ROBOTICS

Operating manual

Machining Software

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Operating manual
Machining Software
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Original instructions.

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Overview of the manual

About this manual

This manual describes how to use Machining Software to work with machining applications on the web user interface using PC or in the MSF application using FlexPendant.

Usage

This manual should be used during the work with Machining Software.

Who should read this manual?

This manual is intended for application engineers, commissioning engineers and operators.

Prerequisites

The reader should have basic knowledge of:

- Industrial robots and their terminology
- RAPID programming language
- RobotStudio
- Machining PowerPac add-in

References

Reference	Document ID
Operating manual - IRC5 Integrator's guide	*3HAC050940-001*
Operating manual - Emergency safety information	*3HAC027098-001*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Operating manual - Machining PowerPac - Machining Functionality	*3HAC054781-001*
Technical reference manual - RAPID overview	*3HAC050947-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Technical reference manual - System parameters	*3HAC050948-001*
Operating manual - RobotStudio	*3HAC032104-001*

[i] This manual contains all safety instructions from the product manuals for the manipulators and the controllers.

Revision

Revision	Description
A	First edition

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Revision	Description
B	Published with version 1.1. The following updates are done in this revision: • Renamed the product from Machining Shopfloor HMI to Machining Software. • Changed descriptions of option Shopfloor and Shopfloor Advanced to Machining Standard and Machining Premium, respectively. • Supported working with OmniCore controller. • Supported working with projects using the MSF application on FlexPendant. • Added calibration procedure for crossbeam-type toolkit. • Updated calibration procedure for cutters, separating cutters into sander type and machining tool type. • Added the wave path settings and related RAPID information. • Added the multiple instruction exporting function. • Added new error information.
C	Published with version 1.2.0. The following updates are done in this revision: • Added calibration toolkit crossbeam and probe setup information. • Updated calibration procedure of probe-type toolkit.

Network security

Network security

This product is designed to be connected to and to communicate information and data via a network interface. It is your sole responsibility to provide, and continuously ensure, a secure connection between the product and to your network or any other network (as the case may be).

You shall establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB Ltd and its entities are not liable for damage and/or loss related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Safety

Safety of personnel

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

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

Safety regulations

Before beginning work with the robot, make sure you are familiar with the safety regulations described in the safety manuals for manipulators and controllers.

You can find safety descriptions in following but not limited to following manuals:

- *Operating manual - Emergency safety information* (3HAC027098-001)
- *Operating manual - General safety information* (3HAC031045-001)
- Safety chapter in product manuals for manipulators and controllers

1 Overview

Introduction

Machining Software (previous known as Machining Shopfloor HMI) is a RobotWare option that allows users to work with machining projects on site using PC or FlexPendant.

Machining Software complements the Machining PowerPac - Machining Functionality (hereinafter referred as Machining PowerPac) add-in in RobotStudio. After creating programs in Machining PowerPac, users can synchronize or load the programs to Machining Software and then perform program tuning in web browser on PC or in the dedicated Machining application on FlexPendant. Different from Machining PowerPac that provides offline programming functions, Machining Software can load the tuned programs to the connected controller (virtual or real) directly. This improves programming efficiency and reduce the onsite commissioning time.

Machining Software also provides the auto-calibration function that allows users to define calibration toolkits (eg. probe), cutters, external axis and work objects. The calibrated data can be copied to and reused in RAPID for other projects, which simplifies the calibration process.

Note

The MSF application on FlexPendant is only supported by OmniCore controllers operating in RobotWare 7.*X*.

Key features

Machining Software provides the following main features:

- Web-based access to machining projects (using PC)
- Dedicated Machining application for working with machining projects (using FlexPendant)
- Tuning programs created by Machining PowerPac, including path smoothing and instruction editing
- Auto-calibration on calibration toolkit, cutters, external axis and work objects

Versions

Machining Software provides two versions, Machining Standard (option 877-2 for IRC5 and 3418-1 for OmniCore) and Machining Premium (option 877-3 for IRC5 and 3418-2 for OmniCore), with different user access to functions. The following table lists the main functions to which the two options can access.

Function		Standard	Premium
File operations	File loading	X	X
	File export	X	X

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Function		Standard	Premium
Program tuning	Path smoothing		X
	Wave path setting		X
	Instruction editing		X
Auto-calibration	Toolkit calibration	X	X
	Cutter calibration	X	X
	Work object calibration	X	X

Note

Only one Machining Software version can be installed on a controller at a time.

For the web-based Machining Software, if the version is changed, clean the browser cache and restart the browser to make the new version take effect. Otherwise, a version incompatibility message will be displayed.

Prerequisites

Hardware and software

Requiring...	Note
PC	**Note** Required only for web-based Machining Software using PC. • OS: Windows 10, 64-bit • CPU: 4x2.0Hz or faster processors • RAM: 8GB at minimum • Resolution: 1024 x 768 Pixels • An account with administrator's privileges
Browser	**Note** Required only for web-based Machining Software using PC. **Google Chrome** and **Microsoft Edge** are recommended.
Controller	• IRC5 controller in RobotWare 6.13.04 or later • OmniCore controller in RobotWare 7.6 or later
FlexPendant	FlexPendant must be connected and available to use.
RobotStudio	RobotStudio 2022
Machining PowerPac - Machining Functionality	Machining PowerPac 2022.1 or later Available in *https://new.abb.com/products/robotics/robotstudio/downloads*.

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License

Machining Software requires a license to activate. Contact ABB to order the option Machining Standard or Machining Premium and obtain a license.

> **Note**
>
> If the option Machining Premium is selected, option Multitasking (option 623-1 for IRC5 and 3114-1 for OmniCore) will be selected together.

User grants

Machining Software requires a user account to log in, which must have been granted access permission to the connected controller and corresponding grants to specific functions. Refer to the following table for the required grants.

Functions	Required grant...[i]
Access to the main page of Machining Software	Read access to controller disks
New file, load file and save file	Write access to controller disks
Synchronize programs created by Machining PowerPac to Machining Software	I/O write access
Click **Apply** button to apply changes	Load program
Request write access	Program debug
Access to calibration functions	Calibration
Access to program tuning functions	Edit RAPID code
Click **Calibration** button to start calibration	• Load program • Program debug • Execute program
Selection of mechanical unit (Mechanism-type work object)	Required only for RobotWare 6.*X* • Remote restart • Modify configuration

[i] For RobotWare 6.*X*, controller restart is required after grants are modified. For RobotWare 7.*X*, grant modification takes effect in real time.

If the Default User is active, users can also use the user name **Default User** and its password **robotics** to log in as the default user.

For details about user account management, see information about User Authentication System (UAS) in the operation manual of the controller.

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2 Getting started

Installing

Generally, Machining Software is integrated in the controller system at delivery. It is also available as an add-in RobotStudio. To add it to an existing controller or do an update, use the following procedure to install:

1. Start RobotStudio and open the **Add-Ins** tab. The **Gallery** window is displayed.
2. In the displayed **Gallery** window, use the **Search** function or **Common tags** to find the Machining Software add-in.
3. Click the displayed add-in icon.
4. In the right pane, click **Add**.

   The package is automatically installed and listed in the **Add-in** navigation tree in the left pane of the window.
5. In the **Controller** tab page, click the **Modify RobotWare** button in the **Configuration** group.
6. In the **Modify RobotWare** dialogue, connect to a real controller or select/create a virtual controller.
7. Follow the instructions in the installation wizard and add the Machining Software add-in to the controller.

   Note

   In the **Application** tab page of the **Option** window, you have to choose the Machining Software version in the **Machining** list according to the license you obtained; otherwise, a warning message is displayed.

   Only one Machining Software version is allowed to be installed on the controller at a time. To change the version, deselect the original version and select the new one.

   The Machining Software add-in is displayed in the controller overview if it is successfully added to the controller.

Logging in

You can log in Machining Software in one of the following ways:

- Use web browser in PC
- Use the Machining application in FlexPendant

The modifications are automatically synchronized between the web-based Machining Software and Machining application in FlexPendant, which are opened for the same robot system. To view the latest modifications made in the other way, refresh the web page or reopen the setting window in the application.

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Detailed logging in procedures are as follows.

Using PC

> **Note**
>
> Before working with web-based Machining Software, make sure the PC opening the Machining Software web page has connected to the required controller and works in the same local subnet of the controller.

1 Start the browser.

Google Chrome and **Microsoft Edge** are recommended.

2 Enter the IP address of the connected controller in the Address bar.

	Virtual controller	**Real controller**
RobotWare 6.*X*	http://127.0.0.1/docs/MSF.html	http://*Controller IP address*/docs/MSF.html
RobotWare 7.*X*	https://127.0.0.1:80/docs/MSF.html	https://*Controller IP address*/docs/MSF.html

3 In the displayed window, enter the user name and password.

Make sure the account has the access permission to the connected controller. You can also enter as the Default User.

Using FlexPendant

> **Note**
>
> The Machining application on FlexPendant is only supported by OmniCore controllers operating in RobotWare 7.*X*.

