	_____	to	_____

...
...
...

For example:
Traversing range axis 1 : -5.00 m to + 5.00 m (translatory axis)
Traversing range axis 2 : -180 ° to + -180 ° (rotary axis)

1.4 Axis drive type

Drive types for which the motor rotation is transferred linear to the axes via gearboxes and for which possible linear couplings to other axes can result, do not require any special handling with regard to the transformation.
Is the relationship between motor speed and axis movement (mm or degree) linear?

Please mark with a cross

	yes	no
Axis 1	☐	☐
Axis 2	☐	☐
Axis 3	☐	☐
Axis 4	☐	☐
Axis 5	☐	☐
Axis 6	☐	☐

Important

In case of a non-linear relationship, we require exact details about the type of the drive.

In the transformation, spindles in triangular arrangement and trapezoid connections are provided for such drives and couplings.

Note for spindles

A spindle consists of a variable length s and two legs of the length g or h. With the help of the spindle s, the angle α enclosed by g and h is set.
α then transfers itself using mechanical levers to the axis angle β.

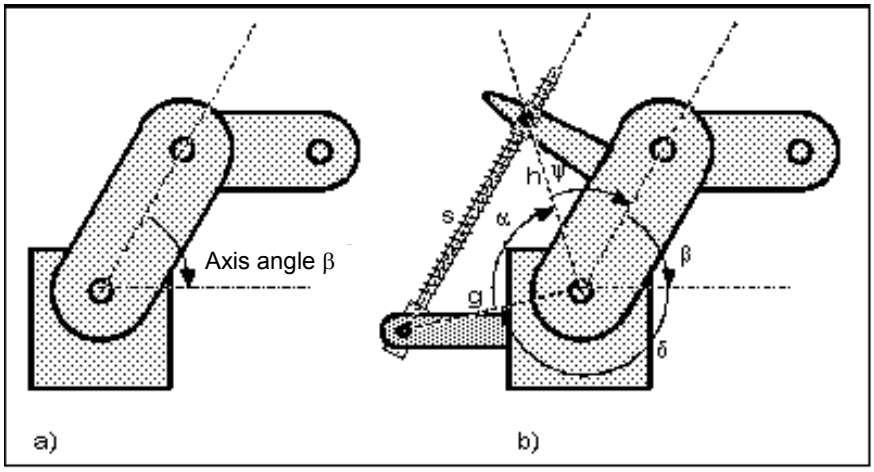


Figure 1-4: Spindle drive

For the configuration specify:
Axis number: _____
Leg length g: _____
Leg length h: _____
Angle α: _____
Angle β: _____

The angles α and β are specified for a specific position, e.g. the zero position.

If a spindle drive is combined with a trapezoid connection, we also require the lengths A, B, C and D and the angles θ and γ, preferably at the zero position, as the following figure shows.

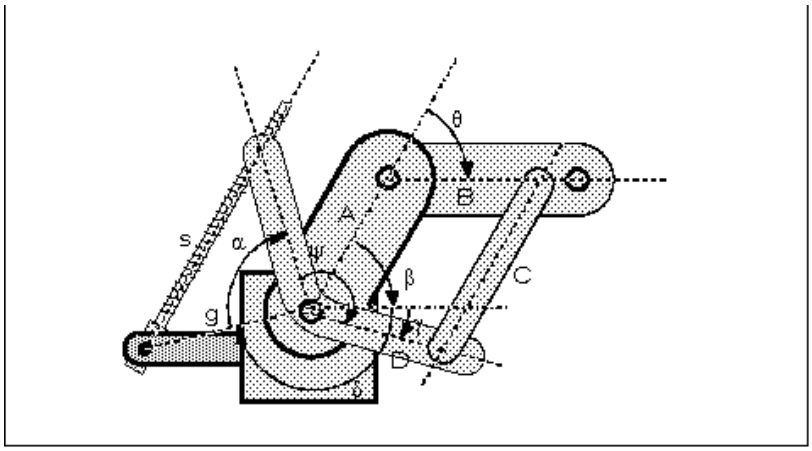


Figure 1-5: Trapezoidal connection

Length A: _____
Length B: _____
Length C: _____
Angle θ: _____
Angle γ: _____

1.5 Mechanical axis couplings

Depending on the construction, a machine may have mechanical axis couplings. If axis M is traversed through an angle a_m, axis couplings may also change the position of another axis N (by an angle of a_n), without the motor of axis N moving (angle encoder of axis N does not record a change).
If such mechanical axis couplings are present, please enter them in the following table.
The coupling factor to be specified results from the angular ratio of the coupled axis to the traversed axis:

$$\textbf{Coupling factor} = \frac{\Delta a_n}{\Delta a_m}$$

Δa_m : Angular change of the traversed axis
Δa_n : Angular change of the coupled axis

