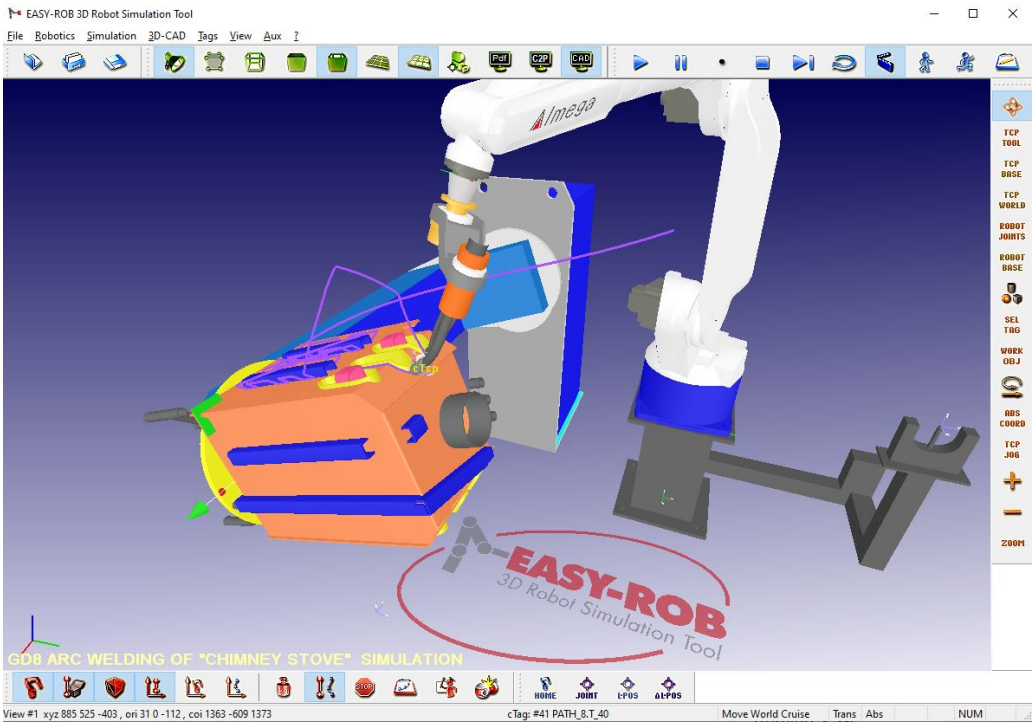
Operation References

EASY-ROB™ V8.6



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EASY-ROB™

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Introduction

Overview of existing documents and Installation

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.

Please make sure that all documentation about EASY-ROB™ is available, to support you with the first steps.

List of all existing documentation :

- Product description
  (General description about all EASY-ROB™-products, options and API's)
- Operation References
  (How to use EASY-ROB™. Detailed description about system files, functions and dialogs)
- EASY-ROB-ERPL
  (Reference for ERPL- and ERCL language)
- TrainLib-Tutorial
  (Training manual)
- Installation-Guidelines
  (Detailed description for the whole installation procedure)

Make sure as well, that the following libraries are installed:

- TRAINLib (library for training)
  (The Training library and the Tutorial will support the user on the first steps in EASY-ROB from an empty workcell to the simulation)
- Tutorial folder with "Proj_example_erpl"
  (The examples will demonstrate how to use the ERPL- and ERCL language commands)

Installation:
To install EASY-ROB™ just use the document "Installation-Guidelines". It describes in detail the whole installation procedure.

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Content of the Installation CD

In the root folder you will find the installation setup programs for the following EASY-ROB™ Products

• Installation-Guidelines.pdf	Installation guidelines for EASY-ROB™
• EASY-ROB App Setup x64.exe	EASY-ROB™ App Professional, Education Version
• EASY-ROB LicenseManager Setup.exe	EASY-ROB™ License Manager
• EASY-ROB Viewer Setup x64.exe	Free of charge EASY-ROB™ Viewer Version
• EASY-ROB Demo Setup x64.exe Installation-Guidelines-DEMO.pdf	Free of charge EASY-ROB™ DEMO Version with installation guidelines

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Content of the installation CD

Sub folder:

• /Easy_Rob_EROSA Project	EASY-ROB™ Open Software Architecture with API Examples as Microsoft® Visual Studio 2017
• /Easy_Rob_Kernel	Examples and documentations for EASY-ROB™ Kernel
• /Easy_Rob_Updates	Update archives for the following products
○ /Easy_Rob_Framework_Update	EASY-ROB™ Framework
○ /Easy_Rob_LicenseManager_Update	EASY-ROB™ License Manager
○ /Easy_Rob_App_Update	EASY-ROB™ App Professional, Education Version
○ /Easy_Rob_Kernel	EASY-ROB™ Kernel
○ /Easy_Rob_Viewer_Update	EASY-ROB™ Viewer Version
○ /SystemFilesTemplate ...)	Templates for System Files (config.dat, easy-rob.pth,
• /Easy_Rob_Viewerx64	Free of charge EASY-ROB™ Viewer Version
• /EasyEdit-Offline-Programm-Editor programs)	EasyEdit™ a customized solution with b+m surface systems GmbH (OLP for painting
• /Famos-Demoversion V9	Famos robotic® Demo version from carat robotic GmbH, uses the EASY-ROB™ Robotics Simulation Kernel
• /Foxit-PDF-Reader	Foxit PDF-Reader® to read PDF-Files
• /Manual ERPL_ENG.pdf	Examples and Descriptions as PDF files such as Operation-References.pdf, EASY-ROB-
• /Options Examples	VRML-Examples.zip with examples to convert VRML II,97 – files in to the IGP part file format with subsequent optimization „merge“. CAD-Import.zip: IGES-, STEP-, VRML-Import-
• /Product-Info	PDF-Documents for EASY-ROB™ Product Suite
• /RobotLib	Complete Robot Library ABB, KUKA, Stäubli, Fanuc, Yaskawa b+m, Comau, Mitsubishi, Universal Robots…
• /SystemDlls	Microsoft® Visual C++ Redistributable 2017
• /TeamViewer	TeamViewer for Presentation and Remote Support
○ TeamViewerQJ*.exe	Starts EASY-ROB™ TeamViewer QuickJoin
○ TeamViewerQS*.exe	Starts EASY-ROB™ TeamViewer QuickSupport
• /WibuKey Driver	Installation Setup for WibuKey & CodeMeter Dongle

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System Files

The Environment File: easy-rob.env

The environment file "**easy-rob.env**" contains all initial settings for the appearance of EASY-ROB™ and will be loaded automatically on each start of EASY-ROB™.
Additionally the user can load an environment file by an ERC command while a running simulation to change the settings.

The file contains (e.g.) variables to set the
- the floor states ON/OFF
- the background color
- the style of the toolbar
- the clipping plane settings
- etc.

By having an "own" Environment File every user can start and use EASY-ROB™ with the personalized preferred settings.

Changing the variables can be done on two ways:
a) manually by editing the file
b) saving the environment after changing the settings in the application

To edit the file the user can use:
the shortcut : "Alt+Shift+E"

or the menu: File menu ->Edit-> EASY-ROB System files-> „Environment file"

To save the environment by the menu after changing the settings in the application:

File menu ->Save-> „Environment file"

Remark:
An exclamation mark (!) in the beginning of a line in a System File stands for a comment line – you can put any comment behind it – the line will be skipped while reading.

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Command and Syntax	Valid Values	Description
FLOOR_ON	0; 1	switch the floor OFF / ON
FLOOR_WIRE_ON	0; 1	switch the Floor as wire frame OFF / ON
FLOOR_LENGTH	0.100000 ….. 25.000000	length of the floor [m]
FLOOR_DLENGTH	0.100000 ….. 25.000000	length of one grid [m]
FLOOR_POSITION	X Y Z RX RY RZ X, Y, Z : +/- 0.000 ….. ~ RX, RY, RZ : +/- 0.00 …. +/-180.00	position of the floor referred to world zero X,Y,Z [mm]; RX,RY,RZ [deg] Tip: Use this function to shift the floor if the zero of the workcell is not onto the floor.
FLOOR_COLOR	0.0...1.0 0.0...1.0 0.0...1.0	color of the floor [R G B] example: FLOOR_COLOR 0.6800 0.6850 0.6850
BACKGROUND_COLOR	0.0...1.0 0.0...1.0 0.0...1.0	color of the background [R G B] example: BACKGROUND_COLOR 0.0050 0.0000 0.3200
HITHER 0.020000	0.000500 ….. 4.000000	set the hither plane [m]
YONDER 20.000000	1.000000 ….. 200.000000	set the yonder plane [m]
VIEW_STEPS 20	1 ….. 100	set the view steps
TOOLTIPS	0; 1	Switch tooltips OFF / ON, which appear by moving the cursor on a symbol.
COI_ON	0; 1	Switch Center of Interest OFF / ON
2_MOUSE_BUTTONS	0; 1	switch 2-Button Mouse OFF / ON **Tip:** Use 1 if your computer has only 2 mouse buttons. The middle mouse button is realized while pressing the left and right mouse button together.
MONI_MSG_OUTPUT	0; 1	switch the Monitoring MSG OFF / ON