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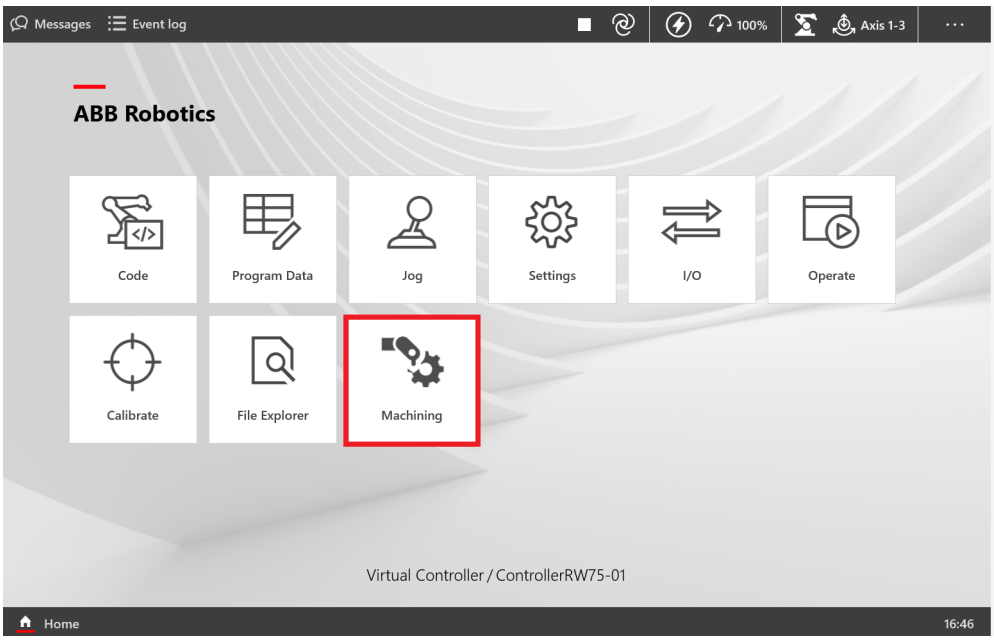
You can access the main window of Machining Software directly by tapping the following application icon on the FlexPendant touch screen.



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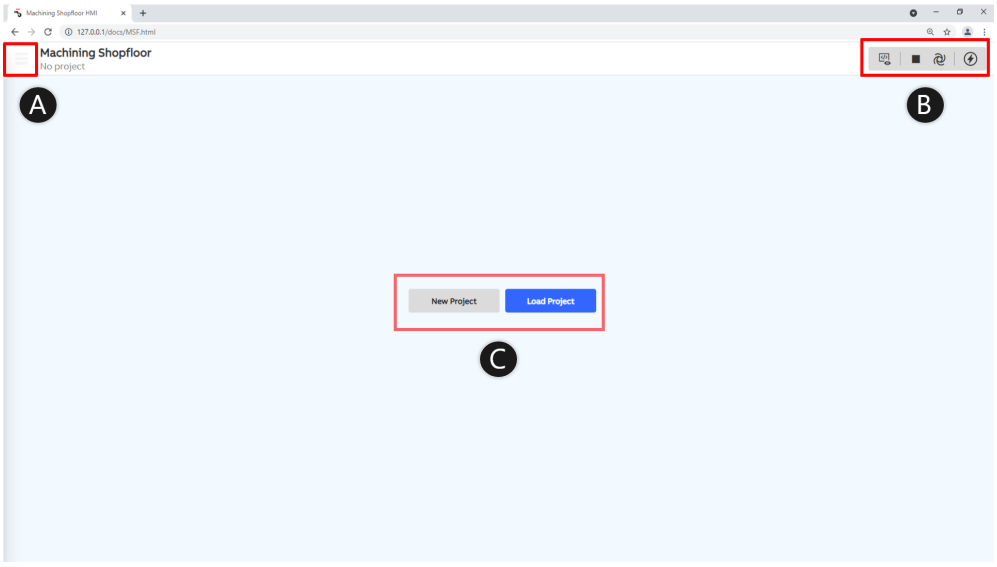
The user interface

Home page



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	Item	Description
A	Menu	Displays the menu when clicking the hamburger button. **Note** The menu is available to use only when a project has been created or loaded.

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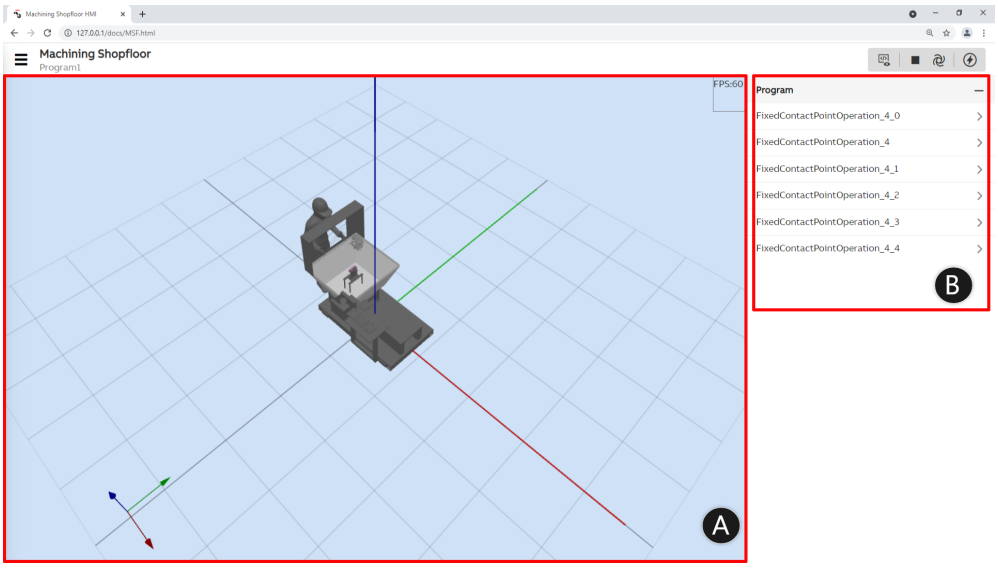
	Item	Description
B	Status bar	Shows the controller status. You can click the icons to display the status details, including controller name, controller status, operating mode and motor status. In the status details page, you can click **Request Write Access** to get permission of program editing. Otherwise, the program settings can only be viewed. After the write access is granted, an **Apply** button is displayed next to the status bar. **Note** The status bar is displayed only for web-based Machining Software using PC. In the Machining application on FlexPendant, only the **Apply** button is available.
C	Start buttons	Starts working with Machining Software by clicking **New Project** or **Load Project**. • **New Project**: a new project is created and auto-calibration function is available. • **Load Project**: an existing project can be loaded from the controller or a local folder. **Note** If there is an unsaved project existing, a message window is displayed before you can click the start buttons, urging you to save or discard the previous editing.

Main working page



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	Item	Description
A	3D graphics window	Shows the 3D graphics of the station and provides an intuitive and realtime preview of the editings. You can also drag the mouse to control the graphics view.
B	Setting window	Displays the detailed setting pages.

3 Creating, loading and exporting projects

About Machining Software project

Machining Software project document is a .mpstn file that contains data of a machining process. It stores information about operations, toolkits, cutters, work objects and cell layout. A project can contain all or part of the information.

Users can create a new project or work on an existing project in Machining Software. The generated or modified projects can be exported to local folder or the connected controller.

Creating a new project

The following table lists the ways to create a new project in Machining Software.

Create project from...	Description
Home page	In the home page, click **New Project**.
Menu	1 Click the hamburger button on the upper-left corner of the window to display the menu. 2 Choose **File** > **New Project**. A message is displayed prompting you to save any unsaved data.

Loading an existing project

The following table lists the ways to load an existing project to Machining Software.

Load project by...	Description
Synchronizing from the Machining PowerPac add-in	After programs are created in the Machining PowerPac add-in in RobotStudio: 1 Click **Sync** in the **Shopfloor Tool** group. 2 Check the information shown in the displayed window and click **OK**. 3 Choose the controller to which Machining Software is connected and click **OK**. The programs are automatically synchronized to Machining Software. 4 Click **Accept** or **Decline** in the Machining Software.
Loading from a local file	1 In the home page, click **Load Project** and then choose **Load file**, or in the main working page, click the menu bar and then choose **File** > **Load file**. 2 In the displayed window, choose the required program file in .mpstn format from a local folder. 3 Click **Open**.
Loading from the controller	1 In the home page, click **Load Project** and then choose **Load file from controller**, or in the main working page, click the menu bar and then choose **File** > **Load file from controller**. 2 In the displayed window, choose the required program file in .mpstn format. Only the files saved in the **HOME** folder of the controller system are displayed. 3 Click **Load**.

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Exporting a project

The following table lists the ways to export a project.

Export project to...	Description
Local folder	**Note** Exporting project to local is valid only for web-based Machining Software using PC. 1 In the main working page, click the menu bar and then choose **File** > **Save file**. 2 In the displayed window, choose the items to be downloaded. By default, all the items are selected. You can also select or remove a category in the left pane, or choose or remove part of items in a specified category. 3 Click **Save**. A .mpstn project file is download to the specified local folder.
Controller	1 In the main working page, click the menu bar and then choose **File** > **Save file to controller**. 2 In the **Contents** area in the displayed window, choose the items to be downloaded. By default, all the items are selected and shown by their categories in the **Contents** area. You can click the drop-down arrow, and in the displayed window, select or remove a category in the left pane, or choose or remove part of items in a specified category. 3 Click **OK**. 4 Click **Browse** to select a folder in controller system for download. The **HOME** folder is selected by default. 5 Enter a name in the **File Name** text box. 6 Click **Save**.

4 Tuning programs

Overview

In Machining PowerPac, machining processes are defined in operations, which are further grouped in programs. The programs can be synchronized to Machining Software directly or saved in a Machining Software project file.

If users load a project file containing program information to the Machining Software, all the programs in the file will be listed in the **Program** setting window. You can click the **Plus** or **Minus** button next to a program to expand or collapse the list of operations that are included in the program.

Note

Only the Machining Software in advanced version (option Machining Premium) supports the program synchronization and program tuning.

Note

For web-based Machining Software, before program tuning, make sure the writing access to the controller has been requested and granted. To request write access, click the icon on the status bar and then click **Request Write Access** in the status details page.

Smoothing path

Use the following procedure to smooth target positions in a path or path segment:

1. Expand the required program and click the required operation.

   On the **Path** tab page of the displayed window, information of the tool and work object associated to the selected operation can be viewed.
2. Click **Smooth**.

   The **Smooth** window is displayed.
3. Select a method from the **Smooth Method** list.
   - **Position**: the path will be smoothed based on the X/Y/Z coordinates of the targets.
   - **Orientation**: the path with be smoothed based on the Rx/Ry/Rz coordinates of the targets.
   - **Process**: the path will be smoothed based on the axis settings of the tool.
4. Select targets from the **Segment** list for defining a path or path segment.

