MITSUBISHI ELECTRIC

Mitsubishi Industrial Robot

CR800/750/700/500 Series

RT ToolBox3 Pro MELFA-Works Function
Instruction Manual

MELFA FR

BFP-A3554-J

Revision History

Date of print	Specifications No.	Revision details
2017/03	＊	First release.
2017/06	A	Reflect the changes after 1.01 B to 2.2 Installation Procedure. Reflect the changes after 1.01 B to 5.1 Starting MELFA-Works.
2017/11	B	Reflect the changes of Robot/Parts position save function to 7.2. Reflect the changes of travel axis function to 8.3. Reflect the changes of recording to 12.
2018/04	C	Reflect the addition of CR800-Q robot model and CH series of CR800-D to Supported Models in the MELFA-Works function.
2018/08	D	Reflect the changes of function to convert the path to spline file on creation of work flow screen to 14.1.
2019/03	E	Reflect the addition of mist and clean model to 1.2 Supported Models in the MELFA-Works function.
2019/11	F	Reflect the middle model to 1.2 Supported Models in the MELFA-Works function.
2020/04	G	Reflect the collaborative model to 1.2 Supported Models in the MELFA-Works function.
2023/06	H	Reflect the large model to 1.2 Supported Models in the MELFA-Works function.
2024/04	J	Reflect middle range model and large mist model to 1.2 Supported Models in the MELFA-Works function. 【Middle range model】 ・ RV-12CRL-D 【Large mist model】 ・ RV-35FRM-D/Q/R ・ RV-50FRM-D/Q/R ・ RV-80FRM-D/Q/R

INTRODUCTION

Thank you for purchasing the MELSOFT "RT ToolBox3 Pro" software for Mitsubishi Electric industrial robots. MELFA-Works is a tool for SolidWorks that can be used to simulate Mitsubishi Electric industrial robots. Using RT ToolBox3, it becomes possible to verify robot program operations and creat processing path data. This manual describes how to perform these operations.

This product requires SolidWorks. Please note that SolidWorks needs to be provided by the customer. Refer to “2.1 Installation confirmation of SolidWorks” for supported versions.

Symbols Used in This Manual

⚠ **DANGER**	Indicates that incorrect handling is likely to cause hazardous conditions resulting in death or severe injury to the operator.
⚠ **WARNING**	Indicates the possibility that incorrect handling might cause hazardous conditions resulting in death or severe injury to the operator.
⚠ **CAUTION**	Indicates that incorrect handling might cause hazardous conditions resulting in material damage or injury to the operator.

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1. Overview

In the RT ToolBox3 Pro, you can use the function of MELFA-Works in addition to the function of RT ToolBox3 standard edition. MELFA-Works is the add-in function of SolidWorks. In the MELFA-Works, it is possible to simulate production system by robot and to convert processing paths defined for workpieces to data.

MELFA-Works is the add-in function of SolidWorks, so it is possible to make use of parts (such as peripheral devices and hands) created by SolidWorks.

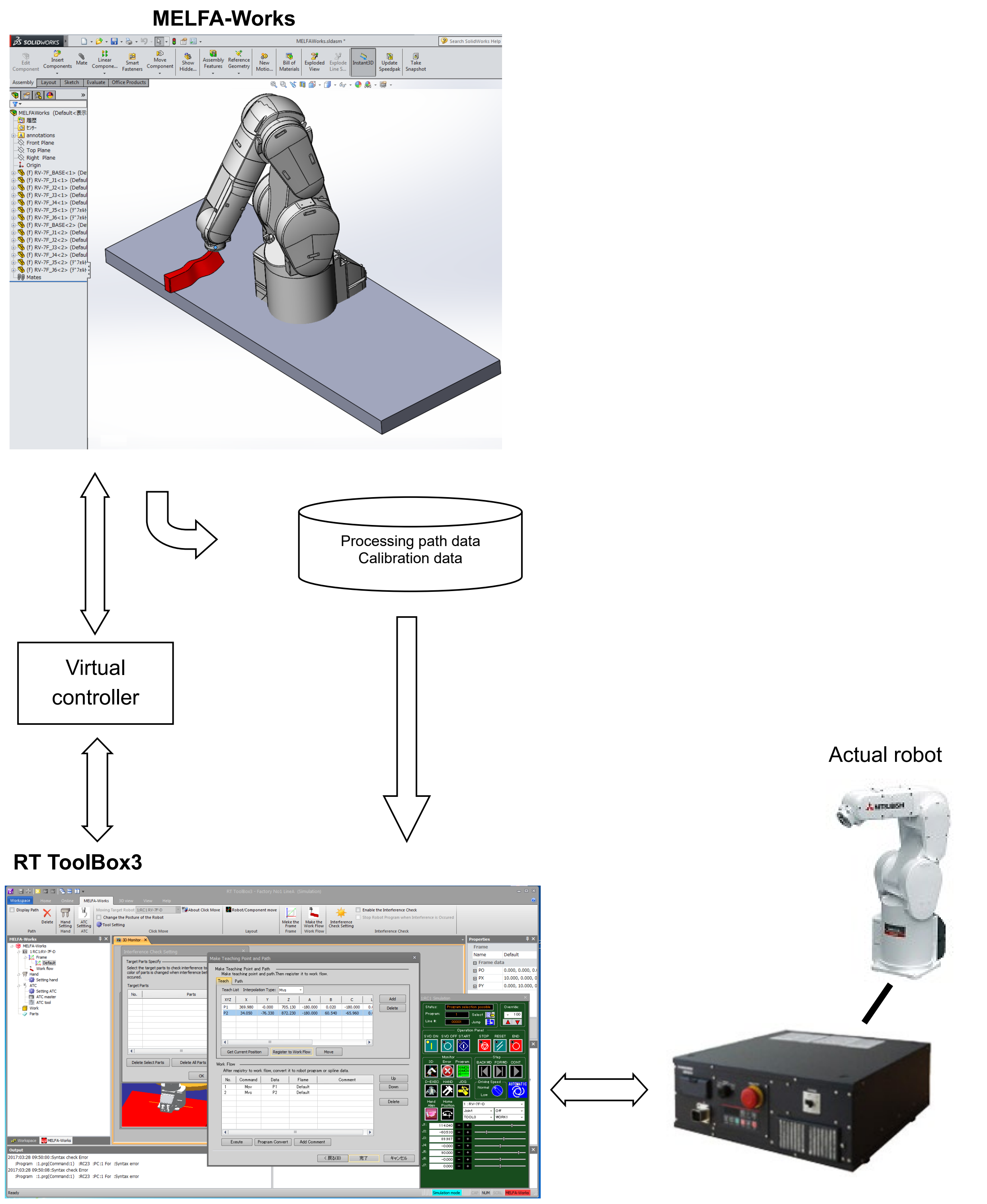


Fig. 1-1 Product Configuration

Extension memory can be used by the following controllers and versions.

Controller	Supported	Remarks
CRn-500	△ (2 Mbytes)	Before K6 Non-supported CAD link function K7 Non-supported extension memory Since K8 Supported extension memory
CRnD-700	○ (4 Mbytes)	P6 Non-supported extension memory Since P7 Supported extension memory
CR750-D CR-751-D	×	
CRnQ-700 CR750-Q CR751-Q	×	
CR800-D CR800-Q CR800-R	×	

The figure below illustrates a block diagram showing the components included in RT ToolBox3 Pro and the environment in which each of them operates.

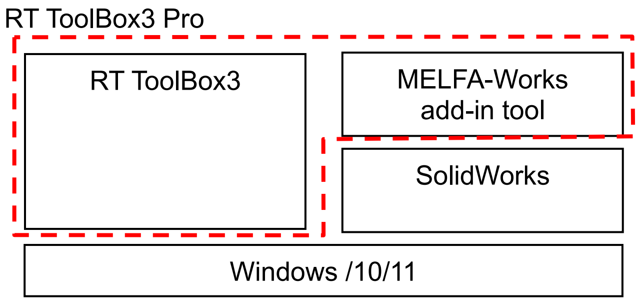


Fig. 1-2 Product Block Diagram

1.1. Basic Functions

The table below describes the basic functions of MELFA-Works.

	Function	Feature
1	Display of robot movement trajectory	With this function, it is possible to display the movement trajectory of a robot.
2	Attaching hands	This function allows attaching hands which is designed and created by SolidWorks to a robot. By setting the signal to the connected hand, it is possible to handle the workpieces due to the signal change (See “6.4 Set of hand I/O signals”). <Note> In order to connect the hand and simulate the workpiece handling, you necessary to set workpiece names according to the naming convention (See ”4.2 Part Names and Marking”).
3	Attaching ATC (Auto Tool Changer)	This function allows attaching ATC master/ATC tool designed and created by SolidWorks to a robot. By setting the signal to the connected ATC master, it is possible to attach the ATC tool due to the the signal change (See “6.4 Set of hand I/O signals”). <Note> In order to connect the ATC and simulate to attach the ATC tool, you necessary to set workpiece names according to the naming convention (See” 4.2 Part Names and Marking”).
4	Component move	This function allows to move component loaded on the Solidworks. (See ”7 Robot/Component Move”).
5	Robot move	This function allows to move robot loaded on the SolidWorks (See ”7 Robot/Component Move”).
6	Creating frame data	Create frame data to be the reference coordinate system when outputting robot position data. Frame data is used when performing path calibration. (See “15 “Calibration”).
7	CAD link	This function allows creating data necessary for operations that would otherwise require large amounts of teaching, such as laser welding, sealing and other operations involving tracing some parts on a workpiece, simply by selecting processing parts from 3-dimensional CAD data. Since data is created based on 3-dimensional CAD data, it is possible to handle complicated, 3-dimensional curves and the man-hours required for the teaching can also be reduced significantly (See “10 Creation of Work Flow”). * Only vertical 6-axis and horizontal 4-axis robots support this function. (See “1.2 Supported Models in the MELFA-Works function” for more information about supported models). * Using the expanded memory might extend the operating time (See “**Table 1-8 Relation CAD link function and Robot Version**” for more information). * This function supports the MELFA-BASIC IV, MELFA-BASIC V and MELFA-BASIC VI language.
8	Interference check	This function allows checking interference between a robot and peripheral devices (See ”11 Interference Check”). Targets of an interference check can be specified simply by clicking on the display of SolidWorks. Also, information when interference occurred (name of contacting part, program line being executed at the occurrence of interference, etc.) can be displayed in output window.
9	Calibration	Correct the point sequence data at the CAD coordinates created by the work flow creation (CAD link) function to the robot coordinate data. In addition, we transfer operation program and point sequence data to robot. * Only dot sequence data can be calibrated. See “10.3 Path Creation” for more information. Cannot calibrate teaching points (See “10.2 Creating Teaching Points”).

1.2. Supported Models in the MELFA-Works function

The table below lists models supported in the MELFA-Works function.

Table 1-1 Robots that can be used (CRn-500 series)

Robot \ Function		Simulation	CAD link
RV-S series	RV-3S/3SC/3SB/3SBC	O	O
	RV-3SJ/3SJC/3SJB/3SJBC	O	×
	RV-6S/6SC	O	O
	RV-6SL/6SLC	O	O
	RV-12S/12SC	O	O
	RV-12SL/12SLC	O	O
	RV-18S/18SC	O	O
	RV-6S/6SC-SM	O	O
	RV-6SL/6SLC-SM	O	O
	RV-6S-SE	O	O
	RV-6SL-SE	O	O
	RV-12S/12SC-SE	O	O
	RV-12SL/12SLC-SE	O	O
RH-SH series	RH-6SH3520/3717M/3717C	O	O
	RH-6SH4520/4517M/4517C	O	O
	RH-6SH5520/5517M/5517C	O	O
	RH-6SH3532/3520M/3520C	O	O
	RH-6SH4532/4520M/4520C	O	O
	RH-6SH5532/5520M/5520C	O	O
	RH-12SH5535/5530M/5530C	O	O
	RH-12SH7035/7030M/7030C	O	O
	RH-12SH8535/8530M/8530C	O	O
	RH-18SH8535/8530M/8530C	O	O
RV-A series	RV-1A	O	O
RP series	RP-1AH	O	O
	RP-3AH	O	O
	RP-5AH	O	O

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-2 Robots that can be used (CRnD-700 series)

Robot \ Function		Simulation	CAD link
RV-SD series	RV-2SD/2SDB	O	O
	RV-3SD/3SDB/3SDC/3SDBC	O	O
	RV-3SDJ/3SDJB/3SDJC/3SDJBC/3SDJ-SR	O	×
	RV-6SD/6SDC	O	O
	RV-6SDL/6SDLC	O	O
	RV-12SD/12SDC	O	O
	RV-12SDL/12SDLC	O	O
	RV-18SD/18SDC	O	O
	RV-3SDB/3SDBC-SUL3	O	O
	RV-3SDB/3SDJB-SULM6	O	O
	RV-3SDJB/3SDJBC-SUL3	O	×
	RV-6SD/6SDC-SUL	O	O
	RV-6SD-SULM6	O	O
	RV-6SDL/6SDLC-SUL	O	O
	RV-6SDL-SULM6	O	O
	RV-12SD/12SDC-SUL	O	O
	RV-12SDL/12SDL-SUL	O	O
	RV-6SD-SE	O	O
	RV-6SDL-SE	O	O
	RV-6SD-SEZ	O	O
	RV-6SDL-SEZ	O	O
	RV-6SD/6SDC-SM	O	O

	RV-6SDL/6SDLC-SM	○	○
	RV-6SD/6SDC-SMZ	○	○
	RV-6SDL/6SDLC-SMZ	○	○
	RV-6SD/6SDC-SZ	○	○
	RV-6SDL/6SDLC-SZ	○	○
	RV-12SD/12SDC-SE	○	○
	RV-12SDL/12SDLC-SE	○	○
	RV-12SD/12SDC-SEZ	○	○
	RV-12SDL/12SDLC-SEZ	○	○
	RV-12SD/12SDC-SZ	○	○
	RV-12SDL/12SDLC-SZ	○	○
RH-SDHR series	RH-3SDHR3515	○	○
RH-SDH series	RH-6SDH3520/3520M/3520C/3517M/3517C	○	○
	RH-6SDH4520/4520M/4520C/4517M/4517C	○	○
	RH-6SDH5520/5520M/5520C/5517M/5517C	○	○
	RH-6SDH3532/3527M/3527C	○	○
	RH-6SDH4532/4527M/4527C	○	○
	RH-6SDH5532/5527M/5527C	○	○
	RH-12SDH5535/5530M/5530C	○	○
	RH-12SDH7035/7030M/7030C	○	○
	RH-12SDH8535/8530M/8530C	○	○
	RH-12SDH5545/5538M/5538C	○	○
	RH-12SDH7045/7038M/7038C	○	○
	RH-12SDH8545/8538M/8538C	○	○
	RH-18SDH8535/8530M/8530C	○	○
	RH-6SDH3520/3517M/3517C-SUL3	○	○
	RH-6SDH4520/4517M/4517C-SUL3	○	○
	RH-6SDH5520/5517M/5517C-SUL3	○	○
	RH-6SDH3517M-SULM6	○	○
	RH-6SDH4517M-SULM6	○	○
	RH-6SDH5517M-SULM6	○	○
	RH-12SDH5535/5530M/5530C–SUL	○	○
	RH-12SDH7035/7030M/7030C–SUL	○	○
	RH-12SDH8535/8530M/8530C–SUL	○	○
	RH-12SDH5530M-SULM6	○	○
	RH-12SDH7030M-SULM6	○	○
	RH-12SDH8530M-SULM6	○	○
	RH-18SDH8535-SUL	○	○
	RH-18SDH8530M-SUL	○	○
	RH-18SDH8530C-SUL	○	○
	RH-18SDH8530M-SULM6	○	○
	RH-20SDH8535/8530M/8530C	○	○
	RH-20SDH8545/8538M/8538C	○	○
	RH-20SDH10035/10030M/10030C	○	○
	RH-20SDH10045/10038M/10038C	○	○

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-3 Robots that can be used (CRnQ-700 series)

Robot	Function	Simulation	CAD link
RV-SQ series	RV-2SQ/2SQB	○	○
	RV-3SQ/3SQB/3SQC/3SQBC	○	○
	RV-3SQJ/3SQJB/3SQJC/3SQJBC/3SQJ-SR	○	×
	RV-6SQ/6SQC	○	○
	RV-6SQL/6SQLC	○	○
	RV-12SQ/12SQC	○	○
	RV-12SQL/12SQLC	○	○
	RV-18SQ/18SQC	○	○
	RV-6SQ-SE	○	○
	RV-6SQL-SE	○	○
	RV-6SQ-SEZ	○	○
	RV-6SQL-SEZ	○	○
	RV-6SQ/6SQC-SM	○	○
	RV-6SQL/6SQLC-SM	○	○
	RV-6SQ/6SQC-SMZ	○	○
	RV-6SQL/6SQLC-SMZ	○	○
	RV-6SQ/6SQC-SZ	○	○
	RV-6SQL/6SQLC-SZ	○	○
	RV-12SQ/12SQC-SE	○	○
	RV-12SQL/12SQLC-SE	○	○
	RV-12SQ/12SQC-SEZ	○	○
	RV-12SQL/12SQLC-SEZ	○	○
	RV-12SQ/12SQC-SZ	○	○
	RV-12SQL/12SQLC-SZ	○	○
RH-SQHR series	RH-3SQHR3515	○	○
RH-SQH series	RH-6SQH3520/3517M/3517C/3520M/3520C	○	○
	RH-6SQH4520/4517M/4517C/4520M/4520C	○	○
	RH-6SQH5520/5517M/5517C/5520M/5520C	○	○
	RH-6SQH3532/3527M/3527C	○	○
	RH-6SQH4532/4527M/4527C	○	○
	RH-6SQH5532/5527M/5527C	○	○
	RH-12SQH5535/5530M/5530C	○	○
	RH-12SQH7035/7030M/7030C	○	○
	RH-12SQH8535/8530M/8530C	○	○
	RH-12SQH5545/5538M/5538C	○	○
	RH-12SQH7045/7038M/7038C	○	○
	RH-12SQH8545/8538M/8538C	○	○
	RH-18SQH8535/8530M/8530C	○	○
	RH-20SQH8535/8530M/8530C	○	○
	RH-20SQH8545/8538M/8538C	○	○
	RH-20SQH10035/10030M/10030C	○	○
	RH-20SQH10045/10038M/10038C	○	○

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-4 Robots that can be used (CR750-D series)

Robot	Function	Simulation	CAD link
RH-xFH-D series	RH-1FHR5515-D	○	○
	RH-3FH3515/3512C-D	○	○
	RH-3FHR3515-D	○	○
	RH-3FH4515/4512C-D	○	○
	RH-3FH5515/5512C-D	○	○
	RH-6FH3520/3520C/3520M-D	○	○
	RH-6FH4520/4520C/4520M-D	○	○
	RH-6FH5520/5520C/5520M-D	○	○
	RH-6FH3534/3534C/3534M-D	○	○
	RH-6FH4534/4534C/4534M-D	○	○
	RH-6FH5534/5534C/5534M-D	○	○
	RH-12FH5535/5535C/5535M-D	○	○
	RH-12FH7035/7035C/7035M-D	○	○
	RH-12FH8535/8535C/8535M-D	○	○
	RH-12FH5545/5545C/5545M-D	○	○
	RH-12FH7045/7045C/7045M-D	○	○
	RH-12FH8545/8545C/8545M-D	○	○
	RH-20FH8535/8535C/8535M-D	○	○
	RH-20FH8545/8545C/8545M-D	○	○
	RH-20FH10035/10035C/10035M-D	○	○
	RH-20FH10045/10045C/10045M-D	○	○
	RH-3CH4018-D	○	○
	RH-3CH4018-D-S2	○	○
	RH-6CH6020-D	○	○
	RH-6CH6020-D-S2	○	○
	RH-6CH7020-D	○	○
	RH-6CH7020-D-S2	○	○
RV-xF-D series	RV-2F-D	○	○
	RV-2FL-D	○	○
	RV-4F/4FC/4FM-D	○	○
	RV-4F-D-SH	○	○
	RV-4FL/4FLC/4FLM-D	○	○
	RV-4FL-D-SH	○	○
	RV-7F/7FC/7FM-D	○	○
	RV-7F-D-SH	○	○
	RV-7FL/7FLC/7FLM-D	○	○
	RV-7FL-D-SH	○	○
	RV-7FLL/7FLLC/7FLLM-D	○	○
	RV-7FLL-D-SH	○	○
	RV-13F/13FC/13FM-D	○	○
	RV-13F-D-SH	○	○
	RV-13FL/13FLC/13FLM-D	○	○
	RV-13FL-D-SH	○	○
	RV-13FLR/13FLRM-D	○	○
	RV-20F/20FC/20FM-D	○	○
	RV-20F-D-SH	○	○
	RV-20FL/20FLC/20FLM-D	○	○
	RV-35F-D	○	○
	RV-35FM-D	○	○
	RV-50F-D	○	○
	RV-50FM-D	○	○
	RV-70F-D	○	○
	RV-70FM-D	○	○

Table 1-5 Robots that can be used (CR750-Q series)

Robot \ Function		Simulation	CAD link
RH-xFH-Q series	RH-1FHR5515-Q	○	○
	RH-3FH3515/3512C-Q	○	○
	RH-3FHR3515-Q	○	○
	RH-3FH4515/4512C-Q	○	○
	RH-3FH5515/5512C-Q	○	○
	RH-6FH3520/3520C/3520M-Q	○	○
	RH-6FH4520/4520C/4520M-Q	○	○
	RH-6FH5520/5520C/5520M-Q	○	○
	RH-6FH3534/3534C/3534M-Q	○	○
	RH-6FH4534/4534C/4534M-Q	○	○
	RH-6FH5534/5534C/5534M-Q	○	○
	RH-12FH5535/5535C/5535M-Q	○	○
	RH-12FH7035/7035C/7035M-Q	○	○
	RH-12FH8535/8535C/8535M-Q	○	○
	RH-12FH5545/5545C/5545M-Q	○	○
	RH-12FH7045/7045C/7045M-Q	○	○
	RH-12FH8545/8545C/8545M-Q	○	○
	RH-20FH8535/8535C/8535M-Q	○	○
	RH-20FH8545/8545C/8545M-Q	○	○
	RH-20FH10035/10035C/10035M-Q	○	○
	RH-20FH10045/10045C/10045M-Q	○	○
RV-xF-Q series	RV-2F-Q	○	○
	RV-2FL-Q	○	○
	RV-4F/4FC/4FM-Q	○	○
	RV-4F-Q-SH	○	○
	RV-4FL/4FLC/4FLM-Q	○	○
	RV-4FL-Q-SH	○	○
	RV-7F/7FC/7FM-Q	○	○
	RV-7F-Q-SH	○	○
	RV-7FL/7FLC/7FLM-Q	○	○
	RV-7FL-Q-SH	○	○
	RV-7FLL/7FLLC/7FLLM-Q	○	○
	RV-7FLL-Q-SH	○	○
	RV-13F/13FC/13FM-Q	○	○
	RV-13F-Q-SH	○	○
	RV-13FL/13FLC/13FLM-Q	○	○
	RV-13FL-Q-SH	○	○
	RV-13FLR/13FLRM-Q	○	○
	RV-20F/20FC/20FM-Q	○	○
	RV-20F-Q-SH	○	○
	RV-20FL/20FLC/20FLM-Q	○	○
	RV-35F-Q	○	○
	RV-35FM-Q	○	○
	RV-50F-Q	○	○
	RV-50FM-Q	○	○
	RV-70F-Q	○	○
	RV-70FM-Q	○	○

Table 1-6 Robots that can be used (CR800-D series)

Robot \ Function		Simulation	CAD link
RH-xFRH-D series	RH-1FRHR5515-D	○	○
	RH-3FRH3515/3512C-D	○	○
	RH-3FRHR3515-D	○	○
	RH-3FRH4515/4512C-D	○	○
	RH-3FRH5515/5512C-D	○	○
	RH-6FRH3520/3520C/3520M-D	○	○
	RH-6FRH4520/4520C/4520M-D	○	○
	RH-6FRH5520/5520C/5520M-D	○	○
	RH-6FRH3534/3534C/3534M-D	○	○
	RH-6FRH4534/4534C/4534M-D	○	○
	RH-6FRH5534/5534C/5534M-D	○	○
	RH-12FRH5535/5535C/5535M-D	○	○
	RH-12FRH7035/7035C/7035M-D	○	○
	RH-12FRH8535/8535C/8535M-D	○	○
	RH-12FRH5545/5545C/5545M-D	○	○
	RH-12FRH7045/7045C/7045M-D	○	○
	RH-12FRH8545/8545C/8545M-D	○	○
	RH-20FRH8535/8535C/8535M-D	○	○
	RH-20FRH8545/8545C/8545M-D	○	○
	RH-20FRH10035/10035C/10035M-D	○	○
	RH-20FRH10045/10045C/10045M-D	○	○
RH-xCRH-D series	RH-3CRH4018-D	○	○
	RH-6CRH6020-D	○	○
	RH-6CRH7020-D	○	○
RV-xFR-D series	RV-2FR-D	○	○
	RV-2FRL-D	○	○
	RV-4FR/4FRC/4FRM-D	○	○
	RV-4FR-D-SH	○	○
	RV-4FRL/4FRLC/4FRLM-D	○	○
	RV-4FRL-D-SH	○	○
	RV-7FR/7FRC/7FRM-D	○	○
	RV-7FR-D-SH	○	○
	RV-7FRL/7FRLC/7FRLM-D	○	○
	RV-7FRL-D-SH	○	○
	RV-7FRLL/7FRLLC/7FRLLM-D	○	○
	RV-7FRLL-D-SH	○	○
	RV-13FR/13FRC/13FRM-D	○	○
	RV-13FR-D-SH	○	○
	RV-13FRL/13FRLC/13FRLM-D	○	○
	RV-13FRL-D-SH	○	○
	RV-20FR/20FRC/20FRM-D	○	○
	RV-20FR-D-SH	○	○
	RV-35FR/35FRM-D	○	○
	RV-50FR/50FRM-D	○	○
	RV-80FR/80FRM-D	○	○
RV-xCRL-D series	RV-8CRL-D	○	○
	RV-12CRL-D	○	○
MELFA ASSISTA	RV-5AS-D	○	○

Table 1-7 Robots that can be used (CR800-R series)

Robot \ Function		Simulation	CAD link
RH-xFRH-R series	RH-1FRHR5515-R	○	○
	RH-3FRH3515/3512C-R	○	○
	RH-3FRHR3515-R	○	○
	RH-3FRH4515/4512C-R	○	○
	RH-3FRH5515/5512C-R	○	○
	RH-6FRH3520/3520C/3520M-R	○	○
	RH-6FRH4520/4520C/4520M-R	○	○
	RH-6FRH5520/5520C/5520M-R	○	○
	RH-6FRH3534/3534C/3534M-R	○	○
	RH-6FRH4534/4534C/4534M-R	○	○
	RH-6FRH5534/5534C/5534M-R	○	○
	RH-12FRH5535/5535C/5535M-R	○	○
	RH-12FRH7035/7035C/7035M-R	○	○
	RH-12FRH8535/8535C/8535M-R	○	○
	RH-12FRH5545/5545C/5545M-R	○	○
	RH-12FRH7045/7045C/7045M-R	○	○
	RH-12FRH8545/8545C/8545M-R	○	○
	RH-20FRH8535/8535C/8535M-R	○	○
	RH-20FRH8545/8545C/8545M-R	○	○
	RH-20FRH10035/10035C/10035M-R	○	○
	RH-20FRH10045/10045C/10045M-R	○	○
RV-xFR-R series	RV-2FR-R	○	○
	RV-2FRL-R	○	○
	RV-4FR/4FRC/4FRM-R	○	○
	RV-4FR-R-SH	○	○
	RV-4FRL/4FRLC/4FRLM-R	○	○
	RV-4FRL-R-SH	○	○
	RV-7FR/7FRC/7FRM-R	○	○
	RV-7FR-R-SH	○	○
	RV-7FRL/7FRLC/7FRLM-R	○	○
	RV-7FRL-R-SH	○	○
	RV-7FRLL/7FRLLC/7FRLLM-R	○	○
	RV-7FRLL-R-SH	○	○
	RV-13FR/13FRC/13FRM-R	○	○
	RV-13FR-R-SH	○	○
	RV-13FRL/13FRLC/13FRLM-R	○	○
	RV-13FRL-R-SH	○	○
	RV-20FR/20FRC/20FRM-R	○	○
	RV-20FR-R-SH	○	○
	RV-35FR/35FRM-R	○	○
	RV-50FR/50FRM-R	○	○
	RV-80FR/80FRM-R	○	○

Table 1-8 Robots that can be used (CR800-Q series)

Robot \ Function		Simulation	CAD link
RH-xFRH-Q series	RH-1FRHR5515-Q	○	○
	RH-3FRH3515/3512C-Q	○	○
	RH-3FRHR3515-Q	○	○
	RH-3FRH4515/4512C-Q	○	○
	RH-3FRH5515/5512C-Q	○	○
	RH-6FRH3520/3520C/3520M-Q	○	○
	RH-6FRH4520/4520C/4520M-Q	○	○
	RH-6FRH5520/5520C/5520M-Q	○	○
	RH-6FRH3534/3534C/3534M-Q	○	○
	RH-6FRH4534/4534C/4534M-Q	○	○
	RH-6FRH5534/5534C/5534M-Q	○	○
	RH-12FRH5535/5535C/5535M-Q	○	○
	RH-12FRH7035/7035C/7035M-Q	○	○
	RH-12FRH8535/8535C/8535M-Q	○	○
	RH-12FRH5545/5545C/5545M-Q	○	○
	RH-12FRH7045/7045C/7045M-Q	○	○
	RH-12FRH8545/8545C/8545M-Q	○	○
	RH-20FRH8535/8535C/8535M-Q	○	○
	RH-20FRH8545/8545C/8545M-Q	○	○
	RH-20FRH10035/10035C/10035M-Q	○	○
	RH-20FRH10045/10045C/10045M-Q	○	○
RV-xFR-Q series	RV-2FR-Q	○	○
	RV-2FRL-Q	○	○
	RV-4FR/4FRC/4FRM-Q	○	○
	RV-4FR-Q-SH	○	○
	RV-4FRL/4FRLC/4FRLM-Q	○	○
	RV-4FRL-Q-SH	○	○
	RV-7FR/7FRC/7FRM-Q	○	○
	RV-7FR-Q-SH	○	○
	RV-7FRL/7FRLC/7FRLM-Q	○	○
	RV-7FRL-Q-SH	○	○
	RV-7FRLL/7FRLLC/7FRLLM-Q	○	○
	RV-7FRLL-Q-SH	○	○
	RV-13FR/13FRC/13FRM-Q	○	○
	RV-13FR-Q-SH	○	○
	RV-13FRL/13FRLC/13FRLM-Q	○	○
	RV-13FRL-Q-SH	○	○
	RV-20FR/20FRC/20FRM-Q	○	○
	RV-20FR-Q-SH	○	○
	RV-35FR/35FRM-Q	○	○
	RV-50FR/50FRM-Q	○	○
	RV-80FR/80FRM-Q	○	○

Table 1-9 Relation CAD link function and Robot Version

Controller	Memory	Operating time	Remarks
CRn-500	Standard 256K bytes	Approx. 17 sec	Before K6 Non-supported CAD link function K7 Non-supported extension memory Since K8 Supported extension memory
	Extension 2M bytes	Approx. 160 sec	
CRnQ-700 CR750-Q CR751-Q	Standard 1M bytes	Approx. 85 sec	Correspondence from first edition.
	-	Non-supported	
CRnD-700	Standard 1M bytes	Approx. 85 sec	P6 Non-supported extension memory Since P7 Supported extension memory
	Extension 4M bytes	Approx. 320 sec	
CR750-D CR751-D	Standard 3M bytes	Approx. 255 sec	Correspondence from first edition.
CR800-D CR800-Q CR800-R	Standard 16M bytes	Approx. 1320 sec	Correspondence from first edition.

* Operating time varies depending on the job conditions.

2. Install

2.1. Installation confirmation of SolidWorks

Please confirm that the SolidWorks®2010 ～ SolidWorks®2017* is installed.

- The above-mentioned is a confirmed operation version in our company. Therefore, it is likely to be able to use it even with SolidWorks that will be released in the future.
- Combination of the SolidWorks and operating system depends on the operating environment of SolidWorks.
- Depending on SolidWorks specifications, data created in higher version can not be used in lower version..

* For the recommended SolidWorks operating environment, please refer to Home page of SolidWorks "https://www.solidworks.co.jp/" (SolidWorks Corp.).
[Top page]-[TRAINING & SUPPORT]-[Technical Support]-[System Requirements and Graphics Cards]

2.2. Installation Procedure

2.2.1 In the case of RT ToolBox3 Pro 1.00A

⚠ CAUTION

If you installed the RT ToolBox3 Pro 1.00A, conventional MELFA-Works will become unusable. If you use a conventional MELFA-Works, please uninstall the RT ToolBox3 Pro1.00A and conventional MELFA-Works. When the uninstall is complete, please re-install the RT ToolBox3 Pro 1.01B or later and conventional MELFA-Works

(1) Insert the product in the personal computer's DVD-ROM drive; the setup launcher automatically appears.

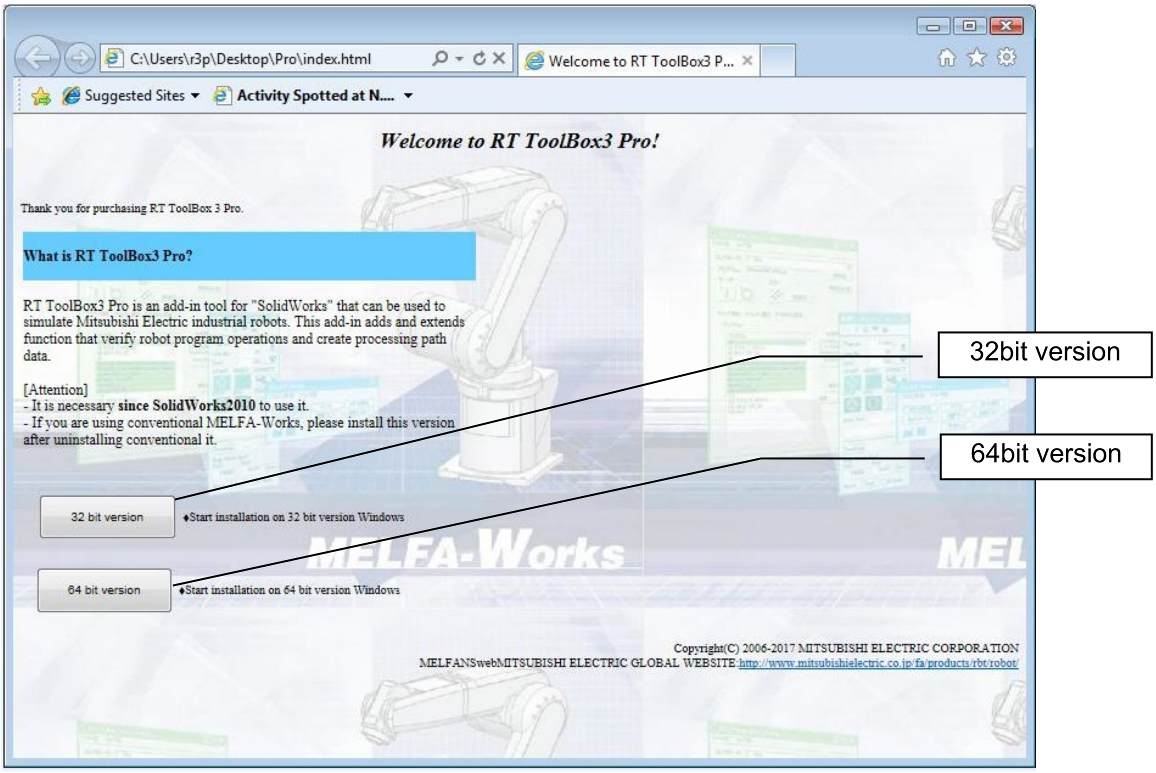


Fig. 2-1 Setup launcher

Please start a correct installer after confirming the use environment when you install it. The error is displayed when a wrong installer is started and the installation fails.