Traversed axis (axis number)	Coupled axis (axis number)	Coupling factor

Example:
When the axis 4 is traversed by + 90°, the axis 5 is also moved by - 45°. This results in a coupling factor between the axes 4 and 5 of

$$\frac{-45°}{90°} = -0{,}5$$

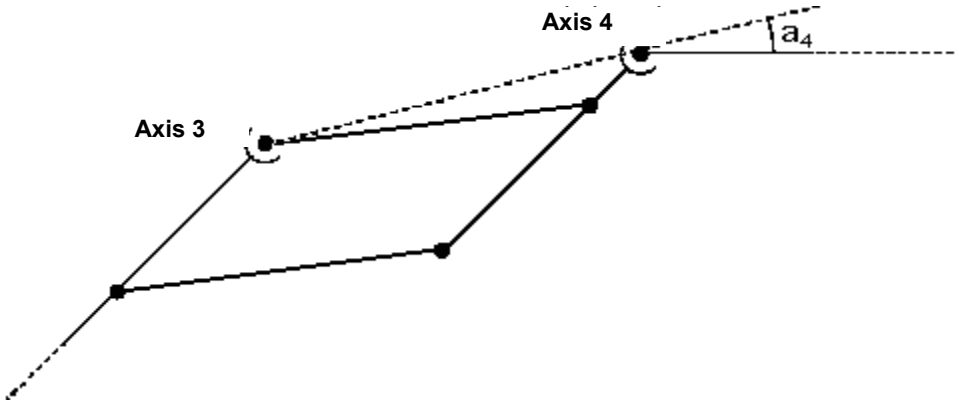
! Important

The coupling factor specified in the above table must be equal for every position of the traversed axis and the coupled axis (linear)!
Non-linear couplings require a separate explanation.

1.6 Forcibly coupled axes

If, for an articulated-arm robot, the movement of an axis by struts causes the angular position of another axis to change, this axis is called "forcibly coupled".

Example:
A parallelogram construction causes a robot arm to always remain in the same direction despite the movement of an axis.



If the axis 3 is moved, the robot arm behind axis 4 always remains horizontal (a_4 changes).

Please mark with a cross

☐ The robot kinematics does not have any forcibly coupled axes

☐ Forcibly coupled axes exist

! Important

In case of forcibly coupled axes, we always require a technical drawing of the robot with dimensioned struts.

1.7 Addition

Add to the completed questionnaire a technical drawing of the robot. If available, also provide an additional figure.

■

A

A Appendix

(to be retained by the customer)

Examples with details for the following robots follow:

- Articulated robot
- SCARA robot
- Gantry robot

A.1 Articulated Robot Details

A.1.1 Kinematic equivalent diagram of the robot

Produce for the robot, including the additional axes or the external axes, a schematic equivalent diagram of the front view. This diagram must clearly show the kinematics. If this is not possible, also provide the side view.

Enter here the front view of the robot:

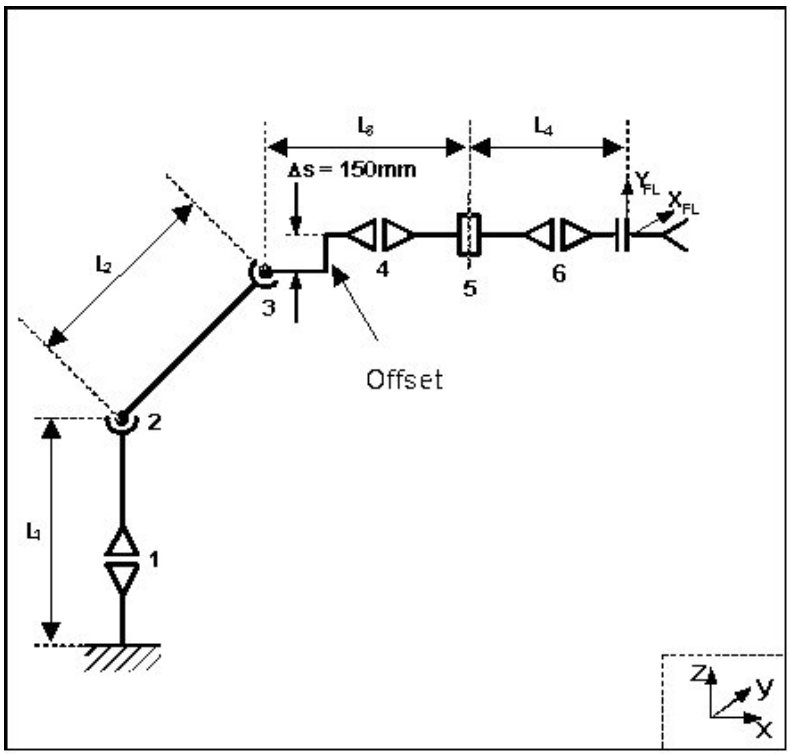


Figure A-1: Kinematic equivalent diagram of the robot from the front
Lower right figure element: Details of the directions of the coordinate system in the robot base point.

Between which joints do offsets occur? (Please mark with a cross)

	yes	no
Offset between axis 1 and axis 2	☐	☒
Offset between axis 2 and axis 3	☐	☒
Offset between axis 3 and axis 4	☒	☐
Offset between axis 4 and axis 5	☐	☒
Offset between axis 5 and axis 6	☐	☒

A.1.2 Robot arm lengths

Specify the arm lengths between the individual kinematic elements.

