



Add-on Library Machine Library (Machine Type R6)

User's Manual

BCN-B62005-771-*

User's manual revisions

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Add-on library revisions

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1. Summary

1.1 Summary

This document describes the MELSEC iQ-R series Motion controller compatible add-on library 011 "Machine Library (Machine type R6)".

1.2 Add-on library configuration

1.2.1 Add-on library naming

Application	Model	Add-on library name
2-axis vertical articulated (parallel linkage) machine type	MCNTYP-R006	McNType006.adm

1.2.2 Add-on module list

There is no add-on module used by the MCFUN instruction in this library.

1.2.3 File size and memory usage

The file size and memory usage of the add-on library is shown below.

Add-on library name	File size [byte]	Memory usage [byte]
McNType006.adm	4980	5248

1.3 Supported software versions

The supported software versions are shown below.

Refer to Section 1.3 of "MELSEC iQ-R Motion Controller User's Manual" for how to check the software version.

1.3.1 Operating system software

The version of the Motion controller operating system software that supports the add-on library is shown below.

Motion CPU	Model	Version
R64MTCPU	SW10DNC-RMTFW	Ver.07 or later
R32MTCPU		
R16MTCPU		

1.3.2 Engineering software

The version of the engineering software that supports the add-on library is shown below.

(1) Motion controller engineering software

Product name	Model	Version
MELSOFT MT Works2 • MT Developer2 • MR Configurator2	SW1DND-MTW2-E	1.120A or later

1.4 Restrictions by the software version

There are restrictions in which functions can be used depending on the version of the add-on library, operating system software, and engineering software.

The combination of each version and a function is shown below.

Function	Add-on library version		Operating system software version	Engineering software version	
	Major version	Minor version		MELSOFT MT Works2 (MT Developer2)	GX Works3
Machine type R6	01	01	07	1.120A	—

2. Machine type R6

2.1 Performance specifications

- (1) In machine type R6, a 2-axis vertical articulated robot such as the robot illustrated below is controlled.
- With the parallel linkage, the control point is always kept horizontal regardless of the driving of joint axis 1 and 2.

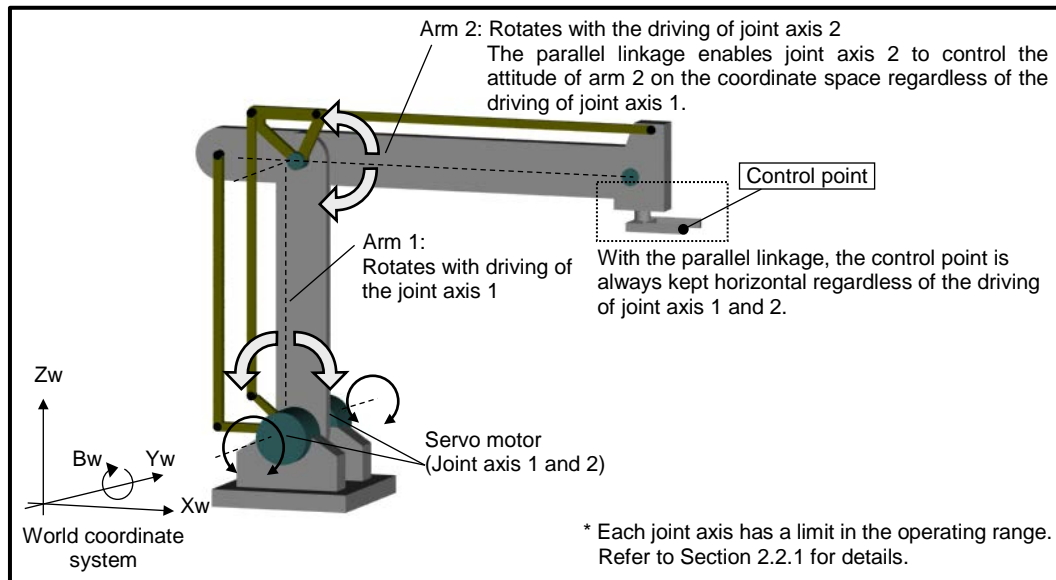


Fig. 2.1 Controlled robot

- (2) The specifications for machine type R6 are shown below.