*The following messages concerning security alert might be displayed to launcher according to the environment of the personal computer. In this case, click the message with the mouse, and select [Allow Blocked Content…].

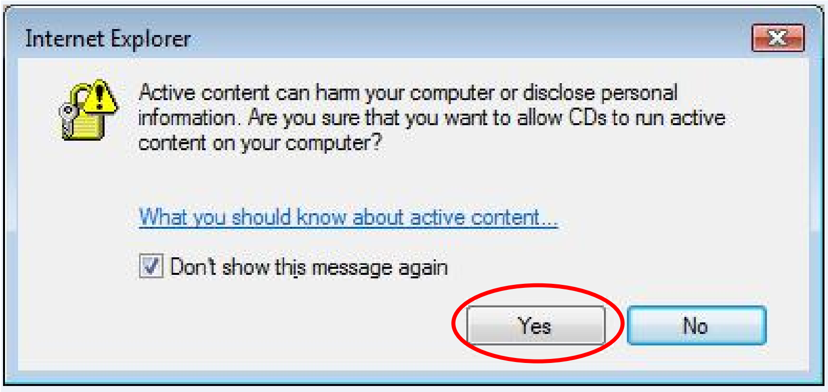


Fig. 2-2 Message to help protect your security (Microsoft Windows® Vista Professional is used)

(2) Install RT ToolBox3 Pro from the menu of launcher.

① Click the button of the installed product.
② If the security alert message as follows is displayed, click [Run] button.
(* If [Save] button is clicked and, “Setup.exe” which is saved in hard disk is executed, the installation is not correctly completed. Click [Run] button absolutely.)

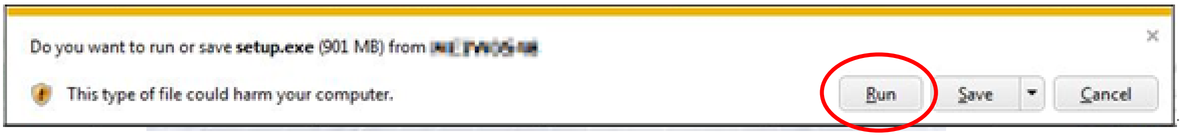


Fig. 2-3 Security Warning 1

③ The following screens are displayed. Then click [Run].
The installation of this application is started.

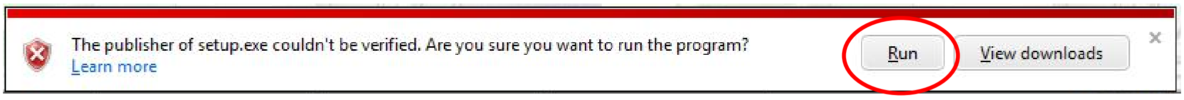


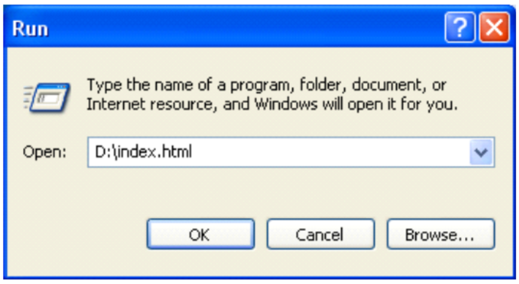
Fig. 2-4 Security Warning 2

Memo

When the installation launcher doesn't start

(A) If the setup dialog box does not appear when you insert the product in the DVD-ROM drive, display the setup launcher according to the following procedure.

① Click the [Start] button and then select [Run...].
② Check the DVD-ROM drive name and enter "drive name":/index.html
(e.g., if the DVD-ROM drive is "D:," type "D:/index.html").



(B) Please install RT ToolBox2 and MELFA-Works by the method of the following when the installation cannot begin from the setup launcher.

① Click the [Start] button and then select [Run...].
② Install RT ToolBox3 Pro below according to your use environment.

[When using in a 32-bit environment]
Check the DVD-ROM drive name and enter "drive name":/32bit/Setup.exe
(e.g., if the DVD-ROM drive is "D:," type "D:/32bit/Setup.exe").
The setup is begun.

[When using in a 64-bit environment]
Check the DVD-ROM drive name and enter "drive name":/64bit/Setup.exe
(e.g., if the DVD-ROM drive is "D:," type "D:/64bit/Setup.exe").
The setup is begun.

2.2.2 In the case of RT ToolBox3 Pro 1.01B or later

The installation launcher screen displayed when RT ToolBox 3 Pro 1.00 A is installed is not displayed.
Please refer to "RT ToolBox3 / RT ToolBox3 mini User's Manual Section 1.5.1 Installation").

3. Flow of Operations

In this chapter, we will explain the flow of operation until the robot is operated on actual machine when launching the system using the MELFA-Works function. The operation on each screen is explained in the following chapters.

3.1. Operation Steps

There are several steps before constructing the system using the MELFA - Works function, but if you divide it into a large size it will be the next 4 steps.

Table 3-1 Operation Steps

① Creating parts	Create parts such as works and hands on SolidWorks (including conversion from other CAD data) and embed marks for MELFA-Works. In MELFA-Works the coordinate system which is SolidWorks functions are used as marks.(See “4.2 Part Names and Marking”)
② Creating program	Execute workflow creation, and finally create robot programs, point sequence data, and calibration programs that will be a template while designating machining locations, intermediate attitude, and various parameters.
③ Alignment	Using the calibration tool, correct the point sequence data to the machining position of the workpiece in the real space. Also, the corrected point sequence data is written in the robot controller. * When reading point sequence data as spline data, the calibration tool is not used. (See “13 Spline conversion”).
④ Edit program	Using the program editing function, based on the template program created in ②, edit and debug the program that can be operated on the actual system.

3.2. Flow of Robot Program Development

This section explains how to develop robot programs without using the CAD link function. Refer to the corresponding chapter for further details. The numbers ① to ④ to the left of each of the items indicate the operation steps explained in “3.1 Operation Steps”.
To use CAD link functions see “3.3 Flow of CAD Link System Development”.

①	Create parts required for simulation	Create workpieces, hands and other parts in SolidWorks (See ”4 Creation of Parts”).
②	↓ Create a project	Create a new project or load an existing project (See “RT ToolBox3 / RT ToolBox3 mini User's Manual”) *1.
②	↓ Setting travel base	Setting travel base to robot by project setting (See “RT ToolBox3 / RT ToolBox3 mini User's Manual”).
②	↓ Load a robot	Start the MELFA-Works and load the robot on the SolidWorks (See ”5.1 Starting MELFA-Works”).
②	↓ Attach hands	Attach hands (fixed hands, ATC) to the robot (See “6 Hand”).
②	↓ Move parts	Move loaded parts in arbitrary positions (See ”7 Robot/Component Move”).
②	↓ Move robot	Move the loaded robot to an arbitrary location (See ”7 Robot/Component Move”).
②	↓ Change posture	Change the robot posture (See ”8 Robot Operations”) .
②	↓ Create frame data	Make some coordinate systems (frame) which is the reference of work (See “9 Frame”).
②	↓ Teach posture	Teach the robot postures of operations. See”10.2 Creating Teaching Points”
②	↓ Create work flow	Decide the flow of work by combining teach points and path. (See “10 Creation of Work Flow”).
②	↓ Create a program	Create a robot movement program based on a work flow (See “10.5 Robot program conversion”).
③	↓ Check movement with the operation panel	By execute the created robot program from the operation panel, you will confirm the movement.
④	↓ Create an operational program	Modify an automatically created program according to your specific system using the function of program edit (See “15 CAD Link Programming”).

3.3. Flow of CAD Link System Development

This section explains the flow of development of robot programs using the CAD link function. The numbers ① to ④ to the left of each of the items indicate the operation steps explained in “3.1 Operation Steps”.

①	Create parts required for simulation	Create workpieces, hands and other parts in SolidWorks (See “4 Creation of Parts”).
②	Create a project	Create a new project or load an existing project (See “RT ToolBox3 / RT ToolBox3 mini User's Manual”) *1.
②	Setting travel base	Setting travel base to robot by project setting (See “RT ToolBox3 / RT ToolBox3 mini User's Manual”).
②	Load a robot	Start the MELFA-Works and load the robot on the SolidWorks (See “5.1 Starting MELFA-Works”).
②	Attach hands	Attach hands (fixed hands, ATC) to the robot (See “6 Hand”).
②	Move parts	Move loaded parts in arbitrary positions. (See ” 7 Robot/Component Move”)
②	Move robot	Move the loaded robot to an arbitrary location (See ” 7 Robot/Component Move”).
②	Change posture	Change the robot posture (See “8 Robot Operations”).
②	Create frame data	Make some coordinate systems (frame) which is the reference of work (See “9 Frame”).
②	Teach posture	Teach the robot postures of operations. See”10.2 Creating Teaching Points”
②	Create work flow	Decide the flow of work by combining teach points and path. (See “10 Creation of Work Flow”).
②	Create a program	Create a robot movement program based on a work flow (See “10.5 Robot program conversion”).
③	Check movement with the operation panel	By execute the created robot program from the operation panel, you will confirm the movement.
③	Teach to calibration program	Transfer the calibration program to the controller in order to teach the robot (See “14 Calibration”).
③	Calibrate dot sequence and transfer to controller	Perform calibration using the teaching result and transfer the calibrated dot sequence data to the controller (See “14 Calibration”) *2.
④	Create an operational program	Modify an automatically created program according to your specific system using the function of program edit (See “15 CAD Link Programming”).

* 1 It is not compatible with the old MELFA-Works project. Please create a new project with RT ToolBox 3.

* 2 When importing point sequence data as spline data, calibration is not necessary.
Execute spline conversion. (For details, see "13 Spline Conversion")

4. Creation of Parts

With MELFA-Works, parts created by customers can be used as hands or workpieces. When connecting a hand to a robot or handling a workpiece, please prepare parts such as a hand and a workpiece in advance according to the creation rules described in this chapter.
If you just want to operate the robot, this task is unnecessary.
We will prepare sample data such as hands and workpieces in the sample folder so please refer to it.

4.1. Data Formats that can be Used

With the MELFA-Works, it is possible to use data created by other CAD as long as it can be read by SolidWorks. In that case, please convert it to SolidWorks part file (* .sldprt format) before loading.

* Please check the supported file formats in the SolidWorks at the Website of SolidWorks Corporation.

4.2. Part Names and Marking

Parts used in MELFA-Works include robot components, hands, workpieces, and other peripheral devices. Among these, there are the following rules for parts that MELFA-Works has special control.

The rules can mainly be categorized into the following two types.

① Part Names
This is equivalent to the part name when reading in SolidWorks, that is, the file name, and it is used to distinguish whether the part is hand or work. As a character string for distinguishing parts, insert "_ identifier" before the extension as in the following example.

(Example) Sample_ identifier.sldprt

* For "identifier", refer to "Table 4-1 Rules in Parts Creation ".

② Marking
Embed the "coordinate system" of a specific name in the part as the reference point for connecting parts such as robot and hand, hand and work (first origin, second origin).

※ Coordinate system name is case sensitive.

③ File Format
Only parts files (* .sldprt) are recognizable as parts of MELFA-Works, such as hands and workpieces. Since you can not use the assembly file (* .sldasm), convert it to a parts file and use it. Also, in order to be subject to interference checking, specify the solid model and save it when converting.

Table 4-1 Rules in Parts Creation

Part name	Format of part name (= file name)	First origin	Second origin
Fixed hand	Arbitrary character string + "_Hand.sldprt" (Example) Sample_Hand.sldprt	Coordinate system: **Orig1**	In the case of gripping hands Coordinate system: **Pick1 to 8** * Set to gripping area In the case of processing hands Coordinate system: **Orig2** * Set to processing point
ATC master	Arbitrary character string + "_MasterATC.sldprt" (Example) Sample_MasterATC.sldprt	Coordinate system: **Orig1**	Coordinate system: **Orig2**
ATC tool	Arbitrary character string + "_ToolATC.sldprt" (Example) Sample_ToolATC.sldprt	Coordinate system: **Orig1**	None
Workpiece	Arbitrary character string + "_Work.sldprt" (Example) Sample_Work.sldprt	Coordinate system: **Orig1** * Set to gripping area (Can be omitted)	None

First origin: Used to connect of parts in front and back. For example, the second origin of the front part and the first origin of the rear part, such as Orig2 of the J6 axis of the 6 axis robot, Orig1 of the fixed hand, Orig1 of the ATC master, Orig2 of the ATC tool, etc are identical.

Second origin: It is the coordinate system for gripped a workpiece or connected to parts. In case of "Gripping hand", please set "Pick*" (set 1 to 8 for "*"). In case of "Processing hand" or "ATC master", please set "Orig2".

4.3. Hand type

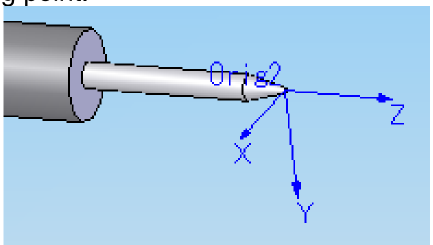
MELFA-Works can handle the following hands.

Table 4-2 Hands that can be Used

Type	Explanation
Fixed hand	Fixed hands are directly attached to a flange.
ATC master	The master side of ATC (Auto Tool Changer). The ATC master part will be connected to the flange in the robot. The ATC tool can be removed or attached according to commands issued via robot input/output signals. In order to attach the tool via a signal, the ATC tool must be in the vicinity of the robot (no more than 200 mm away).
ATC tool	The tool side of ATC. The ATC tool part will be connected to the ATC master.

Two types of hand applications, gripping hands and processing hands, can also be handled by this software. These types of hand applications are defined as follows.

Table 4-3 Hand Applications

Type	Explanation
Gripping hand	A gripping hand is used to handle workpieces. Up to 8 gripping areas can be set for each hand and it is possible to grip up to 8 workpieces at the same time. **A marking (Pick 1 to 8)** is required for each gripping area. The hand can grip a workpiece by signal input / output of the robot. In order to gripping via a signal, the workpiece must be in the vicinity of the hand (no more than 200 mm away).
Processing hand	A processing hand is used in laser welding, sealing and other operations that involve tracing of specific locations on a workpiece. **A marking (Orig2)** is required for the hand processing point.  **Fig. 4-1 Hand processing point**

4.4. Connection of parts

By setting the coordinate system, each part can be connected to the robot or workpiece. Connection types are shown below.

4.4.1 Connect hand and robot

It is connected to the robot so that the first origin (Orig1) set in the hand matches Orig2 set in the robot flange. Please set Orig1 to the hand before connecting. In principle, set the coordinate system (Orig *) so that the direction away from the robot origin is + Z. If it is reversed, the direction of connection will also be reversed.

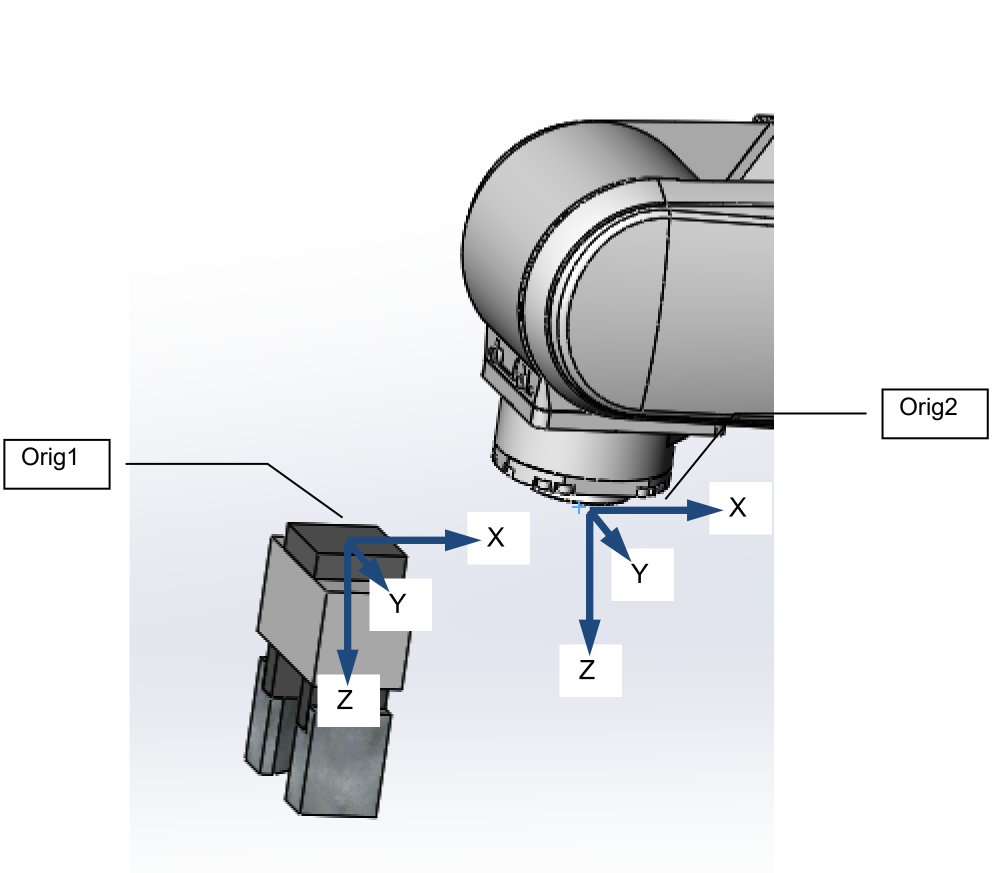


Fig. 4-2 Connect hand and robot

4.4.2 Connect ATC master and robot

It is connected to the robot so that the first origin (Orig1) set in the ATC master matches the orientation of Orig2 set in the robot flange. Before connecting, please set Orig1 to ATC master. In principle, set the coordinate system (Orig *) so that the direction away from the robot origin is + Z. If it is reversed, the direction of connection will also be reversed.

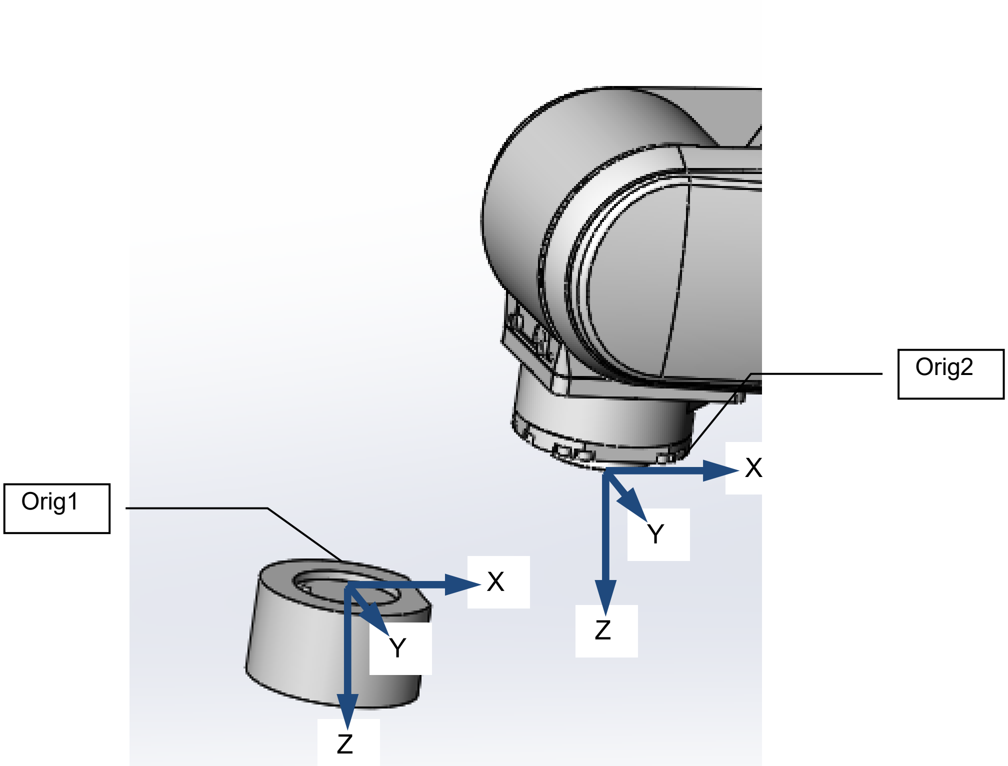


Fig. 4-3 Connect ATC master and robot

4.4.3 Connect ATC master and ATC tool

It is connected so that the second origin (Orig2) set in the ATC master matches the first origin (Orig1) set in the ATC tool. Before connecting the ATC tool, please connect the ATC master to the robot.

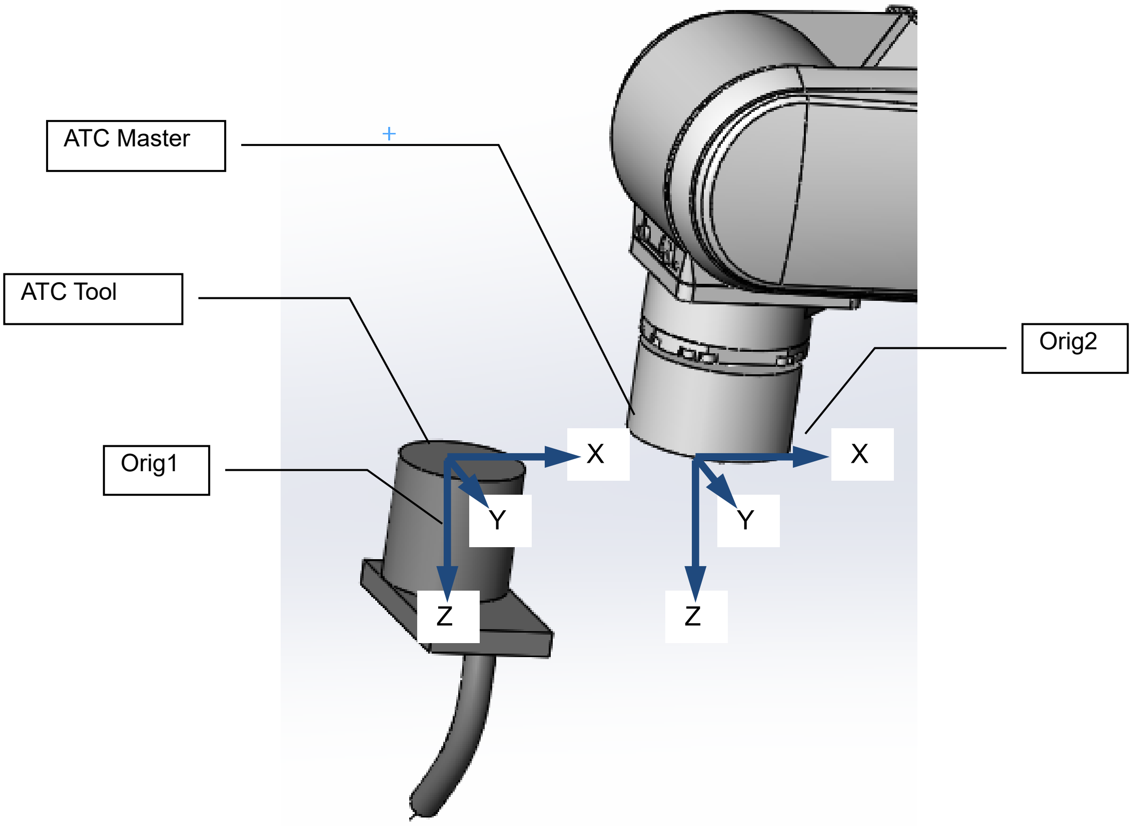


Fig. 4-4 Connect ATC master and ATC tool

4.4.4 Connect had and workpiece

It is connected so that the second origin (Pick 1 to Pick 8) set in the hand matches the orientation of Orig 1 set in the workpiece. As preparation, please connect the hand (gripping hand) for which Pick is set to the robot.

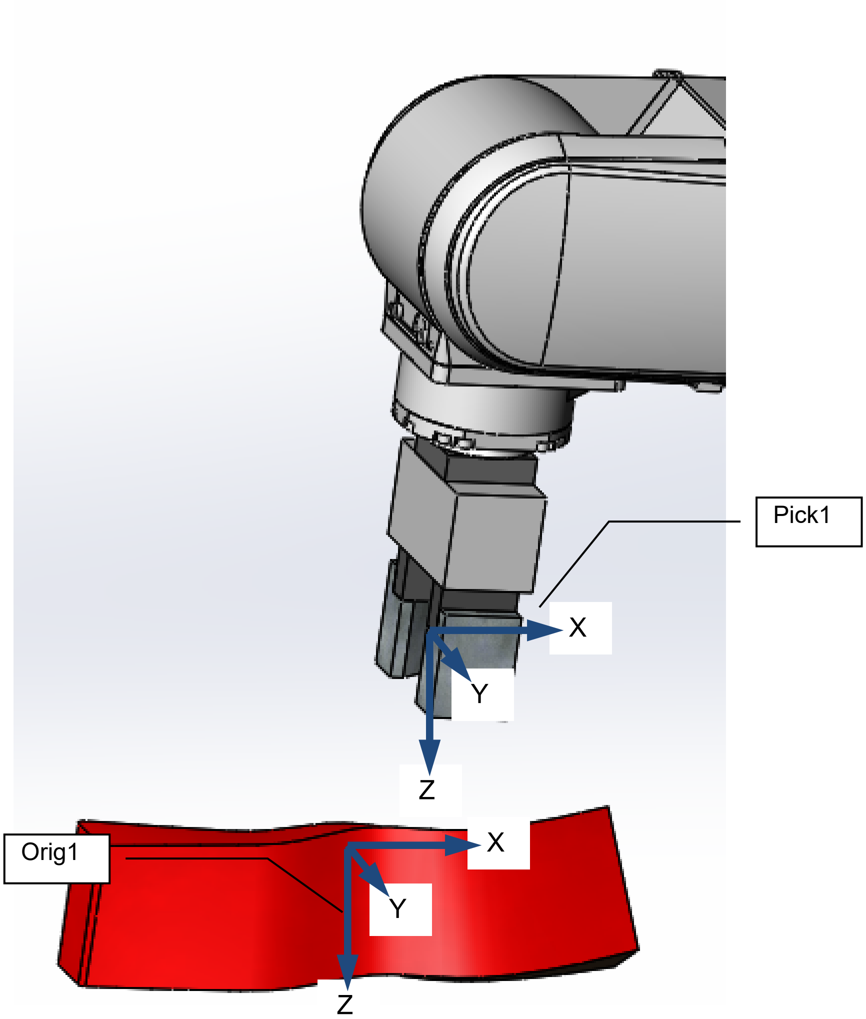


Fig. 4-5 Connect hand and workpiece

5. Starting and Closing

5.1. Starting MELFA-Works

5.1.1 In the case of RT ToolBox3 Pro 1.00A

① Start RT ToolBox3 and connect with the Simuration mode.
② Start SolidWorks. If you are already running, close all Windows on SolidWorks.
③ After starting SolidWorks, select [Start] from the [MELFA-Works] menu to start MELFA-Works.

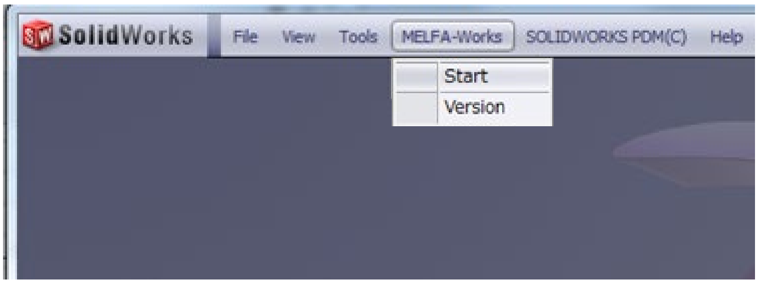
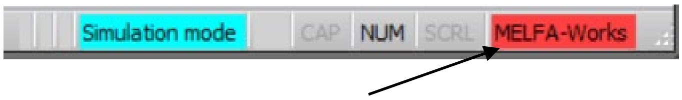


Fig. 5-1 Starting from MELFA-Works add-in menu

④ When you start MELFA-Works, MELFA-Works item is displayed in the status bar of RT ToolBox3 in the bottom right of the screen.



MELFA-Works is displayed in the status bar.

Fig. 5-2 Display of the status bar

⑤ When you found that the item of MELFA-Works in the status bar is visible, you double-click [Start] under [MELFA-Works] from project tree. Once read the robot on SolidWorks is a complete startup.

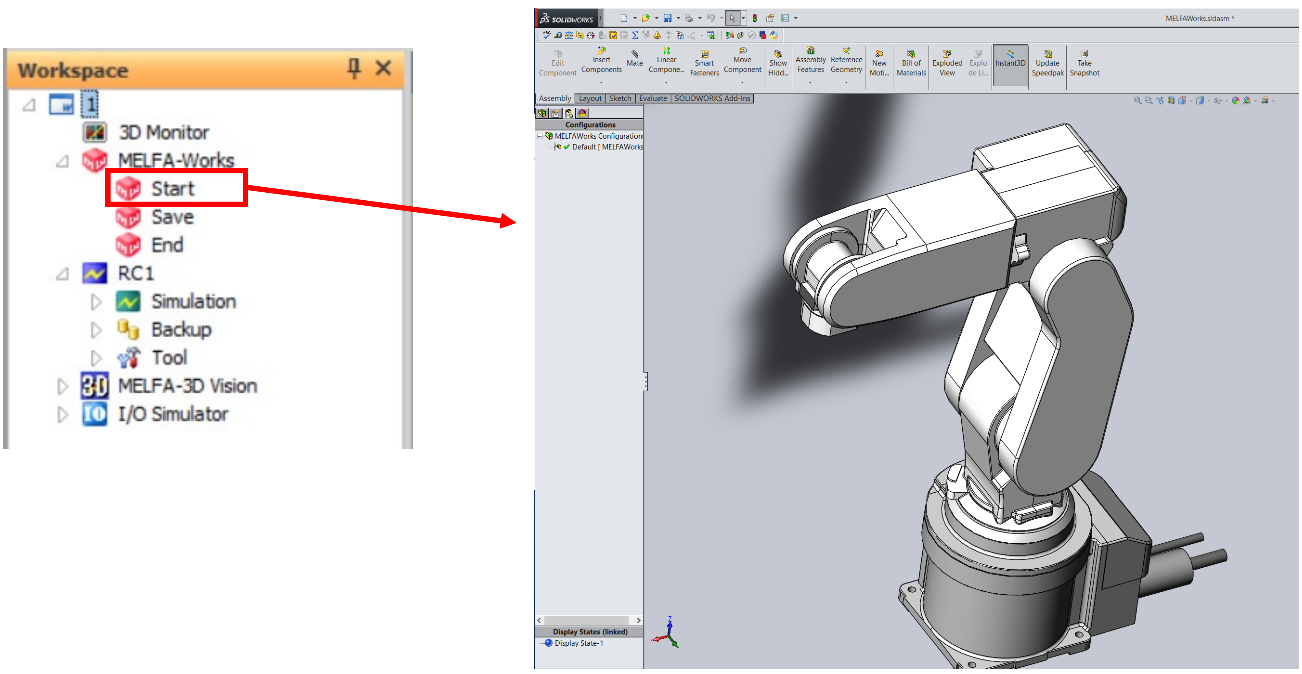


Fig. 5-3 Starting MELFA-Works

⚠ CAUTION

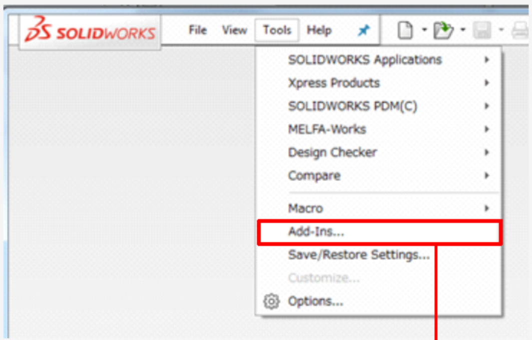
At starting, close all Windows on SolidWorks

If you open windows on SolidWorks, [MELFA-Works] is not displayed on the menu.

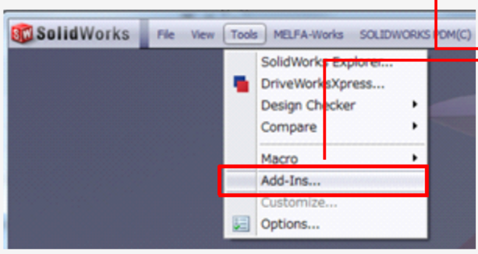
Tips

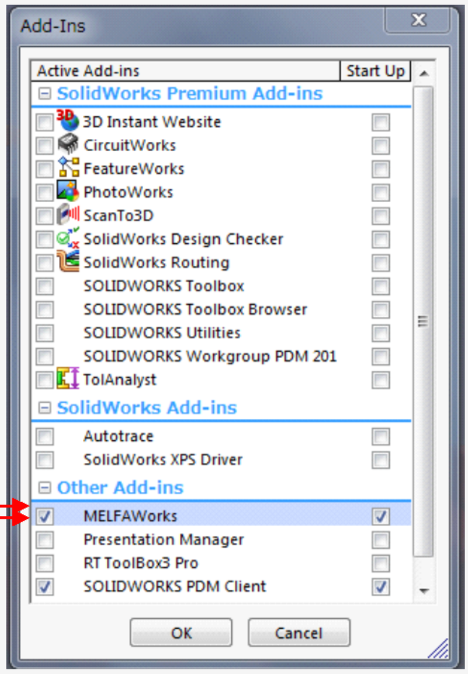
If "MELFA-Works" does not appear in SolidWorks menu after installation, please click "Add-ins" from SolidWorks' Tools menu and enable "MELFA - Works" from add - ins setting screen.

In the case of SolidWorks2017



In the case of SolidWorks2010





5.1.2 In the case of RT ToolBox3 Pro 1.01B or later

① Start RT ToolBox3 and connect with the Simuration mode.
② Start SolidWorks. If you are already running, close all Windows on SolidWorks.
③ After starting SolidWorks, select [Start] from the [RT ToolBox3 Pro] menu to start MELFA-Works.

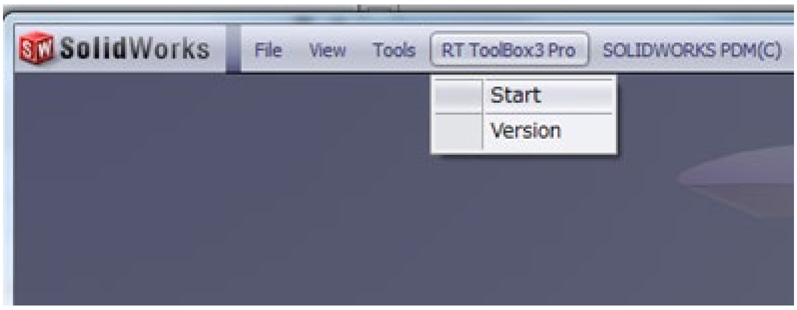
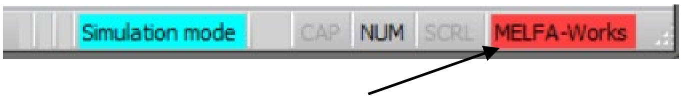


Fig. 5-4 Starting from MELFA-Works add-in menu

④ When you start MELFA-Works, MELFA-Works item is displayed in the status bar of RT ToolBox3 in the bottom right of the screen.



MELFA-Works is displayed in the status bar.

Fig. 5-5 Display of the status bar

⑤ When you found that the item of MELFA-Works in the status bar is visible, you double-click [Start] under [MELFA-Works] from project tree. Once read the robot on SolidWorks is a complete startup.