L_1:	1158	[mm]
L_2:	972	[mm]
L_3:	623	[mm]
L_4:	442	[mm]
L_5:		[mm]
L_6:		[mm]
L_7:		[mm]
L_8:		[mm]

Important

Enter the designations of the arm lengths also in the kinematic equivalent diagrams Figure A-1. If the details are incomplete, there is the danger that the coordinate transformation is incorrectly configured and so cause additional costs.

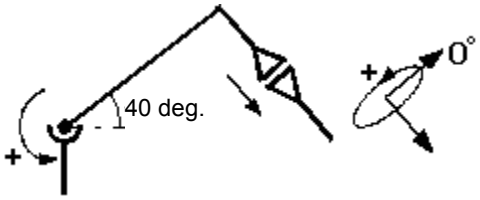
Note

Intentional changes of arm lengths (e.g. other model variants) can also be specified in parentheses here.
To the extent possible, these length details are also used for creating the coordinate transformation or the machine data.
If after completion of the transformation, additional arm lengths and offsets are used, this will cause additional efforts.

A.1.3 Maximum traversing range of the axes (starting from the mechanical zero position)

The definition of the maximum axis traversing ranges is based on the mechanical zero position of the machine.
Please enter the mechanical zero position with angle specifications in the following frame.
The length of the spindle s ( ) at the adjustment point must be specified for spindle drives.
Also specify the positive direction of the axis traversing range of the individual axes. This definition applies for the axis-specific traversing in JOG mode.

Example:



For swivel joints, to uniquely specify the axis rotation, also specify the direction of the vector used for the rotation (corresponding to a right-handed screw).

This is the front view ☒ Side view ☐

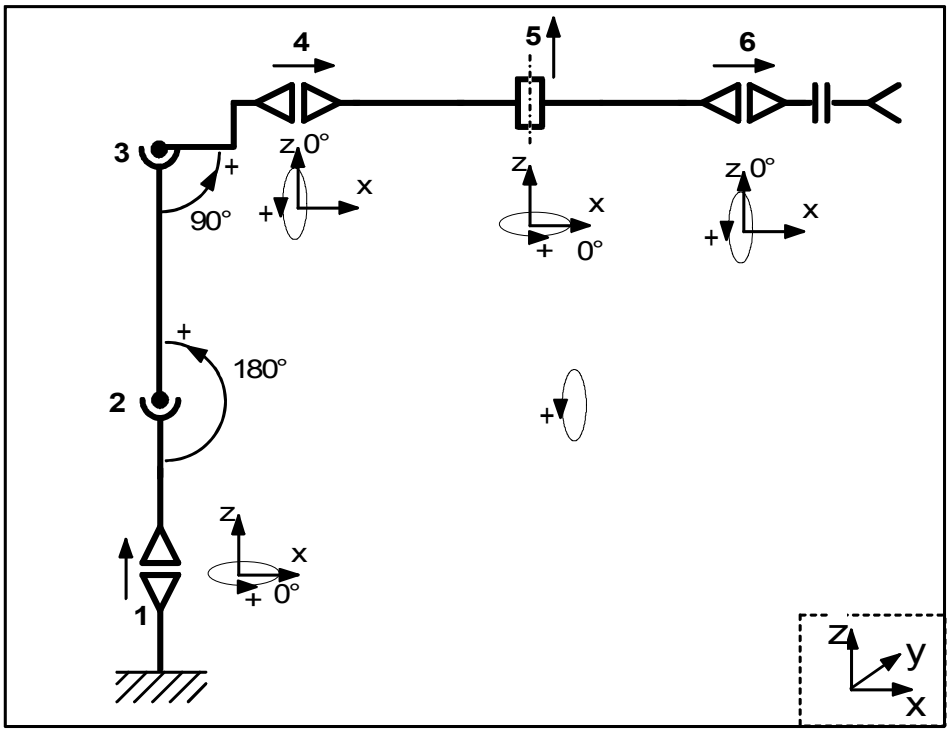


Figure A-2: Mechanical zero position of the robot and axis traversing direction
Lower right figure element: Details of the directions of the coordinate system in the robot base point

Now enter, starting from the mechanical zero position specified above, for translatory axes, the maximum traversing range (length), and for rotary axes, the maximum rotational angle in both directions.

	Maximum negative traversing range		Maximum positive traversing range
Traversing range axis 1:	-270°	to	+270°
Traversing range axis 2:	-75°	to	+75°
Traversing range axis 3:	-40°	to	+80°
Traversing range axis 4:	-180°	to	+180°
Traversing range axis 5:	-100°	to	+100°
Traversing range axis 6:	-270°	to	+270°
Traversing range ext. axis 1:	_____	to	_____
Traversing range ext. axis 2:	_____	to	_____
Traversing range ext. axis 3:	_____	to	_____

...
...
...

For example:
Traversing range axis 1 : -5.00 m to +5.00 m (translatory axis)
Traversing range axis 2 : -180° to +180° (rotary axis)

A.1.4 Axis drive type

Drive types for which the motor rotation is transferred linear to the axes via gearboxes and for which possible linear couplings to other axes can result, do not require any special handling with regard to the transformation.
Is the relationship between motor speed and axis movement (mm or degree) linear?

