

ROBOTICS

Application manual

Additional axes and standalone controller



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Application manual
Additional axes and standalone controller

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Overview of this manual

About this manual

This manual details the setup of additional axes and non-ABB robots.

Usage

This manual can be used as a brief description of how to install, configure and tune additional axes and non-ABB robots. It also provides information about related system parameters. Detailed information regarding system parameters, RAPID instructions and so on can be found in the respective reference manual.

Who should read this manual?

This manual is primarily intended for advanced users and integrators.

Prerequisites

The reader should...

- be familiar with industrial robots and their terminology
- be familiar with controller configuration and setup
- be familiar with the mechanical and dynamic properties of the controlled mechanism.

References

Reference	Document ID
<i>Application manual - Controller software IRC5</i>	3HAC050798-001
<i>Application manual - Servo Gun Setup</i>	3HAC065014-001
<i>Operating manual - RobotStudio</i>	3HAC032104-001
<i>Operating manual - IRC5 with FlexPendant</i>	3HAC050941-001
<i>Technical reference manual - RAPID Instructions, Functions and Data types</i>	3HAC050917-001
<i>Technical reference manual - System parameters</i>	3HAC050948-001
<i>Product manual - IRC5</i>	3HAC047136-001
<i>Product manual - Motor Units and Gear Units</i>	3HAC040148-001
<i>Product specification - Controller IRC5 with FlexPendant</i>	3HAC041344-001
<i>Product specification - Motor Units and Gear Units</i>	3HAC040147-001
<i>Application manual - TuneMaster</i>	3HAC063590-001
<i>Operating manual - Troubleshooting IRC5</i>	3HAC020738-001

Revisions

Revision	Description
-	Released with RobotWare 6.0.

Continues on next page

Revision	Description
A	Released with RobotWare 6.01. Replaced picture in section Commutation with service routine on page 106 , just to increase clarity. Added a note in the section Defining brake relays on page 80 .
B	Released with RobotWare 6.02. Updated the path to the template files, see Template files on page 22 . Notch filter removed.
C	Released with RobotWare 6.05. The allowed values are updated for parameters: <i>K Soft Max Factor</i> , <i>K Soft Min Factor</i> and <i>Kp/Kv Ratio Factor</i> . Minor corrections.
D	Released with RobotWare 6.06. Added section Relays on page 175 .
E	Released with RobotWare 6.07. Added information about <code>l_stator</code> in Motor Type on page 135 . References to the new manual <i>Application manual - Servo Gun Setup</i> , that replace the old <i>Application manual - Servo Gun Tuning</i> . Added information about not having fast coordinated movements with non-ABB track motion.
F	Released with RobotWare 6.08. <ul style="list-style-type: none"> Removed information about tuning of servo control parameter and refer to the TuneMaster manual instead. Max number of motion tasks for MultiMove system changed to seven. Added information and example for Arm Type on page 120.
G	Released with RobotWare 6.09. <ul style="list-style-type: none"> Added Kinematic model XY on page 62.
H	Released with RobotWare 6.10. <ul style="list-style-type: none"> Updated the information regarding tool data, see Limit peripheral speed of external axis on page 65.
J	Released with RobotWare 6.13.03. <ul style="list-style-type: none"> Added limitation for number of instances of the types <i>Robot</i> and <i>Single</i>, see System parameters on page 117. Minor corrections.
K	Released with RobotWare 6.15. <ul style="list-style-type: none"> Minor corrections. Added missing manipulators in section Configuration of the drive system on page 149. Updated section Error handling on page 115.
L	Released with RobotWare 6.15.02. <ul style="list-style-type: none"> Added information about <i>Service Information System</i>.

Product documentation

Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.



Tip

All documents can be found via myABB Business Portal, www.abb.com/myABB.

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Troubleshooting.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.

Continues on next page

- Examples of how to use the application.

Operating manuals

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and troubleshooters.

Safety

Safety of personnel

A robot is heavy and extremely powerful regardless of its speed. A pause or long stop in movement can be followed by a fast hazardous movement. Even if a pattern of movement is predicted, a change in operation can be triggered by an external signal resulting in an unexpected movement.

Therefore, it is important that all safety regulations are followed when entering safeguarded space.

Safety regulations

Before beginning work with the robot, make sure you are familiar with the safety regulations described in the manual *Safety manual for robot - Manipulator and IRC5 or OmniCore controller*.

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1 Introduction

1.1 Overview

Purpose

The additional axes option is used when the robot controller needs to control additional axes besides the robot axes. These axes are synchronized and, if desired, coordinated with the movement of the robot, which results in high speed and high accuracy.

Standalone controller is an ABB controller delivered without an ABB robot. The purpose is to use it to control non-ABB equipment.

When the controller is used in a robot system with external axes or a non-ABB manipulator, the system requires configuration and tuning as detailed in this manual. This manual can also be useful when such a system needs to be upgraded.

As external axes and non-ABB robots consume more power the drive system needs a more powerful transformer, rectifier and capacitor. In addition, suitable drive units must be installed in the controller. The hardware setup must also be configured with software to make the system functional.

Basic approach

This is the basic approach for the setup of additional axes or a standalone controller.

- Installation
- Configuration
- Tuning

For a detailed description of how this is done, see the respective section.

For more information on the hardware components see [Hardware on page 149](#).



WARNING

The manual mode peripheral speed of the external axis must be restricted to 250mm/s for personal safety reasons. The speed is supervised at three different levels, which means that three system parameters need to be set up. For more information see [Limit peripheral speed of external axis on page 65](#).

1 Introduction

1.2 Definitions

1.2 Definitions

Robot

A robot is a mechanical unit with a tool center point (TCP). A robot can be programmed both in Cartesian coordinates (x, y and z) of the TCP and in tool orientation.

Single-robot system

A single-robot system can have

- only one motion task
- only one robot
- up to 6 additional axes (which can be grouped in an arbitrary number of mechanical units)



Note

When adding more than one external axis, an additional drive cabinet may be required (depending on manipulator and controller combination, see [Configuration of the drive system on page 149](#)). To establish communication between the robot controller and an additional drive cabinet, the option *MultiMove Independent* is required.

- up to 12 axes in total (located in one or two drive modules)



Tip

In a single-robot system, semi-independent programming of individual mechanical units or axes can be achieved through the option *Independent Axes*. However, *MultiMove* is normally preferred when independent programming is desired.

MultiMove system

A MultiMove system can have

- up to 7 motion tasks
 - up to 4 robots
 - up to 4 drive modules (i.e. up to 36 axes including the robot axes)
-

Additional axes

The robot controller can control additional axes besides the robot axes. They can be jogged and coordinated with the movements of the robot. The system may have a single additional axis, for example, a motor, or a set of additional axes such as a two axis positioner.

Continues on next page

Standalone controller

Standalone controller means an ABB controller delivered without an ABB robot. The standalone controller can be used to control non-ABB equipment, usually TCP robots. It can be used for single-robot and MultiMove systems alike. MultiMove makes it possible to configure and run multiple mechanical units on the same drive module.

1 Introduction

1.3 General guidelines and limitations

1.3 General guidelines and limitations

Use integer gear ratio

The transmission gear ratio between motor and arm of a continuously rotating axis shall be an integer in order not to cause calibration problems when updating revolution counters.

When the revolution counter is updated, the number of motor revolutions is reset. In order for the zero position of the motor to coincide with the zero position of the arm, independent of number of revolutions on the arm side, the gear ratio needs to be an integer (not a decimal number).

Example: Gear ratio = 1:81 (not 1:81.73).

This problem will only be visible when updating revolution counters with the arm side rotated n turns from the original zero position. I.e. an axis with mechanical stops will not have this problem.

2 Getting started

2.1 Get started with additional axes, servo guns and non-ABB robots

Overview

This section describes the steps to get started with:

- additional axes
- a servo gun
- non-ABB robots

Step by step

	Action	See
1	Install the hardware, such as motor unit, connection box cables and connectors.	See the product manual for the respective product.
2	For additional axes and servo guns there are various template files available depending on the setup of the hardware. If the user does not already have a specific template file, see information on what file to use.	Template files on page 22.
3	For a non-ABB robot find the Kinematic model to be used.	Kinematic models on page 28.
4	Install the RobotWare software and create a system using RobotStudio.	Creating a standalone controller system on page 64.
5	Download the system to the robot controller.	
6	Use RobotStudio or the FlexPendant for a basic configuration of system parameters.	Limit peripheral speed of external axis on page 65. Minimal configuration of general additional axes on page 67 or Minimal configuration of servo gun on page 69 or Minimal configuration of non-ABB robots on page 72.
7	Verify if any advanced setting needs to be done.	Advanced settings on page 77.
8	When the configuration is done, the system needs to be fine calibrated and tuned.	Commutation with service routine on page 106. Tuning of servo control parameters on page 111.

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3 Installation

3.1 Additional axes and servo guns

3.1.1 Standard additional axis

Overview

Normally all necessary configuration parameters regarding drive unit, rectifiers and transformers are pre-loaded at ABB, and do not need to be re-installed. For more information on how to add options to the system, see *Operating manual - RobotStudio* or *Operating manual - IRC5 Integrator's guide*.

Peripheral equipment

If the supplier of other equipment, such as track motion or peripheral equipment, supplies configuration files, these files should be used instead of the standard files. For more information, see the documentation provided by the supplier.

3 Installation

3.1.2 Template files

3.1.2 Template files

Overview

This section details the template files for respective hardware. Normally you only need to change the motor data in these files. For more information on how to change these files, see *Operating manual - RobotStudio*.

The template files are located in the following directory in the RobotWare installation: ...*RobotPackages\RobotWare_RPK_<version>\utility\AdditionalAxis*.



Tip

Navigate to the RobotWare installation folder from the RobotStudio **Add-Ins** tab, by right-clicking on the installed RobotWare version in the **Add-Ins** browser and selecting **Open Package Folder**.

Motors

There are template files used to connect the motors to the drive system and measurement system.

Listed below are files for motors connected to drive module 1. They are located in: ...*utility\AdditionalAxis\General\DM1*.

Similar template files exist for drive modules 2-4. These files are adjusted for additional axes on the same drive unit as a robot.

File name	Measurement link	Board position	Measurement node
M7L1B1_DM1.cfg	1	1	7
M7L1B2_DM1.cfg	1	2	7
M7L2B1_DM1.cfg	2	1	1
M8L2B1_DM1.cfg	2	1	2
M9L2B1_DM1.cfg	2	1	3

There are also common template files for a general purpose. These files exist for drive module 1-4 (but are rarely used for drive module 1 since axes 1-6 for drive module 1 are usually used by the robot). Listed below are these files for drive module 2. They are located in: ...*utility\AdditionalAxis\IRC_U\DM2*.

File name	Measurement link	Board position	Measurement node
M1_DM2	1	1	1
M2_DM2	1	1	2
M3_DM2	1	1	3
M4_DM2	1	1	4
M5_DM2	1	1	5
M6_DM2	1	1	6

Template files for defining general kinematics can be found in: ...*utility\AdditionalAxis\GeneralKinematics\DM1*.

Continues on next page

These files exist for drive module 1-4. The measurement link, board position and measurement node are all configured as for a regular robot. The manipulator XZB(X) is chosen as it is composed of two linear and one rotating axis thus highlighting the import settings described in section [Defining parameters for general kinematics on page 91](#).

Listed below are the configuration files for drive module 1. Primarily the "_11"-files should be used. The other files exist to support the case when the XZB(X) manipulator is connected together with for example another XZB(X) manipulator on the same drive module.

Load all four "_11"-files (or all "_12"-files if it is the second XZB(X), "_13" for the third and "_14" for the fourth) and then restart the controller.

File name
EXT_XZB(X)_TEMPLATE_11.cfg
INT_XZB(X)_TEMPLATE_11.cfg
SEC_XZB(X)_TEMPLATE_11.cfg
UNCALIB_11.cfg

Servo gun or track motion

The template files for servo gun and track motion are all prepared for drive module 1-4. The files contain default data for servo gun and track motion. Motor data etc. for selected motor must be changed. Listed below are the template files for drive module 1.

Servo Gun template files located in: ...*utility\AdditionalAxis\ServoGun*.

File name	Measurement link	Board position	Measurement node
M7L1B1S_DM1.cfg	1	1	7
M7L1B2S_DM1.cfg	1	2	7
M8L2B1S_DM1.cfg	2	1	2

Track motion template files located in: ...*utility\AdditionalAxis\Track*.

File name	Measurement link	Board position	Measurement node
M7L1B1T_DM1.cfg	1	1	7
M7L1B2T_DM1.cfg	1	2	7
M8L2B1T_DM1.cfg	2	1	2

Recommended combinations

The following combination of configuration files for motor 7, 8, and 9 are the recommended combinations in one drive module.

Motor 7	Motor 8	Motor 9
M7L1B1_DM1.cfg	M8L2B1_DM1.cfg	M9L2B1_DM1.cfg
M7L1B2_DM1.cfg	M8L2B1_DM1.cfg	M9L2B1_DM1.cfg
M7L2B1_DM1.cfg	M8L2B1_DM1.cfg	M9L2B1_DM1.cfg

Continues on next page

3 Installation

3.1.2 Template files

Continued



Note

See examples in [Serial Measurement Link examples on page 158](#).

3.1.3 Serial measurement system configuration

Overview

The following section details how to configure the measurement link.

Measurement Channel

The Measurement Channel parameters can easily be changed via RobotStudio or the FlexPendant. Select the configuration topic *Motion* and the type *Measurement Channel*. Another alternative is to edit the parameters in the file `MOC.cfg` and load this file to the controller. For information about how to load a `cfg` file, see *Operating manual - RobotStudio*.

	Action	Info/Illustration
1	Select the serial measurement link by changing the value of the parameter <i>Measurement Link</i> .	selectable values: 1 or 2
2	Select the SMB placement by changing the value of the parameter <i>Board Position</i> .	selectable values: 1 or 2
3	Select the measurement node by changing the value of the parameter <i>Measurement Node</i> .	selectable values: 1 to 7



Note

Each node (1 to 7) must not be used more than once on each serial measurement link.

3 Installation

3.2.1 Introduction

3.2 Non ABB robots

3.2.1 Introduction

Overview

This section details how to create and install a standalone controller system, i.e. a system to be used with non-ABB robots. The basic steps to do this are as follows:

- Find the correct drive unit configuration.
- Find the appropriate kinematic model.
- Install RobotWare and the standalone controller software on your PC.
- Create a standalone controller system with the selected kinematic model.
- Download the system to the robot controller.

This section also details how to modify and distribute a standalone package for easy installation and startup at a customer.

3.2.2 Drive module for non-ABB robots

Drive unit configuration

The table shows the different drive units available for non-ABB robots.

No of axes	Corresponding robot	Drive units
6	IRB 140, 1410, 1600	MDU-430A
4	IRB 260, 360	MDU-430A
6	IRB 2400, 2600, 4400, 4600, 66xx, 7600	MDU-790A
4	IRB 460, 660, 760 IRB 4400, 66xx (with only 4 active drives)	MDU-790A

For definitions of drive units and power stages see [Drive units on page 155](#).

3 Installation

3.2.3.1 Introduction

3.2.3 Kinematic models

3.2.3.1 Introduction

Overview

This section describes the different built-in kinematic models available in the controller. It serves as a guideline for choosing the appropriate model for the current robot system.

Model groups

The table below describes the different groups of kinematic models.

Notation:	Indicates:
Single Axes	one axis
Area	three to six axes
Linear	two to five axes
TopLoader	four to six axes
Doppin Feeder	two or three axes

Model notation

The specific kinematic models within a model group are designated with a combination of capital letters. The table below details the meaning of this notation.

Notation:	Indicates:
X, Y, Z	linear motion
A, B, C, D, E, F	rotational movement
A(X)	rotational movement around X-axis
A(Y)	rotational movement around Y-axis
A(Z)	rotational movement around Z-axis



Note

The base frame is orientated so that the linear motions are parallel to the directions of the base frame axes X, Y and Z.

Related information

Useful information:

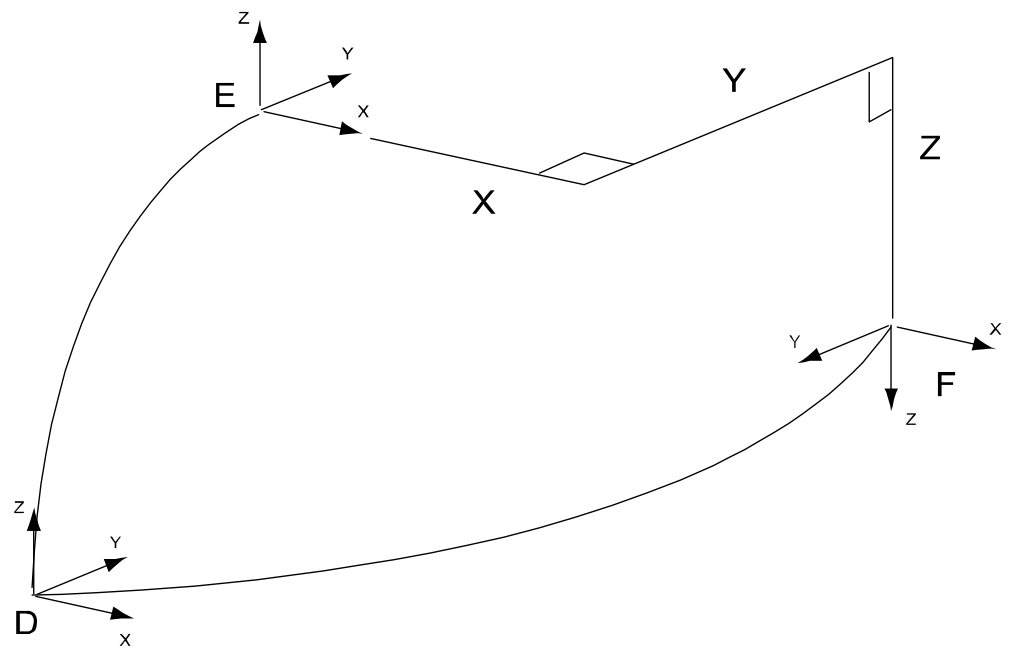
- Read about base and world coordinates in *Operating manual - IRC5 with FlexPendant*, section *Jogging*.

3.2.3.2 Kinematic model XYZ

Description

The kinematic model is based on an area gantry concept, with three linear motions and no rotations.

Illustration



xx0300000614

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion

3 Installation

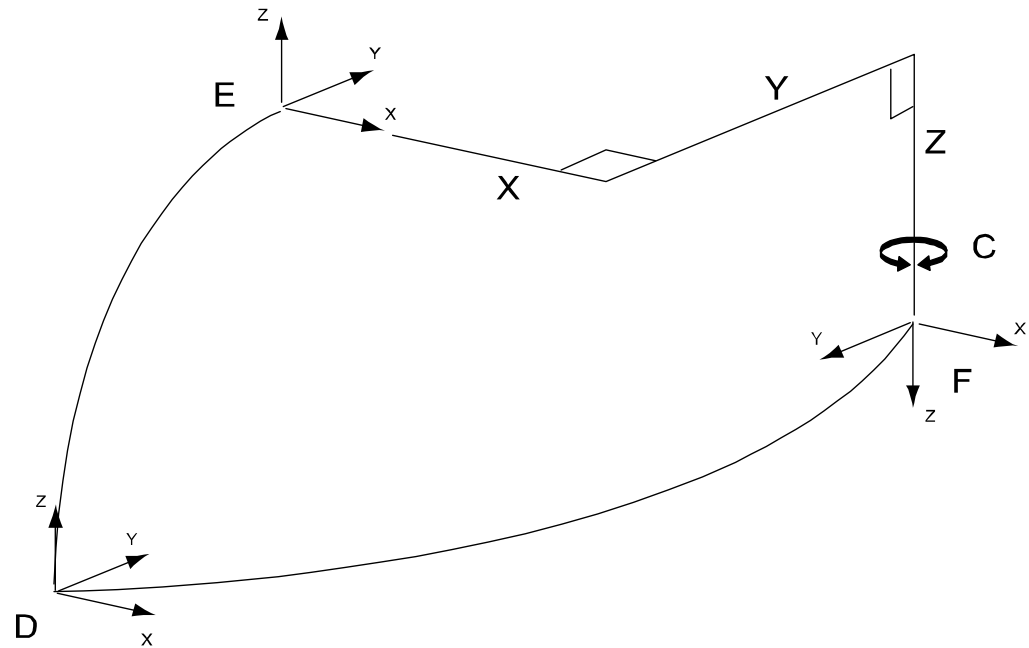
3.2.3.3 Kinematic model XYZC(Z)

3.2.3.3 Kinematic model XYZC(Z)

Description

The kinematic model is based on an area gantry concept, with three linear motions and one rotation.

Illustration



xx0300000616

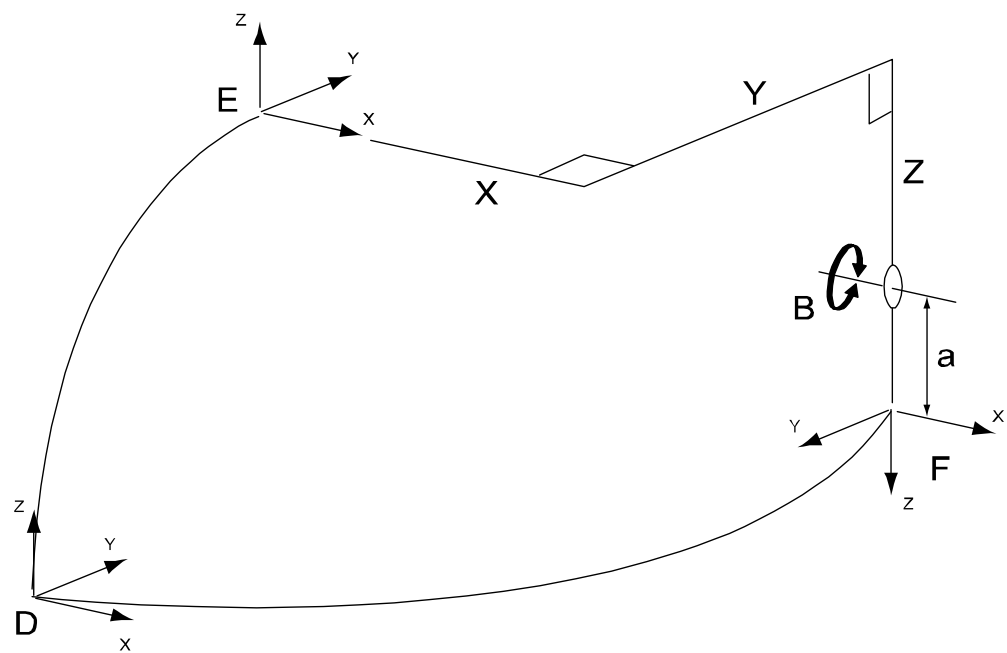
D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame

3.2.3.4 Kinematic model XYZB(X)

Description

The kinematic model is based on an area gantry concept, with three linear motions and one rotation.

Illustration



xx0300000617

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
a	offset_z of arm "robx_6"

3 Installation

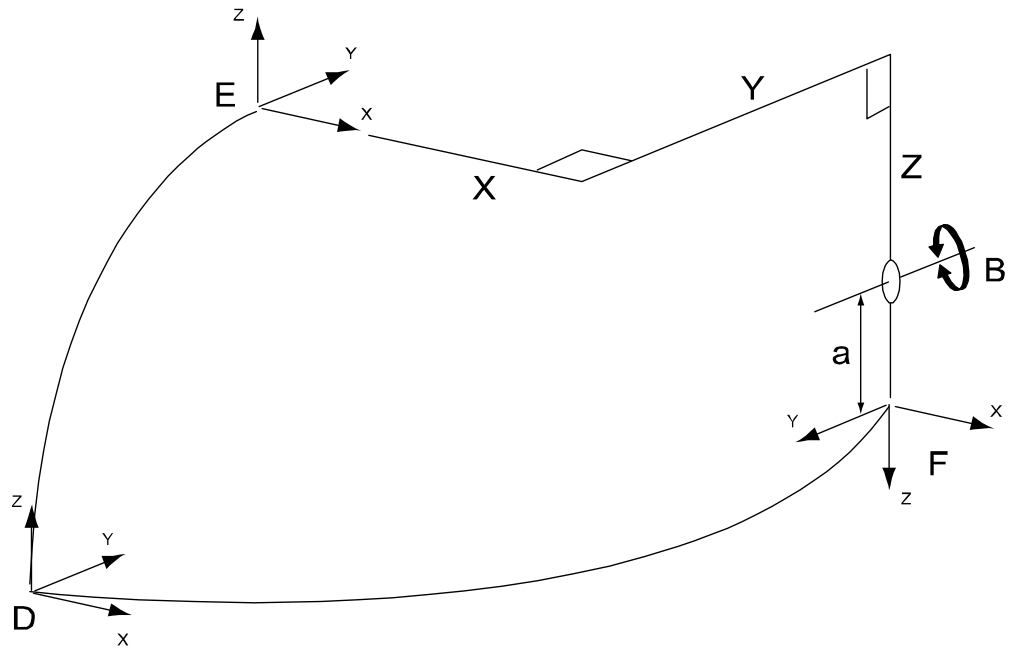
3.2.3.5 Kinematic model XYZB(Y)

3.2.3.5 Kinematic model XYZB(Y)

Description

The kinematic model is based on an area gantry concept, with three linear motions and one rotation.

Illustration



xx0300000618

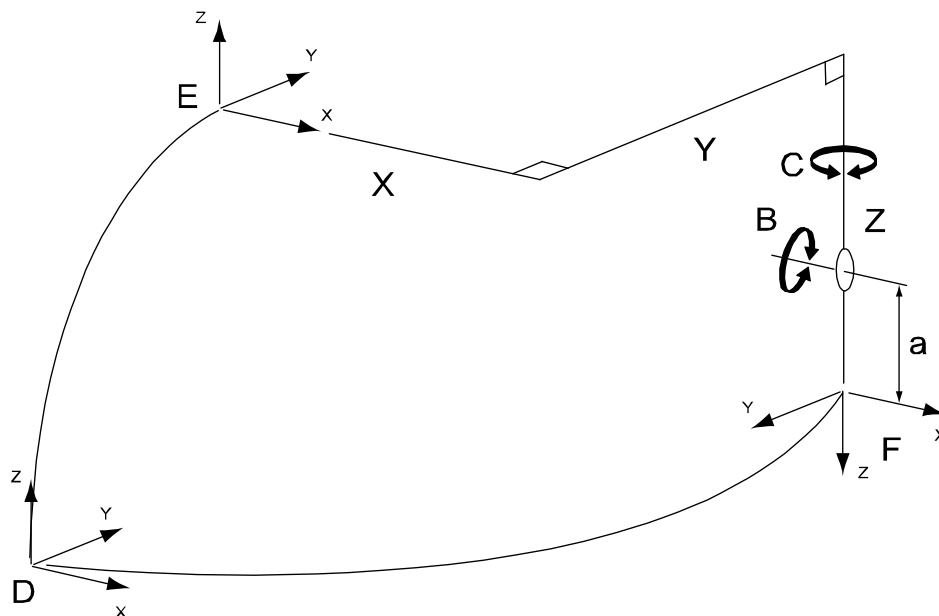
D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
a	offset_z of arm "robx_6"

3.2.3.6 Kinematic model XYZC(Z)B(X)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations.

Illustration



xx0500002122

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame
a	offset_z of arm "robx_6"

3 Installation

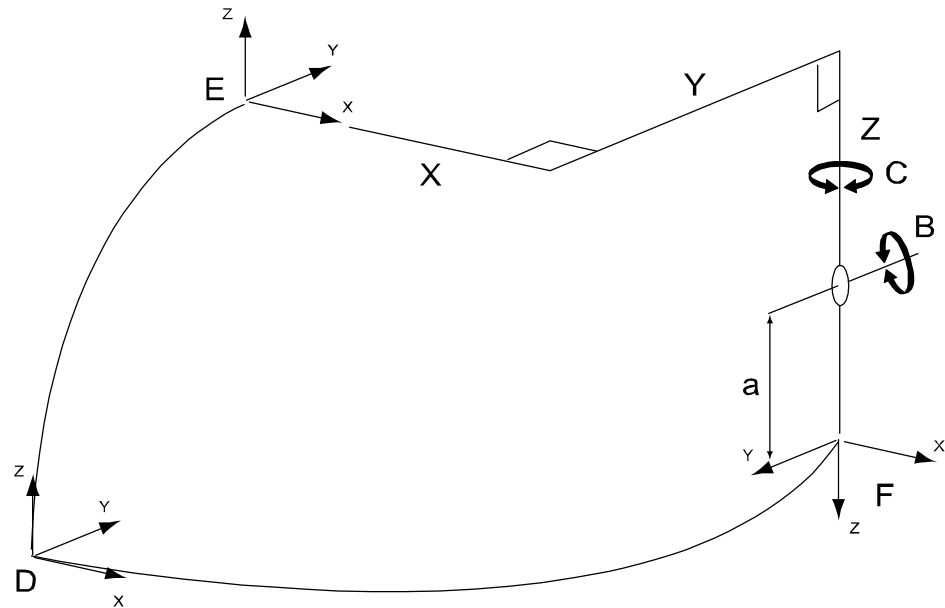
3.2.3.7 Kinematic model XYZC(Z)B(Y)

3.2.3.7 Kinematic model XYZC(Z)B(Y)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations.

Illustration



xx0500002123

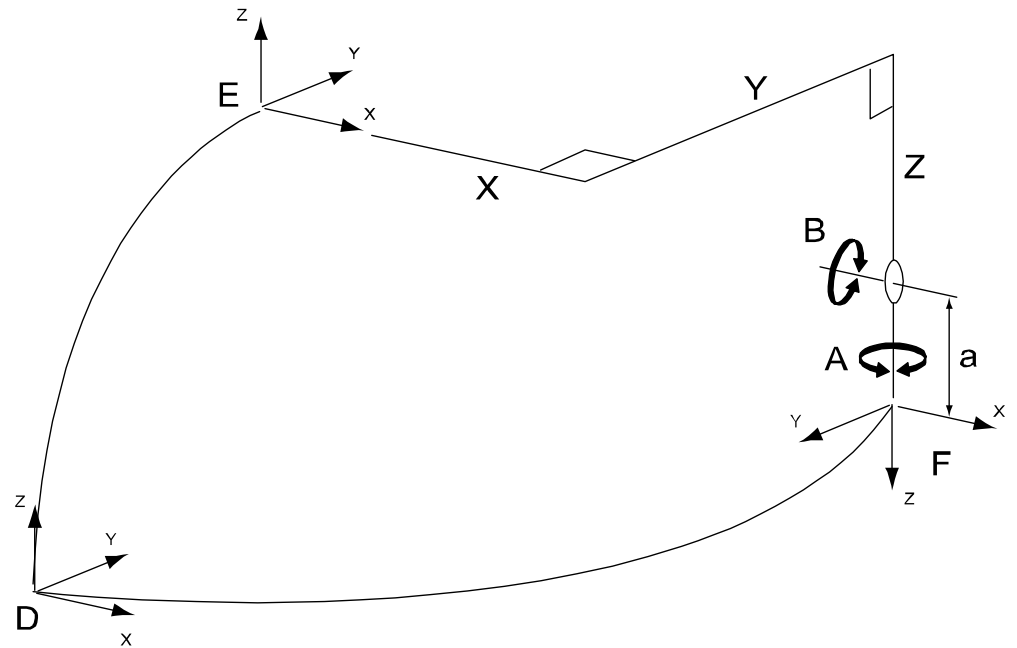
D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around Y axis in base frame
a	<i>offset_z</i> of arm "robx_6"

3.2.3.8 Kinematic model XYZB(X)A(Z)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations.

Illustration



xx0300000619

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3 Installation

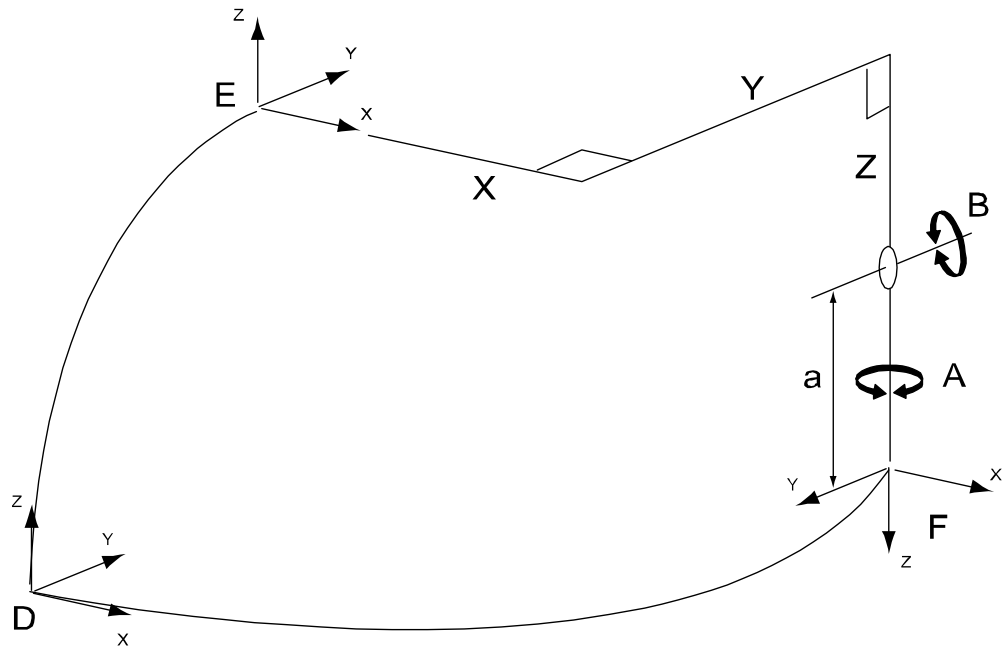
3.2.3.9 Kinematic model XYZB(Y)A(Z)

3.2.3.9 Kinematic model XYZB(Y)A(Z)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations.

Illustration



xx0300000620

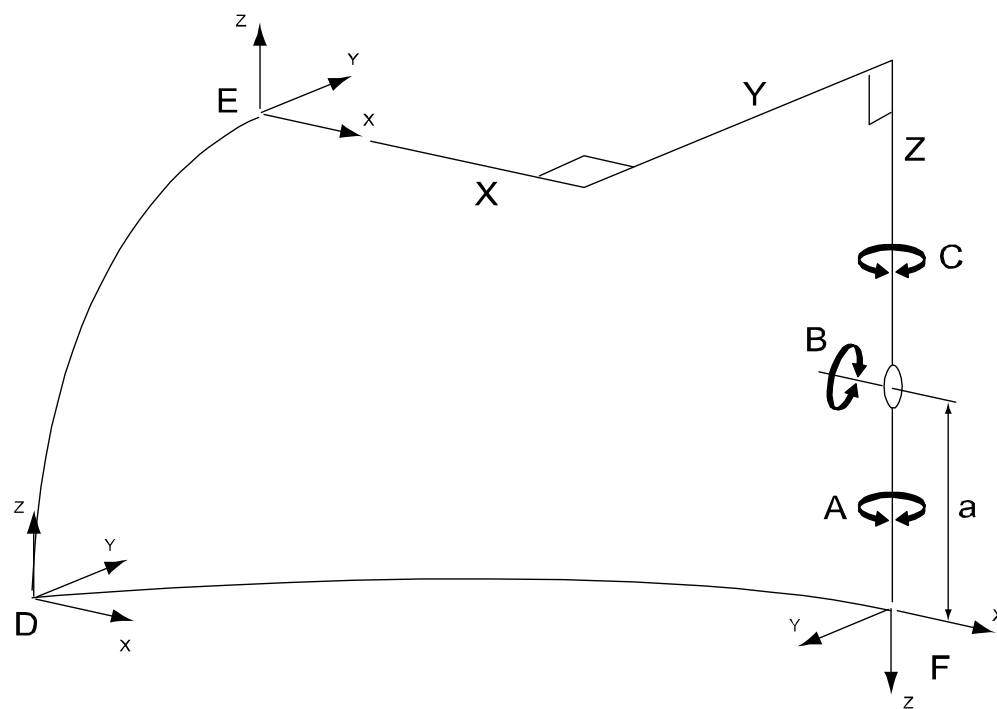
D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3.2.3.10 Kinematic model XYZC(Z)B(X)A(Z)

Description

The kinematic model is based on an area gantry concept, with three linear motions and three rotations.