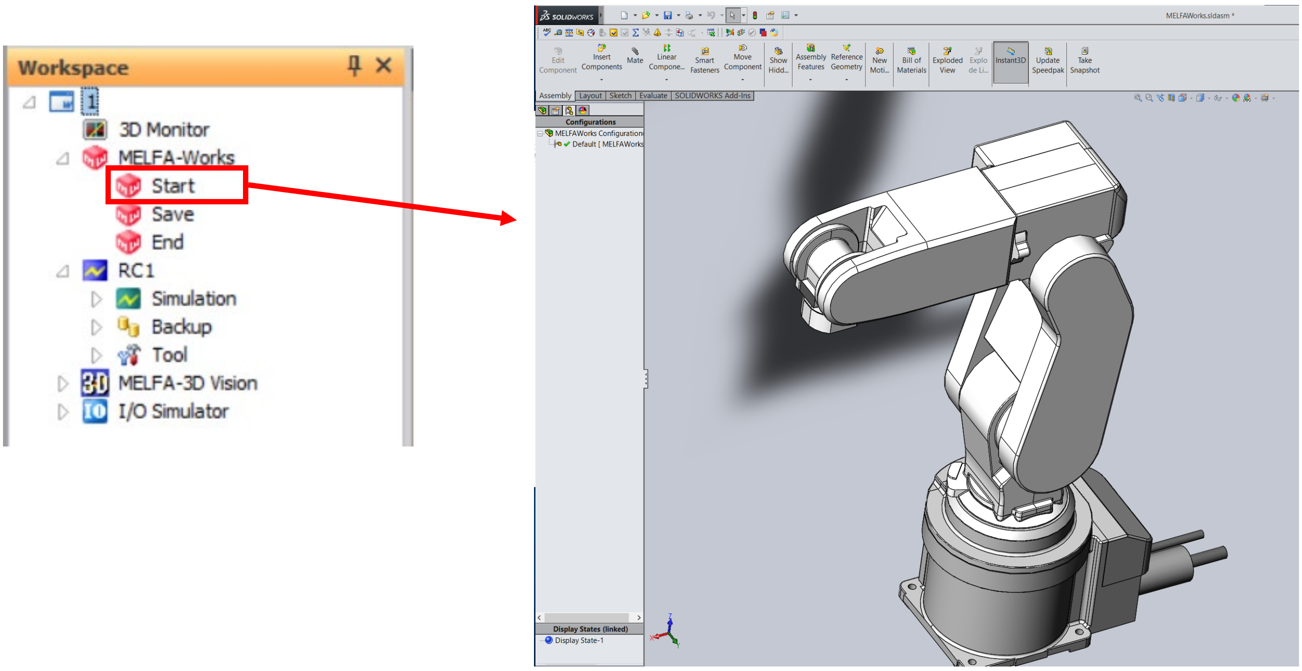


Fig. 5-6 Starting MELFA-Works

⚠ CAUTION

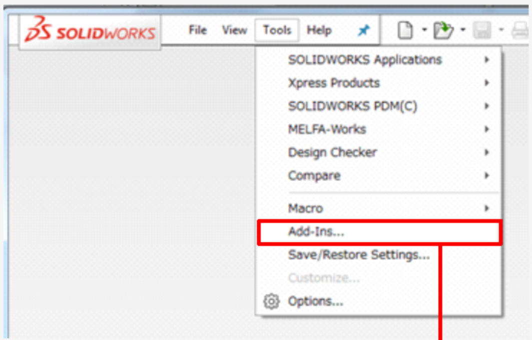
At starting, close all Windows on SolidWorks

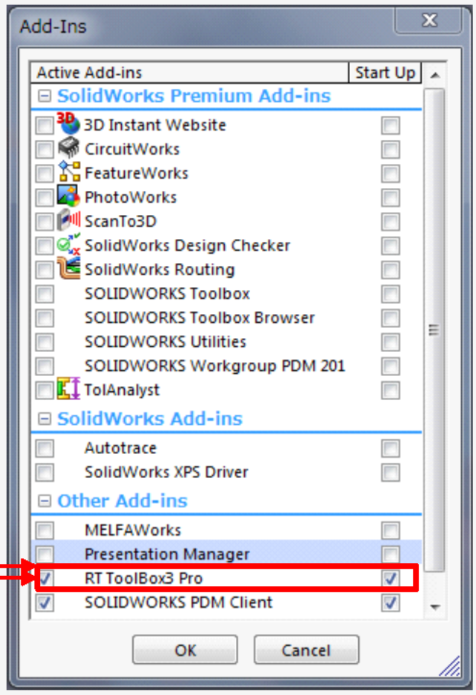
If you open windows on SolidWorks, [RT ToolBox3 Pro] is not displayed on the menu.

Tips

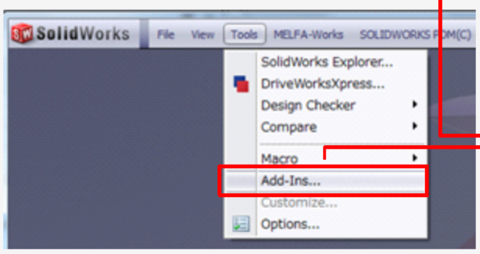
If "RT ToolBox3 Pro" does not appear in SolidWorks menu after installation, please click "Add-ins" from SolidWorks' Tools menu and enable " RT ToolBox3 Pro " from add - ins setting screen.

In the case of SolidWorks2017





In the case of SolidWorks2010



5.1.2.1 When conventional MELFA-Works is installed

*RT ToolBox 3 Pro and conventional MELFA-Works can not be started at the same time. When using RT ToolBox 3 Pro, disable traditional MELFA-Works, and disable RT ToolBox 3 Pro when using conventional MELFA-Works.

Table 5-1 Enable / disable of add-ins menu

	MELFA-Works	RT ToolBox3 Pro
Use conventional MELFA-Works	Set enable	Set disable
Use RT ToolBox3 Pro	Set disable	Set enable

• When you use conventional MELFA-Works

→Please click "Add-ins" from the SolidWorks Tools menu, enable "MELFA - Works" from the add - ins setting screen, and disable "RT ToolBox 3 Pro".

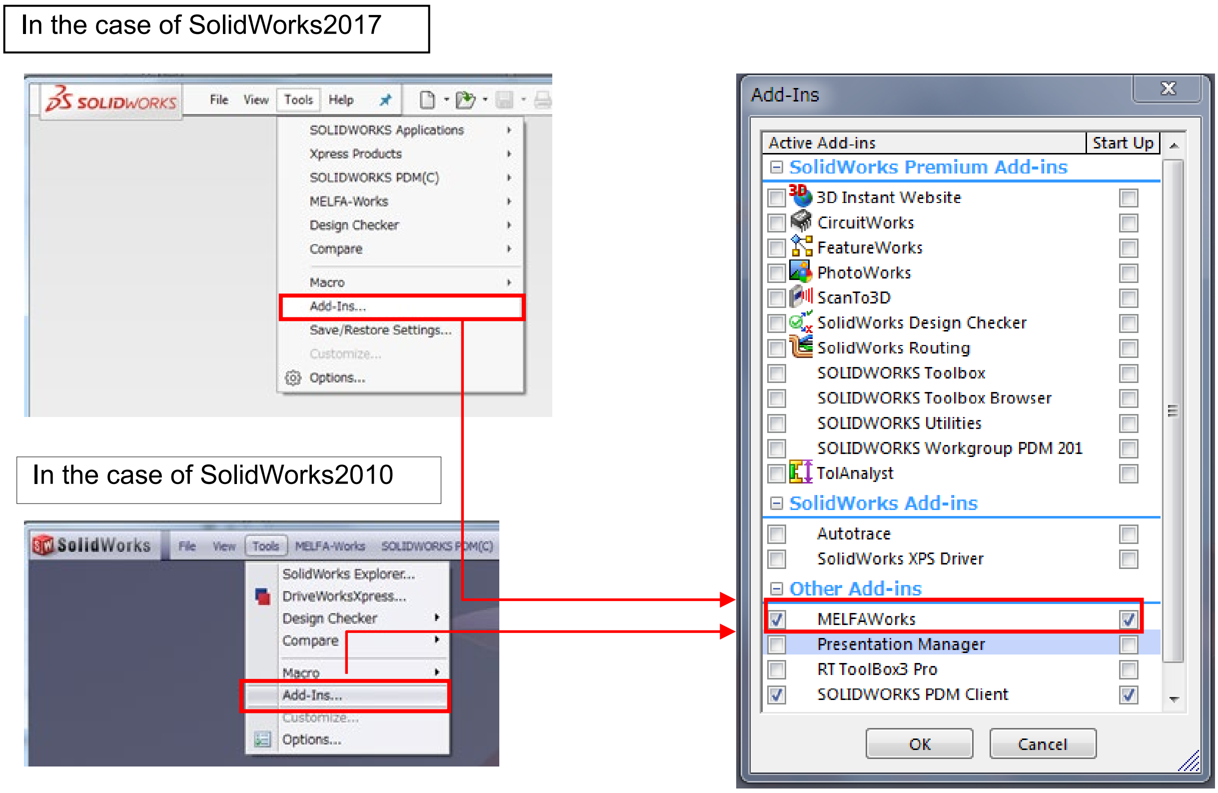


Fig. 5-7 Setting of conventional MELFA-Works Add-ins menu.

• When you use RT ToolBox3 Pro

→Please click "Add-ins" from the SolidWorks Tools menu, enable " RT ToolBox 3 Pro " from the add - ins setting screen, and disable " MELFA - Works ".

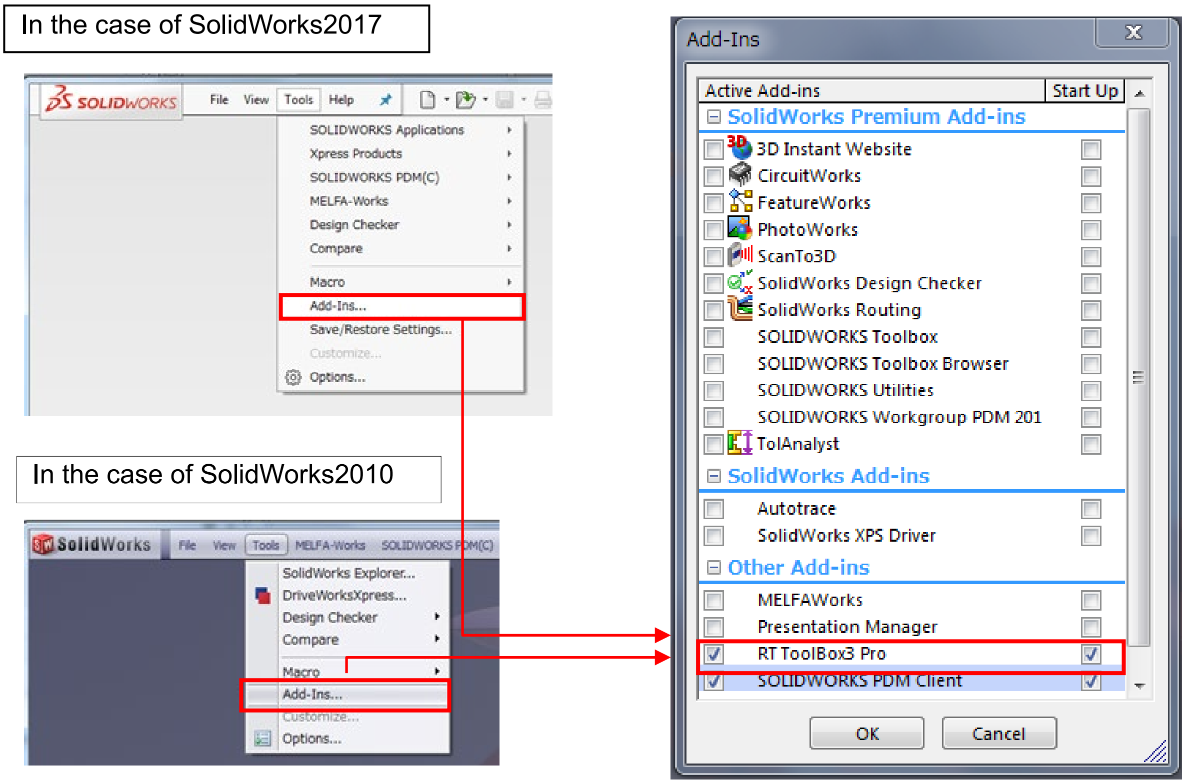
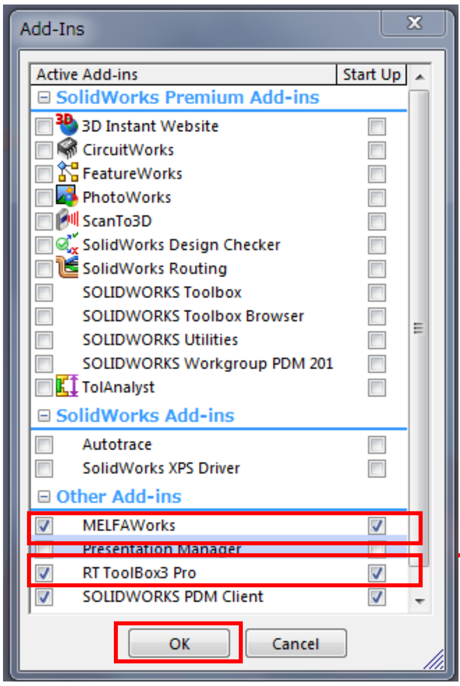


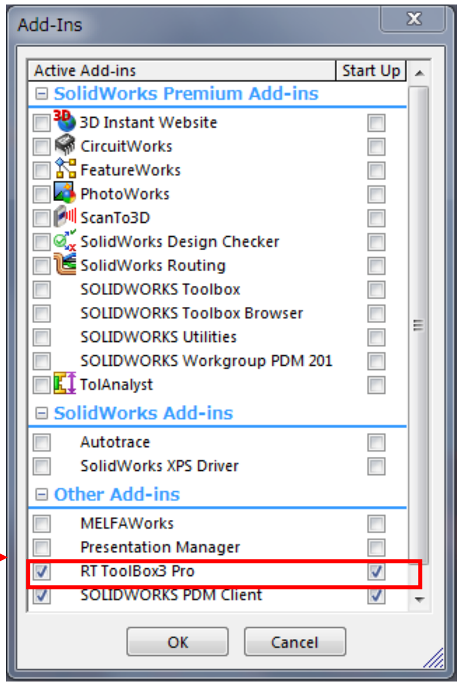
Fig. 5-8 Setting of conventional RT ToolBox3 Pro Add-ins menu.

⚠ CAUTION

When RT ToolBox 3 Pro is enabled, conventional MELFA-Works is automatically disabled.

If the RT Toolbox 3 Pro item is enabled on the add-ins setting screen, the item of MELFA-Works is automatically disabled when you click OK. When you use conventional MELFA-Works, please disable RT ToolBox 3 Pro item.

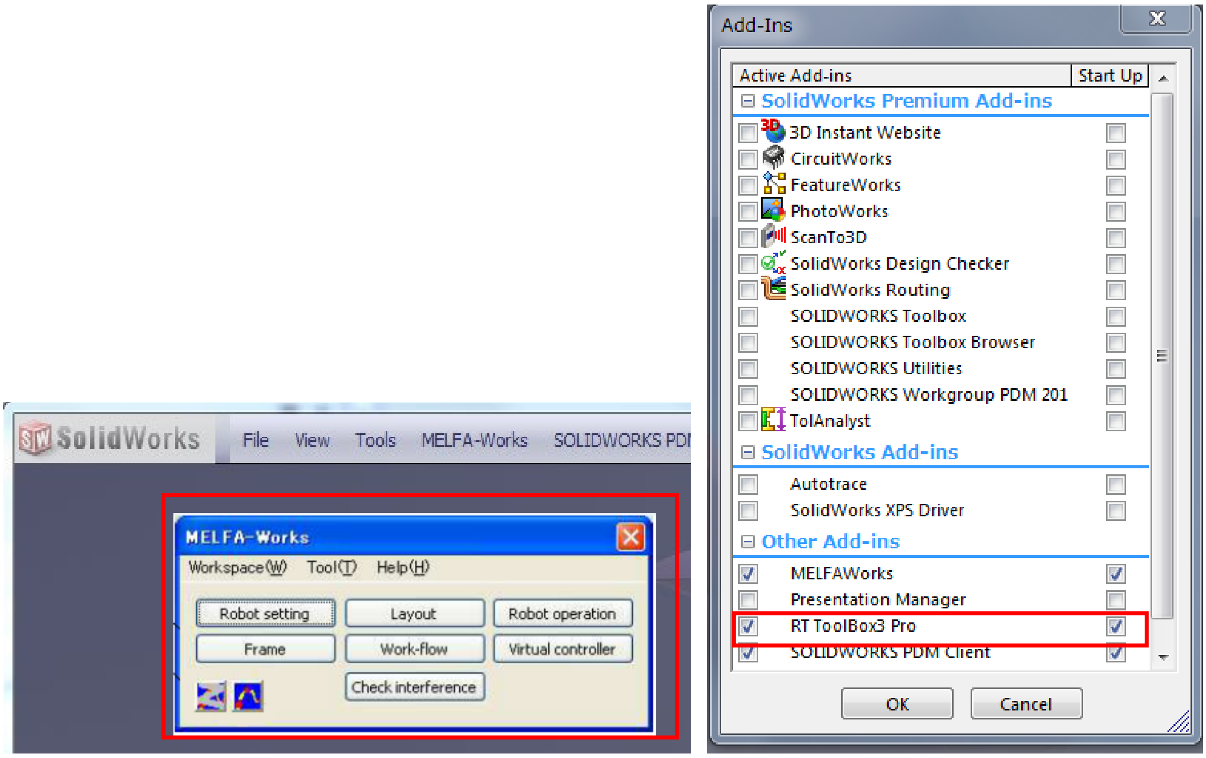


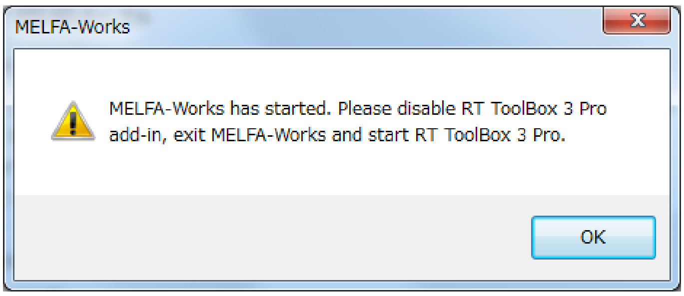


⚠ CAUTION

A warning message will be displayed if RT ToolBox3 Pro is enabled while the conventional MELFA-Works is running.

With the conventional MELFA-Works screen activated, if you enable the RT Toolbox 3 Pro item on the add-ins setting screen, the following warning screen will be displayed. When the conventional MELFA-Works is running, please exit MELFA-Works and start RT ToolBox 3 Pro.





5.2. Closing MELFA-Works

When you close MELFA-Works, you double-click [End] under [MELFA-Works] from project tree. Data of workspace will be stored and closing MELFA-Works.

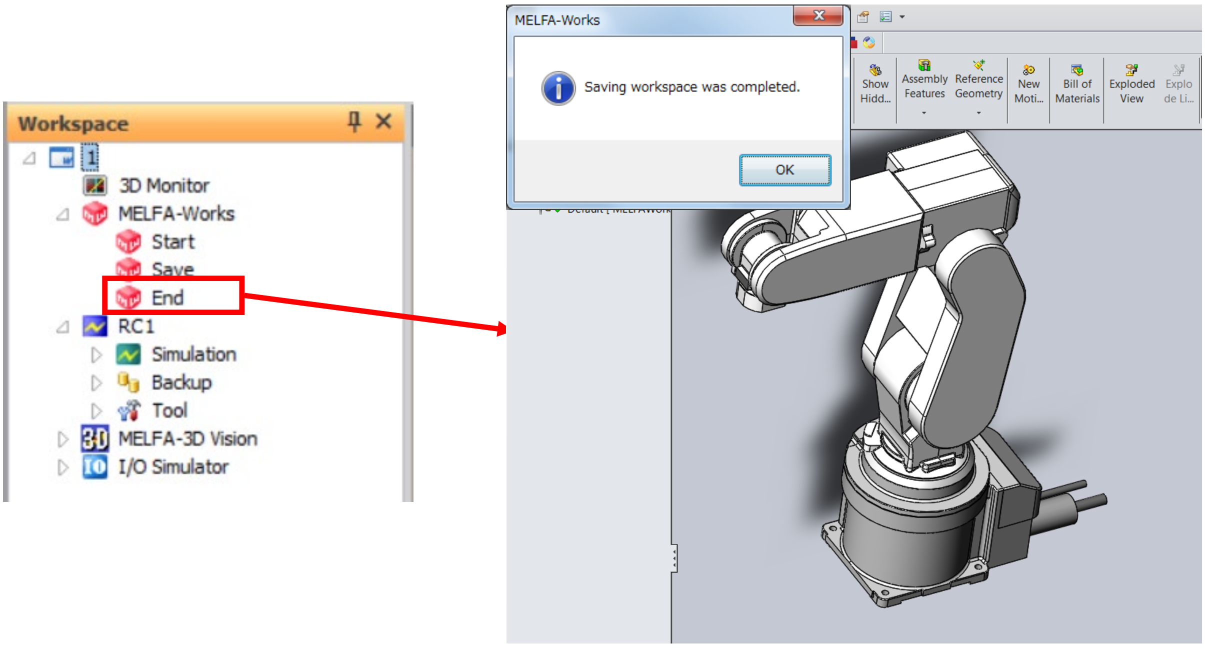


Fig. 5-9 Closing MELFA-Works

5.3. Ribbon menu

MELFA-Works ribbon menu is structured as follows. You can perform path, hand, ATC, click move, moving robot/component, making frame, making work flow and interference check setting from each menu.

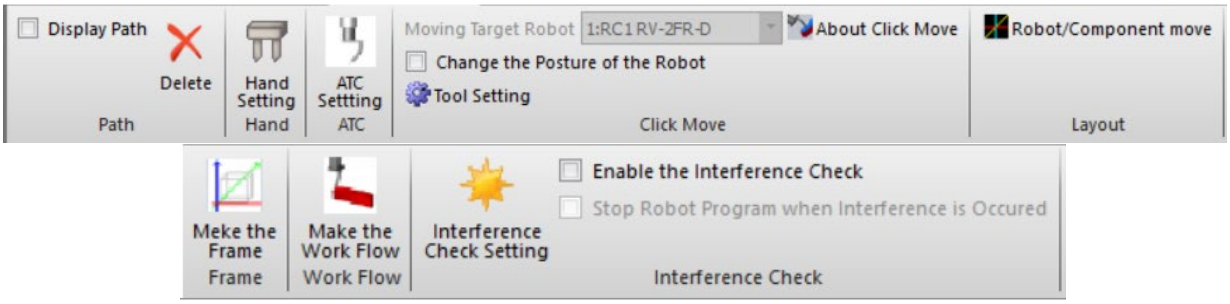


Fig. 5-10 Main Window

Table 5-1 Operations Provided by the Main Window

Item	Explanation
Path	You can switch show/hide path and delete path.
Hand	You can set hand (connection and signal setting).
ATC	You can set ATC (connection and signal setting).
Click Move	You can set click move and tool.
Layout	You can change the position of robots and components.
Frame	You can make frame data.
Work Flow	You can edit path, flow, teaching points of robot.
Interference Check	You can check for interference of robot, hand, tool and work.

6. Hand

In MELFA-Works, you can connect hands and ATC to the robot. Parts that can be used as a hand or ATC have some rules. Refer to “Chapter 4 Creation of Parts” for further details.

Hand and ATC settings is executed in hand setting screen and ATC setting screen.
Hand setting screen is started the [MELFA-Works] tab of the ribbon -> [Hand] group -> [Hand Setting] button.
ATC setting screen is started the [MELFA-Works] tab of the ribbon -> [ATC] group -> [ATC Setting] button.

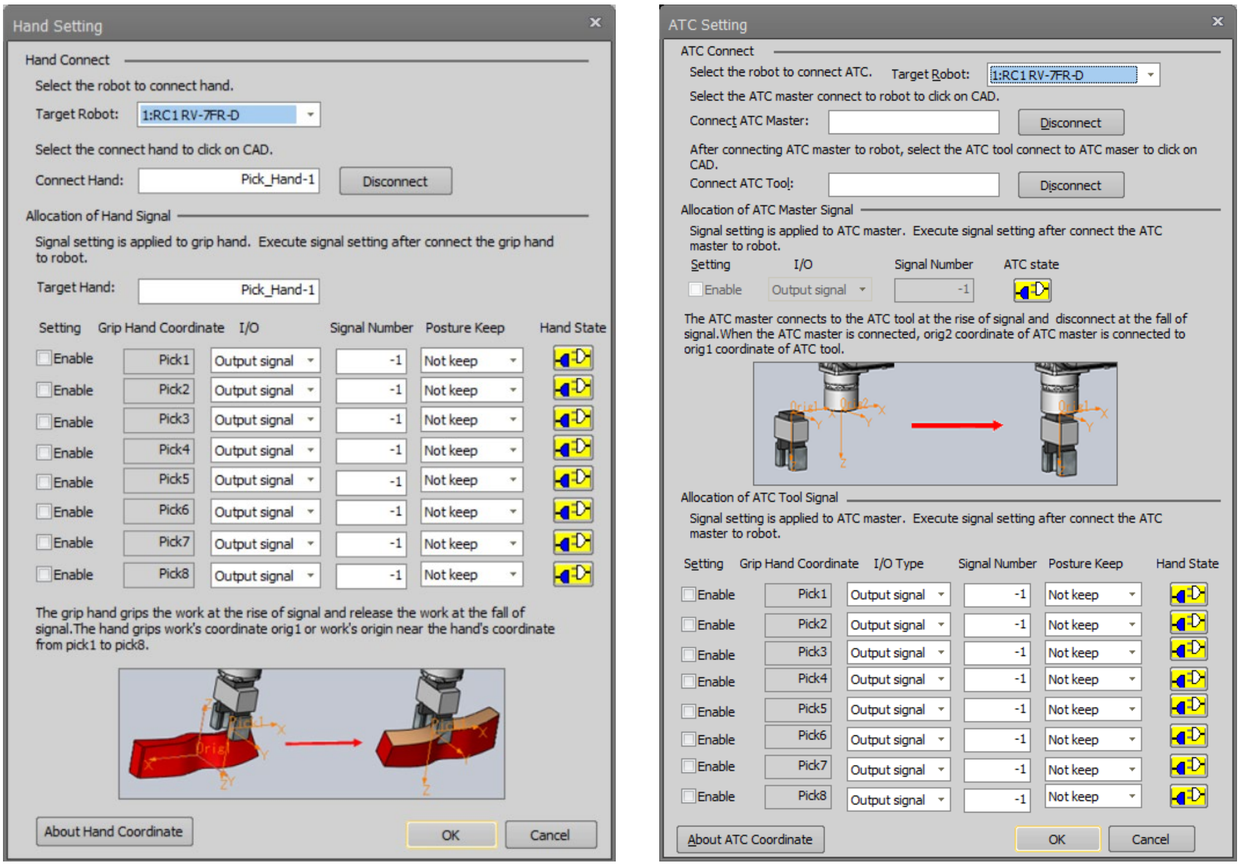


Fig. 6-1 Hand/ATC setting screen

6.1. Connection of the hand

How to set connection of the hand has following three types. First, you drag and drop hands to connect and load them into SolidWorks screen.

※ When you connect the hand, hand that was already connected is disconnected.

※ If the hand is connected to the other robots to connect to other robots, hand is disconnected from the original robot.

Method 1: When you select [connection hand] field in hand setting screen, click hand parts.

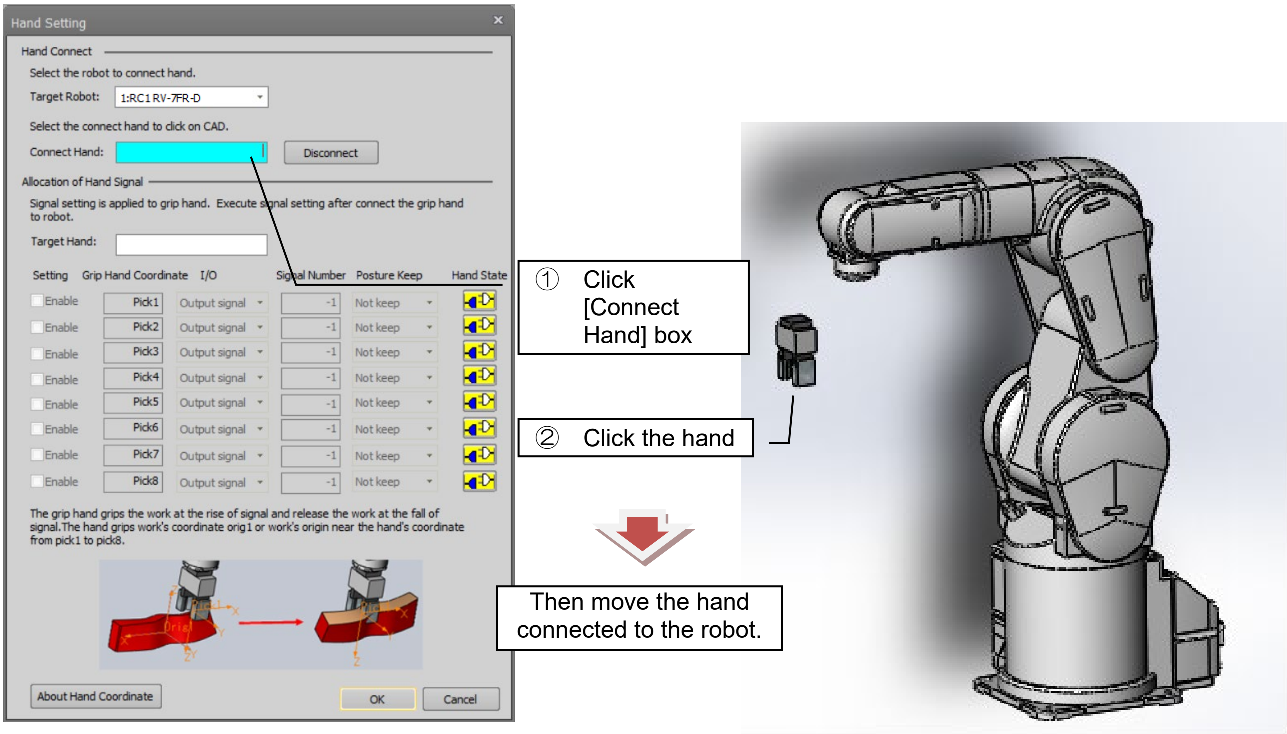


Fig. 6-2 Connection of the hand 1

Method 2: Drag and drop the hand into the robot on MELFA-Works tree.

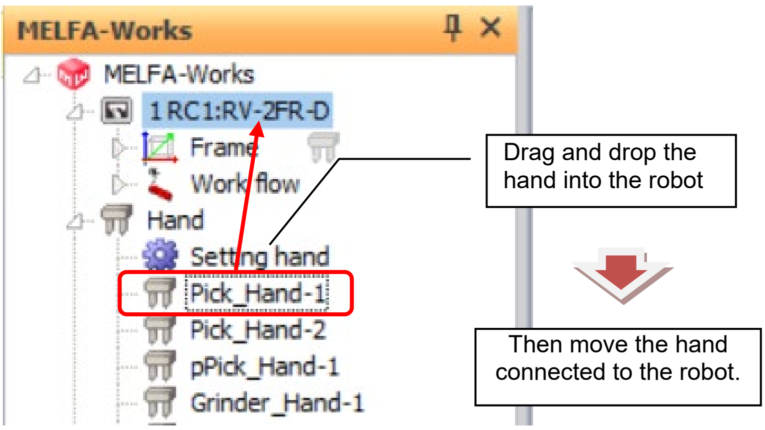


Fig. 6-3 Connection of the hand 2

Method 3: Select the robot to connect on hand property.

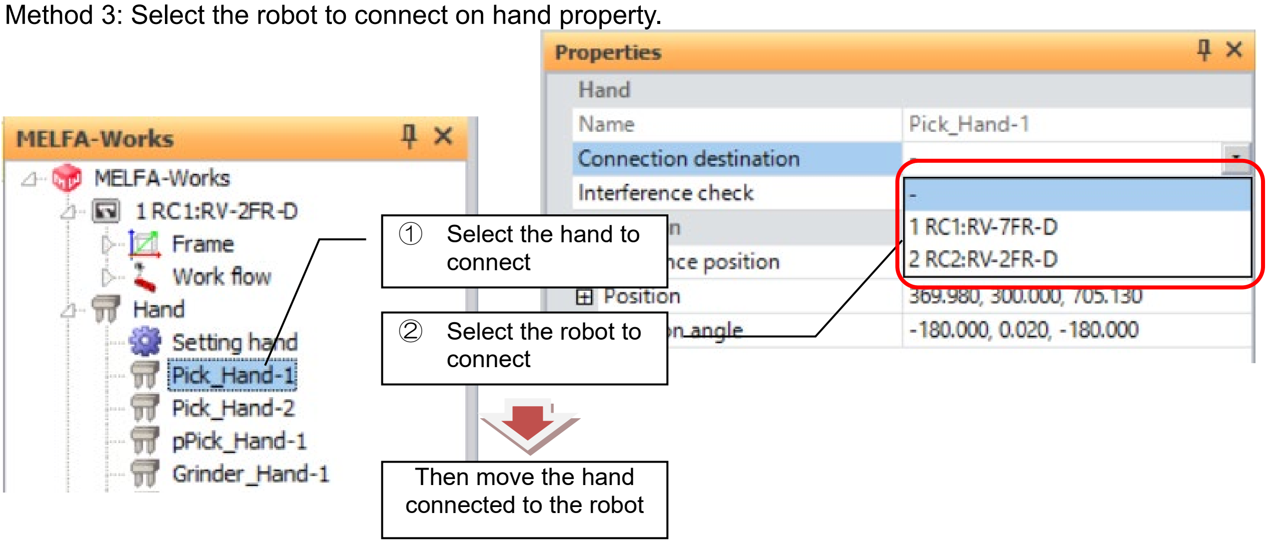


Fig. 6-4 Connection of the hand 3

6.2. Disconnection of the hand

How to set disconnection of the hand has following three types.

Method 1: You click [Disconnect] button on hand setting screen.

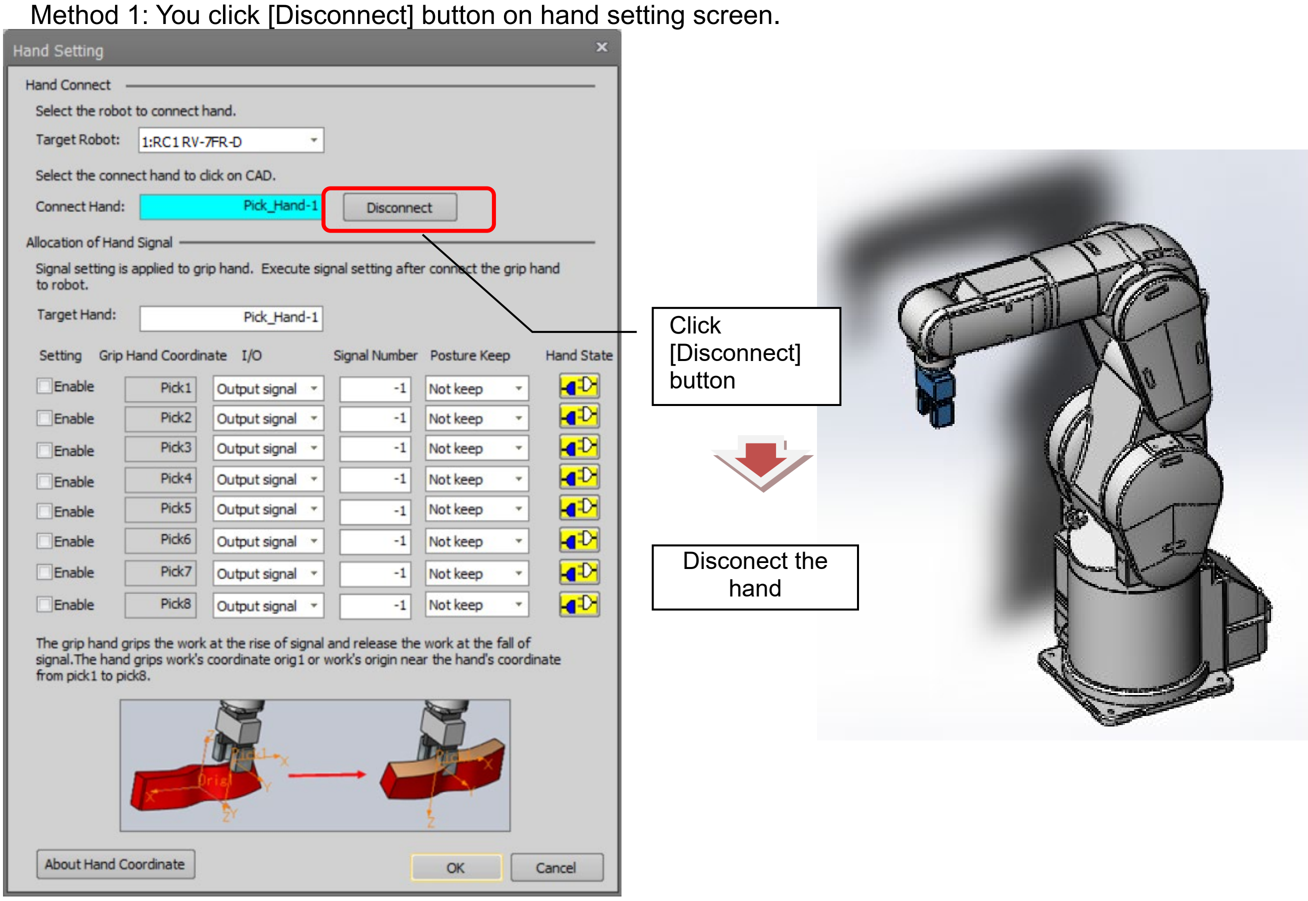


Fig. 6-5 Disconnection of the hand 1

Method 2: Drag and drop the hand on MELFA-Works tree.

