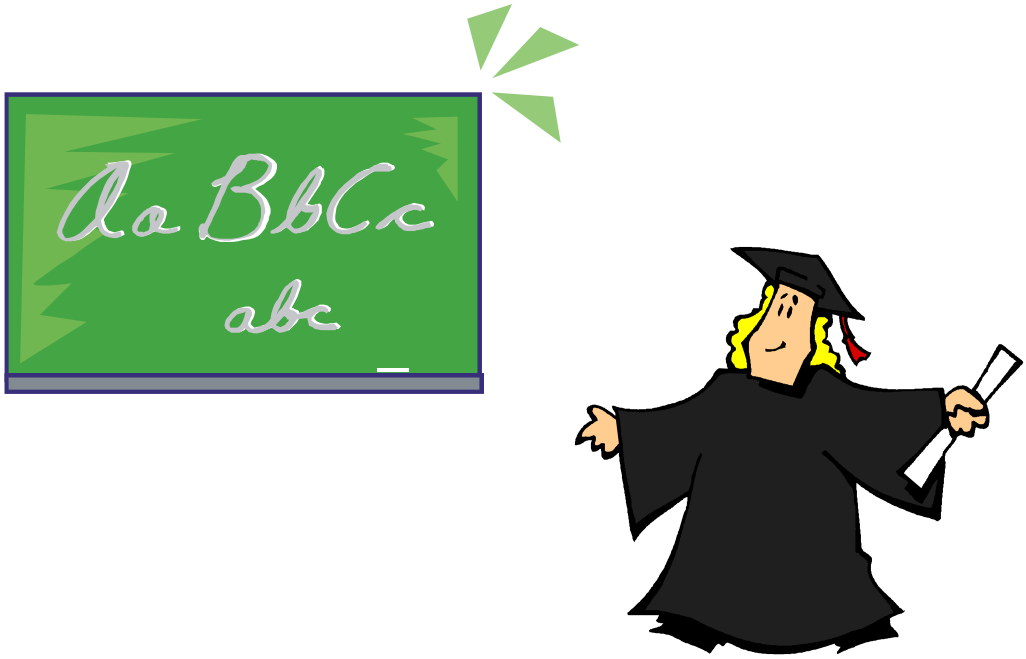
Tutorial

EASY-ROB™ V8.6



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Version 3.5

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EASY-ROB™

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EASY-ROB™

Tutorial

1 Your guide

1.1 Product Overview

An overview of the most important EASY-ROB™-documentations

This tutorial is intended to explain and to show you the most fundamental EASY-ROB™-functionalities, such as creating and loading a work cell with its associated simulation program.
It contains lessons with step-by-step examples, which should be exercised carefully. Regardless of this tutorial you should become familiar with the 3D-simulation software in advance. To help you, you have access to a lot of important and detailed documentations.
This guide shows you, which documentations are available.

There are 3 ways to access these documentations:

1) **Online**:
https://easy-rob.com/en/downloads-2/

2) In the **CD-directory** under Manual

3) In the **Installation-directory** under Manual

1. Product Description

Are you interested in other EASY-ROB™ products? Or do you just want to get information about the features of the single versions?

Take a look into the product description

>> EASY-ROB-ProductDescription.pdf

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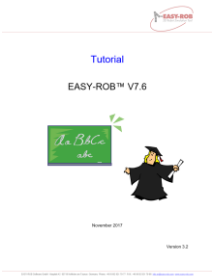
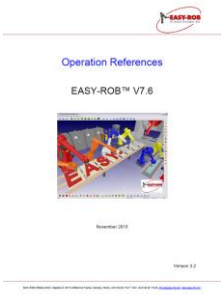
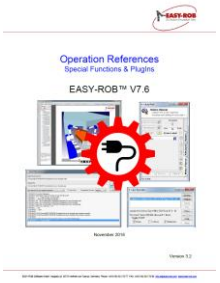
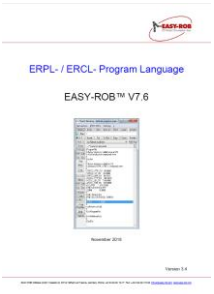
1. Tutorial This tutorial is intended to explain and implement the most fundamental EASY-ROB ™ functionalities. In a step-by-step instruction with a reference to examples you will learn here how to use EASY-ROB ™. This guide is part of the TrainLib-Tutorial. >> TrainLib-Tutorial_ENG.pdf	
2. Operation References The Operation References will be a helpful assistant while working with EASY-ROB™. It contains detailed basic information which is required for to use all software features from beginning in proper way. The user will find information about the system files for the start configuration and the environment, description about short keys or the main dialogs as well as short tutorials >> Operation-References.pdf	
3. Operation References – Special Functions & Plug-Ins The Operation References – Special Functions & Plug-Ins are an extension to the Operation References. They contain detailed information to the EASY-ROB™-Plug-Ins as well as the special functions. >> Operation-References-Functions-PlugIns.pdf	
4. ERPL- / ERCL-Programming Language This description gives an overview about the EASY-ROB™ program structure and the available robot motion commands >> EASY-ROB-ERPL_ENG.pdf	

EASY-ROB™ Multi-Robot Version

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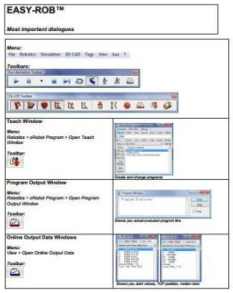
5. Update-Descriptions All new features of an updated EASY-ROB ™ version are documented and described in the associated update descriptions. Use the Update descriptions to gain an overview of the new features of current or older versions and to familiarize yourself with their function. >> Update-ER_v8003-2019_ENG.pdf	
6. EASY-ROB™ Short Keys The EASY-ROB ™ user interface can be operated by using the mouse and or the keyboard by so-called short keys. This document provides an overview of all buttons and short keys and describes their function. >> EASY-ROB-ShortKeys_ENG.pdf	
7. EASY-ROB™ Dialogues The most important EASY-ROB-dialogues as overview and how to open them. >> EASY-ROB-Dialogues.pdf	
8. Adding a 7th tracking axis Learn how to add a 7th tracking axis. >> Tracking-Axis.pdf	

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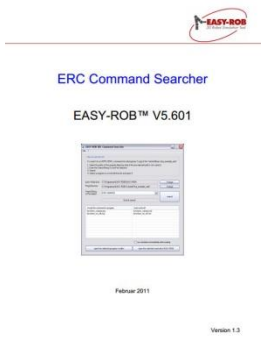
9. ERC Command Searcher

The ERC Command Searcher will support the user to search for a specific ERC commands in the example library “Proj_example_erpl”, which is normally installed in the directory:
“.\EASY-ROB\Tutorial\Proj_example_erpl

This description shows how to use the ERC Command Searcher.

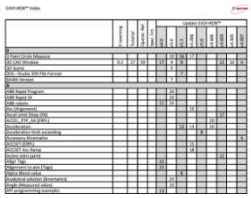
>> ERC-Command-Searcher_ENG.pdf



10. Index

The index makes it easy to search for terms and to seek the corresponding detailed explanations in the operation references, update descriptions of older versions and eLearning modules.

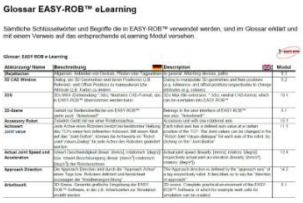
>> EASY-ROB-Index.pdf



11. Glossar EASY-ROB™ eLearning

All keywords and terms that are used in EASY-ROB™ are explained in the glossary. They are also provided with a reference to the corresponding e-learning module.

>> Glossar_DE_ENG_CHS.pdf

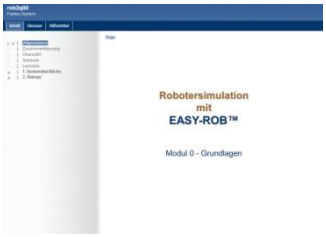


12. eLearning platform

In cooperation with the Handwerkskammer Münster an eLearning platform with a total number of 25 modules for EASY-ROB™ has been created. This feature is only available in german language.

You can access the e-learning modules from the customer area of our website at https://www.easy-rob.com/en/service/training.html. As part of your EASY-ROB ™ software maintenance and support contract, you can use this platform free of charge.

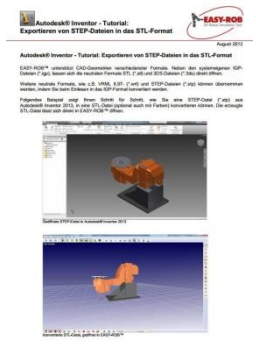
>> https://www.hbz-online.de/login/index.php



13. Autodesk® Inventor - Tutorial: Exporting STEP-files into STL-format

This documentation shows step-by-step how to convert a STEP-file (*.stp) into a STL-file (optionally with colours) using Autodesk® Inventor 2013. This STL-file can be opened directly with EASY-ROB™.