Illustration



xx0300000621

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame when C is zero
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3 Installation

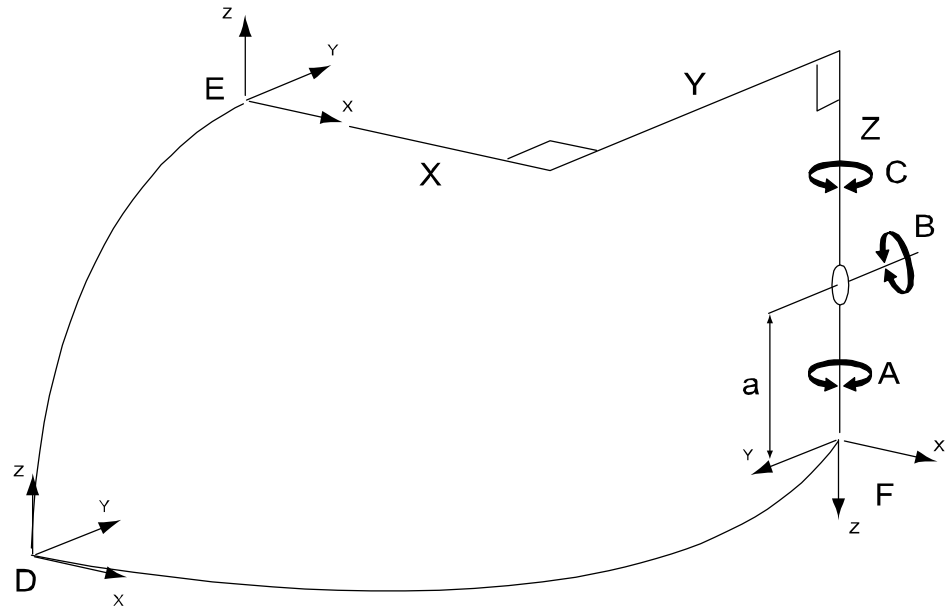
3.2.3.11 Kinematic model XYZC(Z)B(Y)A(Z)

3.2.3.11 Kinematic model XYZC(Z)B(Y)A(Z)

Description

The kinematic model is based on an area gantry concept, with three linear motions and three rotations.

Illustration



xx0500002211

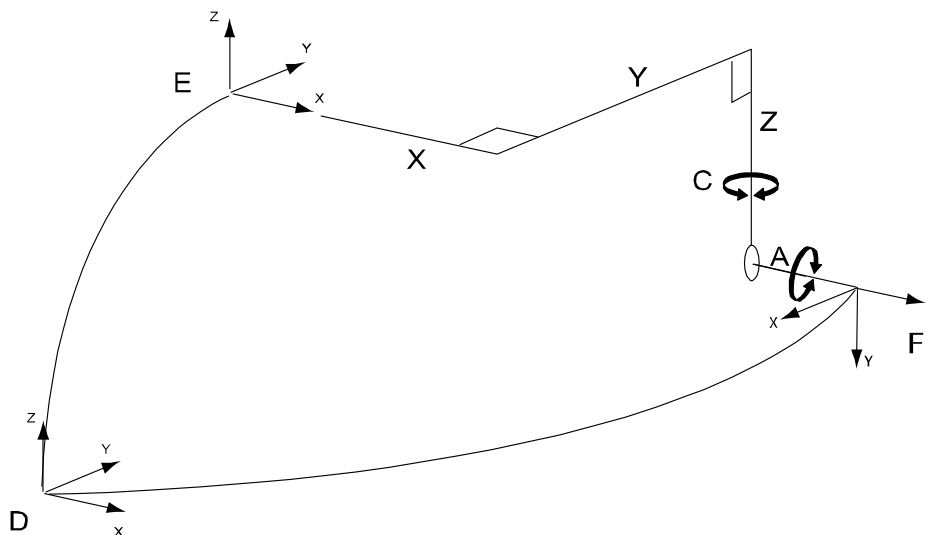
D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around Y axis in base frame when C is zero
A	A rotating around Z axis in base frame if B is zero
a	offset _z of arm "robx_6"

3.2.3.12 Kinematic model XYZC(Z)A(X)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations.

Illustration



xx0500002202

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
A	A rotating around X axis in base frame

3 Installation

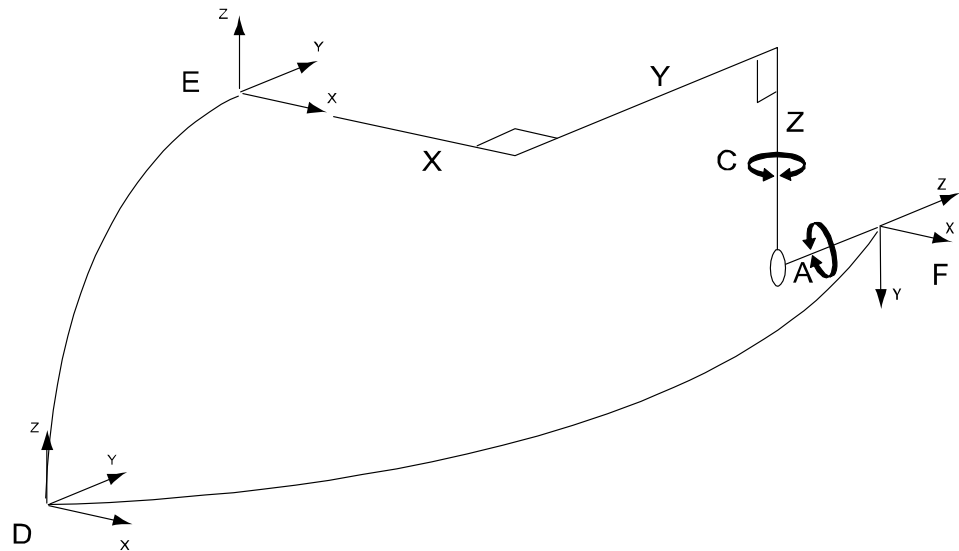
3.2.3.13 Kinematic model XYZC(Z)A(Y)

3.2.3.13 Kinematic model XYZC(Z)A(Y)

Description

The kinematic model is based on an area gantry concept, with three linear motions and two rotations

Illustration



xx0500002203

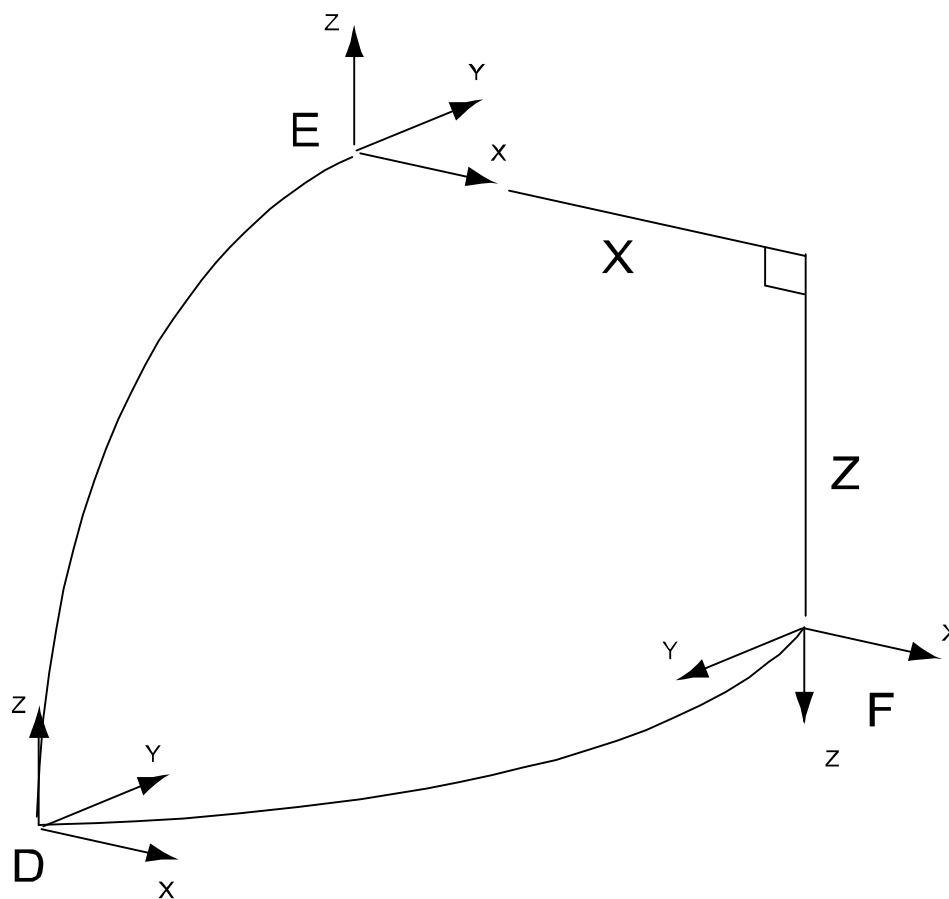
D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
A	A rotating around Y axis in base frame

3.2.3.14 Kinematic model XZ

Description

The kinematic model is based on a linear gantry concept, with two linear motions.

Illustration



xx0500002110

D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion

3 Installation

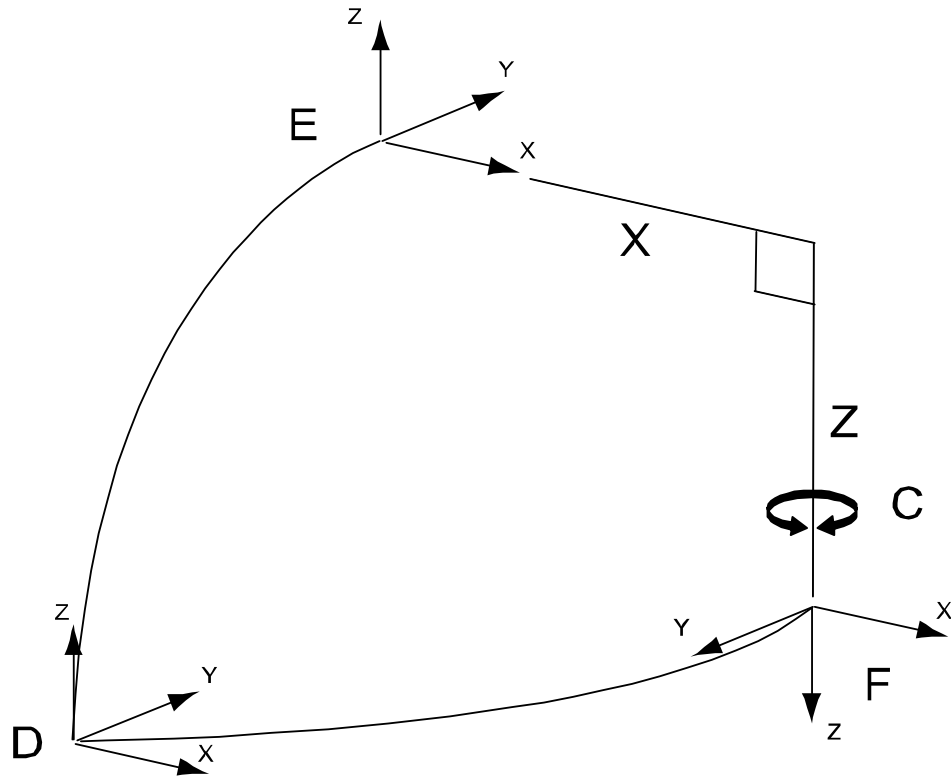
3.2.3.15 Kinematic model XZC(Z)

3.2.3.15 Kinematic model XZC(Z)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and one rotation.

Illustration



xx0500002115

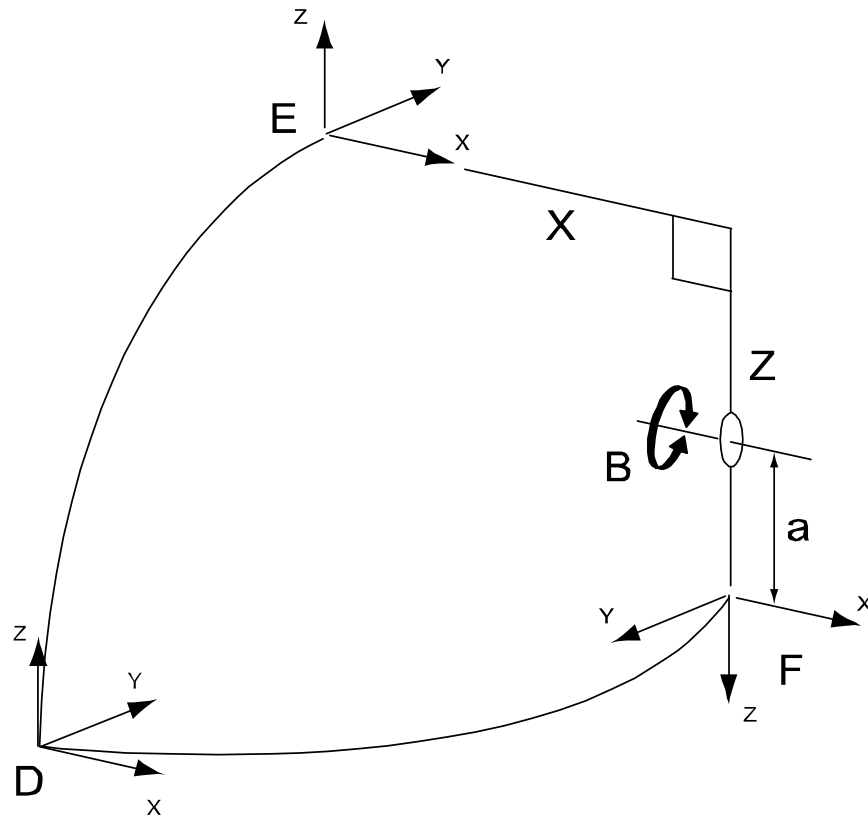
D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame

3.2.3.16 Kinematic model XZB(X)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and one rotation.

Illustration



xx0500002111

D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
a	offset_z of arm "robx_6"

3 Installation

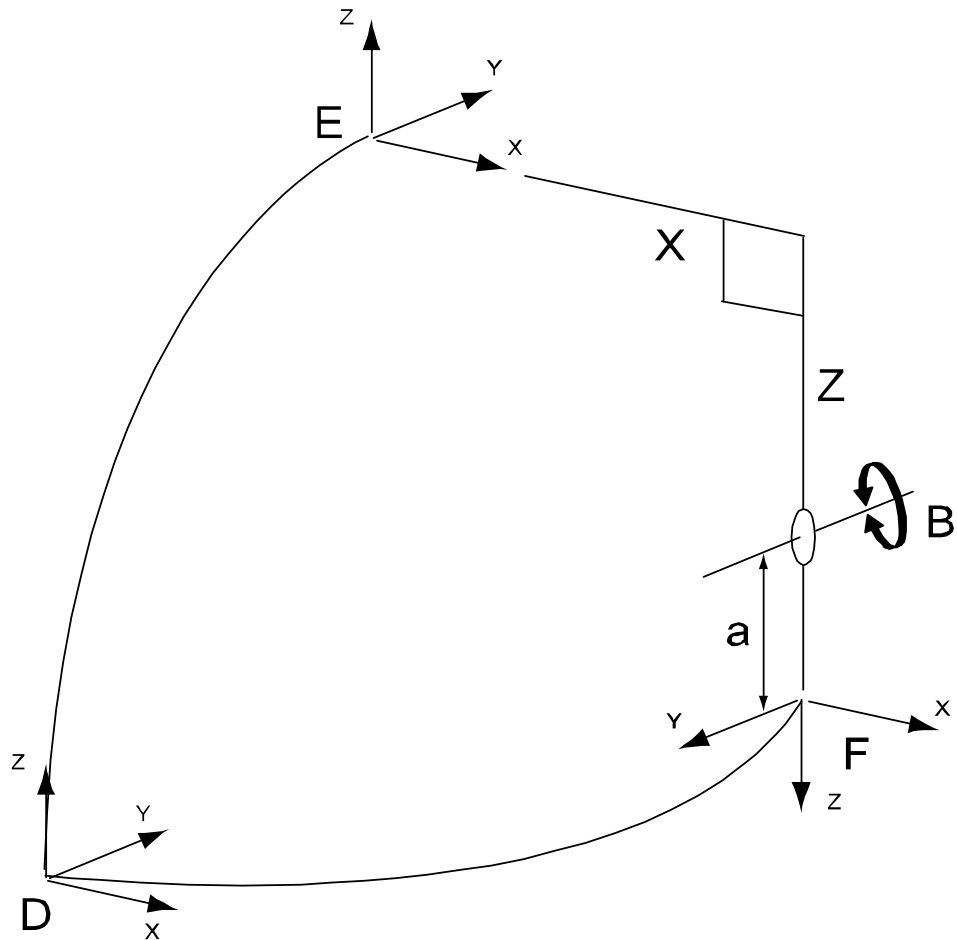
3.2.3.17 Kinematic model XZB(Y)

3.2.3.17 Kinematic model XZB(Y)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and one rotation.

Illustration



xx0500002113

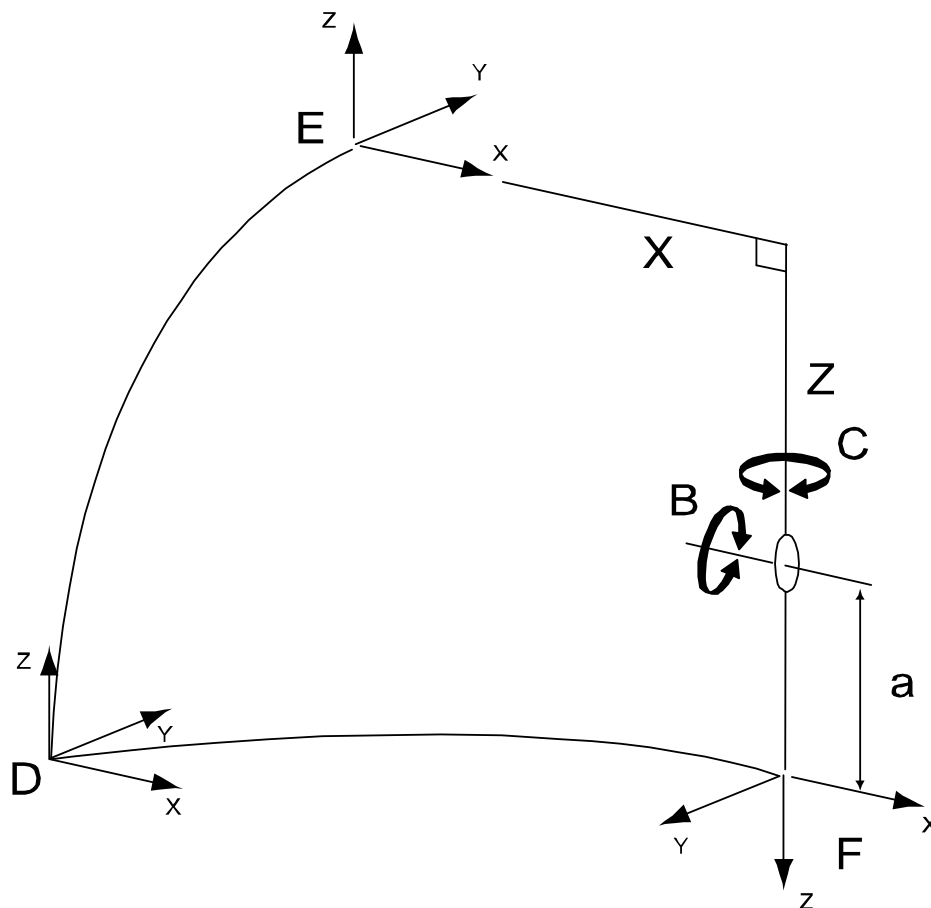
D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
a	offset_z of arm "robx_6"

3.2.3.18 Kinematic model XZC(Z)B(X)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002116

D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame
a	offset_z of arm "robx_6"

3 Installation

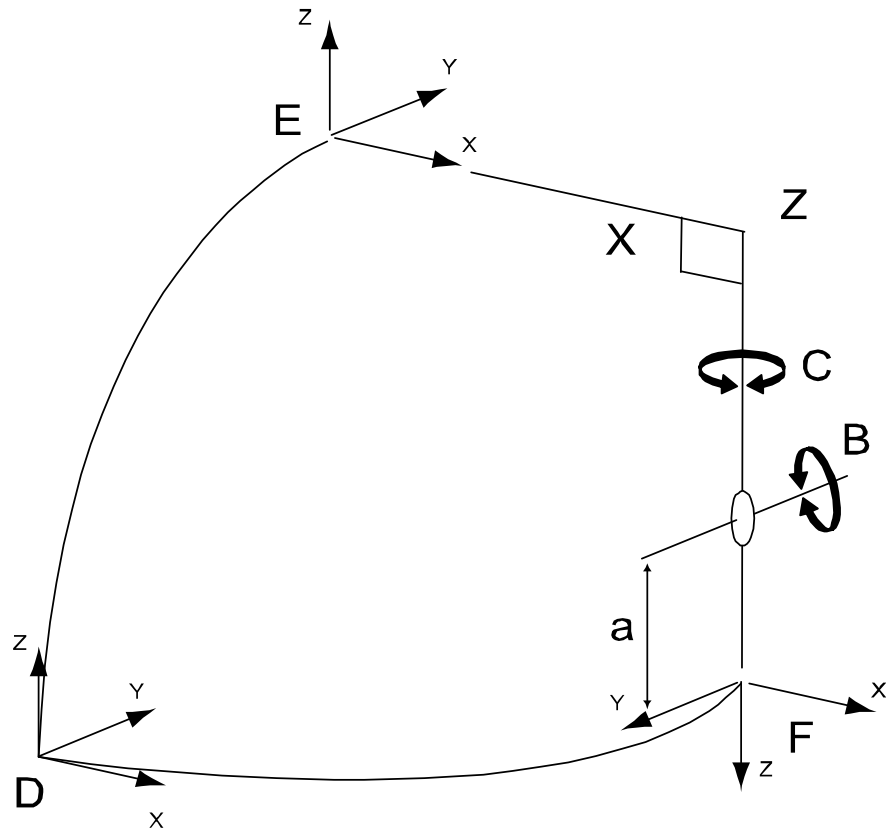
3.2.3.19 Kinematic model XZC(Z)B(Y)

3.2.3.19 Kinematic model XZC(Z)B(Y)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002118

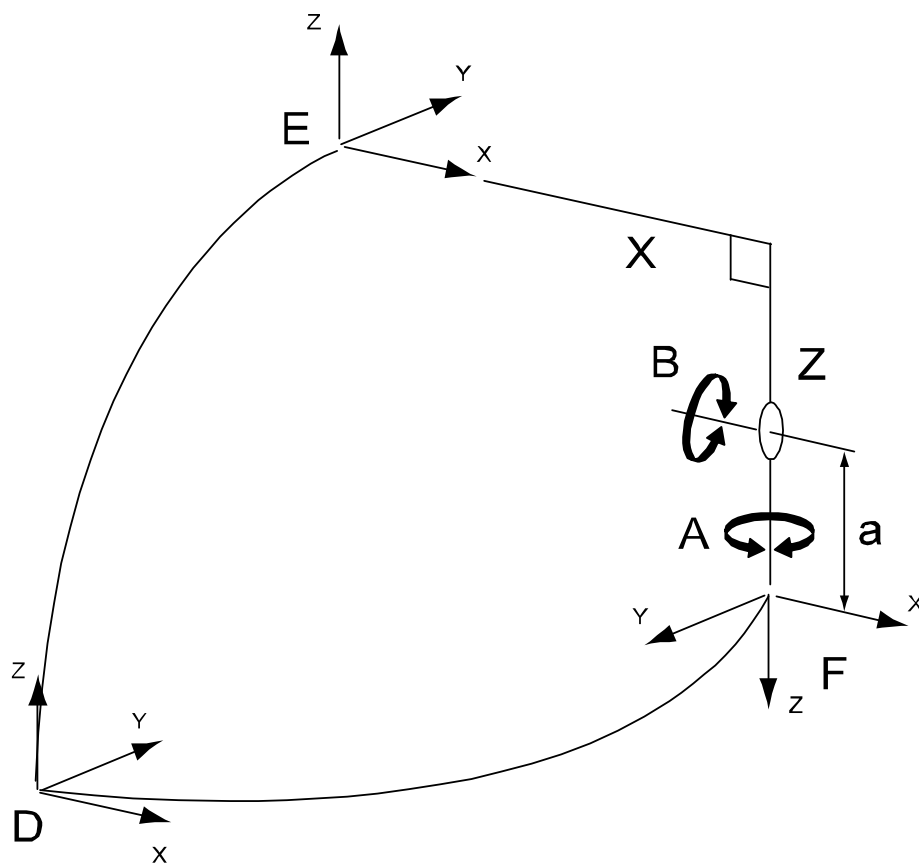
D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around Y axis in base frame
a	offset_z of arm "robx_6"

3.2.3.20 Kinematic model XZB(X)A(Z)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002112

D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
A	A rotating around Z axis in base frame
a	offset_z of arm "robx_6"

3 Installation

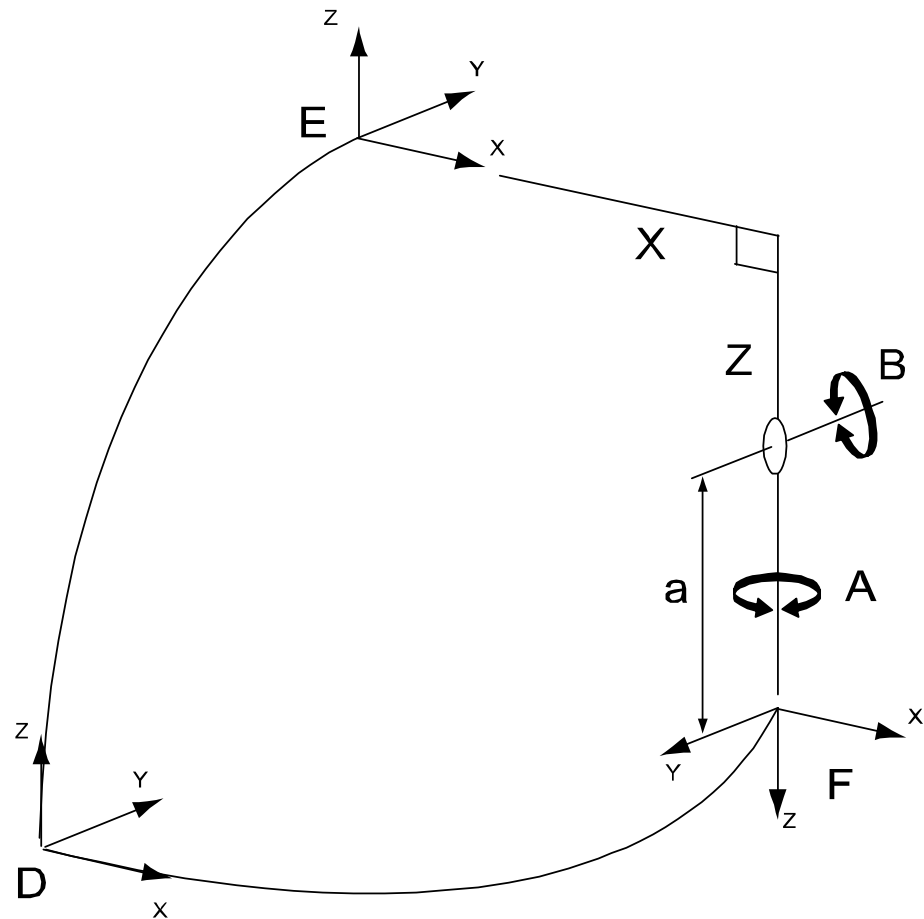
3.2.3.21 Kinematic model XZB(Y)A(Z)