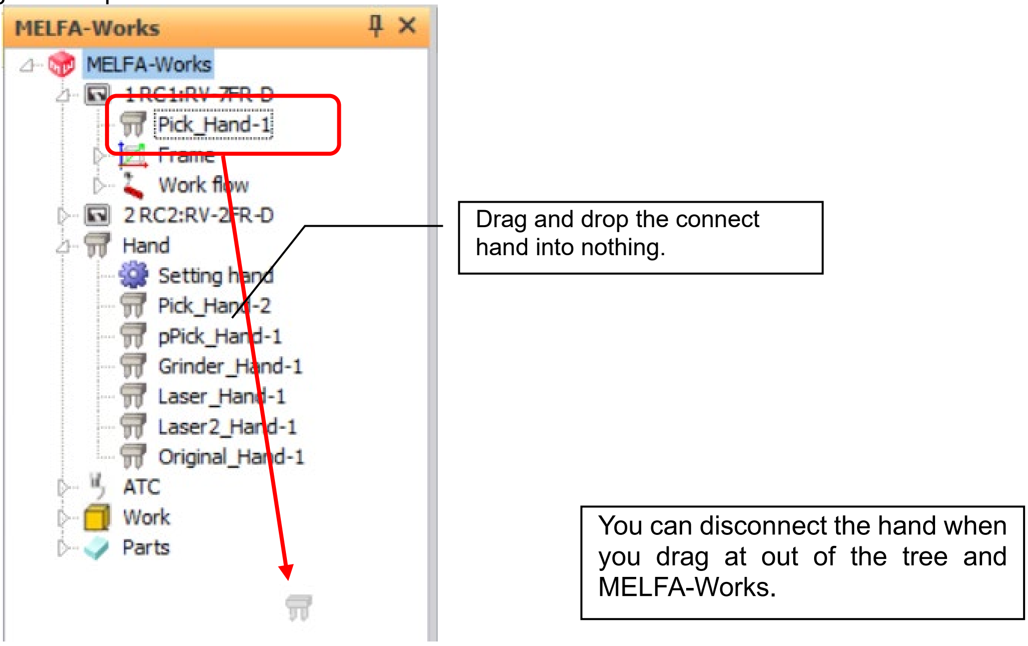


Fig. 6-6 Disconnection of the hand 2

Method 3: Change connection destination on hand property.

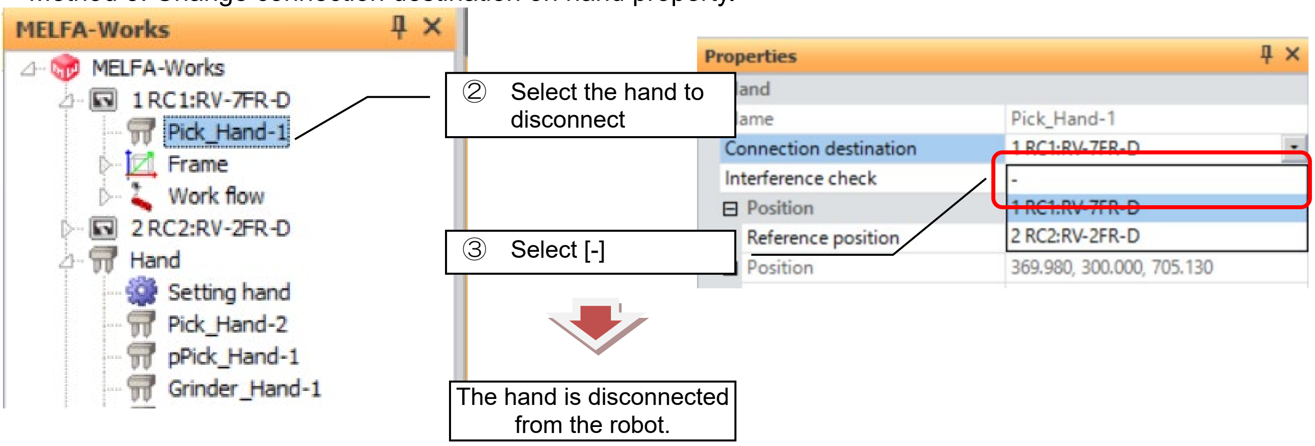


Fig. 6-7 Disconnection of the hand 3

6.3. Connection/Disconnection of ATC

How to set up connection/disconnection setting of ATC master / tool is similar to the hand, please see “6.1. Connection of the hand” and “6.2. Disconnection of the hand”.

However, you can not connect the ATC tool unless the ATC master is connected. Also, if you disconnect the ATC master with ATC tool connected, the ATC tool will also be disconnected

6.4. Set of hand I/O signals

When you simulate the robot program, you can also simulate hand operation, connecting/disconnecting of ATC, holding/releasing of the work in MELFA-Works. You can control these operation by the signal. You can associate hand operation with signals in hand setting screen and ATC setting screen.

When you place the hand signal, the corresponding coordinate pic1-pic8 requires holding hand.
When you place the ATC signal, the coordinate Orig2 requires ATC master. Also, if the coordinate system Pick 1 - Pick 8 is set in the ATC tool, it is possible to grip the workpiece by signal assignment like a hand.
For more information see “Chapter 4 Creation of Parts”.

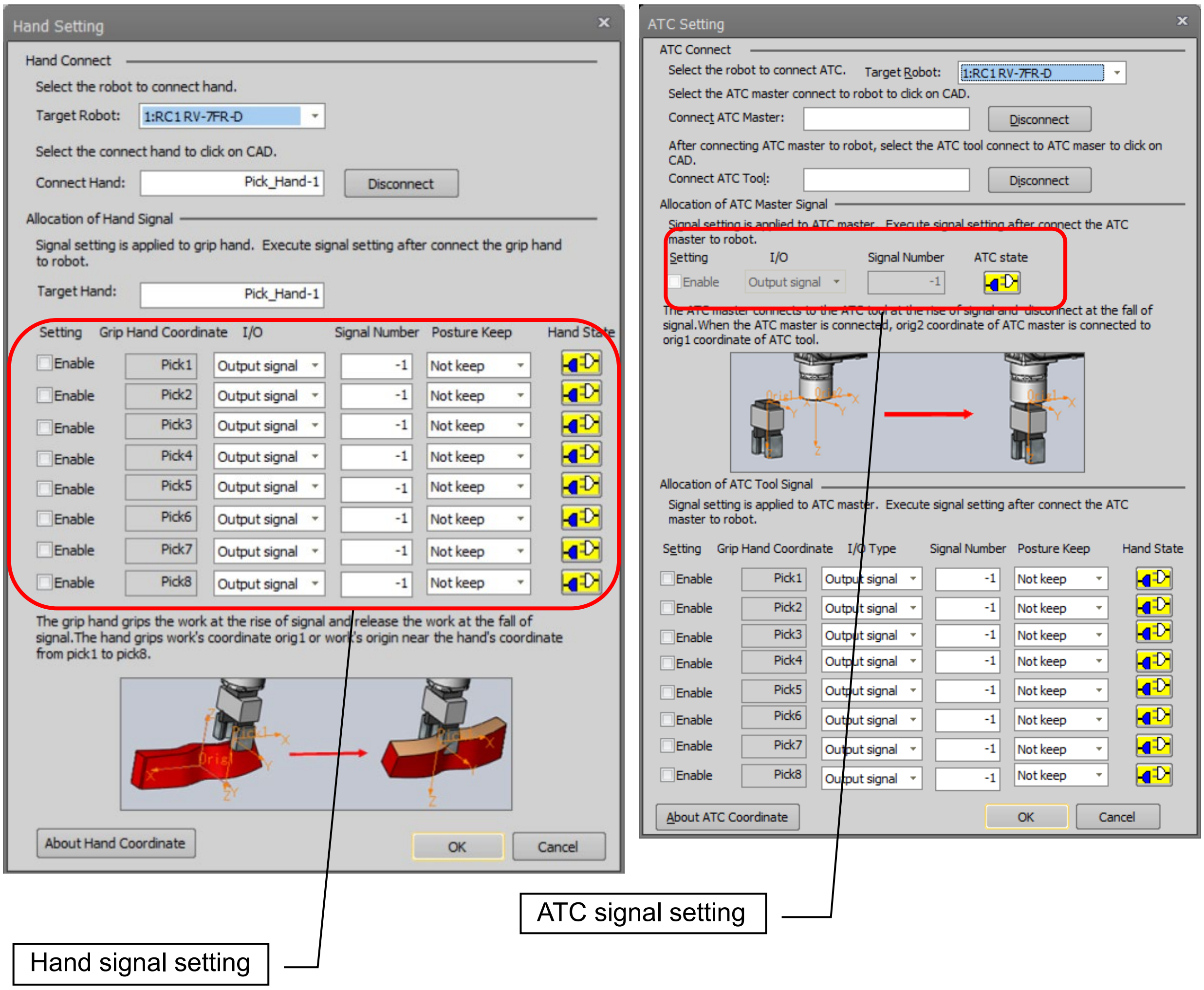
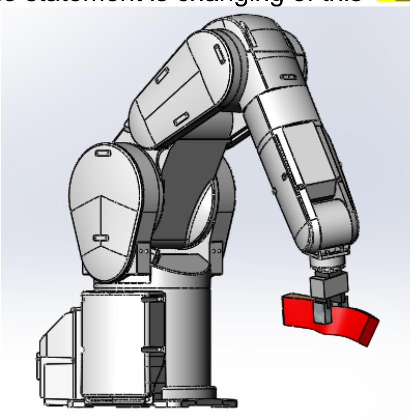


Fig. 6-8 Hand/ATC setting screen

Table 6-1 Operations screen detail

Item	Explanation
Signal Number	You can set robot signal number placing hand and ATC signals. When you set “-1”, you do not set anything. When you create the robot program to output setting signals, you can control connecting/disconnecting of ATC, holding/releasing of the work in simulating. [ATC setting screen]: Connecting signals of ATC master and ATC tool Connecting signals of ATC tool and work [Hand setting screen]：Connecting signals of holding hand and work ※Connecting/holding on rising edge, disconnecting/releasing on falling edge.
I/O Type	You select input/output signals of the robot. Input signal: You can simulate signal by inputting to the robot, i.e. M_IN(n) changes. Equivalent if the external equipment (the PLC such as) controls the robot. Output signal：You can simulate signal by outputting to the robot, i.e. M_OUT(n) changes. Equivalent if the robot program controls the robot.
Hand State /	You simulate hand state. : The hand is in the hold state. When you click this statement, simulate releasing hand. : The hand is in the release state. When you click this statement, simulate holding hand. In holding hand, the robot hold the work (**Orig1 or origin**) in the vicinity (less than 200mm) of holding hand (**Pick***). When holding was successful, the statement is changing of this .  When you connect ATC tool, install the ATC tool (**Orig1**) located in the vicinity (less than 200mm) of ATC master (**Orig2**). ※If the signal number is not setting, does not simulate connecting or disconnecting.
Posture Keep	You can specify whether or not to hold a posture when holding work. If you hold: It keeps the positional relation between hand and work when holding work. If you do not hold: When grasping, grasp the Pick * of the hand and the coordinate system Orig1 of the work by matching them. It is possible to take a certain grasping posture not limited to the grasping position.

7. Layout

7.1. Robot/Component Move

With MELFA-Works, it is possible to use the Robot/Component Move dialog to specify positions of robots and peripheral devices such as travel bases relative to the CAD software origin as well as robot origin, component origin and arbitrary coordinate systems.

The standard position can be selected from the following 4 types.

The standard position	Explanation
CAD origin	Move the robot or part with the origin set on the CAD as the reference position.
Robot origin	Move the part or robot based on the origin position of the robot. Select the reference robot from the combo box and move the part or robot.
Component origin	Move the robot or part based on the parts specified by clicking on Solidworks.
Optional coordinate	Move the robot or part with reference to the coordinate system specified by clicking on SolidWorks.

Robot/Component move are achieved by the following procedure.

① Robot/Conponent move screen is started from the [MELFA-Works] tab of the ribbon -> [Layout] group -> [Robot/Component Move] button.
② You switch from [Robot move]/[Component move] tab.
③ Select the robot to move from the [Target Robot] combo box. If you click on a part in SolidWorks with the [Target Component] edit box selected, the name of the selected part is set in the [Target Component] edit box.
④ When selecting a reference position other than the CAD origin point, select the reference target (robot, part, coordinate system).
⑤ When you click [Move to Standard Position] button, the robot/component move to the standard position.
⑥ Operate the operation area to adjust the position of the robot / part.

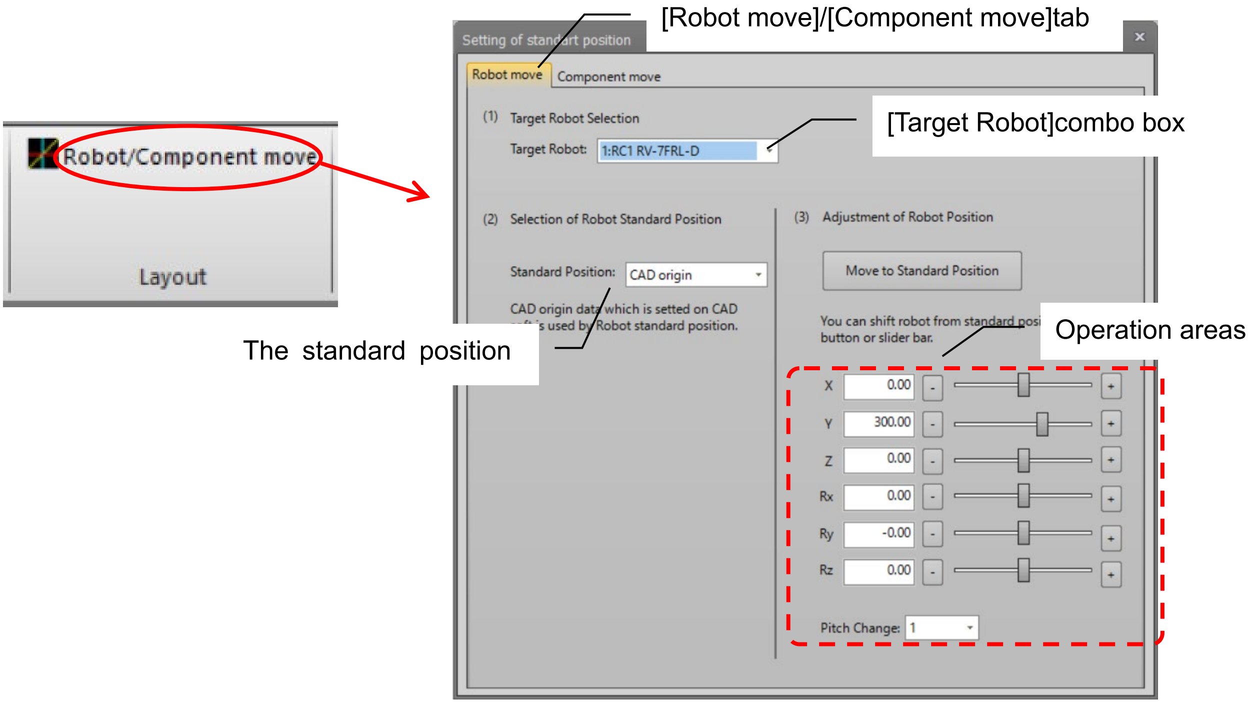


Fig. 7-1 **Robot/Component Move screen**

Tips

After loading peripheral devices, let's place a robot.

It is possible to work efficiently by create the coordinate system on the peripheral devices beforehand, and place the robot in the coordinate system. SolidWorks functions can also be used for layout of products not controlled by MELFA-Works such as hands not connected to robots or peripheral devices.

7.1.1 When placing a robot in the coordinate system on the peripheral device

To place the robot in the coordinate system on the peripheral device, follow the procedure below.

① Operate SolidWorks menu and put the coordinate system in display state.

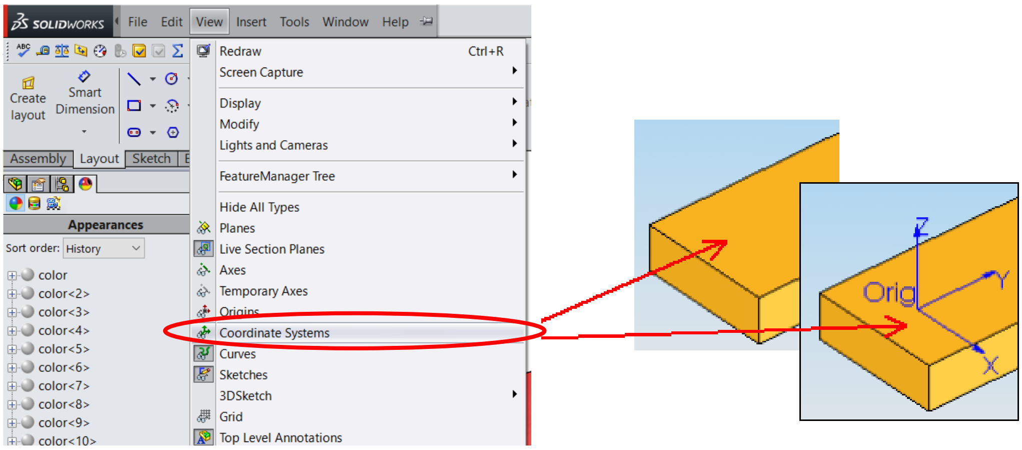


Fig. 7-2 Coordinate System Display

② You execute steps ① through ⑥ of 7. Robot/Components move.

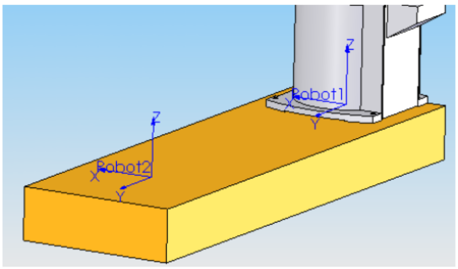
③ Finally, hide the coordinate system again to operate the menus of SolidWorks.

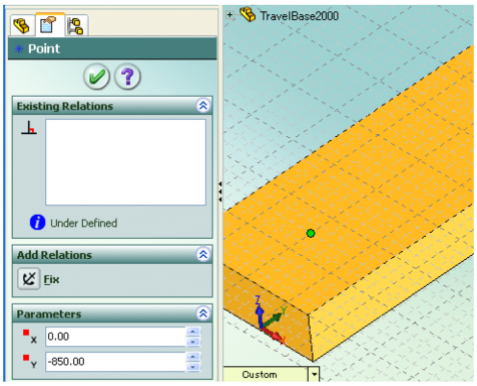
Tips

To place a robot on a peripheral device, create a coordinate system for the peripheral device in advance.

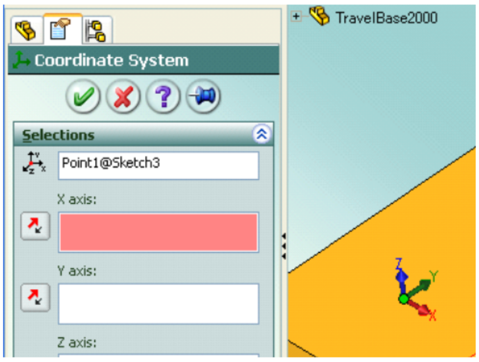
To place a robot on a peripheral device, create a coordinate system at the layout position.

Here is an example for forming coordinates using SolidWorks.



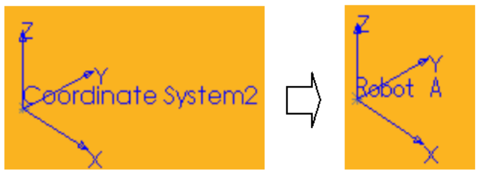


① Open the product file where you want to embed coordinates, and set "Insert sketch" on the surface where you want to embed the coordinates. Add "points" to the sketch, and set the desired coordinates.



②Select the "Coordinate System" from "Reference Geometry" and set the point formed in ①. Set the direction if needed.

③Change the coordinate system name.



7.2. Robot/Parts position save

It is possible to save the position of the robot and peripheral devices such as hands and workpieces. By putting back the saved position data, it is possible to reproduce the arrangement of the robot and peripheral devices.

7.2.1 Save

If you click [Layout] → [Robot / Parts position save] on the ribbon menu of MELFA -Works, the input screen of save name opens. When you enter the save name, the current robot and part position are saved.

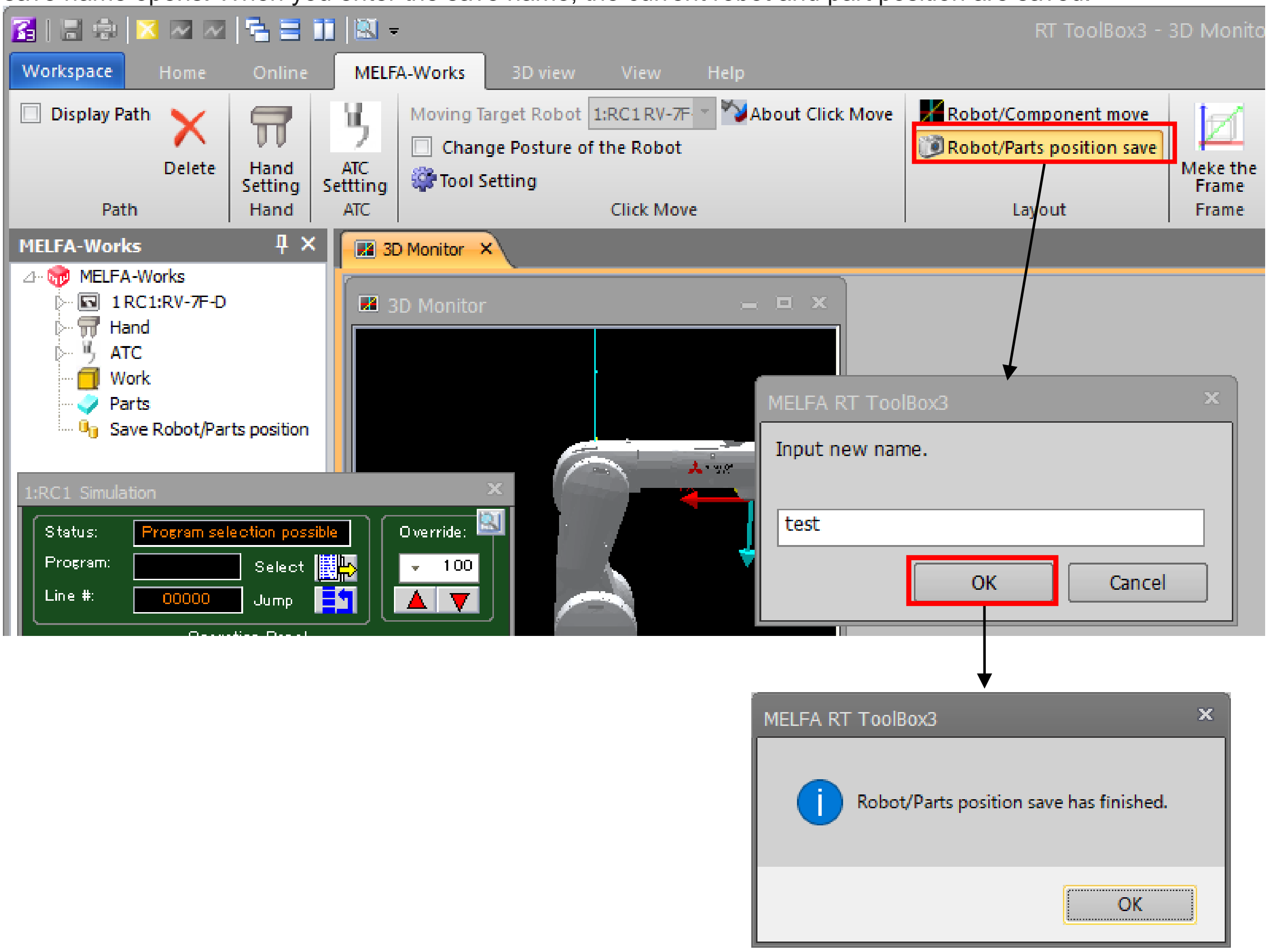


Fig. 7-3 Robot/Parts position save from ribbon menu.

You can also save the robot and parts position from [Save] displayed when right clicking on Save Robot / Parts position item of MELFA-Works tree.

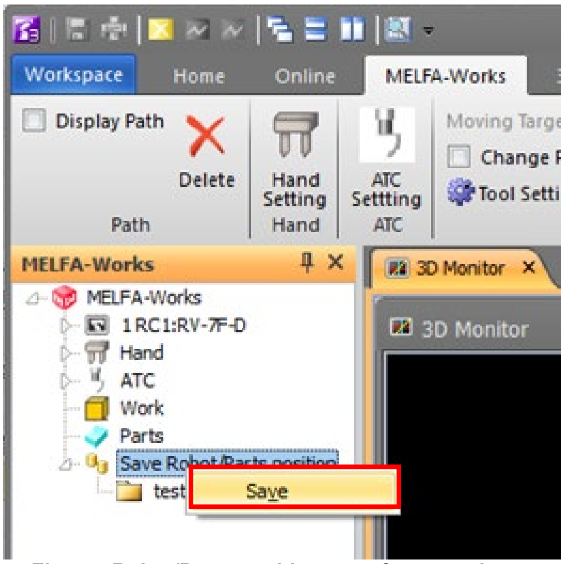


Fig. 7-4 Robot/Parts position save from tree item.

The saved position data is displayed under the Save Robot / Parts position of the MELFA-Works tree.

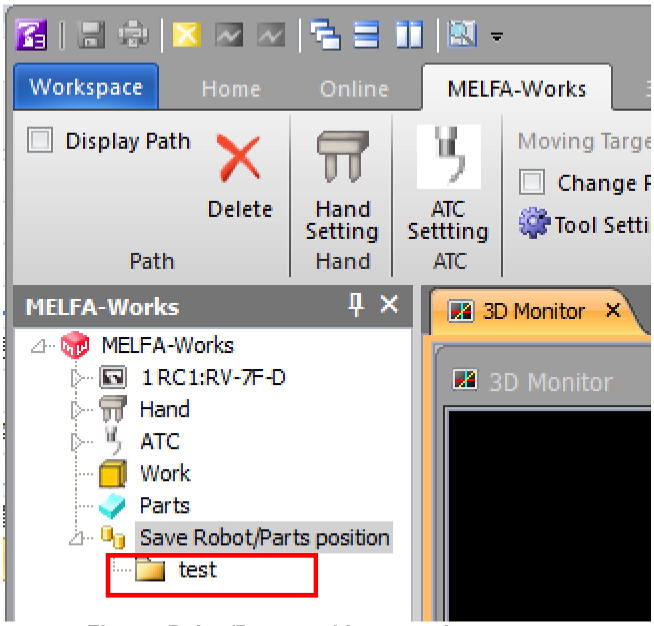


Fig. 7-5 Robot/Parts position save data on tree.

7.2.2 Put back

To put back saved position data, right click on the Robot / Parts position saved data of the tree and select [Put back]. When executed, the saved data will be put backed and a confirmation message will be displayed. Please check the position data of robot and parts and click [Yes] if it is OK. To return to the position data before the put back, click [No].

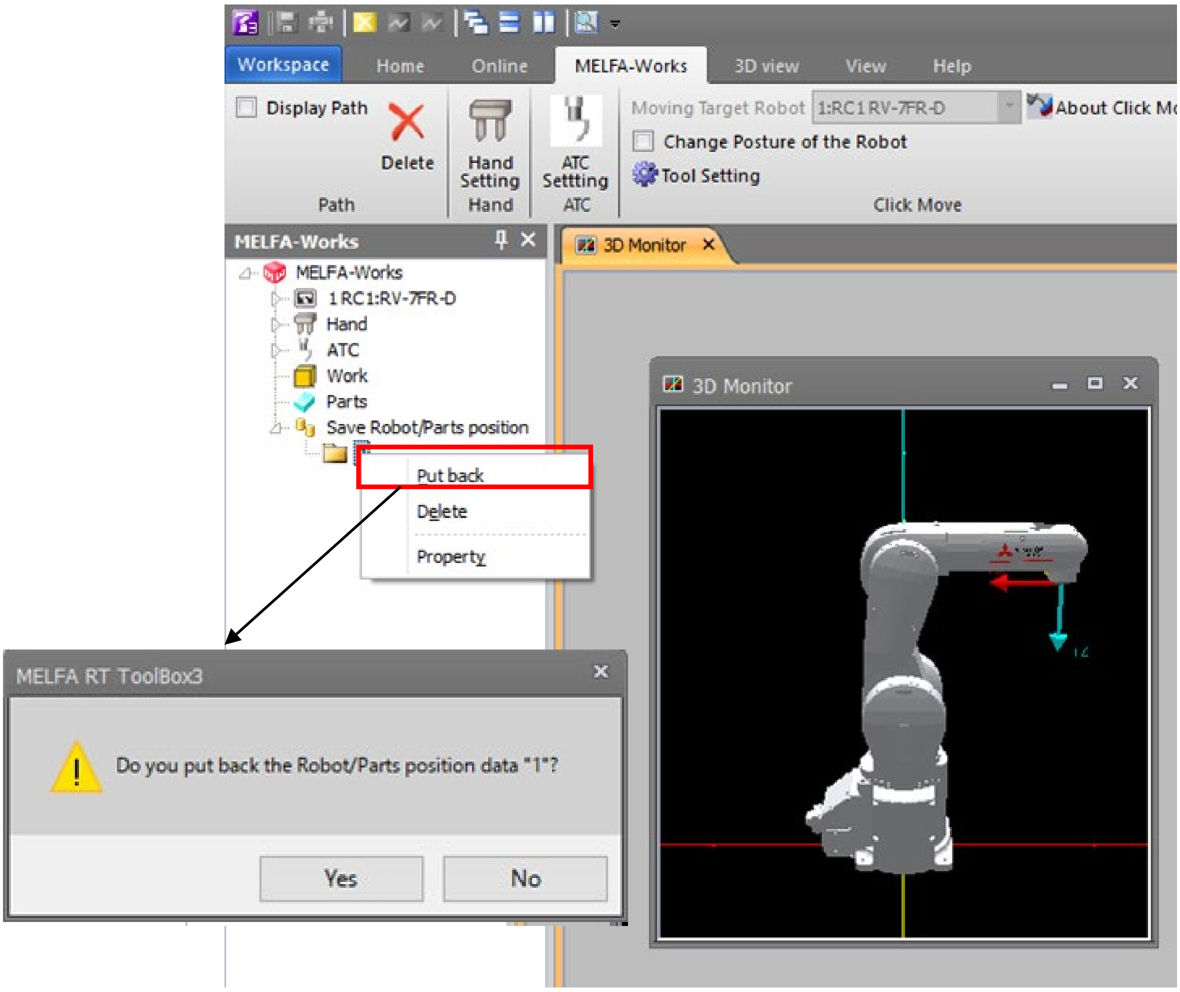


Fig. 7-6 Robot/Parts position save data put back.

8. Robot Operations

Use the operation panel to operate the posture of the currently loaded robot. The robot posture can be specified by XYZ coordinates or joint coordinates.

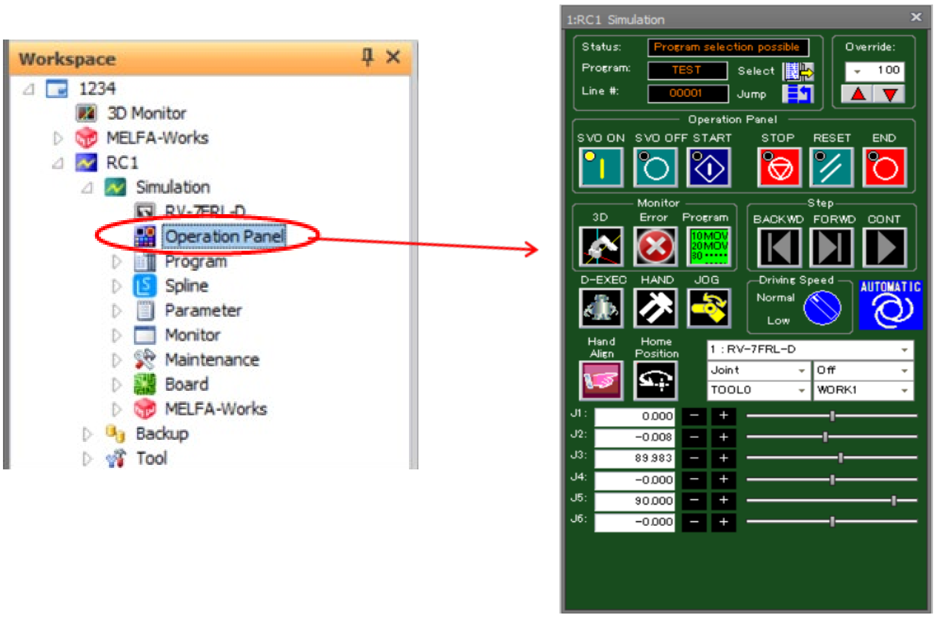


Fig. 8-1 Robot Operation(Operation panel)

Please see "RT ToolBox3 / RT ToolBox3 mini / RT ToolBox3Pro instruction manual" which is a detailed explanation of the operation panel.

8.1. Movement to a Click position

When the machining hand (the second origin (Orig2) is being installed) is connected to robot, clicking the part with the Alt key pressed will move the hand to the clicked position.

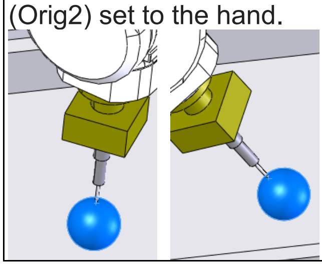
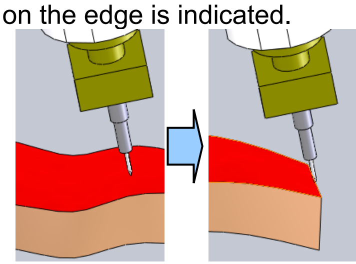
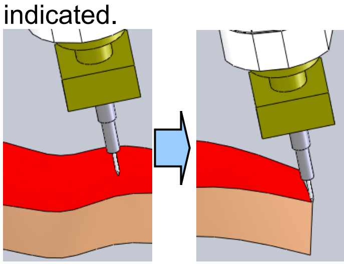
Face	Edge	Coner
Move to the click point on the face. At this time, if you select the [Change posture of the robot] check box, change the posture so that match the normal direction at the click position and the Z direction of the second origin (Orig2) set to the hand. 	The robot moves with posture kept positional in which the click point on the edge is indicated. 	The robot moves with posture kept positional in which the corner is indicated. 

