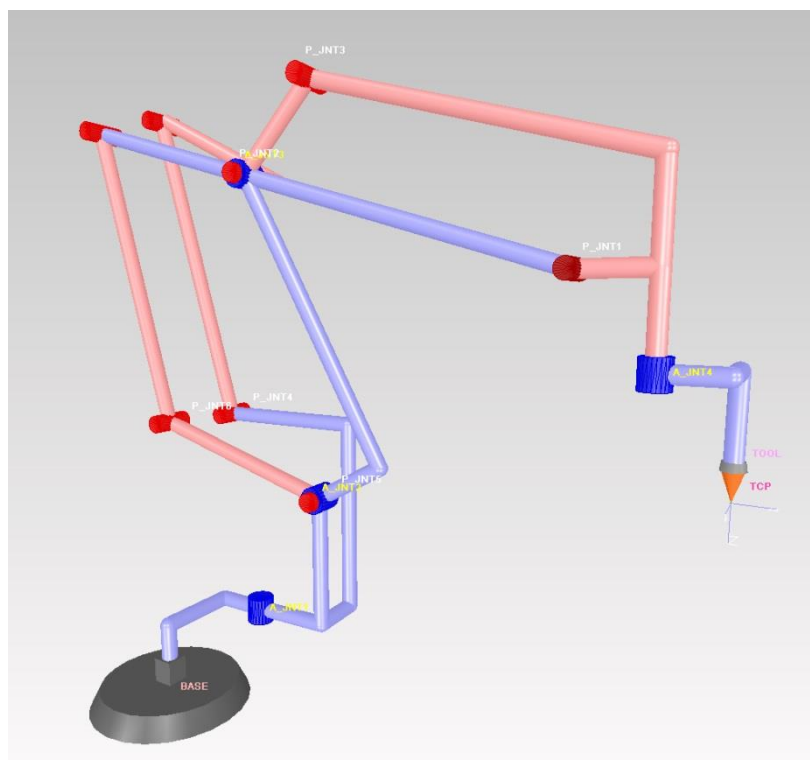


Kinematic Structures at a glance

EASY-ROB™



November 2019

Version 1.3

Subject to change or improve without prior notice

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Overview of kinematic structures in EASY-ROB™

This document provides a compact overview of the most important kinematic structures in EASY-ROB™.

For each kinematic model, which is defined in EASY-ROB™ by the Inverse Kin-ID and an associated Sub-ID, you will also find a transformation table in addition to the specifications of the kinematics and an overview of the permitted extended attributes. Together they result in the reference kinematic ID = RefKin ID

Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis "Geometric Data to next", so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

For each kinematic example you will find a corresponding ROB-file in directory "KinIDs". The representation of these example models was reduced to the essential. Thus, active rotation axes are visualized as blue cylinders and active translation axes as blue cubes. Passive axes, on the other hand, are correspondingly red. The connection between the individual axes and thus the kinematic chain is represented by thin cylinders.

The following kinematic structures are described more into detail in this document:

- Vertical articulated robot with central wrist (if necessary with coupling and backlink (BL); 6 axes)
- Jet robots (if necessary with coupling and backlink (BL); 6 axes)
- Palletizing robots (if necessary with backlink (BL); 4 axes)
- SCARA kinematic (3, 4 or 6 axes)
- Portal (gantry) robots (1 up to 6 axes)
- Redundant Kinematics with more and less than 6 DOF

In addition, on the last page you will find a redundant kinematics with 7 independent axes whose inverse kinematics is solved by means of "Numerical Solution" (Kin-ID 100, Sub-ID 0). This provides a solution for calculating the inverse of kinematic models for which no analytical solution is available.

In the document "TrainLib-Tutorial_ENG.pdf", chapter 6 "Setting up kinematics", you will find a detailed step-by-step guide of how to create kinematics from standard CAD components on your own.

Vertical Articulated Robot with Central Wrist: Kin-ID 110, Sub-ID 0

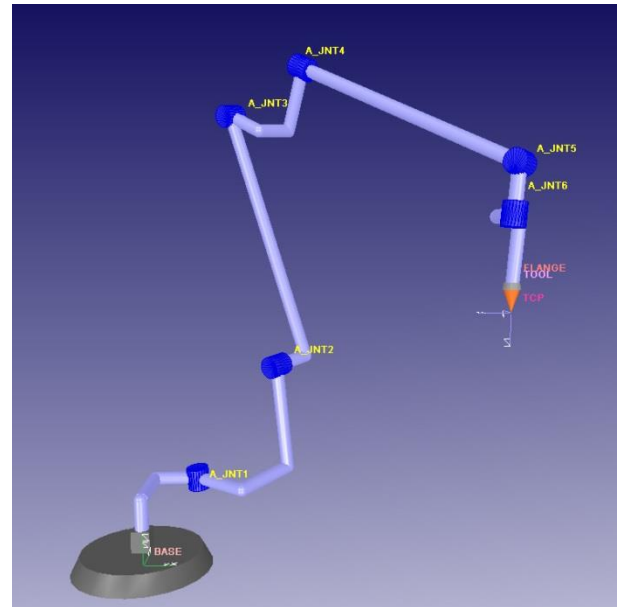
Kinematic: „Kin-ID-110-SID-0.rob“

Specifications:

Kin-ID Sub-ID	110 0
Kin-Structure	Vertical articulated robot with central wrist
Number of active and passive axes	6 0
Kin-Type & Kin-Direction	RzRyRy : RxRyRx
Number of configurations	8

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each *active axis* to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

Vert. Articulated Robot with Central Wrist, A2A3 Coupl. w/o BL: Kin-ID 111, Sub-ID 0

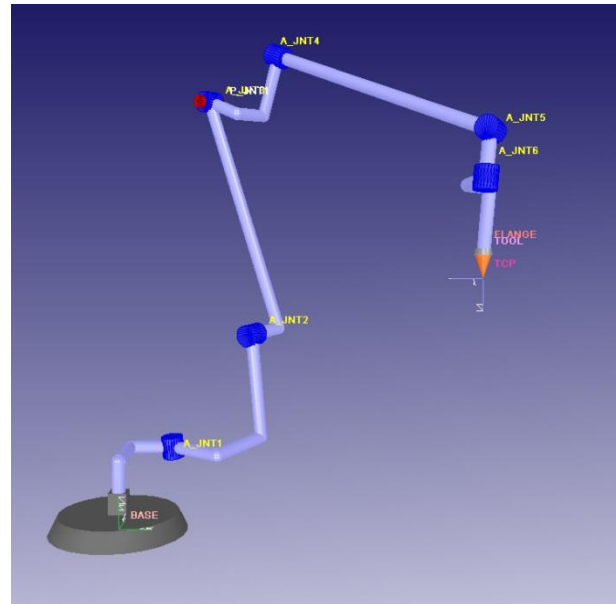
Kinematic: „Kin-ID-111-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	111 0
Kin-Structure	Vertical articulated robot with central wrist, A2A3 coupling without backlink
Number of active and passive axes	6 1
Kin-Type & Kin-Direction	RzRyRy : RxRyRx
Number of configurations	8