3.2.3.21 Kinematic model XZB(Y)A(Z)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002114

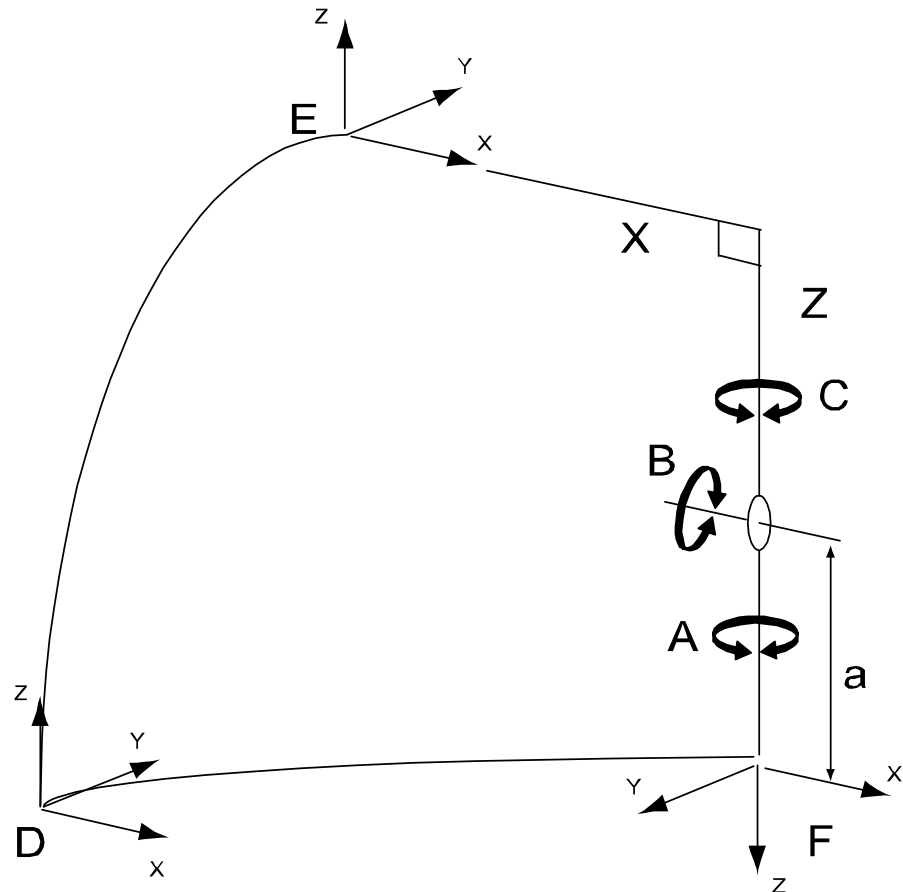
D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
A	A rotating around Z axis in base frame
a	offset_z of arm "robx_6"

3.2.3.22 Kinematic model XZC(Z)B(X)A(Z)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and three rotations.

Illustration



xx0500002117

D	World Frame
E	Base Frame
F	Tool Frame
X	X-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame if C is zero
A	A rotating around Z axis in base frame
a	offset_z of arm "robx_6"

3 Installation

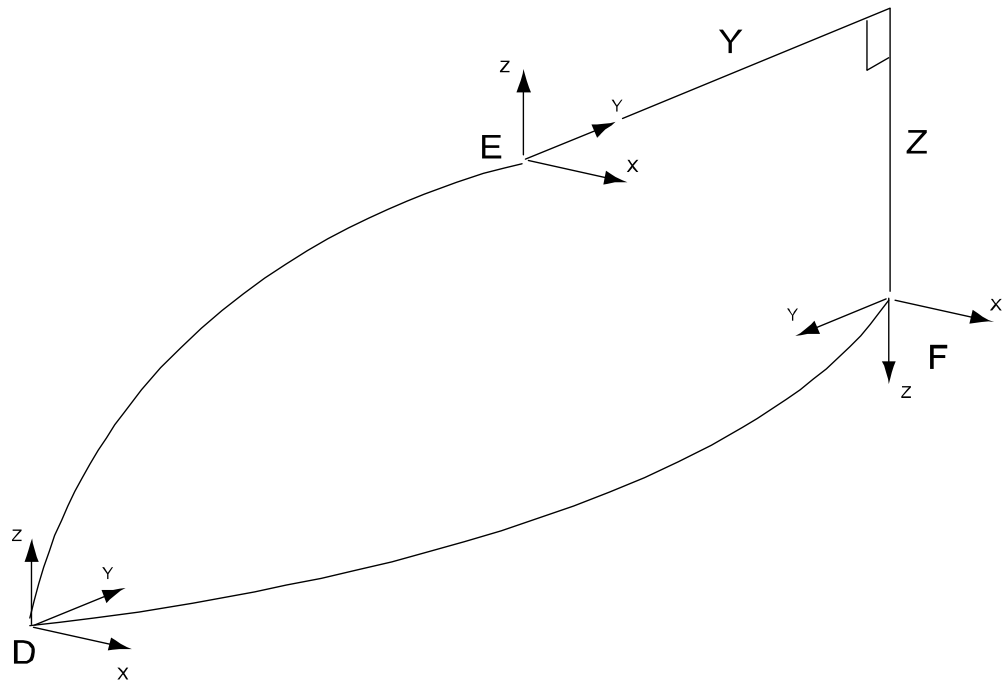
3.2.3.23 Kinematic model YZ

3.2.3.23 Kinematic model YZ

Description

The kinematic model is based on a linear gantry, with two linear motions and no rotation.

Illustration



xx0300000622

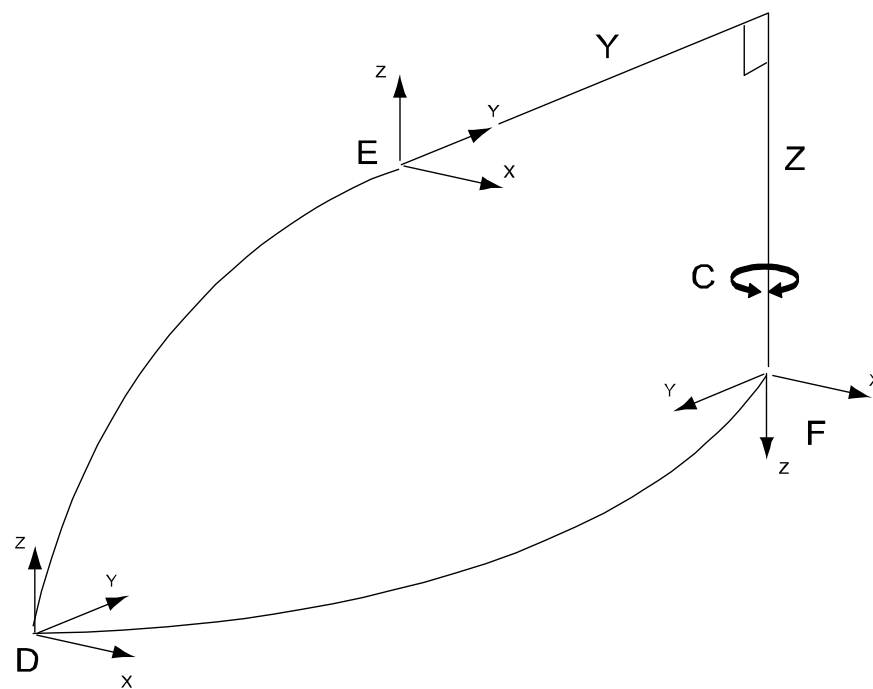
D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion

3.2.3.24 Kinematic model YZC(Z)

Description

The kinematic model is based on a linear gantry, with two linear motions and one rotation.

Illustration



xx0300000623

D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame

3 Installation

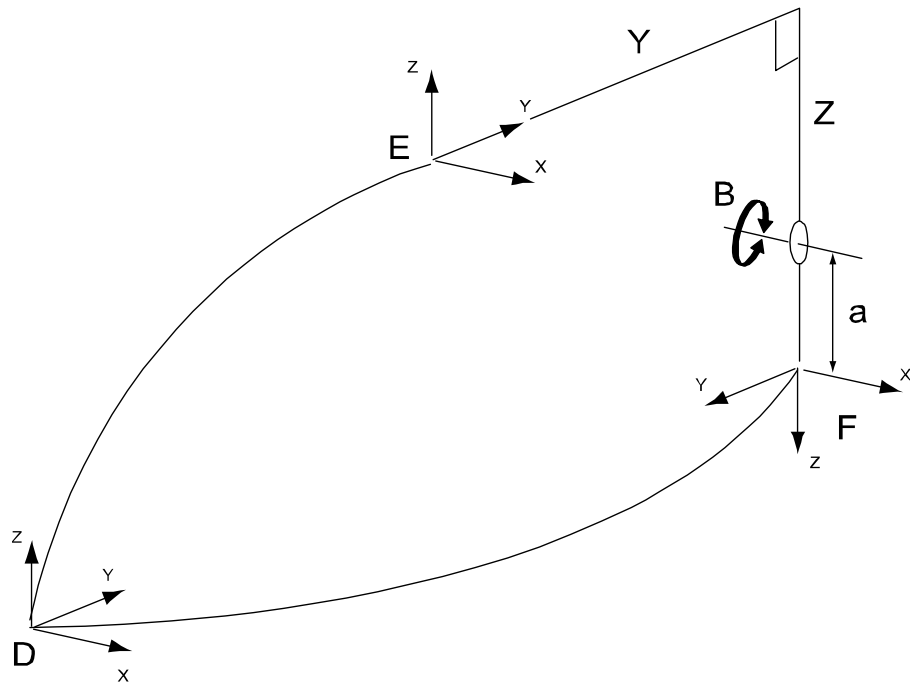
3.2.3.25 Kinematic model YZB(X)

3.2.3.25 Kinematic model YZB(X)

Description

The Y_Z_B(X) is a kinematic model, based on a linear gantry, with two linear motions and one rotation.

Illustration



xx0300000624

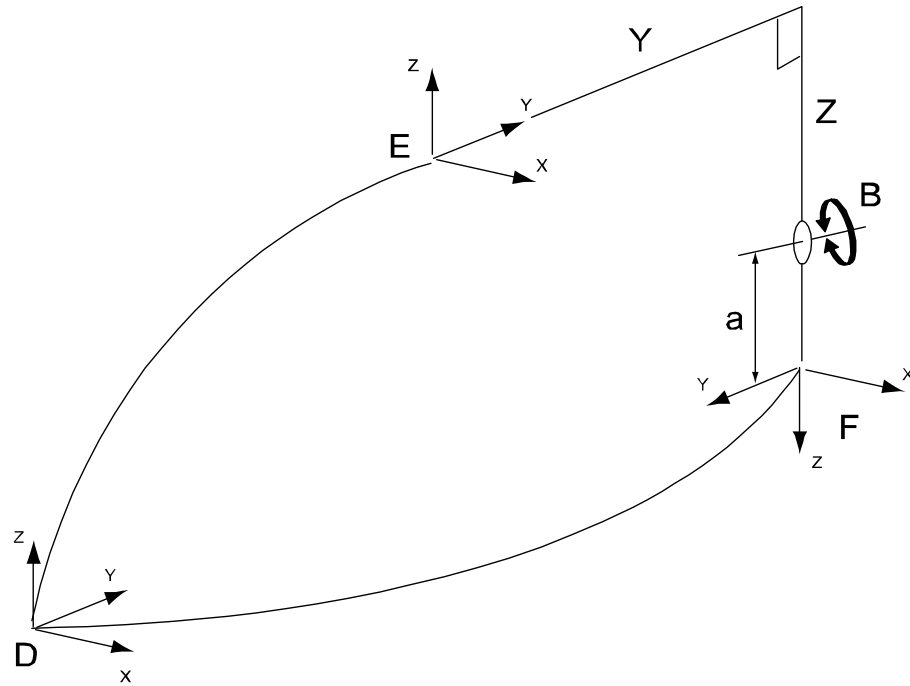
D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
a	offset_z of arm "robx_6"

3.2.3.26 Kinematic model YZB(Y)

Description

The kinematic model is based on a linear gantry, with two linear motions and one rotation.

Illustration



xx0300000625

D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
a	offset_z of arm "robx_6"

3 Installation

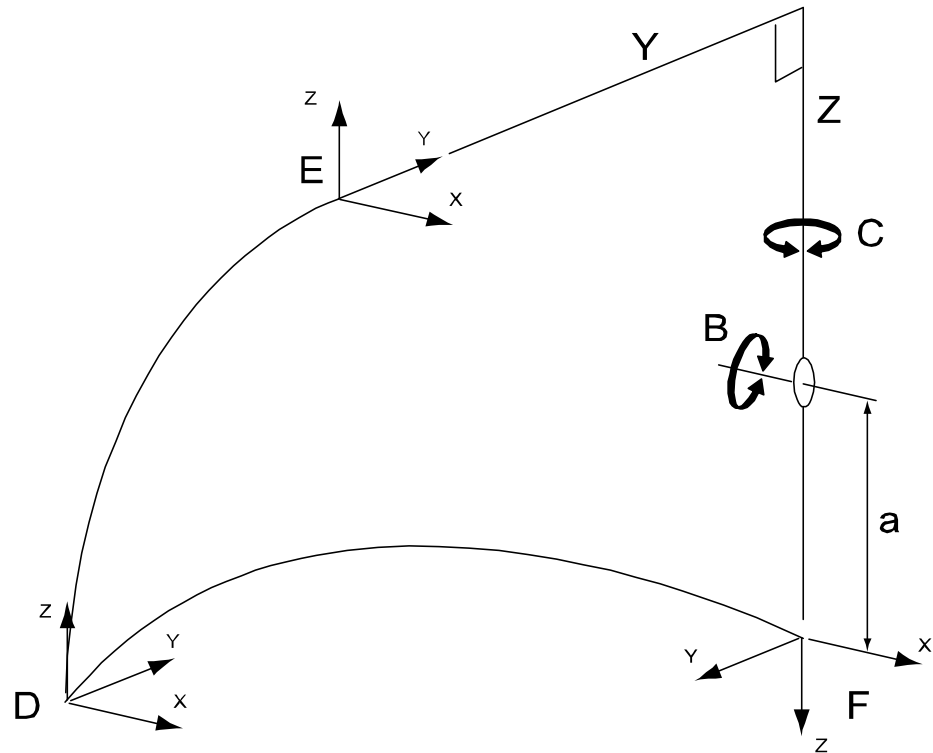
3.2.3.27 Kinematic model YZC(Z)B(X)

3.2.3.27 Kinematic model YZC(Z)B(X)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002119

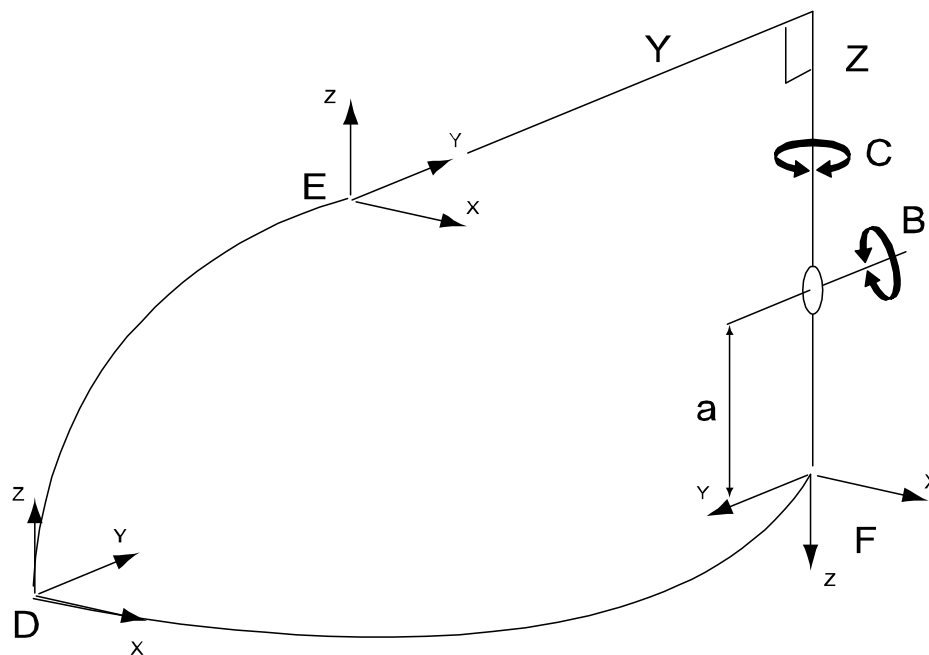
D	World Frame
E	Base Frame
F	Tool Frame
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame if C is zero
a	offset_z of arm "robx_6"

3.2.3.28 Kinematic model YZC(Z)B(Y)

Description

The kinematic model is based on a linear gantry concept, with two linear motions and two rotations.

Illustration



xx0500002120

D	World Frame
E	Base Frame
F	Tool Frame
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around Y axis in base frame
a	offset_z of arm "robx_6"

3 Installation

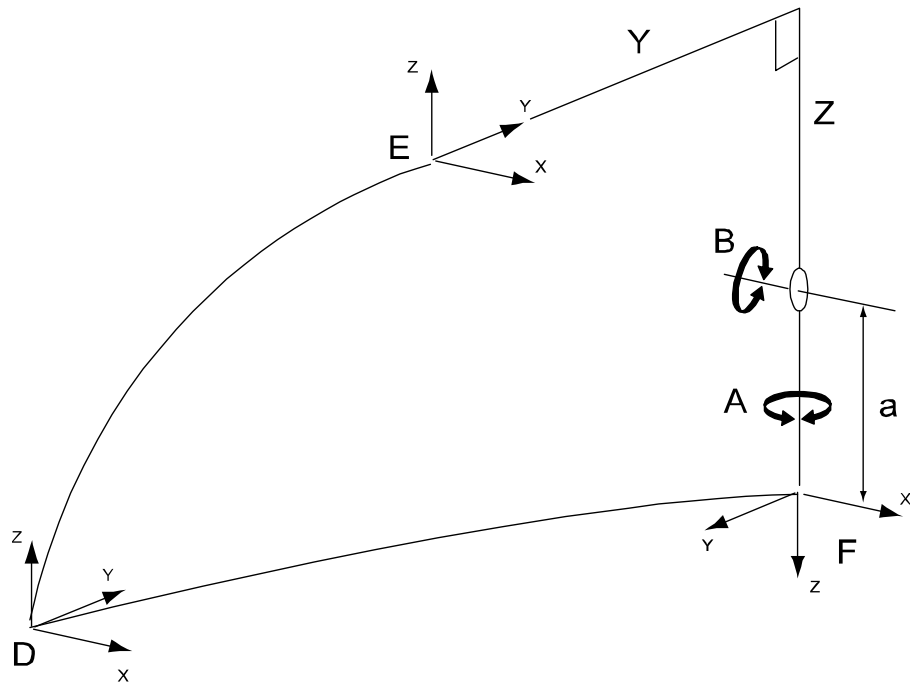
3.2.3.29 Kinematic model YZB(X)A(Z)

3.2.3.29 Kinematic model YZB(X)A(Z)

Description

The kinematic model is based on a linear gantry, with two linear motions and two rotations.

Illustration



xx0300000626

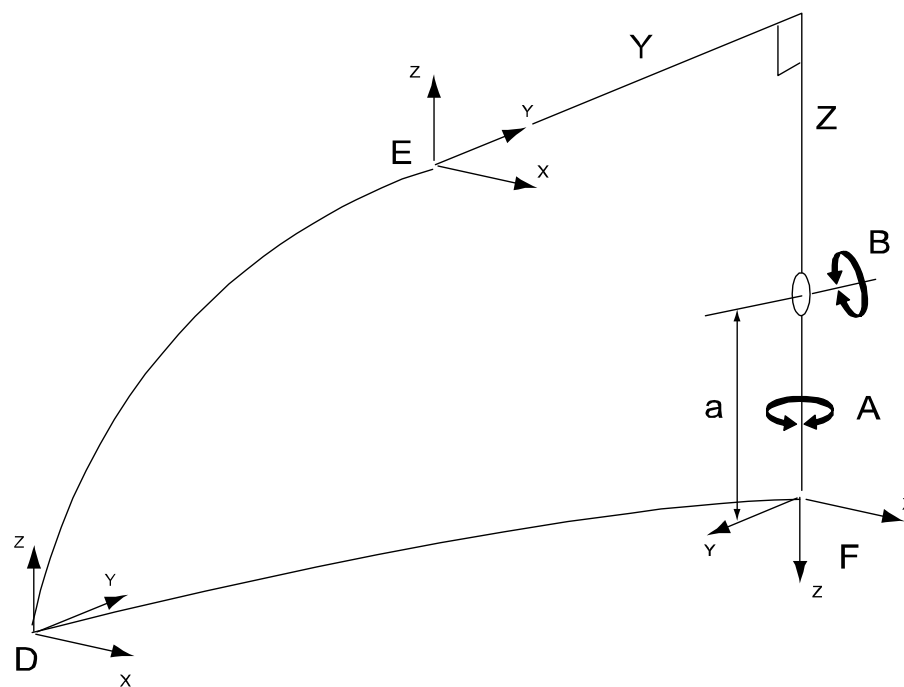
D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around X axis in base frame
A	A rotating around Z axis in base frame if B is zero
a	<i>offset_z</i> of arm "robx_6"

3.2.3.30 Kinematic model YZB(Y)A(Z)

Description

The kinematic model is based on a linear gantry, with two linear motions and two rotations.

Illustration



xx0300000627

D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
B	B rotating around Y axis in base frame
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3 Installation

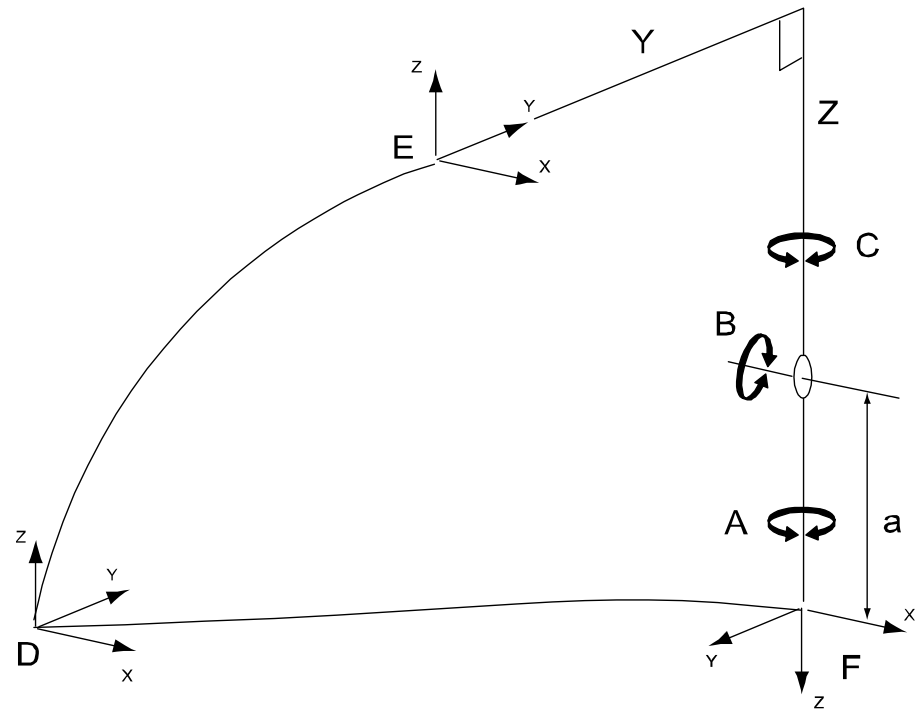
3.2.3.31 Kinematic model YZC(Z)B(X)A(Z)

3.2.3.31 Kinematic model YZC(Z)B(X)A(Z)

Description

The kinematic model is based on a linear gantry, with two linear motions and three rotations.

Illustration



xx0300000628

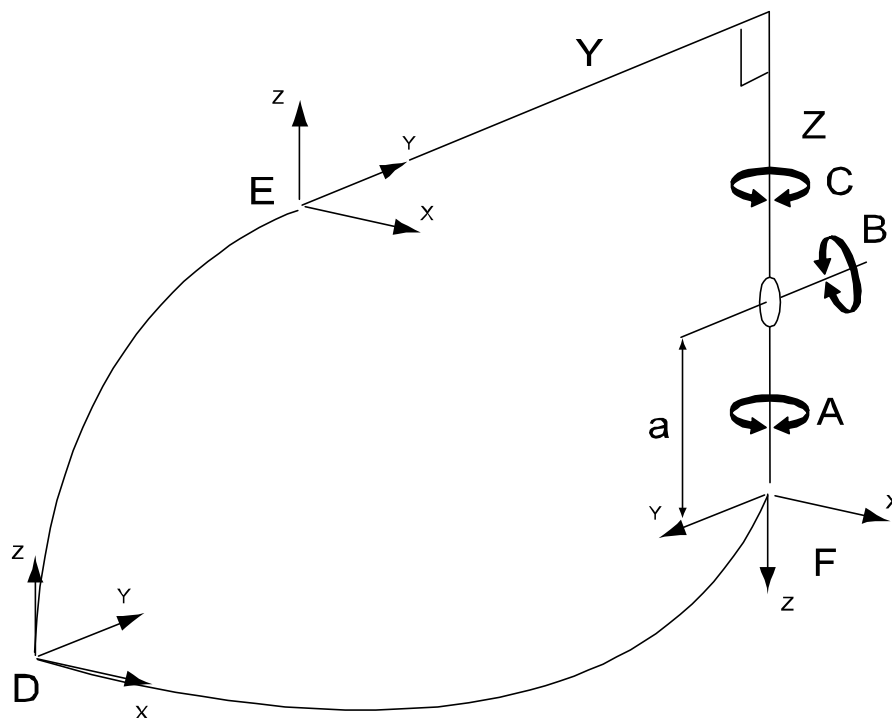
D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around X axis in base frame when C is zero
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3.2.3.32 Kinematic model YZC(Z)B(Y)A(Z)

Description

The kinematic model is based on a linear gantry, with two linear motions and three rotations.

Illustration



xx0500002223

D	World frame
E	Base frame
F	Tool frame
Y	Y-linear motion
Z	Z-linear motion
C	C rotating around Z axis in base frame
B	B rotating around Y axis in base frame when C is zero
A	A rotating around Z axis in base frame if B is zero
a	offset_z of arm "robx_6"

3 Installation

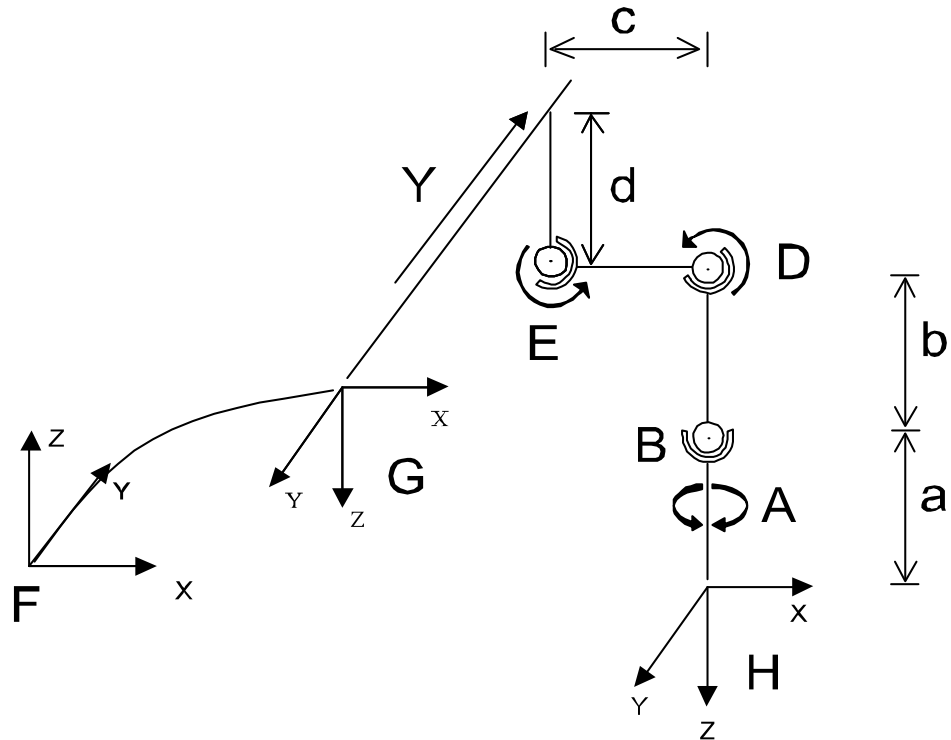
3.2.3.33 Kinematic model YE(Y)D(Y)B(Y)A(Z)

3.2.3.33 Kinematic model YE(Y)D(Y)B(Y)A(Z)

Description

The five axes kinematic model is based on a TopLoader concept. It consists of a manipulator with five rotating axes that can move with a linear movement. The home position is shown in the figure below.

Illustration



xx0500002224

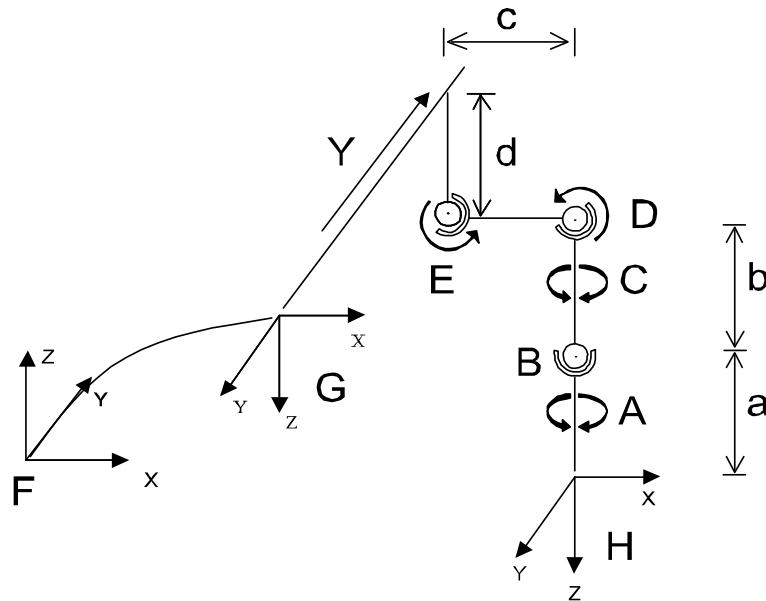
F	World frame
G	Base frame
H	Tool frame
Y	Joint "robx_1" linear along Y axis in base frame
E	Joint "robx_2" rotating around Y axis in base frame
D	"robx_3" rotating around Y axis in base frame
B	Joint "robx_5" rotating around Y axis in base frame if the others are zero
A	Joint "robx_6" rotating around Z axis in base frame if the others are zero
a	<i>offset_z</i> of arm "robx_6"
b	<i>offset_z</i> of arm "robx_4"
c	<i>offset_z</i> of arm "robx_3"
d	<i>offset_z</i> of arm "robx_2"

3.2.3.34 Kinematic model YE(Y)D(Y)C(Z)B(Y)A(Z)

Description

The six axes kinematic model is based on a TopLoader concept. It consists of a manipulator with five rotating axes that can move with a linear movement. The home position is shown in the figure below.