Fig. 8-2 Moving to a Click position

8.1.1 Switch the click move target robot

You switch click move target robot with click from [MELFA-Works] tab of the ribbon -> [Click Move] tab -> [Moving Target Robot] combo box.

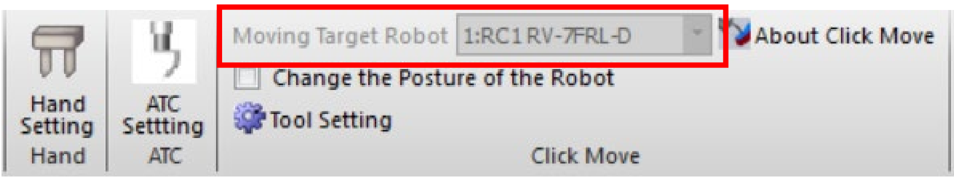


Fig. 8-3 To switch moving target robot with click

8.2. Tool setting

You can read tool data setting for the robot on the CAD and set tool data.
Tool data displayed here shows the distance between the the first origin (Orig1) to second origin (Orig2) of the tools (hand, ATC) that are currently connected to the robot.

※When you connect the hand or ATC to robot on SolidWorks, if the tool setting is not executed, there is a possibility that the position of the click movement or the position may shift at the time of path operation when creating the work flow.

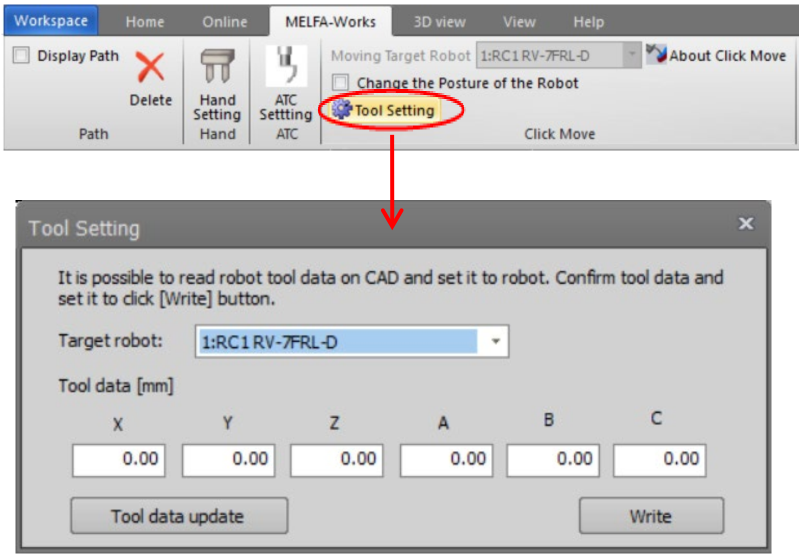


Fig.8-4 Tool setting screen

Tool setting are achieved by the following procedure.

① Tool setting screen is started from the [MELFA-Works] tab of the ribbon -> [Click Move] group -> [Tool Setting] button.
② You select the robot with [Target robot] combo box.
③ After you check tool data, you click [Write] button and write tool data.
④ When you click [Tool data update] button, the value of data between the the first origin (Orig1) to second origin (Orig2) of the tools(hand, ATC) that are currently connected to the robot is updated.

8.3. Travel axis

By setting the travel axis in the project setting of RT Toolbox 3, it is possible to move robot by travel axis. Moving the J7 (L1) axis or J8 (L2) axis from the operation panel will cause the robot to move in the direction set for the travel axis. For details of setting the travel axis, refer to **"9.2.6 Travel base setting for display" in "RT ToolBox 3 / RT ToolBox 3 mini user's manual".**

*MWLFA-Works does not correspond to travel axis slope.
* The travel base is not displayed on the SolidWorks screen.

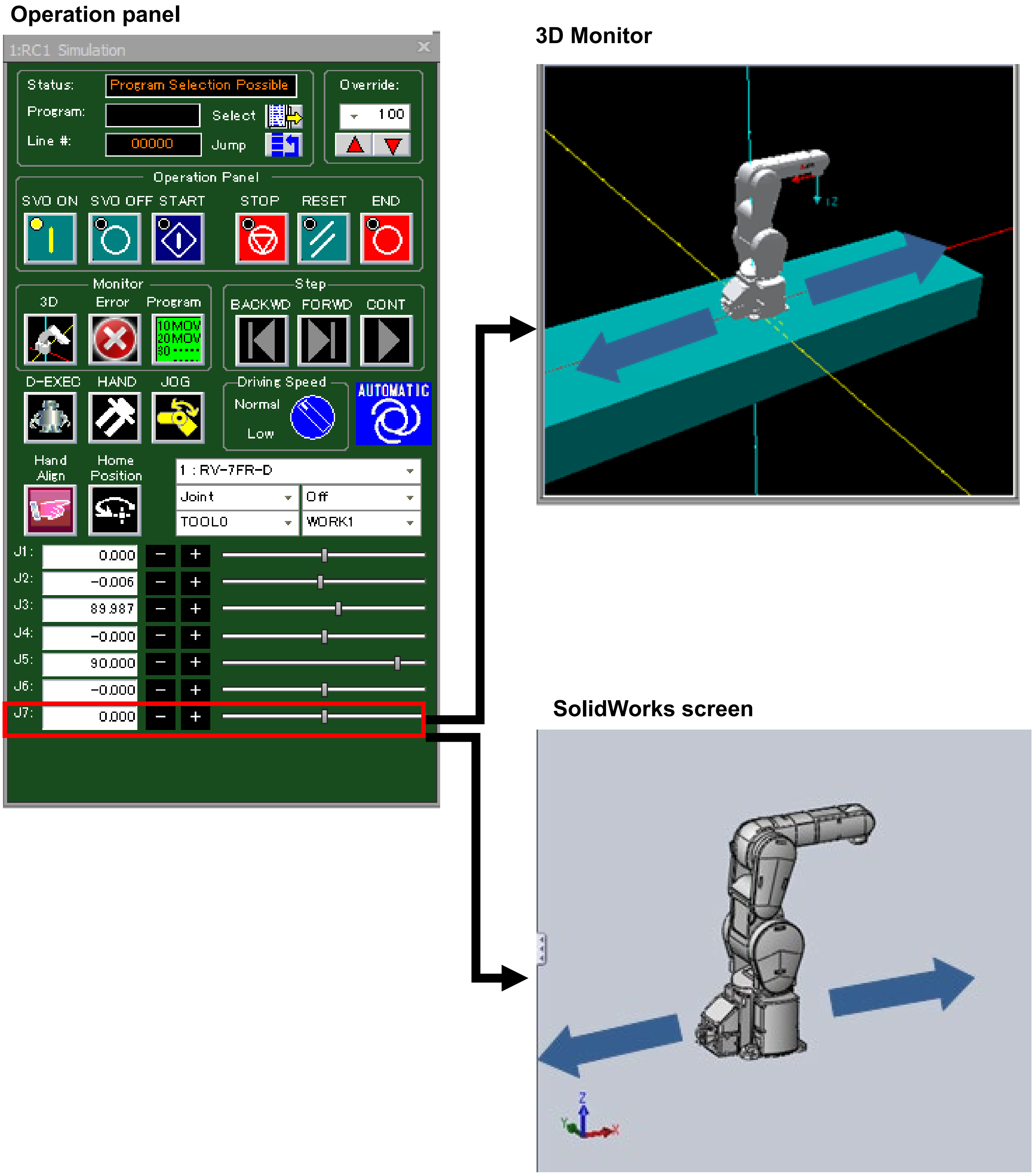


Fig.8-5 Robot move by travel axis

9. Frame

Frame is a coordinate system in CAD space. Use the frame for the following purposes.

(1) Alignment between CAD space and real space at calibration

Teach the frame data of the real space to a robot corresponding to the created frame data.Calibration is executed by using the difference between these two frames.

※ The object of the correction is only the point sequence data. Teach point data is not corrected.

(2) Relative position output of offline teaching result.

In the work flow creation, position data of the teach point will be output by relative position from the specified frame.

The frame creation screen is started from the [MELFA - Works] tab of the ribbon -> [frame] group -> [fMake the Frame] button.

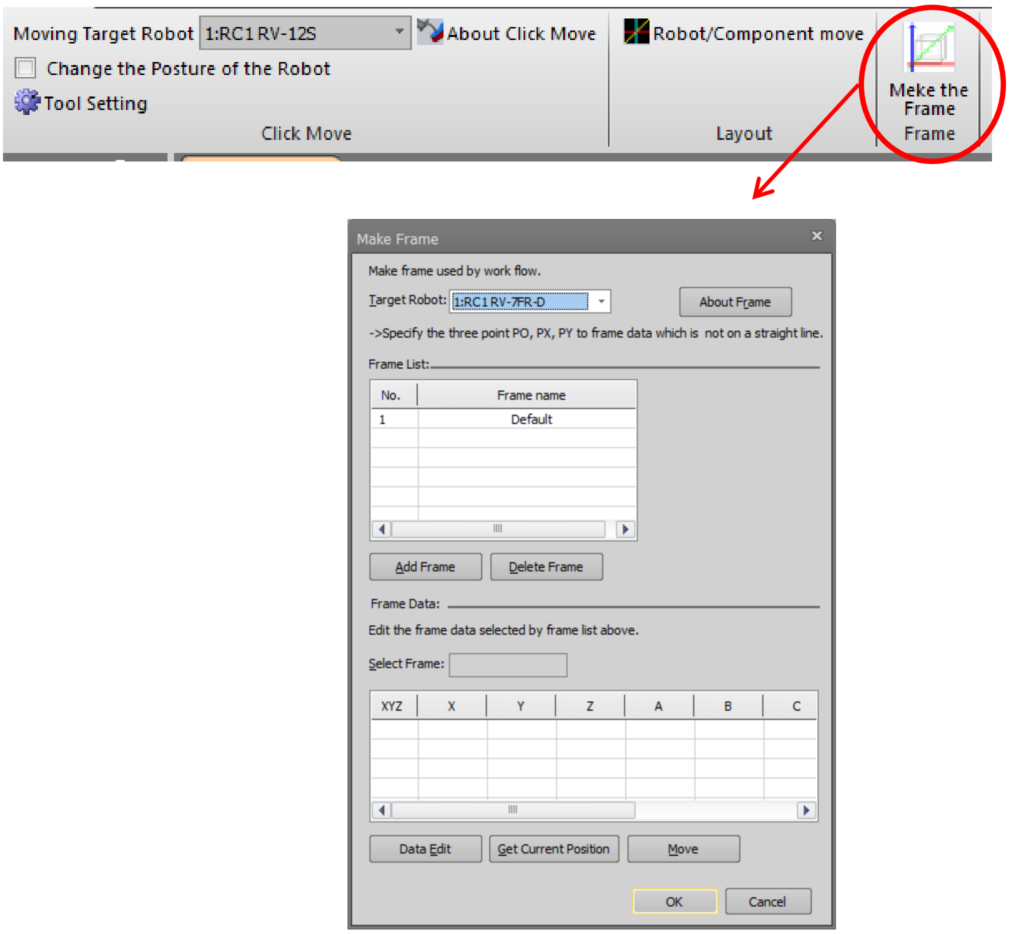
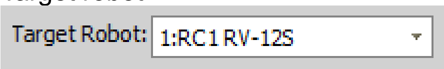
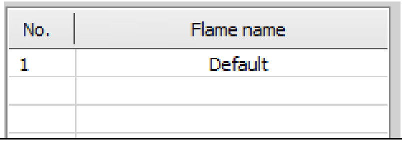
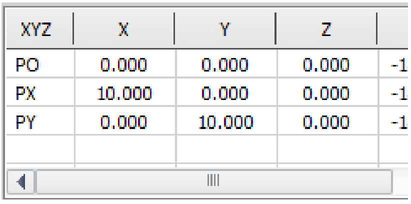
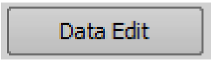
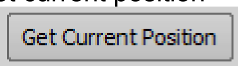


Fig. 9-1 Frame creation screen

Table 9-1 Details of Operations in the Dialog Box

Item	Explanation
Target robot 	Select the robot for which you want to create a frame.
Frame name list 	The created frame name is displayed as the list.The display items are frame number and frame name. Double-clicking at item in the list displays the frame name change screen and it is possible to change the frame name.
Frame add 	Add new frame data. The frame name is added automatically and added to the end of the list. The added frame name can be changed.
Delete 	Delete the frame data selected at the frame name list.
Frame data list 	The position data of the frame selected at the frame name list is displayed. [Get current position] button and [Move] button will operate on the position data selected here. This list stores the coordinate values of three points used in the frame. The position of 3 points is "3 points not on the straight line". In addition, we teach against this point at calibration, so please set it within the range of motion of the robot.
Data edit 	Edit specified point of frame selected at the frame data list. Clicking on this button will display the position data edit screen and you can edit the specified point position data of the frame.
Get current position 	Fetches the current coordinates of the robot into the specified point (PO / PX / PY) of the selected frame data.
Move 	Move the robot to the specified point (PO / PX / PY) of the selected frame data.

9.1. Frame Data Creation Procedure

Frame data is the data set consisting of 3 points that satisfy the following conditions.

- They have clear position relationships with workpieces.
- They are not on a straight line.
- They can be taught.

In MELFA-Works, it is possible to set multiple frame data. For example, when there are multiple workpieces in the vicinity of the robot, it can be corrected with high precision by setting a frame for each workpiece.

① Click the [Add Frame] button and add frame data.
② Click the target frame data at the frame data list.
③ Move the robot to the frame point (see section 8.1 Movement to a Click position).
④ Select the coordinate data (PO, PX, PY) and click the [Get current position] button to capture the position.

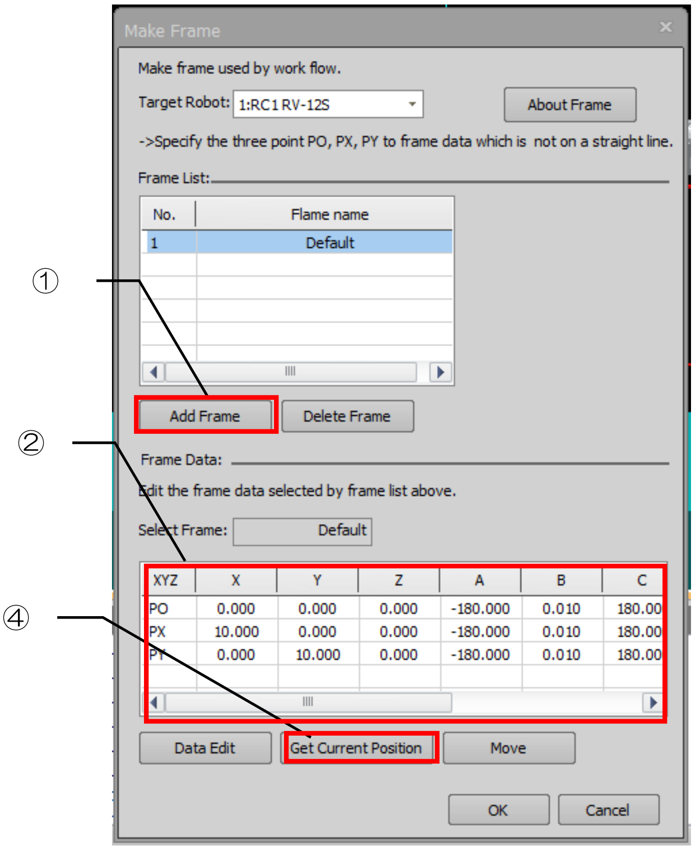


Fig. 9-2 Frame data creation procedure

If you prepare three points to be used for creating frame data in advance, you can improve positioning accuracy by the robot. Since teaching is performed for these three points during calibration, characteristic points such as corners can be more accurately teached.

If three points can not be prepared on the workpiece model, specify three points on a peripheral device with clear positional relationship, such as a work fixing table.

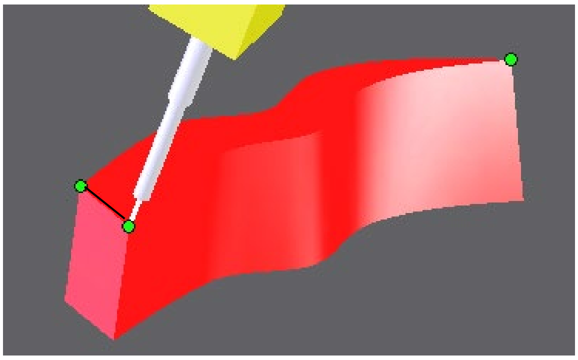


Fig. 9-3 Specifying 3 Points on Workpiece

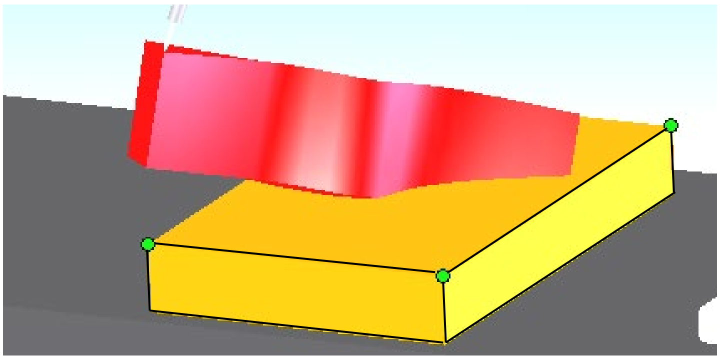
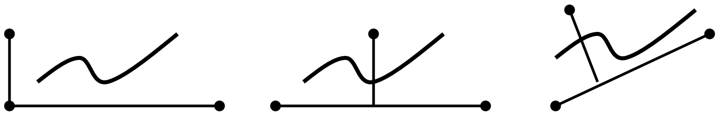


Fig. 9-4 Specifying 3 Points on Workpiece Fixing Base

⚠ CAUTION

About calibration

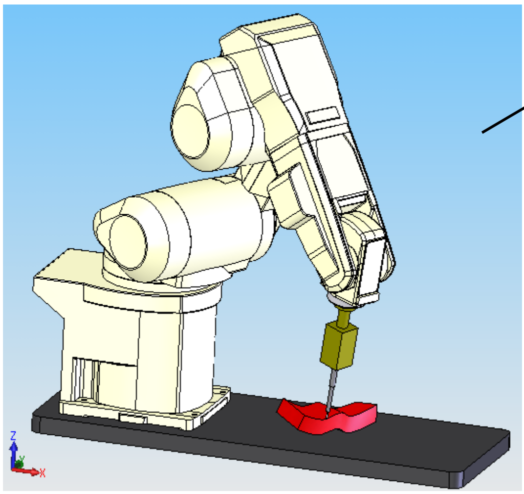
In order to move the actual robot with high accuracy, the accuracy of calibration is important. "3 points that are not on a straight line" are required for teaching during calibration. These 3 points should preferably be located at some distance from each other, rather than very densely together, in order to improve the accuracy. Distances cannot be collectively set due to the work size and robot coordinates but can be set in a trace area by using the CAD link function.



9.2. To Perform Highly Accurate Calibration

In order to perform highly accurate calibration, specify the layout of the robot and workpiece position relationship as accurately as possible. It is possible to correct deviance through calibration, but the smaller the difference between the status before and after calibration, the higher the accuracy. It is essential to create conditions in the CAD software that match the actual environment as closely as possible.

To specify the layout of the robot and workpiece position relationship, it is convenient to use the layout function of MELFA-Works (refer to "Chapter 7 Robot/Component Move")



Use the layout function of MELFA-Works to create conditions that match the actual environment as closely as possible.

Fig. 9-5 Example of CAD Link Execution

10. Creation of Work Flow

A work flow refers to a series of operations such as moving to point A, carrying out processing along path B and finally moving to point C. In MELFA-Works, such work flows are created and eventually converted to robot programs. Such robot program contains position data and information for tracing along a path, it can be used as templates for programs used in actual systems.

It is possible to add teaching data and path data to a work flow. This chapter explains how to create teaching data, path data and work flows.

The different terms have the following meaning.

The meaning of each word is as follows.

Item	Explanation
Teaching data	It is the data that captured robot attitude information. The posture information includes the position and direction at the mechanical interface part of the robot, and the structure flag. (See "10.2 Creating Teaching Points").
Path data	It is a general term for edges on workpieces and other areas processed by a robot and various conditions such as speed and acceleration/deceleration required for processing. Processed areas are extracted from path data and converted to collective dot sequence data with direction. The posture/path registration area is used (see "10.3 Path Creation").
Work flow	It is a sequence of work tasks created by combining teaching data and path data.It can convert from work flow to robot program and point sequence data. (See "10.5 Robot program conversion").

10.1. Input of work flow name

Click the [Work Flow] tab → [Make the Work Flow] button on the ribbon to open the following screen. Enter the work flow name and click the [Next] button to proceed to the next page. Frame data is necessary to create work flow. If you want to use data other than the default frame data, click the [Make Frame] button and create the frame data before proceeding to the next page.

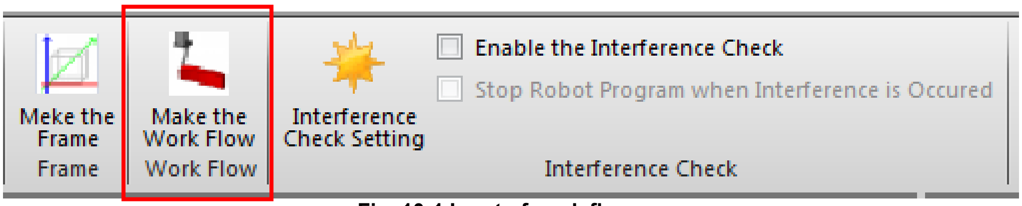


Fig. 10-1 Input of work flow name

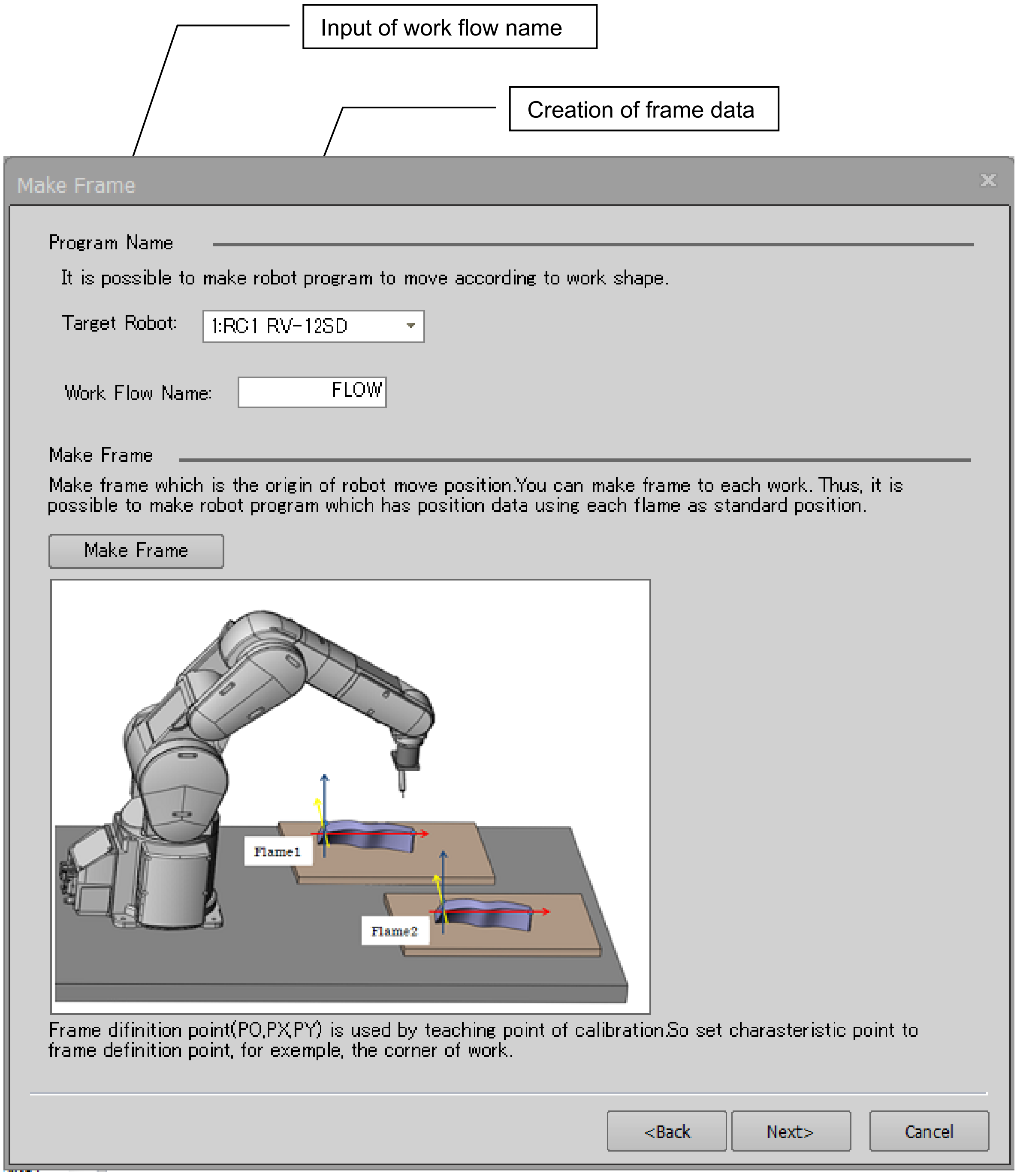


Fig. 10-2 Input of work flow name

10.2. Creating Teaching Points

When you go to the next page from the work flow name input screen, the following screen will be displayed. Clicking the teach tab on the upper side of the screen displays the teaching point list and you can register the posture of the robot. By registering posture to the work flow as a command, it can be reflected to the robot program finally outputted.

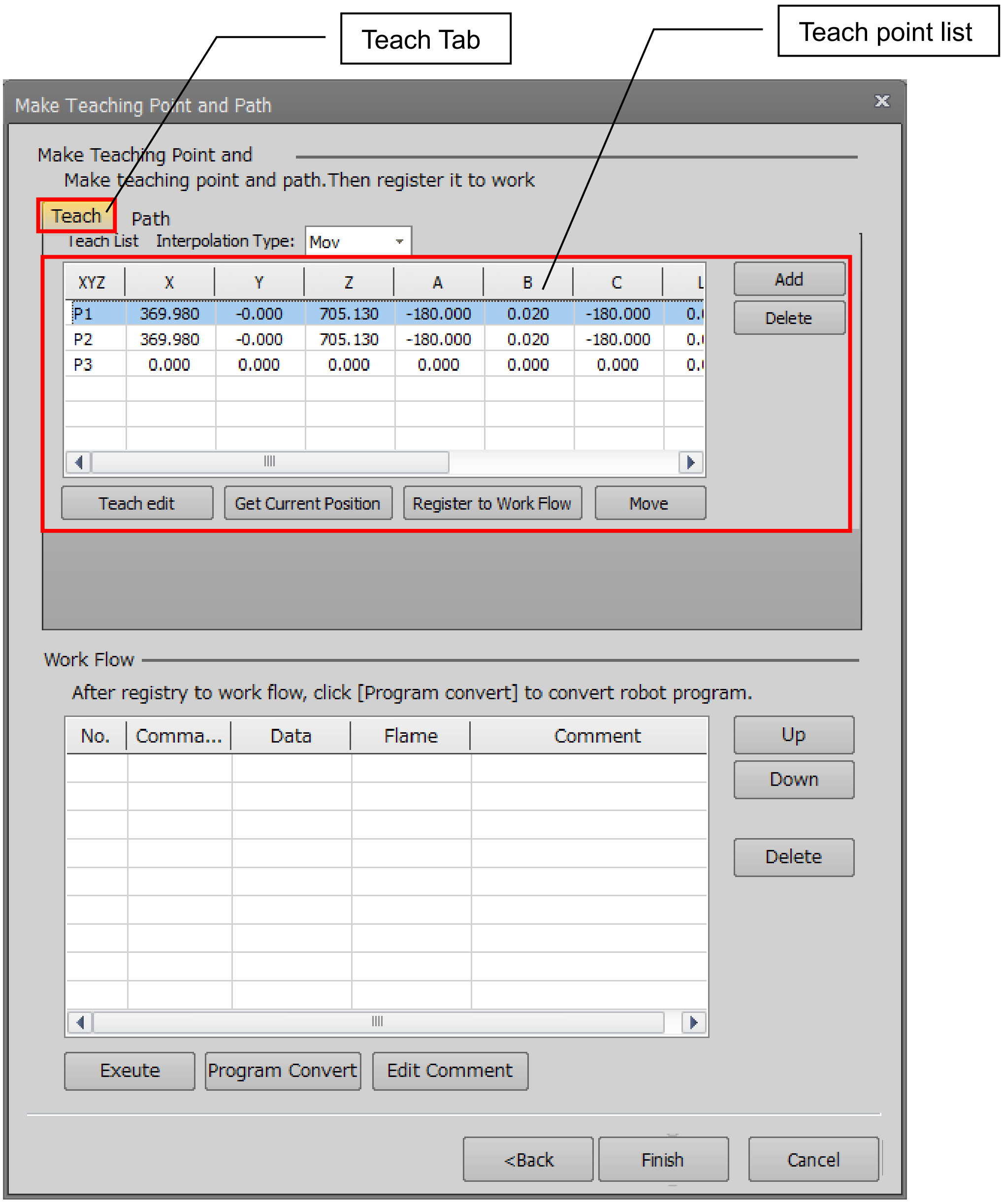


Fig .10-3 Registration of teach points

Teaching point addition procedure

① Change the posture of the robot to the target position by Jog operation on the operation panel or click movement

② Click the [Add] button to add a teaching point to the list.

③ Click the [Get Current position] button to capture the current position of the robot.

④ Click the [Move] button to check the position of the registered teach point.

⑤ Select the teaching point and click on the [Register to Work Flow] button to add it to the work flow..

10.2.1 Position data edit screen of teach point

Double-clicking on the registered teaching point on the list opens the position data editing screen as shown below and you can edit the position data. Also, you can select a frame as a coordinate system to output position data.

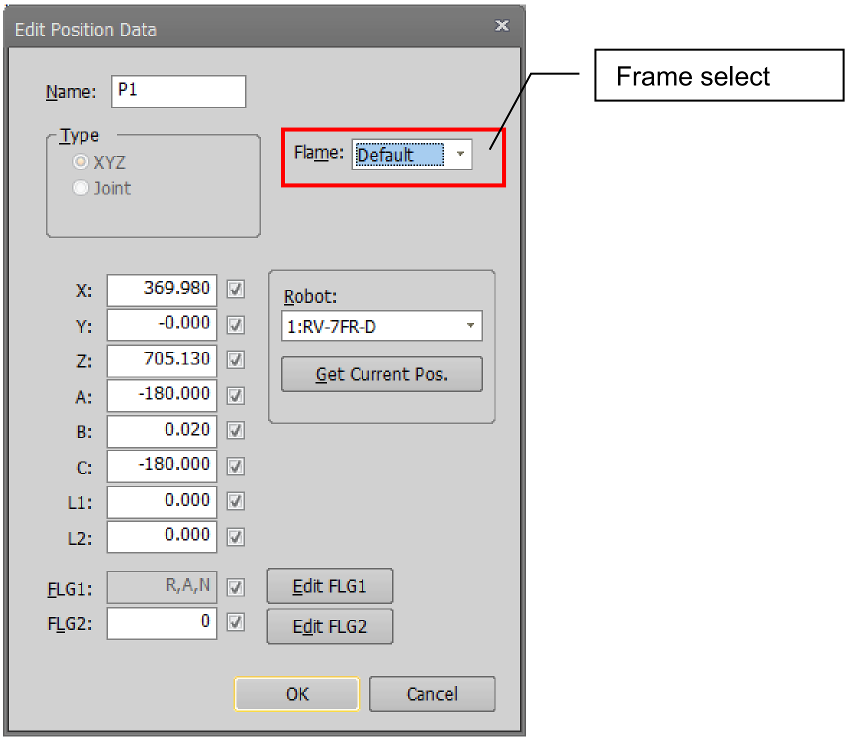


Fig .10-4 Teach point position data edit

10.2.2 Relative position output by frame

In the robot program created from the work flow, teaching data is output as a relative position relative to the frame selected on the position data edit screen.When using default frame data, position data is not converted because it is outputted as absolute coordinates.

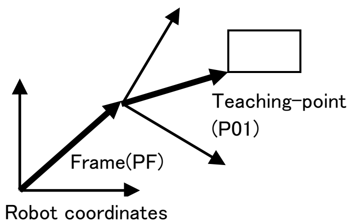
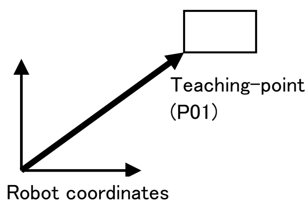
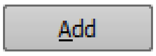
Use frame data created (Output in relative coordinates)	Use default frame data (Output in relative coordinates)
	

Table 10-1 Teach point creation screen operation details

Item	Explanation
Teaching point list	Names and coordinates of created teaching points are displayed in a list. Double-clicking an item in the list displays the teaching point position editing screen, and you can edit coordinate values.
Add 	Add teach points to the teaching point list. The name is automatically added at the time of addition. The teaching data name can be changed from the teaching point position data editing screen.
Get Current Position 	Fetches the posture of the robot that is the object of operation.
Delete 	Deletes the teaching point selected in the teaching point list.

Item	Explanation
Move Move	Moves the robot to the teaching point selected in the teaching point list.
Interpolation Tyoe Interpolation Type: Mov	In the robot program finally converted from the work flow, from MOV / MVS, select the method by which the robot moves to the registered teaching point.
Register to Work Flow Register to Work Flow	The teaching point selected in the teaching point list can be registered as a command in the work flow. When a command is selected in the work command list, it is added above the selected line, and when not selected, it is added to the last line. If multiple items were selected then all selected items are added.

10.3. Path Creation

A path means a motion path when tracing a specific part (edge part) on a work with a robot having a processing hand. Paths created here can be reflected in the final output robot program by registering them to work flows.

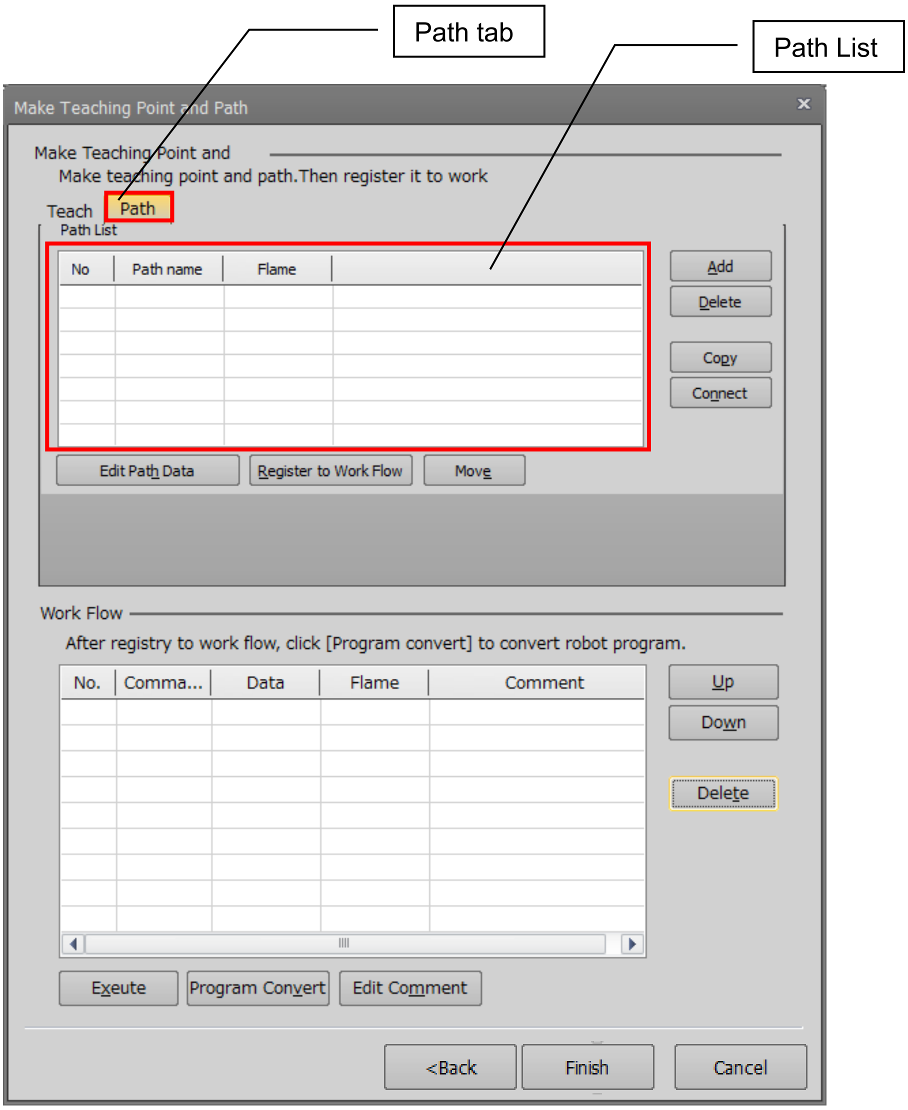


Fig. 10-5 Route creation

Route addition procedure
① Click the [Add] button in the Path tab to add a path to the list.
② Double click on the created path, or click the [Edit Path Data] button to open the path data edit screen and edit the path information.
③ Select the path and click the [Move] button to check the operation of the robot.
④ Select the path and click the [Add to work flow] button to add it to the work flow.