   By default, all the targets in the whole path are selected. You can also select several targets to define a path segment. The number of selected targets can be viewed.

   In the **Segment** window,
   - Click two targets as the first and last targets of the path/path segment. All the targets in between will be selected.

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- Click **Select All** to re-select all the targets. This button is available only when part of targets are selected.
- Click **OK** to accept the selection or click **Cancel** to discard the selection.

5 Click the **Local** or **Wobj** tab to choose the reference coordinate system of the targets, on which the path smoothing is based.

6 Modify target positions to smooth path.

- Only the positions of fixed targets can be modified. The first and last targets in a path/path segment are fixed targets by default. For other targets, turn the **Fixed Target** switch on to change the target characteristics.
- You can drag the target to a required position in 3D graphics window or type a value in the corresponding coordinates text box for a specific target.

  - If **Position** is selected in the **Smooth Method** list, the **X(mm)**, **Y(mm)** and **Z(mm)** parameters referring to the variations on the X, Y and Z axis can be set.

  - If **Orientation** is selected in the **Smooth Method** list, the **Rx(deg)**, **Ry(deg)** and **Rz(deg)** parameters referring to the variations on the orientation rotating around the X, Y and Z axis can be set.

  - If **Process** is selected in the **Smooth Method** list, the **Indentation(mm)**, **Tilt Angle(deg)** and **Lead Angle(deg)** parameters referring to the tool position based on the TCP can be set.

7 Click **Save** to accept the settings.

You can also click **Reset** to cancel the settings.

8 Click **Apply** in the status bar to apply the modifications to the connected controller.

Setting wave path

What is wave path?

Wave path settings are used to generate new paths based on the original machining paths in operations generated by Machining PowerPac. Enabling wave path for a specified machining path will wiggle the tool from side to side in the defined pattern when the tool moves along the path. With wave path, better processing effects could be achieved because it could provide sufficient processing on contact areas. It especially benefits to deburring and grinding applications.

Wave path is available to use when:

- Target processing moves forward along X+ or Y+ directions of local coordinate system of targets.

  The processing direction can be set in target configuration for an operation in Machining PowerPac.
- Distances between the targets in the original machining paths are even.

  To obtain proper target distance, it is recommended to set interpolation method to **MaxLengthOnly** when setting process move parameters for operations in Machining PowerPac.

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- Processing method is using tool tip.

  In Machining PowerPac, the machining method for a tool shall be set to **Face Machining**.

Procedure

Use the following procedure to enable and set wave path for the path in a specified operation:

1 Expand the required program and click the required operation.
2 In the displayed new window, click **Wave Path**.
3 In the displayed **Wave Path** window, turn on the switch to enable wave path.

  Detailed settings are displayed.
4 Choose the machining direction, **Tool X+** or **Tool Y+**.

  The tool will process along the selected direction based on the local coordinate system of the tool.
5 Choose a wave pattern or create a new pattern.
   - To use a predefined pattern or an existing pattern, select the desired pattern from the list to apply the pattern. No further actions required.

     Note

     Three predefined patterns are available, square, circle and diamond. The patterns are allowed to be duplicated or edited by clicking **Edit** on the right corner of the window first and then clicking corresponding button.

     For detailed procedure of editing a pattern, proceed to *6*. The edited pattern will be applied to all the operations whose paths have enabled wave path with this pattern.
   - To create a new pattern, click **New Pattern** and proceed to *6*.
6 In the **Pattern Name** area of the **Edit Pattern** or **New Pattern** window, keep the automatically generated name or type another name as required.
7 Set the step for the pattern to loop.

  The distance between two adjacent targets in the original machining path is considered as one step. The pattern loops in a distance based on the defined step. Default step is 3.
8 Set the basic source targets that could be used for setting the pattern.

  Source targets are the ones in the original path. They will be used as reference to generate wave nodes that will be the new targets in wave path for the tool to process. Default target number is 5.
9 Select the motion type that the tool moves from wave node to wave node.
   - **Linear**: the tool moves using MoveL, that is, in linear movement.
   - **Circular**: the tool moves along the path using MoveC, that is, in circular movement.
10 In the pattern preview window:
   a Click a source target in blue to generate one or more wave nodes.

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Every wave node is shown with a number. The node numbers also represent the processing sequence, that is, the tool will move in number order.

b Click on the generated wave nodes and set the pattern with them.
   - The tool processes along the wave path in the wave node number order. The order could be changed by modifying the node number in the **Number** text box of the quickset dialog box. The pattern changes with the order change.
   - The wave node position can be modified by dragging it to the desired position or, in the quickset dialog box, setting the offsets from the targets where the wave node generated in both the machining direction and the direction perpendicular to the machining direction.
   - A single wave node can be deleted by clicking **Delete Node** in the quickset dialog box. It is also possible to clear all the wave nodes by clicking **Delete All Nodes** on the right upper corner of the preview window.

The defined pattern is displayed as a blue path in real time, and other looped patterns are displayed in grey.

Note

The final wave path depends on both the motion type and the way how the pattern is defined. If a pattern contains *N* wave nodes and,

- the motion type is **Linear**, positions of all the *N* wave nodes will be repeated in following looped patterns. That is, all the patterns contain *N* wave nodes.
- the motion type is **Circular**, the first wave node in defined pattern works as the wave start point but it is not repeated in the following looped patterns. That is, the following patterns will contain only *N-1* wave nodes (wave node in number 1 is excluded).

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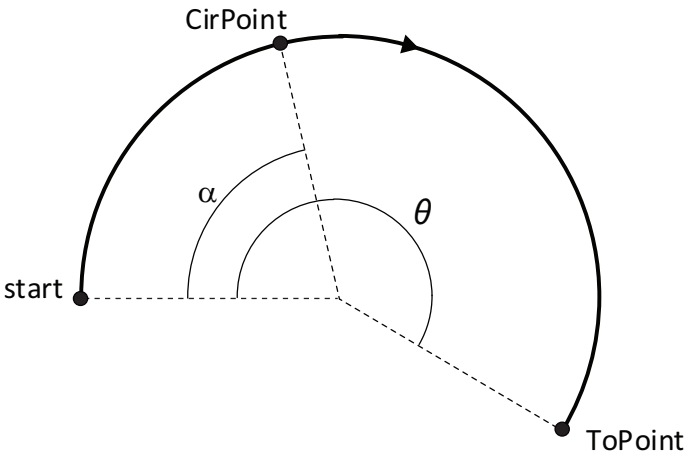
Note

For a circular pattern, it requires a minimum of 3 wave nodes and the total node number should be 3+2*N* (*N* represents 0, 1, 2...). The wave node in number 3+2*N* and 3+2(*N*+1) function as the StartPoint and ToPoint in a circluar movement, and the wave node between them will be the CirPoint, as shown in the following figure.



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There are some limitations in how the `CirPoint` and the `ToPoint` can be placed.

- Minimum distance between start and `ToPoint` is 0.1 mm
- Minimum distance between start and `CirPoint` is 0.1 mm
- Minimum distance between `CirPoint` and `ToPoint` is 0.1 mm
- If the system parameter *Restrict placing of circle points* is set to Yes, then the following additional limitations are active:
  - The angle of the circular path (θ in the picture above) may not be larger than 240°.
  - The circle point must be in the middle part of the circular path (α must be 25-75% of θ, according to the picture above).

For more details, refer to the description of MoveC in *Technical reference manual - RAPID Instructions, Functions and Data types*.

11 Click **Save** to return to the **Wave Path** window.

Note

Wave path settings could also be modified in RAPID programs. See *RAPID instructions on page 55* for more information.

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Modifying instructions

An instruction includes information such as movement mode and movement speed on a specific target. Use the following procedure to modify instruction settings:

1 Expand the required program and click the required operation.

2 Click the **Instruction** tab to display the list of instructions associated with the selected operation.

3 Select instructions to be modified.

> **Tip**
>
> You can click the **Filter** button to filter instructions by types, approach, process or depart.

- To modify a specific instruction, click it to enter the setting window.
- To modify a group of instructions as a whole, click **Select** in the right corner of the window to select more than one instructions and then click **Edit** at the bottom of the window to display the setting window.

> **Note**
>
> Instructions could also be selected and exported as arrays by clicking the **Export** icon first and then choosing to save to local or controller.
>
> Note that exporting to local is only available for web-based Machining Software using PC.

> **Note**
>
> Available parameters for setting a specific instruction and setting a group of instructions are similar. But you can only set position, start event and end event for a specific instruction. Therefore, the following steps take the setting of a specific instruction as an example.

4 Select a movement speed (speed data) from the **Speed** list.

5 Select the position termination mode (zone data) from the **Zone** list.

6 Click the unfold button next to **Target***X*.

7 In the displayed **Target***X* window:

a Click the **Local**, **Wobj** or **Process** tab to choose the reference coordinate system on which the modification is based.

b Drag the coordinate axis to a required position in 3D graphics window or type a value in the corresponding coordinates text box.

- In the **Local** and **Wobj** tab page,

  - the **X(mm)**, **Y(mm)** and **Z(mm)** parameters referring to the variations on the X, Y and Z axis can be set;

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- the **Rx(deg)**, **Ry(deg)** and **Rz(deg)** parameters referring to the variations on the orientation rotating around the X, Y and Z axis can be set.
- In the **Process** tab page, the **Indentation(mm)**, **Tilt Angle(deg)** and **Lead Angle(deg)** parameters referring to the tool position based on the TCP can be set.

c Set external axis positions, if external axes exist.

If the value **9E+09** is displayed, it refers that no external axis is connected and the positions cannot be set.

d Click **Save** to accept the settings.

8 If there are events defined and bound to the specified instruction, click the unfold button next to **Start Event** or **End Event** to set the events.