Please mark with a cross

	yes	no
Axis 1	☒	☐
Axis 2	☒	☐
Axis 3	☒	☐
Axis 4	☒	☐
Axis 5	☒	☐
Axis 6	☒	☐

! **Important**

In case of a non-linear relationship, we require exact details about the type of the drive.

A.1.5 Mechanical axis couplings

Depending on the construction, a machine may have mechanical axis couplings. If axis M is traversed through an angle a_m, axis couplings may also change the position of another axis N (by an angle of a_n), without the motor of axis N moving (angle encoder of axis N does not record a change).
If such mechanical axis couplings are present, please enter them in the following table.
The coupling factor to be specified results from the angular ratio of the coupled axis to the traversed axis:

$$\textbf{Coupling factor} = \frac{\Delta a_n}{\Delta a_m}$$

Δa_m : Angular change of the traversed axis
Δa_n : Angular change of the coupled axis

Traversed axis (axis number)	**Coupled axis (axis number)**	**Coupling factor**
Axis 4	Axis 5	-0.1045
Axis 4	Axis 6	-0.21
Axis 5	Axis 6	0.0223

Example:
When the axis 4 is traversed by + 90°, the axis 5 is also moved by - 45°. This results in a coupling factor between the axes 4 and 5 of

$$\frac{-45°}{90°} = -0{,}5$$

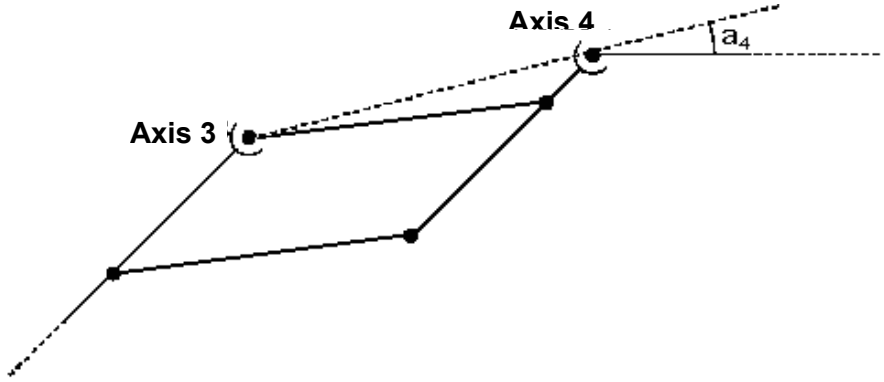
! Important

The coupling factor specified in the above table must be equal for every position of the traversed axis and coupled axis (linear)!
Non-linear couplings require a separate explanation.

A.1.6 Forcibly coupled axes

If, for an articulated-arm robot, the movement of an axis by struts causes the angular position of another axis to change, this axis is called "forcibly coupled".

Example:
A parallelogram construction causes a robot arm to always remain in the same direction despite the movement of an axis.



If the axis 3 is moved, the robot arm behind axis 4 always remains horizontal (a_4 changes).

Please mark with a cross

☒ The robot kinematics does not have any forcibly coupled axes

☐ Forcibly coupled axes exist

! Important

In case of forcibly coupled axes, we always require a technical drawing of the robot with dimensioned struts.

A.2 SCARA Robot Details

A.2.1 Kinematic equivalent diagram of the robot

Produce for the robot, including the additional axes or the external axes, a schematic equivalent diagram of the front view. This figure must clearly show the kinematics. If this is not possible, also provide the side view.

Enter here the front view of the robot.

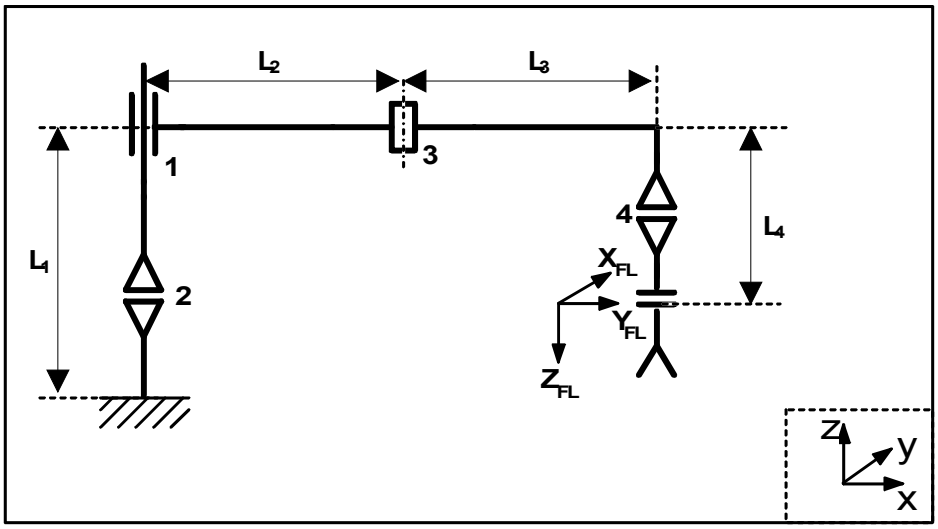


Figure A-3: Kinematic equivalent diagram of the robot from the front
Lower right figure element: Details of the directions of the coordinate system in the robot base point

Between which joints do offsets occur? (Please mark with a cross)

	yes	no
Offset between axis 1 and axis 2	☐	☒
Offset between axis 2 and axis 3	☐	☒
Offset between axis 3 and axis 4	☐	☒
Offset between axis 4 and axis 5	☐	☐
Offset between axis 5 and axis 6	☐	☐

A.2.2 Robot arm lengths

Specify the arm lengths between the individual robot axes.