Table 10-2 Details of Operations in the Dialog Box

Item	説明
Path List	Displays a list of created paths. Double-click an item in the list to display the path data editing screen, and you can make detailed settings about the path.
Add Add	You can add a new path to the path list. The name is automatically added at the time of addition. The new path is added to the path list with no configuration in place. Click the [Edit path data] button or double-click the item in the path list to make detailed settings for path data.
Delete Delete	Click this button to delete the path selected in the path list.
Edit Path Data Edit Path Data	Click this button to edit detailed settings of the path selected in the path list.
Connect Connect	Unites multiple paths into a single path. Click this button to combine multiple paths selected in the path list to create a new path. Only information of edges and faces is combined for the created path. Other setting information such as the speed and tool offsets is used in the lead (beginning) path information. (The processing direction corrected by tool offset is canceled.)
Copy Copy	Click this button to copy the path selected in the path list.
Move Move	Operate the robot by the created path unit and check whether there is an unreasonable posture.
Register to Work Flow Register to Work Flow	The teaching point selected in the path list can be registered as a command in the work flow. When a command is selected in the work command list, it is added above the selected line, and when not selected, it is added to the last line. If multiple items were selected then all selected items are added.

10.4. Path data edit screen

You can add path data and set path settings (speed of operation, direction of movement, signal settings, etc.).

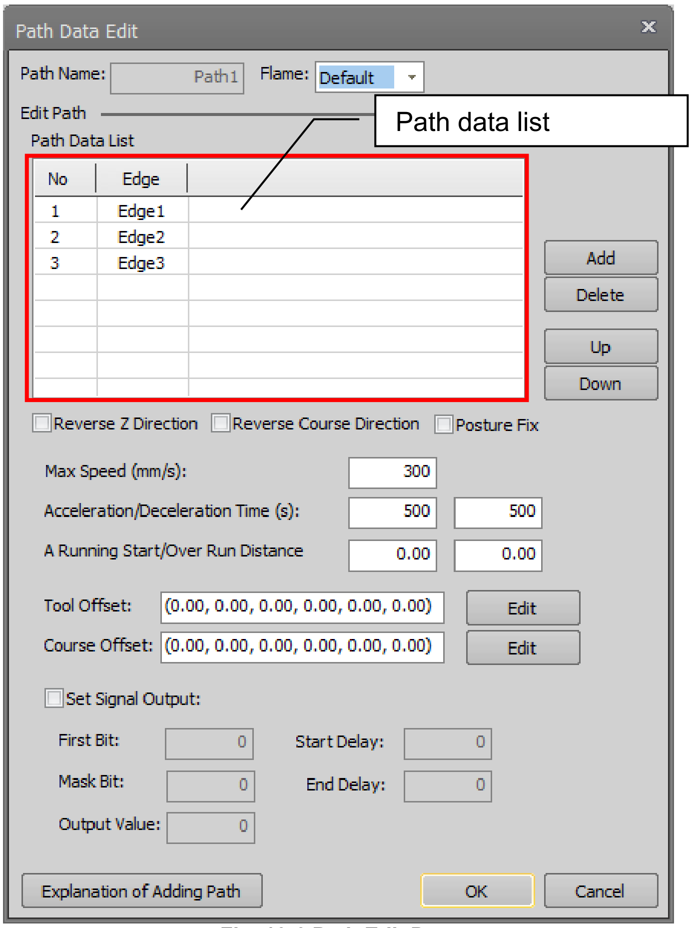


Fig. 10-6 Path Edit Data

10.4.1 Offset Edit Screen

When you click the [Edit] button to the right of the tool offset or course offset item, the following offset edit screen is opened. Input the offset value and click OK to change the offset value.

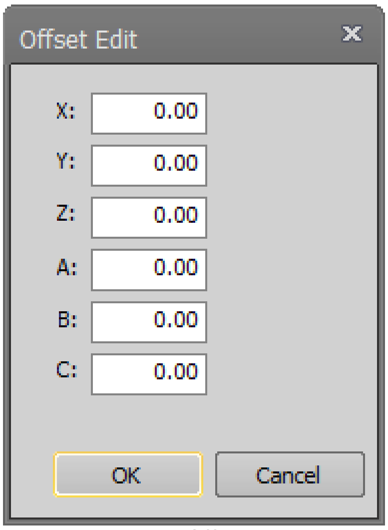


Fig. 10-7 Offset Edit

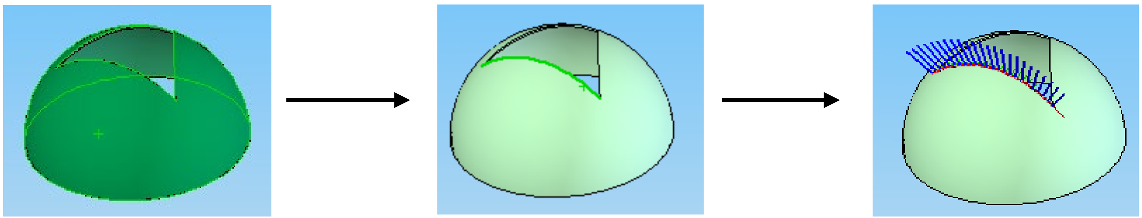
10.4.2 How to add path data

Path data addition method　* The target is work ("*** _ Work.sldprt") only.

① Load target work on SolidWorks.

② On the target workpiece, click the face (face) containing the edge (line segment) that you want the robot to operate on it, and then click the edge (line segment). Click the [Add] button to add the path data to the path data list. When correctly added, a point sequence is drawn as shown in ③.

① Click surface　　② Click edge　　③ Click [Add]



③ Click OK to close the path edit data screen, select the path on the path creation screen, and click the [Move] button to confirm the operation.

10.4.3 Path data addition method explanation

When you click the [Explanation of Adding Path], the explanation screen of the path data adding method as shown below will be displayed.

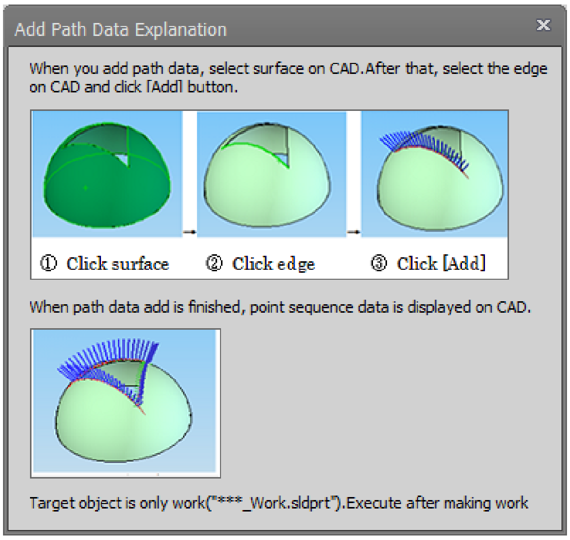


Fig. 10-8 Path data addition method explanation

10.4.4 Direction of path movement

When the path data is added, the point sequence is drawn on the path on the work. In the coordinate system that draws this point sequence, the direction in which the robot operates is displayed. The blue arrow in the coordinate system drawn in the point sequence data is the Z direction of the tool, the green arrow is the Y direction of the tool, and the red arrow is the X direction of the tool as shown below. The robot moves along the path so that the orientation of the tool of the robot matches the orientation of this coordinate system.The direction of travel is the X direction of the coordinate system.

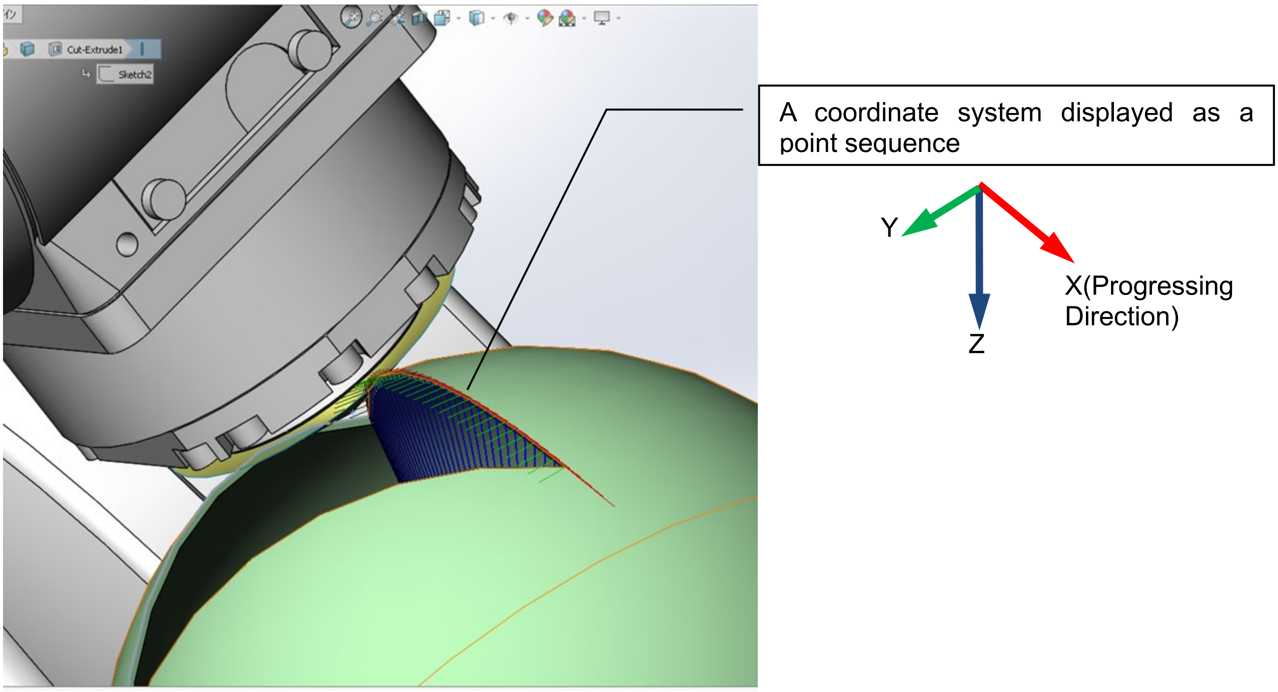
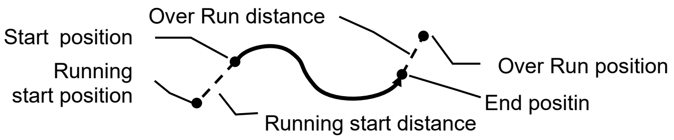
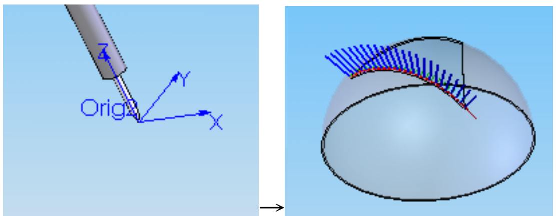
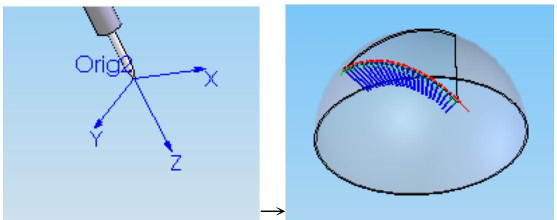
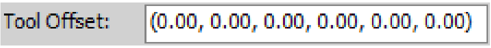
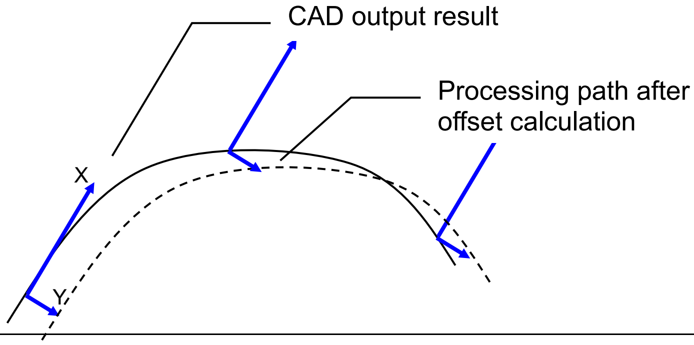
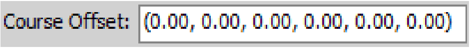
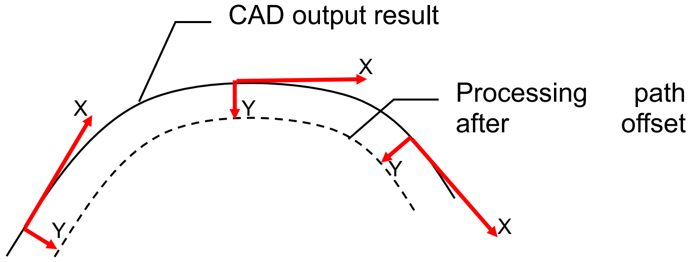
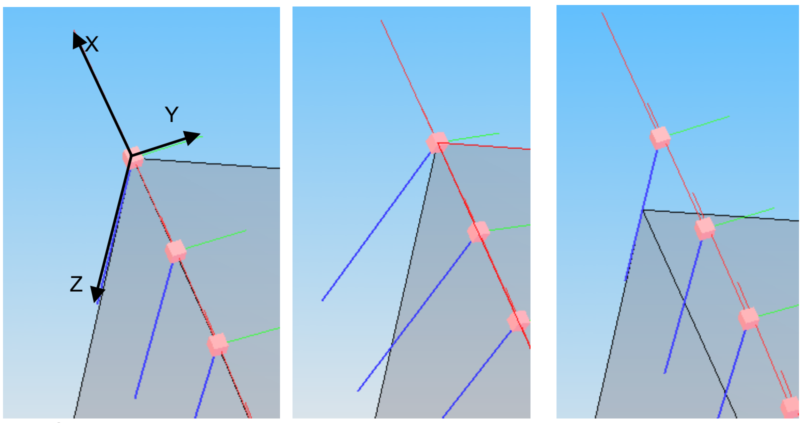
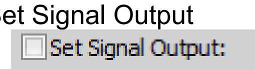
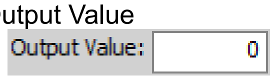
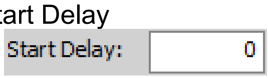


Fig. 10-9 Path movement direction

Table 10-3 Details of Operations in the Dialog Box

Item	Explanation
Path Name Path Name: Path1	The path name selected on the make path screen is displayed.
Path Data List No / Edge 1 Edge1 2 Edge2 3 Edge3	Path data registered in the path is displayed as a list.
Up / Down. Up Down	You can change the position of the path data selected in the path data list.
Add Add	Adds a new path data to the path data list.
Delete Delete	Click this button to delete the path data selected in the path data list.
Max Speed Max Speed (mm/s): 300	Specify the maximum speed of the robot when it processes a path.
Acceleration/Deceleration Time Acceleration/Deceleration Time (s): 500 500	Specify the acceleration/deceleration time of the robot when it processes a path.
A Running Start/Over Run Distance A Running Start/Over Run Distance 0.00 0.00	Specify the approach and overrun distances of the robot when it processes a path. At the start and end of robot movement, the speed fluctuates due to acceleration/deceleration. In order to be able to process the specified edge at a constant speed, specify approach and overrun distances. Running Start： It is possible to set an approach position at a point along an extension of the specified path, extending from the start position of the path in the opposite direction of the traveling direction. Specify the distance of the approach section (mm). Over Run： It is possible to set an overrun position at a point along an extension of the specified path, extending from the end position of the path in the traveling direction. Specify the distance of the overrun section (mm).  *Specification by 1/100mm unit is possible. 1/1000mm or less is rounded down.
Posture Fix Posture Fix	Specify whether or not the posture should be fixed when the robot processes a path. If the check box is enabled, the posture is fixed. If it is disabled, the posture is not fixed.
Reverse Course Direction Reverse Course Direction	Specify whether or not to reverse path processing direction. If the check box is enabled, the course is reversed. If it is disabled, the course is not reversed.

Item	Explanation
Reverse Z Direction 	Specify whether or not to reverse in the Z-axis direction of a dot sequence when the robot move a path. If the check box is enabled, the coordinate system is reversed in the Z-axis direction. If it is disabled, the coordinate system is not reversed. When a hand processing area moves an path, it moves by matching the Z direction of Orig2 to the normal line direction and the X direction of Orig2 to the traveling direction. Thus, it is possible to determine absolutely whether or not to reverse in the Z-axis direction by the processing point ("Orig2") and the normal line direction on the face when creating a hand. （Example1） （Examole2） *[The normal line direction] reverse for RH/RP series.。
Tool Offset 	For the motion path, you can set the offset in the tool coordinate system. Enter a value directly into the text box or enter the amount of offset in the offset input dialog box displayed by clicking the [Edit] button next to the text box. ool Offset specifies the amount of deviation when the actual hand processing point deviates from the processing point (coordinate system "Orig2") on the hand model. The figure below shows an example where the Y component is corrected. It is possible to use Course Offset at the same time. 

Item	Explanation
Course Offset  	Offset the course of the path. Enter a value directly into the text box or enter the amount of offset in the offset input dialog box displayed by clicking the [Edit] button next to the text box. Specify the amount of offset in the coordinate system where the forward direction of the path course is set as the +X-axis direction and the direction away from a face as the +Z-axis direction. For example, when moving the path of the curve, the Y component indicates the inward/outward rotation, the Z component indicates the amount of approach and the A component indicates the bank angle. The figure below shows an example where the Y component is corrected.  The examples in the figures below show the standard conditions, conditions where the Z component is corrected, and conditions where the A component are corrected, respectively.  Standard condition Z component correction A component correction
Set Signal Output  	Sets the signal condition. If the check box is disabled: The signal status before processing is maintained as is. If the check box is enabled: Turns the signal on according to the set conditions and off at completion.
First Bit  	When outputting signals while the robot is processing a segment, it is possible to specify the head bit of the output signal (decimal expression).
Mask Bit  	Specify the bits to be controlled for 16 bits from the head bit (hexadecimal expression).
Output Value  	Specify a value to be output (decimal expression). The actual output consists of the bits, starting from the head bit, for which the corresponding mask bits are turned on.
Start Delay  	Allows specifying to turn a signal on after the specified time (in milli seconds) has elapsed since the beginning of movement. A negative value can be set here as well. In this case, the robot starts moving after the specified number of seconds has elapsed after the signal is output.

Item	Explanation
End Delay End Delay: 0	Allows specifying to turn a signal on after the specified time (in milli seconds) has elapsed since the end of movement. A negative value can be set here as well. In this case, the signal is turned off the specified number of seconds before the robot reaches the end point.

* Each item set in this dialog box becomes valid for all paths displayed in the path data list.

10.5. Robot program conversion

In creating workflow, you can register the created teaching points / path in the work flow and convert them into robot programs, which can be used as a model of programs at system operation.

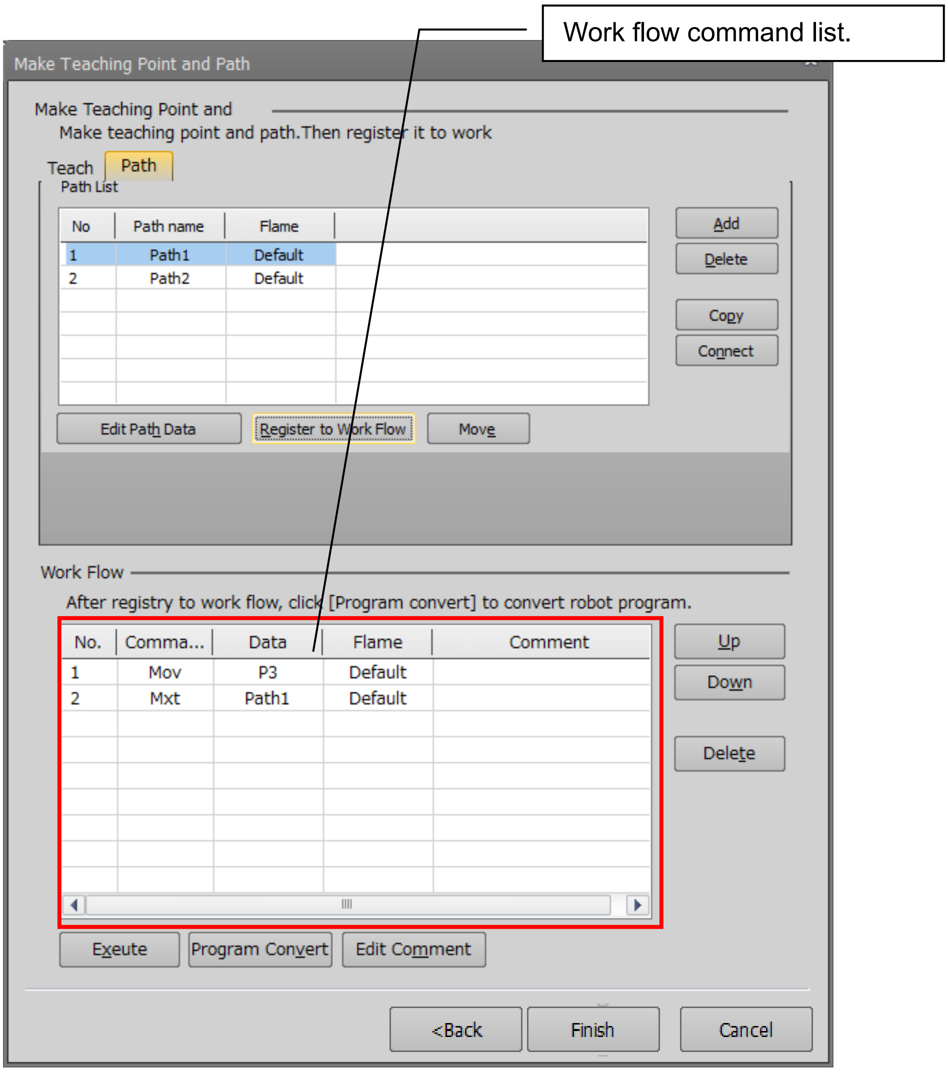


Fig. 10-10 Make Work Flow

Robot program conversion procedure

① Select the teach tab or the path tab and register the teaching points and path in the work flow by clicking the [Register to Work Flow] button. Registered data is displayed as a command in the command list of the work flow.

② When you click the [Program Convert] button, it is converted from the data in the command list of the work flow to the robot program. When converting the robot program, output the file as shown in Table 10-4 below. These files are necessary for calibration execution. These files are stored in the [Conversion program name] folder under the [MELFA - Works] folder which is directly under the project.

Table 10-4 List of Output Files

MXT***.mxt	Point sequence data in which path information is stored. The robot program reads this file and moves the specified path. The file name is automatically generated depending on the number of point columns to be outputted etc.
MXT***.cal	A copy of MXT***.mxt
CLB.prg	A calibration program. Calibration program for correcting the path. It is necessary to correct the path using the calibration tool. (Refer to 14 Calibration)
CLB.cal	A copy of CLB.prg

Table 10-5 Operation details

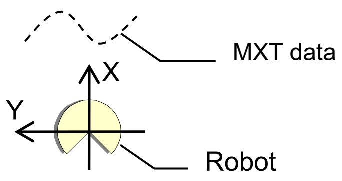
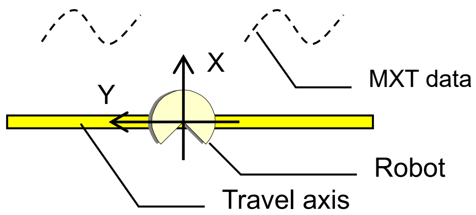
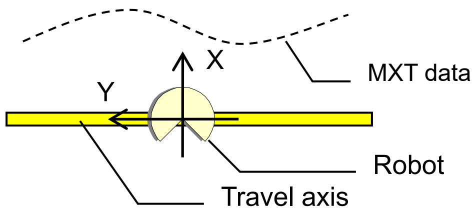
項目	説明
Work flow list	The teaching points / paths registered in the work flow are displayed as a list as commands.
Up/Down Up Down	Change the order of the work flow list.
Delete Delete	Delete the command from the work flow command list.
Execute Exeute	You can check the operation of the command. If the command selected in the list is a teaching point, it moves to the specified position. In the case of a path, the path operation is executed. After the operation is completed the cursor will move to the next command line. However, the interpolation operation is not executed for the movement command.
Program Convert Program Convert	Converts a work flow into a robot program. Click this button to convert the work flow selected in the work flow list and create a robot program and/or **a dot sequence data set** (information based on which an actual robot can move).
Edit Comment Edit Comment	With an item selected in the work flow command list, clicking the add comment button will open the comment edit screen and you can add a comment to the command. The added comments are reflected in the converted robot program.

10.6. MXT with Travel base

There is a limitation in the MXT operation of MXT with Travel base. CAD Link cannot operate though Travel base is operated.

Please avoid making Travel base effective and using MXT.

Table 10-6 Details of Operations in the Dialog Box

Item	Figure	Explanation
Case1		Type of fixed robot MXT operates by the robot without Travel base.
Case2		Type of with Travel base1 The robot stops at the position of the Travel axis by the robot with Travel base and MXT operates. The value of the Travel axis when the MXT data is made by [conv button] is output to the MXT data.
Case3		Type of with Travel base2 It synchronizes with Travel axis, and MXT operates in the area more than the motion limit of the robot. **Not Support.**

Memo

About MXT Data (Path Data)

When you use the MXT data(*.mxt) output by [Conv] button. It is necessary to **forward it to Robot Controller** by Calibration tool.

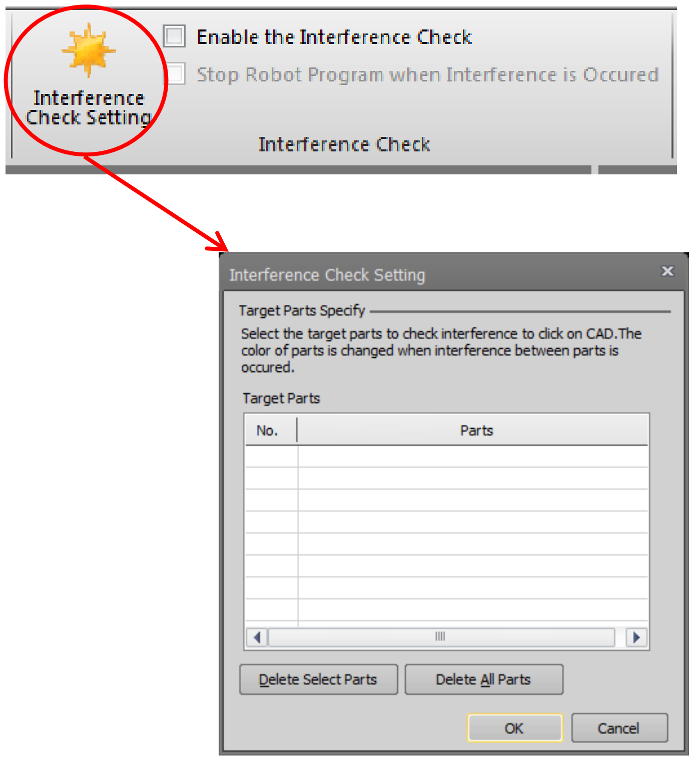
Please refer to Chapter 14 for details.

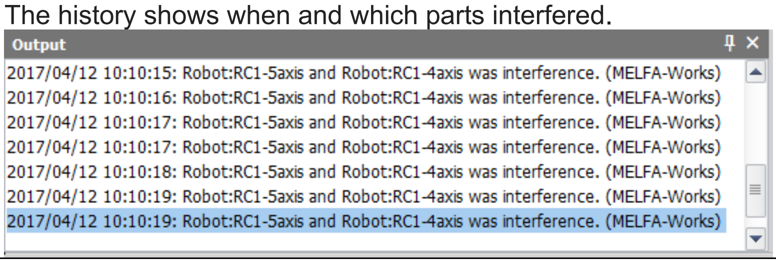
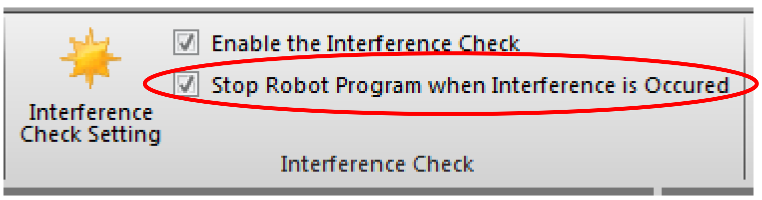
11. Interference Check

MELFA-Works checks the interference of all combination of registered parts. In addition to checking the current interference state, it is also possible to stop robot program when interference is detected.

Although there are differences according to the performance of the personal computer, as the number of registered parts increases, the checking time becomes longer, so please register only the necessary minimum parts.

Table 11—1 Screen operation details

<table>
<tr><th>Item</th><th>Contents</th></tr>
<tr><td>Interference check setting</td><td>The interference check setting screen is started from the [MELFA - Works] tab of ribbon -> [interference check] group -> [Interference Check Setting] button.


When you click a part on SolidWorks, the part name is added to the target part list. Also, if the parts on the list is clicked,corresponding parts on SolidWorks becomes selected state.
Interference is checked of all combination of parts on the list.</td></tr>
<tr><td>History</td><td>The interference history is displayed in the "Output" window.
The history shows when and which parts interfered.

</td></tr>
<tr><td>Interference stop</td><td>If the interference is occured, it is possible to stop the robot program.


If the [MELFA-Works] tab of ribbon -> [Interference Check] group -> [Stop Robot Program when Interference is Occured] check box is ON, the robot program will stop at the time of interference. It will not stop when check box is OFF.</td></tr>
</table>

12. Recording

It is possible to record the screen displayed in SolidWorks and save it in AVI file.
Click the [MELFA-Works] tab -> [Rec.] group -> [Start] button on the ribbon. The recording is started.

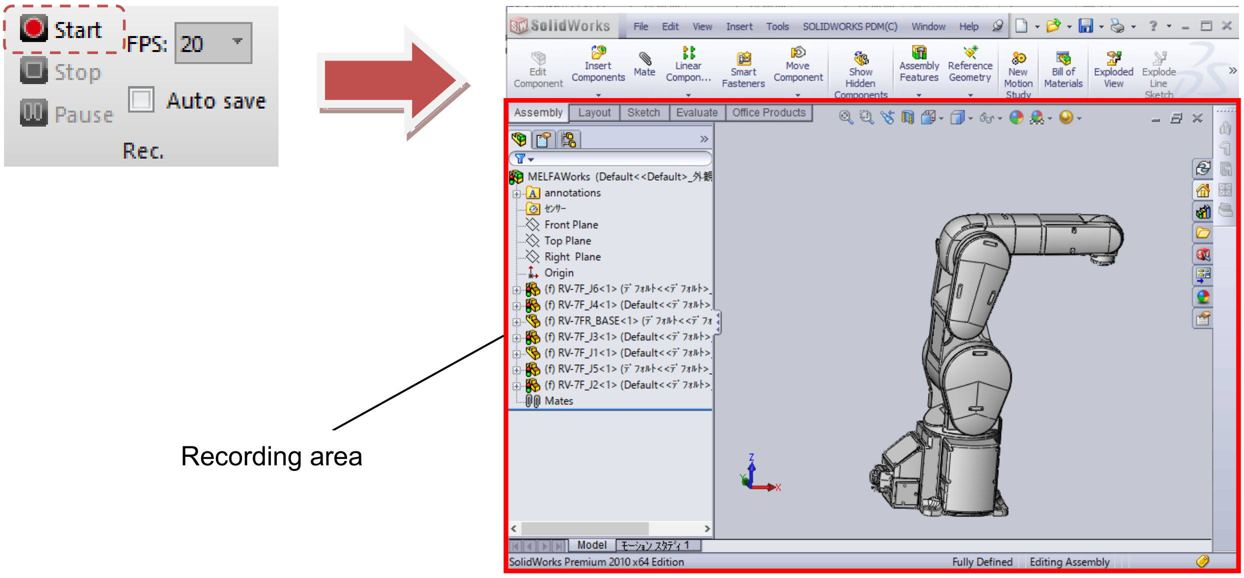


Figure 12-1 Solidworks recording

To pause recording, click the [MELFA-Works] tab -> [Rec.] group -> [Pause] button on the ribbon.

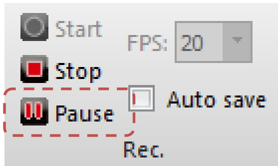


Figure 12-2 Pause

Clicking the [MELFA - Works] tab -> [Rec.] group -> [Stop] button on the ribbon during recording or pause stops recording and opens a dialog for saving AVI files.

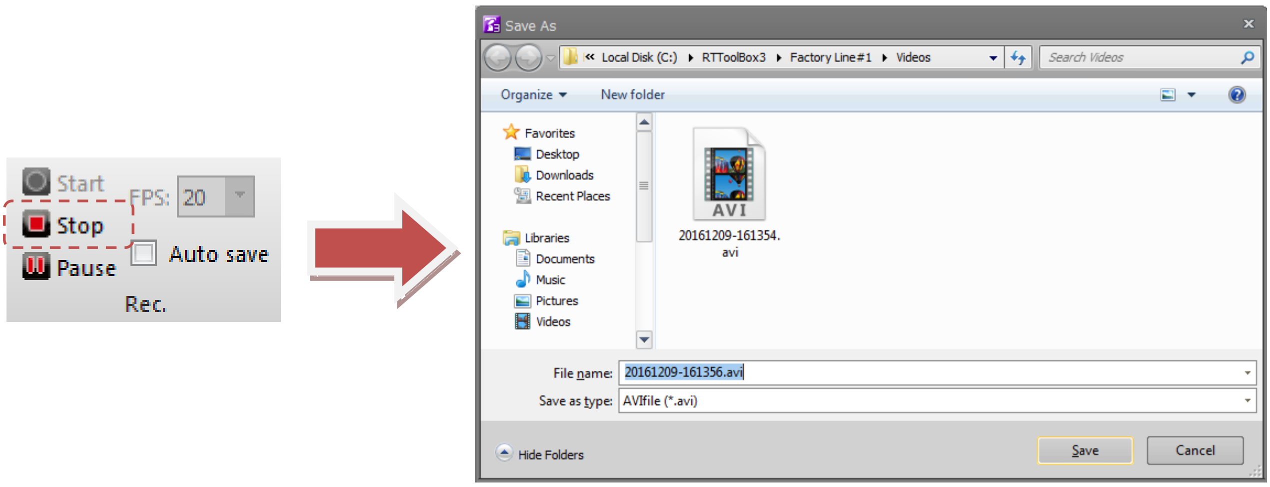


Figure 12-3 Save Dialog

In addition, you can change recording settings on the ribbon's [MELFA-Works] tab -> [Rec.] group -> [FPS] combo box / [Auto save] check box before recording. While recording, you can not operate, please set in advance.

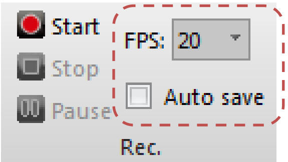


Figure 12-4 Recording Options

Frame rate (FPS)

You can change the frame rate of the video data to save the avi file.