Extended Attributes:

Backlink	No
A2A3 Coupling	Yes
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each *active axis* to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

In addition, all permitted transformation lengths and rotations ("Geometric Data from Last") are specified for each passive axis, which belongs to the kinematic chain and is thus an integral part of the kinematic.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓

Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓
-------------------------------	---	---	---	---	---	---

Kinematic: „Kin-ID-111-SID-0.rob“

	Chain Spec.	Attach to aJnt	Geometric Data /	x	y	z	Rx	Ry	Rz
pJnt1 RYC2-	C	2	from last	✗	✗	✗	✗	✗	✗
			to next	✗	✗	✗	✗	✗	✗
			Math. Jnt Dep.	=-DOFOFFSIGN(2)					

Vert. Articulated Robot with Central Wrist, A2A3 Coupl. & BL: Kin-ID 111, Sub-ID 0

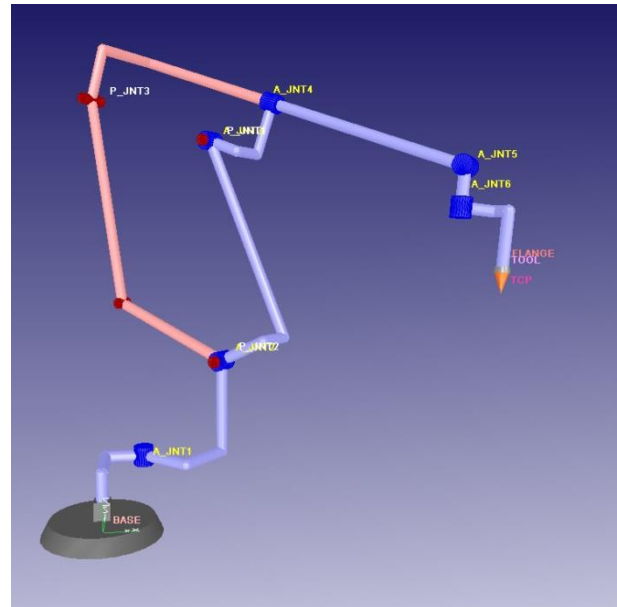
Kinematic: „Kin-ID-111-SID-0-BL.rob“

Specifications:

Inv-Kin-ID Sub-ID	111 0
Kin-Structure	Vertical articulated robot with central wrist, A2A3 coupling and backlink
Number of active and passive axes	6 3
Kin-Type & Kin-Direction	RzRyRy : RxRyRx
Number of configurations	8

Extended Attributes:

Backlink	Yes
A2A3 Coupling	Yes
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each *active axis* to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

In addition, all permitted transformation lengths and rotations ("Geometric Data from Last") are specified for each passive axis, which belongs to the kinematic chain and is thus an integral part of the kinematic.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

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Kinematic: „Kin-ID-111-SID-0-BL.rob“

	Chain Spec.	Attach to aJnt	Geometric Data /	x	y	z	Rx	Ry	Rz
pJnt1 RYC2-	C	2	from last	x	x	x	x	x	x
			to next	x	x	x	x	x	x
			Math. Jnt Dep.	=-DOFOFFSIGN(2)					

Passive axes for the backlink display:

The following passive axes do not belong to the kinematic chain. They are used to visualize the mechanical backlink and are optional. A transformation to the next axis or from the previous axis is allowed for all directions and orientations.

	Chain Spec.	Attach to aJnt	Geometric Data /	x	y	z	Rx	Ry	Rz
pJnt2 RY_1-	-	1	from last	✓	✓	✓	✓	✓	✓
			to next	✓	✓	✓	✓	✓	✓
			Math. Jnt Dep.	=DOFOFFSIGN(3)					
pJnt3 RY_3-	-	3	from last	✓	✓	✓	✓	✓	✓
			to next	✓	✓	✓	✓	✓	✓
			Math. Jnt Dep.	=DOFOFFSIGN(2)-DOFOFFSIGN(3)					

Explanations on chain specification:

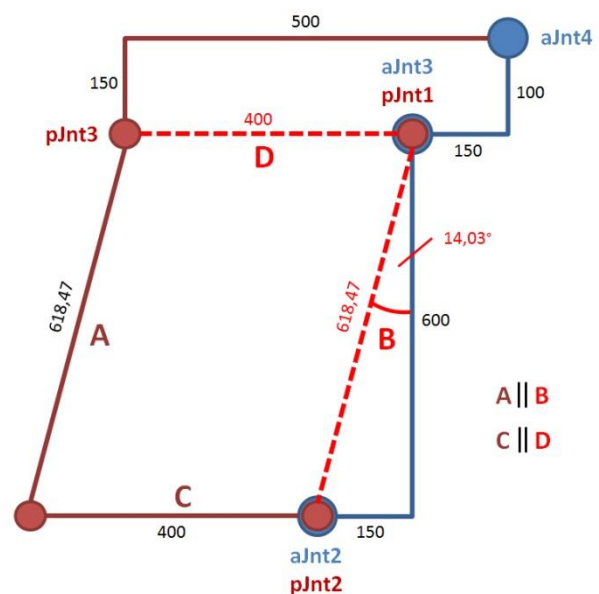
- C : Joint in the kinematic chain
- : Joint NOT in the kinematic chain
- : Joint separated & NOT in kin. chain

The following applies to this example:

In order to display the movement of the backlink correctly, the criteria A || B and C || D (Parallelogram) shown in the sketch must be fulfilled during the modeling process.

The lengths A and C represent the backlink. These lengths must correspond to the lengths of the connecting lines between pJnt2 and pJnt1 (B), as well as pJnt1 and pJnt3 (D) to create a parallelogram.

The angle of 14.03° can be determined by the \tan^{-1} of the transformation-lengths from aJnt2 to aJnt3 (150 and 600). Correspondingly, the required length for A and B can be then calculated.