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Command and Syntax	Valid Values	Description
S3DM_MENU	0; 1	Space Mouse Menu OFF / ON
S3DM_SPEED	1.0	Space Mouse Speed
S3DM_THRESHOLD	1.0	Space Mouse threshold
M_TO_UNIT	1000.000 mm 1.000000 m 39.370079 inch	User defined Unit The internal EASY-ROB™ unit is “meter”. The variable “M_TO_UNIT” defines in which unit all the values will be displayed in EASY-ROB™ (1m = 1000mm = 39.37inch) Example: M_TO_UNIT 1000.000000 mm -> all will be displayed in “mm” M_TO_UNIT 39.370079 inch -> all will be displayed in “inch” (see Menu -> View: ->Graphic View Data)
REMOTE_MSG_OUTPUT	0; 1	remote messages in the message Window OFF or ON
REMOTE_TRACE_FILE	REMOTE_TRACE_PRG.PRG	if remote connection exists, the remote commands will be stored in the file.
EXPORT_FILE	0; 1	creating a batch file OFF / ON (function to export all involved parts from workcell while saving, to make sure that all related parts are together e.g. for a data transfer) (see Operation References for details)
ENABLE_RUNTIME	0; 1	RunTime-function for workcells OFF / ON
TOOLBAR_MODE	2; 0; 1	change the toolbar style 0-Standard Icons 1-New Icons Normal 2-New Icon Hot (this is the default value)
SHOW_TAG_CONNECT	0; 1	connect all tags in current path OFF / ON, (see Operation References -Tag Window)

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Command and Syntax	Valid Values	Description
SHOW_TAG_TEXT	0; 1	display the name of all tags in the current path OFF / ON (see Operation References -Tag Window)
TAG_APPROACH_DIRECTION	1;-1;2;-2;3;-3	1 use x direction for picked normal -1 use -x direction for picked normal 2 use y direction for picked normal -2 use -y direction for picked normal 3 use z direction for picked normal -3 use -z direction for picked normal
GRAD_BCKGND	0; 1	gradient background OFF / ON Recommendation: Set “GRAD_BCKGND 0” (OFF), if the graphic board is “below average”
STOP_UNREACH	0; 1	stop on unreachable position OFF / ON (see Menu-> Simulation -> Run Settings)
STOP_SWE	0; 1	stop on limit switch OFF / ON
KEEP_IN_TRAVEL_RANGE	0; 1	keep robot joints in travel range OFF / ON Assumption: 1. axis 6 (rotZ) with limits swe=[-180,+180]; 2. KEEP_IN_TRAVEL_RANGE set to ON (1) If the axis is rotating to e.g. “+181°”, the value will be set automatically to “-179°” to let the mathematic in the background calculate the angles in the limits. To let the mathematic in the background calculate the shortest angle to the previous joint angle, set the variable to OFF (0). The state (OFF) is default, because the second case is more common.
STOP_SPEED	0; 1	stop on speed exceeding OFF / ON
STOP_ACCEL	0; 1	stop on acceleration exceeded OFF / ON
STOP_COLLISION	0; 1	stop on collision OFF / ON

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Command and Syntax	Valid Values	Description
USE_VBO	0; 1	**V**ertex **B**uffer **O**bjects OFF / ON (if supported by the graphic board) Remark: By using VBO the geometry will be loaded into the graphic board. To increase the rendering performance the geometry should be merged as well. VBO requires minimum OpenGL Version 1.5 (check your settings in: Menu -> Aux -> Show current Settings) In case of trouble (even with OpenGL Version 1.5) set USE_VBO OFF.
DISABLE_CROBOT_BBOX	0; 1	visualization of bBox for current selected robot OFF / ON
DISABLE_3D_CAD_BBOX	0; 1	visualization of bBox for current selected 3D Cad object
DISABLE_TOOLBAR	00000000 …. 11111111	switch toolbar OFF / ON Bit 0: forces to enable all available toolbars Bit 1: Load,Save toolbar Bit 2: Render toolbar Bit 3: Run toolbar Bit 4: OnOff toolbar Bit 5: 3DCad toolbar Bit 6: Move toolbar Bit 7: MouseMove toolbar Example 00010000 --> Bit 3 disables Run toolbar Example 01111110 --> shows MouseMove toolbar only