Table 2.1 Machine type R6 specifications

Item		Specifications
Machine type		6
Operating range type		—
Joint axis configuration	Joint axis 1 (JNT1)	Rotating axis Operating range: -177.50000 to 177.50000 [degree]
	Joint axis 2 (JNT2)	Rotating axis Operating range: -87.50000 to 267.50000 [degree]
	Joint axis 3 (JNT3)	—
	Joint axis 4 (JNT4)	—
	Joint axis 5 (JNT5)	—
	Joint axis 6 (JNT6)	—
Machine control	Control unit	mm
	Control coordinate (World coordinate system)	Xw: -214748364.8 to 214748364.7 [μ m] Zw: -214748364.8 to 214748364.7 [μ m] Bw: 0.00000 to 359.99999 [degree] *1 FL1: Attitude flag is available.
Coordinate conversion	Base conversion	Available
	Tool conversion	Available
JOG operation	Joint JOG	JOG operation for each joint axis
	Machine JOG	JOG operation for each coordinate component of the world coordinate system (Xw, Zw)

*1: With the parallel linkage, the value of the world coordinate system (Bw) is always equal to that of the base conversion (Bb).

2.2 Robot structure and coordinate system

The structure of the robot controlled in machine type R6 is shown below.

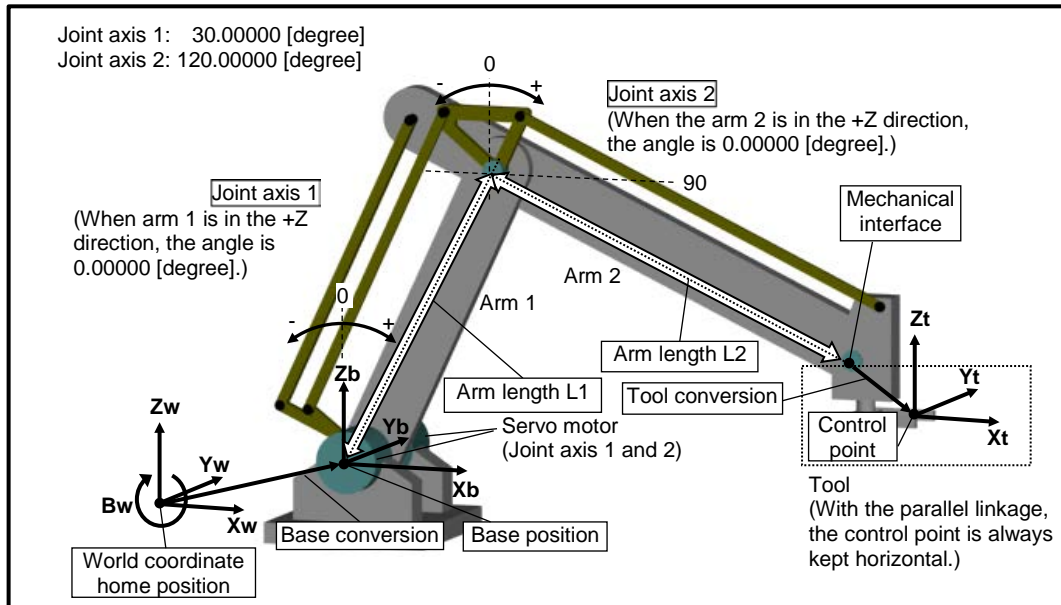


Fig. 2.2 Robot structure

2.2.1 Joint axis configuration

- (1) The robot is a 2-axis (joint axis 1 to 2) configuration vertical articulated robot.
- (2) Refer to Table 2.7 for axis units (axis setting parameter).

Table 2.2 Joint axis configuration

Joint axis	Operation	Remarks
Joint axis 1 (JNT1)	Rotating axis	Operating range: -177.50000 to 177.50000 [degree]
Joint axis 2 (JNT2)	Rotating axis	Operating range: -87.50000 to 267.50000 [degree]
Joint axis 3 (JNT3)	—	—
Joint axis 4 (JNT4)	—	—
Joint axis 5 (JNT5)	—	—
Joint axis 6 (JNT6)	—	—

- (3) Configure a system in the base coordinate with joint axis movement direction and 0.00000 [degree] positions as shown in the diagram below.