>> Autodesk-STEP2STL-Tutorial_ENG.pdf



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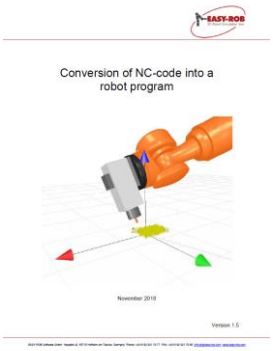
1. Conversion of NC-code into a robot program

This description shows you how to create a path with tagpoints out of a NC-code and how to convert it into a manufacturer-specific robot programd, by using EASY-ROB™.

>> EASY-ROB-NC-Import-Description.pdf

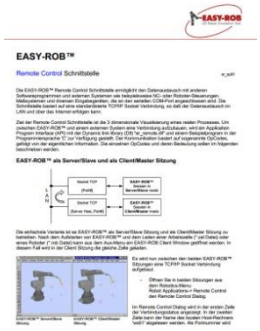


2. EASY-ROB™ Remote Control

The EASY-ROB™ remote control feature with TCP sockets allows it to interchange data with other programs, such as Robot or NC machine controller. An Application Program Interface (API) is provided with the Dynamic link library (Dll) “er_remote.dll

This document describes the function and how to use the remote control feature.

>> Remote-Description-Ext_ENG.pdf



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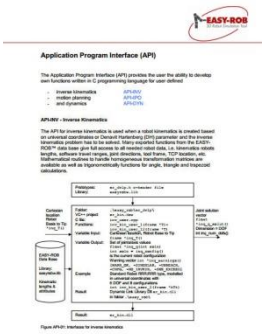
1. API-Description

The Application Program Interface (API) provides the user the ability to develop own functions written in C programming language for user defined inverse kinematics, motion planning and dynamics.

CD-directory: .\Manual\API\API-Description.pdf

Installation-directory: .\Manual\API-Description.pdf



2. API-Sensor: Programmable Sensor interface

The sensor interface allows the user to connect an external device - like a SpaceMouse or a digitizer to capture axis angle and cartesian positions - and visualize the data direct in EASY-ROB™.

CD-directory: .\Product-Info\API-Sensor_DE.pdf

Installation-directory: .\Manual\API-Sensor_ENG.pdf

3. API-UserDll

The optional API-UserDll is an enhancement of the EASY-ROB™ programming interface and enables you to create user specific dialogs that can be loaded automatically at the startup of EASY-ROB™. By using the API UserDll EASY-ROB™can easily be customized to fit the customer's needs.

CD-directory: .\Product-Info\ API-UserDll_ENG.pdf

Installation-directory: .\Manual\API-UserDll_ENG.pdf

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4. API - Doxygen documentation of methods class ER_CAPI

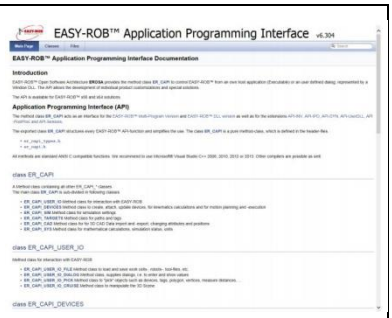
For the control of EASY-ROB ™ and for individual product customization the methods class ER_CAPI provides a variety of functions that are documented with doxygen.

The documentation is available as Browser-version (index.html) and as compiled HTML-file (*.chm).

Online: https://www.easy-rob.com/en/product/extensions/apis-additional-options.html

CD-directory: .\Manual\API\EASY-ROB ER_CAPI.chm or .\Manual\doxygen_ER_CAPI\html\index.html

Installation-directory: .\Manual\EASY-ROB ER_CAPI.chm



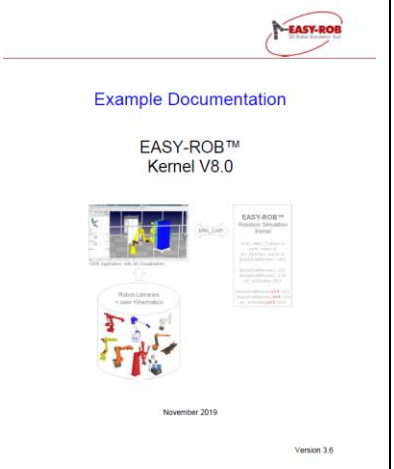
5. EASY-ROB™ Kernel - Example Documentation

This documentation shows and describes examples for the „EASY-ROB™ Kernel“.

Online: https://www.easy-rob.com/fileadmin/Userfiles/doc/erk/erk-example-documentation.pdf

CD-directory: .\Manual\API\ERK-Example-Documentation.pdf

Installation-directory : .\Manual\ ERK-Example-Documentation.pdf



6. API - Doxygen Dokumentation der Klasse ERK_CAPI

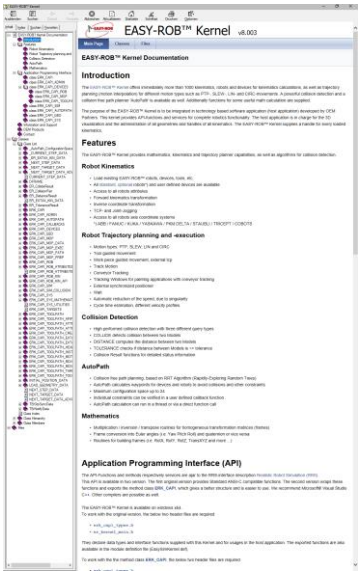
For the integration of the EASY-ROB™ Kernel in your own technology-based software solutions the methods class ERK_CAPI provides a variety of functions that are documented with doxygen.

The documentation is available as Browser-version (index.html) and as compiled HTML-file (*.chm).

Online: https://easy-rob.com/fileadmin/Userfiles/doc/erk_capi/index.html

CD-directory: .\Manual\API\ EASY-ROB Kernel.chm or .\Manual\doxygen_ERK_CAPI\html\index.html

Installation-directory: .\Manual\EASY-ROB Kernel.chm



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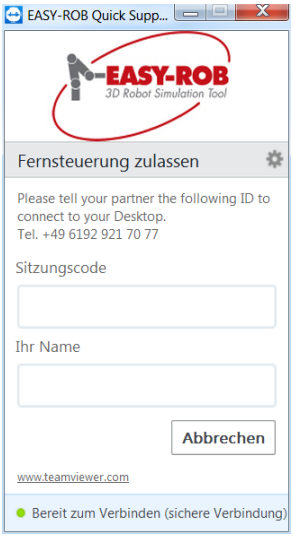
1. Remote Support with TeamViewer

In order to support our customers much better, we provide you with the EASY-ROB™ TeamViewer Quick Support**.** A lot of problems can be solved much faster, by joining and watching either your or our EASY-ROB™ session.

Online: https://easy-rob.com/en/contact/teamviewer/

CD-directory: .\TeamViewer\TeamViewerQSen.exe

Installation-directory: .\TeamViewer\TeamViewerQSen.exe



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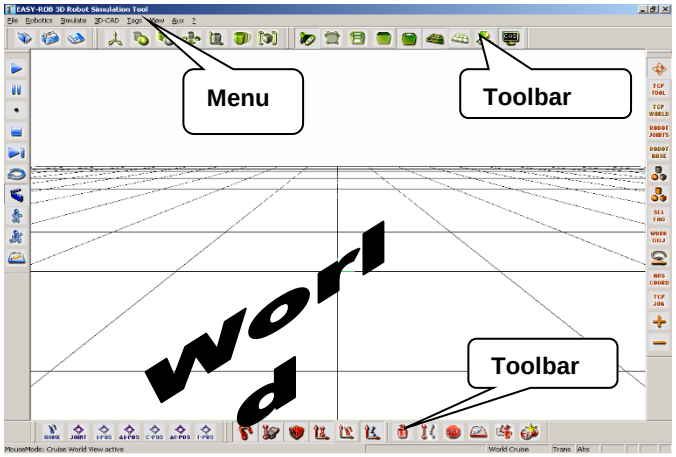
2 Basics

2.1 Terms

Target of the chapter: Introduction of the terms and the environment in EASY-ROB™	
The screen consist of the following components: - Menu - Toolbars - World	
The **Menu** and **Toolbars** are providing different functions. Toolbars can be placed everywhere in the world..	
Cell file or Work cell (*.cel)	The Work cell contains all into simulation involved devices (e.g. robots, tools, tables,…) and the programs.
Robot/Device file (*.rob)	A robot file is device kinematics – e.g. a robot, a weld gun or a positioner.
Robot/Device Assembly file (*.ras)	Robot assembly consisting of several robots/devices, that can be linked together.
Tool file (*.tol)	A simple tool - TCP be set automatically