Only bound events are displayed and available for setting. You can delete, add or change event order for the instruction.

9 Click the unfold button next to **Optional Arguments**, and in the displayed window, set values for the arguments.

- **Offset**: used to add a displacement in the work object coordinate system to a robot position. The value is defined as [*x*,*y*,*z*] in unit of mm.
- **RelEuler**: used to add a displacement and/or a rotation in the active tool object coordinate system to a robot position. The value is defined as [*x*,*y*,*z*,*Rx*,*Ry*,*Rz*] in unit of mm.
- **ID**: specifies the synchronization id and is mandatory in the MultiMove system if the movement is synchronized or coordinated synchronized. By using the id number the movements are not mixed up at the runtime.
- **T**: used to specify the total time in seconds during which the robot moves.

The arguments will be used in the RAPID instruction. See *RAPID instructions on page 55* for more information.

10 Click **Apply** in the status bar to apply the modifications to the connected controller.

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5 Auto-calibrating

5.1 Overview

Introduction

If a Machining Software project file contains the information of toolkits, cutters and work objects, users can define and calibrate their data with the auto-calibration function. For a new project, it also allows users to define new toolkits and work objects.

To calibrate cutters and work objects, a toolkit must be available to use and calibrated first. The following table lists the required toolkit for each cutter and workobject type.

Type		Required toolkit
Cutter	Orbit sander	Probe
	Random orbital sander	Probe
	Machining tool	Crossbeam
Work object	External axis (Mechanism)	Probe
	Wobjdata (work object)	Probe

Every time the calibration is successfully performed, the calibration data is recorded. A maximum of 10 latest records will be listed in the calibration history and available for reuse. You can view the calibration history in the setting windows by clicking the **History** icon on the right upper corner of the windows.

Note

For web-based Machining Software, before performing calibration, make sure the writing access to the controller has been requested and granted. To request write access, click the icon on the status bar and then click **Request Write Access** in the status details page.

Toolkit setup

Crossbeam

Crossbeam is an optical sensor that radiates two perpendicular laser beams (X-direction and Y-direction) within its inner for TCP measurement. By moving the tool on a circular or square path within the crossbeam and interrupting the laser beams, the TCP could be observed and then referenced for tool calibration. It is also possible to determine the center point of the crossbeam where both laser beams cross. At this center point, it can be checked whether the calibration was correct since both laser beams are interrupted at the same time.

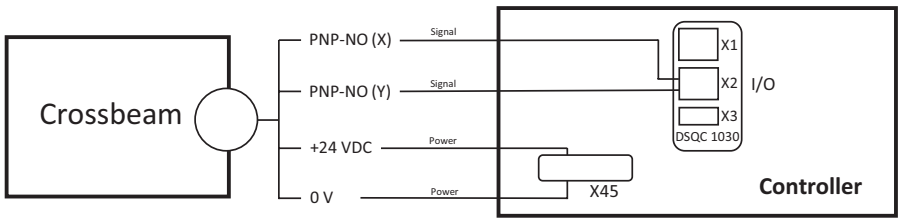
To calibrate cutters using a crossbeam in Machining Software, the crossbeam must be available to use and calibrated first. Detailed procedures about how to set up and configure a crossbeam, see the user manual from the vendor. Following

Continues on next page

lists the necessary preparations of using the crossbeam with the Machining Software:

- The crossbeam can have a circular inner, which is also recommended, or a square inner. To calibrate the crossbeam with the Machining Software, the **Inner Radius** parameter must be properly set according to the crossbeam inner shape. For circular inner, it is set to the circle radius; for square inner, it is set to the short diameter.
- The crossbeam shall connect to a controller with an I/O device, which could provide 2 pins for power connection and 2 pins for signal connection.

  The following figure illustrates a typical connection between the crossbeam and OmniCore with the digital base device DSQC1030 supporting the communication over Ethernet/IP.



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Note

If your controller is an IRC controller, the XS16 connector shall be used for power connection. If your controller is installed with a DSQC652, the X3 connector shall be used for signal connection.

For connections with other controllers or I/O boards, contact your local ABB Robotics Service representative, see *http://www.abb.com/*.

- Signals for identifying the laser beams in X direction and Y direction are configured using RobotStudio.
  1. In the **Controller** ribbon tab in the RobotStudio, click **Configuration** and then click **I/O system**.
  2. In the **Type** pane of the **Configuration - I/O system** window, right-click **Signal** and choose **New Signal**.
  3. In the displayed **Instance Editor** dialog box,
     - specify a name to the x-direction or y-direction laser beam
     - set **Type of Signal** to **Digital Input**
     - select the connected IO board in the **Assigned to Device** drop-down list
     - set **Default Value** to **0**
     - remain default settings for other parameters

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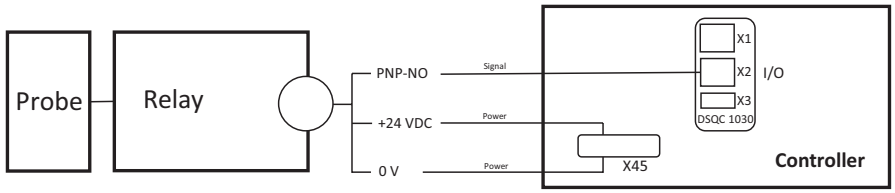
Probe

Probe is a displacement sensor that commonly consists of a sensor and a tooling ball (or known as needle). The tooling ball can "feel" the contact surfaces and, by measuring the displacement, feed back the position of the approached target.

To calibrate cutters or work objects using a probe in Machining Software, the probe must be available to use and calibrated first. Detailed procedures about how to set up and configure a probe, see the user manual from the vendor. Following lists the necessary preparations of using the probe with the Machining Software:

- The tooling ball locates at the end of the probe and can be in any size. To calibrate the probe with the Machining Software, the **Ruby Ball Radius** parameter must be properly set according to the actual tooling ball radius.
- The probe shall connect to a relay first and then to a controller with an I/O device, which could provide 2 pins for power connection and 1 pin for signal connection..

  The following figure illustrates a typical connection between the probe and OmniCore with the digital base device DSQC1030 supporting the communication over Ethernet/IP.



xx2300001217

> **Note**
>
> If your controller is an IRC controller, the XS16 connector shall be used for power connection. If your controller is installed with a DSQC652, the X3 connector shall be used for signal connection.
>
> For connections with other controllers or I/O boards, contact your local ABB Robotics Service representative, see *http://www.abb.com/*.

- Signal for identifying the tooling ball is configured using RobotStudio.
  1. In the **Controller** ribbon tab in the RobotStudio, click **Configuration** and then click **I/O system**.
  2. In the **Type** pane of the **Configuration - I/O system** window, right-click **Signal** and choose **New Signal**.
  3. In the displayed **Instance Editor** dialog box,
     - specify a name to the tooling ball of the probe
     - set **Type of Signal** to **Digital Input**
     - select the connected IO board in the **Assigned to Device** drop-down list
     - set **Default Value** to **0**

Continues on next page

- remain default settings for other parameters

5.2 Calibrating toolkits

Preparation procedure for new toolkit

For a new toolkit, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Toolkit** setting window on the right, click **New** at the bottom of the window.
4. Choose the required tool type, **Probe** or **CrossBeam**.

Preparation procedure for existing toolkit

For an existing toolkit, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Toolkit** setting window on the right, click the **More options** icon next to the required toolkit.
4. Click an icon according to your requirement.
   - **Edit**: to edit basic information of the toolkit, such as name and trigger signal.
   - **Define**: to define the toolkit calibration settings and perform calibration.

     Note

     The **Define** item is available only when a trigger signal has been set for the toolkit.

   - **Delete**: to delete the toolkit.

Calibration procedure - toolkit (probe type)

Use the following procedure to define and calibrate a probe:

1. In the **Probe Name** area of the **Probe** setting window, keep the automatically generated name or type another name as required.
2. Turn on/off the **Robot Hold** switch based on where the probe is installed.
   - If the probe is hold by the robot, turn on the switch, that is, set it to **True**.
   - If the probe is stationary or hold by another robot, turn off the switch, that is, set it to **False**.
3. In the **tooldata** area, check the current probe position and calibration status.
4. Choose a signal from the **Trigger Signal** drop-down list.

   After a signal is chosen, the **Define** button at the bottom of the page is available.
5. Set **Trigger Value** to **0** or **1**.

Continues on next page

The trigger value represents the returned value when the probe contacts the calibrating object.

6 Set **Ruby Ball Radius (mm)** to the actual radius of the tooling ball at the end of the probe.

7 Click **Define** to enter the calibration process.

The **Define** *ProbeName* window is displayed.

8 Click **Ball** to enter the setting window for defining the calibrating ball that is the calibration target for the probe to touch.

In the displayed **Ball** window,

- Set **Ball Radius (mm)** to the actual value.

  The ball is automatically named with its radius.
- Set **Accessible Offset (mm)**, which defines a safe area for the probe to touch the ball.

  This parameter defines a height from the top point of the ball. The safe area refers to the ball surface covered by the projecting plane of the height. You can also drag the arrow in the 3D graphics window to set the safe area and the setting is displayed in real time.

  The **Accessible Offset (mm)** value must be equal to or smaller than the **Ball Radius (mm)** value.

Click **Save** to return.

9 Click **Search Settings** to enter the setting window for defining how the probe goes to search.

In the displayed **Search Settings** window,

- Set **Search Mode** and **Accuracy Level**.

  Five accuracy levels are predefined, with level 4 set by default.

  The higher the level is selected, the more the touchpoints are defined and the higher the calibration accuracy is, but the slower the calibration process is. For example, in default level 4, nine touchpoints are defined and the calibration is relatively more accurate, but it will take estimate 240 s for the calibration.
- Click the **Advanced** arrow to expand the settings and set **Search Offset** and **Approach Distance**.

Tip

You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.

Continues on next page

10 Jog the probe to touch the ball at the **Contact**, **Home** and other four **Pose** positions, and click **Update Target** to record corresponding values.