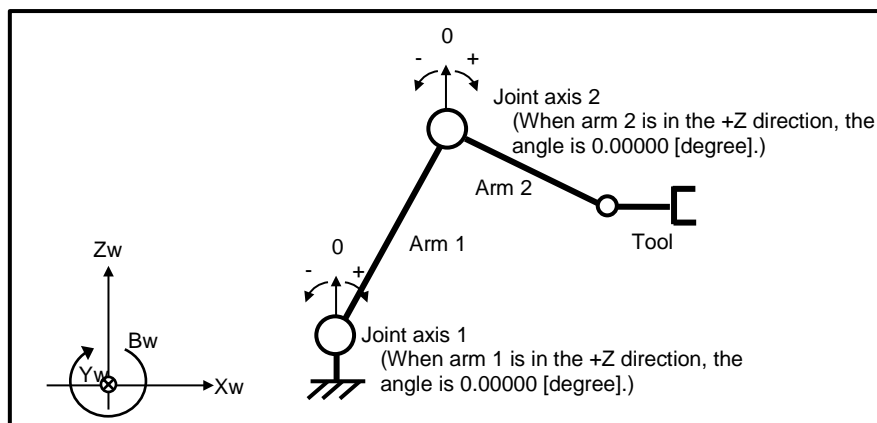


Fig. 2.3 Joint axis of robot

- (4) The operating range of joint axis 1 is shown below. Set each axis stroke limit (fixed parameter) within the following operating range.

Configure a system in which the angle of joint axis 1 is 0.00000 [degree] when arm 1 is in the +Z direction.

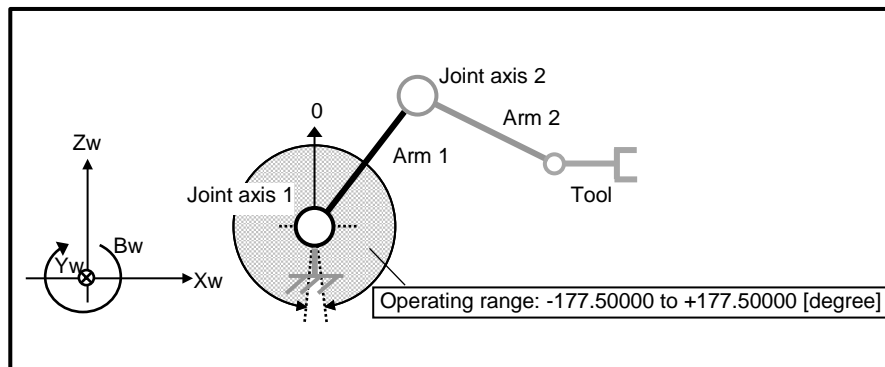


Fig. 2.4 Operating range of joint axis 1

- (5) The operating range of joint axis 2 is shown below. Set each axis stroke limit (fixed parameter) within the following operating range.

Configure a system in which the angle of joint axis 2 is 0.00000 [degree] when arm 2 is in the +Z direction.

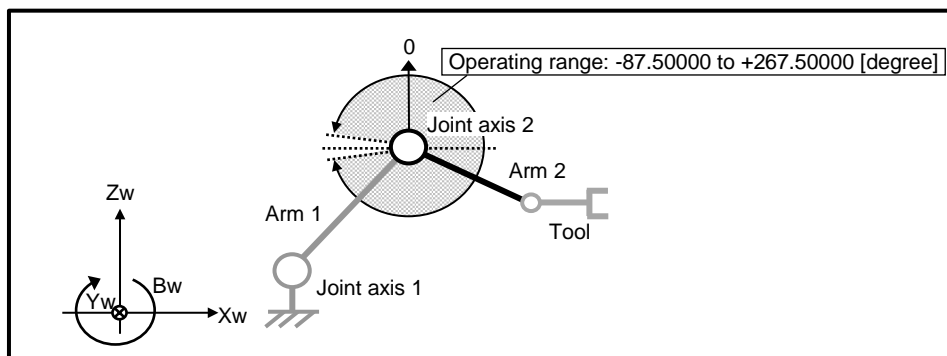


Fig. 2.5 Operating range of joint axis 2

[Cautions]

The attitude of the parallel linkage may not be kept when the difference of joint axis 1 and 2 is near 0.00000 [degree] or 180.00000 [degree] (the state in which arm 1 and 2 lie on a straight line).