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Body file (*.bod)	A simple geometry without kinematics
Program file (*.prg, *.nc)	A program in EASY-ROB-language ERPL and ERCL for „Robot files“
Mimic file (*.mmc)	A Machine-Interface file, containing ERPL and ERCL commands
View file (*.vie)	File the store a position for a view, defined by the user
Camera file (*.cam)	A file to store the current camera settings like the focus
Tagpoint file (*.tag)	A file to store the tagpoints in a separate place

System files

Environment file (easy-rob.env)	File to set the variables for the environment – such as background color, floor on/off, etc ….
Config file (config.dat)	System file: sets the location of the license.dat and paths for temporary and user files
License file (license.dat)	System file: contains your license information
Er_load (er_LoadFromLibPb_prefered.ini)	System file: contains preferred paths for the Device Manager
Working Pathes File (easy-rob.pth)	System file: sets paths for the working and geometry directories with "WORKDIR =" and "IGPDIR ="
Localization file (easy-rob-localizationx64.ini)	System file: sets the language of the GUI (English / German / Chinese)

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2.2 Mouse Navigation

Cruise, Zoom and moving the world

„Modify World view“ – activate by click

Cruise Mode (rotate / cruise the world):	Press and hold Left Mouse Button (**LMB**) and move the cursor to the **left** respectively to the **right** -> the world will rotate around Z-axis. Press and hold Left Mouse Button (**LMB**) and move the cursor **up** or **down** -> the world will rotate around the X-axis
Zoom Mode	Press Middle Mouse Button (**MMB**) [or RMB if you are using a 2button mouse] and move the cursor to the **up-right** corner -> Zoom-In, Press Middle Mouse Button (**MMB**) [or RMB if you are using a 2button mouse] and move the cursor to the **down-left** corner -> Zoom-Out.
Pan Mode	Press Left und Right Mouse Button (LMR+RMB) at the same time and move the cursor -> the whole world will move

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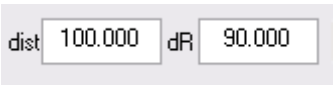
3 Setting up a work cell

3.1 Load and place existing components

Target of this chapter:
How to load and place an existing device from the library into the work cell.

Note:
Please read as well the Operation-References, topic *Kinematics Window* and *Frame Dialog*.

1. Load a robot into the world by using the button *Starte Device Manager* Directory: ../EASY-ROB / TRAINlib / … Robot: AX-V6.rob	 or shortcut „Ctrl+Shift+O“
2. Open the *Kinematics Window* by double click the button *Robot Base*	
3. Double click the headword *Base* to open the *Frame Dialog*	
4. Place the robot in X-direction -500 by inserting the numbers or by buttons. The “delta” you can adjust in the field „dist“.	  

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5. Confirm with OK.	
6. Save the new position as “Start Condition”	 
7. Save the work cell – use the button *Save Cell File* or shortcut Answer the question „Reset all Positions and Joints to Start Condition“ with *Yes* Save the work cell cell with the name *tutorial_01.cel* in the directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
8. Clear all by shortcut: Answer the question „Unload Cell“ with *Yes*	„Ctrl+U“

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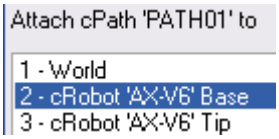
3.2 Creating paths and tag points

Target of the chapter:
How to create a path with tag points and how to move along the path with different motion types.

Note:
Please read as well the Operation-References, topic *Tag Window*

1. Load the work cell *tutorial_01.cel* by using the button *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Save the work cell by using the button *Save Cell File* with the name *tutorial_02.cel* in directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
3. Move the robot to home position by using the button *Home*	
4. Open the *Tag Window* – click on button *Sel Tag*	
5. Information: EASY-ROB always creates automatically one default path with the name *PATH01.*This path will be located in world zero and has to be assigned (or attached) to a device – e.g. the workpiece. In this case we attach the path to robots base Re-Attach the path *PATH01* to the robot base	 

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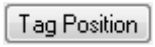
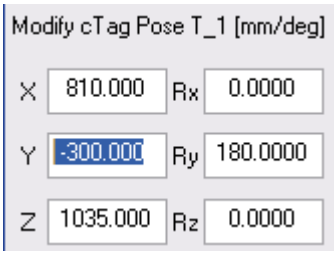
Answer the question to “keep the world position” with *No*	
6. Create a new tagpoint at the TCP of the robot with button *New TCP Tag* Information: - the new point will get the default name T_1 (but you can change that) - the new tagpoint will be assigned automatically to the default path - and will be located on the TCP of the robot	
7. Double click on *Tag Position* to open the *Frame Dialog* and move the tag point to Y= - 300 by inserting the coordinates or use the buttons.	  
8. Repeat step 6 and 7 for three more tag points and place them like in the table: TAG T_2 x = 810 y = 300 z = 1035 TAG T_3 x = 810 y = 300 z = 800 TAG T_4 x = 810 y = -300 z = 800	

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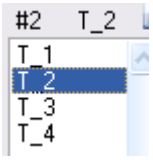
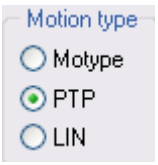
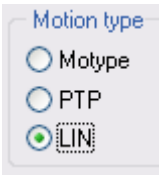
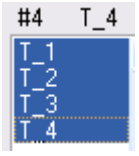
9. Double click onto the tag point name and the robot will move to the location or use buttons *next* und *prev.* to select the tagpoint and move by using the button *Move cTag*	 
10. Move to Tag T_1 Switch on the TCP-Trace with button: Change the *Motion Type* to *PTP* Move to every tag point - one after the other – and at the end move again to T_1 Change the *Motion Type* to *LIN* and move again to every tag point	  
11. To move along all tag points just hold „Shift“, select all tag points and use the “Move Along-button” Move the robot to home position by clicking on *HOME*	  
12. Save the cell with the name *tutorial_02.cel* in directory: ../EASY-ROB / TRAINlib / (Answer the question „Reset all Positions and Joints to Start Condition“ with *No)*	

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3.3 Creating a program

Target of the chapter:
How to create a program with all needed information like speed, motion type, etc.

Note:
Please read as well the Operation-References, topic *Teach Window*

1. Load the work cell *tutorial_02.cel* by using the button *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Save the cell with *Save Cell File,* name: *tutorial_03.cel* in directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
3. Open the *Teach Window* by clicking on the button *Open Program Teach Window*	
4. Create a new program with the button *New* and save the program with *Save as* and the suggested name „tutorial_03-AX-V6.prg“ in directory: ../EASY-ROB / TRAINlib / answer the question to get the program loaded with *YES*	 
5. Open the program line window and set the cursor to line 10	

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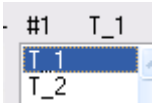
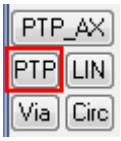
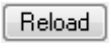
6. Click > *Control* to open the panel for setting *Control Commands* set *Default SPEEDs and ACCELs* for speeds and acceleration **Note**: To initialize the speed and acceleration it is very important to get correct results in a simulation.	 
7. First insert the "*Home"*-Command to let the robot move to the home position.	
8. Open *Tag Window* by double click on the button *Sel Tag*	
9. Select the first tag point T_1 from the list in the *Tag Window*	
10. In the Teach Window click on PTP to insert the PTP-command into the program. Repeat step 9. and 10. for every tag point and at the end one more time for tag T_1 Move the robot to the home position Now your program should look like this:	  
11. Save the program with *Save* and reload the program into the robot by clicking on *Reload*	 

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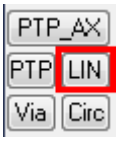
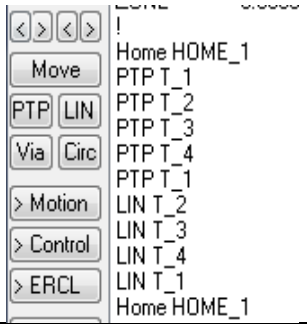
12. Start the simulation with the button *Run Program*	 or shortcut „Ctrl+R“
13. Place the cursor after the second *Home1* command and extend the program like shown: Open the *Tag Window* with double click on button *Sel Tag* Select the 2. tagpoint T_2 in the list *Tag Window*	
14. Click on LIN in the *Teach Window* to insert the LIN-Command into the program. Repeat the step for every tag point and at the end one more time for tagpoint T_1 Now your program should look like this :	 
15. Save the program with *Save* and reload the program into the robot	 
16. Switch the trace on and start the simulation	 
17. Save the cell as *tutorial_03.cel* in directory: ../EASY-ROB / TRAINlib /	