> **Note**
>
> The **Contact** position is the one where the probe touches the calibrating ball, and must be updated before the probe is jogged to the **Home** position.
>
> When jogging the probe to the four **Pose** positions, make sure the tooling ball of the probe only rotates around the **Home** position without any displacement.

11 Click **Calibrate** and then click **Play**.
- If the controller is in Auto mode, the calibration process runs automatically.
- If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.

12 Click **Save** to save the data after the calibration done.

Calibration procedure - toolkit (crossbeam type)

> **Note**
>
> Before calibration, make sure a valid cutter has been defined. See *Calibration procedure - cutters (machining tool type) on page 41*.

Use the following procedure to define and calibrate a crossbeam:

1 In the **Name** area of the **CrossBeam** setting window, keep the automatically generated name or type another name as required.

2 Turn on/off the **Robot Hold** switch based on where the crossbeam is installed.
- If the crossbeam is hold by the robot, turn on the switch, that is, set it to **True**.
- If the crossbeam is stationary or hold by another robot, turn off the switch, that is, set it to **False**.

3 In the **Wobjdata** area, check the crossbeam position and calibration status.

By default, the wobjdata **wobj0** is displayed.
- If the crossbeam is installed with X and Y lasers whose directions close to the X and Y directions of the coordination system for wobj0, remain the wobjdata.
- If the crossbeam is defined with other wobjdata, click **Copy wobjdata from controller** and select valid wobjdata for the crossbeam.
- If X and Y lasers of the crossbeam are not in the same X and Y directions of the coordination system for wobj0 and no worbjdata is valid for the crossbeam, define the crossbeam using the **User defined with 3 points** method in FlexPendant.

4 Choose signals for both X and Y lasers from the **Trigger Signal** drop-down lists.

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The **Define** button at the bottom of the page is available only after the signals are selected.

> **Note**
>
> For crossbeam, the trigger value is always be 1, which represents the returned value when the corresponding laser is interrupted by the calibrating objects.

5 Set **Inner Radius (mm)** to the actual inner radius of the crossbeam.

6 Click **Define** to enter the calibration process.

The **Define** *CrossbeamName* window is displayed.

7 Select a cutter from the **Cutter** drop-down list.

Only cutters in machining tool type and in opposite robot-hold position to the crossbeam are available to choose.

8 Click **Search Settings** to enter the setting window for defining how to search with the crossbeam.

In the displayed **Search Settings** window,

- Set **Search Direction** and **Search Speed**.
- Click the **Advanced** arrow to expand the settings and set **Search Depth (mm)** and **Search Radius (mm)**.

> **Note**
>
> The larger the search radius is, the higher the search precision is and the less the possibility of reporting search error messages is. However, a larger search radius may also cause collisions. Always set the search radius properly.

> **Tip**
>
> You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.

9 Jog the cutter to approach the inner circle of the crossbeam at the **Home**, **ContactXY** and other four **Pose** positions, and click **Update Target** to record corresponding values.

> **Note**
>
> The positions are related to both the workobject coordinate system of the crossbeam and the tool coordinate system of the selected cutter.

Continues on next page

> **Note**
>
> The **ContactXY** position is the one where the cutter reaches the crosspoint of the X and Y lasers, that is, the center point of the crossbeam inner circle.
>
> When jogging the cutter to the four **Pose** positions, make sure the cutter only rotates around the center point of the crossbeam inner circle.

10 Click **Calibrate** and then click **Play**.
   - If the controller is in Auto mode, the calibration process runs automatically.
   - If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.

11 Click **Save** to save the data after the calibration done.

5.3 Calibrating cutters

Preparation procedure for new cutters

For a new cutter, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Cutter** setting window on the right, click **New** at the bottom of the window.

Preparation procedure for existing cutters

For an existing cutter, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Cutter** setting window on the right, click the **More options** icon next to the required cutter.
4. Click an icon according to your requirement.
   - **Edit**: to edit basic information of the cutter, such as name and tool type.
   - **Define**: to define the cutter calibration settings and perform calibration.
   - **Delete**: to delete the cutter.

Calibration procedure - cutters (sander type)

Setting basic cutter information

Use the following procedure to set basic information of the cutter:

1. In the **Name** area of the **Cutter** setting window, keep the automatically generated name or type another name as required.
2. Turn on/off the **Robot Hold** switch based on where the cutter is installed.
   - If the cutter is hold by the robot, turn on the switch, that is, set it to **True**.
   - If the cutter is stationary or hold by another robot, turn off the switch, that is, set it to **False**.
3. In the **tooldata** area, check the current cutter position and calibration status.

   By default, the tooldata **tool0** is displayed.
   - If the TCP of the cutter is at position of tool0, remain the tooldata.
   - If the cutter is defined with other tooldata, click **Copy tooldata from controller** and select valid tooldata for the cutter.
   - If the TCP of the cutter is not at position of tool0 and no tooldata is valid for the cutter, create tooldata for the cutter in FlexPendant.
4. Choose the sander-type cutter from the **Tool Type** list.
   - **Orbital Sander**: choose this type if the sanding paper is square.
   - **Random Orbital Sander**: choose this type if the sanding paper is circle.

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5 Click **Define** to enter the calibration process.

The **Define** *CutterName* window is displayed.

Defining and calibrating the cutter

In the **Define** *CutterName* window, use the following procedure to define and calibrate the sander:

1 Click **Calibration Method** to select the required method.

- **DOF3**: calibration will be performed on the surface of sanding paper on the sander.
- **DOF6**: calibration will be performed on the sander.

Click **Save** to return.

2 Click **Shape** to enter the page for setting the shape of the sanding paper or sander based on the previous selection of the sander type and calibration method.

Cutter type	Calibration method	Shape type	Parameter description
Orbital sander	DOF3	Default Pad	• **Length/Width/Height** Defines the shape of square sanding paper. • **Rotation** Defines a degree based on which the XY plane of the sanding paper or sander rotates around the Z direction.
		CAD	• **Load Sander Model** Click to upload a 3D model from local PC. Make sure the Z direction of the model is the same as the polishing direction. • **Rotation** Defines a degree based on which the XY plane of the sanding paper or sander rotates around the Z direction.
	DOF6	CAD	• **Load Sander Model** Click to upload a 3D model from local PC. Make sure the Z direction of the model is the same as the polishing direction. • **Rotation** Defines a degree based on which the XY plane of the sanding paper or sander rotates around the Z direction.

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Cutter type	Calibration method	Shape type	Parameter description
Random orbital sander	DOF3	Default Pad	• **Radius** Defines the shape of circle sanding paper. • **Rotation** Defines a degree based on which the XY plane of the sanding paper or sander rotates around the Z direction.
	DOF6	CAD	• **Load Sander Model** Click to upload a 3D model from local PC. Make sure the Z direction of the model is the same as the polishing direction. • **Rotation** Defines a degree based on which the XY plane of the sanding paper or sander rotates around the Z direction.

Note

To ensure the calibration validity, the defined shape shall not be larger than the actual shape of the sanding paper or sander.

Click **Save** to return.

3 Click **Touchpoints** to add the touchpoints used for calibration.
   - If the calibration method is **DOF3**, add touchpoints directly by clicking on the surface of the model shown in the 3D view.
   - If the calibration method is **DOF6**, choose a plane first and then add touchpoints on the selected plane.

     Note

     If there are steps on a plane, adding touchpoints in different steps may affect the final calibration result slightly.

   Effective Touchpoints in Total shows the quantity of effective touchpoints. You could also remove the selection by clicking **Clear Points**.

   After selection, click **Save** to return.
4 Choose a calibrated probe from the **Probe** list.
5 Click **Search Settings** to enter the setting window for defining how the probe goes to search.

   In the displayed **Search Settings** window,
   - Set **Search Mode** and **Search Speed**.
   - Click the **Advanced** arrow to expand the settings and set **Search Offset** and **Approach Distance**.

Continues on next page

> **Tip**
>
> You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.

6 Jog the probe to touch the sanding paper surface or sander at the required position and click **Update Target** to record the value.
   - If the calibration method is DOF3, the **Home** position is required.
   - If the calibration method is DOF6, the **Home**, **Home_X+**, **Home_Y+**, **Home_X-** and **Home_Y-** positions are required.

> **Note**
>
> The positions are related to both the tool coordinate system of the selected probe and the tool coordinate system of the sander itself. At the same time, the sander tooldata will be referred as wobjdata.

7 Click **Calibrate** and then click **Play**.
   - If the controller is in Auto mode, the calibration process runs automatically.
   - If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.

8 Click **Save** to save the data after the calibration done.

Calibration procedure - cutters (machining tool type)

Setting basic cutter information

Use the following procedure to set basic information of the cutter:

1 In the **Name** area of the **Cutter** setting window, keep the automatically generated name or type another name as required.
2 Turn on/off the **Robot Hold** switch based on where the cutter is installed.
   - If the cutter is hold by the robot, turn on the switch, that is, set it to **True**.
   - If the cutter is stationary or hold by another robot, turn off the switch, that is, set it to **False**.
3 In the **tooldata** area, check the current cutter position and calibration status.

   By default, the tooldata **tool0** is displayed.
   - If the TCP of the cutter is at position of tool0, remain the tooldata.
   - If the cutter is defined with other tooldata, click **Copy tooldata from controller** and select valid tooldata for the cutter.
   - If the TCP of the cutter is not at position of tool0 and no tooldata is valid for the cutter, use the tooldata tool0.
4 Choose the machining tool-type cutter from the **Tool Type** list.
5 Click **Define** to enter the calibration process.

   The **Define** *CutterName* window is displayed.

Continues on next page

Defining and calibrating the cutter

In the **Define** *CutterName* window, use the following procedure to define and calibrate the cutter:

1. Choose a calibrated crossbeam from the **CrossBeam** list.
2. Click **Search Settings** to enter the setting window for defining how the probe goes to search.