Check the operation of the machine in JOG operation, etc. in advance, when performing an operation in which the attitude flag (bit4 of the structure flag (FL1)) at the start and end points is different, or arm 1 and 2 move to lie on a straight line.

Refer to Section 2.4 "Point data" for the attitude flag.

2.2.2 Coordinate configuration

(1) The robot is configured by the X and Z coordinates, and the Structure flag (FL1).

The world coordinate system, base coordinate system, and tool coordinate system are shown in the table below.

Table 2.3 Coordinate configuration

Coordinate axis	Remarks
X	Position of the control point in the X direction. The unit is $\times 10^{-1} \mu\text{m}$.
Y	Not used.
Z	Position of the control point in the Z direction. The unit is $\times 10^{-1} \mu\text{m}$.
A	Not used.
B	Inclination of the tool against the Y coordinate axis (the inclination of Zt coordinate axis of the tool coordinate system). The unit is [degree]. The ring address ranges from 0.00000 to 359.99999 [degree]. The parallel linkage keeps the value fixed.
C	Not used.
FL1	bit 4: Indicates the robot attitude.

Table 2.4 Coordinate system

Coordinate system	Symbol	Remarks
World coordinate system	(Xw, Zw, Bw) *1	The coordinate system set to the ground or the floor.
Base coordinate system	(Xb, Zb, Bb) *2	The coordinate system set to the base of the robot.
Tool coordinate system	(Xt, Zt, Bt) *2	The coordinate system with the control point as the home position.

*1: With the parallel linkage, the value of the world coordinate system (Bw) always equals to that of the base conversion (Bb).

Refer to Section 2.3.1 "Machine parameter settings" for details of the base conversion.

*2: With the parallel linkage, the value of the base coordinate system (Bb) and the tool coordinate system (Bt) are always 0.00000 [degree].

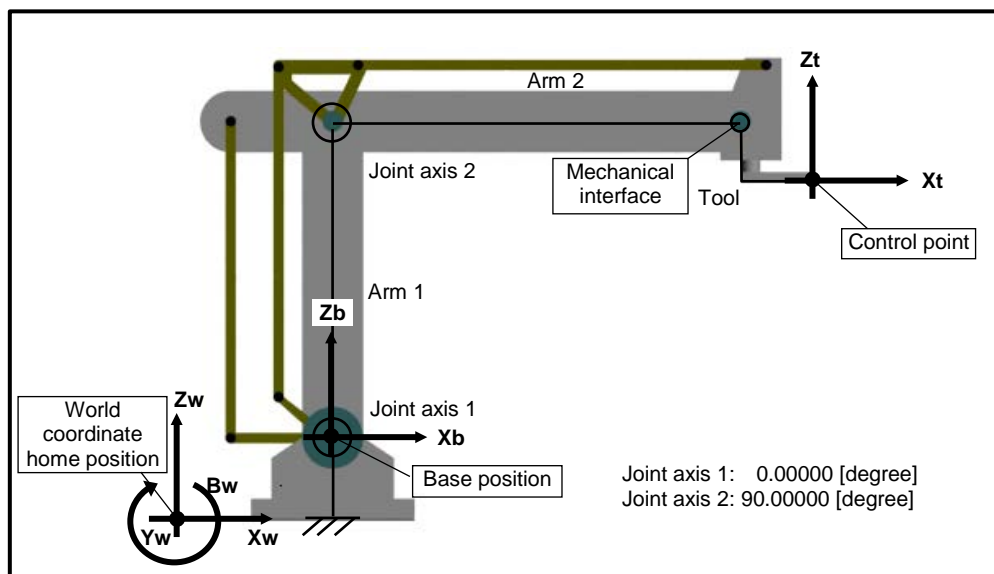


Fig. 2.6 Robot coordinate system

- (2) The base position is the center of rotation of joint axis 1.
- (3) The mechanical interface is the point where arm 2 and the tool meet.
- (4) Set the interpolation control unit to [mm].
(Set with the parameter block specified by machine parameter.)
- (5) The control point is specified by the X and Z coordinates, and structure flag of the world coordinate system and the base coordinate system. The Y coordinate (depth of the robot) is not used.