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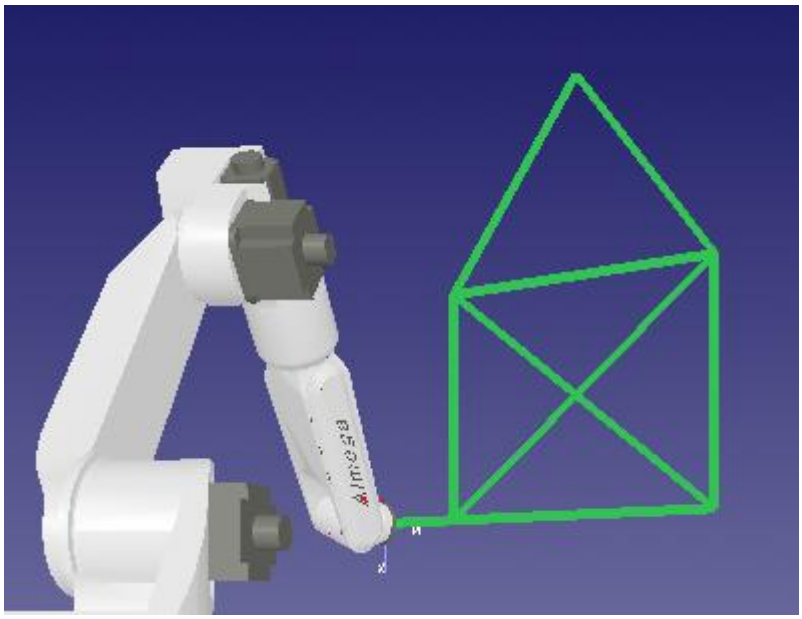
3.4 Practice

Practice:
Create a program that enables the robot to “draw with the trace” the figure shown below.

Remark:
It's not allowed to draw a line 2 times and not allowed to “jump” to another position.

It has to be done in one go.



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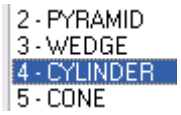
4 Creating components

4.1 Creating simple geometry in EASY-ROB™

Target of the chapter:
How to create a simple geometry in EASY-ROB™ .

Remark:
EASY-ROB™ is a tool to plan and simulate work cells with robots or other kinematics. It's not a 3D-CAD-System. Therefore EASY-ROB™ only provides functions to create simple geometries like cubes, cylinder, cones and spheres. More complex parts should be generated in a 3D-CAD-program and imported to EASY-ROB™ afterwards.

Note:
Please read as well the Operation-References, topic *3D-CAD Window*

1. Create a new device (Rob-file) : *Robotics* | *cRobot Kinematics* | *Create new Robot* | *Universal Coordinates (1-12 dof)* Answer the question to create simple geometry with a click on *No*	
2. Double click on the button *3D-CAD Window* to open the 3D-CAD Window and select *Create Import* to get the creation dialog	 
3. Create a cylinder with the numbers shown below 1 Radius 1.000000 <= 200.0000 2 Height 1 1.000000 <= 20.0000 3 y Scal 0.010000 <= 1.000000 4 Radius top 1.000000 <= 200.0000 5 Height 2 0.000000 <= 20.0000 6 y Scal top 0.010000 <= 1.000000 and save it with name: *r_stat_00*	

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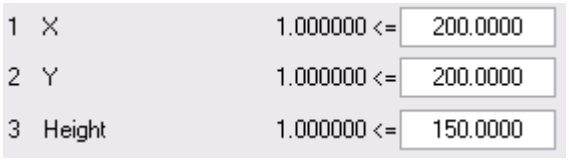
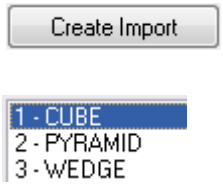
4.
Create a second cylinder:

and save it with the name: *r_stat_01*

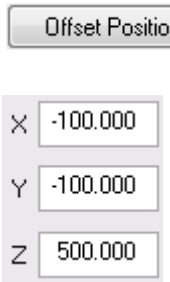
5.
Create a cube:



and save it with the name: *r_stat_02*

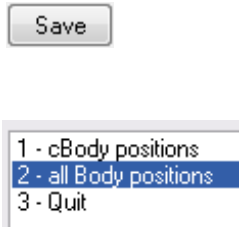


6.
Change the position of the cube:



7.
Save the current position of all bodies with *Save*

all Body positions



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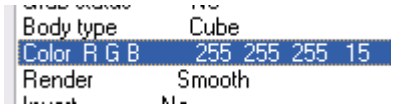
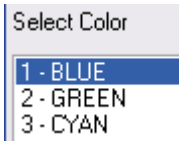
8. Change the color of the cube: double click on *Color RGB* in the properties in the 3D-CAD Window select *1- BLUE* Answer the question “Copy color for whole robot” with *No*	 
9. Double click the button *Robot Base* to open the Kinematics Window Double click on *Name* to open the String Dialog and rename the DEVICE to *„cleaningstation“*	 
10. Save the DEVICE with a click on *Save* in Kinematics Window accept the suggested name and save the DEVICE under the name *CLEANINGSTATION.rob* in directory: ../EASY-ROB / TRAINlib /	
11. Clear the work cell : Answer the question „Unload Cell“ with *Yes* Save cell: *No*	„Ctrl+U“

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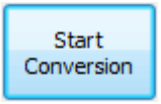
4.2 Import geometry from VRML

Target of the chapter:
How to import 3D-CAD geometry from VRML.

The imported VRML files will be stored in EASY-ROB™ as IGP-Format (*.igp). The importer creates automatically a *.rob-file besides the *.igp-file.

Note:
Please read as well the Operation-References, topic *CAD Import - VRML*

1. Select Menu : *File* | *Load* | *Import / Convert* | *Convert VRML1.0 /2.0 into CAD Preview* or use Drag & Drop to import the file *workpiece_panel.wrl* from directory: ../EASY-ROB / TRAINlib / igp	
2. Save the file *workpiece_panel.igp* in the directory: ../EASY-ROB / TRAINlib / igp	
3. Don't change the default settings and start the conversion. Answer the question to load the file with *Yes* to view the result. Answer the question if the "file" should be "merged" with *Yes* Answer the question if the "lines" should be "skipped" with *Yes* The importer saves automatically the *.ROB- and the *.IGP-file.	

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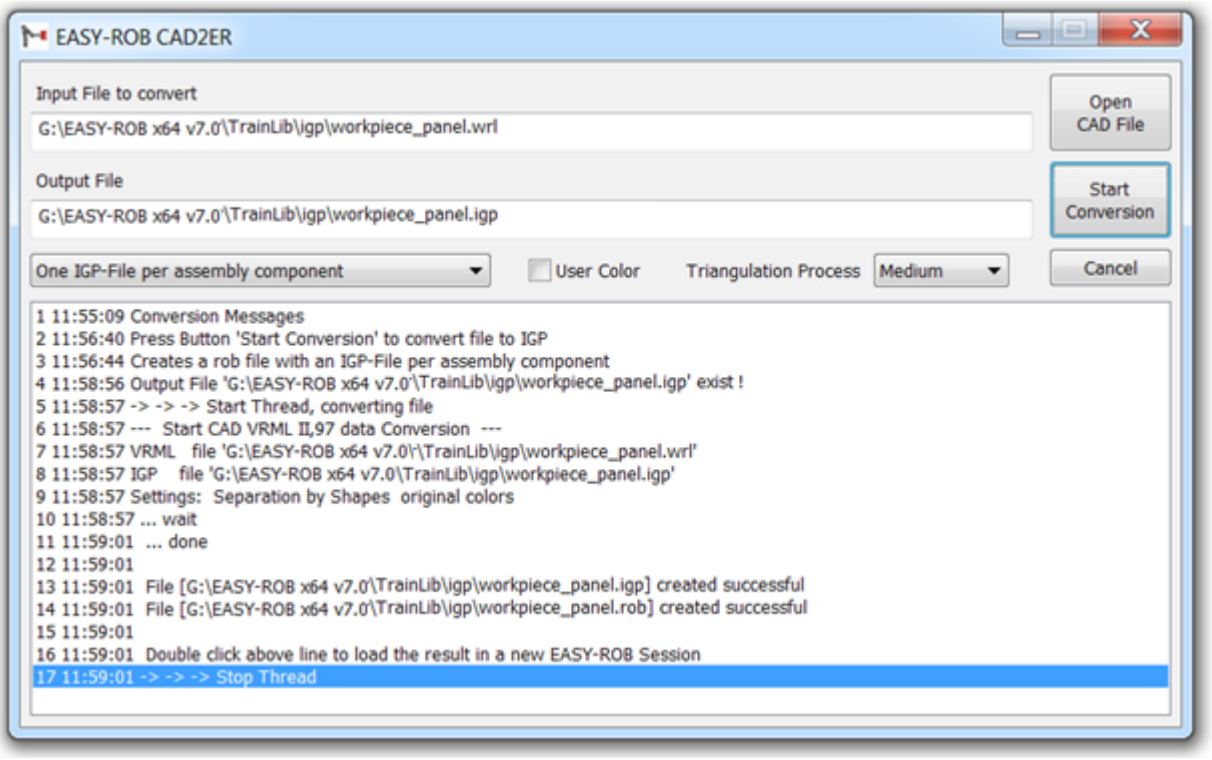
4. Switch to Windows Explorer and open the directory ../EASY-ROB / TRAINlib / igp now move the created *.ROB-file one directory up.	