   In the displayed **Search Settings** window,
   - Set **Search Mode** and **Search Speed**.
   - Click the **Advanced** arrow to expand the settings and set **Search Offset** and **Approach Distance**.

   Tip

   You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.
3. Jog the cutter to approach the inner circle of the crossbeam at the **Home** and **ContactXY** positions, and click **Update Target** to record corresponding values.

   Note

   The positions are related to both the workobject coordinate system of the selected crossbeam and the tool coordinate system of the cutter itself.

   Note

   The **ContactXY** position is the one where the cutter reaches the crosspoint of the X and Y lasers, that is, the center point of the crossbeam inner circle.
4. Click **Calibrate** and then click **Play**.
   - If the controller is in Auto mode, the calibration process runs automatically.
   - If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.
5. Click **Save** to save the data after the calibration done.

5.4 Calibrating external axes and work objects

Preparation procedure for new external axis/work object

For a new external axis/work object, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Wobj** setting window on the right, click **New** at the bottom of the window.
4. Click the **Mechanism** or **Wobj** icon as required.

Preparation procedure for existing external axis/work object

For an existing toolkit, perform the following preparation actions:

1. Click the hamburger button on the upper-left corner of the window to display the menu.
2. Click **Calibration**.
3. In the displayed **Wobj** setting window on the right, click the **More options** icon next to the required external axis/work object.
4. Click an icon according to your requirement.
   - **Edit**: to edit basic information of the external axis/work object, such as name.
   - **Define**: to define the external axis/work object calibration settings and perform calibration.
   - **Delete**: to delete the external axis/work object

Calibration procedure - external axis

Use the following procedure to define and calibrate an external axis:

1. In the **Name** area of the **Mechanism** setting window, keep the automatically generated name or type another name as required.
2. Select an external axis from the **Mechanism Unit** list.

   A message will be displayed if the base frame of the selected external axis is different in the Machining Software and in the controller, prompting you to load data from controller or overwrite the data in the controller.
   - If loading from the controller, the axis information and base frame of the external axis are displayed automatically.
   - If overwriting, you will be promoted to restart the controller. The data takes effect only after the controller is restarted. After the controller restarts, you can view the updated axis information in the Machining Software by reselecting the external axis.
3. Click **Define** to enter the calibration process.

   The **Define** *ExternalAixsName* window is displayed.
4. Choose a calibrated probe from the **Probe** list.

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5 Click **Ball** to enter the setting window for defining the calibrating ball that is placed on the external axis and the calibration target for the probe to touch.

In the displayed **Ball** window,

- Set **Ball Radius (mm)** to the actual value.

  The ball is automatically named with its radius.
- Set **Accessible Offset (mm)**, which defines a safe area for the probe to touch the ball.

  This parameter defines a height from the top point of the ball. The safe area refers to the ball surface covered by the projecting plane of the height.

  The **Accessible Offset (mm)** value must be equal to or smaller than the **Ball Radius (mm)** value.
- Move the **Number of touchpoints** slider to set the quantity of points on the ball for the probe to touch.

Click **OK** to return.

6 Click **Search Direction** to select a direction for the probe to touch the calibrating ball.

The direction could be based on the probe coordinate system (**Tool** tab) or work object coordinate system (**Wobj** tab).

7 Click **Search Settings** to enter the setting window for defining how the probe goes to search.

In the displayed **Search Settings** window,

- Set **Search Mode** and **Search Speed**.
- Click the **Advanced** arrow to expand the settings and set **Search Offset** and **Approach Distance**.

> **Tip**
>
> You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.

8 Jog the probe to touch the ball at **AngleX+**, **Angle2**, **Angle3** and **Angle4** positions, and click **Update Target** to record corresponding values.

More positions can be added by clicking the **+** button.

> **Note**
>
> The positions are related to both the workobject coordinate system of the wobj0 (robot base frame) and the tool coordinate system of the selected probe.

> **Note**
>
> Before jogging the probe to the **AngleX+** position, make sure that the external axis is in 0° position.

Continues on next page

9 Click **Calibrate** and then click **Play**.
   - If the controller is in Auto mode, the calibration process runs automatically.
   - If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.

10 Click **Save** to save the data after the calibration done.

   A message displays, promoting you to restart the controller. The calibration data takes effect only after the controller restarts.

Calibration procedure - work object

Use the following procedure to define and calibrate a work object:

1 In the **Wobj Name** area of the **Wobj** setting window, keep the automatically generated name or type another name as required.
2 Turn on/off the **Robot Hold** switch based on where the work object is installed.
   - If the work object is hold by the robot, turn on the switch, that is, set it to **True**.
   - If the work object is stationary, or hold by another robot or external axis, turn off the switch, that is, set it to **False**.
3 Click **External Axis** to enable or disable the external axis. If enabled, select the valid external axis from the list.

   Note

   External Axis is valid for setting only when **Robot Hold** is set to **False**.

4 In the **Wobjdata** area, check the current work object position and calibration status.
5 Click **Define** to enter the calibration process.

   The **Define** *WobjName* window is displayed.
6 Choose the calibration method based on the work object shape from the **Calibration Method** list.

   Note

   In Machining Software version 1.0, only the cube type is supported.

7 Choose a calibrated probe from the **Probe** list.
8 Click **Cube** to enter the setting window for defining the calibration target for the probe to touch.

   In the displayed **Cube** window,
   - Set **Length (mm)**, **Width (mm)** and **Height (mm)** to the actual values.
   - Click the **Touchpoint Layout** arrow to display the panel for selecting point matrix.

     At least a 2x2 matrix, that is, 4 points, must be selected.

   Click **OK** to return.

Continues on next page

9 Click **Search Settings** to enter the setting window for defining how the probe goes to search.

In the displayed **Search Settings** window,

- Set **Search Mode** and **Search Speed**.
- Click the **Advanced** arrow to expand the settings and set **Search Offset** and **Approach Distance**.

Tip

You can click the **Information** icon at the upper-right corner of the **Search Settings** window to view the parameter definitions.

10 Select a corner on the work object as the origin point in the 3D graphics window.

Only after the origin point is selected, the position information can be displayed and target updating can be performed. You can click **Change Origin** to change an origin point.

Note

The coordination system is based on whether the work object is hold by the robot. If yes, the tool coordinate system is used; otherwise, the work object coordinate system is used.

11 Jog the probe to touch the work object at the **Origin**, **X** and **Y** positions, and click **Update Target** to record corresponding values.

Note

If the external axis is enabled, before jogging the probe to the **Origin** position, make sure that the external axis is in 0°.

Note

The **Origin**, **X** and **Y** positions are related to both wobj0 (robot base frame) and the tool coordinate system of the selected probe.

The **Home**, **XOYHome**, **XOZHome** and **YOZHome** positions are related to the workobject coordinate system of the work object, which has been calculated based on the **Origin**, **X** and **Y** positions.

Continues on next page

Note

The **Origin** position is the one where the probe touches the origin point. The **X** position is the corner point where the probe touches after moving along the X axis direction of the origin point. The **Y** position is a point on the positive Y-axis side.

The **Home**, **XOYHome**, **XOZHome** and **YOZHome** positions are valid for updating only after the **Origin**, **X** and **Y** positions are updated.

After the **Home** position is updated, the **XOYHome**, **XOZHome** and **YOZHome** positions update automatically. You can further update the three positions separately.

12 Click **Calibrate** and then click **Play**.
- If the controller is in Auto mode, the calibration process runs automatically.
- If the controller is in Manual mode, follow the instructions in the displayed messages to perform the calibration.

13 Click **Save** to save the data after the calibration done.

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6 RAPID programming

Overview

RAPID programming is supported only by Machining Software in advanced version (option Machining Premium).

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6.1 RAPID exporting and reloading

RAPID exporting

Machining Software allows users to apply the tuned programs to the connected controller or export them to a local folder for future use. After program tuning, click the **Apply** button to apply or export the programs.

Note

The **Apply** button is valid only when the writing access has been requested and granted. If the controller is in Auto mode, the writing access will be automatically granted to Machining Software; if the controller is in Manual mode, the writing access have to be granted in FlexPendant.

If the writing access is held by another client, release the access first and request from Machining Software again.

A main module and several related modules will be generated.

Module	Description
CalibData_HMI	Includes the tool data, work object data, speed data, zone data and calibration result data.
EventDefGroup_*ProgramID*	If events are specified for instructions, the event data will be loaded in the EventDefGroup_*ProgramID* module. *ProgramID* specifies the program to which the events belong.
Group_*ProgramID_OperationID*_000	Includes the path data. *ProgramID* and *OperationID* specify the program and operation to which the instruction belongs.
Main_test_*ProgramID*	The main module of the Machining Software program.
ProcessDefGroup_*ProgramID_OperationID*_000	Includes the machining process data. *ProgramID* and *OperationID* specify the program and operation to which the machining process belongs.
TargetDefGroup_*ProgramID_OperationID*_000	Includes the target point data. *ProgramID* and *OperationID* specify the program and operation to which the target point belong.
WaveGroup_*ProgramID_OperationID*_000	Includes the wave path data, including wave pattern, speed data, zone data, tool data and work object data. *ProgramID* and *OperationID* specify the program and operation that enables wave path. **Note** The speed data and zone data are not defined for wave paths in Machining Software. They are set to **v50** and **z0** respectively by default and allow users to modify in RAPID editor.
*InstructionName*_T	Includes the point array data for wave paths. *InstructionName* specifies the name of the instruction that enables wave path.

Continues on next page

Module	Description
*PatternName*_NodeMod	Includes the wave path pattern data. *PatternName* starts with "C" or "L" that specifies the motion type, circular or linear and follows with the user-defined pattern name.

Exporting RAPID to controller

The modules are loaded into the `T_ROB1` task of the controller after clicking **Apply**.