Illustration



xx0300000629

F	World frame
G	Base frame
H	Tool frame
Y	Joint "robx_1" linear along Y axis in base frame
E	Joint "robx_2 " rotating around Y axis in base frame
D	"robx_3" rotating around Y axis in base frame
C	Joint "robx_4" rotating around Z axis in base frame if the others are zero
B	Joint "robx_5" rotating around Y axis in base frame if the others are zero
A	Joint "robx_6" rotating around Z axis in base frame if the others are zero
a	<i>offset_z</i> of arm "robx_6"
b	<i>offset_z</i> of arm "robx_4"
c	<i>length</i> of arm "robx_3"
d	<i>length</i> of arm "robx_2"

3 Installation

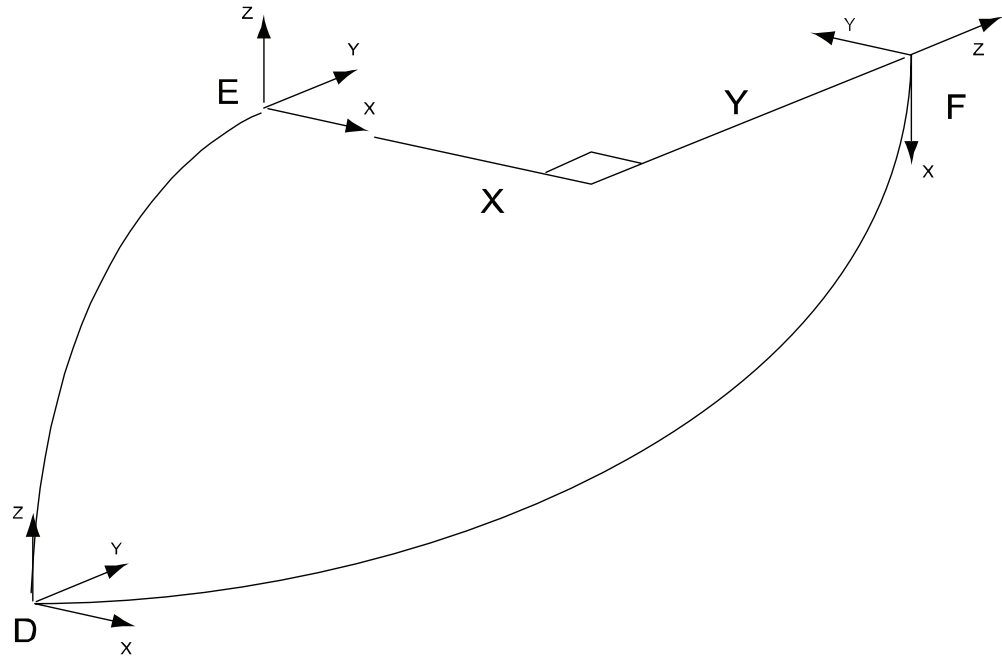
3.2.3.35 Kinematic model XY

3.2.3.35 Kinematic model XY

Description

The kinematic model is based on an area gantry concept, with two linear motions.

Illustration



xx1900001180

D	World frame
E	Base frame
F	Tool frame
X	X-linear motion
Y	Y-linear motion

3.2.3.36 Doppin Feeder

Description

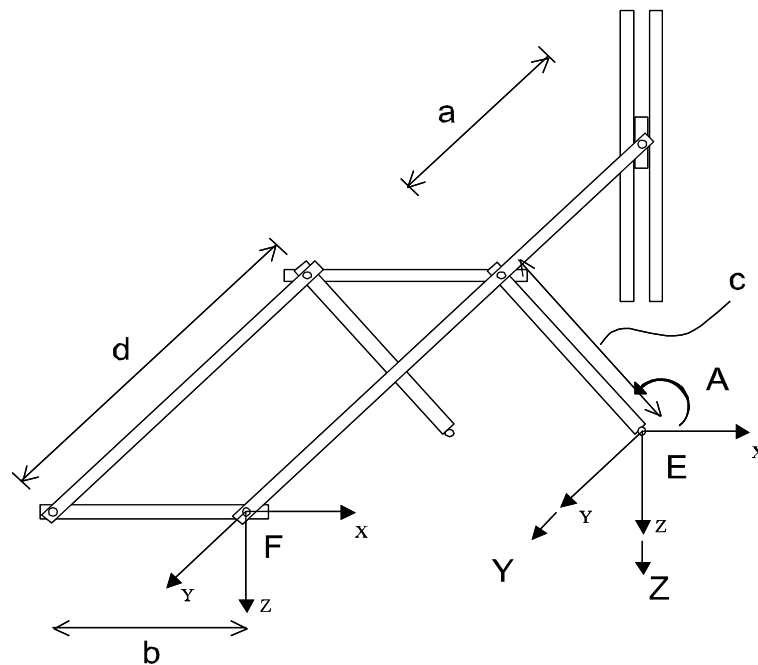
The Doppin Feeder is a two or three axes kinematical model. (doppin_2; 2 axes and doppin_3; 3 axes)

Home position for this model is with the arm "robx_2" pointing vertically upwards.

Illustration

The figure below illustrates the kinematic model for the Doppin Feeder.

Note! The moving revolute joint "robx_2" will result in a non-linear motion of the tool frame if the length of the arm "robx_2" is not equal to the length of the arm "robx_3". The linear motion along "robx_1" and "robx_3" moves the whole mechanism.



xx030000630

E	Base frame
F	Tool frame
Y	Joint "robx_1" linear along Y axis in base frame
A	Joint "robx_2" rotating around Y axis in base frame
Z	Joint "robx_3" linear along Z axis in base frame
a	<i>offset_z</i> of arm "robx_2"
b	<i>offset_x</i> of arm "robx_2"
c	<i>length</i> of arm "robx_2"
d	<i>length</i> of arm "robx_3"

3 Installation

3.2.4 Creating a standalone controller system

3.2.4 Creating a standalone controller system

Overview

This section describes how to create a standalone controller system using the Installation Manager in RobotStudio.

General procedure

Follow these basic steps to create a standalone controller system. For more information on how to install RobotWare, SAC (standalone controller), and create a new system see *Operating manual - RobotStudio*.

	Action
1	Install RobotWare, as described in <i>Operating manual - RobotStudio</i> .
2	Install the SAC Add-In, as described in <i>Operating manual - RobotStudio</i> .
3	Create a standalone controller system using the Installation Manager in RobotStudio, see Installation Manager procedure on page 64 .

Installation Manager procedure

General information about creating a new system is available in the **Help** menu in RobotStudio. This section gives information specific for the standalone controller option.

	Action
1	Open the Installation Manager in RobotStudio.
2	Add the products for RobotWare and SAC.
3	Add the licenses for RobotWare and SAC.
4	The next dialog is used to modify options. Select the Drive Modules tab and expand the SAC node in the tree view.
5	Select the appropriate kinematic model to be used under the First Mechanical Unit node.
6	If the system has several mechanical units, a kinematic model for each one of them should be selected. Continue by selecting kinematic models for Second Mechanical Unit etc.
7	The next dialog is used to verify all selections before downloading the system to the robot controller. <ul style="list-style-type: none">• Check that the correct drive system has been selected.
8	Click Apply to download the system.

Errors at start up

When the system is ready with start-up, inform yourself on system status by studying the event log on the FlexPendant or in RobotStudio.

A system with non-ABB equipment needs configuration to become functional, and it is even quite likely that your system is in system failure state at this point. Ignore any errors until you are ready with the configuration procedure described in section [Minimal configuration of non-ABB robots on page 72](#).

If there are remaining errors after configuration is done find out more about error localization in section [Error handling on page 115](#).

4 Configuration

4.1 Basic settings

4.1.1 Limit peripheral speed of external axis



CAUTION

Incorrectly defined parameters will result in incorrect speed. Always verify the speed after changing these parameters.

There is a hazard that the speed 250 mm/s is exceeded in manual reduced speed mode.

Calculate parameter values

Two system parameters need to be configured. The parameters belong to the type *Supervision Type* in the configuration topic *Motion* and are expressed in ratio of max speed (1 = 100%).

Teach Max Speed Main

$Teach\ Max\ Speed\ Main = (x / Arm\ Length) * (Transmission\ Gear\ Ratio / Speed\ Absolute\ Max)$

where:

- x is the speed in mm/s
- *Transmission Gear Ratio* belongs to the type *Transmission*.
- *Speed Absolute Max* belongs to the type *Stress Duty Cycle* (rad/s).
- *Arm Length* should be measured from the rotational center of the external axis (meter).

If the result of the calculation exceeds 0.94, use 0.94 instead of the calculated value.

Insert the calculated result at the type *Supervision Type: Teach Max Speed Main*.

Teach Max Speed DSP

Calculate and use the largest value of:

- $Teach\ Max\ Speed\ Main * 1.20$
- $Teach\ Max\ Speed\ Main + (8 / Speed\ Absolute\ Max)$

Insert the calculated result at the type *Supervision Type: Teach Max Speed DSP*.

Example

Given parameter values

$Transmission\ Gear\ Ratio = 120$

$Speed\ Absolute\ Max = 320\ rad/s$

$Arm\ Length = 0.5\ m$

Continues on next page

4 Configuration

4.1.1 Limit peripheral speed of external axis

Continued

Calculations

$$\text{Teach Max Speed Main} = (0.25 / \text{Arm Length}) * (\text{Transmission Gear Ratio} / \text{Speed Absolute Max}) = (0.25 / 0.5) * (120 / 320) = 0.188$$

$$\text{Teach Max Speed Dsp} = \max\{(\text{Teach Max Speed Main} * 1.20), (\text{Teach Max Speed Main} + (8 / \text{Speed Absolute Max}))\} = \max\{(0.188 * 1.2), (0.188 + (8 / 320))\} = \max\{0.226, 0.213\} = 0.226$$

4.1.2 Minimal configuration of general additional axes

Overview

This section describes how to make a minimal configuration of a standard additional axes.



WARNING

Incorrect definition of system parameters for brakes or additional axes may cause damage to the robot or personal injury.

Load parameters


Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*.

	Action
1	Right click on configuration icon in the system view, and select Load Parameters .
2	Select Load parameters if no duplicates and click Open .
3	Browse to the template files in the RobotWare installation, see Template files on page 22 . <ul style="list-style-type: none"> • For general additional axis, browse to the directory: ...\\utility\\AdditionalAxis\\DriveSystem 09\\General\\DM1 • For track motion, browse to the directory: ...\\utility\\AdditionalAxis\\DriveSystem 09\\Track\\DM1
4	Select the configuration file for required axes and click Open .
5	Perform a warm start of the system from the FlexPendant or RobotStudio.

Configure parameters

Use RobotStudio or the FlexPendant to perform the following instructions. See *Operating manual - RobotStudio*.

For parameter description, see [System parameters on page 117](#).

	Action	Info/Illustration
1	Select the topic <i>Motion</i> and type <i>Mechanical Unit</i> and define the following in the parameter.  Note For a single axis mechanical unit without kinematic model, <i>Name</i> and <i>Use Single 1</i> in the type <i>Mechanical Unit</i> and <i>Name</i> in the type <i>Single</i> must be the same.	<ul style="list-style-type: none"> • <i>Name</i> • <i>Activate at Start Up</i> • <i>Deactivation Forbidden</i> • <i>Use Single 1</i> • <i>Allow Move of User Frame</i>
2	Select the topic <i>Motion</i> and type <i>Single</i> and specify which <i>Single Type</i> to use.	<ul style="list-style-type: none"> • <i>Name</i> • <i>Use Single Type</i>
3	Select the topic <i>Motion</i> and type <i>Single Type</i> and specify the type of additional axis in the parameter <i>Mechanics</i> .	Example of values of the parameter <i>Mechanics</i> : <ul style="list-style-type: none"> • TRACK • FREE_ROT

Continues on next page

4 Configuration

4.1.2 Minimal configuration of general additional axes

Continued

	Action	Info/Illustration
4	Select the topic <i>Motion</i> and type <i>Joint</i> and set the parameter <i>Logical Axis</i> to the logical axis number.	Example: Logical axis 10 will then correspond to the field <code>eax_d</code> in the RAPID data type <code>robtarget</code> .
5	Select the topic <i>Motion</i> and type <i>Arm</i> and specify the arm characteristics for the axis.	<ul style="list-style-type: none">• <i>Upper Joint Bound</i>• <i>Lower Joint Bound</i>
6	Select the topic <i>Motion</i> and type <i>Acceleration Data</i> and specify the arm performance for the axis.	<ul style="list-style-type: none">• <i>Nominal Acceleration</i>• <i>Nominal Deceleration</i>
7	Select the topic <i>Motion</i> and type <i>Transmission</i> and specify the following.	<ul style="list-style-type: none">• <i>Transmission Gear Ratio</i>• <i>Rotating Move</i>• <i>Transmission High Gear</i>• <i>Transmission Low Gear</i>
8	Select the topic <i>Motion</i> and type <i>Motor Type</i> and specify the following.	<ul style="list-style-type: none">• <i>Pole Pairs</i>• <i>ke Phase to Phase (Vs/rad)</i>• <i>Max current (A rms)</i>• <i>Phase resistance (ohm)</i>• <i>Phase inductance (H)</i>
9	Select the topic <i>Motion</i> and type <i>Motor Calibration</i> and define the calibration and commutation offsets.	<ul style="list-style-type: none">• <i>Calibration Offset</i>• <i>Commutator Offset</i>
10	Select the topic <i>Motion</i> and type <i>Stress Duty Cycle</i> and define the torque and speed absolute max on the motor side.	<ul style="list-style-type: none">• <i>Torque Absolute Max (Nm)</i>• <i>Speed Absolute Max (rad/s)</i>
11	Perform a warm start of the system from the FlexPendant or RobotStudio.	



Note

If *Torque Absolute Max* is too high it may result in a configuration error at restart.

Limitations

If *Torque Absolute Max* is too high it may result in a configuration error at restart. To avoid errors, do not set *Torque Absolute Max* higher than:

$$\text{Torque Absolute Max} < \sqrt{3} * \text{ke Phase to Phase (Vs/rad)} * \text{Max Current}$$

where:

- *Max Current*, belonging to the type *Motor Type*, is the maximum current of the used drive module
- *ke Phase to Phase (Vs/rad)*, belonging to the type *Motor Type*, is a voltage constant

4.1.3 Minimal configuration of servo gun

Overview

This section describes how to configure a servo gun. It details the usage of important parameters, some of them servo gun specific, which need to be set up. Most of the advanced settings, such as relays, brakes and supervision, which are described in the following sections, are also valid for servo guns.



WARNING

Incorrect definition of system parameters for brakes or additional axes may cause damage to the robot or personal injury.

Load parameters

Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*.

	Action
1	Right click on configuration icon in the system view, and select Load Parameters .
2	Select Load parameters if no duplicates and click Open .
3	Browse to the template files in the RobotWare installation, see Template files on page 22 \utility\AdditionalAxis\DriveSystem 09\ServoGun
4	Select the configuration file for required axes and click Open .
5	Perform a restart of the system from the FlexPendant or RobotStudio.

Configure parameters

Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*.

For parameter description, see [System parameters on page 117](#).

	Action	Info/Illustration
1	Select the topic <i>Motion</i> and the type <i>Mechanical Unit</i> and define the following parameter:	<ul style="list-style-type: none"> Name
2	Select the topic <i>Motion</i> and the type <i>Joint</i> and specify the logical axis number under parameter <i>Logical Axis</i> .	Example: Logical axis 10 will then correspond to the field <code>eax_d</code> in a RAPID data of the type <code>robtaraget</code> .
3	Select the topic <i>Motion</i> and the type <i>Arm</i> and specify the arm characteristics for the axis.	<ul style="list-style-type: none"> Upper Joint Bound Lower Joint Bound <p><i>Lower Joint Bound</i> should be set to zero or a small negative value (e.g. -0.005 m) in order to protect the gun from collisions. The limit is not active during force control of the gun. For force control there is another positional limit, <i>Max Force Control Position Error</i>, in the type <i>Supervision</i>.</p>

Continues on next page

4 Configuration

4.1.3 Minimal configuration of servo gun

Continued

	Action	Info/Illustration
4	Select the topic <i>Motion</i> and the type <i>Acceleration Data</i> and specify the arm performance for the axis.	<ul style="list-style-type: none">• <i>Nominal Acceleration</i>• <i>Nominal Deceleration</i>
5	Select the topic <i>Motion</i> and the type <i>Transmission</i> and specify the following parameters:	<ul style="list-style-type: none">• <i>Transmission Gear Ratio</i>
6	Select the topic <i>Motion</i> and the type <i>Motor Type</i> and specify the following parameters:	<ul style="list-style-type: none">• <i>Pole Pairs</i>• <i>ke Phase to Phase (Vs/rad)</i>• <i>Max Current (A rms)</i>• <i>Phase Resistance (ohm)</i>• <i>Phase Inductance (H)</i>
7	Select the topic <i>Motion</i> and the type <i>Motor Calibration</i> and define the calibration and commutation offsets.	<ul style="list-style-type: none">• <i>Calibration Offset</i>• <i>Commutation Offset</i>
8	Select the topic <i>Motion</i> and type <i>Stress Duty Cycle</i> and define the torque and speed absolute max on the motor side.	<ul style="list-style-type: none">• <i>Torque Absolute Max (Nm)</i>• <i>Speed Absolute Max (rad/s)</i>
9	Perform a restart of the system from the FlexPendant or RobotStudio.	

Tuning

After configuration additional axis tuning needs to be performed. See [Tuning of servo control parameters on page 111](#) for tuning of the system.

Configure servo gun parameters

After tuning, the servo gun specific parameters can be defined.

	Action	Info/Illustration
1	Select the topic <i>Motion</i> and the type <i>Supervision Type</i> and define the supervision limits during force control.	<ul style="list-style-type: none">• <i>Max Force Control Position Error</i>• <i>Max Force Control Speed Limit</i>
2	Select the topic <i>Motion</i> and the type <i>SG Process</i> and define the process parameters specific for servo gun.	<ul style="list-style-type: none">• <i>Sync check off</i>• <i>Close Time Adjust</i>• <i>Force Ready Delay</i>• <i>Max Force Control Motor Torque</i>• <i>Post-synchronization Time</i>• <i>Calibration Mode</i>• <i>Calibration Force High</i>• <i>Calibration Force Low</i>• <i>Calibration Time</i>

Continues on next page

Tip force

The relationship between the programmed tip force and the resulting motor torque is set up in the following parameters. The torques may be negative due to the sign of the gear ratio while the forces must always be positive. Before setting up this table, the parameters in the Force Master should be tuned. See *Application manual - Servo Gun Setup*.

The easiest way to set up the table is by using a RAPID force calibration service routine.

Parameter	Description
<i>Number of Stored Forces</i>	Number of stored forces in the force vs motor torque table. The minimum value allowed is 2.
<i>Tip Force 1</i>	Gun tip force 1 (N)
<i>Motor Torque 1</i>	Motor torque 1 (Nm)
<i>Tip Force 2</i>	Gun tip force 2 (N)
<i>Motor Torque 2</i>	Motor torque 2 (Nm)
<i>Tip Force 10</i>	Gun tip force 10 (N)
<i>Motor Torque 10</i>	Motor torque 10 (Nm)

4 Configuration

4.1.4 Minimal configuration of non-ABB robots

4.1.4 Minimal configuration of non-ABB robots

Overview

This section describes basic configuration of non-ABB robots.



WARNING

Incorrect definition of system parameters for brakes or additional axes may cause damage to the robot or personal injury.

General approach

For each kinematic model a corresponding set of default configuration files are supplied with the additional option *Standalone Controller*. It is possible to configure system parameters by editing these configuration files directly with a text editor. The recommended way, however, is to use RobotStudio or the FlexPendant.

Configure system parameters

Use RobotStudio or the FlexPendant to configure the following system parameters for non-ABB robots. They all belong to the configuration topic *Motion*. For more information on how to do this see *Operating manual - IRC5 with FlexPendant* and *Operating manual - RobotStudio*. For more information about the parameters see [System parameters on page 117](#).

	Action	Parameter name
1	Select the type <i>Robot</i> and specify name. Note! Naming a robot is optional but often convenient.	<ul style="list-style-type: none">Name
2	Select the type <i>Measurement Channel</i> and specify:	<ul style="list-style-type: none">Measurement Node
3	Select the type <i>Arm</i> and define the limits for the robot's working range. There is one set of parameters for each joint. Specify:	<ul style="list-style-type: none">Upper Joint BoundLower Joint BoundCalibration Position
4	Select the type <i>Arm Type</i> . Depending on selected kinematic model, different parameters need to be configured.	See Setting the Arm Type parameters on page 73 .
5	Select the type <i>Transmission</i> and specify:	<ul style="list-style-type: none">Transmission Gear RatioRotating MoveTransmission Gear HighTransmission Gear Low
6	Select the type <i>Brake</i> and specify brake parameters.	See Defining brake behavior on page 82 .
7	Select the type <i>Drive system</i> and specify:	<ul style="list-style-type: none">Use Drive Unit
8	Select the type <i>Motor</i> and specify:	<ul style="list-style-type: none">Use Motor Type

Continues on next page

	Action	Parameter name
9	Select the type <i>Motor Type</i> and specify: Note! Values for these parameters can be found in the motor specifications.	<ul style="list-style-type: none"> • Pole Pairs • Stall Torque • Ke Phase to Phase • Max Current • Phase Resistance • Phase Inductance
10	Select the type <i>Stress Duty Cycle</i> and specify:	<ul style="list-style-type: none"> • Speed Absolute Max • Torque Absolute Max
11	If the system uses MultiMove and has several mechanical units attached to the same drive module further configuration is needed.	See Setting up a motion planner and a RAPID task on page 75 .
12	Check if any advanced configuration needs to be done.	See the chapter Advanced settings on page 77 in this manual.
13	Fine calibrate the system.	On the FlexPendant tap Calibration , select a Mechanical Unit and tap Fine Calibration . For more information see <i>Operating manual - IRC5 with FlexPendant</i> , section <i>Calibrating</i> .
14	Tune the system before starting to use it.	See <i>Application manual - TuneMaster</i> .

Setting the Arm Type parameters

Arm Type parameters need to be configured if any of the kinematic models below is used:

- Linear Gantry and Area Gantry with B-rotation
- TopLoader
- Doppin Feeder

Linear Gantry or Area Gantry with B-rotation

Parameters to be changed when using the kinematic model *Linear Gantry* or *Area Gantry with B-rotation*:

For arm...	Parameter name	Description
robx_6 in the default configuration file for kinematic models <ul style="list-style-type: none"> • XYZB(X) • XYZB(X)A(Z) • XYZC(Z)B(X)A(Z) • YZB(X) • YZB(Y) • YZB(X)A(Z) • etc. 	offset_z	Length of arm robx_6 (in meter), see the selected Kinematic models on page 28 .

Continues on next page

4 Configuration

4.1.4 Minimal configuration of non-ABB robots

Continued

TopLoader

Parameters to be changed when using the kinematic model *TopLoader*:

For arm...	Parameter name	Description
robx_2	length	Length in meter according to the selected Kinematic models on page 28 .
robx_3	length	Length in meter according to the selected Kinematic models on page 28 .
robx_4	offset_z	Length in meter according to the selected Kinematic models on page 28 .
robx_6	offset_z	Length in meter according to the selected Kinematic models on page 28 .

Doppin Feeder

Parameters to be changed when using the kinematic model *Doppin Feeder*:

For arm...	Parameter name	Description
robx_2	length offset_x offset_z	Length in meter according to the selected Kinematic models on page 28 .
robx_3	length	Length in meter according to the selected Kinematic models on page 28 .

Several mechanical units on the same drive module

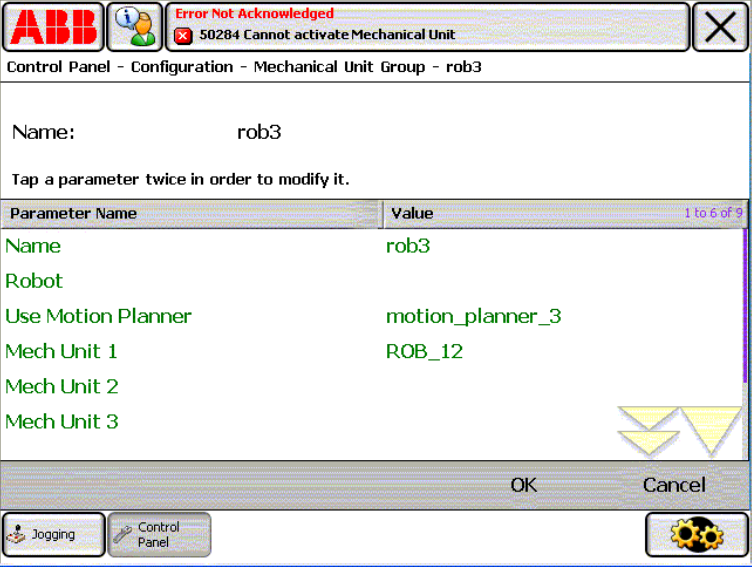
If the system has several mechanical units attached to the same drive module, the system will come up with the error message **50284 - Cannot activate Mechanical Unit**. This is perfectly normal, as no motion planner or RAPID task has been defined by the system for a second or third mechanical unit on a drive module. This means you need to specify a RAPID task and a motion planner for all mechanical units that are not number one on a drive module. For information on how to do this see [Setting up a motion planner and a RAPID task on page 75](#).

Continues on next page

Setting up a motion planner and a RAPID task

Suppose the system has two drive modules and three mechanical units, two of which are connected to the first drive module. At system setup motion planner 1 and motion planner 2 have been dedicated to the first mechanical units on the respective drive module. A motion planner for the second mechanical unit on drive module one must be configured manually, using either the FlexPendant or RobotStudio.

The following procedure shows how to do this using the FlexPendant.

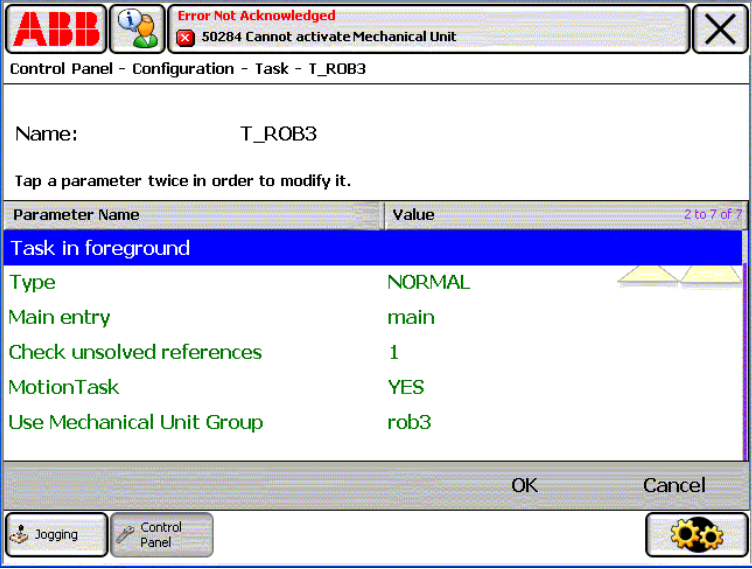
	Action														
1	Select the configuration topic <i>Controller</i> and add a new <i>Mechanical Unit Group</i> . Connect it to motion planner 3 and specify the second mechanical unit on drive module one (ROB_12) in the parameter <i>Mech Unit 1</i> .														
	 <p>Control Panel - Configuration - Mechanical Unit Group - rob3</p> <p>Name: rob3</p> <p>Tap a parameter twice in order to modify it.</p> <table border="1"> <thead> <tr> <th>Parameter Name</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Name</td> <td>rob3</td> </tr> <tr> <td>Robot</td> <td></td> </tr> <tr> <td>Use Motion Planner</td> <td>motion_planner_3</td> </tr> <tr> <td>Mech Unit 1</td> <td>ROB_12</td> </tr> <tr> <td>Mech Unit 2</td> <td></td> </tr> <tr> <td>Mech Unit 3</td> <td></td> </tr> </tbody> </table> <p>en0600003035</p>	Parameter Name	Value	Name	rob3	Robot		Use Motion Planner	motion_planner_3	Mech Unit 1	ROB_12	Mech Unit 2		Mech Unit 3	
Parameter Name	Value														
Name	rob3														
Robot															
Use Motion Planner	motion_planner_3														
Mech Unit 1	ROB_12														
Mech Unit 2															
Mech Unit 3															

Continues on next page

4 Configuration

4.1.4 Minimal configuration of non-ABB robots

Continued

	Action
2	<p>To be able to program the mechanical unit you need to create a Rapid task. Select the configuration topic <i>Controller</i> and add a new <i>Task</i>. Attach it to the mechanical group created in step 1.</p>  <p>en0600003036</p>

4.2 Advanced settings

4.2.1 Disconnect a servo motor

Overview

It is possible to disconnect and reconnect the motor of a deactivated axis if a certain deactivation mode is set up.



Note

If the axis is moved when disconnected, the position of the axis might be wrong after reconnecting, and this will not be detected by the controller. The position after reconnection will be correct if the axis is not moved, or if the movement is less than 0.5 motor revolutions. For servo guns, there is a RAPID calibration method available (the ToolChange calibration) that will adjust any positional error caused by gun movement during disconnection.

Configure parameters

Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*

For parameter description, see chapter [System parameters on page 117](#).

	Action	Info/Illustration
1	Select the topic <i>Motion</i> and type <i>Measurement Channel</i> and define the following in the parameter.	<ul style="list-style-type: none"> <i>Disconnect at Deactivate</i>

4 Configuration

4.2.2 Servo Tool Change

4.2.2 Servo Tool Change

Overview

With the option *Servo Tool Change* it is possible to disconnect the resolver and motor cables from the motor of one external axis and connect them to the motor of another additional axis.

For details about *Servo Tool Change*, see *Application manual - Controller software IRC5*.



WARNING

It is important that no other mechanical unit used with one tool changer are activated, but the one corresponding to the currently connected servo gun! An activation of the wrong mechanical unit may cause unexpected movements and personal injury. See [Defining relays on page 80](#).



Note

In case the Servo Gun is equipped with a brake, the 24V to the brake must be switched off before and during servo tool change. This is done via an I/O -signal and brake relay (e.g. by using the instruction `WaitTime` on the brake relay). See [Defining relays on page 80](#), for defining of brake relays.

Considerations

The list below specifies special considerations when switching motors:

- The two (or more) additional axes sharing the same motor cables are configured as separate mechanical units.
- The additional axes are configured to use the same measurement node and drive unit node.
- If two servo guns are used with a tool changer, the template file `M7L1B1S_DM1.cfg` can be used for configuration of both guns (change the name of the instance in one of the files).
- A motor switch can be done only if all sharing axes are deactivated.
- The reconnected motor is activated and this activation will restore the position of the axis to the latest position.
- Always use the tool change tip calibration after activation (for spot welding guns).

Connection relay

To make sure that the correct mechanical unit is active, some tool changers support I/O signals that specify which gun is currently connected.

It is also possible to lock unconnected mechanical units from activation by specifying a connection relay and connect it to a digital input (DI).

Continues on next page

Defining a connection relay

Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*.

For parameter descriptions, see [System parameters on page 117](#).

	Action	Parameter
1	Select the topic <i>Motion</i> and type <i>Mechanical Unit</i> and define the name of the relay, or check the name if this is already defined.	<ul style="list-style-type: none">• <i>Use Connection Relay</i>
2	Select the topic <i>Motion</i> and type <i>Relay</i> and select the named relay, if this is defined.	
3	If the named connection relay is not defined, a new relay must be created.	
4	Change the name of the newly created relay to the same as the <i>Use Connection Relay</i> parameter. Define an activation lock signal.	<ul style="list-style-type: none">• <i>Name</i>• <i>Output Signal</i>• <i>Input Signal</i>

4 Configuration

4.2.3 Defining relays

4.2.3 Defining relays

Overview

The additional drive unit can be activated via signals from the robot controller. When a module is activated, e.g. by choosing the module in the Jogging window on the FlexPendant, the output signal is automatically set. A check is made later that the corresponding input signal from the relay is set.