Jet Robot: Kin-ID 127, Sub-ID 0

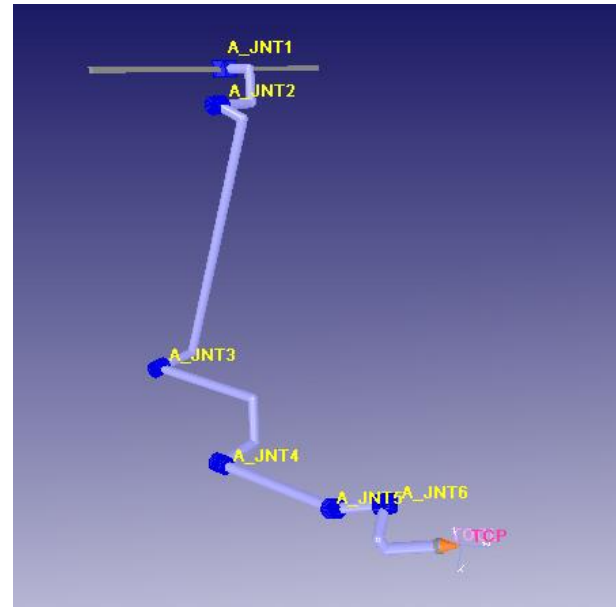
Kinematic: „Kin-ID-127-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	127 0
Kin-Structure	Jet robot
Number of active and passive axes	6 0
Kin-Type & Kin-Direction	TyRyRy : RxRyRx TyRyRy : RzRyRz
Number of configurations	4

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✗	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✗	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✗	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

Jet Robot with A2A3 Coupling: Kin-ID 128, Sub-ID 0

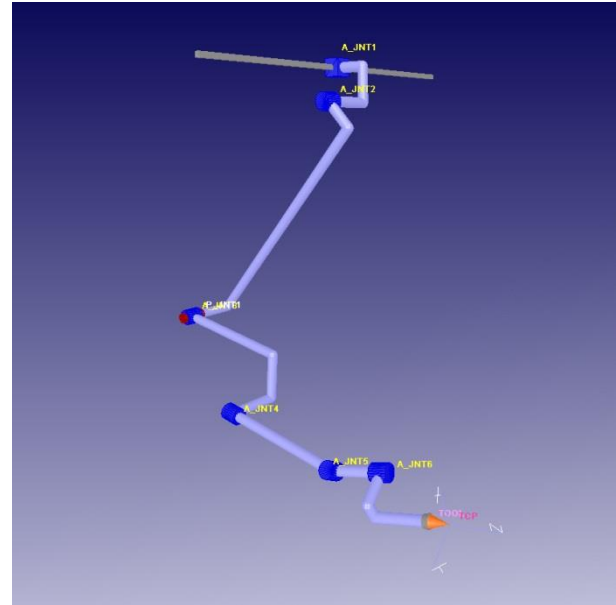
Kinematic: „Kin-ID-128-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	128 0
Kin-Structure	Jet robot with A2A3-coupling
Number of active and passive axes	6 0
Kin-Type & Kin-Direction	TyRyRy : RxRyRx TyRyRy : RzRyRz
Number of configurations	4

Extended Attributes:

Backlink	No
A2A3 Coupling	Yes
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✗	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✗	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✗	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange) → TCP (Tool data)	✓	✓	✓	✓	✓	✓

For the passive axis of the A2A3 coupling, the same rules apply for the transformation lengths and rotations ("Geometric Data from last" / "Geometric Data to next ") as for the kinematic "Kin-ID-111-SID-0. rob ".

Palletizing Robot: Kin-ID 129, Sub-ID 0

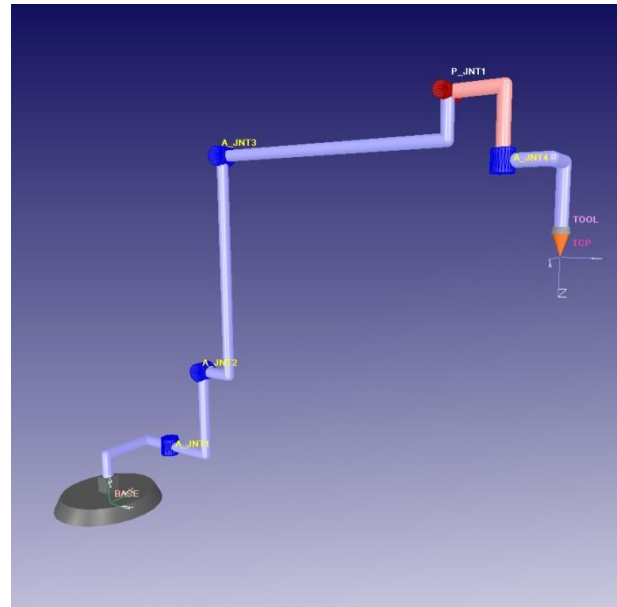
Kinematic: „Kin-ID-129-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	129 0
Kin-Structure	Palletizing robot
Number of active and passive axes	4 1
Kin-Type & Kin-Direction	RzRyRy : Rz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✗	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✗	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✗	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✓	✗	✓
Tip (Flange) → TCP (Tool data)	✓	✓	✓	✓	✓	✓

Palletizing Robot with Backlink: Kin-ID 129, Sub-ID 1

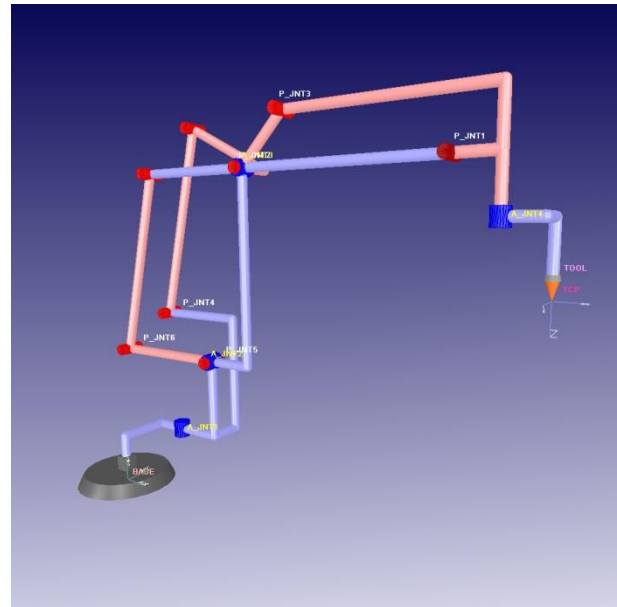
Kinematic: „Kin-ID-129-SID-1.rob“

Specifications:

Inv-Kin-ID Sub-ID	129 1
Kin-Structure	Palletizing robot with backlink
Number of active and passive axes	4 2
Kin-Type & Kin-Direction	RzRyRy : Rz
Number of configurations	2

Extended Attributes:

Backlink	Yes
A2A3 Coupling	Yes
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✗	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✗	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✗	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✓	✗	✓
Tip (Flange) → TCP (Tool data)	✓	✓	✓	✓	✓	✓