Exporting RAPID to local folder

The modules are by default applied to the connected controller. To export modules to a local folder, the exporting rule has to be manually reset:

1. Navigate to the folder `$HOME\docs\assets\ruleLib`.
2. Open the file *Mach_Export_Rules_Library.yml*.
3. Set the `Enabled` value to `true` for the `LoadDynamically` parameter.

After clicking **Apply**, the modules, except the **CalibData_HMI** module, are exported to the folder `$HOME\`*`ProgramName`*`\Main_test`.

RAPID reloading

The applied/exported Machining Software modules must be edited based on programming rules to ensure successful reloading to Machining Software.

Note

Wave path modules could be edited in RAPID editor without programming limitations and applied to the controller directly, but they could not be reloaded from the controller to Machining Software.

In module,	Programming rule
CalibData_HMI	Not allowed to be edited.
EventDefGroup_*ProgramID*	• Events included in a procedure (between PROC and ENDPROC) can be modified, either the complete event routine or the parameters defined in the event routine. • Do not insert new event routines in an event routine. • Do not modify the procedure name. Event routines in the procedure cannot be reloaded to Machining Software even the events are modified. • Do not delete event routines. Deleted events will not be deleted from Machining Software and will be exported again when program download/export is executed in Machining Software.
Group_*ProgramID_OperationID*_000	• Values of the speeddata and zonedata in the instructions can be modified, but only predefined values are allowed. • Do not modify the names of the robtarget, RCS, tooldata, wobjdata or process in the instructions. Values of the robtarget, RCS, tooldata, wobjdata or process whose name is modified cannot be reloaded to Machining Software. • Do not delete instructions. Deleted instructions will not be deleted from Machining Software and will be exported again when program download/export is executed in Machining Software.

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In module,	Programming rule
Main_test_*ProgramID*	Whether the elements in this module can be edited, it depends on the setting of the `Enabled` value for `LoadDynamically` parameter in the file *Mach_Export_Rules_Library.yml*: • If the `Enabled` value is set to `false`, the `Main_test_ProgramID` module is downloaded to the controller. No element is required for further programming. • If the `Enabled` value is set to `true`, the `CalibData_HMI` module will not be generated in local file, and the tooldata/wobjdata/speeddata/zonedata will be included in the `Main_test_ProgramID` module. In this case, the programming rules for the `CalibData_HMI` module applies to the `Main_test_ProgramID` module.
ProcessDefGroup_*ProgramID_OperationID*_000	• Values of the EngageDistance, TiltAngle and LeadAngle components in MachineProcess data type can be modified. • Do not modify the names of the PreRoutine or PostRoutine components in MachineProcess data type. Values of the components whose name is modified cannot be reloaded to Machining Software. • Do not modify the names of processes in MachineProcess data type. Values of the EngageDistance, TiltAngle and LeadAngle components cannot be reloaded to Machining Software even they are modified. • Do not add new processes in MachineProcess data type. Values of the new processes cannot be reloaded to Machining Software. • Do not delete processes in MachineProcess data type. Deleted processes will not be deleted from Machining Software and will be exported again when program download/export is executed in Machining Software.
TargetDefGroup_*ProgramID_OperationID*_000	• Value of the robtarget can be modified. • Do not modify RCS values. Modified RCS values cannot be reloaded to Machining Software. • Do not modify the target names. Value of the target whose name is modified cannot be reloaded to Machining Software. • Do not add new robtarget or RCS. Values of the new robtarget and RCS cannot be reloaded to Machining Software. • Do not delete robtarget or RCS. Deleted robtarget and RCS will not be deleted from Machining Software and will be exported again when program download/export is executed in Machining Software.

All the Machining Software modules (wave path related modules excluded) are also declared with "`! Generated by ABB Machining Software HMI - Machining Functionality for ABB Robot xxx`", which cannot be removed.

Before reloading the modules to the Machining Software, verify that the declaration remains and the modules are programmed following the rules.

Reloading from controller

When reloading the modules from the controller to the Machining Software,

- if there is no modification made in the Machining Software, the programs will be reloaded to Machining Software directly.

Continues on next page

- if there is modifications made in the Machining Software, a message will be displayed, prompting you to synchronize from the controller or keep the modification in Machining Software.

Reloading from local file

The modules saved to the local folder must be loaded to the `T_ROB1` task of the controller first, and then be programmed and reloaded to Machining Software.

Multiple instruction exporting

Introduction

If the targets in a program is more than 2000, it is recommended to enable the multiple instruction exporting function. With the function enabled, every 200 instructions will be grouped and included in a separate module in the T_Large task. The modules in the T_Large task will be further called by the main routine in the T_ROB1 task. This facilitates program programming and reading.

The multiple instruction exporting function is supported only by Machining Software in advanced version (option Machining Premium). To enable the function, make sure the Multitasking option is selected and then select option Machining Premium > More than 2000 instructions > Add T_large task in the **Modify RobotWare** dialogue.

Working with multiple instruction exporting function

1 Open RobotStudio.
2 In the Add-Ins tab, click **Machining 202*X.X***.
3 In the **Machining** tab, choose **Export Settings** from the **Export** list in the **Path Tools** group.
4 In the displayed **Export Settings** window, choose **Large_Export_Rules_Library.yml** from the **Active Template** drop-down list in the **Export template library** area, and then click **OK**.
5 In the **Program** tab page on the left pane of the window, right-click the required program and choose **Export RAPID** from the shortcut menu.
   - Information of every 200 targets is included in an LN file. If less than 200 targets are left for the last file, default data will be added to make sure 200 target items are included in the file.
   - The LN files are named with suffix "_LN_{index}", in which "index" refers to the file number.
   - The LN files are generated and exported to directory `$HOME/LN{ProgramName}/Opr_{ProgramID}_{Operation_ID}`.
6 Click the **Controller** tab and, in the **RAPID** category in the **Controller** navigation tree in the displayed window:
   - Right-click the T_Large task, choose **Load Module** from the shortcut menu and load modules `BackgroundCalibData.mod` and `BackgroundMain.mod`.
   - Right-click the T_ROB1 task, choose Load Module from the shortcut menu and load modules `MotionCalibData.mod`, `MotionMain.mod` and, if any, `MotionEventDefGroup`.

Continues on next page

7 Click the **RAPID** tab and remove the selection of the T_ROB1 task from the **Selected tasks** list in the **Test and Debug** group.
8 Set the program pointer to the GenerateModules_Opr routine in the T_Large task.
9 Run the program to start RAPID compiling.

   Corresponding binary files are generated for the LN files in the same directory.
10 Click the **RAPID** tab and select the T_ROB1 task from the **Selected tasks** list in the **Test and Debug** group.
11 Set the program pointer to the main routine in the T_ROB1 task.
12 Run the program.

6.2 RAPID instructions

6.2.1 MachL - Moves linearly

Usage

In machining programs, `MachL` is used to move the tool center point (TCP) linearly to a given destination.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Arguments

`offset`

Data type: `pose`

`offset` is used to add an offset to the robot position in the object coordinate system.

`RelEuler`

Data type: `MachiningPose` (See *MachiningPose - Coordinate transformations in machining programs on page 64*)

`RelEuler` is used to add a displacement and/or a rotation, expressed in the active tool coordinate system, to a robot position.

`ToPoint`

Data type: `robtarget`

`ToPoint` defines the destination point of the robot and external axes.

`\RCS`

Data type: `pose`

`RCS` defines the coordinate system for machining the contact point. The Z-axis direction is the same as the normal vector. The value of the this argument is generated automatically in Machining PowerPac and not allowed to be changed.

`\ID`

Data type: `identno`

The argument `\ID` is mandatory in the MultiMove systems, if the movement is synchronized or coordinated synchronized. This argument is not allowed in any other case. The specified id number must be the same in all the cooperating program tasks. By using the id number the movements are not mixed up at the runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`Zone`

Data type: `zonedata`

Continues on next page

6.2.1 MachL - Moves linearly
Continued

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`\WObj`

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified to perform a linear movement relative to the work object.

`\Corr`

Data type: `switch`

Correction data written to a corrections entry by the instruction CorrWrite will be added to the path and destination position if this argument is present.

The RobotWare option Path Offset is required when using this argument.

`\TLoad`

Data type: `loaddata`

The `\TLoad` argument describes the load attached to the tool flange of the robot.

`process`

Data type: `MachineProcess` (See *MachineProcess - Process definitions in machining programs on page 65*)

The `process` argument describes the required process parameters and other necessary information for machining applications.

6.2.2 MachJ - Moves using joint movement

Usage

In machining programs, `MachJ` is used to move quickly from one point to another when that movement does not have to be in a straight line.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Arguments

`offset`

Data type: `pose`

`offset` is used to add an offset to the robot position in the object coordinate system.

`RelEuler`

Data type: `MachiningPose` (See *MachiningPose - Coordinate transformations in machining programs on page 64*)

`RelEuler` is used to add a displacement and/or a rotation, expressed in the active tool coordinate system, to a robot position.

`ToPoint`

Data type: `robtarget`

`ToPoint` defines the destination point of the robot and external axes.

`\RCS`

Data type: `pose`

`RCS` defines the coordinate system for machining the contact point. The Z-axis direction is the same as the normal vector. The value of the this argument is generated automatically in Machining PowerPac and not allowed to be changed.

`\ID`

Data type: `identno`

The argument `\ID` is mandatory in the MultiMove systems, if the movement is synchronized or coordinated synchronized. This argument is not allowed in any other case. The specified id number must be the same in all the cooperating program tasks. By using the id number the movements are not mixed up at the runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`Zone`

Data type: `zonedata`

Continues on next page

6.2.2 MachJ - Moves using joint movement
Continued

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`\WObj`

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified to perform a linear movement relative to the work object.

`\TLoad`

Data type: `loaddata`

The `\TLoad` argument describes the load attached to the tool flange of the robot.

`process`

Data type: `MachineProcess` (See *MachineProcess - Process definitions in machining programs on page 65*)

The `process` argument describes the required process parameters and other necessary information for machining applications.