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Command and Syntax	Valid Values	Description
COLL_BODY_ROBOT	0; 1	collision all Bodies vs. all Robots OFF / ON (see Operation References - Collision)
COLL_BODY_TOOL	0; 1	collision all Bodies vs. all Tools OFF / ON
COLL_ROBOT_TOOL	0; 1	collision all Robot vs. its Tool OFF / ON
COLL_GRAB_BODY_BODY	0; 1	collision all grabbed Bodies vs. not grabbed Bodies
COLL_GRAB_BODY_ROBOT	0; 1	collision all grabbed Bodies vs. all Robots
COLL_ROBOT_ROBOT	0; 1	collision Robot itself
COLL_BODY_BODY	0; 1	collision Bodies itself
COLL_LINE_ENABLE	0; 1	collision line ON / OFF
COLL_DETECCODE	0; 1; 2	Choice of Collision Detection Code 0 – Load cell without collision 1 - OpCode (only x86) 2 - PQP „A Proximity Query PackageA
TEXT SIZE	1 2	Change of text size and Tags (2. Parametres) 1 - TYPE 10 SEMIBOLD ARIAL to 8 - TYPE 24 SEMIBOLD ARIAL
WORLD_COORSYS	0; 1	Switch World-Coorsys OFF / ON
TAG_COORSYS	0; 1	Switch Paths and Tags OFF / ON
ROBOT_COORSYS	0; 1	Switch Robot-Coorsys OFF / ON
ROBOT_BASE_COORSYS	0; 1	Switch Robot-Base-Coorsys OFF / ON
BODY_COORSYS	0; 1	Switch Body-Coorsys OFF / ON
ROBOT_TCP_COORSYS	0; 1	Switch Robot-TCP-Coorsys OFF / ON
IPO_COORSYS	0; 1	Switch temporary IPO-Coorsys OFF / ON

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CRUISE_ROT_FLAGS	LMB; MMB; RMB, SHIFT, CNTRL	Button for Rotation of the world
CRUISE_ZOOM_FLAGS	LMB; MMB; RMB, SHIFT, CNTRL	Button for Zoom
CRUISE_ZOOM2MB_FLAGS	LMB; MMB; RMB, SHIFT, CNTRL	If „2 Mouse Button“ is deactivated in Aux menu -> „Mouse Mode“; Alternative solution for zoom
CRUISE_PAN_FLAGS	LMB; MMB; RMB, SHIFT, CNTRL	Pan the World
CRUISE_ROT_FLAGS_2	LMB; MMB; RMB, SHIFT, CNTRL, UNDEF	Alternative solution: Button for Rotation of the world
CRUISE_ZOOM_FLAGS_2	LMB; MMB; RMB, SHIFT, CNTRL, UNDEF	Alternative solution: Button for Zoom
CRUISE_PAN_FLAGS_2	LMB; MMB; RMB, SHIFT, CNTRL, UNDEF	Alternative solution: Button for Pan
CRUISE_COMMON_FLAGS	DEFAULT	Filtering Cruise Mouse Button
DLG_TRANSPARENCY	0x1001 alpha; 0x1002 alpha; 0x1004 alpha; 0x1008 alpha; 0x1010 alpha;	Presettings for dialogue-transparency. OFF: 0x1001 Low: 0x1002 Medium; 0x1004 High: 0x1008 User: 0x1010 alpha = 100-255

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The Config File: config.dat

EASY-ROB requires the configuration file to start up. The configuration file "**config.dat**" will be loaded automatically on each start of EASY-ROB™ and contains

- the path/location of your license file "license.dat"
- the path of the temporary files
- the path of the user files
- Library paths and DLL names, used for API-User DLL Option
- Your preferred Editor

By having an “own” Config File every user can start and use EASY-ROB™ with the personalized preferred settings.

Changing the file can be done manually by editing the file

To edit the file you can use:
the shortcut : “Alt+Shift+C”

or use the menu: File menu ->Edit-> EASY-ROB System files-> „Config file“

Remark:
An exclamation mark (!) in the beginning of a line in a System File stands for a comment line – you can put any comment behind it – the line will be skipped while reading.

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Command and Syntax	Valid Values	Description
LICENSE=	..\ or full path c:\.....\.....\	path for the License file default is the destination folder from installation ”c:\program files\EASY_ROB\” (see also details LICENSE below)
TMPDIR=	Absolute and relative folder paths are allowed	Consists file: - moni_msg.txt - Hardwarenumer.dat Example for path: TMPDIR=%USERPROFILE%\EASY-ROB\tmp Default is the destination folder of the installation
USRDIR=	Absolute and relative folder paths are allowed	Consists file: - easy-rob.pth (new file) - easy-rob.env - easy-rob-localizationx64.ini - er_LoadFromLibPb.ini - er_LoadFromLibPb_prefered.ini Example for path: USRDIR=%USERPROFILE%\EASY-ROB Default is the destination folder of the installation
LIBRARY_PATH=	Absolute and relative folder paths are allowed	path for the location of the UserDLL’s example: .\ is current folder ..\ is folder one directory up “c:\home\my_er” absolute folder **default**: LIBRARY_PATH= .\ (see also details API User DLL below)
USER_DLL=	“<name> <start option> <comment string>”	name of the UserDLL (see also details API User DLL below)
EDIT=	any executable editor e.g. notepad, notepad++, ...	Variable to set the preferred editor. Example: EDIT=notepad or EDIT= C:\program files\vim\gvim **default**: EDIT= notepad