3-Axis-SCARA-Kinematic (door opener): Kin-ID 131, Sub-ID 8

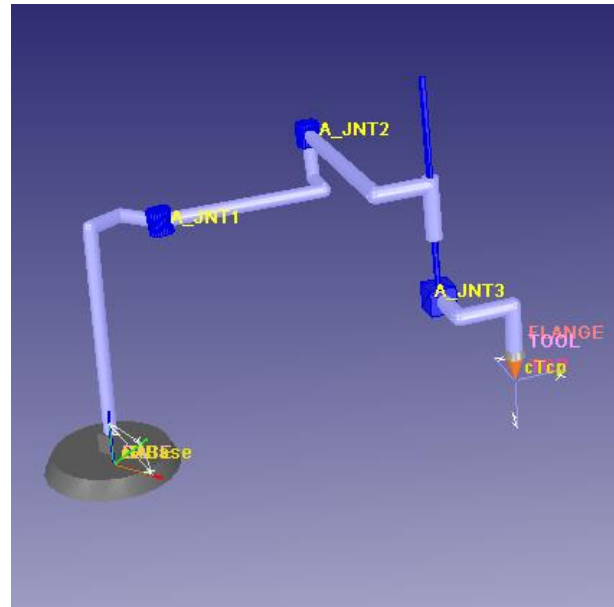
Kinematic: „Kin-ID-131-SID-8.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 8
Kin-Structure	SCARA
Number of active and passive axes	3 0
Kin-Type & Kin-Direction	RzRzTz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

3-Axis-SCARA-Kinematic (door opener): Kin -ID 131, Sub-ID 9

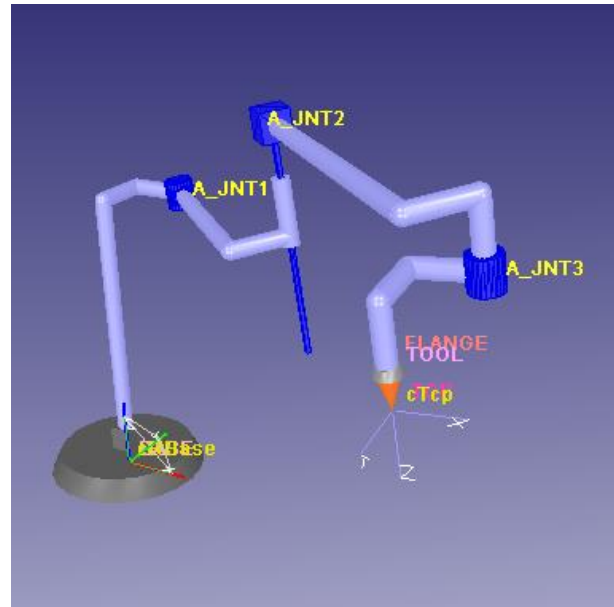
Kinematic: „Kin-ID-131-SID-9.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 9
Kin-Structure	SCARA
Number of active and passive axes	3 0
Kin-Type & Kin-Direction	RzTzRz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

3-Axis-SCARA-Kinematic (door opener): Kin-ID 131, Sub-ID 10

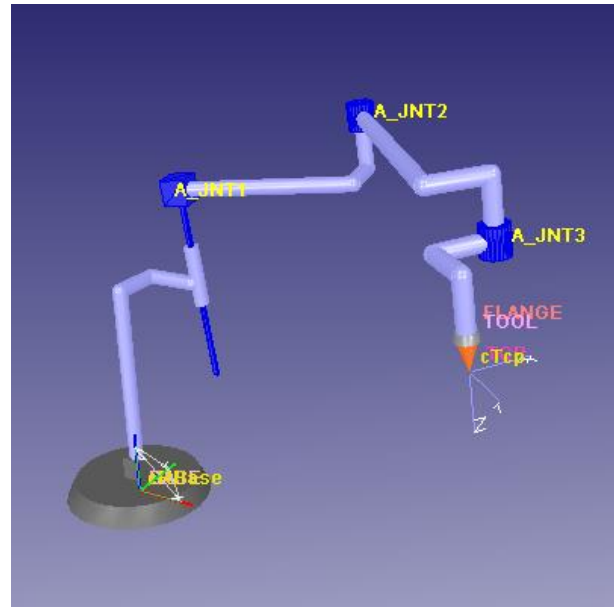
Kinematic: „Kin-ID-131-SID-10.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 10
Kin-Structure	SCARA
Number of active and passive axes	3 0
Kin-Type & Kin- Direction	TzRzRz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

4-Axes-SCARA-Kinematic: Kin-ID 131, Sub-ID 0

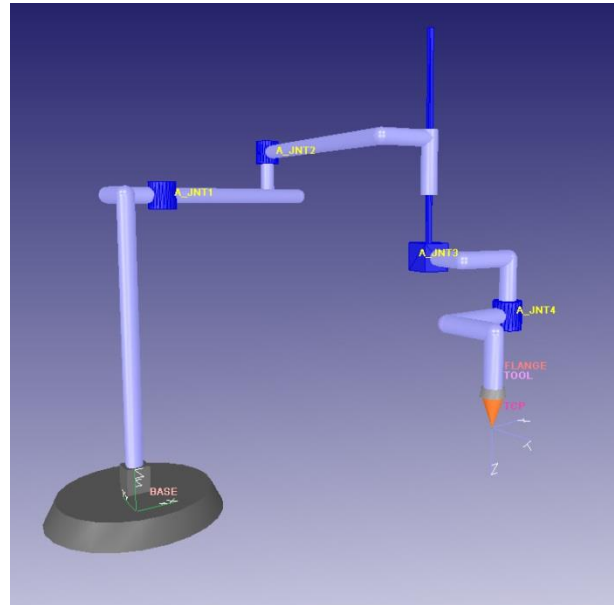
Kinematic: „Kin-ID-131-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 0
Kin-Structure	SCARA
Number of active and passive axes	4 0
Kin-Type & Kin- Direction	RzRzTzRz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