6.2.3 MachC - Moves circularly

Usage

In machining programs, `MachC` is used to move the tool center point (TCP) circularly to a given destination. During the movement the orientation normally remains unchanged relative to the circle.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Arguments

`offset`

Data type: `pose`

`offset` is used to add an offset to the robot position in the object coordinate system.

`RelEuler`

Data type: `MachiningPose` (See *MachiningPose - Coordinate transformations in machining programs on page 64*)

`RelEuler` is used to add a displacement and/or a rotation, expressed in the active tool coordinate system, to a robot position.

`CirPoint`

Data type: `robtarget`

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point.

`\RCS_Cir`

Data type: `pose`

`RCS` defines the coordinate system for circle point.

`ToPoint`

Data type: `robtarget`

`ToPoint` defines the destination point of the robot and external axes.

`\RCS_To`

Data type: `pose`

`RCS` defines the coordinate system for destination point.

`\ID`

Data type: `identno`

The argument `\ID` is mandatory in the MultiMove systems, if the movement is synchronized or coordinated synchronized. This argument is not allowed in any other case. The specified id number must be the same in all the cooperating program tasks. By using the id number the movements are not mixed up at the runtime.

Continues on next page

6.2.3 MachC - Moves circularly
Continued

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`\WObj`

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified to perform a linear movement relative to the work object.

`\TLoad`

Data type: `loaddata`

The `\TLoad` argument describes the load attached to the tool flange of the robot.

`process`

Data type: `MachineProcess` (See *MachineProcess - Process definitions in machining programs on page 65*)

The `process` argument describes the required process parameters and other necessary information for machining applications.

6.2.4 WaveLStartPoint - Moves to the wave start point

Usage

In machining programs, `WaveLStartPoint` is used to specify the position of the wave start point. If the motion type is circular, this instruction is operated and the robot moves to the specified wave start point first to process. If the motion type is linear, this instruction is skipped and the robot directly moves to the next wave node to process.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Arguments

`WShape`

Data type: `WaveShape` (See *WaveShape - wave patterns defined for wave paths on page 69*)

`WShape` specifies the wave pattern, circular or linear.

`ToTarget`

Data type: `robtarget`

`ToTarget` specifies the sourcing target generated by Machining PowerPac, which is used as reference for generating the wave start node.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`\WObj`

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified to perform a linear movement relative to the work object.

6.2.5 WaveL - Moves along the wave path

Usage

In machining programs, `WaveL` is used to move the tool center point (TCP) along the wave path.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Arguments

`WShape`

Data type: `WaveShape` (See *WaveShape - wave patterns defined for wave paths on page 69*)

`WShape` specifies the wave pattern, circular or linear.

`TargetArray`

Data type: `robtarget`

`TargetArray` specifies the array of sourcing targets generated by Machining PowerPac, which are used as reference for generating wave nodes.

`Start`

Data type: `num`

`Start` is the index for the start point, where the wave path starts.

`End`

Data type: `num`

`End` is the index for the end point, where the wave path ends.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`\WObj`

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

Continues on next page

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified to perform a linear movement relative to the work object.

6.3 RAPID data types

6.3.1 MachiningPose - Coordinate transformations in machining programs

Usage

Data of the type `MachiningPose` describes how a coordinate system is displaced and rotated.

Components

x

Data type: `num`

The displacement in X-axis position of the coordinate system.

y

Data type: `num`

The displacement in Y-axis position of the coordinate system.

z

Data type: `num`

The displacement in Z-axis position of the coordinate system.

Rx

Data type: `num`

The orientation in X-axis position of the coordinate system.

Ry

Data type: `num`

The orientation in Y-axis position of the coordinate system.

Rz

Data type: `num`

The orientation in Z-axis position of the coordinate system.

6.3.2 MachineProcess - Process definitions in machining programs

Usage

Data of the type `MachiningProcess` describes parameters specially used during machining process.

Components

`EngageDistance`

Data type: `num`

The pressure amount with which the tool will move a further distance towards to the work object.

`TiltAngle`

Data type: `num`

The angle (inclined right or left) that the tool will rotate along the forward direction of the machining path.

`LeadAngle`

Data type: `num`

The angle (inclined forward or backward) that the tool will rotate along the tangent direction to the forward direction of the machining path.

`PreRoutine`

Data type: `string`

The component `PreRoutine` defines the event that is executed before a motion instruction.

`PostRoutine`

Data type: `string`

The component `PostRoutine` defines the event that is executed after a motion instruction.

6.3.3 WaveDirection - Wave path processing directions

Usage

Data of the type `WaveDirection` describes the coordinate system of the wave nodes and the processing forward direction of the wave paths.

Components

`CoordinateSystem`

Data type: `num`

Value of `TOOLSYSTEM` is `0`, indicating the tool coordinate system is used.

`Direction`

Data type: `string`

Processing forward direction of the wave path.

6.3.4 WaveDistribution - Distribution information of wave nodes

Usage

Data of the type `WaveDistribution` describes the node array, that is, how the nodes distribute.

Components

`Nodes`

Data type: `string`

Name of the node array.

`NodeCount`

Data type: `num`

Quantity of nodes in the node array.

`StartPoint`

Data type: `pos`

Wave start point of the wave path. This parameter works only for the wave path in circular pattern.

6.3.5 WaveNode - wave nodes defined for wave paths

Usage

Data of the type `WaveNode` describes how the wave nodes are defined based on the sourcing targets generated by Machining PowerPac.

Components

`Offset`

Data type: `pos`

Displacement offset of wave nodes from the sourcing targets based on which the nodes are generated.

`Index`

Data type: `num`

Index indicating the sourcing target from which the wave node is generated.

`MotionType`

Data type: `string`

The robot motion type, linear or circular.

6.3.6 WaveShape - wave patterns defined for wave paths

Usage

Data of the type `WaveShape` describes the wave pattern of the wave path.

Components

`WType`

Data type: `string`

Name of the wave path.

`WaveDistribution`

Data type: `WaveDistribution`

Distribution information of nodes in the wave path.

`WaveDirection`

Data type: `WaveDirection`

Coordinate system of nodes and processing forward direction of the wave path.

`nStep`

Data type: `num`

Step for the wave pattern to repeat.

`WMotion`

Data type: `string`

Wave motion function, whose default value is `WaveMotionCustomDefault`. It allows users to customize motion functions as requires. The function is available in the system module `WaveMotionModule`.

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7 Messages and errors

Message list

ID	Message
118001	Calibration Process Information
118002	TouchMotion Information
118003	Parameter error

Error list

118004 Array Length is too short

Description	The array length is too short.
Consequence	The program is stopped.
Causes	None
Actions	None

118005 Distance is zero

Description	The distance between the home point and the contact point is 0.
Consequence	The program is stopped.
Causes	The home point is too close to the contact point.
Actions	None

118006 Tool and Wobj are wrong

Description	Active tool and active work object cannot have the **RobHold** parameter set to the same value, no matter both **True** or both **False**.
Consequence	The program is stopped.
Causes	The setting of the `robhold` component in the `tooldata` and `wobjdata` instructions is conflict.
Actions	Change the setting of the **RobHold** parameter for the active tool and active work object to different value.

118007 External Axis is not at Zero position

Description	The axis is not at zero position.
Consequence	The program is stopped.
Causes	The external axis is found not at the zero position.
Actions	Jog the external axis to the zero position.

118008 Array length mismatch

Description	The size of the array does not match the size used.
Consequence	The program is stopped.
Causes	The length of the array is less than the number of elements used.
Actions	Modify the number of elements used.

Continues on next page

Continued

118009 Precision is not enough

Description	Data or position is not defined accurately.
Consequence	The program is stopped.
Causes	No enough data or the positions do not have the required relations or not specified with enough accuracy.
Actions	Increase the number of data and improve the data correlation.

118010 Collision occurred during probe movement

Description	Collision occurs during probe movement.
Consequence	The program is stopped.
Causes	The probe has collided with an obstacle in the cell during its movement.
Actions	1 Check the probe retraction status, succeeded or failed. 2 If failed, go to Manual mode. 3 Manually run the robot to move the probe away from the object. 4 Resume operation by restarting the program.

118011 Probe retraction succeeded

Description	The manipulator has attempted to move the probe back away from the obstacle, into which it collided, and succeeded.
Consequence	The system is ready to go back to normal operation.
Causes	None
Actions	None

118012 Probe retraction failed

Description	The manipulator has attempted to move the probe back away from the obstacle, into which it collided, and failed
Consequence	The system is NOT ready to go back to normal operation.
Causes	This may be caused by the probe being stuck to the object into which it collided.
Actions	1 Go to Manual mode. 2 Manually run the robot to move the probe away from the object. 3 Resume operation by restarting the program.

118100 Robot-hold status confliction for crossbeam and its related tool

Description	Robot-hold status of the tool and crossbeam (or the wobjdata defined for the crossbeam) conflict.
Consequence	The program is stopped.
Causes	The tool selected for crossbeam calibration and the crossbeam (or the wobjdata defined for the crossbeam) are both set as in fixed position or hold by the robot.
Actions	1 Check the robot-hold status of each item. 2 Modify the required one.

Continues on next page

118101 Robot-hold status confliction for original and calibrated tooldata

Description	Robot-hold status included in the original tooldata and calibrated tooldata of the tool conflict.
Consequence	The program is stopped.
Causes	The robot-hold status in the calibrated tooldata of the tool is different from that in the original tooldata used for the tool.
Actions	• Check the robot-hold status in the original and calibrated tooldata. • Modify the required one.

118610 Rapid module is missing

Description	The specified RAPID module cannot be found.
Consequence	The program is stopped.
Causes	The RAPID module is missing.
Actions	• Check the file path and file name. • Check whether the file exist.

118611 LN file is missing

Description	The specified LN file cannot be found.
Consequence	The program is stopped.
Causes	The LN file is missing.
Actions	• Check the file path and file name. • Check whether the file exist.

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