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Command and Syntax	Valid Values	Description
HELPFLN	.\help.erh	relative location of the help file
ER_KIN_DLL=	er_kinx.dll	API-KIN, User defined name for forward and inverse kinematics x = „“ for EASY-ROB™ x86 Version x = „x64“ for EASY-ROB™ x64 Version x = „dll“ for EASY-ROB™ DLL Version x = „dllx64“ for EASY-ROB™ DLL x64
ER_IPO_DLL=	er_ipox64.dll	API-IPO, User defined name for motion planning and execution
ER_DYN_DLL=	er_dynx64.dll	API-DYN, User defined name for dynamics and control
ER_POST_DLL=	er_postx64.dll	API-PostProcess, User defined name for PostProzessing
ER_SENSOR_DLL=	er_sensorx64.dll	User defined name for Sensor Integration
USR_OWNERKEY_DIR=	Absolute and relative folder paths are allowed	Directory of the OwnerKey file
USR_OWNERKEY_FLN=	Absolute and relative folder paths are allowed	Name of the OwnerKey file

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Details for variable “LICENSE” in Config file

Every EASY-ROB™ product (except for the DEMO- and VIEWER-Version) requires a license to start up.

The license is a text file with the name "**license.dat**" and will be provided by the purchase of the product. While installing the license file will be copied automatically to its default directory.

When starting EASY-ROB™ , the program will search first into the Config file for the location of the license file. After that the program will check the given path and license file for validity.

Note:

While the standard installation the license file will be placed per default into the “destination folder”, which is:

C:\ Program Files \ EASY-ROB \

while EASY-ROB™ software will be installed in folder
C:\ Program Files \ EASY-ROB \ EASY-ROB x64 \

Therefore the default value for the variable of the license is:

LICENSE= ..\

Recommendation:
If you don’t use the default installation path or if you are going to change any of paths after installation, make sure that you verify the variable of the license file in the Config file.

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Details for variable “LIBRARY_PATH” and “USER_DLL“ in Config file

The option **API-UserDLL** will adapt EASY-ROB™ individually to the users needs.
Own dialogs can be developed and loaded automatically every time the user starts EASY-ROB™.

The information for EASY-ROB™ which UserDLL has to be loaded and where to find it is located in the Config file.

The variable for the location is named “***LIBRARY_PATH”*** and defines the place where the UserDLL are located.

Example: LIBRARY_PATH= .\

Valid values are absolute and relative folder paths e.g.:

.\	is current folder
..\	is folder one directory up
c:\home\my_er	absolute folder
\\ws01\my_er	absolute folder

The variable for the name of the UserDLL is “***USER_DLL***” and handles 3 parameter.

1. the DLL name - e.g. "er_vad_exp01.dll"
2. a digit for the start option
   ”1” will start the dialog immediately when EASY-ROB™ starts up.
   "0" requires to start the UserDLL dialog from the View Menu-> API UserDLL Dialogs
3. a user defined string will follow as comment

example: USER_DLL= er_vad_exp01.dll 1 Api UserDll Expl_01
USER_DLL= er_vad_exp02.dll 1 Api UserDll Expl_02

Note:
If you don’t use the default location for the API-UserDLL in current folder and place it in another folder, you have to make sure, that all other DLL’s (required by the UserDLL) can be found

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The License File: license.dat

The license file "**license.dat**" contains the unique License key for all licensed products and the expiration date.

You can open the file over the menue:

File -> Edit-> EASY-ROB System files-> „License file"

or by the shortcut : "Alt+Shift+L"

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Monitoring Message File: moni_msg.txt

The file „**moni_msg.txt** “ is monitoring general system information while an EASY-ROB™ session .

Information like

- the working directory
- Date and Time
- License Key
- Enabled or Disabled option
- location of the environment file and config file

are the focus of the monitoring.

The file can help the EASY-ROB-Support-Team in trouble shooting. In case of trouble you can send the monitoring message file to EASY-ROB to be analyzed.

To view the moni_msg.txt file use the menue:

File -> Edit-> EASY-ROB System files-> „moni_msg file“

or the shortcut : “Alt+Shift+M”

Tip:
In case of time-consuming output while loading a work cell with a huge number of tag points, you can set the environment variable MONI_MSG_OUTPUT in “*easy-rob.env*” to [0].