4-Axes-SCARA-Kinematic: Kin-ID 131, Sub-ID 1

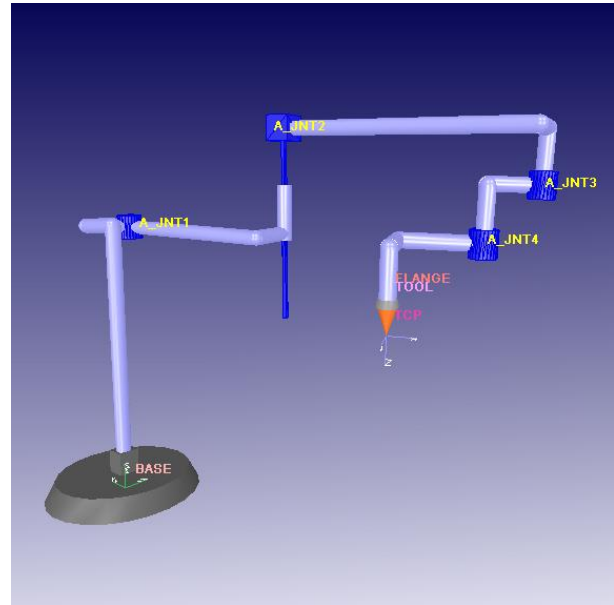
Kinematic: „Kin-ID-131-SID-1.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 1
Kin-Structure	SCARA
Number of active and passive axes	4 0
Kin-Type & Kin- Direction	RzTzRzRz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

4-Axes-SCARA-Kinematic: Kin-ID 131, Sub-ID 2

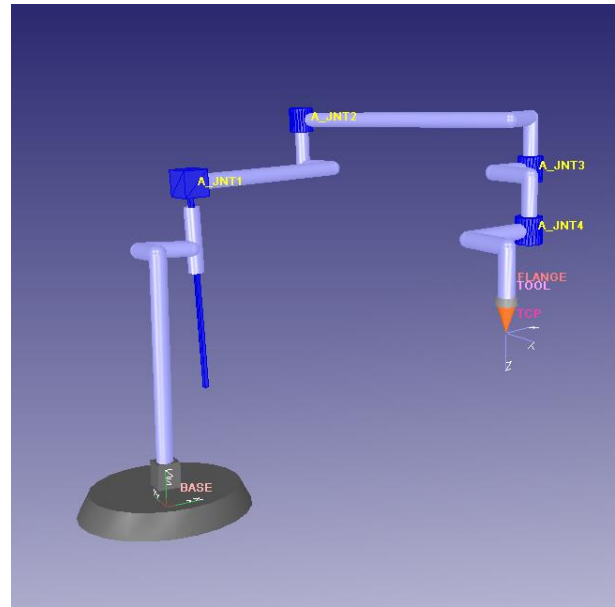
Kinematic: „Kin-ID-131-SID-2.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 2
Kin-Structure	SCARA
Number of active and passive axes	4 0
Kin-Type & Kin- Direction	TzRzRzRz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

4-Axes-SCARA-Kinematic: Kin-ID 131, Sub-ID 3

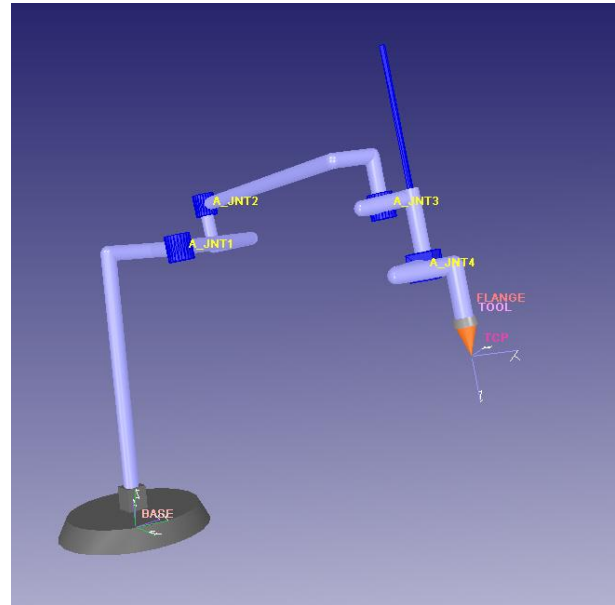
Kinematic: „Kin-ID-131-SID-3.rob“

Specifications:

Inv-Kin-ID Sub-ID	131 3
Kin-Structure	SCARA
Number of active and passive axes	4 0
Kin-Type & Kin- Direction	RzRzRzTz
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✓	✓	✗	0°, 180°	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

6-Axes-Portal-Robot: Kin-ID 136, Sub-ID 0

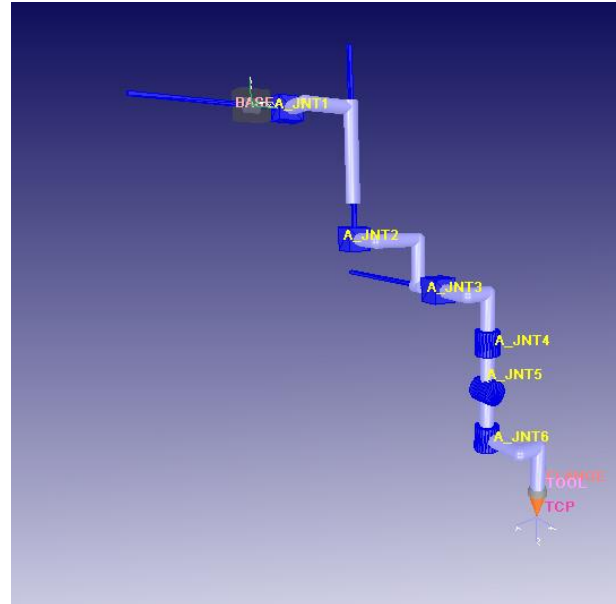
Kinematic: „Kin-ID-136-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	136 0
Kin-Structure	Portal
Number of active and passive axes	6 0
Kin-Type & Kin- Direction	TxTyTz, TyTxTz, TzTxTy, TzTyTx, TxTzTy, TyTzTx : Rot (Rot=RzRxRz, RzRyRz)
Number of configurations	2

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

6-Axes-SCARA-Kinematic: Kin-ID 139, Sub-ID 0

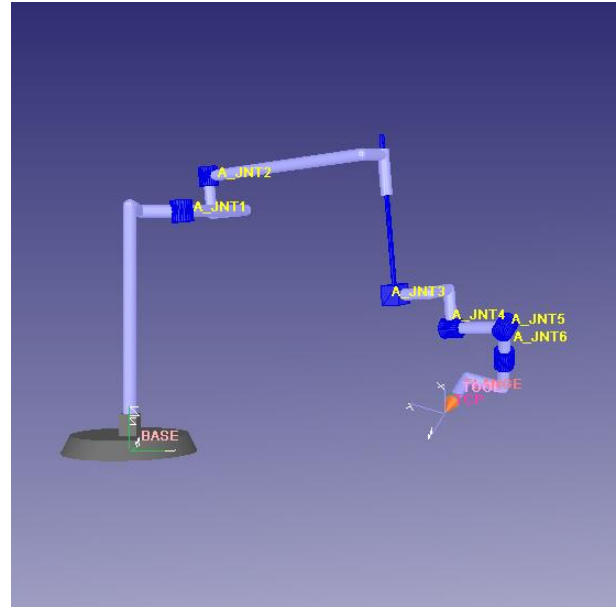
Kinematic: „Kin-ID-139-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	139 0
Kin-Structure	SCARA
Number of active and passive axes	6 0
Kin-Type & Kin-Direction	RzRzTz : RxRzRx
Number of configurations	4