2.3 Positioning control parameters

The following describes the parameters set in machine type R6.

2.3.1 Machine parameter settings

The following items are set in the machine parameter.

(1) Machine parameters

Table 2.5 Machine parameter

Item		Setting value/range [unit]	Remarks	Reference section
Machine basic setting	Machine type *1	6	• Set machine type R6.	—
	Operating range type *1	0	• Set 0.	—
Joint axis structure *1	J1	1 to 64	• Allocate the axis No. to be used for the joint axis 1 and 2.	—
	J2			
	J3	0	• Joint axes 3 to 6 are not used. Set to 0.	
	J4			
	J5			
	J6			
Arm length setting	L1	0.1 to 100000000.0 [μm]	• Set the arm length of the robot.	(2)
	L2			
	L3	0.0 [μm]	• Arm lengths L3 to L6 are not used. The setting values are ignored.	
	L4			
	L5			
	L6			
Machine speed setting	Parameter block designation	1 to 64	• Set the parameter block to be used in machine operation. • Set the interpolation units of the parameter block to [mm].	—
	Machine JOG speed limit value (mm)	0.01 to 6000000.00 [mm/min]	• Set the maximum speed for machine JOG operation.	—
	Machine JOG speed limit value (degree)	0.00000 [degree/min]	• Not used. The setting values are ignored.	—
XYZ stroke limit setting	+X	-214748364.8 to 214748364.7 [μm]	• Set the movable range of the control point in the base coordinate system. When not using, set both + and - to 0.0. • When upper limit ≤ lower limit, the XYZ stroke limit check is not performed. • ±Y is not used. The setting values are ignored.	—
	-X			
	+Y	0.0 [μm]		
	-Y			
	+Z	-214748364.8 to 214748364.7 [μm]		
	-Z			
Base conversion	Bx	-99999999.9 to 99999999.9 [μm]	• Set the base position as viewed from the world coordinates at the power supply ON, or CPU reset. • Y, and A and C are not used. The setting values are ignored.	(3)
	By	0.0 [μm]		
	Bz	-99999999.9 to 99999999.9 [μm]		
	Ba	0.00000 [degree]		
	Bb	-359.99999 to 359.99999 [degree]		
	Bc	0.00000 [degree]		
Tool conversion	Tx	-99999999.9 to 99999999.9 [μm]	• Set the position of the control point as viewed from the mechanical interface at the power supply ON, or CPU reset. • Y is not used. The setting value is ignored.	(4)
	Ty	0.0 [μm]		
	Tz	-99999999.9 to 99999999.9 [μm]		
Option setting A		H0	• Option settings A1 to A10 are not used. The setting values are ignored.	—
Option setting B		H0	• Option settings B1 to B10 are not used. The setting values are ignored.	—

*1: When setting value is outside range, a moderate error (error code: 30FAH) occurs.

(2) Arm length setting

Arm length L1 is the distance from the center of rotation of joint axis 1 to the center of rotation of joint axis 2 on a ZX plane.

Arm length L2 is the distance from the center of rotation of joint axis 2 to mechanical interface on a ZX plane.

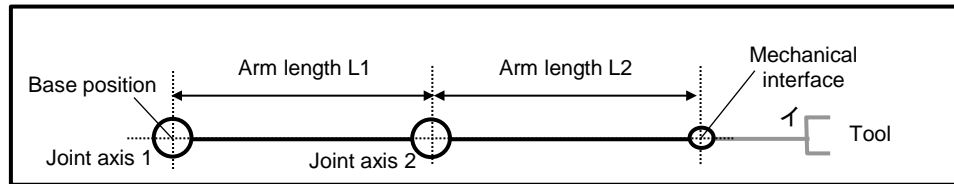


Fig. 2.7 Arm length

When L1 equals L2, singularity of the control point occurs when the difference of joint axis 1 and 2 is 180.00000 [degree] (the state of joint axis 1 and the mechanical interface overlapping: Fig. 2.8).