Remark:
Import of other CAD formats from other CAD Systems

EASY-ROB™ uses the 3D_Evolution® API of CT Core Technology GmbH to import CAD data. The CT Kernel_IO was especially designed for CAD data import and allows importing and optimizing CAD data formats generated by different CAD-Systems.

Please read the chapter *CAD Import – CT Kernel_IO* in the Operation References.

Start CAD2ER as x86 Version .\cad2er\Cad2ErExe.exe 1. Select file "workpiece_panel.wrl" 2. Choose from list "One IGP-File per assembly component" 3. Choose "Start Conversion" to create "workpiece_panel.igp" and "workpiece_panel.rob".	



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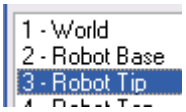
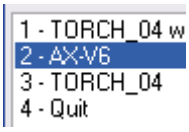
5 Extend a work cell

5.1 Add components

Target of the chapter:
How to load and place additional DEVICES like a welding gun, a cleaning station, a positioner and workpiece.

Note:
Please read as well the Operation-References, topic *Kinematics Window* und *Frame Dialog*.

1. Load the work cell *tutorial_03.cel* *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Save the cell with *Save Cell File* name it: *tutorial_04.cel* in directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
3. Double click on *Robot Base* to open the Kinematics Window Load the welding gun *torch_04.rob* from directory: ../EASY-ROB / TRAINlib /	 
4. Re-attach the gun with *Re-Attach* at robot tip Answer the question with *No* to keep the position	  

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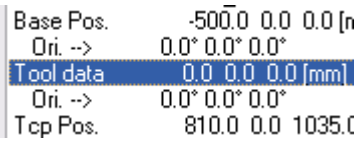
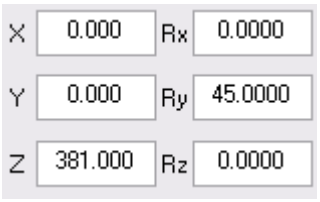
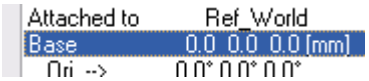
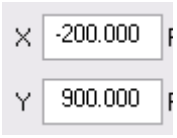
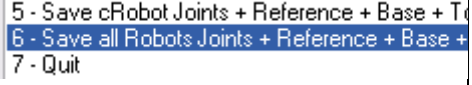
5. Click *Pick Robot* and select the robot by a mouse click Open the Frame Dialog by a mouse click on *Tool* in the properties to set a new tool Set the following values to:	  
6. Load the cleaning station *cleaningstation.rob* (that one you created and saved in the previous chapter) from directory: ../EASY-ROB / TRAINlib / Place the cleaning station by using the Frame Dialog (open the dialog by mouse click *Base*) Set the following values:	 
7. Save the current position of all existing devices by using “Save Start Condition”	 

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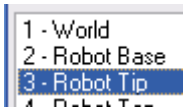
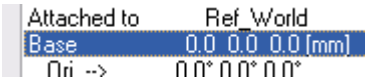
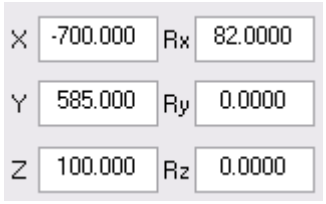
8. Load the positioner *drehtisch.rob* from directory: ../EASY-ROB / TRAINlib / Open the Frame Dialog (double click on Base) to place the positioner Set the following value:	 
9. Load with button *Load* the workpiece *workpiece_panel.rob* from directory: ../EASY-ROB / TRAINlib /	
10. Attach the workpiece with button *Re-Attach* to the positioner tip Don't keep the position in the world Place the workpiece with Frame Dialog Set the following values:	    

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11. Save cell with *Save Cell File* name it *tutorial_04.cel* in the directory: ../EASY-ROB / TRAINlib / **IMPORTANT:** Question to “Reset all Positions and Joints to Start Condition” : *No* Save position as start position: *Yes*	 or shortcut „Ctrl+S“

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EASY-ROB™
Extend a work cell

Tutorial

5.2 Creating paths and tag points at devices

Target of the chapter:
How to create paths and tag points at the workpiece.

Note:
Please read as well the Operation-References, topic *Tag Window und Kinematics Window*

1. Load the cell *tutorial_04.cel* *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Move the robot to home position by clicking on *Home*	
3. Open the *Tag Window* (double click on *Sel Tag*) Delete all existing paths by clicking on *Delete*	 

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4. Save cell with *Save Cell File* name it: *tutorial_05.cel* in directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
5. Open the Kinematics Window (double click on *Robot Base)* Select robot (*Pick Robot*) Open Joint Values and set the following values Axis 2 = -30 Grad Axis 5 = 60 Grad	 
6. Rename the path *PATH01* to *start_pos* in the *Tag Window* Re-Attach the part *start_pos* robots base Keep position: *No*	  
7. Create a new tag point with *New TCP Tag* Rename the tag point to *T_start_pos*	 
8. Create a new path with *New* Rename the *PATH02* to *clean_stat* Re-Attach the path *clean_stat* by using the option *Pick Body* to the base of cleaning station Keep position: *No* Create a new tag point (*New TCP Tag*) Rename the tag point to *T_clean_stat01*	     

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9. Open the *Frame Dialog* by clicking on *Tag Position* and shift the tag point to the position:	
10. Clone the tag point *T_clean_stat01* and place the new tag point in z = 600 Rename the tag point to *T_clean_stat02*	
11. Select the robot with *Pick Robot* in Kinematics Window and move to the tag points by double click onto the tag point's name	
12. Change the path and move to start position by double click onto the tag point *T_start_pos*	
13. Save cell and name it *tutorial_05.cel* in the directory: ../EASY-ROB / TRAINlib /	
14. Select the positioner "drehtisch" with *Pick Robot* in the Kinematics Window Open the Joint Values and set them to: Axis 1 = -90 Grad	

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15. Create a new path in Tag Window Rename the path *PATH03* to *seam* Re-Attach the path *seam* with option *Pick Body* to the workpiece Keep position: *No*	
16. Select the robot (*Pick Robot* Kinematics Window) Create a new tag point with *New TCP Tag* Open the *Frame Dialog* by click on *Position* and shift the tag point to:	
17. Move the tag point switch *TCP Jog* on Create a new tag point (*New TCP Tag*) Select *MouseMode Tag*	

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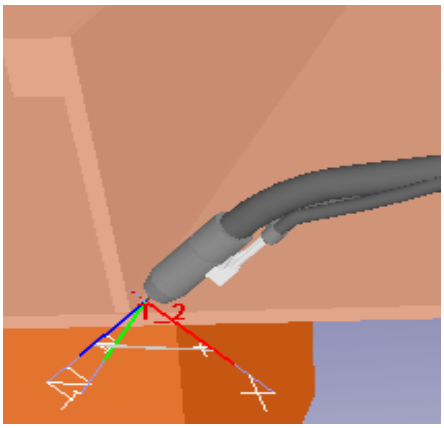
and shift the tag point with your mouse by moving it to the start position of the welding seam.	

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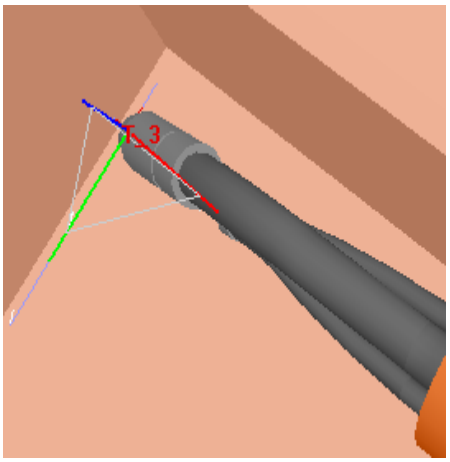
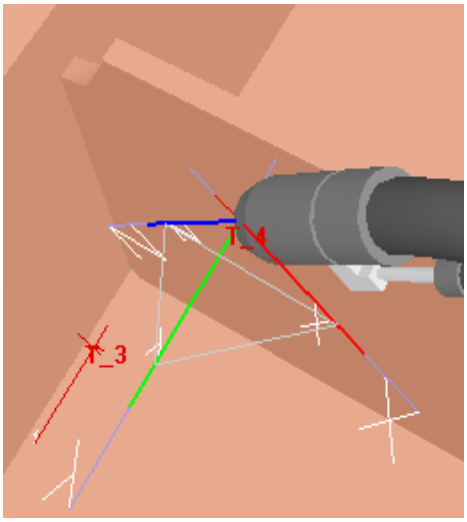
18. Create a new tag point (*New TCP Tag*) Select *MouseMode Tag* and shift the tag point with your mouse by moving it to the end of the welding seam.	New TCP Tag MouseMode Tag 
19. Create a new tag point with *New TCP Tag* Select *MouseMode Tag* and shift the tag point with your mouse by moving it away from the “welding seam”.	New TCP Tag MouseMode Tag 