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Preferred Paths File: er_LoadFromLibPb_prefered.ini

Preferred Paths

In addition to the automatically generated path history the Device Manager provides in the same Pulldown-Menu the „preferred paths“. The list of „preferred paths” paths has to be created by the user and will be stored in the file ***„er_LoadFromLibPb_prefered.ini“***.

The basic file will be created once automatically if it doesn’t exist. The difference to the path history is, that the preferred paths won’t change and that enables the user to have a quick access to his 12 most important paths.

The paths have to be written complete.
Each line starting with an exclamation mark will be interpreted as a comment.

Example:

```
!
! This file contains all your prefered/favorite paths
!
! All lines starting with "!" will be ignored
!
! Maximum numbers of paths is 12
!-----------------------------------------------------
!
C:\Program Files\EASY-ROB\ApplicationLib
C:\Program Files\EASY-ROB\DeviceLib
C:\Program Files\EASY-ROB\RobotLib
C:\Program Files\EASY-ROB\Tutorial\Proj_example_erpl
!
!
```

To edit the file, use the menu to open it:

File -> Edit-> EASY-ROB System files-> „er_LoadFromLibPb_prefered.ini“

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Working Pathes File: easy-rob.pth

Details for variable “WORKDIR” and “IGPDIR” in Config file

In order for users to define their own work and geometry folders, which may differ from the user folders, the paths for these folders have been separated from the config.dat and will be managed in the future by the "easy-rob.pth" file.

Paths for the work and geometry directories can also be set here by

- WORKDIR=
- IGPDIR=

To keep the overview it is highly recommended that you keep all your projects separate in different libraries and that you keep a certain order inside the libraries.

The philosophy for keeping data in EASY-ROB™ is based on 2 directories.
The working directory (WORKDIR) and the 3D CAD directory (IGPDIR).

The working directory (WORKDIR) contains:

- cell files (*.cel)
- robot files (*.rob)
- program files (*.prg)
- view files (*.vie)
- text files (*.txt),
- bitmap files (*.bmp)
- data files (*.dat)
- JPEG (*.jpg)

The 3D CAD directory (IGPDIR) contains all 3D geometry files such as:

- *.igp
- *.stl
- *.wrl
- *.stp
- *.3ds

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Details for variable “WORKDIR” and “IGPDIR” in Config file

To let EASY-ROB™ know where to find the parts for a specific workcell, the WORKDIR and IGPDIR paths have to be declared in the Working Pathes File (easy-rob.pth).

Example:
WORKDIR= ..\ApplicationLib\ArcWelding
IGPDIR= ..\ApplicationLib\ArcWelding\igp

By these given paths the system knows where to find the corresponding parts, programs, robots, etc. of a workcell.

Note:
Absolute and relative folder paths are allowed:

.\	is current folder
..\	is a folder one directory up
c:\home\my_er	absolute folder
\\ws01\my_er	absolute folder

Important Notice:
An EASY-ROB™ workcell- or robot-file (.cel /.rob) contains only a file name (plus the extension) of a 3D CAD geometry, but not its content!
To find the specified file on the hard disk, memory stick or in a network, EASY-ROB will search in all below defined IGPDIR paths. Per default EASY-ROB™ searches as well in a sub folder with the name .”\igp” of the loaded cell- or rob-file.

Command and Syntax	Valid Values	Description
WORKDIR=	Absolute and relative folder paths are allowed	Path for the working directory example: .\ is current folder ..\ is folder one directory up “c:\home\my_er” absolute folder “\\ws01\my_er” absolute folder (see also details WORKDIR below)
IGPDIR=	Absolute and relative folder paths are allowed	Path for the 3D CAD geometry example: .\ is current folder ..\ is folder one directory up “c:\home\my_er” absolute folder “\\ws01\my_er” absolute folder (see also details IGPDIR below)

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Localization File: easy-rob-localizationx64.ini

Details for variables “en-US”, “de-DE” and “zh-Hans”

The localization takes place under the menu point
„File → Edit → EASY-ROB System Files → Localization file“
and is achieved by excluding the *undesired* languages with a "!" before the lines.

- en-US for English
- de-DE for German
- zh-Hans for Chinese (traditional)

On the following page the German language was activated in the localization file.

```
! EASY-ROB 3D Robot Simulation Tool
!
! EXE - Simulation Version x64
!
! Localization file
!
! "easy-rob-localizationx64.ini"
!
! Make sure that the localization Dlls exist
!
! Allowed language keys are
!
! en-US ==> EasyRobwx64ENU.dll (english)
! de-DE ==> EasyRobwx64DEU.dll (german)
! zh-Hans ==> EasyRobwx64CHS.dll (chinese)
!
! Note: '!' or ';' comment a line
!
!en-US
de-DE
!zh-Hans
!
```

The localization file easy-rob-localizationx64.ini is located in the installation directory of EASY-ROB™.