[Cautions]

When the joint axis passes near the singularity, the command speed may be excessive in linear/circular interpolation or machine JOG operation. When the joint axis passes near the singularity, use joint interpolation.

In addition, when positioning the joint axis to the singularity, use joint interpolation specified by the joint axis coordinate.

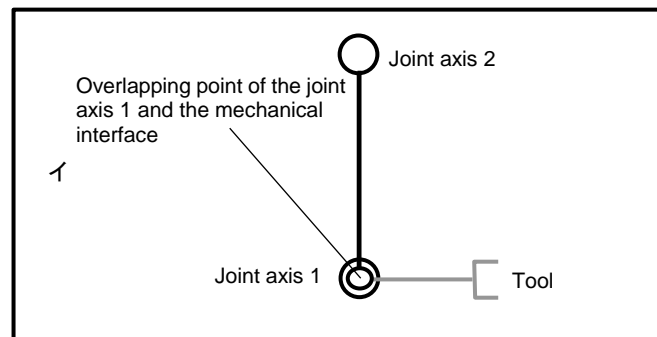


Fig. 2.8 Singularity

(3) Base conversion

Set the base position as viewed from the world coordinates.

The base position (the home position of the base coordinate system) is the center of rotation of joint axis 1. It is possible to set the base conversion (B_x) in the X coordinate direction, the base conversion (B_z) in the Z coordinate direction, and the base conversion (B_b) in the B coordinate direction.

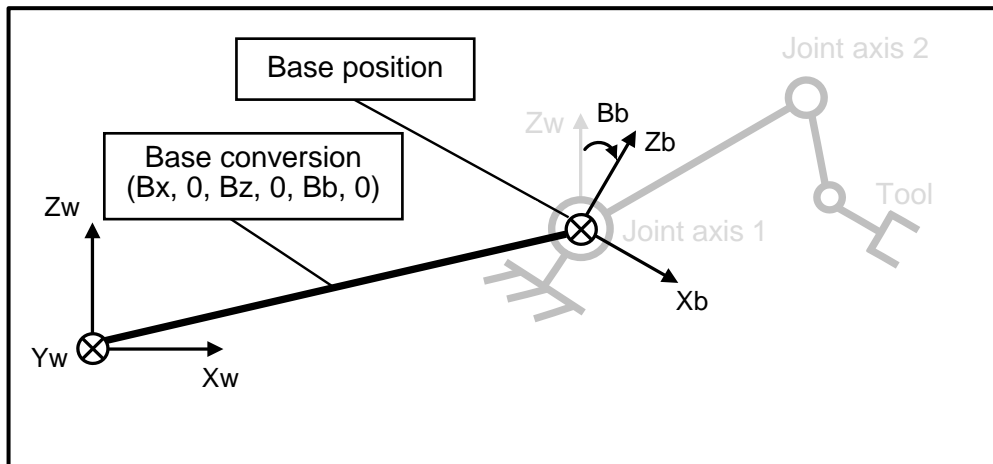


Fig. 2.9 Base conversion

(4) Tool conversion

Set the control point as viewed from the mechanical interface.

The mechanical interface is the point where arm 2 and the tool meet.

With the parallel linkage, the tool coordinate system is always parallel to the base coordinate system.

When the tool conversion is set as $(T_x, T_y, T_z) = (0, 0, 0)$, the mechanical interface is the control point.