L_1: 1158 [mm]
L_2: 760 [mm]
L_3: 423 [mm]
L_4: 268 [mm]
L_5: [mm]
L_6: [mm]
L_7: [mm]
L_8: [mm]

! **Important**

Enter the designations of the arm lengths also in the kinematic equivalent diagrams Figure A-3. If the details are incomplete, there is the danger that the coordinate transformation is incorrectly configured and so cause additional costs.

Note

Intentional changes of arm lengths (e.g. other model variants) can also be specified in parentheses here.
To the extent possible, these length details are also used for creating the coordinate transformation or the machine data.
If after completion of the transformation, additional arm lengths and offsets are used, this will cause additional efforts.

A.2.3 Maximum traversing range of the axes (starting from the mechanical zero position)

The definition of the maximum axis traversing ranges is based on the mechanical zero position of the machine.
Please enter the mechanical zero position with angle specifications in the following frame.
The length of the spindle s ( ) at the adjustment point must be specified for spindle drives.
Also specify the positive direction of the axis traversing range of the individual axes. This definition applies for the axis-specific traversing in JOG mode.

Example:

For swivel joints, to uniquely specify the axis rotation, also specify the direction of the vector used for the rotation (corresponding to a right-handed screw).

This is the front view ☒ Side view ☐

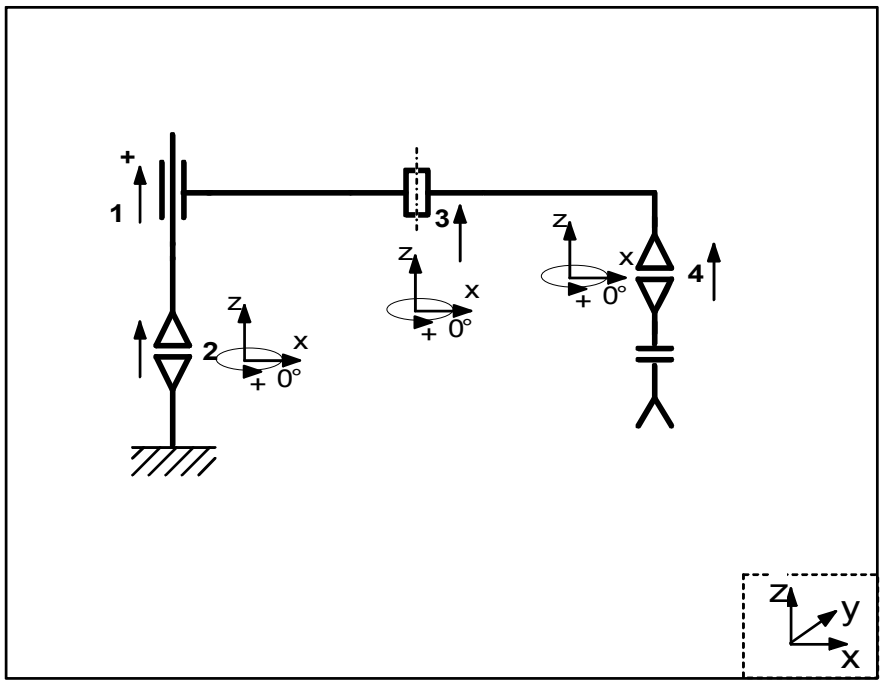


Figure A-4: Mechanical zero position of the robot and axis traversing direction
Lower right figure element: Details of the directions of the coordinate system in the robot base point

Now enter, starting from the mechanical zero position specified above, for translatory axes the maximum traversing range (length) and for rotary axes the maximum rotational angle in both directions.

	Maximum negative traversing range		Maximum positive traversing range
Traversing range axis 1:	-600 mm	to	+600 mm
Traversing range axis 2:	-135°	to	+135°
Traversing range axis 3:	-160°	to	+160°
Traversing range axis 4:	-270°	to	+270°
Traversing range axis 5:	_____	to	_____
Traversing range axis 6:	_____	to	_____
Traversing range ext. axis 1:	_____	to	_____
Traversing range ext. axis 2:	_____	to	_____
Traversing range ext. axis 3:	_____	to	_____

...
...
...

For example:
Traversing range axis 1 : -5.00 m to +5.00 m (translatory axis)
Traversing range axis 2 : -180° to +180° (rotary axis)

A.2.4 Axis drive type

Drive types for which the motor rotation is transferred linear to the axes via gearboxes and for which possible linear couplings to other axes can result, do not require any special handling with regard to the transformation.
Is the relationship between motor speed and axis movement (mm or degree) linear?