If the localization DLLs do not exist, EASY-ROB ™ starts with English GUI, which is also the default setting.

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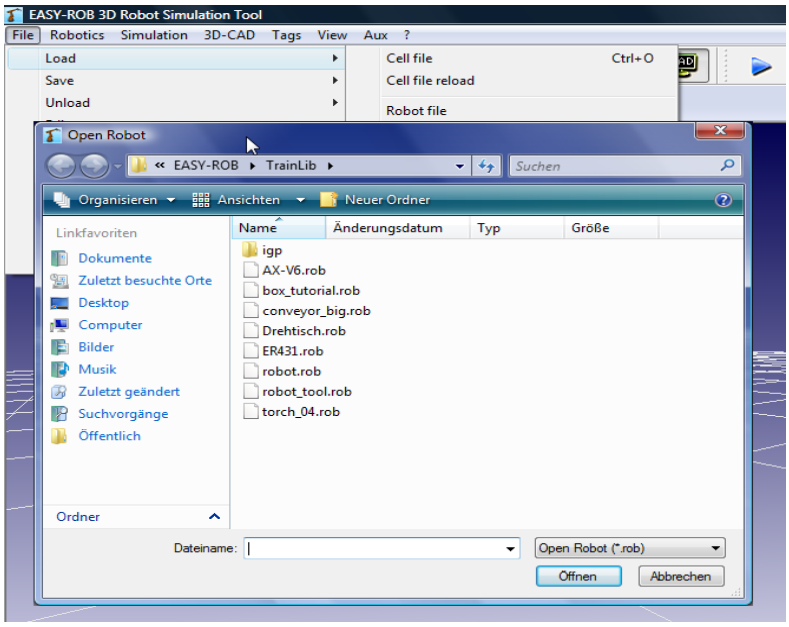
First our simple working cell should consist of one robot with a tool.



Loading a robot

After launching EASY-ROB™ load the robot *robot.rob* from directory ".\Easy-Rob\TrainLib" by clicking *Load Robot file* in the *File* menu.

The robot is now visible in the main window of EASY-ROB™. It's an articulated arm robot with six axes, thus a typical industry robot.

Loading a tool

The tool file *tool.tol* is loaded analogical by clicking *Load Tool file* in the *File* menu.

Now save the intermediate result in a file named *robot_tool.rob* by clicking *Save Robot file* in the *File* menu and entering the filename in the dialog (Notice: The ending *.rob will be added automatically).

Note: Files with the extension *.rob* can contain information about the robot as well as the used tool.

Hint: You can also load files by directly pulling them from the Windows® -Explorer into the EASY-ROB™-main window (*Drag'n'Drop*).

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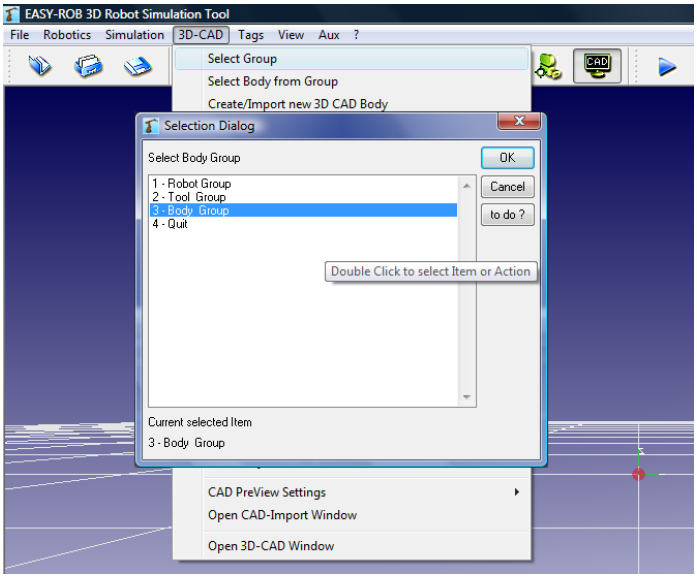
Navigating in the working cell and moving the robot

Using the buttons shown to the right you can navigate in the working cell and move the robot. The first button is the navigation cursor which enables you to move in the world. The second and third button allows you to move the robot in tool- or world coordinates whereas the last button switches between translatory and rotatory motion. The button *Robot Joints* allows you to move the robot in axis coordinates.

Note: Become familiar with these functions by selecting one of them and moving the mouse inside the EASY-ROB™-main window with mouse buttons held down. If you use a two button mouse you have to activate option *2 Mouse Buttons* in the *Aux / Mouse Mode* menu and save the settings with *File / Save / Environment file*.