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

6-Axes-SCARA-Kinematic: Kin-ID 139, Sub-ID 1

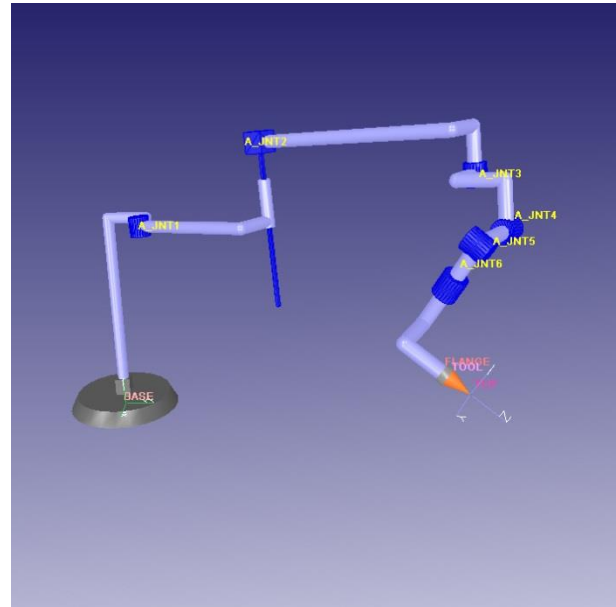
Kinematic: „Kin-ID-139-SID-1.rob“

Specifications:

Inv-Kin-ID Sub-ID	139 1
Kin-Structure	SCARA
Number of active and passive axes	6 0
Kin-Type & Kin-Direction	RzTzRz : RxRzRx
Number of configurations	4

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

6-Axes-SCARA-Kinematic: Kin-ID 139, Sub-ID 2

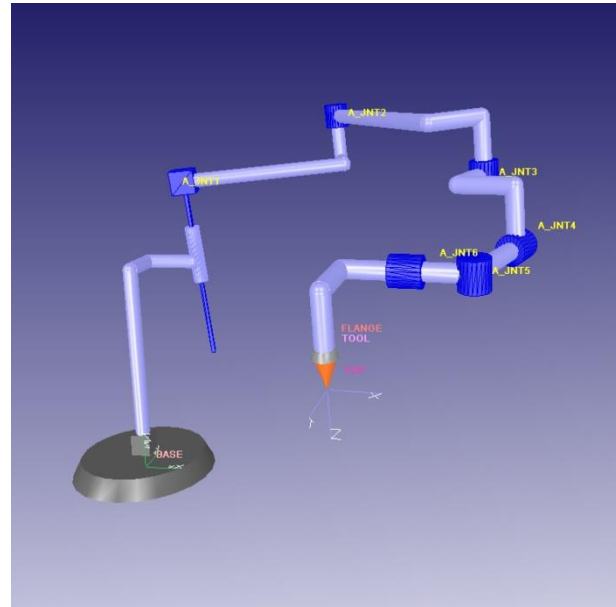
Kinematic: „Kin-ID-139-SID-2.rob“

Specifications:

Inv-Kin-ID Sub-ID	139 2
Kin-Structure	SCARA
Number of active and passive axes	6 0
Kin-Type & Kin- Direction	TzRzRz : RxRzRx
Number of configurations	4

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → aJnt5	✓	✗	✗	✗	✗	✗
aJnt5 → aJnt6	✓	✗	✗	✗	✗	✗
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

3-Axes-Portal-Robot: Kin-ID 133, Sub-ID 0, 123

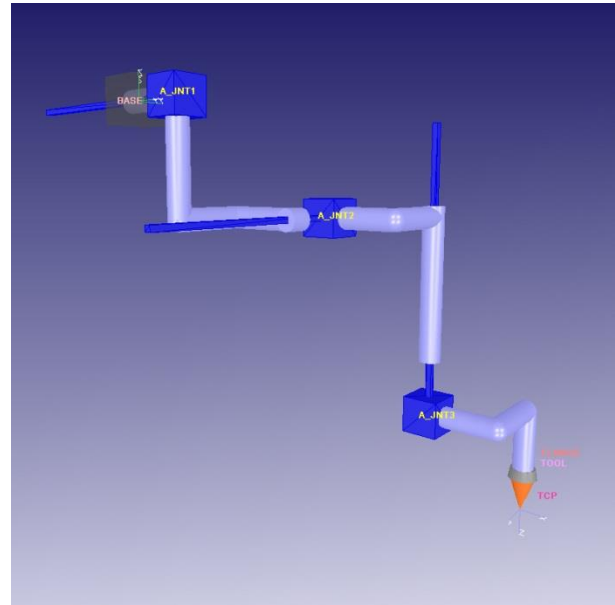
Kinematic: „Kin-ID-133-SID-0-123.rob“

Specifications:

Inv-Kin-ID Sub-ID	133 0, 123
Kin-Structure	Portal
Number of active and passive axes	3 0
Kin-Type & Kin-Direction	TxTyTz, TyTxTz, TzTxTy, TzTyTx, TxTzTy, TyTzTx
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

2-Axes-Portal-Robot: Kin-ID 133, Sub-ID 13, 23

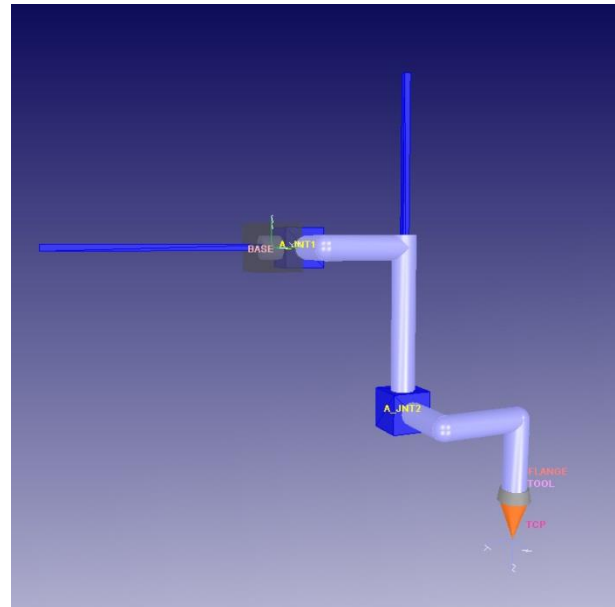
Kinematic: „Kin-ID-133-SID-13-23.rob“

Specifications:

Inv-Kin-ID Sub-ID	133 13, 23
Kin-Structure	Portal
Number of active and passive axes	2 0
Kin-Type & Kin-Direction	TxTz, TyTz, TzTx TzTy, TxTy, TyTx
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → Tip (Flange)	✓	✓	✓	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

1-Axes-Portal-Robot: Kin-ID 133, Sub-ID 1, 2, 3

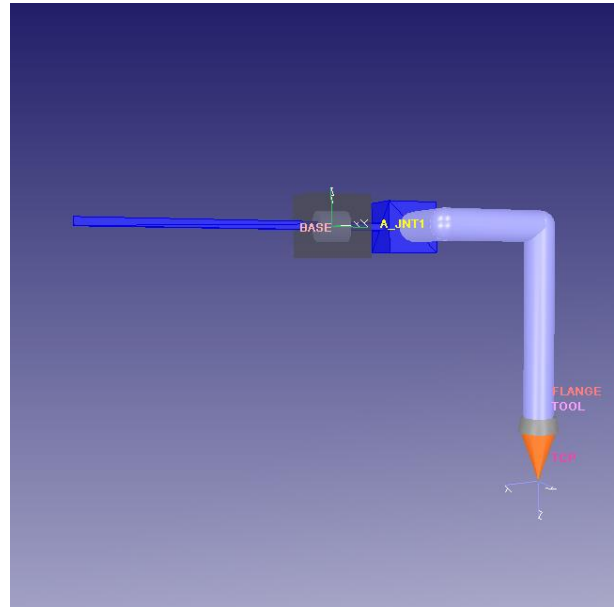
Kinematic: „Kin-ID-133-SID-1-2-3.rob“

Specifications:

Inv-Kin-ID Sub-ID	133 1, 2, 3
Kin-Structure	Portal
Number of active and passive axes	1 0
Kin-Type & Kin-Direction	Tx, Ty, Tz *)
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → Tip (Flange)	✓	✓	✓	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

*) Sub-ID: 1 = Tx, 2 = Ty, 3 = Tz

4-Axes-Portal-Robot: Kin-ID 134, Sub-ID 0, 123

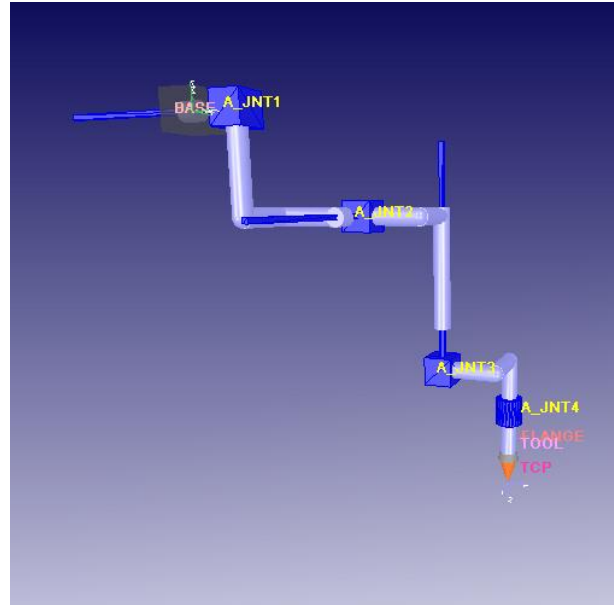
Kinematic: „Kin-ID-134-SID-0-123.rob“

Specifications:

Inv-Kin-ID Sub-ID	134 0, 123
Kin-Structure	Portal
Number of active and passive axes	4 0
Kin-Type & Kin- Direction	TxTyTz, TyTxTz, TzTxTy, TzTyTx, TxTzTy, TyTzTx : Rz
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	✗	✗
aJnt4 → Tip (Flange)	✓	✗	✗	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

3-Axes-Portal-Robot: Kin-ID 134, Sub-ID 13, 23

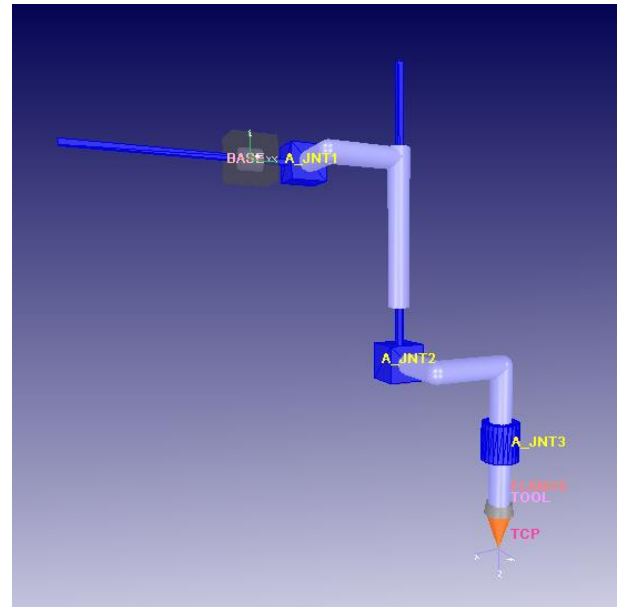
Kinematic: „Kin-ID-134-SID-13-23.rob“

Specifications:

Inv-Kin-ID Sub-ID	134 13, 23
Kin-Structure	Portal
Number of active and passive axes	3 0
Kin-Type & Kin-Direction	TxTz, TyTz, TzTx TzTy, TxTy, TyTx : Rz
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → Tip (Flange)	✓	✗	✗	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

5-Axes-Portal-Robot: Kin-ID 135, Sub-ID 0

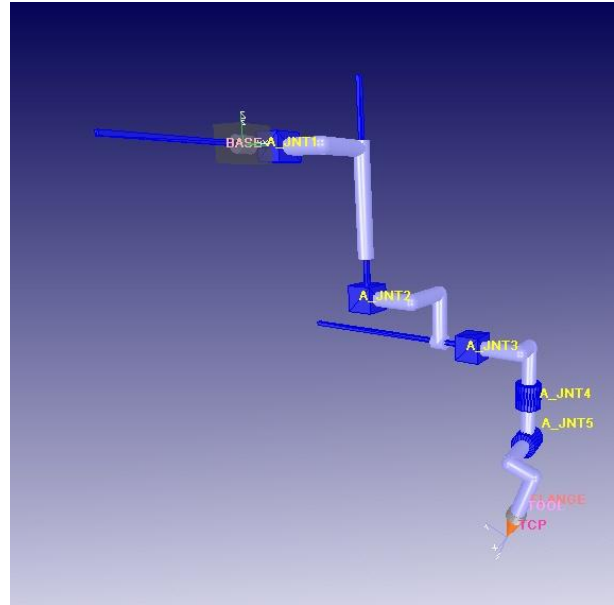
Kinematic: „Kin-ID-135-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	135 0
Kin-Structure	Portal
Number of active and passive axes	5 0
Kin-Type & Kin- Direction	TxTyTz, TyTxTz, TzTxTy, TzTyTx, TxTzTy, TyTzTx : CA (CA=RzRx *)
Number of configurations	1