Setting range: 30/20/10[FPS]

* By raising the frame rate the video will be smoothed, but on the other hand, the file size will be large(recordable time is short).

Auto save

When the [Auto save] checkbox is selected, the AVI file is automatically saved to the "Videos" folder in the workspace folder when recording is stopped.

*Depending on the combination of OS of the PC and SolidWorks version, it may not be able to successfully acquire video data. In that case, please use the video recording function of SolidWorks.

• Record video function of SolidWorks2016.

Launch from SolidWorks menu [View] → [Screen Capture] → [Record video]

(In the case of SolidWorks2016)

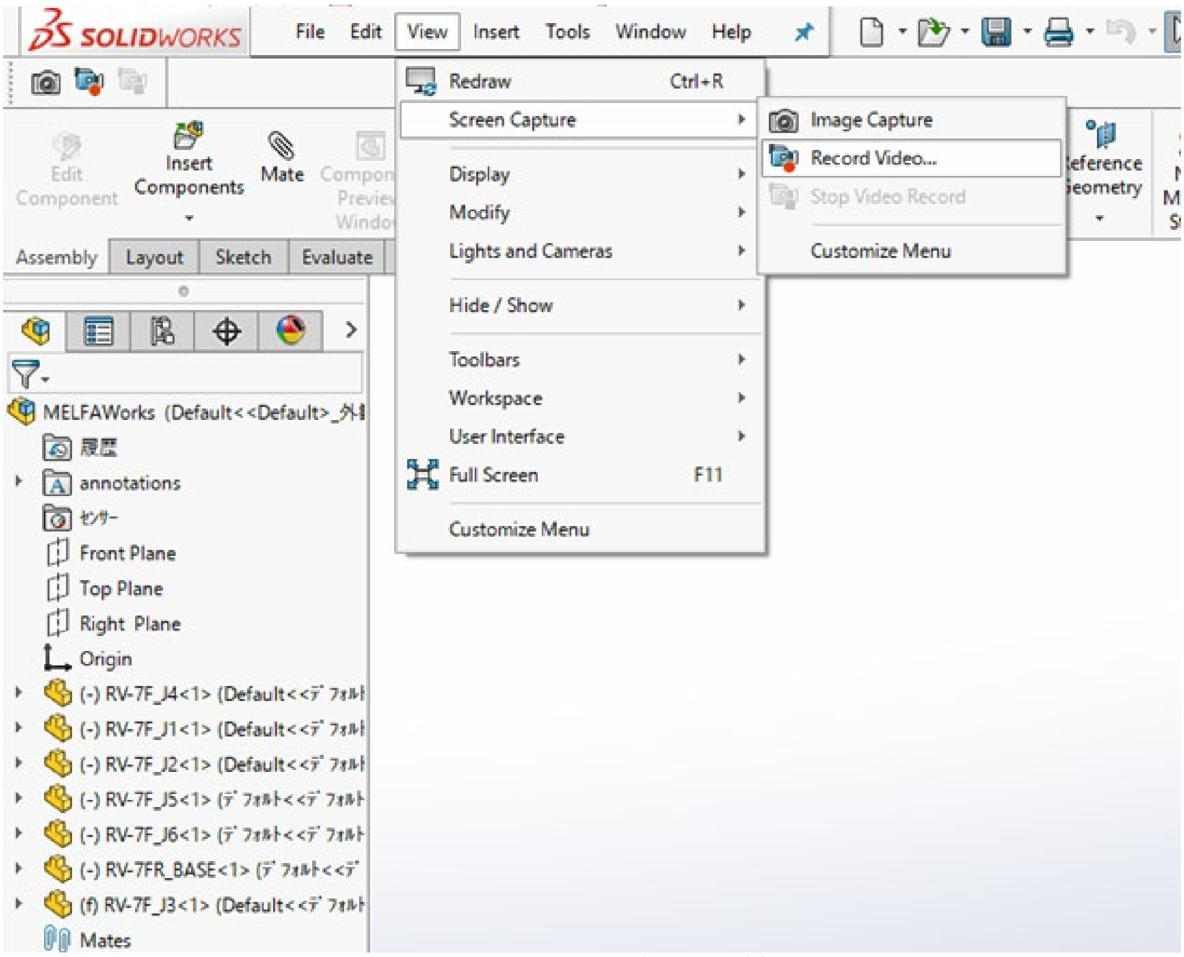


Figure 12-5 Record video function of SolidWorks.

Caution

About the recordiable time

The recordable time is affected by the screen size of the Solidworks screen and the frame rate.
To extend the recording time, reduce the screen size or the frame rate. If the initial screen size and frame rate is 20, it can be recorded for about 2GB(about 4 minutes).

About codec

The recorded video is saved and compressed with codec [Microsoft Video 1]. If you can not see the recorded video, please play on a computer environment that corresponds to the codec [Microsoft Video 1].

About display position of SolidWorks screen

Please record with the display of the SoliWorks screen visible. If the SoliWorks screen is hidden behind other windows, correct video data can not be acquired.

13. Tree/Property

MELFA-Works tree is displayed when you start MELFA-Works.
That tree is illustrated in the figure below, registered MELFA-Works robot, frame, work flow, hand, ATC master, ATC tool, work, parts will be shown.
When you want to know how to categorize the parts, please see “Chapter 4.2 Part Names and Marking”. Component which were not categorized by the identifier is treated as a parts.

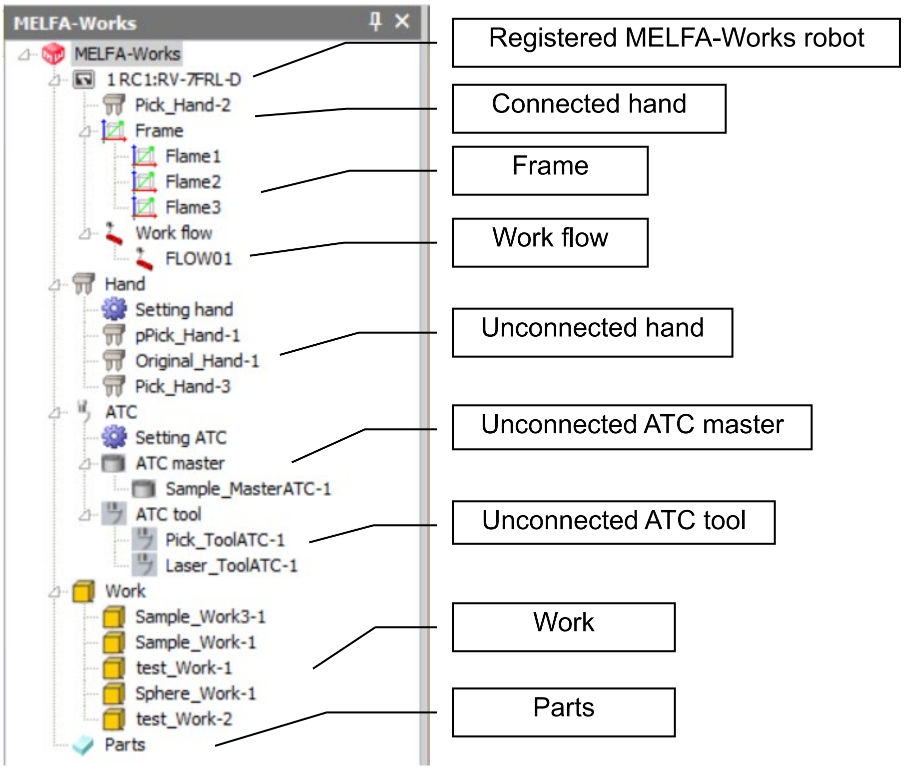


Fig. 13-1 MELFA-Works tree

13.1. Tree operations

You can connect / disconnect hand, ATC master and ATC tool by drag and drop on the MELFA-Works tree. To connect, you drag disconnected hand, ATC master and ATC tool that is listed in the MELFA-Works tree to the robot. If it is possible to connect to the robot, the dragged hand etc will be connected to the dragged robot.

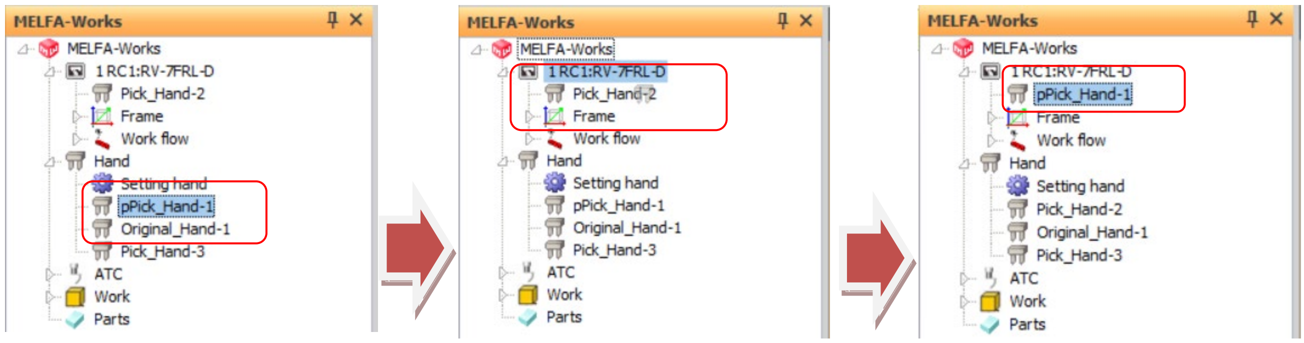


Fig. 13-2 The hand/ATC master/ATC tool connection process by drag

To disconnect, you drag connected hand, ATC master and ATC tool that is listed in the MELFA-Works tree out to position where does not show anything. They are disconnected.

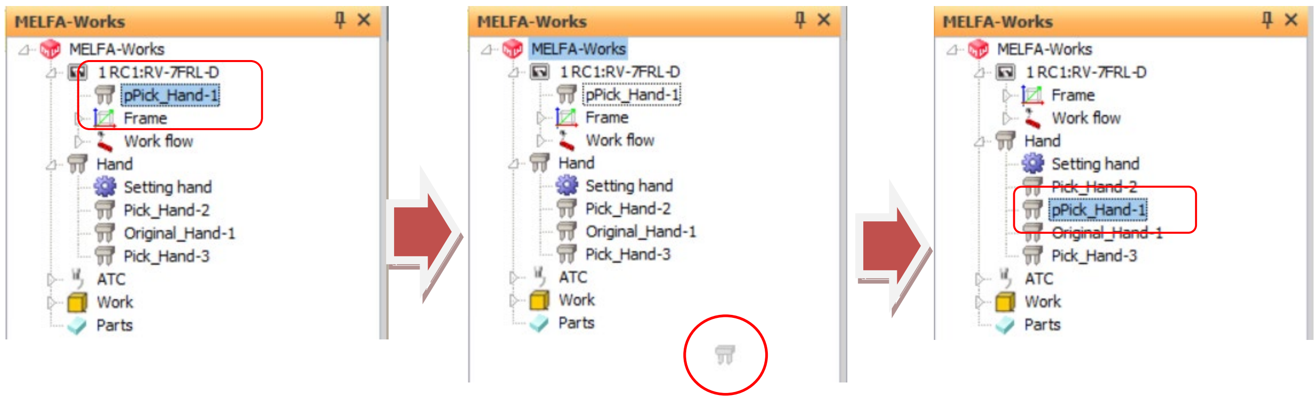


Fig. 13-3 Dragging a hand ATC master ATC tool disconnection process

If you open hand setting screem, you can not connect / disconnect hand. Also ATC setting screen is opend, you can not connect / disconnect ATC master and ATC tool.

You can open each setting screen from the context menu that appears when you right-click the item in the MELFA-Works tree.
In the context menu actions is outlined in the following table.

Table 13-1 MELFA-Works tree context menu actions

The type of item	Operation
Frame	[New]: Display make frame screen.
Frame data	[Edit frame data]: Display make frame screen. (You can also do the same with double-click.) [Delete]: You delete the currently selected data. [Property]: Display property window.
Work flow	[New]: Display make frame screen.
Work flow data	[Edit teach point]: Display make teaching point and path screen. (You can also do the same with double-click.) [Edit route]: Display make teaching point and path screen. [Delete]: You delete the currently selected data.
Setting hand	[Open]: Display hand setting screen. (You can also do the same with double-click.)
Hand	[Disconnection]: Disconnect the hand. (Hand connection state only) [Set signal]: Display hand setting screen. (Hand connection state only) [Component Move]: Display hand position with setting of standard position screen. [Property]: Display property window.
Setting ATC	[Open]: Display ATC setting screen. (You can also do the same with double-click.)
ATC master data	[Disconnection]: Disconnect ATC master. (ATC master connection state only) [Set signal]: Display ATC setting screen. (ATC master connection state only) [Component Move]: Display ATC master position with setting of standard position screen. [Property]: Display property window.
ATC tool data	[Disconnection]: Disconnect ATC tool. (ATC tool connection state only) [Set signal]: Display ATC setting screen. (ATC tool connection state only) [Component Move]: Display ATC tool position with setting of standard position screen. [Property]: Display property window.
Work data	[Component Move]: Display work position with setting of standard position screen. [Property]: Display property window.
Parts data	[Component Move]: Display parts position with setting of standard position screen. [Property]: Display property window.
Save Robot/Parts position	[Save]: Save Robot/Parts position data.
Robot/Parts position data	[Put back]: Put back Robot/Parts position data. [Delete]: Delete Robot/parts position data. [Property]: Display property window.

However, if you had already display the setting screen, the display is unchanged.

13.2. Property

When you select frame, hand, ATC master, ATC tool, work, parts on the MELFA-Works tree, you can see each setting in the property and edit them.
However, depending on the item of the property, if the corresponding setting screen is opened, it may not be able to edit by the property. When you edit settings, you can set by setting screen or property after closing setting screen.

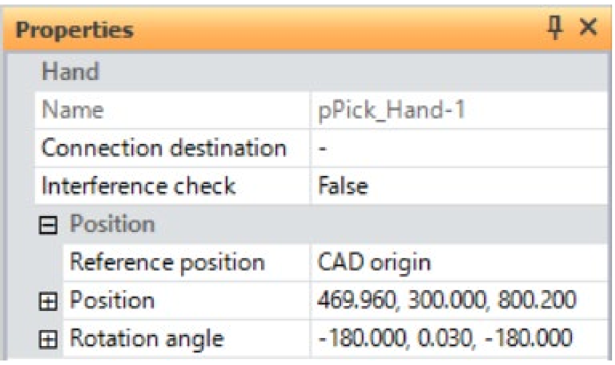


Fig. 13-4 Connect hand property example

For each item of the property, it is the same as each setting screen, so refer to the chapter corresponding to each screen.

When you select [Component origin] or [Optional coordinate] on the property [Standard Position], item of "reference parts" or "arbitrary coordinate system as reference" is displayed immediately below. With that selected, please select a part or coordinate system on MELFA-Works. Then, the name of the selected data is displayed in [Reference parts / Reference optional coordinate], and the placement position and rotation angle are changed to relative positions from reference.

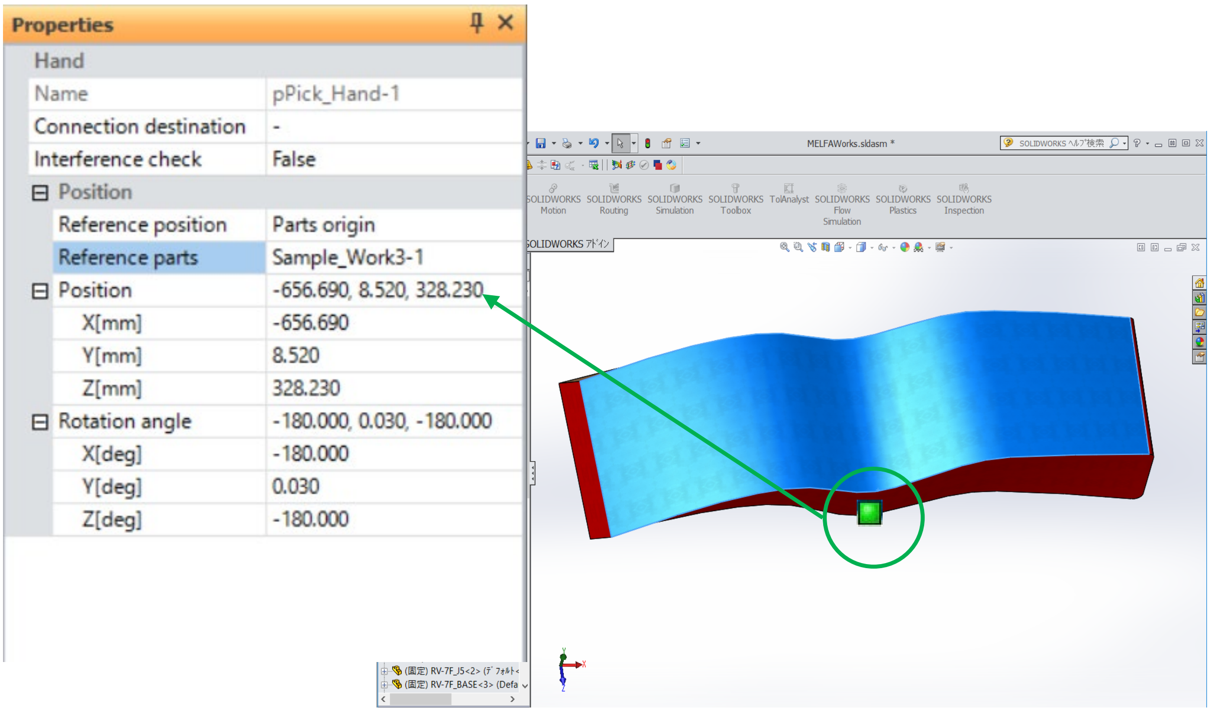


Fig. 13-5 Standard position change

14. Spline conversion

The point sequence data created in the work flow can be imported as spline data. Right-click on [Spline] item in the project tree of RT ToolBox 3 and click [New] from the context menu.

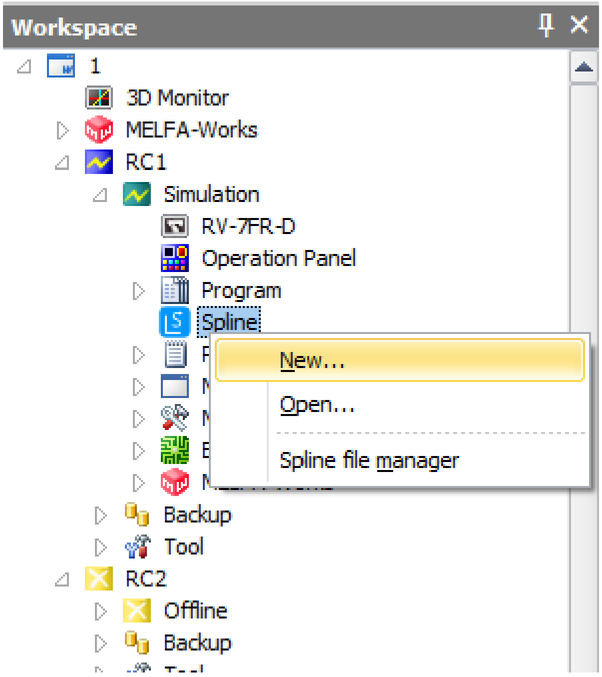


Fig. 14-1 Spline New

When you open the newly created screen, the [File] tab of the ribbon is displayed. Click [File] tab of the ribbon -> [File] group -> [import] button.

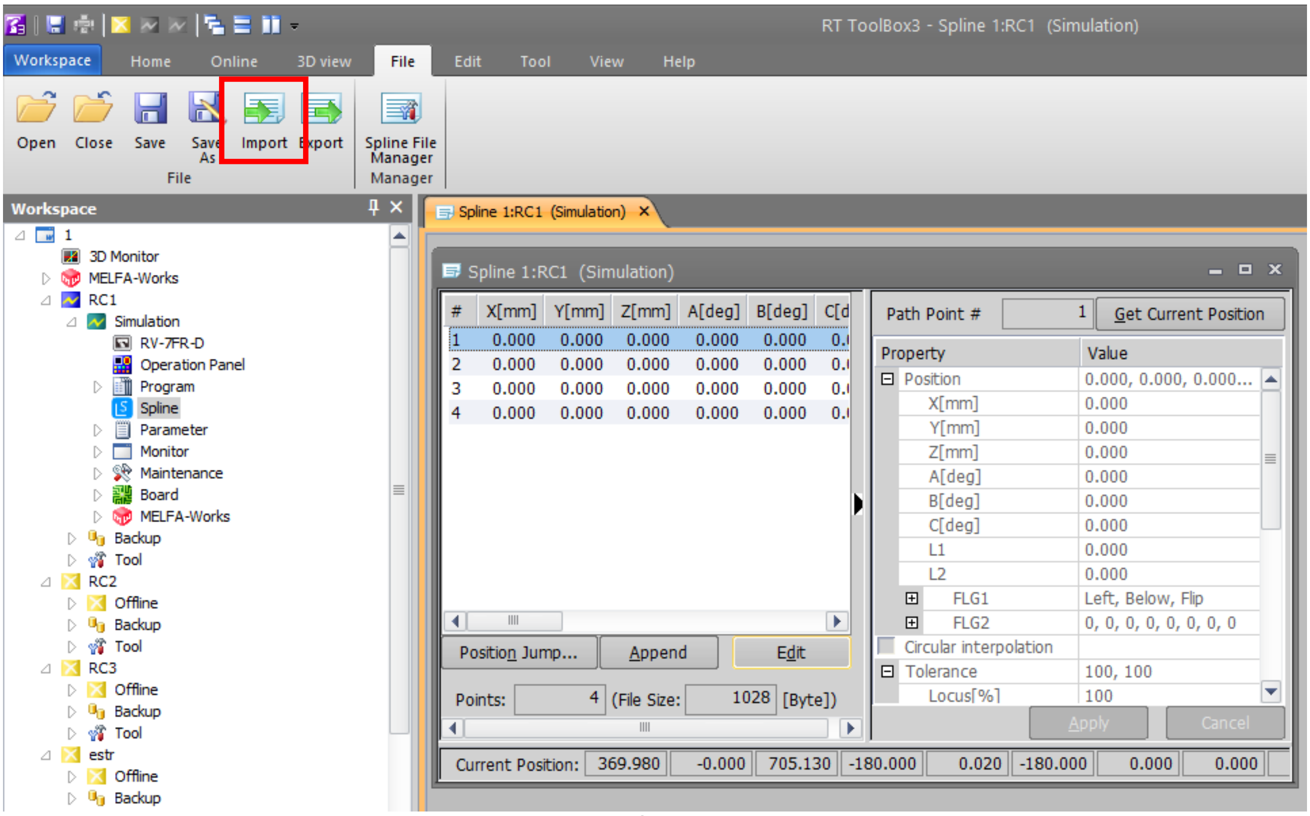


Fig. 14-2 Spline Import

Click [Import], the following file selection dialog will be opened. Here, select Mxt data generated by workflow creation and import it as spline data.

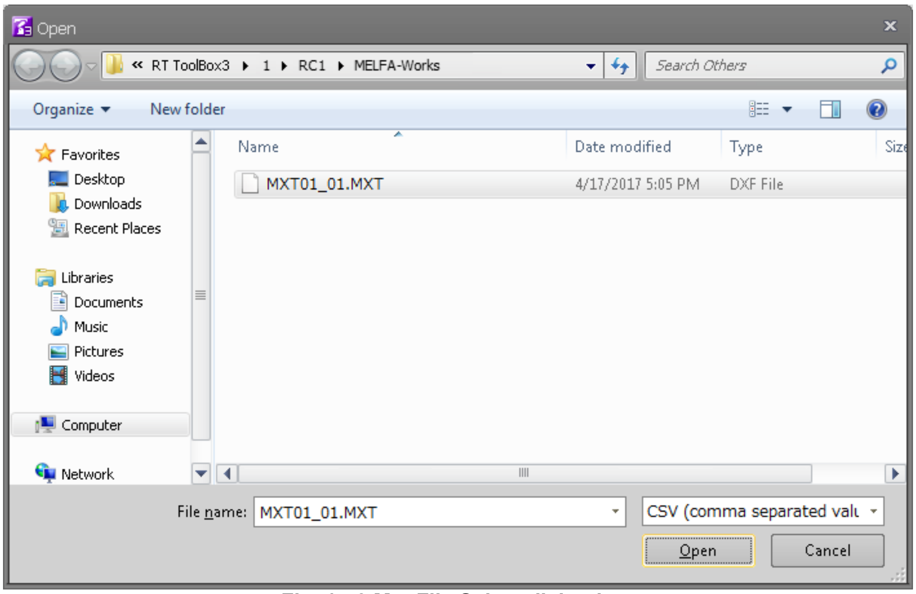


Fig. 14-3 Mxt File Select dialog box

After selecting the Mxt file, set the tolerance on the following import setting screen. After entering the tolerance setting, click the OK button.

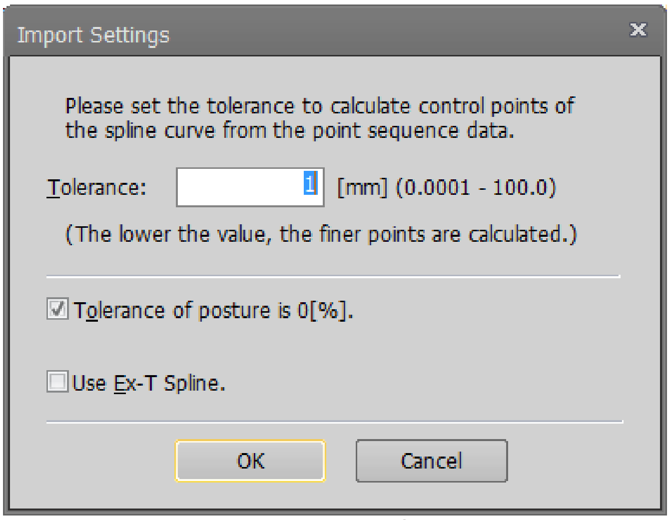


Fig. 14-4 Tolerance Setting

When point sequence data of Mxt is captured as spline data as follows, spline conversion is completed.

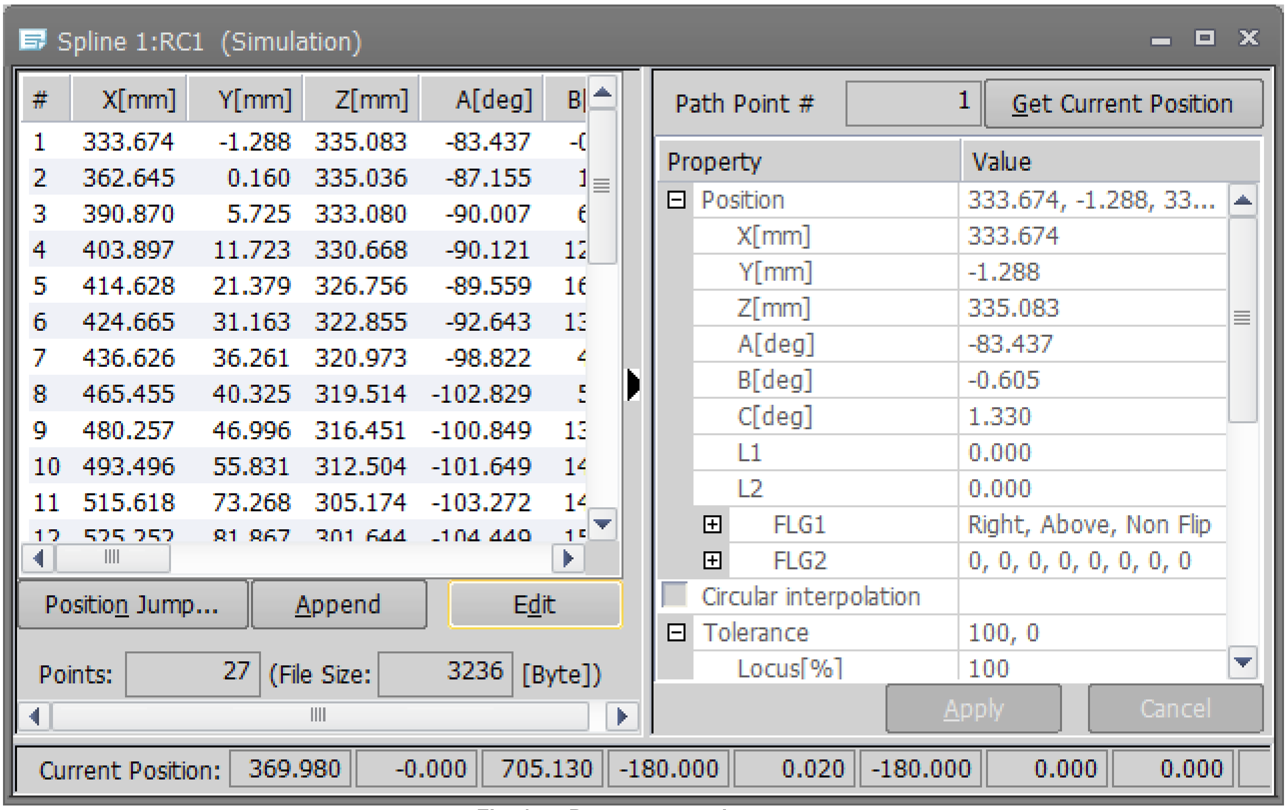
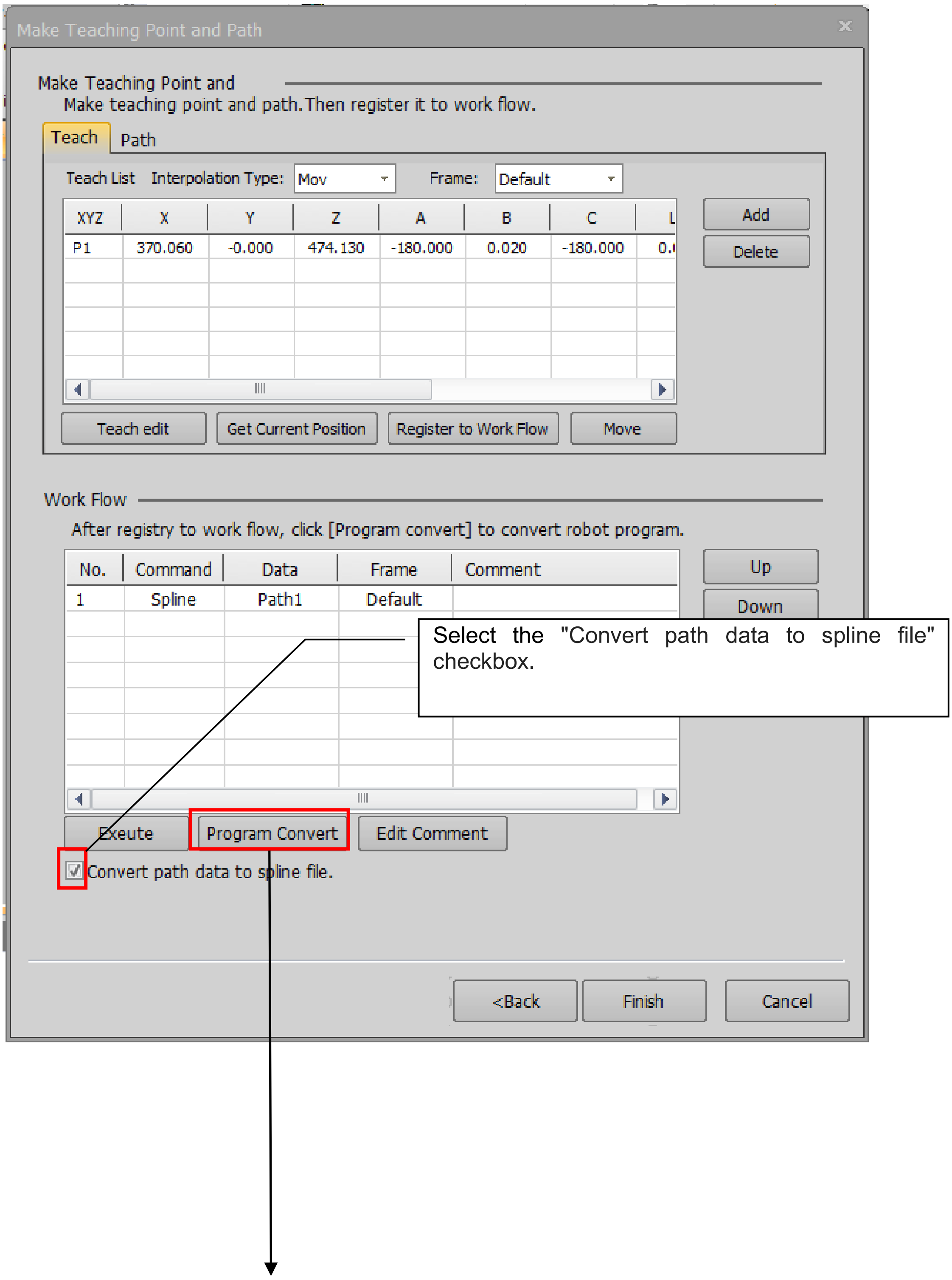


Fig. 14-5 Dot sequence data

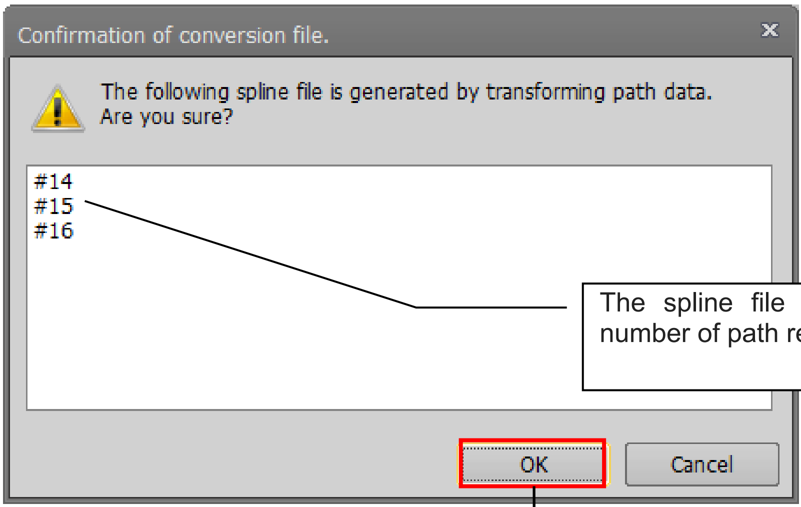
14.1. Convert the path to spline on work flow creation screen

When the version of RT ToolBox 3 is 1.30G or later, the path can be converted directly to a spline file when executing program convert on the creation of work flow screen.With the path registered to the work flow, select the "Convert path data to spline file" checkbox and click the [Convert Program] button.

When you click the [Convert Program] button, the spline file creation confirmation screen is displayed, then the spline import setting screen will be launched. When you set a value on the import setting screen and click the [OK] button, the path data is converted to a spline file, and the robot program that operates on the generated spline file is generated.

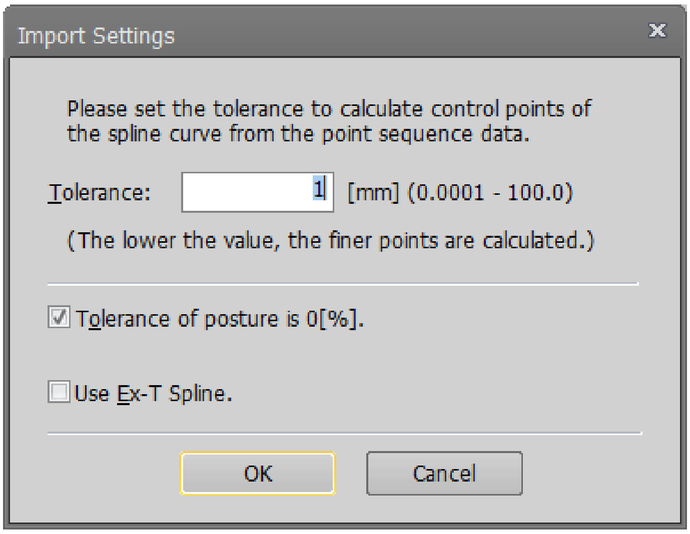


Spline file creation confirmation screen



The spline file is generated as many as the number of path registered to the work flow.