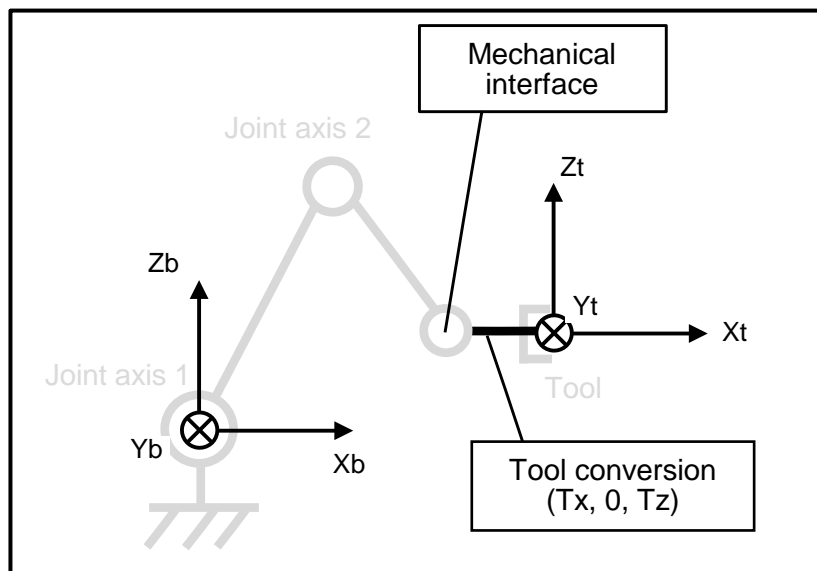


Fig. 2.10 Tool conversion

2.3.2 Axis setting parameter (fixed parameter) settings

Set the following items in the fixed parameter of axes defined as joint axes.

(1) Fixed parameter

Table 2.6 Fixed parameters

No.	Item	Setting value/range [unit] (setting by peripheral equipment)		Remarks
		Joint axis 1	Joint axis 2	
1	Unit setting	degree		<ul style="list-style-type: none"> Select [degree] for the unit of the joint axis.
2	Upper stroke limit	0.00000 to 177.50000 [degree]	0.00000 to 267.50000 [degree]	<ul style="list-style-type: none"> Set the upper/lower stroke limit value of the moving range of the machine. Make sure the upper/lower stroke limit values are not the same. There are restrictions in the operating range of the joint axis 1 and 2. When the setting value is incorrect, a moderate error 30FAH (machine configuration error) occurs. Refer to (2) for details of the stroke limit setting.
3	Lower stroke limit	0.00000 to 177.50000, 182.50000 to 359.99999 [degree]	0.00000 to 267.50000, 272.50000 to 359.99999 [degree]	

(2) Stroke limit setting

Set the stroke range (stroke limit) of each joint axis within the operating range.

Table 2.7 Operating range of rotating axis

Joint axis	Operating range [degree]	Stroke range [degree]
Joint axis 1	-177.50000 to 177.50000	182.50000 to 177.50000
Joint axis 2	-87.50000 to 267.50000	272.50000 to 267.50000

Set the stroke limit (fixed parameter) of joint axis 1 and 2 within the range of 0.00000 to 359.99999 [degree].

Table 2.8 Stroke limit setting example (Joint axis 1)

Stroke range	Stroke limit setting value	
	Upper limit [degree]	Lower limit [degree]
<p>Lower limit: 225.0 (-135.0)</p> <p>Upper limit: 135.0</p>	135.00000	225.00000 (-135.00000)

2.4 Point data

(1) When using machine type R6, the setting range of point block data are as follows.

Table 2.9 Point data (position type) setting range

Position component	Details	Command range	
		Absolute value command (ABS)	Incremental value command (INC)
X	Position (distance) to move in the X direction	-214748364.8 to 214748364.7 [μm]	-214748364.7 to 214748364.7 [μm]
Y	Position (distance) to move in the Y direction *1	0.0	
Z	Position (distance) to move in the Z direction	-214748364.8 to 214748364.7 [μm]	-214748364.7 to 214748364.7 [μm]
A	Angle to rotate the A coordinate *1	0.00000 [degree]	
B	Angle to rotate the B coordinate *1		
C	Angle to rotate the C coordinate *1		
FL1	Structure flag 1	H0 to HFFFF	
-	Unusable *1	0	

*1: The setting value is ignored.

Table 2.10 Point data (joint type) setting range

Position component	Details	Command range	
		Absolute value command (ABS)	Incremental value command (INC)
J1	Position (distance) for moving JNT1	0.00000 to 177.50000, 182.50000 to 359.99999 [degree]	-359.99999 to 359.99999 [degree]
J2	Position (distance) for moving JNT2	0.00000 to 272.50000, 267.50000 to 359.99999 [degree]	
J3	Position (distance) for moving JNT3 *1	0	
J4	Position (distance) for moving JNT4 *1		
J5	Position (distance) for moving JNT5 *1		
J6	Position (distance) for moving JNT6 *1		
-	Unusable *1	H0	
-	Unusable *1	H0	

*1: The setting value is ignored.