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20. Move along all tag points	
21. Move robot to start position	
22. Select the positioner “drehtisch” with *Pick Robot* in Kinematics Window move the positioner to home position	
23. Save cell as *tutorial_05.cel* in the directory: ../EASY-ROB / TRAINlib / Reset all positions: *No* Save current positions as start positions: *Yes*	

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EASY-ROB™
Extend a work cell

Tutorial

5.3 Creating a program (welding simulation)

Target of the chapter:
How to create a program to simulate welding

Note:
Please read as well the Operation-References, topic *Teach Window*

1. Load cell *tutorial_05.cel* *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Save cell (*Save Cell File*) name it *tutorial_06.cel* in directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
3. Select the robot (*Pick Robot*) in Kinematics Window	
4. Open the *Teach Window* by a mouse click on the Button *Open Program Teach Window*	
5. Create a new program (*New*) and save the program with the suggested name „tutorial_06-AX-V6.prg“ in the directory: ../EASY-ROB / TRAINlib / Reload the program : *Yes*	 
6. Open the program line window and set the cursor to line 10	

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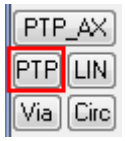
7. Click > *Control* to open the panel to set *Control Commands* and set Default SPEEDs and ACCELs	 
8. Move the robot to home position	
9. Open *Tag Window* (double click *Sel Tag*)	
10. Select the tag point T_START_POS from path START_POS click on PTP in Teach Window to insert the tagpoint with command	 
11. Select the tag point T_REIN_STAT01 from path REIN_STAT click on PTP in Teach Window to insert the tag point with command	
12. Select the tag point T_REIN_STAT02 from path REIN_STAT click on PTP in Teach Window to insert the tag point with command	
13. Select the tag point T_REIN_STAT01 from path REIN_STAT click on PTP in Teach Window to insert the tag point with command	

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14. Save the program (*Save)* and reload the program into the robot	 
15. Run the simulation (*Run Program*)	 or shortcut „Ctrl+R“
16. Set the cursor after the last *PTP*- command and continue programming:	
17. Deactivate the robot: clickon *>ERCL* , then *Set., Unset cRobot* and select *UNSET*	  
18. Activate the positioner: click *>ERCL* , then *Set., Unset cRobot* and select *SET* (select the positioner “DREHTISCH”) open the Joint Values und set axis 1 = -90 Grad click > *Motion*, click *PTP AX* (to insert axis value into the program)	     
19. Deactivate the positioner: click *>ERCL* , then *Set., Unset cRobot* and select *UNSET*	  

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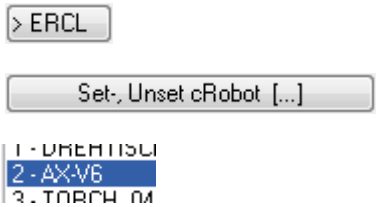
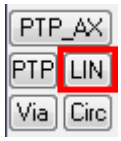
20. Activate the robot: click *ERC* , then *Set., Unset cRobot* and select *SET* (select the robot)	
21. Select the tagpoint T_1 from path SEAM in Tag Window click on LIN in the Teach Window to insert the tagpoint with the command Repeat this step for every tagpoint from path *SEAM*	
22. Select the tagpoint T_START_POS from path START_POS click on PTP in the Teach Window to insert the tagpoint with the command	
23. Deactivate the robot: click *ERC* , *then Set., Unset cRobot* and select *UNSET* Activate the positioner: click *ERC* , then *Set., Unset cRobot* and select *SET* (select “drehtisch”) open Joint Values and set axis 1 = 0 deg Select *Motion*, click *PTP AX* (to insert the axis value) Deactivate the positioner: click *ERC* , then *Set., Unset cRobot* and select *UNSET* Activate the robot : click *ERC* , then *Set., Unset cRobot* and select *SET* (select the robot)	
24. Add the *Home*-command to the program	

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25. Save the program (*Save)* and reload the program into the robot	 
26. Save the work cell as *tutorial_06.cel* in the directory: ../EASY-ROB / TRAINlib /	
27. Run the simulation	
28. Switch collisions control ON and run the simulation again, to check for collisions. In case of collisions modify your path.	 

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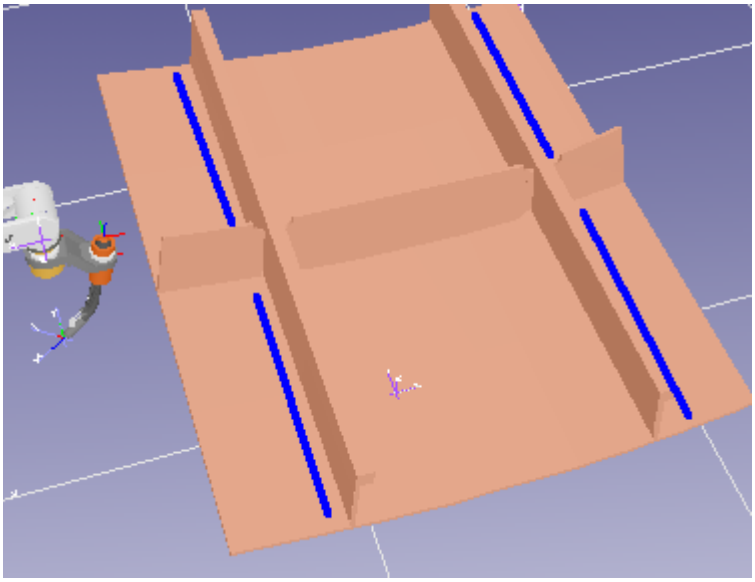
5.4 Practice

Practice:
Extend the program of the welding simulation and weld all 4 outer seams.

Create all tag points and make sure that the program runs without any collision.



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6 Setup kinematics

6.1 Creating a positioner with simple kinematics

Target of the chapter:
Creating a simple kinematics for a positioner with standard CAD components. All required properties like travel limits or home position will be set.

Note:
Please read as well the Operation-References, topic *Kinematics Window*

1. Create a new device (Rob-file) : *Robotics* | *cRobot Kinematics* | *Create new Robot* | *Universal Coordinates (1-12 dof)* Answer for creating simple geometry: *No*	
2. Open kinematics Window (double click on *Robot Base*)	
3. Open the String Dialog (double click on *Name*) and change the name of the device to „tutorial_positioner“	
4. Open the Selection Dialog to change the kinematics properties: click on *Kinematics* and set the number of active joints in this case leave the default setting to 1 Set the direction for the axis: click on *active Jnt* and press *OK* select rotation around Z	    

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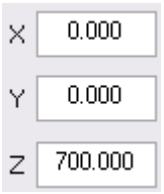
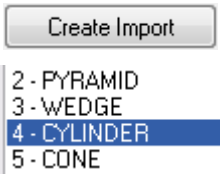
in Frame Dialog set the position of the joint z=700

confirm with OK and close the dialog



5.
Open the 3D-CAD Window (double click *3D-CAD Window)*

and select *Create Import* to get the Selection Dialog to create basic geometries



Create a cylinder

like shown in the table:

1	Radius	1.000000 <=	200.0000
2	Height 1	1.000000 <=	700.0000
3	y Scal	0.010000 <=	1.000000
4	Radius top	1.000000 <=	200.0000
5	Height 2	0.000000 <=	700.0000
6	y Scal top	0.010000 <=	1.000000

and save the part with the name *tut_positioner_00*

6.
Create a second cylinder like shown below:

1	Radius	1.000000 <=	500.0000
2	Height 1	1.000000 <=	50.0000
3	y Scal	0.010000 <=	1.000000
4	Radius top	1.000000 <=	500.0000
5	Height 2	0.000000 <=	50.0000
6	y Scal top	0.010000 <=	1.000000

and save the part with the name *tut_positioner_01*

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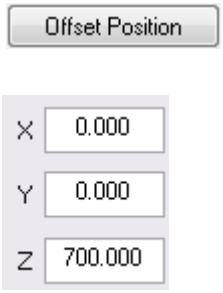
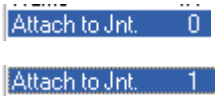
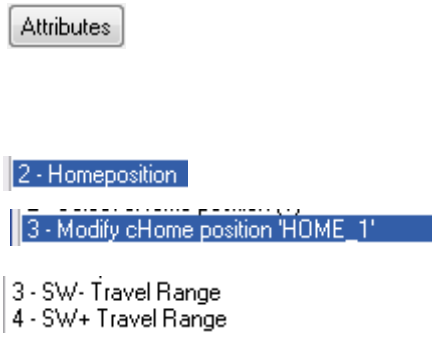
7. Change the position of the part *tut_positioner_01* with *Offset Position* to Z=700	
8. Select A*ttach to Jnt* in the properties of the part *tut_positioner_01* and attach the part to Joint 1	
9. Open the attributes of the positioner with a click on *Attribute* in the *Kinematics Window* Select *Homeposition* then select „*Modify cHome position ‚Home1'*“ and confirm the question to save the current position as Home Position with *Yes* change the travel limits to -360 and +360 degree close the dialog	
10. Change the color of the base *tut_positioner_00* in the 3D-CAD Window to grey	
11. Save the positioner (*Save)* – confirm the suggested name	
12. Select *Robot Joints* and move the mouse (hold LMB down) or set axis values in *Joint* to rotate the table.	