Extended Attributes:

Backlink	No
A2A3 Coupling	No
Counterweight	No
Travel range dependencies	No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✗	✗	✗
aJnt2 → aJnt3	✓	✓	✓	✗	✗	✗
aJnt3 → aJnt4	✓	✓	✓	✗	0°, 180°	✗
aJnt4 → aJnt5	✗	✗	✓	✗	✗	✗
aJnt5 → Tip (Flange)	✓	✓	✓	✗	✗	✗
Tip (Flange)→ TCP (Tool data)	✗	✗	✓	0°, 180°	0°, 180°	✓

Numerical Solution 7-Axis: Kin-ID 100, Sub-ID 0

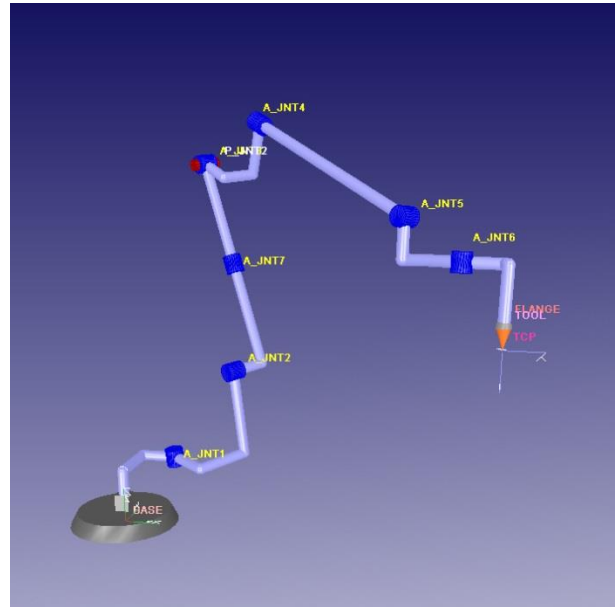
Kinematic: „Kin-ID-100-SID-0.rob“

Specifications:

Inv-Kin-ID Sub-ID	100 0
Kin-Structure	Serial Chain Numerical Solution
Number of active and passive axes	7 up to 12 1 *) up to 12
Kin-Type & Kin-Direction	Rzzyz : Rxxyx any
Number of configurations	1

Extended Attributes:

Backlink	Yes/No
A2A3 Coupling	Yes/No
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✓	✓	✓
aJnt2 → aJnt3	✓	✓	✓	✓	✓	✓
aJnt3 → aJnt4	✓	✓	✓	✓	✓	✓
aJnt4 → aJnt5	✓	✓	✓	✓	✓	✓
aJnt5 → aJnt6	✓	✓	✓	✓	✓	✓
aJnt6 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

*) The 7th active axis is not in the kinematic chain. The rotation of this axis causes a rotation of the first passive axis, which is located in the kinematic chain and serves as the actual rotation axis between aJnt2 and aJnt3.

Numerical Solution 5-Axis: Kin-ID 100, Sub-ID 1

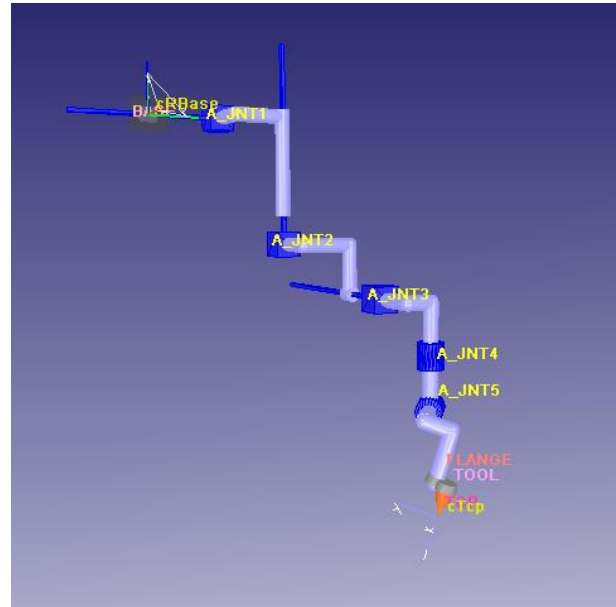
Kinematic: „Kin-ID-100-SID-1.rob“

Specifications:

Inv-Kin-ID Sub-ID	100 1*)
Kin-Structure	Serial Chain Numerical Solution
Number of active and passive axes	5 up to 12 0 up to 12
Kin-Type & Kin-Direction	Tyzz : Rzx any
Number of configurations	1

Extended Attributes:

Backlink	Yes/No
A2A3 Coupling	Yes/No
Counterweight	Yes/No
Travel range dependencies	Yes/No



Using this table, you can see which transformation lengths and rotations are allowed for each active axis to the next active axis ("Geometric Data to next"), so that the inverse transform (IK) with the specified Kin-ID and Sub-ID can calculate a result for each possible configuration. Green hooks indicate that a corresponding transformation is allowed.

"Geometric Data to next"	x	y	z	Rx	Ry	Rz
Robot Base → 1st Joint (aJnt1)	✓	✓	✓	✓	✓	✓
aJnt1 → aJnt2	✓	✓	✓	✓	✓	✓
aJnt2 → aJnt3	✓	✓	✓	✓	✓	✓
aJnt3 → aJnt4	✓	✓	✓	✓	✓	✓
aJnt4 → aJnt5	✓	✓	✓	✓	✓	✓
aJnt5 → Tip (Flange)	✓	✓	✓	✓	✓	✓
Tip (Flange)→ TCP (Tool data)	✓	✓	✓	✓	✓	✓

*) This kinematics has only 5 DOF and is global degenerated. The Cartesian Mask Vector is set to Pxyz = 1 1 1 and Rxyz = 1 1 0. The rotation about the tool axis is not determined. Based in Sub-ID = 1, the robot will reach the xyz position w.r.t. Robot Base and the direction of the tool axis (approach axis).