Please mark with a cross

	yes	no
Axis 1	☒	☐
Axis 2	☒	☐
Axis 3	☒	☐
Axis 4	☒	☐
Axis 5	☐	☐
Axis 6	☐	☐

Important

In case of a non-linear relationship, we require exact details about the type of the drive.

A.2.5 Mechanical axis couplings

Depending on the construction, a machine may have mechanical axis couplings. If axis M is traversed through an angle a_m, axis couplings may also change the position of another axis N (by an angle of a_n), without the motor of axis N moving (angle encoder of axis N does not record a change).
If such mechanical axis couplings are present, please enter them in the following table.
The coupling factor to be specified results from the angular ratio of the coupled axis to the traversed axis:

$$\textbf{Coupling factor} = \frac{\Delta a_n}{\Delta a_m}$$

Δa_m : Angular change of the traversed axis
Δa_n : Angular change of the coupled axis

Traversed axis (axis number)	**Coupled axis (axis number)**	**Coupling factor**
Axis 3	Axis 4	-1

Example:
When the axis 4 is traversed by + 90°, the axis 5 is also moved by - 45°. This results in a coupling factor between the axes 4 and 5 of

$$\frac{-45°}{90°} = -0{,}5$$

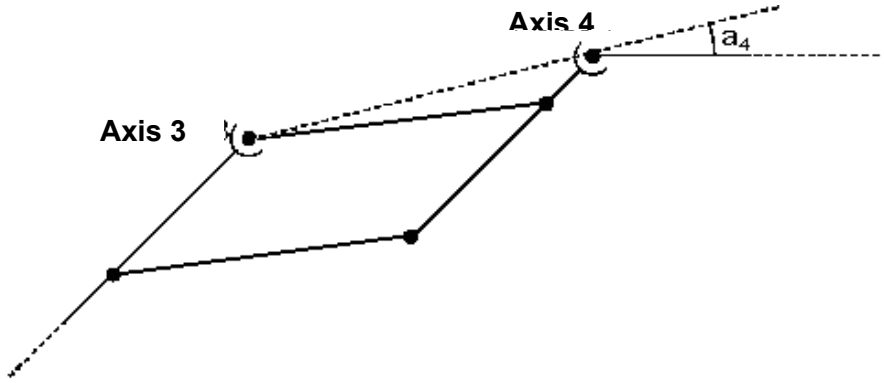
! Important

The coupling factor specified in the above table must be equal for every position of the traversed axis and coupled axis (linear)!
Non-linear couplings require a separate explanation.

A.2.6 Forcibly coupled axes

If, for an articulated-arm robot, the movement of an axis by struts causes the angular position of another axis to change, this axis is called "forcibly coupled".

Example:
A parallelogram construction causes a robot arm to always remain in the same direction despite the movement of an axis.



If the axis 3 is moved, the robot arm behind axis 4 always remains horizontal (a_4 changes).

Please mark with a cross

☒ The robot kinematics does not have any forcibly coupled axes

☐ Forcibly coupled axes exist

! **Important**

In case of forcibly coupled axes, we always require a technical drawing of the robot with dimensioned struts.

A.3 Gantry Robot Details

A.3.1 Kinematic equivalent diagram of the robot

Produce for the robot, including the additional axes or the external axes, a schematic equivalent diagram of the front view. This figure must clearly show the kinematics. If this is not possible, also provide the side view.

Enter here the front view of the robot.

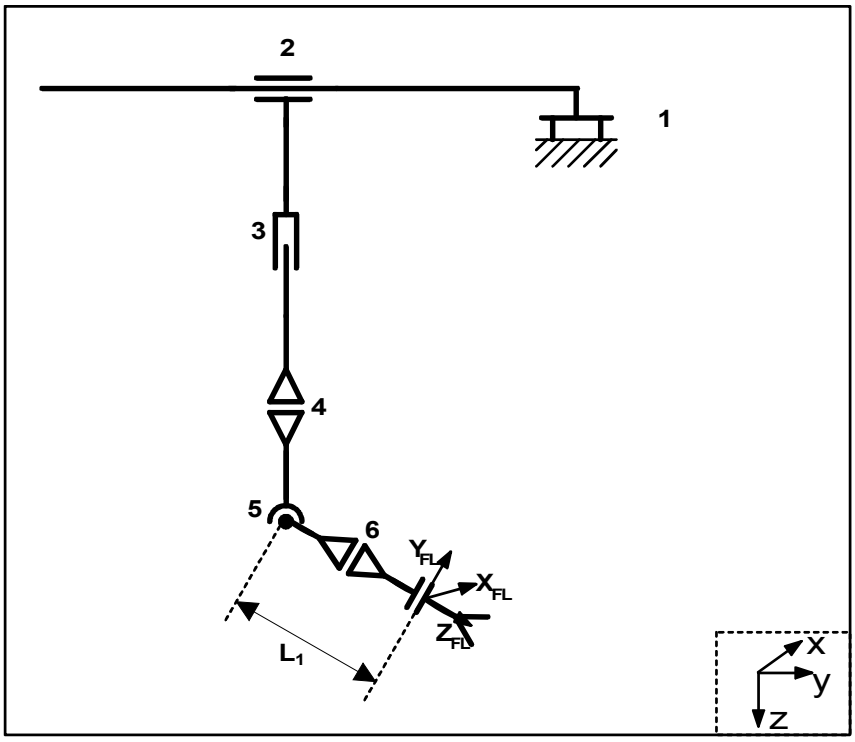


Figure A-5: Kinematic equivalent diagram of the robot from the **front**
Lower right figure element: details of the directions of the coordinate system in the robot base point