For information about the hardware requirements for relays, see [Relays on page 175](#).

Defining activating relays

Define the input and output signals for all connected relays. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description, see [System parameters on page 117](#).

	Action	Parameters
1	Restart the controller to check that the additional axes can be activated from the I/O window on the FlexPendant.	
2	Select the topic <i>Motion</i> and type <i>Relay</i> and define the following parameters.	<ul style="list-style-type: none">• <i>Name</i>• <i>Output Signal</i>• <i>Input Signal</i>
3	Select the topic <i>Motion</i> and type <i>Mechanical Unit</i> and specify the name of the activation relay.	<ul style="list-style-type: none">• <i>Use Activation Relay</i>
4	Perform a restart of the system.	

Defining brake relays

If the additional mechanical units are equipped with brakes, these will automatically be activated when the unit is deactivated or when the robot system assumes the MOTORS OFF state. They will also be activated when the axes have been stationary for a certain time (*Brake on Time*) in the MOTORS ON state. For a MultiMove system, the largest value of the *Brake on Time* parameters define when the brakes are activated.



Note

Mechanical units that share brake relay with the robot must not be deactivated. Set the system parameters *Deactivation Forbidden* and *Activate at Start Up* to Yes.

Defining the input and output signals for brake relays

Define the input and output signals for all connected relays. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description, see [System parameters on page 117](#).

	Action	Parameters
1	Restart the controller to check that the brakes can be activated from the I/O window on the FlexPendant.	

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	Action	Parameters
2	Select the configuration topic <i>Motion</i> and the type <i>Relay</i> and define the following parameters:	<ul style="list-style-type: none">• <i>Name</i>• <i>Output Signal</i>• <i>Input Signal</i>
3	Select the topic <i>Motion</i> and the type <i>Mechanical Unit</i> and specify the name of the brake relay.	<ul style="list-style-type: none">• <i>Use Brake Relay</i>
4	Perform a restart of the system.	

4 Configuration

4.2.4 Defining brake behavior

4.2.4 Defining brake behavior

Overview

If the axis has a brake, parameters which control brake behavior should be configured. If the axis is affected by gravity, more accurate parameter settings are necessary.

This section describes how to set up brake behavior for additional axes and non ABB robots.

Brake behavior at emergency stop

When an emergency stop has been ordered, it will take about 50 to 300 ms before the mechanical brake is physically active. Meanwhile there is ramp deceleration by motor. After a certain period of time, the speed of the axis will determine whether or not the electrical torque brake is to be used along with the mechanical brake.

Good brake behavior is characterized by low oscillation in speed during deceleration. TuneMaster can be used to verify this; study *Speed* (signal number 6) and *TorqueRef* (signal number 9).

Measures must be taken to prevent the axis from dropping due to gravitation. This will happen if the motor torque is turned off before the mechanical brake has become physically active.

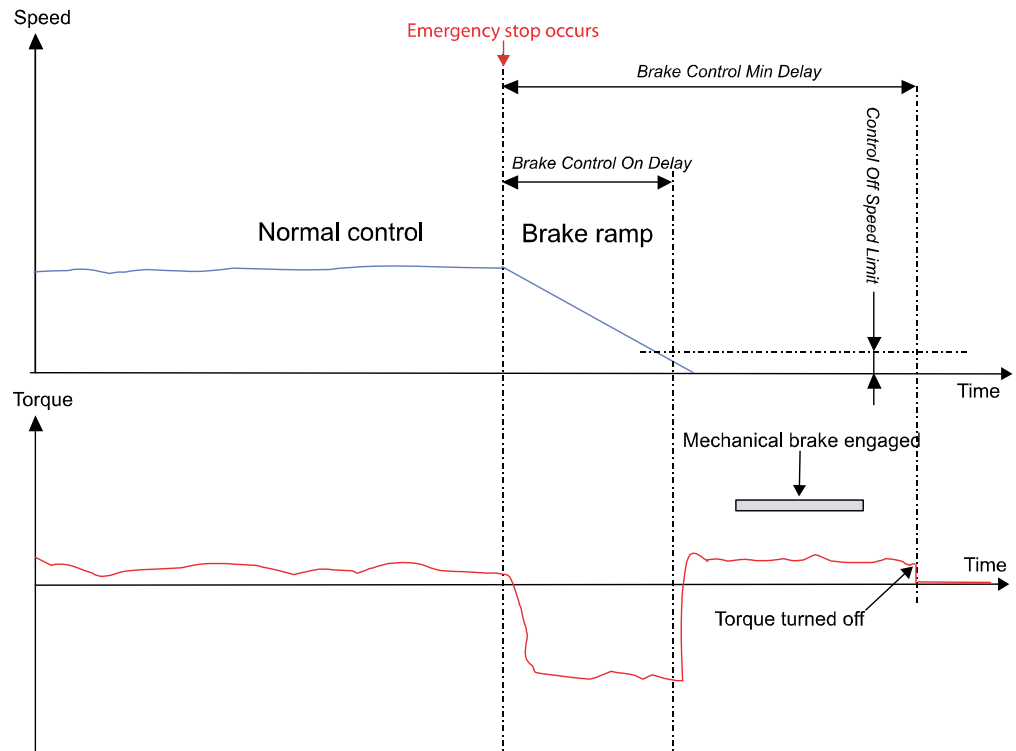
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Emergency brake algorithm

There are a few parameters which need to be configured to achieve good brake behavior. Understanding their role in the brake algorithm of the robot controller will simplify the task. The scenarios below illustrate how the brake parameters support the emergency brake algorithm of the robot controller.

Scenario 1

Axis almost at standstill after brake ramp, electrical torque brake not activated.



en0600003145

- 1 Emergency stop occurs. Immediately, ramp deceleration by motor is started.
- 2 The axis has stopped when the *Brake Control On Delay* time has passed. The motor torque is used until the time *Brake Control Min Delay* has passed. This prevents the axis from falling before the mechanical brake is engaged.

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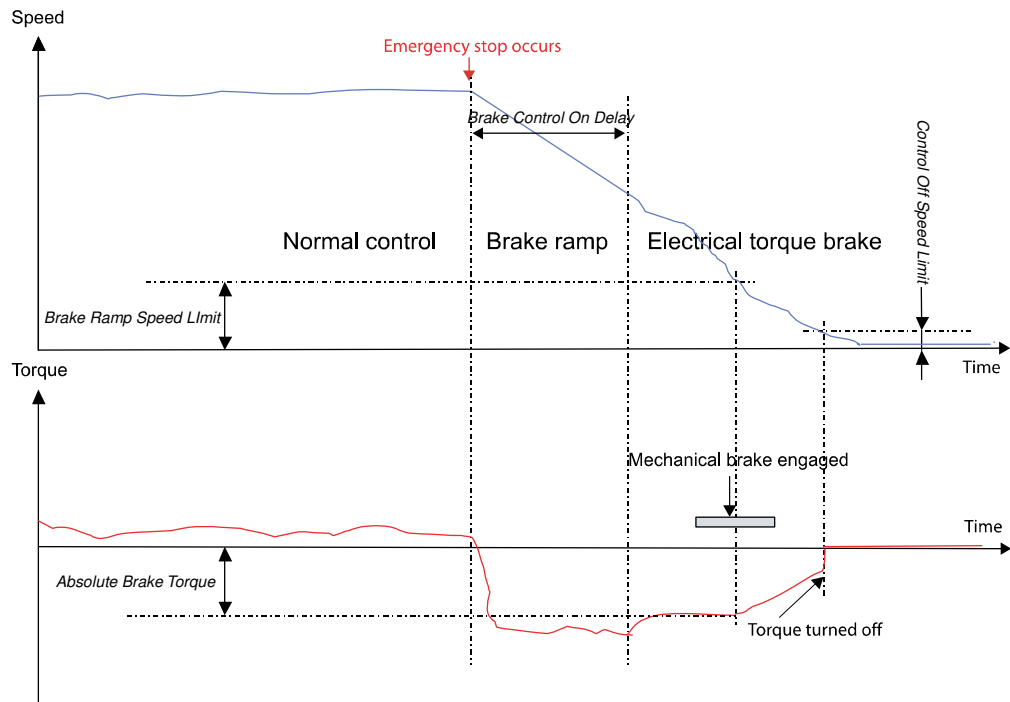
4 Configuration

4.2.4 Defining brake behavior

Continued

Scenario 2

Axis still moving after brake ramp, electrical torque brake activated.



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- 1 Emergency stop occurs. Immediately, ramp deceleration by motor is started.
- 2 As the axis is still moving (that is, speed exceeds *Control Off Speed Limit*) when *Brake Control On Delay* time has expired, the brake algorithm changes to Electrical torque brake.
- 3 The motor generates a brake torque specified by *Absolute Brake Torque*.
- 4 Torque reduction is started when the axis speed equals the value of *Brake Ramp Speed Limit*.
- 5 When the axis comes to a standstill the motor torque is turned off.

Defining brake parameters

Use RobotStudio or the FlexPendant to configure the brake parameters of the axis. See [Getting started with a simple brake configuration on page 85](#) for recommended start values for some of these parameters. All parameters belong to the type *Brake* in the configuration topic *Motion*.

	Action	Note
1	Define <i>Control Off Delay</i> in seconds.	Specifies for how long the control of the axis should be active. Time should be longer than it takes for the mechanical brake to become physically active, as to prevent the axis from dropping due to gravitation.
2	Define <i>Brake Control Min Delay</i> in seconds.	Should be set to the same value as <i>Control Off Delay</i> .

Continues on next page

	Action	Note
3	Define <i>Brake Control On Delay</i> in seconds.	Specifies the period of time during which deceleration by motor is used. It should be set close or equal to the mechanical brake activation time, but must be long enough to damp mechanical oscillation. After the time has expired, the speed of the axis is measured against <i>Control Off Speed Limit</i> . If it is higher the electrical torque brake is activated.
4	Define <i>Absolute Brake Torque</i> in Nm.	Specifies max brake torque generated by the motor in the electrical torque brake phase. <i>Absolute Brake Torque</i> together with torque generated by the mechanical brake must not exceed max allowed torque for the arm, in order not to damage arm and gearbox.
5	Define <i>Brake Ramp Speed Limit</i> in rad/s.	Specifies the speed limit for torque reduction in the electrical torque brake phase and is typically set to zero.
6	Perform a restart of the controller.	

Getting started with a simple brake configuration

To facilitate brake configuration, this section provides initial values for some brake parameters. It is necessary, however, to adjust these parameter settings until good brake behavior is achieved.

The table below shows recommended initial values. All parameters belong to the type *Brake* in the configuration topic *Motion*.

Parameter	Start value
Control Off Delay	150% of mechanical brake activation time
Brake Control Min Delay	same as Control Off Delay
Brake Control On Delay	mechanical brake activation time
Absolute Brake Torque	0
Brake Ramp Speed Limit	0



Note

Do not modify *Control Off Speed Limit*! Its predefined ratio of max speed value defines zero speed.

4 Configuration

4.2.5 Supervision

4.2.5 Supervision

Overview

Supervision is used to avoid overload on the motors. To prevent misleading supervision errors due to influence forces, all axes with mutual influences shall be configured to the same influence group.

Description

If a manipulator mounted on a track motion accelerates, the reaction (influence) forces affect the track motion. In the same way, if the track motion accelerates, the manipulator is affected. Up to 10 different influence groups can be used (1-10). By default the manipulator belongs to the influence group number 1.

Define influence groups

Define the parameter for supervision on the additional axes. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see [System parameters on page 117](#).

	Action	Parameters
1	Select the topic <i>Motion</i> and type <i>Supervision Type</i> .	
2	Select the additional axes to be grouped.	
3	Specify the following parameter. Default value: 0.	<i>Influence Group</i>

4.2.6 Independent joint

Overview

With the option *Independent Axis*, an additional axis (linear or rotating) can run independently of the other axes of the robot.

Description

An axis is set in independent mode by executing an independent move instruction. Use the independent reset instruction to return to normal mode. Independent reset instruction can also be used in normal mode in order to change the logical position of the axis.

For more information about Independent Axis, see *Application manual - Controller software IRC5*.

Activate Independent Joint

Define the parameter for supervision on the additional axes. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see section [System parameters on page 117](#).

	Action	Parameter
1	Select the topic <i>Motion</i> and type <i>Arm</i> .	
2	Double click the axis to be activated	
3	Select the parameter <i>Independent Joint</i> in the appearing list.	
4	Set the Independent Joint to value On .	<ul style="list-style-type: none"> • <i>Independent Joint</i> • <i>Independent Upper Joint Bound</i> • <i>Independent Lower Joint Bound</i>

Defining transmission ratio

For external axes, the transmission ratio must be defined as normal with the parameter *Transmission Gear Ratio*, but also with its nominator and denominator values in order to get exact value (no rounding off). Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see section [System parameters on page 117](#).

	Action	Parameter
1	Select the topic <i>Motion</i> and type <i>Transmission</i> .	
2	Specify the following parameters.	<ul style="list-style-type: none"> • <i>Transmission High Gear</i> • <i>Transmission Low Gear</i>

4 Configuration

4.2.7 Soft servo

4.2.7 Soft servo

Overview

Soft servo can be activated for additional axes which are configured with *Lag Control Master 0*. The behavior of movements with the soft servo activated is described in the *Technical reference manual - RAPID Instructions, Functions and Data types*.

Description

There are four system parameters to consider when the soft servo is used for an additional axis. The parameter are set to default values.

Set soft servo parameters

Define the parameter for soft servo on the additional axes. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see section, [System parameters on page 117](#).

	Action	Parameters
1	Select the topic <i>Motion</i> and type <i>Lag Control Master 0</i> .	
2	Select the lag control master corresponding to the external axis.	
3	Select the desired parameter and change its value.	<ul style="list-style-type: none">• <i>K Soft Max Factor</i>• <i>K Soft Min Factor</i>• <i>Kp/Kv Ratio Factor</i>• <i>Ramp Time</i>
4	Click OK to confirm.	
5	Perform a restart for the changes to take effect.	

4.2.8 Activate force gain control

Overview

Force gain control is used in cases when heavy load, high friction and low speed makes it difficult for an additional axis to reach its end point.

All axes that affect force gain control must be within a certain position range from the end point before forced gain control is enabled. This position range is also specified in the configuration topic *Motion*, type *Supervision*.

Description

When activating forced gain control for an additional axis, two types under *Motion* must be considered. Decide which axes should have forced gain control in *Lag Control Master 0*, and decide which axes should affect forced gain control in *Supervision*.

Set force gain control parameters

Define the parameter for forced gain control on the additional axes. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see section, [System parameters on page 117](#).

	Action	Parameter
1	Select the topic <i>Motion</i> and type <i>Lag Control Master 0</i> .	
2	Select the lag control master corresponding to the additional axis.	
3	Select the parameter to be changed.	<ul style="list-style-type: none"> • <i>Forced Control Active</i> • <i>Forced Factor for Kp</i> • <i>Forced Factor for Ki</i> • <i>Rise Time for Kp</i>
4	Press: OK to confirm.	
5	Perform a restart for the changes to take effect.	

Set supervision parameters

Define the parameter for supervision on the additional axes. Use RobotStudio to perform the following instructions. See *Operating manual - RobotStudio*. For parameter description see section, [System parameters on page 117](#).



CAUTION

Do not change supervision for the robot axes. Changes on these values could affect the service interval cycles and impair its performance.

	Action	Parameter
1	Select the topic <i>Motion</i> and type <i>Supervision</i> .	
2	Select the supervision corresponding to the axis that should or should not affect forced gain control.	

Continues on next page

4 Configuration

4.2.8 Activate force gain control

Continued

	Action	Parameter
3	Select the parameter to be changed.	<ul style="list-style-type: none">• <i>Affects Forced Control</i>• <i>Forced on Position Limit</i>• <i>Forced off Position Limit</i>
4	Click OK to confirm.	
5	Perform a restart for the changes to take effect.	

4.2.9 Defining parameters for general kinematics

Overview

It is possible to use general kinematics for most manipulators. A set of template configuration files can be found in ...*utility\AdditionalAxis\DM1\GeneralKinematics.*, see [Template files on page 22](#).



Note

Definition is not possible via the FlexPendant or RobotStudio. PC editing of the configuration files is necessary.

General kinematics for robots

The following needs to be defined.

Type	Description
ROBOT_TYPE	<ul style="list-style-type: none"> base_pose_rot_u0, base_pose_rot_u1, base_pose_rot_u2, base_pose_rot_u3 (Rotation between user defined robot base and internal base according to Denavit - Hartenberg definition). no_of_joints = highest joint number type GEN_KIN
TRANSMISSION	For each arm of the additional robot in question. <ul style="list-style-type: none"> rotating_move if rotating axes, exclude otherwise
ARM_TYPE	For each arm of the external robot in question. <ul style="list-style-type: none"> length theta_home_position offset_z attitude For information about the parameters, see Arm Type on page 120 .

4 Configuration

4.2.10 Enabling *Service Information System* functions

4.2.10 Enabling *Service Information System* functions

Overview

To enable *Service Information System* functions such as *GetAxisDistance*, the following needs to be added manually to the configuration file.

This modification cannot be done in RobotStudio or on the FlexPendant.

Example for non-ABB robot

```
ROBOT_TYPE:
-name "STN1" -type "IRBP_A" -error_model "NOMINAL"\
-no_of_joints 2 -use_sis "STN1"
SIS:
-name "STN1" -sis_active -use_sis_joint_0 "STN1_sis_joint_0"\
-use_sis_joint_1 "STN1_sis_joint_1"
#
SIS_JOINT_INFO:
-name "STN1_sis_joint_0"
-name "STN1_sis_joint_1"
```

Example for single

```
SINGLE_TYPE:
-name "M7DM1" -mechanics "FREE_ROT" -use_sis "M7DM1"
SIS_SINGLE:
-name "M7DM1" -sis_active -use_sis_param "M7DM1"
```

4.3 Coordinated axes

4.3.1 About coordinated axes

Additional axes, general

All additional axes are handled in mechanical units. This means that before an additional axis may be moved, the mechanical unit to which it belongs, must be activated. Within a mechanical unit, the different axes will be given a logical name, from *a* to *f*. In the system parameters, these logical axes will be connected to the additional axes joints. For each joint a motor and a drive unit is defined. Different joints may share the same motor and drive unit.

Two or more mechanical units may be activated at the same time, as long as they do not have the same logical axes defined in their set of additional axes. However, two or more mechanical units may have the same logical axes, if they are not activated simultaneously. Two or more mechanical units may not be activated at the same time, if they share one or more drive units, even if they use separate logical axes. This means that two logical axes, each belonging to different mechanical units, may control the same drive unit, but not at the same time.

Coordination

A mechanical unit may be coordinated or not coordinated with the robot movements. If it is not coordinated, each axis will be moved independent of the robot movements, e.g. when jogging, only the separate axis will move. However during program execution, the additional axes will be synchronized to the robot movement, in such a way that both movements will be completed in the same time.

If the mechanical unit is coordinated, the TCP velocity in the object coordinate system, will be the programmed velocity irrespective of the movements of the additional axes. Two types of coordination categories exist. The first category of coordination is when the robot base is moved, e.g. the coordination to a gantry or track movement. This means that the robot is mounted on a gantry or a track, and may be moved along these axes. The world and user/object coordinate systems, however, will be fixed in the room, and the robot movements in these coordinate systems will be independent of simultaneous gantry or track movements. This coordination is automatically active, if the mechanical unit with the track motion is active.

The second coordination category, is when the robot movements are coordinated to the movements of a user frame connected to a mechanical unit. E.g. a user frame may be placed on a turntable and connected to its movements. An ordinary work object may be used for this purpose, if it is marked with the name of the mechanical unit to be connected to, and that it should be moveable. The coordination will be active if the mechanical unit is active, and the coordinated work object is active. When such a coordinated work object is used, in jogging or in a move instruction, the data in the `uframe` component will be ignored and the location of the user coordinate system will only depend on the movements of the mechanical unit. However the `oframe` component will still work giving an object frame related to the user frame and also the displacement frame may be used.

4 Configuration

4.3.2.1 How to get started with a coordinated track motion

4.3.2 Coordinated track motion

4.3.2.1 How to get started with a coordinated track motion

Coordination procedure

In the checklist below, the steps required to coordinate track motion are described. In each step, there may be a reference to another chapter in this manual, where more details of the specific actions to be taken will be found.

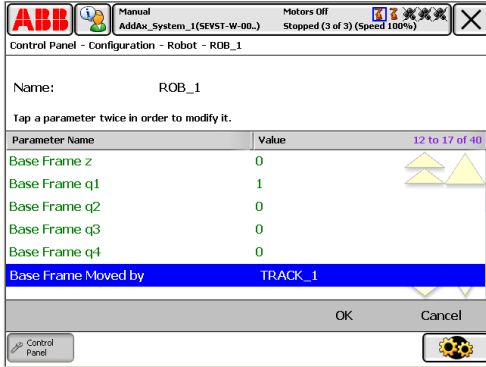


CAUTION

If a non-ABB track motion is used, no fast robot movements can be made coordinated with the track motion. Slow movements with reduced acceleration may work, but preferably the robot shall be still while the track moves.

	Action	Info/illustration
1	Make sure the system parameter <i>Mechanics</i> in the type <i>Single Type</i> is set to TRACK.	
2	Calibrate the robot and the track motion, i.e. the zero position of the measuring system for both robot and track must be carefully determined.	See section <i>Calibrating</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
3	Define the base frame of the robot. This defines the robot base frame relative to the world frame. The procedure is necessary only if the world frame is separate from the robot base frame. Please observe that the track must be in its calibration position when the robot base frame is defined.	See section <i>4 points XZ calibration</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
4	Define the base frame of the track. This defines the rotation of the robot base relative to the track.	See Defining the base frame for a track motion on page 96 .

Continues on next page

	Action	Info/illustration
5	<p>Activate the base frame coordination by setting the system parameter <i>Base frame moved by</i> (topic <i>Motion</i> and type <i>Robot</i>) for the robot to the name of the track.</p>	 <p>en0600002756</p> <p>WARNING</p> <p>The combined speed of the track motion and the robot must not exceed 250 mm/s in manual mode. This can only be ensured if the correct mechanical unit (the track motion) is set in the parameter <i>Base frame moved by</i> for the robot.</p>
6	<p>Create a backup of the system by tapping ABB menu - Backup and Restore -Backup Current system.</p>	<p>See <i>Back up and restore systems in Operating manual - IRC5 with FlexPendant.</i></p>
7	<p>Activate the track unit in the jogging window and check that the coordination is working satisfactorily.</p> <p>This may be done by choosing World or Work Object in the field Coordinate System and then jogging the track axis. The robot TCP should not move, but be fixed relative to the object coordinate system.</p>	



Note

If the robot base frame is rotated after the calibration of the track base frame, a new base frame calibration of the robot has to be done and also a new baseframe calibration of the track.

4 Configuration

4.3.2.2 Defining the base frame for a track motion

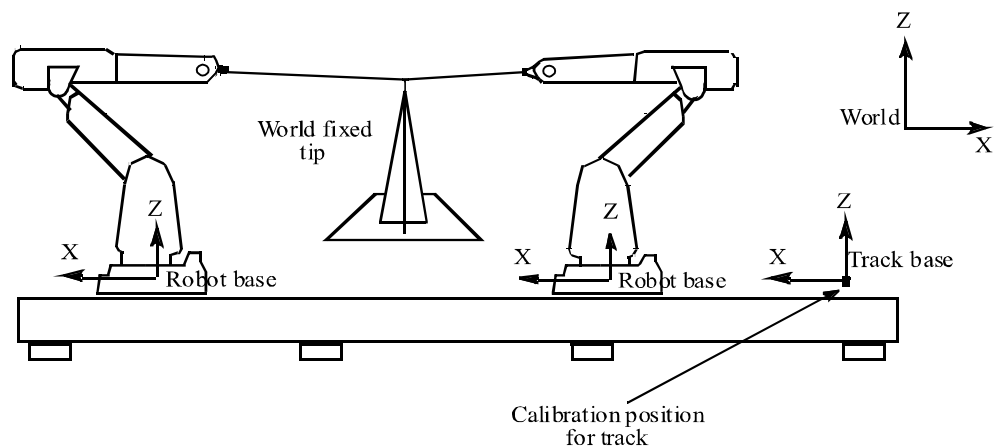
4.3.2.2 Defining the base frame for a track motion

Prerequisites

To make coordinated track motion possible it is necessary to define the base frame of the track. This frame is located in the calibration position of the track (see illustration below).

For the definition of a track base frame you need a world fixed tip within the robot's working range. The calibration procedure consists of a number of positionings of the TCP to the reference point (world fixed tip).

Please note that before the base frame of the track may be defined, the base frame of the robot must be defined with the track in the calibration position, that is robot base frame identical with track base frame.

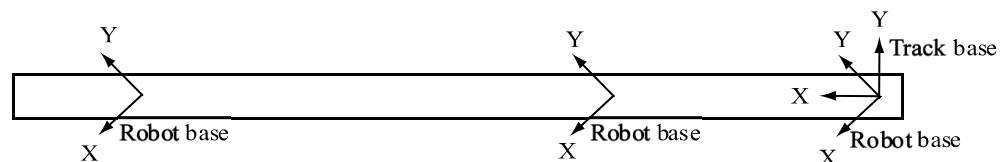


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Definitions for track base coordinate system

The track's base coordinate system has its origin in the robot's base when the track is in its calibration position. The x direction is pointing along the linear track path and the z axis of the track's coordinate system is parallel with the z axis of the robot's base coordinate system.

The illustration below shows an example of how the base systems are oriented for a specific robot mounting. In this case the robot is mounted on the track at an angle of 45 degrees.



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Base frame definition procedure

	Action
1	Tap the ABB menu - Calibration .

Continues on next page

	Action
2	Select the mechanical unit for the track.
3	Select Base Frame and 3 points .
4	Activate the track unit and run it to the calibration position, that is zero position should be displayed on the FlexPendant.
5	Select Point1 .
6	Jog the robot as close as possible to the world fixed tip.
7	Modify the position by tapping Modify Position .
8	Move the robot along the track and repeat the steps above for the points Point 2 and Point 3 .
9	Press OK to calculate the base frame for the track.

Result

The result of the calculation is displayed (expressed in the world coordinate system). The following values are shown:

Listed values	Description
Method	Displays the selected calibration method.
Max error	The maximum error for one positioning.
Min error	The minimum error for one positioning.
Mean error	The accuracy of the robot positioning against the tip.
Cartesian X	The x coordinate for the base frame. (x, y, z is the same as for the robot base frame).
Cartesian Y	The y coordinate for the base frame.
Cartesian Z	The z coordinate for the base frame.
Quaternion 1-4	Orientation components for the base frame.

If the estimated error is acceptable, press **OK** to confirm the new track base frame.

If the estimated error is unacceptable, press **Cancel** to redefine the calibration.

4 Configuration

4.3.3.1 How to get started with a coordinated (moveable) user coordinate system

4.3.3 Coordinated positioners

4.3.3.1 How to get started with a coordinated (moveable) user coordinate system

Coordination procedure

In the checklist below, the steps required to coordinate a user coordinate system are described. In each step, there may be a reference to another chapter in this manual, where more details of the specific actions to be taken will be found.

	Action	Information
1	Calibrate the robot and the positioner, i.e. the zero position of the measuring system for both robot and positioner must be carefully determined.	See section <i>Calibrating</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
2	Define the base frame of the robot.	See <i>4 points XZ calibration</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
3	Define the user frame of the positioner.	See Defining the user frame for a rotational single axis on page 99 or Defining the user frame for a multi axes positioner on page 102 .
4	Create a backup of the system by tapping ABB - Backup and Restore - Backup Current system .	See <i>Back up and restore systems</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
5	Create a new work object data and give it a name, e.g. wobj_turntable. In this work object, change the component <code>ufprog</code> to FALSE, indicating that the user object should be connected to a moveable mechanical unit. Also change the component <code>ufmec</code> to the name of the positioner (e.g. STN_1).	See section <i>Creating a work object</i> in <i>Operating manual - IRC5 with FlexPendant</i> .
6	If you want the object frame to be displaced relative to the user frame, you may write the displacement in the x, y, z values of the <code>oframe</code> component of the work object.	For more information about the object frame, see <i>Operating manual - IRC5 with FlexPendant</i> , section <i>What is a work object</i> and section <i>Defining the work object coordinate system</i> .
7	Activate the positioner in the jogging window and check that the coordination is working satisfactorily. This can be done by: <ul style="list-style-type: none">• selecting Work Object in the field Coordinate system• selecting your work object, e.g. wobj_turntable, in the field Work object When jogging the positioner, the robot TCP should also move, following the moveable object coordinate system.	



Tip

When programming, it is important to have the coordinated work object, in this case wobj_turntable, programmed as an argument in each move instruction. This will be automatically added to the move instruction, if the work object is activated in the jogging window before starting the programming.

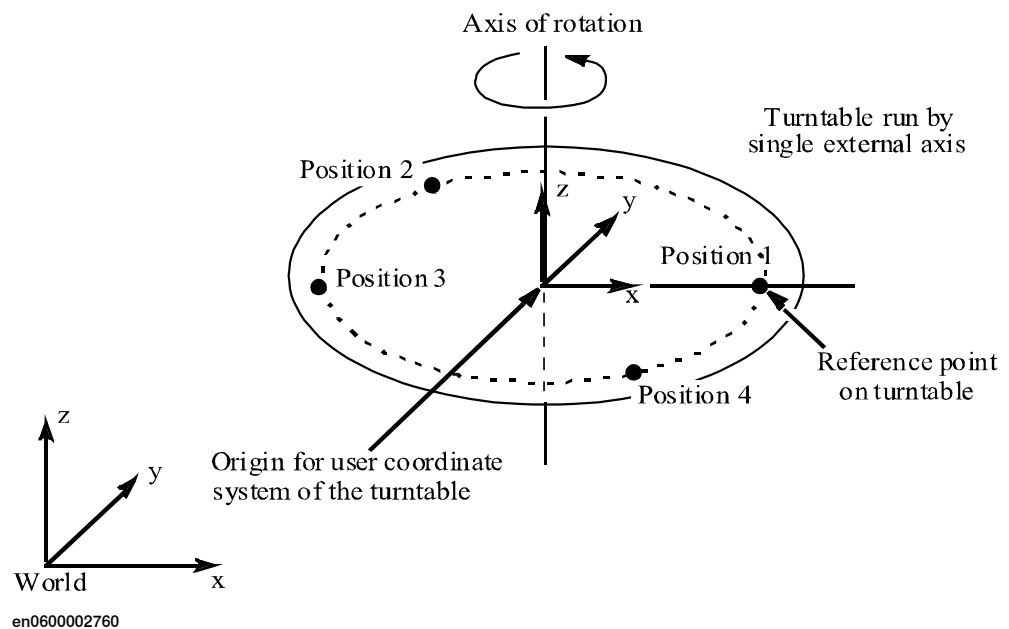
4.3.3.2 Defining the user frame for a rotational single axis

About defining the user frame

This method will define the location of the user coordinate system of a rotational single axis positioner, relative to the world coordinate system. As it is a single axis the base frame and user frame will coincide. This user coordinate system should be used when a coordinated work object is used.

Prerequisites

The definition of a user frame for a rotational additional axis requires that the turntable on the additional axis has a marked reference point. The calibration procedure consists of a number of positionings for the robot's TCP on the reference point when the turntable is rotated to different angles (see illustration below).