(2) The structure of structure flag 1 (FL1) is shown below.

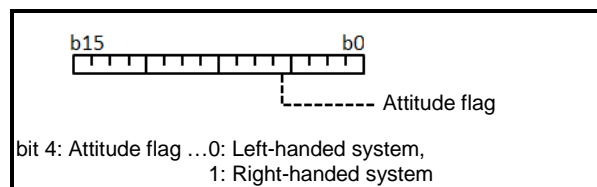


Fig. 2.11 Structure flag 1 (FL1)

(3) There is a right-handed system and a left-handed system in the attitude of the robot which is specified by bit 4 of the structure flag (FL1).

Use joint interpolation when bit 4 of the structure flag (FL1) is different at the start and end points in moving.

Whether the system is right-handed or left-handed, is determined by the angle between arm 1 and 2 (α). α is expressed by the following relational expression.

$$\alpha = 180.00000 - (\text{JNT2} - \text{JNT1})$$

(α : An angle between -180.00000 to 180.00000[degree])

The relationship between α and the attitude is as follows.

Table 2.11 Attitude flag

Attitude flag (FL bit4)	Attitude	Angle between arm 1 and 2 (α) [degree]	Remarks
0	Left-handed system	$0.00000 \leq \alpha \leq 180.00000$	When JNT1 and JNT2 are as follows, the system is left-handed. $(\text{JNT2} - \text{JNT1}) \leq -180.00000$ $0.00000 \leq (\text{JNT2} - \text{JNT1}) \leq 180.00000$ $360.00000 \leq (\text{JNT2} - \text{JNT1})$
1	Right-handed system	$-180.00000 < \alpha < 0.00000$	When JNT1 and JNT2 are as follows, the system is right-handed. $-180.00000 < (\text{JNT2} - \text{JNT1}) < 0.00000$ $180.00000 < (\text{JNT2} - \text{JNT1}) < 360.00000$

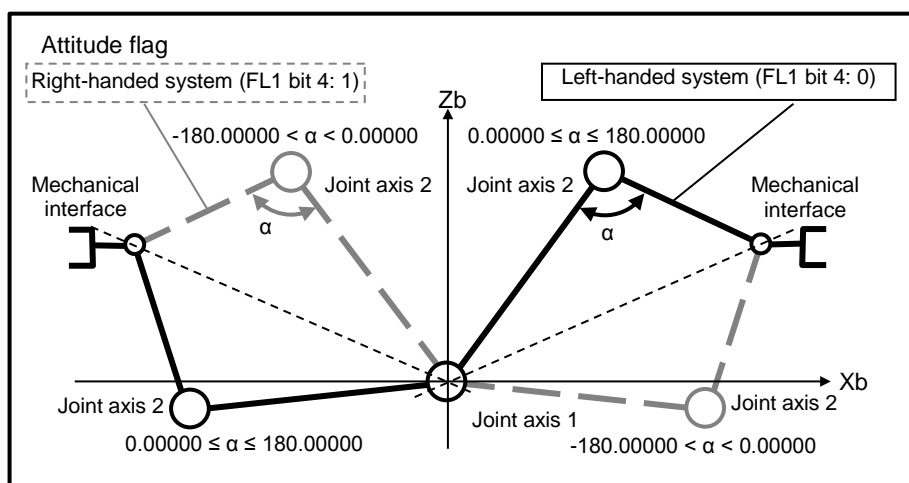


Fig. 2.12 Attitude flag

[Cautions]

The attitude of the parallel linkage may not be kept when the difference of joint axis 1 and 2 is near 0.00000 [degree] or 180.00000 [degree] (the state in which arm 1 and 2 lie on a straight line). Check the operation of the machine in JOG operation, etc. in advance, when performing an operation with joint interpolation in which the attitude flag (bit4 of the structure flag (FL1)) at the start and end points is different.