Between which joints do offsets occur? (Please mark with a cross)

	yes	no
Offset between axis 1 and axis 2	☐	☒
Offset between axis 2 and axis 3	☐	☒
Offset between axis 3 and axis 4	☐	☒
Offset between axis 4 and axis 5	☐	☒
Offset between axis 5 and axis 6	☐	☒

A.3.2 Robot arm lengths

Specify the arm lengths between the individual kinematic elements.

L_1: 356 [mm]
L_2: _____ [mm]
L_3: _____ [mm]
L_4: _____ [mm]
L_5: _____ [mm]
L_6: _____ [mm]
L_7: _____ [mm]
L_8: _____ [mm]

! Important

Enter the designations of the arm lengths also in the kinematic equivalent diagram Figure A-5. If the details are incomplete, there is the danger that the coordinate transformation is incorrectly configured and so cause additional costs.

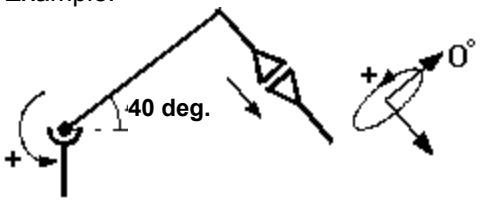
Note

Intentional changes of arm lengths (e.g. other model variants) can also be specified in parentheses here.
To the extent possible, these length details are also used for creating the coordinate transformation or the machine data.
If after completion of the transformation, additional arm lengths and offsets are used, this will cause additional efforts.

A.3.3 Maximum traversing range of the axes (starting from the mechanical zero position)

The definition of the maximum axis traversing ranges is based on the mechanical zero position of the robot.
Please enter the mechanical zero position with angle specifications in the following frame.
The length of the spindle s ( ) at the adjustment point must be specified for spindle drives.
Also specify the positive direction of the axis traversing range of the individual axes. This definition applies for the axis-specific traversing in JOG mode.

Example:



For swivel joints, to uniquely specify the axis rotation, also specify the direction of the vector used for the rotation (corresponding to a right-handed screw).

This is the front view ☒ Side view ☐

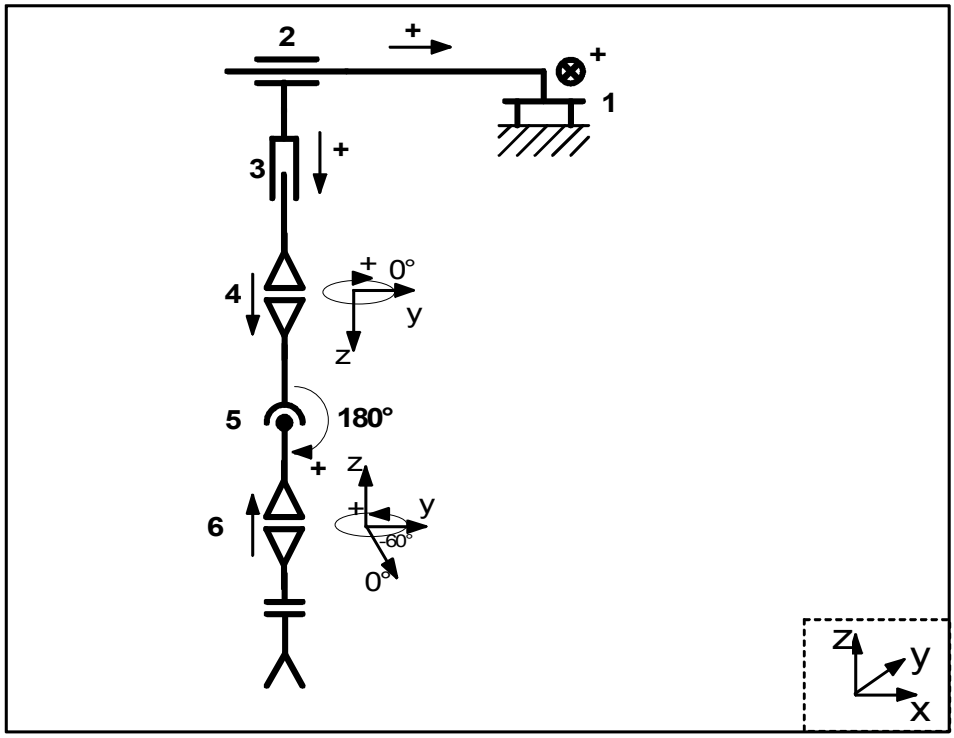


Figure A-6: Mechanical zero position of the robot and axis traversing direction.
Lower right figure element: Details of the directions of the coordinate system in the robot base point

Now enter, starting from the mechanical zero position specified above, for translatory axes the maximum traversing range (length) and for rotary axes the maximum rotational angle in both directions.