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6.2 Creating a robot with kinematics

Target of the chapter:
How to create a kinematics for a robot. All required properties like travel limits or home position will be set.

Note:
Please read as well the Operation-References, topic *Kinematics Window*

1. Create a new device (Rob-file) : *Robotics* | *cRobot Kinematics* | *Create new Robot* | *Universal Coordinates (1-12 dof)* Answer for creating simple geometries: *No*	
2. Open kinematics Window (double click on *Robot Base*)	
3. Open the String Dialog (double click on *Name*) and change the name of the device to „tutorial_robot“	
4. Open the Selection Dialog to change the kinematics properties: click on *Kinematics* and set the number of active joints set axis to 6	   

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Set the direction and the positions for the axis: Joint 2 — Axis: rot Y — Geometry: Z = 300 Joint 3 — Axis: rot Y — Geometry: all values = 0 Joint 4 — Axis: rot Z — Geometry: Z = 400 Joint 5 — Axis: rot Y — Geometry: all values = 0 Joint 6 — Axis: rot Z — Geometry: Z = 100 Joint 1 — Axis: rot Z — Geometry: Z = 500	
5. Assign the kinematics select the *Numerical Inv.Kin +Data* with a SubID = 0 leave all following data values in default	 
6. Select : *Robotics* | *cRobot Kinematics* | *Create new Robot* | *Create Simple Geometries for cRobot* and create simple geometry for the robot	
7. Jog the robot by mouse either by using *TCP TOOL* or by joints (*Robot Joints)* to different positions Try as well the home position	  
8. Jog the robot by *Joint* to this position: Joint 1 — 0 Joint 2 — 50 Joint 3 — 35 Joint 4 — 0 Joint 5 — 55 Joint 6 — 0	

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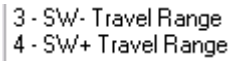
9. Save the current position with *Attributes* as home position	
10. Change the travel limits in *Attributes* like shown below: Joint 1 +/- 180 Joint 2 +/- 145 Joint 3 +/- 140 Joint 4 +/- 180 Joint 5 +/- 130 Joint 6 +/- 180	
11. Save the robot (*Save*) under suggested name	

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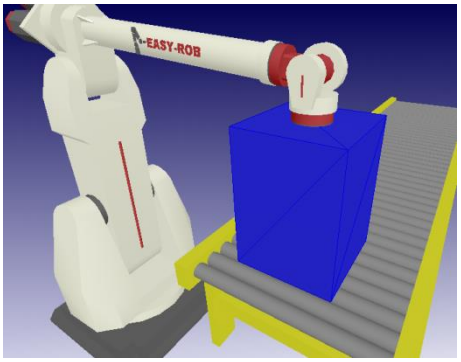
7 Creating a Multi-Robot Work cell

7.1 Creating the programs

Target of the chapter: To build up a simulation with two communicating devices (each one has a single program) by using digital signals. It is a robot and a conveyor. The robot will place the workpiece (blue box) onto the conveyor, which will move the workpiece forward and backward. At the origin the robot will take the workpiece and put it back to the starting place. An existing work cell load from the library will be used for this exercise. **Note:** **The option „Multi-Robot“ is required for this exercise!**	
1. Load the work cell *tutorial_multi_program_01.cel* by using the button *Start Device Manager* from directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Save the work cell by using the button *Save Cell File* with the name *tutorial_multi_program_02.cel* in: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+S“
3. Select the robot (pick robot) and open the *Teach Window* by a mouse click on the button *Open Program Teach Window*	
4. Create a new program by using the button *New* and save the program with *Save as* under the suggested name „tutorial_multi_program_01-ER431.prg“ in the directory: ../EASY-ROB / TRAINlib / Answer the following question (reload the program) with “Yes”.	 

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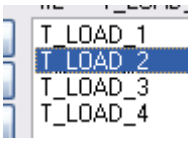
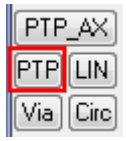
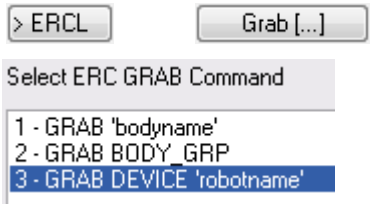
5. Open the line number window and set the cursor to line 10	
6. Open the panel for the *Control Commands* by using the button *> Control* and set the standard speeds and accelerations by using the button "Set Default SPEEDs and ACCELs" **Remark**: This step is very important – the initialization of the speeds and accelerations is the base for proper simulation results.	 
7. At the beginning the robot has to be moved to the Home position Add the *Home* command to the program by using the button *Home*	
8. Open the *Tag Window* by double click on the button *Sel Tag*	
9. Select the tag point T_LOAD_2 from the path LOAD_WP **by double click**, to make sure that the robot is moving to the tag point.	
10. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program Repeat the Step 9. and 10. for the tag point: T_LOAD_1	
11. Let the robot grab the workpiece: and select the workpiece	

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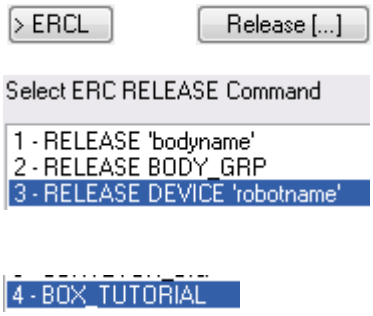
12. Select the tag point T_LOAD_2 from the path LOAD_WP **by double click**, to make sure that the robot is moving to the tag point.	
13. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program Repeat the Step 9. and 10. for the tag point: T_LOAD_3 T_LOAD_4 (the workpiece should be on the conveyor now)	
14. Now the robot has to release the workpiece: Select the workpiece	
15. Select the tag point T_BOX_TOP_2 from the path BOX_TOP **by double click**, to make sure that the robot is moving to the tag point.	
16. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program	
17. Save the program with *Save* (Reset all Positions and Joints to Start condition : Yes)	
Remark: Now the robot is done for the first part and it is the turn of the conveyor. But we continue programming the second part for the robot and we will do later on the program for the conveyor.	

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18. Add the comment to the current line of the program: (important: don't forget the exclamation mark)	! Position for signal
19. Select the tag point T_BOX_TOP_1 from the path BOX_TOP **by double click**	
20. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program.	
21. Let the robot grab the workpiece.	
22. Select the tag point T_LOAD_3 from the path LOAD_WP **by double click**	
23. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program Repeat step 9. and 10. for tag point: T_LOAD_2 T_LOAD_1 (the work piece should be on the floor again)	
24. Now the robot has to release the work piece again.	
25. Select the tagpoint T_BOX_TOP_2 from the path BOX_TOP and add the tag point by click onto PTP into the program.	
26. Drive robot „HOME" (add the *Home* command to the program).	