Spline file import setting screen



15. Calibration

Calibration is a task to correct deviation between the system composed of CAD and the actual system. These tasks are carried out by "calibration tool". The flow of the calibration work is as follows. In addition, only point sequence data is corrected by calibration.

Specify an MXT file (*.MXT) output from MELFA-Works and load the corresponding dot sequence data.

↓

Positional calibration

Transfer a calibration program for positional calibration to the robot controller.

↓

Teach the position variables of the calibration program to the robot.

↓

Load the calibration program into the tool.

↓

Correct the positions of the dot sequence data based on the loaded calibration program.

↓

Distortion calibration

Transfer a program for distortion calibration to the robot controller.

↓

Teach the robot such that it is moved to the correct position in accordance with the dot sequence.

↓

Load the program for distortion calibration to the tool.

↓

Calibrate the distortion of the dot sequence data based on the loaded program for distortion calibration.

↓

Transfer the calibrated dot sequence data to the robot controller.

↓

Create a program that uses the dot sequence data on the robot.

The calibration methods can largely be divided into “positional calibration” and “distortion calibration,” and they have the following features.

Item	Explanation
Positional calibration	Calibrate the layout of the entire dot sequence data set. With this method, it is possible to correct deviations due to system assembly errors such as deviations between specified and actual robot and work station positions. Based on position deviations between 3 points specified in the CAD software and the corresponding actual points, the parallel and rotational component deviation in each coordinate system is calculated, and the entire dot sequence is calibrated accordingly.
Distortion calibration	Calibrate the specified part of the dot sequence data set. With this method, it is possible to correct deviations due to distortion of the workpiece itself and hand mounting errors. Specify the start and end of a part of the dot sequence data set for which position deviations should be calculated. Then teach several deviating points to the robot in order to correct the points in the specified sequence.

15.1. Starting the Calibration Tool

After connecting RT ToolBox 3 in online or simulation mode, please select the following items from the project tree in the workspace.

[Online](or [Simulator]) - [MELFA-Works] – [Calibration Tool]

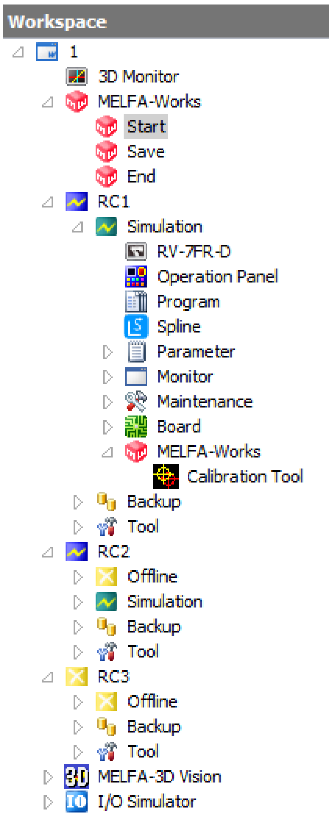


Fig. 15-1 Calibration Tool

15.2. Explanation of the Calibration Tool Window

The screenshot below shows the main window of calibration tool. This window is mainly used to check dot sequence data.

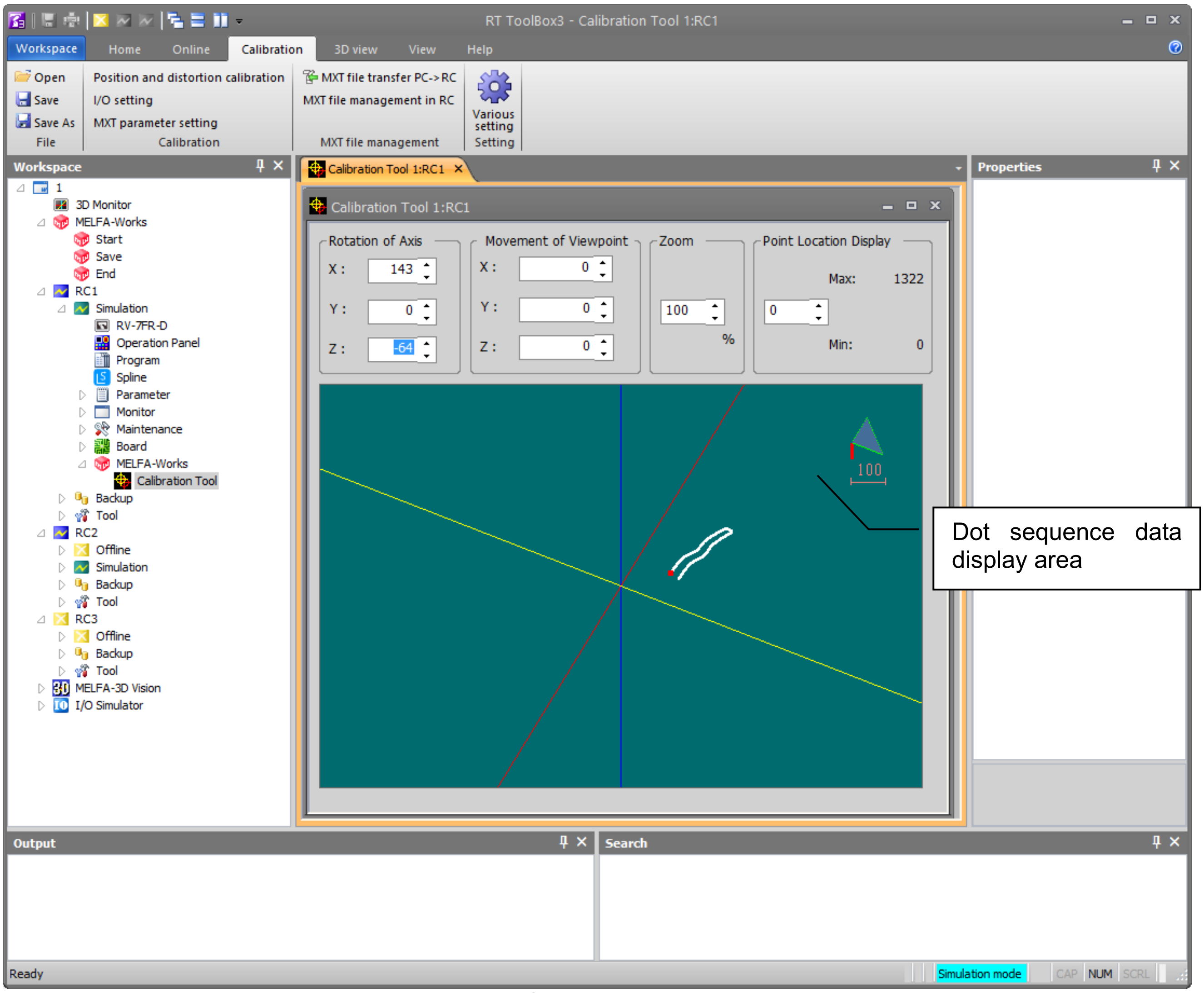


Fig. 15-2 Calibration Tool Window

Table 15-1 Operations in the Calibration Tool Window

Item	Explanation
Rotation of Axis	Change the rotation angles of the coordinate axes in the dot sequence data display area by entering values directly or clicking the up/down button for each axis. It is also possible to change the angle by operating the mouse while clicking the Wheel button.
Movement of Viewpoint	Change the amount of parallel movement of the viewpoint in the dot sequence data display area by entering values directly or clicking the up/down buttons for each axis. It is also possible to change the amount by keeping the [Ctrl] key pressed and clicking the Wheel button of the mouse.
Zoom	Set the zoom scale of the dot sequence data display area by entering a value directly or clicking the scale up/down button. It is also possible to change the zoom scale by clicking the Wheel button, or keeping the [Shift] key pressed and then clicking the Wheel button.
Point Location Display	Displays the specified sequence of points in red.
Dot sequence data display area	Displays the loaded dot sequence data. The point “Point Location Display” specifies is displayed in red.

15.3. Open MXT file

Select [Calibration] tab of the ribbon -> [File] group -> [Open] button specify an MXT file (*.mxt) output from MELFA-Works and load the dot sequence data.
MXT files contain data generated when creating work flows (refer to **10.5** “**Robot program conversion**”)

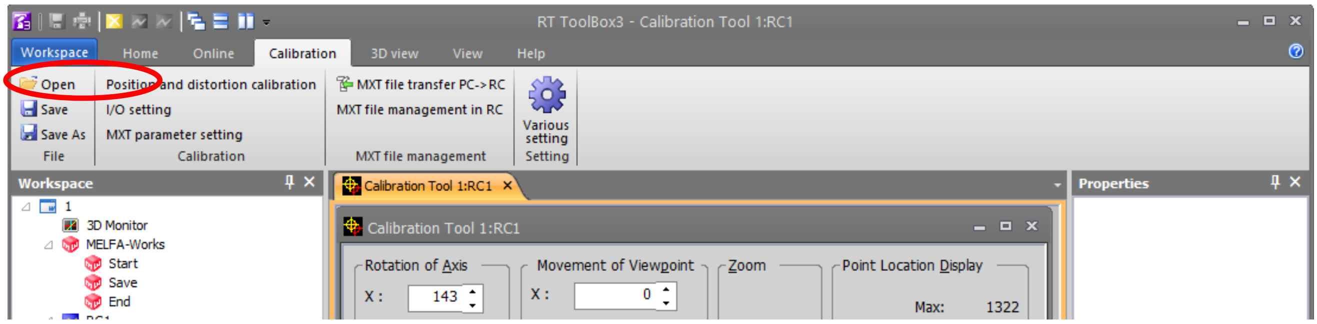


Fig. 15-3 Open MXT file

15.4. Executing Calibration

When reading of the MXT file is completed, select the [Position and Distortion Calibration] button on the [Calibration] tab of the ribbon -> Calibration group to display the position / distortion correction screen.
Calibration can be carried out by performing operations in the order displayed in the dialog box.

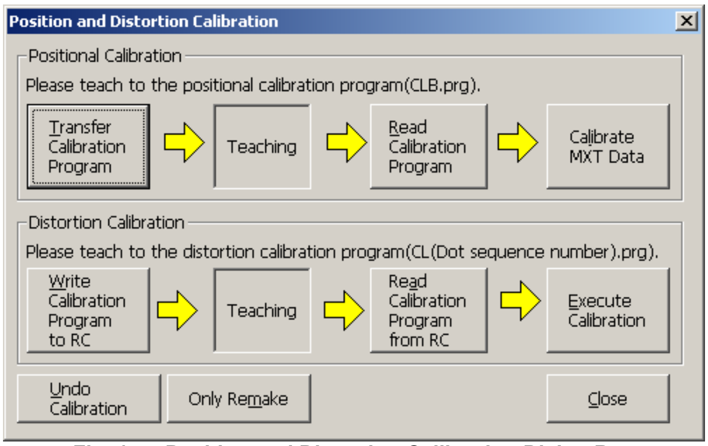


Fig. 15-4 Position and Distortion Calibration Dialog Box

Table 15-2 Operations in the Position and Distortion Calibration Dialog Box

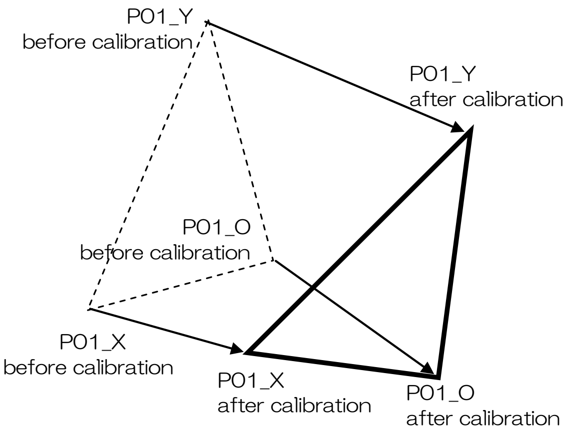
No.	Calibration method	Item	Explanation
1	Positional calibration	[Transfer Calibration Program] button	Transfers the calibration program to the selected robot controller. The program transferred here is the calibration program (CLB.prg), which is stored in the same folder as the loaded dot sequence data set.
2		[Teaching] (display only)	After transferring the calibration program, use a teaching box or similar to perform teaching. See the detailed instruction procedure in Chapter 14.5.
3		[Read Calibration Program] button	Reads the calibration program (CLB.prg) from the robot controller after teaching.
4		[Calibrate MXT Data] button (dot sequence)	Calibrates positions of dot sequence data. Use a calibration program (CLB.prg) uploaded from the robot controller to calibrate a dot sequence data set.
5	Distortion calibration	[Write Calibration Program to RC] button	Generates a distortion calibration program (with the name CL (dot sequence number).prg) and transfers it to the robot controller.

No.	Calibration method	Item	Explanation
6		[Teaching] (display only)	After transferring the distortion calibration program, use a teaching box and similar to perform teaching. See the detailed instruction procedure in Chapter 14.6.
7		[Read Calibration Program from RC] button	Reads the distortion calibration program (CL (dot sequence number).prg) from the robot controller after teaching.
8		[Execute Calibration] button	Calibrates distortion of dot sequence data. Use a distortion calibration program (CL (dot sequence number).prg) uploaded from the robot controller to calibrate positions of the dot sequence data set.
9		[Undo Calibration] button	Click the button to return the dot sequence data set to the initial status before calibration.
10		[Only Remake] button	Reconfigures a dot sequence data set with the current settings without performing positional or distortion calibration. Use this function to test a dot sequence data before calibration to the robot or MELFA-Works.

15.5. How to teach the positional calibration program (CLB.prg)

Select [Transfer Calibration Program] button on “Position and Distortion Calibration” window, the program named “CLB.prg” is transfered to the controller. This program contains the positions for calibration which is set on the work flow creation screen.
Register the correction position in the program for positional calibration as the following procedures.

1. Using the teaching box (T/B) which is connected to the controller, set “CLB.prg” program to edit mode.
2. Execute tool command by step in the program. **Calibration is impossible unless this command is executed.**
3. Move the robot to each positions in this program (P**_O, P**_X, P**_Y(Each [**]is calibration data number in MELFA-Works)). At this time, be carefull to avoid collision to peripherals.
4. If the positions that were moved and which were set on MELFA-Works are shifted, move the robot to the position which is corresponds to an actual system and teach again.
5. Please operate the above-mentioned by all the registered position data.



(Calibration program sample)

```
10 ERROR 9199
20 TOOL (50.0, 0.0, 40.0, 90.0, 0.0, 90.0)
30 'CLB 01
40 MOV P01_O
50 MOV P01_X
60 MOV P01_Y
70 '
80 'CLB 02
90 MOV P02_O
100 MOV P02_X
110 MOV P02_Y
:
```

Auto operation stop line

Execute step and set tool.

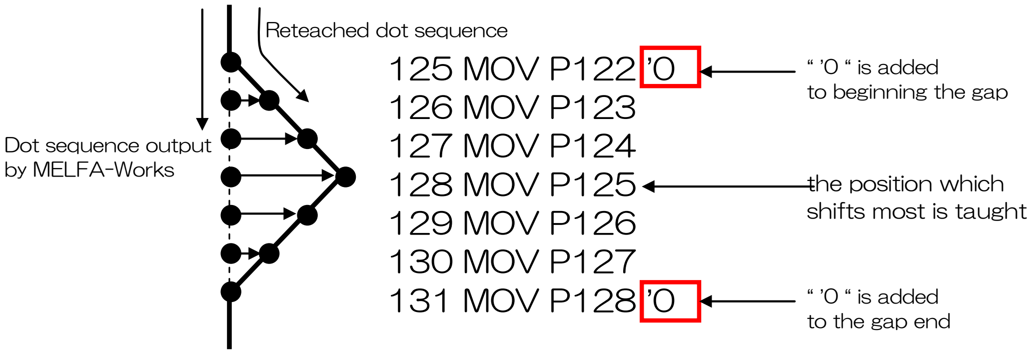
Checking the calibration position.

15.6. How to teach the distortion calibration program(CL(dot sequence number).prg)

Select [Write Calibration Program to RC] button on “Position and Distortion Calibration” window, the program named “CL(dot sequence number)” is registered in the controller. This program is contained all dot sequence positions.
Register the correction position in the program for distortion calibration as the following procedures.

1. Using the teaching box (T/B) which is connected to the controller, set “CL(dot sequence number)” program to edit mode.
2. Move the robot to each positions in this program, check the position set on MELFA-Works whether shift. At this time, move the robot noting no collision to peripherals.
3. If there is shift between moved position and a position set on MELFA-Works, “ ’0 “ is added to move

operation of beginning the gap and gap end position, and the position which shifts most is taught as shown in the figure below.



15.7. Transferring Dot Sequence Data to Robot Controller

When all calibration is finished, transfer the dot sequence data to the controller.
Select the [Calibration] tab of the ribbon -> [MXT file management] group -> [MXT file transfer PC->RC] button to display the Transfer Confirmation of MXT File dialog box.

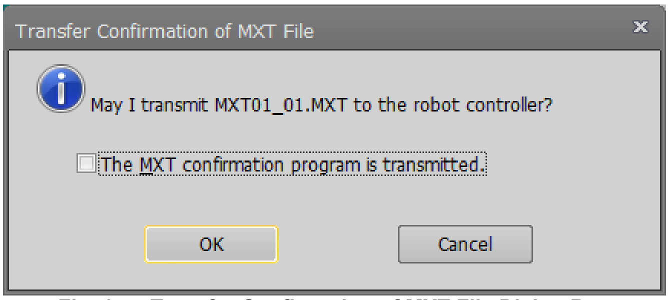


Fig. 15-5 Transfer Confirmation of MXT File Dialog Box

Click the [OK] button in this dialog box to transfer a dot sequence data set for which calibration has been completed to a robot controller. Also, by enabling the [The MXT confirmation program is transmitted] check box, it is possible to create a program (with the name 0101.prg) for confirming the robot movement and transfer it as well.

Using a program for movement confirmation will make the subsequent creation of robot programs easier.

CAUTION

Check movement carefully.

MXT instructions are used in movement confirmation programs (See **15.2** "**Mxt Instruction (Move According to External Instruction)**"). When using MXT instructions, the normal robot movement instructions are not used. Instead, the robot moves via commands from external sources (files or communication); it is thus **not possible to control the speed by the override specification** from a robot controller.
In order to avoid dangerous situations, pay attention to the following points and check the robot movement carefully.

- Always hold the TB with your finger over the stop button so operation can be stopped whenever needed.
- Create dot sequence data at a lower speed. (See **14.9** "**Movement Setting Change**")
- Start up while physically separated from the robot.
- Start from a status without any workpiece.

15.8. Managing Dot Sequence Data in Robot Controller

The amount of dot sequence data that can be transferred to a robot controller is limited; use the MXT File Control in Robot Controller dialog box to delete unnecessary dot sequence data within a controller.
Select [Calibration] tab of the ribbon -> [MXT file management] group -> [MXT file management in RC] button to display the MXT File Control in Robot Controller dialog box.

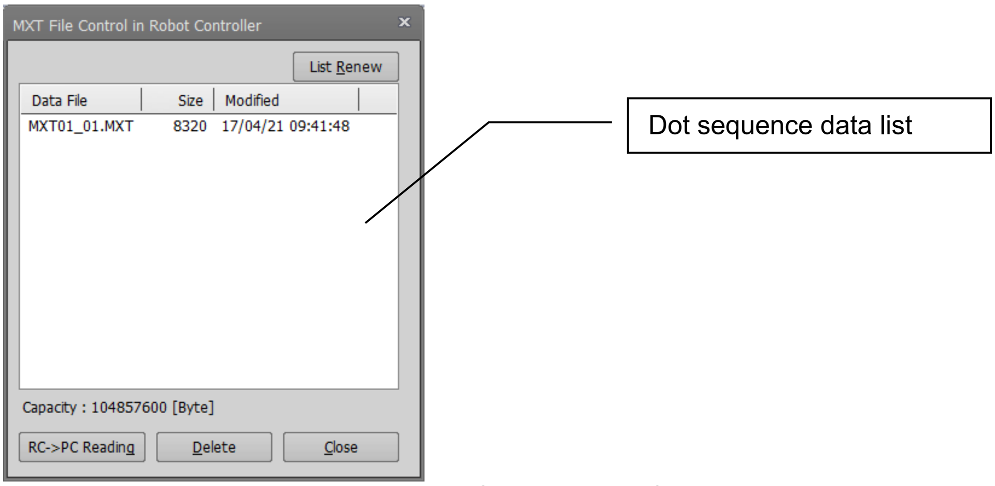


Fig. 15-6 MXT File Control in Robot Controller Dialog Box

Table 15-3 Operations in the MXT File Control in Robot Controller Dialog Box

No.	Item	Explanation
1	Dot sequence data list	Displays a list of dot sequence data existing in a robot controller.
2	[RC → PC Reading] button	Click this button to upload the dot sequence data set in a robot controller and save it in a specified folder on the personal computer.
3	[List Renew] button	Click this button to browse through the dot sequence data set in a robot controller and refresh the contents of the dot sequence data list.
4	[Delete] button	Click this button to delete dot sequence data selected from the dot sequence data list from the robot controller.
5	[Close] button	Click this button to finish MXT file management and close the dialog box.

15.9. Movement Setting Change

The operation setting such as the maximum speed is done in MELFA-Works work flow creation screen, but use this screen when changing again from that state.
Select [Calibration] tab of the ribbon -> [Calibration] group -> [MXT parameter setting] button to display Movement Setting Change screen.

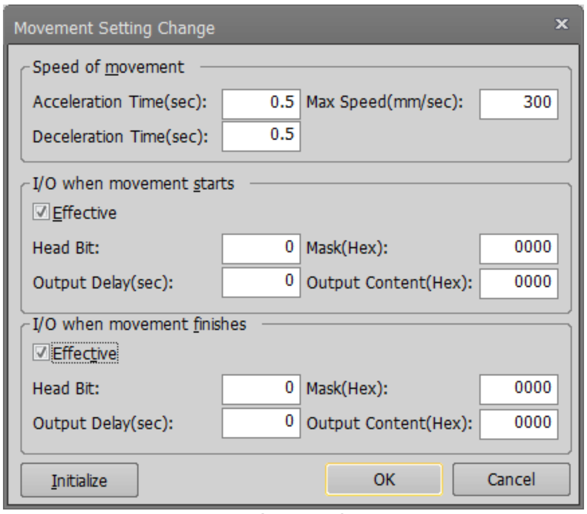


Fig. 15-7 Movement Setting Change Dialog Box

When this screen is shown, it displays the current state. Set only the changed item, and click the [OK] button. The state of the output signal changed on the screen in Chapter 14.10 is overwritten.

15.10.Editing Output Signal Status

The output signal of the entire dot sequence is set by MELFA-Works, but on this screen you can edit the state of the output signal for each point. You can use this function to control the I / O output in detail.
Select [Calibration] tab of the ribbon -> [Calibration] group -> [I/O setting] button to display the I/O Output Setting dialog box.

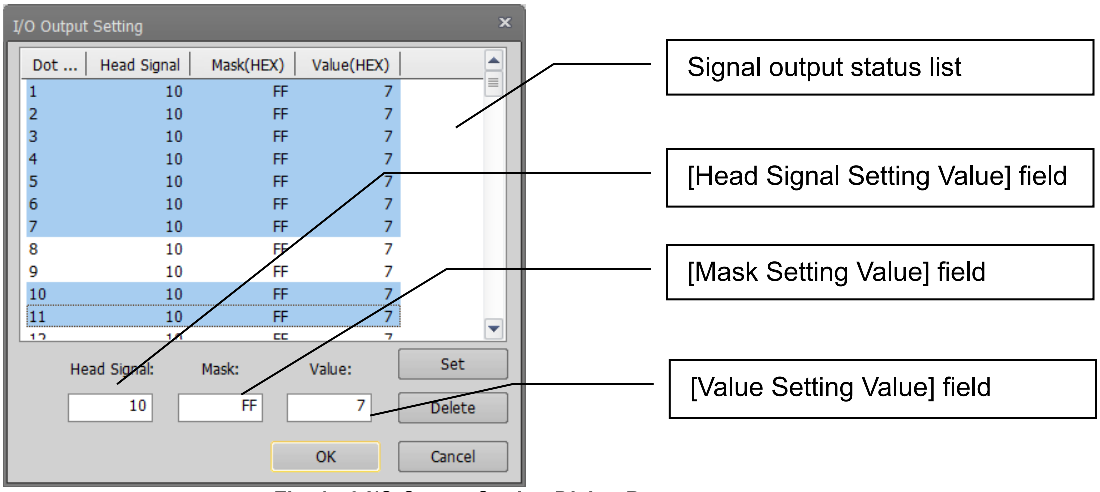


Fig. 15-8 I/O Output Setting Dialog Box

Table 15-4 Operations in the I/O Output Setting Dialog Box

No.	Item	Explanation
1	Signal output status list	The output signal status list displays the states of the output signals of all points. Select a point you want to modify from this list and set the output value in the corresponding text box.
2	[Head Signal] field	Specify the head bit to be output (decimal expression).
3	[Mask] field	Specify up to 16 bits that are permitted to be output, starting from the head bit (hexadecimal expression).
4	[Value] field	Specify the value to be output, starting from the head bit (hexadecimal expression). Only bits for which the corresponding mask bits are turned on are actually output.
5	[Setting] button	Sets the I/O output settings that have been made in this dialog box.
6	[Delete] button	Deletes I/O output settings that have been made.
7	[Cancel] button	Does not set any I/O outputs; instead, closes the dialog box.
8	[OK] button	Sets I/O outputs and closes the dialog box.

15.11.Change error tolerance when calibration

When dot sequence is reconstructed with the distortion correction etc., the error margin is caused in the process of the calculation. This screen is used to change the value (default value is 0.01mm).
Select [Calibration] tab of the ribbon -> [Setting] group -> [Variouse setting] button to display Various Settings screen.

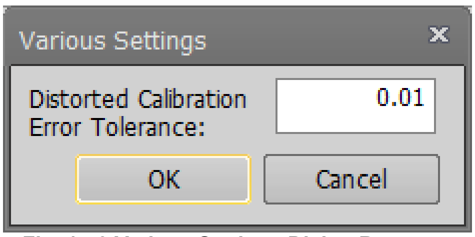


Fig. 15-9 Various Settings Dialog Box

If the value is reduced, the accuracy at the distortion calibration etc. goes up. But the distance of dot sequence which can be corrected, shortens the accuracy or the distance of the dot sequence.
Use default vaule if there is no probrem for accuracy or the distance of dot sequence.

16. CAD Link Programming

So far it has been finished to create dot sequence data, perform calibration and transfer programs for test operations. This chapter explains how to construct an actual system using created data.
The CAD link function supports **MELFA-BASIC Ⅳ、MELFA-BASIC Ⅴ、MELFA-BASIC Ⅵ**language.

The following files are generated in the process of using the CAD link function.

Table 16-1 Files Output by the CAD Link Function

No	File name	Purpose/generation method
1	FLOW.prg	“Work program” This file contains a program converted from a work flow. Copy and use it as a template for your own programs.
2	O1O1.prg	“Movement confirmation program” This file contains sample programs for actually moving a robot using dot sequence data. * The file name is generated automatically according to the naming rule.
3	MXT**_**.MXT	“Dot sequence data (MXT data)” set This file contains dot sequence data describing robot movement along a workpiece. Downloading this file to a robot controller allows a robot to smoothly trace along the edge of a workpiece. This file is created by MELFA-Works and calibrated by the calibration tool. * The file name is generated automatically. After calibration is completed, change the name as necessary and use the file.
4	CLB.prg	”Calibration program” This file contains a robot program used in calibration. Executing this program allows teaching calibration points and calculating calibration values based on the results of teaching. This program is created by MELFA-Works and downloaded/uploaded by the calibration tool to/from a robot. The calibration tool uses the calibration program in the current folder as the source of dot sequence data. * The file name is fixed.
5	MXT**_**.cal	“Dot sequence data before calibration” This file contains dot sequence data before calibration. * The file name is the same as for the dot sequence data set above, but the extension is "*.cal."
6	CLB. cal	“Calibration program before teaching” This file contains a calibration program before teaching. * The file name is fixed.

16.1. Verifying Movement Confirmation Program

The movement confirmation program is structured as follows.

1 'MXT Sample Program (MXT01_01.MXT)
Comment line
2 Tool (+0.00,+0.00,+231.00,+0.00,+0.00,+0.00)
Set installed tool data. The tool data is calculated from the hand used when dot sequence data is output from MELFA-Works and set as the default value. This is required when creating an operational program as well.
3 Close #1
Close file #1 before loading a dot sequence data set. If the file is left open after the previous processing, an error occurs in the Open instruction in line 4. For this reason, it is typical practice to include a Close instruction before the Open instruction in order to prevent unnecessary errors.
4 Open "MXT:MXT01_01.MXT" As #1
Open the dot sequence file as file #1.
5 Mov P_Mxt
Move to the beginning of the currently opened dot sequence data set. At the Mxt instruction on line 6, the robot moves according to the dot sequence data set; an error may occur if the current position and the head position are different. For this reason, the robot is moved to the position indicated by the first element in the dot sequence data set in advance.
6 Mxt 1,0
Move the robot according to dot sequence data of file #1. A detailed explanation of using the Mxt instruction is found in “15.2 Mxt Instruction (Move According to External Instruction).”
7 Close #1
Close file #1.
8 Hlt
Stop the program.
9 End
End of the program.

* The speed with which the Mxt instruction is executed cannot be controlled by the override specification of a controller; exercise caution when checking movement.

As can be seen with the example program for movement confirmation, a program is created in the following sequence to move a robot on dot sequence.

(1) Set a tool.
(2) Open dot sequence data.
(3) Move to the beginning of the dot sequence data set.
(4) Move through the dot sequence data set using the Mxt instruction.

This sequence is the same even when there are multiple dot sequence data sets to be traced.

16.2. Mxt Instruction (Move According to External Instruction)

With the Mxt instruction, data can be acquired not only from a file but also via Ethernet communication. In this section, it is explained how to acquire data from a file.

[Function]
Move a robot directly by acquiring absolute position data from a file in each control sample interval. The file is specified by the Open instruction.

[Format]
Mxt <file number>, <instructed position data type>[, <filter time constant>]

[Terminology]

<File number>	Specify a number in the range from 1 to 8; this value must match a file number assigned with the Open command. If the file specified to be loaded has not been opened with the Open command, an error occurs and a robot does not move.
<Instructed position data type>	Specify the type of position data commanded from the personal computer. Either XYZ or joint coordinate position data can be specified. 0: XYZ coordinate data 1: Joint coordinate data
<Filter time constant>	Specify a filter time constant (msec). If 0 is specified, no filtering is applied (0 is set by default if the specification is omitted). Apply filtering to position data to create dampened instruction values and output to the servo.
<File name>	Specify the name of the position data file loaded with the Mxt instruction.

[Example]

```
1 Open "MXT:SAMPLE.MXT" As #1      ' Open the SAMPLE.MXT file.
2 Mov P1                           ' Move to P1.
3 Mxt 1,0                          ' Move according to the real-time external control.
4 Close #1                         ' Close the file.
5 Hlt
```

[Explanation]
- By executing the Mxt instruction, it is possible to acquire position commands for movement control from the MXT file (format is explained later) specified by an Open instruction.
- In each movement control sample interval, one position command is acquired and the robot is moved accordingly.
- Operation of the Mxt instruction
  (1) When this instruction is executed with the controller, data is loaded sequentially from the MXT file and the robot moves to the specified position.
  (2) When all data in the MXT file is loaded, the Mxt instruction is completed.
  (3) If the movement is stopped via the operating panel or external input, the Mxt instruction is paused and remains in the paused status until it is resumed.

[Format of dot sequence data (reference)]
- The file specified as the source of position data must be a comma-separated text format file.
- If an apostrophe (‘) is placed at the beginning of a line, the line is regarded as a comment line.
- The format is as shown below ([1] or [2]).
  [1] XYZ data format : 1,<X>,<Y>,<Z>,<A>,<B>,<C>,<L1>,<L2>,<FL1>,<FL2>,
  <Presence of output 1/0>,<head bit number>,
  <Hexadecimal mask pattern 0000 to ffff>,<output data>
  [2] Joint data format : 2,<J1>,<J2>,<J3>,<J4>,<J5>,<J6>,<J7>,<J8>,
  <Presence of output 1/0>,<head bit number>,
  <Hexadecimal mask pattern 0000 to ffff>,<output data>
- The units are; XYZ component = mm, angle data = radian.
- Specify either XYZ or joint data format (cannot be changed in the middle).

16.3. P_Mxt Variable

[Function]

Load the position data of the starting point from the currently opened file. Note that this file must be a position data file that meets the requirements for being used by the real-time external control function (Mxt instruction). If a file has not been opened, all position data points are automatically assumed to be equal to the P_Zero variable (all axes at positioned at 0).

[Format]

```
<Position variable>=P_Mxt
```

[Terminology]

<Position variable> Specify a position variable that assigns loaded position data.

[Example]

```
1 Open "MXT:SAMPLE.MXT" As #1      ' Open the position data file.
2 Mov P_Mxt                        ' Move to the starting point of the file.
3 Mxt 1,0                          ' Move according to the real-time external control.
4 Close #1
```

[Explanation]

(1) Load the position variable for the starting point from the position data file of the real-time external control function (Mxt instruction).

(2) If the position data file of the real-time external control function (Mxt instruction) has not been opened, all position data points are automatically assumed to be equal to the P_Zero variable (all axes at positioned at 0).

(3) If a position data file meeting the requirements for being used by the real-time external control function is not used or there is no dot sequence data, the following error occurs when executing the Open instruction. The P_Mxt variable assumes that all position data points are equal to the P_Zero variable (all axes at positioned at 0).

Error number	Cause of error occurrence and countermeasure	
L7850	Error message	Cannot read MXT position file (Cannot load MXT position file that can be used by the Mxt instruction.)
	Cause	Illegal MXT position file (Not a position data file that can be used by the Mxt instruction.)
	Countermeasure	Correct MXT position file (Specify a position data file that can be used by the Mxt instruction.)

If the argument is set wrongly such as P_Mxt(1), an abnormal argument error occurs.

16.4. Precautions

(1) If the Mxt instruction is stopped in the middle, the robot maintains the position it had when the instruction was stopped. Due to this, the on status of the output signal is also maintained; the robot continues processing although it is stopped. In this case, turn the output signal off using the following method.

- Execute robot programs that have a signal initialization routine.
- Create an ALWAYS program and initialize (reset) the signal when the robot stops unexpectedly due to an error or robot stop, etc. See the instruction manual for that robot unit for more information on the ALWAYS program.
- Turn the signal off manually from the teaching box.

(2) The Mxt instruction moves the robot by loading dot sequence data. Since dot sequence data contains acceleration/deceleration information as well, if the robot is moving at high speed via the Mxt instruction, an error occurs and the robot may not be able to continue movement. For this reason, if the instruction is stopped in the middle, the safest way to continue is to evacuate the robot manually and operate it from the start.

(3) The Mxt instruction does not use interpolation by a robot controller but operates purely based on the information in dot sequence data. The speed therefore cannot be controlled via the override on the operating panel so use caution such as stopping immediately in case of unexpected movements.

(4) The Mxt instruction operates by acquiring posture data sequentially, but it may not be able to follow the robot movement perfectly; it may turn slightly inward depending on the robot speed and the curvature of a curve. Generally, this error tends to occur at higher speed or higher curvature.

(5) Robot controllers of system version K7 and later support the CAD link functions. (CRn-500)

(6) Extension memory can be used since Version K8 of robot controller. (CRn-500)

(7) Extension memory can be used since Version P7 of robot controller. (CRnD-700)

17. Appendix

17.1. Q&A

1. Monitor

(1) The Solid Works monitor does not work.

Solid Works has a feature called "Lightweight Mode".

If the robot model is heavy, it may automatically load in lightweight mode.
Note that robot models loaded in lightweight mode will not operate.

If the Solid Works monitor does not work, it may be in lightweight mode.
Please make sure that the monitor is not set to automatically load in lightweight mode.

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