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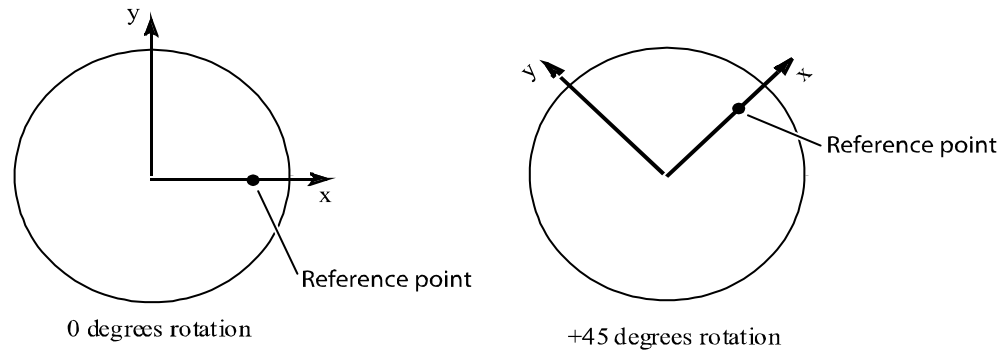
4 Configuration

4.3.3.2 Defining the user frame for a rotational single axis

Continued

Position and directions of the user frame

The user coordinate system for the rotational axis has its origin in the centre of the turntable. The z direction coincides with the axis of rotation and the x axis goes through the reference point. The illustration below shows the user coordinate system for two different positionings of the turntable (turntable seen from above).



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Note

If it is intended to simulate the positioner in RobotStudio, it is recommended to define the user coordinate system of the rotational axis so that it coincides with the user coordinate system of the RobotStudio model.

User frame definition procedure

	Action
1	Tap the ABB menu - Calibration .
2	Select the rotational single axis positioner.
3	Select Base Frame .
4	Select the method 4 Point Z .
5	If you have a MultiMove system, select which robot to use for the calibration. For single-robot, go directly to the next step.
6	Select Point 1 .
7	Jog the robot as close as possible to the reference point.
8	Modify the position by tapping Modify Position .
9	Move the rotational positioner to a new positive position and point out the new position with the robot.
10	Repeat the steps 6-9 for the points Point 2 , Point 3 and Point 4 .
11	Jog the robot to a position where the tool center point (TCP) touches an imaginary extension of the desired positive z axis. In this case, this point should be along the rotational axis of the turntable (above the turntable). This is only to define the positive direction of the z axis. It is not used to increase the accuracy of the calibration. The exact direction of the z axis is defined as the normal of the xy plane.
12	Select Elongator Point Z and tap Modify Position .

Continues on next page

Action	
13	If you want, you can save the entered calibration data to a file. Tap Positions and then Save . Enter the name of the file and then tap OK . To restore this calibration, the file can be loaded from Positions - Load , instead of performing steps 6-12.
14	Press OK to calculate the user frame for the positioner.

Result

The result of the calculation is displayed (expressed in the world coordinate system). The following values are shown:

Listed values	Description
Method	Displays the selected calibration method.
Max error	The maximum error for one positioning.
Min error	The minimum error for one positioning.
Mean error	The accuracy of the robot positioning against the tip.
Cartesian X - Z	The x, y, z coordinates for the user frame.
Quarternion 1-4	Orientation components for the user frame.

If the estimated error is acceptable, press **OK** to confirm the new user frame.

If the estimated error is unacceptable, press **Cancel** to redefine the calibration.

4 Configuration

4.3.3.3 Defining the user frame for a multi axes positioner

4.3.3.3 Defining the user frame for a multi axes positioner

Parameter file required

It is possible to define positioners with more than one axis. To achieve the best possible performance from such a positioner, a set of data, describing its kinematic and dynamic properties (among other things), must be defined. This data cannot be defined in the system parameters via the FlexPendant or RobotStudio, but must be read from a parameter file. If no file was supplied with the manipulator, the manipulator cannot be coordinated with the robot. It can, however, be defined as a number of separate external axes.

Differences between one and multi axes positioner

The principles for defining a user frame for a multi axes positioner are the same as for a one axis positioner, see [Defining the user frame for a rotational single axis on page 99](#). However, note that the axis must be moved in positive direction (see step 9 below).

For a positioner with more than one axis, a 4 point calibration is performed for each axis.



Note

If it is intended to simulate the positioner in RobotStudio, it is recommended to define the user coordinate systems of the rotational axes so that they coincide with the user coordinate systems of the RobotStudio model.

Define number of axes

The number of axes belonging to the positioner must be defined in the configuration file before coordinated motions are possible. The value should represent the number of axes connected in serial.

Parameter	Type	Description
no_of_error_model_joints	ROBOT_TYPE	Number of axes connected in serial belonging to the positioner. The maximum value is 6.

The parameter does not need to be set for ABB positioners.

User frame definition procedure

	Action
1	Tap the ABB menu - Calibration .
2	Select the multi axes positioner
3	Select Base Frame .
4	Select 4 Points for Axis 1 .
5	If you have a MultiMove system, select which robot to use for the calibration. For single-robot, go directly to the next step.
6	Select Point 1 .

Continues on next page

	Action
7	Jog the robot as close as possible to the reference point.
8	Modify the position by tapping Modify Position .
9	Move the first axis in positive direction to a new position (according to right hand rule).
10	Repeat the steps 6-9 for the points Point 2 , Point 3 and Point 4 .
11	If you want, you can save the entered calibration data to a file. Tap Positions and then Save . Enter the name of the file and then tap OK . To restore this calibration, the file can be loaded from Positions - Load , instead of performing steps 6-10.
12	Select 4 Points for Axis 2 and repeat step 5-11 for the other axes belonging to the positioner.
13	Press OK to calculate the user frame for the positioner.

Result

The result of the calculation is displayed (expressed in the world coordinate system).
The following values are shown:

Listed values	Description
Method	Displays the selected calibration method.
Max error	The maximum error for one positioning.
Min error	The minimum error for one positioning.
Mean error	The accuracy of the robot positioning against the tip.
Cartesian X - Z	The x, y, z coordinates for the user frame.
Quarternion 1-4	Orientation components for the user frame.

If the estimated error is acceptable, press **OK** to confirm the new user frame.

If the estimated error is unacceptable, press **Cancel** to redefine the calibration.



Note

When defining a work object for a coordinated motion, the user frame part of the work object is left empty (unit frame). Instead the user part is computed when needed using the kinematic model and the joint position for the mechanical unit.

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5 Commutation

Overview of commutation

There are two methods to find the commutation value for motors that are not included in the ABB offer.

- 1 Automatic method, see [Commutation with service routine on page 106](#).
- 2 Manual method, see [Manual commutation on page 108](#).



CAUTION

If the motor is not properly commutated, it can rev up and break.

Continues on next page

5 Commutation

5.1 Commutation with service routine

5.1 Commutation with service routine

Service routine for commutation

The service routine **Commutation** is used to:

- Find a commutation value for a synchronous permanent magnet motor.
- Verify that the motor phase order is correct.
- Verify that the pole pair parameter value is correct.
- Verify that the resolver connection is correct.

Commutating with the service routine

	Action	Note
1	Set the motor in safe mode by changing the system parameter <i>Current Vector On</i> (topic <i>Motion</i> , type <i>Drive System</i>) to Yes.	Set the motor in safe mode/normal mode on page 106.
2	Start the service routine Commutation .	See <i>Operating manual - IRC5 with FlexPendant</i> section <i>Programming and testing - Running a service routine</i> .
3	Examine the order of the motor phase connections.	Motor phase connection order on page 107.
4	Examine the resolver connection.	Resolver connections on page 107.
5	Move the motor by using the service routine. <ul style="list-style-type: none">• For the pre-commutated motor: Make sure that the motor phase connections are connected to the right phase. If yes, then the existing commutation is ok to use. Do not update the commutation offset.• For the non-commutated motor: Commutate the motor by updating the commutation offset.	<ul style="list-style-type: none">• Motor phase connections on page 107.• Update commutation offset on page 107.
6	The commutation is now finished and the motor is ready to use. When exiting, the program will ask if the motor is to be set in normal mode. The motor can also be set to normal mode by changing the parameter <i>Current Vector On</i> to No.	See Set the motor in safe mode/normal mode on page 106.

Set the motor in safe mode/normal mode

The system parameters can be changed in the FlexPendant or in RobotStudio. On the FlexPendant tap **Control panel/Configuration/Topics/Motion/Drive System**. Then change the parameter *Current Vector On* to Yes or No in the *Drive System*. If the motor is to be set in safe mode set the parameter to Yes. If the motor is to be set in normal mode set the parameter to No.



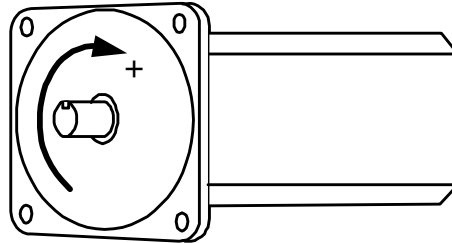
CAUTION

If the motor is not properly commutated, it can destroy itself or other equipment. To avoid this, set the motor in safe mode.

Continues on next page

Motor phase connection order

By stepping the motor in positive direction using the service routine, the motor shaft shall turn in counter clockwise direction, if the shaft is seen from the resolver side and clockwise from the drive shaft side.



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If the motor is turning in the wrong direction then the motor phases have been swapped. Try changing RST to SRT, RTS, or TSR.

Pole pairs parameter

Examine that the pole pairs (*Pole Pairs*) parameter is loaded with the correct value by stepping the motor from the service routine. The motor shall turn 1/16 of a revolution for every step.

Resolver connections

From the service routine step the motor in positive direction. The resolver is connected correctly if the motor angle in the jogging window is increasing. Otherwise check the wiring of the resolver.

Motor phase connections

Using the service routine, move the motor to the commutation position. For best result, commutate without any equipment connected to the motor (a free mounted motor).

There are a number of correct commutation angles (same as *Pole Pairs* parameter). If the difference between the provided commutation angle and the suggested commutation angle is a multiple of $6.283185/\text{number of pole pairs (Pole Pairs)}$ - the commutation is ok. Otherwise all motor phases shall be moved one step forward or backward (same order! RST -> STR or TRS).

A commutation value set by the motor manufacturer is normally more accurate than a value updated by the service routine.

Update commutation offset

To get a good commutation position the motor must not be affected by gravity or large friction from equipment connected to the motor. For best result, commutate without any equipment connected to the motor (a free mounted motor).

When the motor is aligned, the resolver commutation parameter can be set. When the parameter is set the database is also updated.

5 Commutation

5.2 Manual commutation

5.2 Manual commutation

General

Before using an additional axis, the motor must be commutated. To do the commutation manually, connect a DC power source between two nodes and then measure the position of the motor.



Note

ABB motors are pre-commutated with the commutation value 1.5708. Therefore, an ABB motor does not require modifying the commutation offset.

Prerequisites

The motor must comply with the specifications in [Motors on page 162](#). The resolver must comply with the specifications in [Resolvers on page 168](#).

Required material

This is a list of what you need to perform the commutation manually:

Material	Description
PC with TuneMaster	See <i>Application manual - TuneMaster</i> .
Power supply	24 V (DC). The power supply should be equipped with a relay that trips at short circuit. Otherwise a fuse will burn every time the power is applied. Check the motor data to see the current required from the power supply.
2 cable sets	Cables to brake release and motor phase. Each cable set includes one plus and one minus cable.
Motor documentation	Motor data sheet and electrical connection drawing.

Measuring the commutation position

This procedure describes how to measure the commutation position of a motor.

	Action
1	Deactivate the axis for the motor to commutate.
2	Switch off the controller.
3	Disconnect the motor cable from the motor.
4	Disconnect the motor from the gear (or in some other way make sure the motor is not affected by external torque and friction).
5	If the motor is using a brake, release it by connecting the power supply to the contact pins for the brake release. See the motor specification for maximum brake current, which contact is for the brake release, and the polarity of the contacts (if any).
6	Make sure that the brake is released by manually turning the motor.

Continues on next page

	Action
7	<p>Connect the power supply with the plus cable to the phase S (V) and the minus cable (0 V) to the to the phase T (W). A short pulse is enough to move the motor to its commutation position. Disconnect the power after the voltage pulse.</p>
8	<p>Connect the power to give another voltage pulse to the motor. If the motor is already in its commutation position it should not move this time.</p>
9	<p>Disconnect the power supply from the brake release, so that the motor brake is engaged.</p>
10	<p>Reconnect the motor cable from the drive unit to the motor.</p>
11	<p>Start the controller.</p>
12	<p>Activate the axis. Do not move any mechanical unit.</p>
13	<p>Configure TuneMaster, selecting mechanical unit and the signal <i>ResolverAngle</i> (signal number 1). Zoom in on the signal to read at least 2 decimals. Note that the number of commutation positions are equal to the number of pole pairs. For example, a motor with 2 pole pairs have 2 possible values for this measurement. It does not matter which of the commutation points are measured.</p>
14	<p>Set the measured value to the parameter <i>Commutator Offset</i> in the type <i>Motor Calibration</i>. Restart the controller.</p>
15	<p>Reconnect the motor to the gear.</p>

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6 Tuning

6.1 Tuning of servo control parameters

Overview

The servo control parameters can be adjusted (tuned) to achieve the best possible motion performance.

Tuning with TuneMaster

The recommended way to perform the tuning is by using the software TuneMaster. How to perform the tuning is described in *Application manual - TuneMaster*.

6 Tuning

6.2.1 Tuning of the soft servo parameters

6.2 Additional tuning

6.2.1 Tuning of the soft servo parameters

General

This section details how to tune the following parameters in the type *Lag Control Master 0*:

- *K Soft Min Factor*
- *K Soft Max Factor*
- *Kp/Kv Ratio Factor*
- *Ramp Time*



Tip

In most applications these parameters do not have to be trimmed and can be left at their default values.

Tuning of K Soft Min Factor

The procedure below details how to make the initial tuning of the parameter *K Soft Min Factor*.



Tip

The movements in this trim procedure should be done close to the point where the soft servo is activated, to minimize the risk of an axis collapsing.

	Action
1	Determine a maximum axis movement for which the axis should not move, when the softness is 100%. Such a movement can be 0.1 rad for a rotating axis.
2	Determine a minimum axis movement for which the axis should move, when the softness is 100%. Such a movement can be 0.2 rad for a rotating axis.
3	Activate the soft servo with softness 100% and perform the two movements.
4	If the axis moves for both movements, the axis is too stiff and <i>K Soft Min Factor</i> should be reduced. If the axis does not move for any movement, the axis is too soft and <i>K Soft Min Factor</i> should be increased.
5	Repeat step 3 and 4 until the axis does not move for the smaller movement but does move for the bigger movement.

Tuning of K Soft Max Factor

In most cases, *K Soft Max Factor* can be left at its default value (1.0).

If the axis is too stiff at 0% softness, reduce *K Soft Max Factor*. If the axis is too soft at 0% softness, increase *K Soft Max Factor*. The tuning can be made in a similar way as for *K Soft Min Factor*, but with smaller movements.

Continues on next page

Kp/Kv Ratio Factor

Kp/Kv Ratio Factor determines the stability margin for the axis. A value less than 1.0 increases the stability. It is not possible to set this parameter to a value larger than 1.0 since the stability of the axis would be jeopardized.

Ramp Time

If *Ramp Time* is changed, the duration of the activation and deactivation phase will change. A short ramp time can result in a twitch of the axis at activation.

6 Tuning

6.2.2 Additional tuning for servo guns

6.2.2 Additional tuning for servo guns

Description in separate manual

The specifics for tuning a servo gun are described in *Application manual - Servo Gun Setup*.

7 Error handling

Handling errors - an iterative process

This section details how to handle fault localization after having performed system configuration.

Fault localization is an iterative process that must go on until all errors are eliminated. The following steps describe the order of the process:

- 1 Open the event log and select the category **Configuration**. Search for error messages and identify the first error.
- 2 Open the **Configuration Editor** in RobotStudio and correct the parameter value for the error that was found.



Note

To avoid new error messages, only correct one error at a time.

- 3 Restart the controller.
- 4 Go back to step 1 and proceed with the steps above until all errors are eliminated.



Tip

Troubleshooting is also described in the following manuals:

- *Operating manual - Troubleshooting IRC5*
- *Operating manual - IRC5 Integrator's guide*

All event log messages can also be found in *Operating manual - Troubleshooting IRC5*

Summary

Error management is necessary to secure that the right configuration file for a certain kinematic model is used. It is also important to check that parameter settings have been done with correct/allowed values.

Every time a new system configuration is done or axes are tuned, fault localization and error correction must also be done to ensure that any remaining errors will be eliminated.

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8 System parameters

8.1 Acceleration Data

General

These parameters are applicable to each arm of the external robot in question.

Parameter description

The parameters belong to the configuration type *Acceleration Data* in the *Motion* topic.

Cfg name	Parameter name	Description
name	Name	Name of the <i>Acceleration Data</i> group. Max 32 characters.
wc_acc	Nominal Acceleration	Axis acceleration in rad/s^2 (or m/s^2 for linear axes). If the value is too high, the motor will reach the torque limit and result in poor path performance.
wc_dec	Nominal Deceleration	Axis deceleration in rad/s^2 (or m/s^2 for linear axes). If the value is too high, the motor will reach the torque limit and the axis will overshoot in fine points.

8 System parameters

8.2 Arm

8.2 Arm

General

These parameters are applicable to each arm of the robot in question.

Parameter description

The parameters belong to the configuration type *Arm* in the *Motion* topic.

Common parameters

Cfg name	Parameter name	Description
upper_joint_bound	Upper Joint Bound	Upper bound for the axis work area (in radians or meters). The axis cannot be moved beyond this limit during jogging or program execution.
lower_joint_bound	Lower Joint Bound	Lower bound for the axis work area (in radians or meters). The axis cannot be moved beyond this limit during jogging or program execution.

Parameters for additional axes

Cfg name	Parameter name	Description
independent_joint_on	Independent Joint	Set parameter to value On in order to activate the possibility to use independent joint instructions. Default value is Off.
ind_upper_joint_bound	Independent Upper Joint Bound	Upper bound for the axis work area when operating in independent mode (in radians or meters).
ind_lower_joint_bound	Independent Lower Joint Bound	Lower bound for the axis work area when operating in independent mode (in radians or meters).

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the ARM data group, e.g. x.
use_arm_type	Use arm type	ID name for ARM_TYPE data group.
use_acc_data	Use acc data	ID name for ACC_DATA data group.
use_arm_calib	Use arm calib	ID name for ARM_CALIB data group.
lower_joint_bound_min	-	Minimum value for lower_joint_bound. The unit is radian or meters.
upper_joint_bound_max	-	Maximum value for upper_joint_bound. The unit is radian or meters.
cal_position	Calibration position	Calibration position. The unit is in radians or meters.

8.3 Arm Calib

General

These parameters are applicable to each arm of the external robot in question.

Parameter description

The following parameters belong to the topic *Motion* and the type *Arm Calib*.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the ARM_CALIB data group.

8 System parameters

8.4 Arm Type

8.4 Arm Type

General

These parameters are applicable to each arm of the robot in question.

Parameter description

The parameters below are the parameters used to describe a kinematic model in GEN_KIN and they are based on the standard Denavit-Hartenberg convention and follows the description provided in *Introduction to Robotics, Mechanics and Control* by John J. Craig. The parameters are provided for each joint and to be able to set up a kinematic model, it is necessary to understand how coordinate systems in the respective joints are transformed based on the parameters. Here coordinate system 0 is a fixed coordinate system with a certain relation to the world coordinate system. Coordinate system 1 is attached to joint 1, coordinate system 2 is attached to joint 2, etc. The description below is assumed to be provided for joint k (coordinate system k), the previous joint coordinate system is referred to as coordinate system k-1 and the next coordinate system hence k+1.

Parameters for non ABB robots

The following parameters belong to the topic *Motion* and the type *Arm Type*.

Cfg name	Parameter name	Description
name	Name	Name of the ARM_TYPE data group.
length	-	Arm length, measured along the x direction in the current coordinate system k (according to Craig's definition ⁱ). (Meter)
offset_z	-	Offset in z direction in current coordinate system k. Home position of a linear axis. (Meter)
theta_home_position	-	Axis angle of arm in home position, rotation around the z-axis in current coordinate system k (theta according to Craig's definition ⁱ). (Radians)
attitude	-	Angle between z-axis in previous coordinate system k-1 and the current coordinate system k (alpha according to Craig's definition ⁱ). Rotation is around the x-axis in coordinate system k-1. (Radians)

ⁱ The Denavit-Hartenberg notation according to John J. Craig in *Introduction to Robotics, Mechanics and Control*

Example 1 – XYZC(Z), available as template

Build a gantry with linear axes along X, Y and Z and a rotation around the Z axis. In the *MOC.cfg* file, the following information will be included. See also the template files where additional info is also shown.

```
ROBOT:  
  
-name "ROB_11" -use_robot_type "ROB11_XYZC(Z)" \
```

Continues on next page


```
-use_robot_calib "r11_uncalib" \
-use_joint_0 "rob11_1" -use_joint_1 "rob11_2" \
-use_joint_2 "rob11_3" -use_joint_3
```

ROBOT_TYPE:

```
-name "ROB11_XYC(Z)" -type "GEN_KIN3" -error_model "NOMINAL" \
-no_of_joints 4 -master_robot -tcp_robot \
-base_pose_rot_u0 0.70710678 -base_pose_rot_u1 0 \
-base_pose_rot_u2 0.70710678 -base_pose_rot_u3 0
```

The `base_pose_rot` parameters are used to get the coordinate system for the first joint such that the z-axis is aligned with the linear movement direction, the x-axis in the world coordinate system. In addition, `JOINT` and `ARM` sections has to be set up in the `MOC.cfg` to be complete, see the template files. The property to decide whether the axis is rotating or linear is part of the type `TRANSMISSION`. By using `rotating_move`, the axis will be rotating around the local z-axis, otherwise the motion will be translational along the z-axis.

With the parameters above, the type `ARM_TYPE` is shown below.

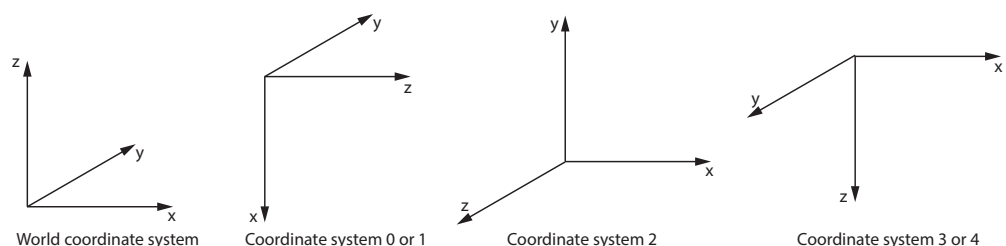
ARM_TYPE:

```
-name "ROB11_1" -length 0 -offset_z 0 -attitude 0 \
-theta_home_position 0

-name "ROB11_2" -length 0 -offset_z 0 -attitude 1.5707963 \
-theta_home_position 1.5707963

-name "ROB11_3" -length 0 -offset_z 0 -attitude 1.5707963 \
-theta_home_position 0

-name "ROB11_4" -length 0 -offset_z 0 -attitude 0 \
-theta_home_position 0
```



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- 1 Transformation from world coordinate system to the joint 1 coordinate system is done by the `base_pose_rot` parameters in `ROBOT_TYPE`. Joint 1 is linear and moves along the z-axis of coordinate system 1, which is aligned with the x-axis of the world coordinate system.
- 2 The Joint 1 coordinate system is rotated around the x-axis of coordinate system 1 to get the z-axis of coordinate system 2 aligned with the negative

Continues on next page

8 System parameters

8.4 Arm Type

Continued

y-axis in the world coordinate system by a rotation of $\pi/2$. This is achieved by using the `attitude` parameter. To prepare for the coordinate system 3 to have x-axis aligned with world coordinate system, a rotation is also performed around the z-axis of the coordinate system 2 by setting the `theta_home_position` parameter to $\pi/2$.

- 3 To achieve a final coordinate system with negative z-axis aligned with the world coordinate system, the `attitude` parameter is used, providing a rotation around the x-axis in coordinate system 2 by $\pi/2$ to achieve coordinate system 3 and 4.

Additional rotations, such as a spherical wrist or an additional linear axis can be attached using similar steps as above.

8.5 Brake

General

These parameters control the emergency brake behavior. They are applicable to each additional axis with a brake strong enough to hold against gravitation.

Parameter description

The parameters belong to the configuration type *Brake* in the *Motion* topic.

Cfg name	Parameter name	Description
name	Name	ID name of the brake.
control_off_delay_time	Control Off Delay	The motor torque is turned off after this delay time has expired. It must be long enough to ensure that the mechanical brake has started working, or the axis risk dropping toward the ground.
brake_control_on_delay_time	Brake Control On Delay	Period of time during which deceleration by motor is used. It should be set close or equal to the mechanical brake activation time and must be long enough to damp mechanical oscillation. If the axis is still moving after this time has expired, the electrical torque brake is activated.
brake_control_on_min_delay_time	Brake Control Min Delay	Used by the brake algorithm much the same as <i>Control Off Delay</i> . Should be set to the same value as that parameter.
absolute_brake_torque	Absolute Brake Torque	Specifies max brake torque generated by the motor in the electrical torque brake phase. <i>Absolute Brake Torque</i> together with torque generated by the mechanical brake must not exceed max allowed torque for the arm, in order not to damage arm and gearbox.
brake_ramp_speed_limit	Brake Ramp Speed Limit	Specifies the speed limit for torque reduction in the electrical torque brake phase and is typically set to zero.

8 System parameters

8.6 Force Master

8.6 Force Master

General

Force Master is used to define how a servo gun behaves during force control. The parameters only affect the servo gun when it is in force control mode.

Parameter description

The following table contains the parameters that belongs to the topic *Motion* and the type *Force master*.

Parameters for additional axes

Cfg	Parameter name	Description
bandwidth_ramping	References Bandwidth	The frequency limit for the low pass filter for reference values.
ramp_time_switch	Use Ramp Time	Determines if the ramping of the tip force should use a constant time or a constant gradient.
ramp_torque_ref_closing	Ramp when Increase Force	Determines how fast force is built up while closing the tool when <i>Use ramp time</i> is set to No.
ramp_time	Ramp Time	Determines how fast force is built up while closing the tool when <i>Use Ramp Time</i> is set to Yes.
bandwidth_lp	Collision LP Bandwidth	Frequency limit for the low pass filter used for tip wear calibration.
alarm_torque	Collision Alarm Torque	Determines how hard the tool tips will be pressed together during the first gun closing of new tips calibrations and tool change calibrations.
col_speed	Collision Speed	Determines the servo gun speed (m/s) during the first gun closing of new tips calibrations and tool change calibrations.
distance_to_contact_position	Collision Delta Position (m)	Defines the distance the servo tool has gone beyond the contact position when the motor torque has reached the value specified in <i>Collision Alarm Torque</i> .
force_ready_detection_bandwidth	Force Detection Bandwidth	The feedback motor speed is filtered through a LP filter with this bandwidth. This is to avoid that variations in the speed will trigger the force detection too early.
force_ready_detection_speed	Force Detection Speed	When the feedback motor speed is below this value, it is considered that the ordered force is reached.
delay_ramp	Delay Ramp	Delays the starting of torque ramp when force control is started.

8.7 Force Master Control

General

These parameters are used to set the speed limit and speed loop gain as functions of the torque.

Parameter description

The following parameters belong to the topic *Motion* and the type *Force Master Control*.

Cfg name	Parameter name	Description
no_of_posts	No. of Speed Limits	The number of points used to define speed limit and speed loop gain as functions of the torque. Up to 6 points can be defined.
torque_1 - torque_6	Torque 1- Torque 6	The torque levels, corresponding to the ordered tip force, for which the speed limit and speed loop gain values are defined.
speed_lim_1 - speed_lim_6	Speed Limit 1-6	<i>Speed Limit 1 to Speed Limit 6</i> are used to define the maximum speed depending on the ordered tip force.
Kv_1 - Kv_6	Kv 1-6	<i>Kv 1 to Kv 6</i> are used to define the speed loop gain for reducing the speed when the speed limit is exceeded.

8 System parameters

8.8 Joint

8.8 Joint

General

These parameters are used to identify individual axes.

Parameter description

The following parameters belong to the topic *Motion* and the type *Joint*.

Parameters for additional axes

Cfg name	Parameter name	Description
logical_axis	Logical Axis	Used by RAPID programs to identify individual axes. Robots from ABB normally use the values 1-6, while additional axes use 7-12. E.g. the value 7 of <i>Logical Axis</i> corresponds to <i>eax_a</i> in the data type <i>robtarget</i> , 8 corresponds to <i>eax_b</i> , etc.

8.9 Lag Control Master 0

General

The type *Lag Control Master 0* is normally used for regulation of axes without any dynamic model.

Parameter description

The following table contains the parameters that belong to the type *Lag Control Master 0* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
Kp	Kp, Gain Position Loop	The amplification of the position control, e.g. 15. A high value will give a stiff axis that quickly assumes its new position. The value should be large without inducing overshoot in the position or oscillations of the axis.
Kv	Kv, Gain speed loop	The amplification of the velocity control, e.g. 2. A high value gives better high frequency stiffness, better response speed and low overshoot. If the value is too high the axis will vibrate.
Ti	Ti, Integration Time Speed Loop	Integration time in the speed regulation loop. The lower the value of <i>Ti Integration Time Speed Loop</i> , the better tracking and disturbance rejection. Too low value may cause oscillation or noise.
ffw_mode	FFW Mode	Feed Forward mode. Possible options are: <ul style="list-style-type: none"> • 0 (No): The controller is driven by the position error (lag). • 1 (Spd): The controller receives information about the desired speed of the axis. Speed is the recommended configuration. • 2 (Trq): The controller uses the desired speed and acceleration of the axis to calculate the desired motor torque. This requires knowledge of the mass inertia of the axis, which must be supplied by the user. For this reason its more difficult to tune and is only recommended for experienced users.

Parameters for additional axes

Cfg name	Parameter name	Description
use_inpos_forced_control	Forced Control Active	Determines whether forced gain control is active for this joint. If set to Yes, <i>Affects Forced Control in Supervision</i> should normally also be set to Yes for this joint (see below).
Kp_forced_factor	Forced Factor for Kp	The forced factor for Kp, if forced gain control is active.
Ki_forced_factor	Forced Factor for Ki	The forced factor for Ki, if forced gain control is active.
Kp_raise_time	Rise time for Kp	The rise time for forced Kp.
bandwidth	Bandwidth	This parameter should be left at its default value.

Continues on next page

8 System parameters

8.9 Lag Control Master 0

Continued

Cfg name	Parameter name	Description
delay_time	Delay	This parameter should be left at its default value.
resonance_frequency	Df	Dynamic factor. This parameter is only available in the Trq configuration. It can be used to damp oscillations of the axis due to mechanical resonance. Initially <i>Df</i> should be left at its default value. It can be adjusted once the other controller parameters have been fixed.
inertia	Inertia	Total mass moment of inertia at motor side.
soft_servo_K_max_factor	K Soft Max Factor	Determines the value of the product $K_p \cdot K_v$ when the soft servo is used with softness 0%. <i>K Soft Max Factor</i> should be in the range 0.001-1000 (default 1.0). When the soft servo is activated with 0% softness, the control parameters K_p and K_v are tuned such that $K_p \cdot K_v = (K_p \cdot K_v)_{normal} \cdot K \text{ Soft Max Factor}$, where $(K_p \cdot K_v)_{normal}$ is the product of K_p and K_v during normal operation.
soft_servo_K_min_factor	K Soft Min Factor	Determines the value of the product $K_p \cdot K_v$ when the soft servo is used with softness 100%. <i>K Soft Min Factor</i> should be in the range 0.001-1000 (default 0.01). When the soft servo is activated with 100% softness, the control parameters K_p and K_v are tuned such that $K_p \cdot K_v = (K_p \cdot K_v)_{normal} \cdot K \text{ Soft Min Factor}$.
soft_servo_Kp_Kv_ratio_factor	Kp/Kv Ratio Factor	Factor used to alter the K_p/K_v ratio during soft servo. <i>Kp/Kv Ratio Factor</i> should be in the range 0.001-1000 (default 1.0). In soft servo mode, K_p and K_v are tuned such that $K_p/K_v = (K_p/K_v)_{normal} \cdot Kp/Kv \text{ Ratio Factor}$.
soft_servo_t_ramp	Ramp time	Default time for activation of the soft servo. The default value is 0.5 s.