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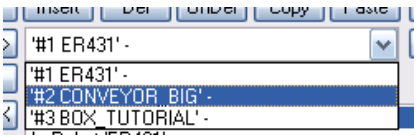
27. Save the program with *Save*	
28. Save the work cell with the name *tutorial_multi_program_02.cel* in the directory: ../EASY-ROB / TRAINlib /	
29. Start the simulation	
Remark: Now we have to create the program for the conveyor and therefore the workpiece should be placed onto the conveyor. Run the robot program in single step mode, until the workpiece is placed onto the conveyor. Unload the robot program!	 
30. Select the conveyor in the Pull Down Menu from the Teach Window	
31. Create a new program by using the button *New* and save the program with *Save as* under the suggested name „tutorial_multi_program_01-CONVEYOR_BIG.prg“ in directory: ../EASY-ROB / TRAINlib / answer the following question (reloading the program) with Yes	 
32. Open the line number window and set the cursor to line 10	

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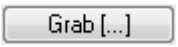
33. Open the panel for the *Control Commands* by clicking on *>Control* and set the standard speeds and accelerations by using the button "Set Default SPEEDs and ACCELs"	 
34. Insert the command Home into the program by using the button *Home*	
35. Now the conveyor has to grab the workpiece: (like the robot earlier)	 
36. Select the tag point T_CONV_2 from the path CONV **by double click**, to make sure that the conveyor is moving to the point.	
37. Click on PTP in the Teach Window to add the tag point with a PTP-command to the program Repeat the Step 36. and 37. for the tagpoint: T_ CONV _1	
38. The conveyor has to release the workpiece:	 
39. Save the program with *Save*	
40. Save the work cell with the name *tutorial_multi_program_02.cel* in the directory: ../EASY-ROB / TRAINlib /	

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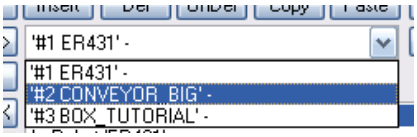
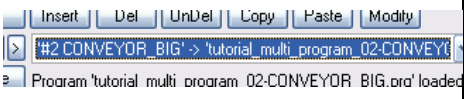
EASY-ROB™
Tutorial

Creating a Multi-Robot Work cell

7.2 Connecting the programs with signals

Target of the chapter:
To connect the created programs from previous chapter by using digital signals.

Note: The option „Multi-Robot“ is required for this exercise!

1. Load the work cell *tutorial_multi_program_02.cel* by using the button *Start Device Manager* from the directory: ../EASY-ROB / TRAINlib /	 or shortcut „Ctrl+Shift+O“
2. Select both devices by the Pull Down Menu in the Teach Window and check if the programs are loaded. If the programs are not loaded, load them by using „LOAD“	
3. Save the work cell with the name *tutorial_multi_program_03.cel* in the directory: ../EASY-ROB / TRAINlib /	
4. Select first the conveyor by using the Pull Down Menu from the Teach Window	
5. To initialize the outgoing signal of the conveyor, set the cursor in the Teach Window to line 5 (before of the “EndInit“-command) and add the command:	conv_out=0

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6. Place the cursor onto the command „ERC GRAB DEVICE BOX_TUTORIAL“ and add the „Wait_Until_Signal_**Set**“ command with the signal name „***rob01_out***“ Then unset the signal (by editing in the command line) of the robot: **Remark**: The conveyor will wait until the robot will set the signal gibt and immediately after that the conveyor will unset the signal again.	  WAIT_UNTIL_SIGNAL_SET rob01_out rob01_out=0
7. Place the cursor after the command „ERC RELEASE DEVICE BOX_TUTORIAL“ and add the „Wait_Until_Signal_**Unset**“ command with the signal name „***conv_out*** **Remark**: The conveyor will only go on when its signal is unset.	WAIT_UNTIL_SIGNAL_UNSET conv_out
8. Set the signal of the conveyor to „***conv_out=1***“ **Remark**: The conveyor will tell the robot that the workpiece is back.	conv_out=1
9. Save the program with *Save*	
10. Select the robot by using the Pull Down Menu from the Teach Window.	
11. To initialize the outgoing signal of the robot, set the cursor in the TeachWindow to line 5 (before of the “EndInit“-command) and add the command:	rob01_out=0

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12. Set the cursor after your comment „! Position for signal“ and add the „Wait_Until_Signal_**Unset**“ - command with the signal name „***rob01_out*** **Remark**: The robot will only go on when its signal is unset.	WAIT_UNTIL_SIGNAL_UNSET rob01_out
13. Set the signal (by editing the command line) of the robot to „***rob01_out=1***“ **Remark**: The robot will tell the conveyor that the workpiece is standing onto the conveyor.	rob01_out=1
14. Add a „Wait_Until_Signal_**SET**“ - command with the signal name „***conv_out***“ Then unset the signal (by editing the command line) of the conveyor: **Remark**: The robot will wait until the conveyor tells that the workpiece is back and then the robot will immediately unset (reset) the signal of the conveyor.	WAIT_UNTIL_SIGNAL_SET conv_out conv_out=0
15. Save both programs with *Save*	
16. Save the work cell with the name *tutorial_multi_program_03.cel* in the directory: ../EASY-ROB / TRAINlib /	
17. Start the simulation To run the simulation in a loop, just push the loop button straight after starting the simulation.	 

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8 Appendix

8.1 Most important dialogues

Menu:

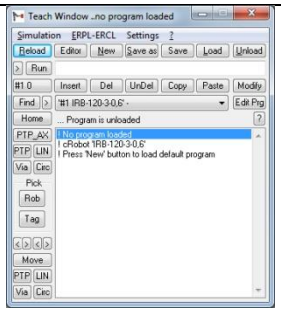
File Robotics Simulation 3D-CAD Tags View Aux ?

Toolbars:

Teach Window

Menu:
Robotics > cRobot Program > Open Teach Window

Toolbar:

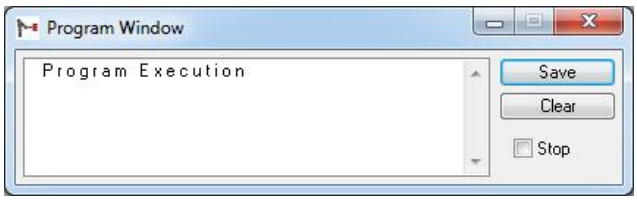


Create and change programs

Program Output Window

Menu:
Robotics > cRobot Program > Open Program Output Window

Toolbar:

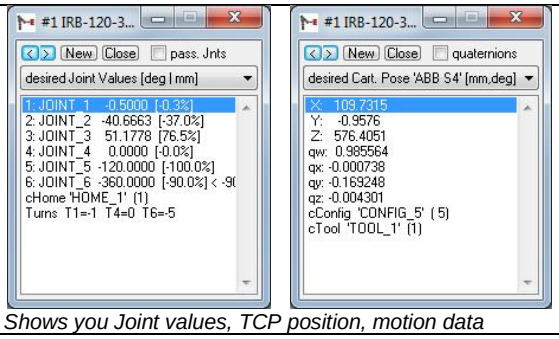


Shows you actual executed program line

Online Output Data Windows

Menu:
View > Open Online Output Data

Toolbar:



Shows you Joint values, TCP position, motion data

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Menu:

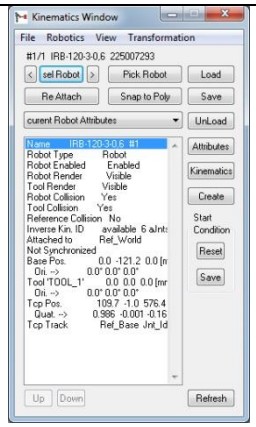
File Robotics Simulation 3D-CAD Tags View Aux ?

Toolbars:

Kinematics Window

Menu:
Robotics > Open Kinematics Window Ctrl+K

Toolbar:

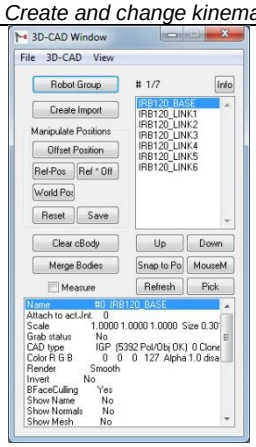


Create and change kinematics

3D-CAD Window

Menu:
3D-CAD > Open 3D-CAD Window

Toolbar:

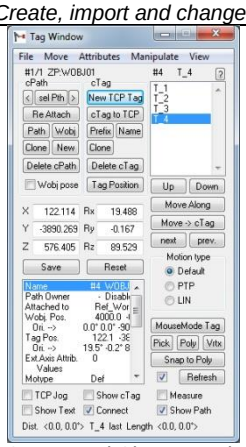


Create, import and change geometry

Tag Window

Menu:
Tags > Open Tag Window

Toolbar:



Create and Change paths and tagpoints

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Menu:

File Robotics Simulation 3D-CAD Tags View Aux ?

Toolbars:

Navigator Window

Menu:
View > Navigator Window *Ctrl+N*

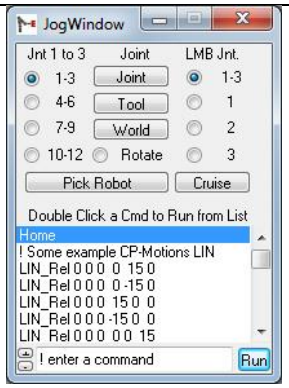
Toolbar:

Selecting by Pick & Click

Jog Window

Menu:
View > Open Window Dialogs > Jog Window

Toolbar:



Jog joints

Message Window

Menu:
View > Message Window *Ctrl+M*

Shows you important messages, status etc.

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EASY-ROB customer area

Content: Program updates and robot libraries

Web: https://easy-rob.com/en/downloads-2/client-area/

Log in data:
User name: customer
Password: **********

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10 Notes

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