	Maximum negative traversing range		Maximum positive traversing range
Traversing range axis 1:	-4000 mm	to	+4000 mm
Traversing range axis 2:	-2500 mm	to	+2500 mm
Traversing range axis 3:	-1000 mm	to	+1000 mm
Traversing range axis 4:	-180°	to	+180°
Traversing range axis 5:	-135°	to	+135°
Traversing range axis 6:	-270°	to	+270°
Traversing range ext. axis 1:	_____	to	_____
Traversing range ext. axis 2:	_____	to	_____
Traversing range ext. axis 3:	_____	to	_____

...
...
...

For example:
Traversing range axis 1 : -5.00 m to +5.00 m (translatory axis)
Traversing range axis 2 : -180° to +180° (rotary axis)

A.3.4 Axis drive type

Drive types for which the motor rotation is transferred linear to the axes via gearboxes and for which linear couplings to other axes can result, do not require any special handling with regard to the transformation.
Is the relationship between the motor speed and axis movement (mm or degrees) linear?

Please mark with a cross

	yes	no
Axis 1	☒	☐
Axis 2	☒	☐
Axis 3	☒	☐
Axis 4	☒	☐
Axis 5	☒	☐
Axis 6	☒	☐

! **Important**

In case of non-linear relationships, we require exact details about the type of the drive.

A.3.5 Mechanical axis couplings

Depending on the construction, a machine may have mechanical axis couplings. If axis M is traversed through an angle a_m, axis couplings may also change the position of another axis N (by an angle of a_n), without the motor of axis N moving (angle encoder of axis N does not record a change).
If such mechanical axis couplings are present, please enter them in the following table.
The coupling factor to be specified results from the angular ratio of the coupled axis to the traversed axis:

$$\textbf{Coupling factor} = \frac{\Delta a_n}{\Delta a_m}$$

Δa_m : Angular change of the traversed axis
Δa_n : Angular change of the coupled axis

Traversed axis (axis number)	**Coupled axis (axis number)**	**Coupling factor**
Axis 4	Axis 5	-0.1045
Axis 4	Axis 6	-0.21
Axis 5	Axis 6	-0.0223

Example:
When the axis 4 is traversed by + 90°, the axis 5 is also moved by - 45°. This results in a coupling factor between the axes 4 and 5 of

$$\frac{-45°}{90°} = -0{,}5$$

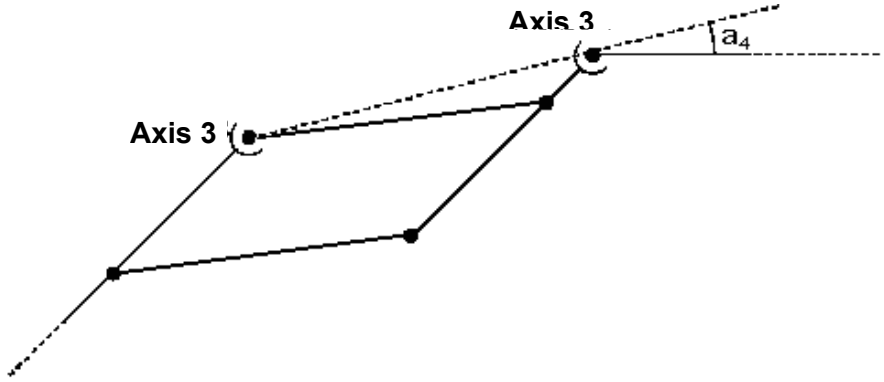
! Important

The coupling factor specified in the above table must be equal for every position of the traversed axis and coupled axis (linear)!
Non-linear couplings require a separate explanation.

A.3.6 Forcibly coupled axes

If, for an articulated-arm robot, the movement of an axis by struts causes the angular position of another axis to change, this axis is called "forcibly coupled".

Example:
A parallelogram construction causes a robot arm to always remain in the same direction despite the movement of an axis.



If the axis 3 is moved, the robot arm behind axis 4 always remains horizontal (a_4 changes).

Please mark with a cross

☒ The robot kinematics does not have any forcibly coupled axes

☐ Forcibly coupled axes exist

! Important

In case of forcibly coupled axes, we always require a technical drawing of the robot with dimensioned struts.

■

To
Siemens AG

I DT MC MS1
P.O. Box 3180

D-91050 Erlangen

Fax +49 (0) 9131 / 98 – 2176 [Documentation]

mailto:docu.motioncontrol@siemens.com

for documentation:

SINUMERIK 840D sl - OEM

Kinematic Transformation
Configuration Questions

Manufacturer Documentation

From

Name:

Address of your company/department

Street: _____

Post code: _____ Town: _____

Phone: _____ / _____

Fax: _____ / _____

Configuration Manual

Order No..: ---
10/2008

If you notice any printing errors when reading this documentation, please use the preprinted form to advise us of these. We would also be grateful for ideas and suggestions on how we can improve this documentation.

Suggestions and/or corrections