8.10 Measurement Channel

General

The type *Measurement Channel* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Measurement Channel* in the topic *Motion*.

Parameters for additional axes

Cfg name	Parameter name	Description
<code>disconnect_at_deactivate</code>	Disconnect at Deactivate	The measurement channel for a deactivated motor can be disconnected (Yes/No).WARNING! If the axis is moved when disconnected, the position of the axis might be wrong after reconnecting, and this will not be detected by the controller. The position after reconnection will be correct if the axis is not moved, or if the movement is less than 0.5 motor revolutions. For servo guns, there is a RAPID calibration method available (the ToolChange calibration) that will adjust any positional error caused by gun movement during disconnection.

Parameters for non-ABB robots

Cfg name	Parameter name	Description
<code>name</code>	Name	Name of the MEASUREMENT_CHANNEL data group, e.g. x.
<code>use_measurement_board_type</code>	Use Measurement Board Type	Measurement board type.
<code>measurement_link</code>	Measurement Link	The number of the measurement system. The number is 1 or 2. Default=1.
<code>board_position</code>	Board Position	The number of the board. The number is 1 or 2. Default=1.
<code>measurement_node</code>	Measurement Node	Measurement node. Node number: 1 to 7. Default=1.
<code>memory_index</code>	Memory Index	The index number on the measurement board where the data is saved.

8 System parameters

8.11 Mechanical Unit

8.11 Mechanical Unit

General

The type *Mechanical Unit* provides parameters that are used to define the Mechanical Unit.

Parameter description

The following table contains the parameters that belong to the type *Mechanical Unit* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
name	Name	Mechanical unit name.
use_activation_relay	Use Activation Relay	ID name for activation relay.
use_brake_relay	Use Brake Relay	ID name for the brake relay.
activate_at_start_up	Activate at Start Up	<i>Activate at Start Up</i> defines if the mechanical unit should be activated at start.
deactivation_forbidden	Deactivation Forbidden	<i>Deactivation Forbidden</i> defines if the mechanical unit is allowed to be deactivated.

Parameters for additional axes

Cfg name	Parameter name	Description
use_connection_relay	Use Connection Relay	ID name of the relay that must be activated when the mechanical unit is activated.
allow_move_of_user_frame	Allow Move of User Frame	The unit can move a user frame, e.g. a work object.
use_single_0 - use_single_5	Use Single 1 - Use Single 6	Defines which singles are part of the mechanical unit. Corresponds to the parameter <i>Name</i> in the type <i>Single</i> .

Parameters for non ABB robots

Cfg name	Parameter name	Description
use_run_enable	Use Run Enable	ID name for run enable input signal.

8.12 Motion Planner

Parameter description

The following table contains the parameters that belong to the type *Motion Planner* in the topic *Motion*.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Motion Planner name.
brake_on_timeout	Brake on Time	Brake activation time in motor on state (in seconds). Min.=0.3, Max.=3600000, Default=3600000.
dynamic_resolution	Dynamic Resolution	(Dynamic sample time)/0.024192. Min.=0.1667, Max.=1.0, Default=1.0.
path_resolution	Path Resolution	(Geometric sample time)/0.024192. If a very low programmed speed (less than 1 mm/s) is used, a small variation of the speed can be observed. This oscillation of the speed can be reduced by increasing path_resolution.
std_servo_queue_time	Queue Time	Standard servo queue time. Min.=0.004032, Max.=0.290304, Default=0.096768.
perpendicular_acc_ratio	-	Perpendicular acceleration ratio. Min.=0.1, Max.=1.5.
dyn_ipol_decbuf_type	-	OPTIMAL_TIME - original, OPTIMAL_PATH - less high torques.
micro_ipol_type	-	micro ipol type 0,..,n. Min.=0.
cpu_load_added_to_dsp	-	Used to verify CPU load margin in DSP. Min=0, Max=25, Default=0.
motion_sup_max_level	Motion Supervision Max Level	Maximum motion sup level and tune value. Min.=10, Max.=500, Default=300.

8 System parameters

8.13 Motion System

8.13 Motion System

Parameter description

The following table contains the parameters that belong to the type *Motion System* in the topic *Motion*.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Motion system name. Min.=-100, Max.=100.
min_temp_ambient_cabinet	Min Temperature Cabinet	Minimum ambient temperature for the cabinet. Min.=-100, Max.=100.
max_temp_ambient_cabinet	Max Temperature Cabinet	Maximum ambient temperature for the cabinet. Min.=-100, Max.=100.
min_temp_ambient_robot	Min Temperature Robot	Minimum ambient temperature for the robot. Min.=-100, Max.=100.
max_temp_ambient_robot	Max Temperature Robot	Maximum ambient temperature for the robot. Min.=-100, Max.=100.

8.14 Motor

General

The type *Motor* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Motor* in the topic *Motion*.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the MOTOR data group.
use_motor_type	Use Motor Type	ID name of the MOTOR_TYPE data group.
use_motor_calib	Use Motor Calibration	ID name of the MOTOR_CALIB data group.
stator_cooling_factor	-	Cooling factor for the stator, multiplied with attribute torque_0. Min.=0, Max.=10, Default=1.

8 System parameters

8.15 Motor Calibration

8.15 Motor Calibration

General

The type *Motor Calibration* provides parameters that are applicable to each axis of the robot in question

Parameter description

The following table contains the parameters that belong to the type *Motor Calibration* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
name	Name	Name of the MOTOR_CALIB data group.
com_offset	Commutator Offset	The motor angle when voltage is applied between the phases S and T. For ABB motors <i>Commutator offset</i> should always be 1.5708.
cal_offset	Calibration Offset	Can be updated by moving the axes to their calibration positions and then fine calibrating.

Parameters for non ABB robots

Cfg name	Parameter name	Description
valid_com_offset	Commutator Offset Valid	Yes If <i>com_offset</i> is valid.
valid_cal_offset	Calibration Offset Valid	Yes if <i>cal_offset</i> is valid.

8.16 Motor Type

General

The type *Motor Type* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Motor Type* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
pole_pairs	Pole Pairs	Number of pole pairs.
ke	ke Phase to Phase	Nominal voltage constant, induced voltage phase to phase (1V/1000rpm \Leftrightarrow 0.00955 Vs/rad) The unit is Vs/rad.
i_max	Max Current	Max. current without irreversible demagnetization. The unit is A rms.
r_stator_20	Phase Resistance	Stator phase resistance at 20 degrees Celsius. If the resistance is measured phase-to-phase, the value should be divided by 2. The unit is ohm.
l_stator	Phase inductance	Stator phase inductance at zero current. The value should be measured at a frequency of about 120Hz to correspond to what the drive expects. If the inductance is measured phase-to-phase, the value should be divided by 2. The unit is Henry.

Parameters for non ABB robots

Cfg name	Parameter name	Description
inertia	-	Motor and resolver inertia on motor side. The unit is kgm ² .
torque_0	Stall Torque	Stall torque, infinite time, temp_stator_rise to temp_stator_max. The unit is Nm.
ke_temp_coef_20	-	Temperature reduction coefficient for ke, at 20 degrees. The unit is 1/K.
ke_stability_coef_20	-	Long-term stability reduction constant for ke after 4000 hours.
ke_tolerance_min	-	Minimum tolerance for ke (%/100) Min. ke= ke*(1+ke_tolerance_min).
ke_tolerance_max	-	Maximum tolerance for ke (%/100). Max. ke= ke*(1+ke_tolerance_max).
ke_red_2i0	-	Current dependant reduction of ke at two times rated current (%/100).

Continues on next page

8 System parameters

8.16 Motor Type

Continued

Cfg name	Parameter name	Description
torque_losses_at_speed1	-	Total torque losses due to friction and iron losses at speed1 (cf. below). The unit is Nm.
torque_losses_at_speed2	-	Total torque losses due to friction and iron losses at speed2 (cf. below). The unit is Nm.
torque_losses_at_speed3	-	Total torque losses due to friction and iron losses at speed3 (cf. below). The unit is Nm.
speed1	-	The speed at which torque_losses_at_speed1 is defined in rad/s.
speed2	-	The speed at which torque_losses_at_speed2 is defined in rad/s.
speed3	-	The speed at which torque_losses_at_speed3 is defined in rad/s.
temp_stator_max	-	Maximum temperature for the stator winding. The unit is degrees Celsius.
temp_stator_rise	-	Maximum temperature rise for the stator winding. The unit is degrees Celsius.
temp_rotor_max	-	Maximum temperature for the rotor. The unit is degrees Celsius.
temp_rotor_rise	-	Maximum temperature rise for the rotor. The unit is degrees Celsius.
r_stator_temp_coef_20	-	Temperature coefficient for the stator resistance at 20 degrees Celsius.

8.17 Relay

General

The type *Relay* provides parameters that are used to define relay.

Parameter description

The following table contains the parameters that belong to the type *Relay* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
name	Name	Name of the relay: <ul style="list-style-type: none"> For ABB axes: Must be the same as the <i>Use connection relay</i> parameter defined in the type <i>Mechanical Unit</i>. For ABB axes: The name must be changed when more relays are added.
out_signal	Output Signal	Denotes the logical name of the output signal to the relay. The name must be identical (including upper and lower case letters) to the name used for the signal definition.
in_signal	Input Signal	Denotes the logical name of the input signal to the relay. The name must be identical (including upper and lower case letters) to the name used for the signal definition. The signal must be defined as "safety" and "INTERNAL".

8 System parameters

8.18 Robot

8.18 Robot

Parameter description

The following table contains the parameters that belong to the type *Robot* in the topic *Motion*.

A maximum of 8 instances of the type *Robot* can be configured in a system.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the robot, for example master.
use_robot_type	Use Robot Type	Name of the kinematic model according to gantry-type kinematic models, see Kinematic models on page 28 .
use_joint_0	Use Joint 1	ID name of 1st axis, for example robx_1.
use_joint_1	Use Joint 2	ID name of 2nd axis, for example robx_2.
use_joint_2	Use Joint 3	ID name of 3rd axis, for example robx_3.
use_joint_3	Use Joint 4	ID name of 4th axis, for example robx_4.
use_joint_4	Use Joint 5	ID name of 5th axis, for example robx_5.
use_joint_5	Use Joint 6	ID name of 6th axis, for example robx_6.
base_frame_pos_x	Base Frame x	Base frame position in respect of world frame coordinate system, x - direction (meters). Min.=1000, Max.=1000, Default=0.
base_frame_pos_y	Base Frame y	Base frame position in respect of world frame coordinate system, y - direction (meters).
base_frame_pos_z	Base Frame z	Base frame position in respect of world frame coordinate system, z - direction (meters).
base_frame_orient_u0	Base Frame q1	Base frame orientation in respect of world frame coordinate system, first quaternion (q1). Min.=-1, Max.=1, Default=0.
base_frame_orient_u1	Base Frame q2	Base frame orientation in respect of world frame coordinate system, second quaternion (q2).
base_frame_orient_u2	Base Frame q3	Base frame orientation in respect of world frame coordinate system, third quaternion (q3).
base_frame_orient_u3	Base Frame q4	Base frame orientation in respect of world frame coordinate system, fourth quaternion (q4).
rot_x_tol	Orientation Tolerance about x	Orientation tolerance (in radians) Min.=0, Max.=4, Default=0.001.
rot_y_tol	Orientation Tolerance about y	Orientation tolerance (in radians). Min.=0, Max.=4, Default=0.001.

Continues on next page

Cfg name	Parameter name	Description
rot_z_tol	Orientation Tolerance about z	Orientation tolerance (in radians). Min.=0, Max.=4, Default=0.001.

8 System parameters

8.19 SG Process

8.19 SG Process

General

The type *SG Process* provides parameters that are applicable for servo guns.

Parameter description

The following table contains the parameters that belong to the type *SG Process* in the topic *Motion*.

Parameters for additional axes

Cfg name	Parameter name	Description
sync_check_off	Sync Check Off	By setting this parameter to 'Yes', it will be possible to close the gun without having done a tip calibration. This is useful during the tuning procedure of a servo gun or if running an application where tip calibrations are not used. When running the gun in production, it is recommended to always have the sync check active in order to prevent possible damage caused by closing an unsynchronized pair of gun tips.
min_close_time_adjust	Close Time Adjust	Constant time adjustment (s), positive or negative, of the moment when the gun tips reach contact during a gun closure. This value is normally zero. May be used to delay the closing slightly when the synchronized pre closing is used for welding.
close_position_adjust	Close Position Adjust	When the tool tips reach the position (plate thickness) ordered by the close instruction, the force control starts. This tool tip position can be adjusted with <i>Close Position Adjust</i> to make the force control start earlier.
pre_sync_delay_time	Force Ready Delay	Constant time delay (s) before sending the weld ready signal after reaching the programmed force.
max_motor_torque	Max Force Control Motor Torque	Maximum allowed motor torque (Nm) during force control. The parameter will protect the gun from too high programmed force, by reducing the resulting motor torque to this upper level. A warning will be logged whenever this happens. The value must not be set higher than the <i>Torque abs. max</i> (type <i>Stress duty cycle</i>) which defines the maximum output of motor torque during both force and position control.
post_sync_time	Post-synchronization Time	Release time anticipation (s) of the next robot movement after a weld. This parameter can be tuned to synchronize the gun opening with the next robot movement. The synchronization may fail if the parameters is set too high.
calib_mode	Calibration Mode	The number of closings performed during a Tipwear calibration. Normally 2 closings will be ok. An increase may improve the accuracy of thickness detection for some servo guns.

Continues on next page

Cfg name	Parameter name	Description
calib_force_high	Calibration Force High	The maximum tip force (N) used during a Tip-Wear calibration. For best result of the thickness detection, it is recommended to use the max programmed weld force.
calib_force_low	Calibration Force Low	The minimum tip force (N) used during a Tip-Wear calibration. For best result of the thickness detection, it is recommended to use the minimum programmed weld force.
calib_time	Calibration Time	The wait time (s) during a calibration before the positional gun tip correction is done. Recommended value ca: 0.5 s.
no_of_active_db_posts	Number of Stored Forces	Number of stored forces in the force VS motor torque table. The minimum value allowed is 2.
squeeze_force_1 - squeeze_force_10	Tip Forces 1 - 10	Gun tip force 1 (N) - Gun tip force 10 (N).
squeeze_torque_1 - squeeze_torque_10	Motor Torque 1 - 10	Motor torque 1 (Nm) - Motor torque 10 (Nm).

8 System parameters

8.20 Single

8.20 Single

Parameter description

The following table contains parameters that belong to the topic *Motion* and the type *Single*.

A maximum of 12 instances of the type *Single* can be configured in a system.

Parameters for additional axes

Cfg name	Parameter name	Description
name	Name	The name of the single. A single axis mechanical unit without kinematic model must have the name of single 1 set to the same name as the mechanical unit.
use_single_type	Use Single Type	Defines which single type to use.

8.21 Single Type

Parameter description

The following table contains the parameters that belong to the topic *Motion* and the type *Single Type*.

Parameters for additional axes

Cfg name	Parameter name	Description
mechanics	Mechanics	<ul style="list-style-type: none">• TRACK - Linear motion.• FREE_ROT - Rotating additional axis.• SG_LIN - Linear servo gun motion.

8 System parameters

8.22 Stress Duty Cycle

8.22 Stress Duty Cycle

General

The type *Stress Duty Cycle* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Stress Duty Cycle* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
name	Name	Name of the STRESS_DUTY_CYCLE.
speed_absolute_max	Speed Absolute Max	The absolute highest motor speed to be used. (rad/s)
torque_absolute_max	Torque Absolute Max	The absolute highest motor torque to be used. (Nm) <ul style="list-style-type: none">• For non ABB robots: If <code>torque_absolute_max</code> is too high it may result in a configuration error at restart. To avoid this make sure that: <code>torque_absolute_max < sqrt(3)*ke*i_max</code>.

8.23 Supervision

General

The type *Supervision* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Supervision* in the topic *Motion*.

Parameters for additional axes

Cfg name	Parameter name	Description
joint_affect_forced_Kp	Affects Forced Control	Determines whether this joint effects forced gain control.
Kp_forced_on_limit	Forced on Position Limit	The upper position limit for forced gain control.
Kp_forced_off_limit	Forced off Position Limit	The lower limit for forced gain control.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the SUPERVISION data group.
use_supervision_type	Use Supervision type	ID name of SUPERVISION_TYPE.
power_up_position_on	Power Up Position Supervision	Power up position supervision On, default is Off.
counter_supervision_on	Counter Supervision	Counter supervision On, default is Off.
position_supervision_on	Position Supervision	Position supervision On, default is Off.
speed_supervision_on	Speed Supervision	Speed supervision On, default is Off.
load_supervision_on	Load Supervision	Load supervision On, default is Off.
jam_supervision_on	Jam Supervision	Jam supervision On, default is Off.
in_position_range	In Position Range	-
normalized_zero_speed	Zero Speed (%)	-
dep_torque_limitation_zero_speed_width	-	Deadband speed width (in rad/s on motor side).

8 System parameters

8.24 Supervision Type

8.24 Supervision Type

General

The type *Supervision Type* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the data group *Supervision Type* in the topic *Motion*.

Parameters for non ABB robots

Cfg name	Parameter name	Description
name	Name	Name of the SUPERVISION_TYPE data group.
static_power_up_position_limit	-	Static power up position error limit at zero speed. The unit is radians, Min.=0 and Max.=30.
dynamic_power_up_position_limit	Dynamic Power Up Position Limit	Dynamic power up position error limit at zero speed, the unit is radians.
static_position_limit	-	Position error limit at zero speed, the unit is radians on motor side.
dynamic_position_limit	-	Position error limit at max speed, the unit is radians on motor side.
static_normalized_speed_limit	-	Speed error limit at zero speed. (% max. speed).
dynamic_normalized_speed_limit	-	Speed error limit at max speed (% max speed).
normalized_influence_sensitivity	-	Speed error influence sensitivity reduction. (% max. speed).
speed_half_time	-	Declination factor half time for supervision limits. The unit is seconds, Min=0 and Max.=5.
max_jam_normalized_speed	-	Speed limit for jam versus overload supervision. (% max. speed).
max_overload_time	-	Maximum overload time. The unit is seconds, Min.=0 and Max.=20.
max_jam_time	Max Jam Time	Max jam time. The unit is seconds, Min.=0 and Max.=20.
teach_mode_speed_max_main	Teach Max Speed Main	Maximum ordered speed ratio in teach mode (% max speed). Min.=0, Max.=1, Default=0.15.
teach_mode_speed_max_dsp	Teach Max Speed DSP	Maximum supervision speed ratio in teach mode for axis computer (% max speed). Min.=0, Max.= 1, Default=0.28.

8.25 Transmission

General

The type *Transmission* provides parameters that are applicable to each arm of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Transmission* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
name	Name	Name off the TRANSMISSION data group.
transm_joint	Transmission Gear Ratio	Gear ratio between motor and axis. For linear axis gear ratio is specified as motor rotation in radians per meter linear move (21.43 denotes that when the motor rotates 21.43 radians - the axis moves 1 m).
rotating_move	Rotating Move	Denotes whether the axis is of the rotating type (Yes) or linear type (No).
high_gear	Transmission Gear High	The integer value of the numerator of the transmission gear ratio. Only used for independent joints.
low_gear	Transmission Gear Low	The integer value of the denominators of the transmission gear ratio. Only used for independent joints. Example: For a rotating axis with high gear 100 and low gear 30, has a transmission gear ratio of $100/30=3.333333$.

8 System parameters

8.26 Uncalibrated Control Master 0

8.26 Uncalibrated Control Master 0

General

The type *Uncalibrated Control Master 0* provides parameters that are applicable to each axis of the robot in question.

Parameter description

The following table contains the parameters that belong to the type *Uncalibrated Control Master 0* in the topic *Motion*.

Common parameters

Cfg name	Parameter name	Description
Kp	Kp, Gain Position Loop	The amplification of the position control, e.g. 15. A high value will give a stiff axis that quickly assumes its new position. The value should be large without inducing overshoot in the position or oscillations of the axis.
Kv	Kv, Gain Speed Loop	The amplification of the velocity control, e.g. 2. A high value gives better high frequency stiffness, better response speed and low overshoot. If the value is too high the axis will vibrate.
Ti	Ti Integration Time Speed Loop	Integration time in the speed regulation loop. The lower the value of <i>Ti Integration Time Speed Loop</i> , the better tracking and disturbance rejection. Too low value may cause oscillation or noise.
speed_max_n	Speed Max Uncalibrated	Max speed for uncalibrated axis (rad/s on motor side).
acc_max_n	Acceleration Max Uncalibrated	Max acceleration for uncalibrated axis (rad/s ² on motor side) Recommended value: <i>Nominal Acceleration * Transmission Gear Ratio</i> .
dec_max_n	Deceleration Max Uncalibrated	Max deceleration for uncalibrated axis (rad/s ² on motor side) Recommended value: <i>Nominal Deceleration * Transmission Gear Ratio</i> .

9 Hardware

9.1 Configuration of the drive system

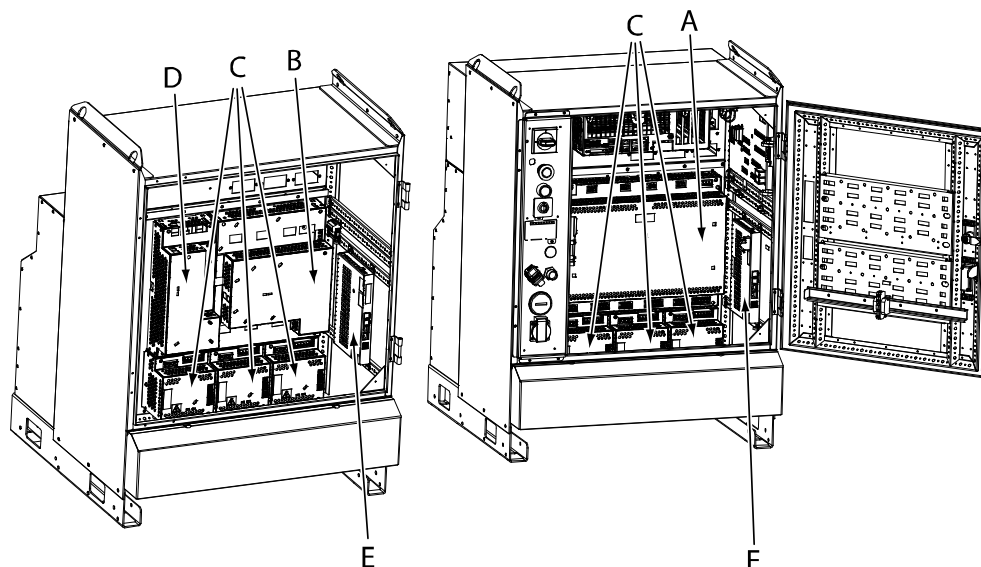
General

The IRC5 Controller contains one Main Drive Unit and up to three Additional Drive Units, and in some cases an Additional Rectifier Unit. The allowed combinations of these, depending on the robot type, is specified below.

The robot system may also be equipped with up to three additional drive modules, which are described in *Product manual - IRC5*.

Location

The drive system is located in the Single Cabinet Controller as shown below.



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A	Main Drive Unit MDU-790A (for large robots)
B	Main Drive Unit MDU-430A (for small robots)
C	Additional Drive Units (for additional axes)
D	Additional Rectifier Unit (only used for additional axes in combination with small robots)

DC bus cables

Between the units are fitted DC bus cables, which are specified below:

Description	Art. no.	Note
DC bus cable	3HAC032612-001	Between Main Drive Unit MDU-790A and Additional Drive Units.
DC bus cable	3HAC036612-001	Between Additional Rectifier Unit and first Additional Drive Unit.
DC bus cable	3HAC036612-002	Between Additional Rectifier Unit and second Additional Drive Unit.

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9 Hardware

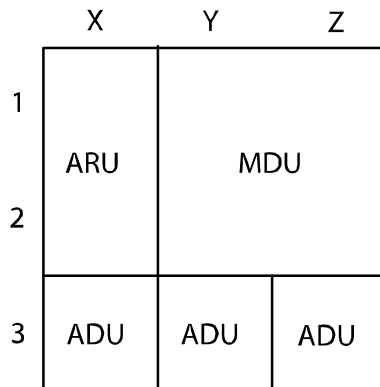
9.1 Configuration of the drive system

Continued

Description	Art. no.	Note
DC bus cable	3HAC036612-003	Between Additional Rectifier Unit and third Additional Drive Unit.

Small robots (up to IRB 1600-1660)

The following illustration shows the drive units. The table specifies which units may be fitted in which positions.



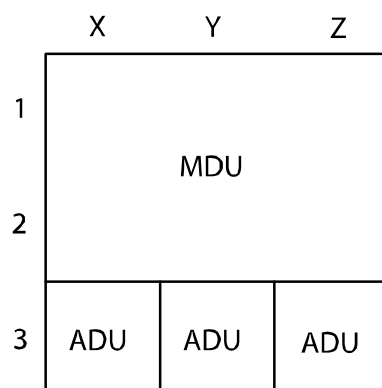
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Pos.	Identification	Description	Art. no.	Note
Y1, Y2, Z1, Z2	DSQC 406	Main Drive Unit MDU-430A	3HAC035301-001	
X1, X2	DSQC 417	Additional Rectifier Unit ARU-430A	3HAC035381-001	Required if any Additional Drive Unit is used.
X3	DSQC 664	Additional Drive Unit ADU-790A	3HAC030923-001	For first additional axis
Y3	DSQC 664	Additional Drive Unit ADU-790A	3HAC030923-001	For second additional axis
Z3	DSQC 664	Additional Drive Unit ADU-790A	3HAC030923-001	For third additional axis

Continues on next page

Medium and large robots

The following illustration shows the drive units. The table specifies which units may be fitted in which positions.



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Pos.	Identification	Description	Art. no.	Note
X1, X2, Y1, Y2, Z1, Z2	DSQC 663	Main Drive Unit MDU-790A	3HAC029818-001	
X3	DSQC 664	Additional drive unit ADU-790A	3HAC030923-001	For first additional axis
Y3	DSQC 664	Additional drive unit ADU-790A	3HAC030923-001	For second additional axis
Z3	DSQC 664	Additional drive unit ADU-790A	3HAC030923-001	For third additional axis

* IRB 8700 uses two ADU, in addition to the MDU, for the robot. Therefore, only one ADU can be used for an additional axis.

Drive unit connection

The following table shows the drive unit connection for each drive unit when using configuration template files for standalone axes.

When using a template file, a power stage is connected to a physical output. The label of this output in the electrical circuit diagram is shown in the column "Designation in circuit diagram".

Main Drive Unit	Template file name (drive unit name) ⁱ	Power stage	Designation in circuit diagram ⁱⁱ
MDU-430C	M1 (DMX)	INV_14_20	M3 (U,V,W)
DSQC 431	M2 (DMX)	INV_14_20	M1 (U,V,W)
Used in IRC5 Compact for IRB 120	M3 (DMX)	INV_6_8	M6 (U,V,W)
	M4 (DMX)	INV_6_8	M4 (U,V,W)
	M5 (DMX)	INV_14_20	M2 (U,V,W)
	M6 (DMX)	INV_6_8	M5 (U,V,W)

Continues on next page

9 Hardware

9.1 Configuration of the drive system

Continued

Main Drive Unit	Template file name (drive unit name) ⁱ	Power stage	Designation in circuit diagram ⁱⁱ
MDU-430A DSQC 406 Used for IRB 120, 140	M1 (DMX) M2 (DMX) M3 (DMX) M4 (DMX) M5 (DMX) M6 (DMX)	INV_14_20 INV_14_20 INV_6_8 INV_6_8 INV_14_20 INV_6_8	M3 (U,V,W) M1 (U,V,W) M6 (U,V,W) M4 (U,V,W) M2 (U,V,W) M5 (U,V,W)
MDU-430A DSQC 406 Used for IRB 1400, 1520, 1600	M1 (DMX) M2 (DMX) M3 (DMX) M4 (DMX) M5 (DMX) M6 (DMX)	INV_14_20 INV_14_20 INV_6_8 INV_6_8 INV_14_20 INV_6_8	M1 (U,V,W) M2 (U,V,W) M4 (U,V,W) M6 (U,V,W) M3 (U,V,W) M5 (U,V,W)
MDU-430A DSQC 406 Used for IRB 360, 390	M1 (DMX) M2 (DMX) M3 (DMX) - M5 (DMX) -	INV_14_20 INV_14_20 INV_14_20 - INV_6_8 -	M2 (U,V,W) M1 (U,V,W) M3 (U,V,W) - M4 (U,V,W) -
MDU-790A DSQC 663 Used for IRB 2400	M1 (DMX) M2 (DMX) M3 (DMX) M4 (DMX) M5 (DMX) M6 (DMX)	INV_31_54 INV_17_26 INV_31_54 INV_17_26 INV_31_54 INV_17_26	M1 (U,V,W) M2 (U,V,W) M4 (U,V,W) M6 (U,V,W) M3 (U,V,W) M5 (U,V,W)
MDU-790A DSQC 663 Used for IRB 2600, 4400, 4600, 6600, 6620, 6640, 6650, 6660, 6700, 7600	M1 (DMX) M2 (DMX) M3 (DMX) M4 (DMX) M5 (DMX) M6 (DMX)	INV_31_54 INV_17_26 INV_31_54 INV_17_26 INV_31_54 INV_17_26	M1 (U,V,W) M4 (U,V,W) M2 (U,V,W) M5 (U,V,W) M3 (U,V,W) M6 (U,V,W)
MDU-790A DSQC 663 Used for IRB 8700	M1 (DMX) M2 (DMX) M3 (DMX) - M5 (DMX) - M7 (DMX) M8 (DMX)	INV_31_54 INV_17_26 INV_31_54 - INV_31_54 - INV_30_55 INV_30_55	M1 (U,V,W) M6 (U,V,W) M2 (U,V,W) - M3 (U,V,W) - M4 (U,V,W) M5 (U,V,W)
MDU-790A DSQC 663 Used for IRB 460, 660, 760	M1 (DMX) - M3 (DMX) - M5 (DMX) M6 (DMX)	INV_31_54 - INV_31_54 - INV_31_54 INV_17_26	M1 (U,V,W) - M2 (U,V,W) - M3 (U,V,W) M6 (U,V,W)
ADU-790A	M7 (DMX)	INV_30_55	M1 (U,V,W)

ⁱ X= drive module number.

ⁱⁱ Phase R,S,T (U,V,W).

Continues on next page

For details about the connection pins, see the circuit diagram for the controller.



Note

The Main Drive Unit can handle a maximum of 3 axes for each of EXC1 and EXC2. Measurement nodes 1, 2 and 3 use EXC1 and measurement nodes 4, 5, 6 and 7 use EXC2. See [Serial measurement cables and connections on page 171](#).

9 Hardware

9.2 Transformers

9.2 Transformers

Overview

The transformer is used to transform the incoming voltage to the voltage used in the cabinet. The selection of transformer depends on the selection of primary voltage and drive units.

Voltage alternative

The transformers are reversible to following primary voltage alternatives.

- 200 V
 - 220 V
 - 400 V
 - 440 V
 - 480 V
 - 500 V
 - 600 V
-

Technical data

The following table details the standard option transformers.

Robot type	Primary voltage (V)	Effect (kVA)
140, 260, 360, 1410, 1600, 2400, 2600, 4400	200-600 V	4.2 kVA
4600, 66xx, 7600, 460, 760	< 400 V 480 V > 480 V	13 kVA 1.2 kVA, for electronics 13 kVA

9.3 Drive units

Overview

A Main Drive Unit (MDU) consists of 6 power stages.

An Additional Drive Unit (ADU) consists of one power stage.

Additional axes in combination with a low voltage Main Drive Unit, requires an Additional Rectifier Unit (ARU) to supply the Additional Drive Units.

Drive Unit voltage

The following table describes the input voltage and the Dc-bus voltage for the different drive units. See also [Requirements for high voltage motors on page 162](#).

Drive Unit Type	Output voltage to motor (V_{rms}) a)	Max dc bus voltage (V_{rms})
MDU-430A DSQC 406	<ul style="list-style-type: none"> nominal 234 V min 198 V 	430 V
MDU-790A DSQC 663 for IRB 2400, 2600, 4400	<ul style="list-style-type: none"> nominal 234 V min 198 V 	430 V
ARU-430A DSQC 417	<ul style="list-style-type: none"> nominal 234 V min 198 V 	430 V
ADU-790A DSQC 664 for IRB 2400, 2600, 4400	<ul style="list-style-type: none"> nominal 234 V min 198 V 	430 V
MDU-790A DSQC 663 for IRB 4600, 660, 66XX, 7600	<ul style="list-style-type: none"> nominal 430 V min 320 V 	790 V
ADU-790A DSQC 664 for IRB 4600, 660, 66XX, 7600	<ul style="list-style-type: none"> nominal 430 V min 320 V 	790 V

a) defined as line to line.

Drive Unit Current

The following table describes the current for the different power stages. For a list of which power stages are used by which drive unit, see [Drive unit connection on page 151](#).

Power stage	Rated current (A_{rms}) a)	Time limited current (A_{rms}) b)	Max current (A_{rms}) c)	Time limit for max current (s) d)
INV_6_8	6.0	8.25	8.3	unlimited
INV_14_20	13.5	17.4	19.6	30
INV_17_26	17	23	26	10
INV_31_54	31	48	54	8
INV_30_55	30	39	55	3

a) Max current for zero speed in indefinite time.

Continues on next page

9 Hardware

9.3 Drive units

Continued

- b) Max current for zero speed in 3 seconds.
- c) Max current during acceleration or deceleration during a limited time (specified by ^{d)}).
- d) Max time for max current during acceleration or deceleration.

9.4 Measurement System

Overview

This system can control up to nine axes at the same time, and measure another five axes.

Axis computer board

The drive module is equipped with one axis computer board. From a connector on the front of the cabinet, serial measurement links are connected to the axis computer.

Serial measurement links

Each drive module has two serial measurement links for measurement boards. The connectors in the front of the drive module are marked, **Measurement system 1** and **Measurement system 2**. These serial links are ring circuits, which means that if there is more than one board on the same link, the output from **Serial Measurement Board 1** is connected to the input on **Serial Measurement Board 2**. See [Serial Measurement Link examples on page 158](#).

Serial Measurement Board

The standard SMB has seven resolver inputs. These inputs can be used as seven different nodes where the node number normally is equal to the axis number e.g. axis 1 to node 1.

Back-up battery

A back-up battery supplies the SMB with power during power failure. If an axis is moved a small distance during power off, the system is ready for operation, and no synchronization is needed after power on.

Features

Specifications for the measurement system:

- Each drive module can handle up to four SMBs divided on two serial links.
- Each serial link can handle up to seven axes.
- Each node 1 - 7 may only be used once on each link.

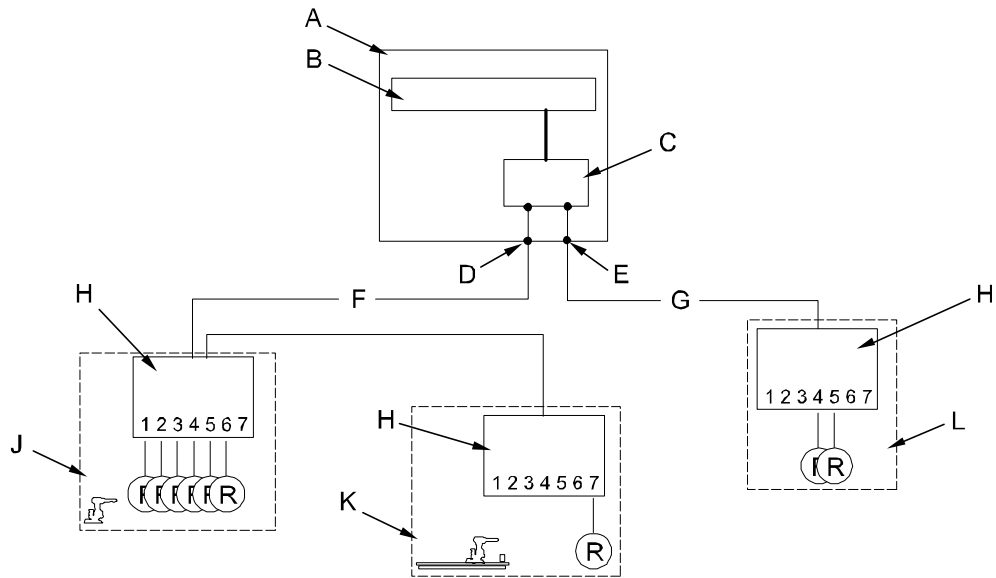
9 Hardware

9.5 Serial Measurement Link examples

9.5 Serial Measurement Link examples

1 + 2 Additional axes

The following is an example of a setup with three serial measurement boards on two measurement links, e.g *Trackmotion*.



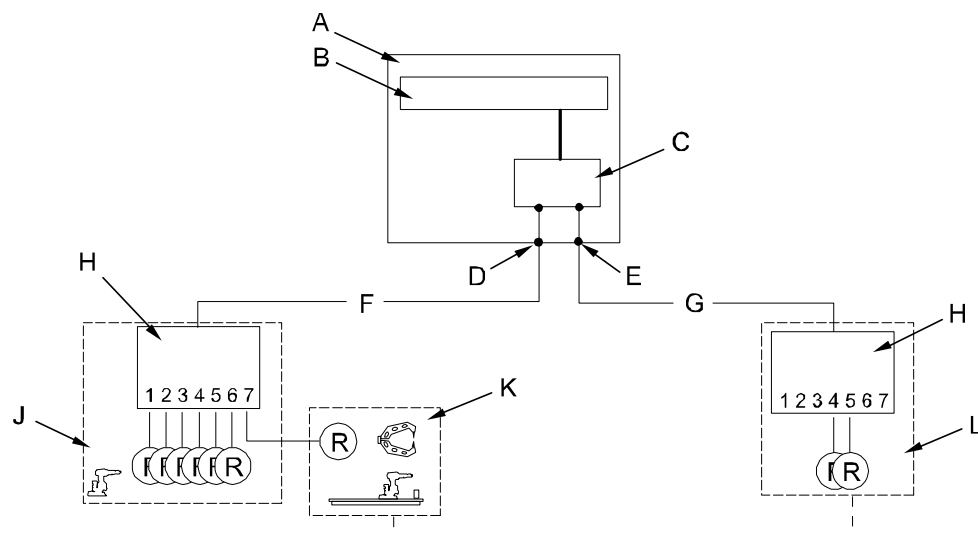
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A	IRC5 Controller
B	Main Computer
C	Axis Computer
D	Serial Measurement Link 1 connector XS.2
E	Serial Measurement Link 2 connector XS.41
F	Serial Measurement Link 1
G	Serial Measurement Link 2
H	Serial Measurement Board
J	Six axes Robot system
K	Trackmotion
L	Axes 8-9
R	Resolvers

Continues on next page

1 + 2 Additional axes

The following is an example of a setup with two serial measurement boards on two measurement links, e.g. *Servo Gun* or *Trackmotion*. If both *Servo Gun* and *Trackmotion* are to be used, the *Trackmotion* is connected to serial measurement link 2 and resolver node 1.



seriematslin

A	IRC5 Controller
B	Main Computer
C	Axis Computer
D	Serial Measurement Link 1 connector XS.2
E	Serial Measurement Link 2 connector XS.41
F	Serial Measurement Link 1
G	Serial Measurement Link 2
H	Serial Measurement Board
J	Six axes Robot system
K	Servo Gun
L	Axes 8-9
R	Resolvers

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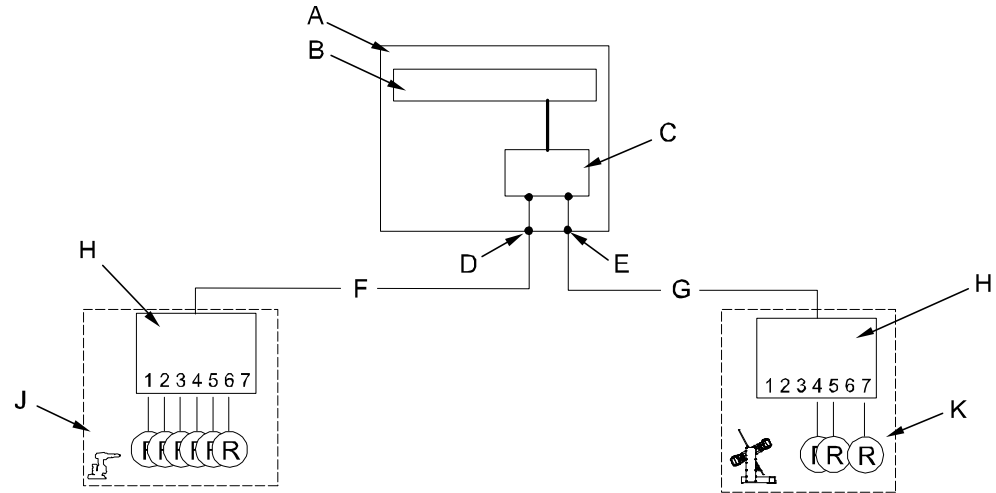
9 Hardware

9.5 Serial Measurement Link examples

Continued

Three Additional axes

The following is an example of a setup with two serial measurement boards on two measurement links, e.g. *3 Axes Positioner*.



seriematslin

A	IRC5 Controller
B	Main Computer
C	Axis Computer
D	Serial Measurement Link 1 connector XS.2
E	Serial Measurement Link 2 connector XS.41
F	Serial Measurement Link 1
G	Serial Measurement Link 2
H	Serial Measurement Board
J	Six axes Robot system
K	Three axes Positioner
R	Resolvers

9.6 Equipment for additional axes

Overview

A number of parts needed to install and operate additional axes are available from ABB.

Motor units and gear units offer

The offer consists of:

- Motors
- Motors with gear boxes
- SMB boxes
- Cables
- Axis selectors

For more information, see *Product specification - Motor Units and Gear Units* and *Product manual - Motor Units and Gear Units*.

9 Hardware

9.7 Motors

9.7 Motors

Overview

The motor units sold by ABB are specifically designed for ABB's robots and can be used for peripherals requiring power-steered motors that are synchronized with the robot movements. The motor units are designed for optimal performance and to facilitate installation and application.



Note

Before a motor is acquired, read also the information on how to calculate the correct motor data, see [Simple dimensioning of the motor on page 164](#).

Motor description

Motor shall be a permanent magnet servo-motor of synchronous type intended for three-phase sinusoidal AC voltage, coupled in star (Y) connection.

- the motor should preferably be wound as class F according to IEC 85.
- dielectric strength minimum 1600 V. For low voltage motors connected to drive module. For high voltage motors connected to drive module, see [Requirements for high voltage motors on page 162](#)
- Measurement signal cables must be separated from motor cables, and cables from temperature sensor and brake.

Requirements for high voltage motors

Third party driveline components used as external equipment on the large robots (IRB 67x0 and larger) must withstand the voltage stress levels as described in the following.

These data are valid for high voltage motors connected to the drive units:

- High Voltage Main Drive Unit DSQC 663
- High Voltage Additional Drive Unit DSQC 664

The maximum allowed motor cable length is 30 m. Rise time is expressed as an indicative value at motor terminals.

Converter specifics	
Voltage (Pulse-Width Modulated)	400-480 VAC
DC link maximum voltage	790 VDC (including tolerance: 825 VDC)
Switching frequency	4 kHz
System specifics	
Rise time / dU/dt (indicative value)	0.2 microsec (as defined in IEC 60034-25) / 9 kV/microsec
Requirement for drive line components	
Insulation strength	According to IEC 60034 (i.e. >2000 V)
Voltage stress withstand capability (including PD deterioration effects)	Above withstand level B according to IEC 60034-25, Figure 17 Chapter 7

Continues on next page

Thermal protection

The temperature sensor normally used is of type PTC resistor. A high resistance or open circuit indicates that the temperature of the motor exceeds the rated level. If temperature sensor is not used, the circuit must be strapped. If more than one motor is used, all PTC resistors are connected in series.

The system input characteristics are:

- High temperature >3500 ohm
- Low temperature <3500 ohm

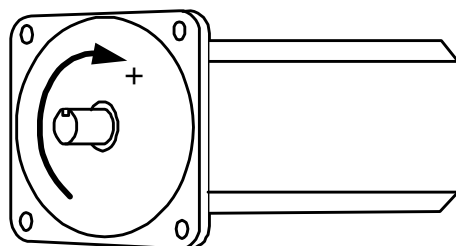


Note

For F class winding with maximum temperature of 155°C, Siemens B59135-M155_A70 can be used.

Motor connection

Positive electric rotation R ->S ->T -> (U, V, W) results in positive mechanical rotation defined as **clock wise** direction, seen from the drive shaft side. See illustration below. For connection and cabling for the motor to the controller, see the product manual for the robot controller listed in [References on page 9](#).



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Brake

Select a brake with minimum brake torque, sufficiently large to handle emergency stop when axis is moving downwards with maximum gravity. Check that maximum brake torque does not exceed allowed mechanical stress levels.

- Brake release voltage: 24 VDC +/- 10%.



Note

Check brake release voltage at maximum brake (motor) temperature and maximum allowed wear out for the brake.

Motor types

For more information about the recommended motor types from ABB, see section [Equipment for additional axes on page 161](#).

9 Hardware

9.8 Simple dimensioning of the motor

9.8 Simple dimensioning of the motor

Overview

Before connecting a motor, read the general description for motors in chapter [Motors on page 162](#)



Note

This section is used as a rough dimensioning of the motor, so before installing the motor make sure that it is dimensioned by a professional.

Calculate system performance

Either the motor or the drive unit sets the limitations for the system performance.

Value	Description
$K_{t_{min}}$	Motor torque constant (Nm/A _{rms}).
$I_{max \text{ drive}}$	Max current for the drive unit (A _{rms}). See Drive units on page 155 .
$I_{max \text{ (motor)}}$	Max current for the motor (A _{rms}).
T_0	Average motor torque (Nm).
I_0	Average drive unit current (A _{rms}). See Drive units on page 155 .

Calculate T_{max} and $T_{average}$ for the drive unit and the motor, then choose the limiting torque.

Criteria	Calculate the minimum value
$T_{max(\text{system})}$	$= \min(K_{t_{min}} * I_{max(\text{drive unit})}, K_{t_{min}} * I_{max(\text{motor})})$
$T_{average(\text{system})}$	$= \min(T_0(\text{motor}), K_{t_{min}} * I_0(\text{drive unit}))$

Check intermittence

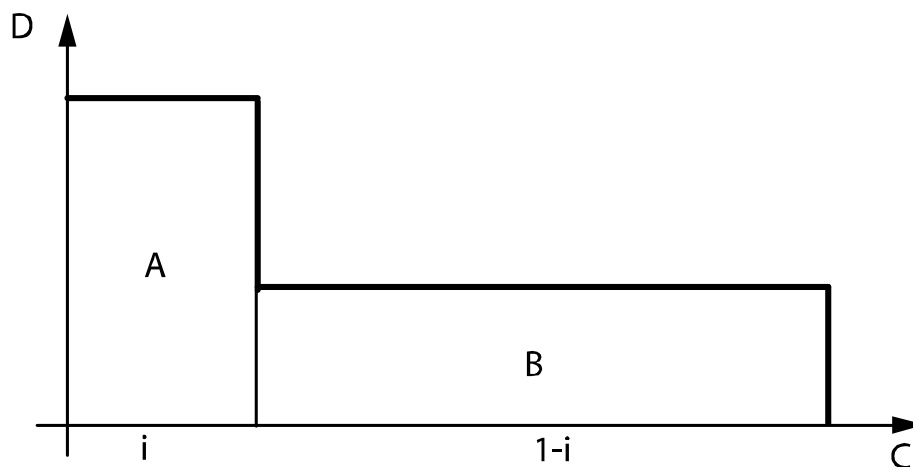
When T_{max} and $T_{average}$ for the system is found, check the thermal load factor. It could be of importance if the additional axis accelerates slowly or if the axis moves with short quick movements without stops. The motor, or the drive unit could be over heated. Observe the planned cycle and calculate the total acceleration time. The other time is treated as static load.

$T_{stat} = \text{friction torque} + \text{gravitational torque}$

Value	Description
i	Time in acceleration and deceleration divided by total time
T_{stat}	Static load
$1-i$	Time in constant speed and standing still (only friction and gravity influences the motor)

Continues on next page

$$\text{Calculate: } T_{\text{rms}} = \sqrt{T_{\text{max}}^2 \cdot i + T_{\text{stat}}^2 \cdot (1-i)}$$



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A	Max torque (T_{max})
B	Static torque (T_{stat})
C	Time
D	Torque

Dimensioning

T_{rms} should be lower than T_{average} . Otherwise reduce T_{rms} or change one of the components, drive unit or motor.

Acceleration performance on arm side could now be calculated:

$$\text{Acceleration} = (T_{\text{max}} - \text{GravitationalTorque} - \text{Friction}) / (\text{Inertia} * \text{Transmission})$$

$$\text{Deceleration} = (T_{\text{max}} - \text{GravitationalTorque} + \text{Friction}) / (\text{Inertia} * \text{Transmission})$$

An alternative is to tune the acceleration and deceleration (parameters: *Nominal acceleration* and *Nominal deceleration*) directly on the external axis and find out if the assessable torque (T_{max}) gives desired performance.

If it is impossible to reach desired performance replace the motor or the drive unit.

Example

In this example we use worst case performance which means acceleration against the gravity

T_0	5 (Nm)
Kt_{min}	1.0 (Nm/A)
I_{max} (motor)	15 (A)
I_{max} (drive unit)	10 (A)
I_0 (drive unit)	6 (A)
intermittence	0.1
Transmission (n)	100

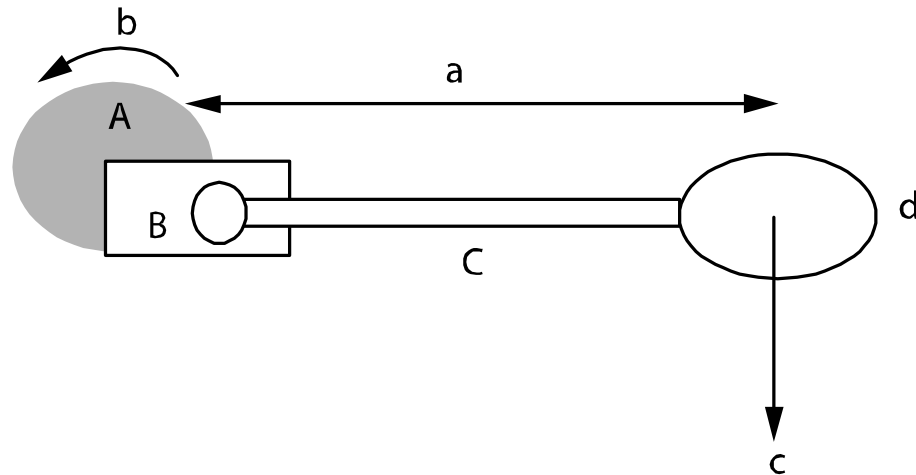
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9 Hardware

9.8 Simple dimensioning of the motor

Continued

Mass (M)	20 (kg)
Friction (F)	2 (Nm)
Gravity constant (g)	9.81 (N/kg)
Length to mass (L)	1.0 (meter)
Motor inertia (J _m)	0.005 (kgm ²)



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a	Length to mass (L)
b	Motor inertia (J _m)
c	Mass (M) * GravityConstant (g)
d	Mass of Arm (M)
A	Motor
B	Gearbox
C	Arm

In this example acceleration needs to be 5 rad/s.

Calculations

$$\text{Gravitational torque} = (M \cdot L \cdot g) / n = (20 \cdot 1 \cdot 9.81) / 100 = 1.96$$

$$T_{\text{stat}} = \text{FrictionTorque} + \text{GravitationalTorque} = 2 + 1.96 = 3.96$$

$$T_{\text{max}}(\text{system}) = \min(Kt_{\text{min}} \cdot I_{\text{max}}(\text{drive unit}), Kt_{\text{min}} \cdot I_{\text{max}}(\text{motor})) = \min(1 \cdot 10, 1 \cdot 15) = 10$$

$$T_{\text{average}}(\text{system}) = \min(T_0(\text{motor}), Kt_{\text{min}} \cdot I_0(\text{drive unit})) = \min(5.0, 1 \cdot 6) = 5.0$$

$$T_{\text{rms}} = \sqrt{T_{\text{max}}^2 \cdot i + T_{\text{stat}}^2 \cdot (1-i)} = (10^2 \cdot 0.1 + 3.96^2 \cdot (1-0.1))^{0.5} = 4.9$$

T_{rms} is lower than average. No need to change motor or drive unit.

$$\text{Total moment of inertia on motor side } J = J_m + (M \cdot L^2) / n^2 = 0.005 + (20 \cdot 1^2) / 100^2 = 0.007$$

$$\text{Acceleration} = (T_{\text{max}} - \text{GravitationalTorque} - \text{Friction}) / (J \cdot n) =$$

$$(10 - 1.96 - 2) / (0.007 \cdot 100) = 8.6$$

Continues on next page

Deceleration = T_{\max} -

Gravitational Torque + Friction) / (J * n) = (10 - 1.96 - 2) / (0.007 * 100) = 14.3

Both acceleration and deceleration are within the demand.

9 Hardware

9.9 Resolvers

9.9 Resolvers

Overview

The resolver is integrated in the motors from ABB. The resolver must be approved by ABB for reliable operation.

Approved resolvers

The following resolvers are approved by ABB

Manufacturer	Article numbers
LTN Servotechnik GmbH	LTN RE-21-1-V02, size 21 LTN RE-15-1-V16, size 15
AG	V23401-U2117-C333, size 21
Tamagawa Seiki Co	TS 2640N141E172, size 21 TS 2640N871E172, size 21 TS 2620N871E172, size 15

Resolver specification

Data	Value	Unit
Single speed resolver		
Operating temperature	-25 to +120	°C
Rated input voltage	5	V _{RMS}
Frequency	4	kHz
Primary (EXC)	Rotor	
Secondary (X, Y)	Stator	
Nominal impedance - Primary (stator winding open) Z _{RO} at 4 kHz	>115	Ω
Nominal impedance - Secondary (rotor winding closed) Z _{SS} at 4 kHz	<440	Ω
Transformation ratio	0.5 ± 20%	
Phase shift out-in	0 ± 10	deg
Max error spread	≤ 10	arcmin
Resolver adjustment (COMOFF)	+90 ± 0.5	deg

The resolver has one rotor and two stator windings. The definition of the output signals are:

$$E(S1, S3) = 0.5 \times E(R1, R2) \times \cos(\text{resolver angle})$$

$$E(S2, S4) = 0.5 \times E(R1, R2) \times \sin(\text{resolver angle})$$



Note

The resolver must be tested together with a robot system to verify that the resolver also functions during battery mode.

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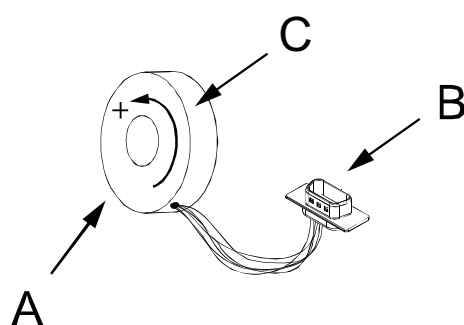
Considerations

The following technical information must be considered before the installation:

- The maximum allowed resolver cable length is 30 m, from the resolver to the serial measurement board (SMB).
- A resolver cable consists of six wires. Two wires for excitation, and two wires each for the X and Y signals
- Use a shielded, AWG 24, max 55pF/m cable.
- To avoid disturbances in the signals due to magnetic fields generated by the brake it is recommended to use non-magnetic motor shaft.

**Note**

The unshielded part of the resolver cable must be as short as possible, less than 100 mm, and be well separated from the motor cables, more than 20 mm.

Resolver connection

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A	Resolver
B	9 pin D-sub
C	Positive motor direction

Normally in ABB motors, resolvers are connected to the internal cable in robot by a 9 pin D-sub connector, with pins at the resolver side.

When the motor rotates in a positive direction, the resolver rotates mechanically in a negative direction, as the resolver is mounted at the opposite side of the drive shaft side.

To deliver electrically positive rotation the y-winding connection S2 and S4 has changed place.

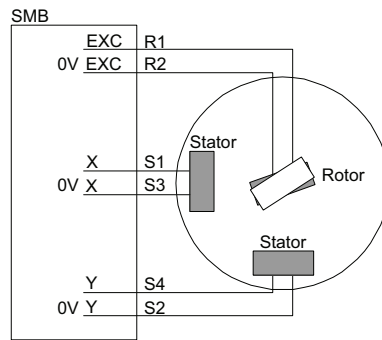
9 pin D-sub	SMB input	Resolver connection	Color resolver wires
6	X	S1	Red
1	X 0V	S3	Black
7	Y	S4	Blue
2	Y 0V	S2	Yellow
3	EXC	R1	Red/White
8	EXC 0V	R2	Yellow/White

Continues on next page

9 Hardware

9.9 Resolvers

Continued



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Resolver direction

Motor angle	X (S1)	Y (S4)
0	Maximum in phase with EXC	0
+90	0	Maximum in phase with EXC

Commutation

Commutation can be done in several ways. The following method is one of the possible methods.

	Action	Info/Illustration
1	Turn the motor to commutation by feeding positive current into power winding S with T connected to ground (R is not connected). For detailed description, follow the first part of the procedure in Manual commutation on page 108 .	The number of different commutation positions that the motor can turn to is the same as the number of pole pairs.
2	Select a resolver commutation position enabling the resolver cables to be routed in the best possible way.	
3	Feed a 4 kHz sinus signal to the EXC (R1) input of the resolver.	
4	Connect an oscilloscope to EXC (R1), X (S1) and Y (S4).	
5	Adjust the commutation position to +90 degrees +/-0.5 degrees by turning the resolver.	The Y (S4) signal should be at max output and with the same phase as the EXC (R1) feeding signal. The X (S1) signal should be 0.00 V xx0500001401

9.10 Serial measurement cables and connections

Overview

This section details the cables and connection between the resolver and the serial measurement board.

Signal classes

The cabling must comply with a valid signal class "measurement signals" see the cable requirements in the product manual for the robot controller. The enclosure for external serial measurement board/boards must comply with enclosure class IP54, in accordance with IEC 144 and IEC 529.



Note

It is very important that the noise level on the measurement signals from the additional axes is kept as low as possible, to prevent bad performance, that is, keep motor and resolver cables apart. Correct shielding and ground connections of cables, measurement boards and resolvers is essential.

Considerations

The X, Y, 0V X and 0V Y:

- Signals are used to connect resolvers to a serial measurement board.

The EXC and 0V EXC:

- are used for common supply for all resolvers, parallel connected.

Resolver:

- 1 - 3, should always be connected to EXC 1.
- 4 - 7, should always be connected to EXC 2.



Note

Maximum allowed length on the serial measurement cable is 50 meters.
For motor cables, see [Motors on page 162](#).

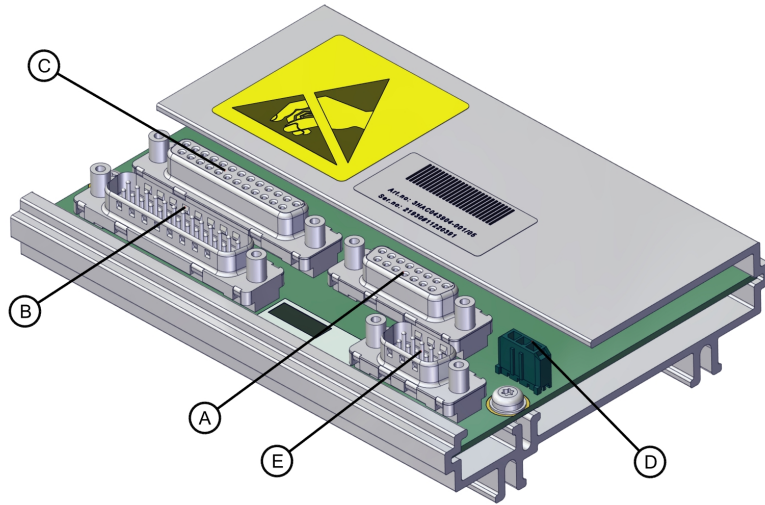
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9 Hardware

9.10 Serial measurement cables and connections

Continued

Illustration DSQC 633C



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A	R2.SMB 1-2 (D-sub 15 socket)
B	R2.SMB 1-4 (D-sub 25 pin)
C	R2.SMB 3-6 (D-sub 25 socket)
D	R2.G
E	R2.SMB (D-sub 9 pin)

Connections to SMB DSQC 633C

Contact point	R2.G	R2.SMB	R2.SMB 1-2	R2.SMB 1-4	R2.SMB 3-6
1	+BAT	GND	GND	GND	GND
2	0V BAT	-	0V EXC2	X1	X4
3		0V	0V EXC1	Y1	Y4
4		SDO-N	Y7	X2	X5
5		SDI-N	X7	Y2	Y5
6		-	Y1	0V EXC1	0V EXC2
7		+24V	X1	0V EXC1	0V EXC2
8		SDO	-	0V EXC1	0V EXC2
9		SDI	EXC2	X3	X6
10			EXC1	Y3	Y6
11			0V Y7	X4	X3
12			0V X7	Y4	Y3
13			0V Y1	0V EXC2	0V EXC1
14			0V X1	0V X1	0V X4
15				0V Y1	0V Y4
16				0V X2	0V X5
17				0V Y2	0V Y5

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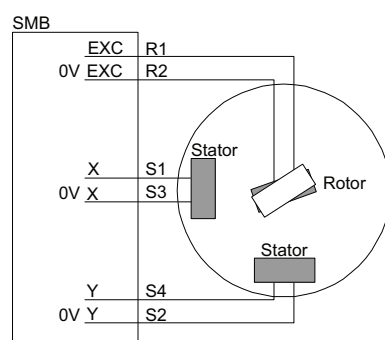
Contact point	R2.G	R2.SMB	R2.SMB 1-2	R2.SMB 1-4	R2.SMB 3-6
18				EXC1	EXC2
19				EXC1	EXC2
20				EXC1	EXC2
21				0V X3	0V X6
22				0V Y3	0V Y6
23				0V X4	0V X3
24				0V Y4	0V Y3
25				EXC2	EXC1

Explanation

Term	Description
SDO	serial communication output
SDI	serial communication input
+BAT	Battery +
0V BAT	Battery 0V
BATLD	Not to be used
BATSUP	Not to be used
EXC1	excitation power to resolver 1, 2, 3
EXC2	excitation power to resolver 4, 5, 6, (7)
+24V	24 V power
0 V	0 V power
X1	Input x-stator node 1
Y1	Input y-stator node 1

Illustration

The connection point on the resolver corresponds to the connection table above.



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Continues on next page

9 Hardware

9.10 Serial measurement cables and connections

Continued

Example

To connect from resolver to SMB, use input 7 (node 7). Connect to contact R2.SMB 1-2.

Signals	Contact point SMB	Contact point resolver
EXC 2	9	3
EXC 2, 0 V	2	8
X7	5	6
X7, 0 V	12	1
Y7	4	7
Y7, 0 V	11	2

9.11 Relays

Additional relays

When using an additional relay between the drive unit and the motor, the power supply to the relay shall be designed with a holdup time of about 800 ms. This is to avoid the motor from losing power before the brakes are applied, which could cause unintended limited movements at power fail.

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