Hint: Clicking twice on one of the buttons will show up additional functions and parameters.

Extending the working cell by adding a work piece



Selecting the CAD-group

In EASY-ROB™ 3D-CAD-data is classified in three groups.

The *Robot Group* contains all data concerning the robot (e.g. the robot base or the muff).

The *Tool Group* contains all data which can be assigned to the tool.

Work pieces and all other geometries of the working cell are classified in the *Body Group* which you can select by the menu *3D-CAD / Select Group / Body Group*.

Note: EASY-ROB™ is no 3D-CAD-system but a robot simulation system. Only simple geometries such as cubes, cylinders, cones and spheres can be created and parameterized in EASY-ROB™. Therefore the modeling of more complex geometries must be done with a 3D-CAD-system. These geometries can then be imported into EASY-ROB™. To allow an efficient simulation the level of detail should be reduced. For performance reasons it's not advisable to show “every screw”.

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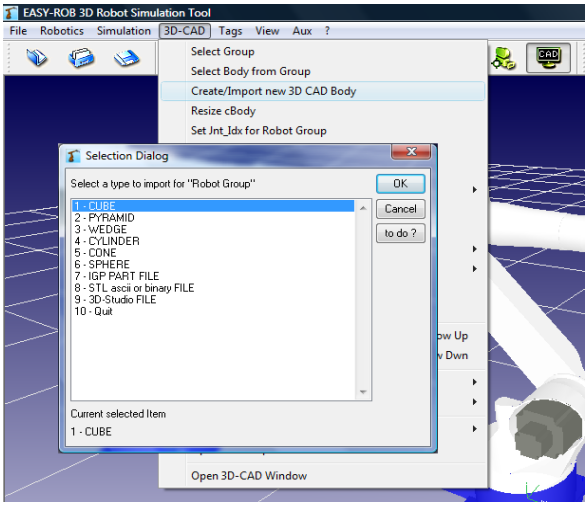
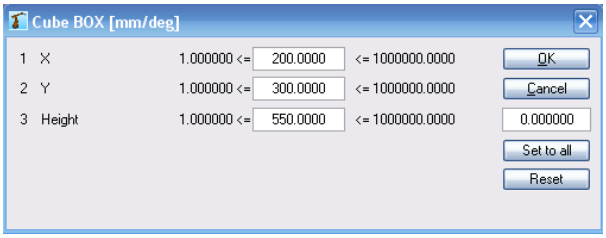
Adding a work piece

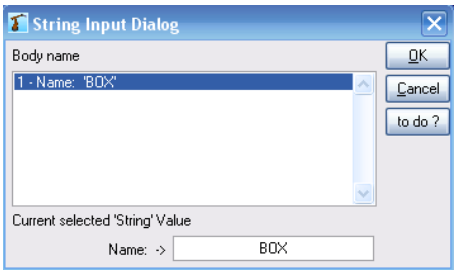
By selecting *3D-CAD / Create/Import new 3D CAD Body / CUBE* a new cube is created in the working cell.

The position and orientation in the space will be set later.



Now set up the bodies' length (X) to 200 mm, the width (Y) to 300 mm and the height to 550 mm.





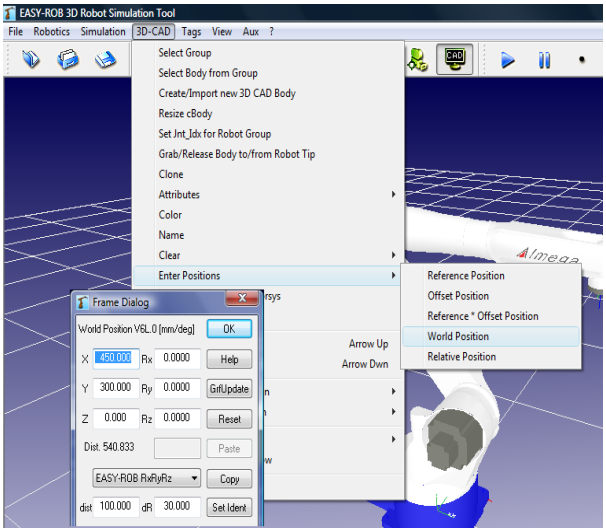
Afterwards name the body *BOX*.

Positioning the work piece.

In order to position the work piece select *Enter Positions / World Position* from the 3D-CAD menu.

The EASY-ROB™ Frame Dialog provides the option to define the position and orientation of the body in 6 degrees of freedom.

Set up the bodies position as shown to X=450 mm, Y=300 mm and Z=0 mm.



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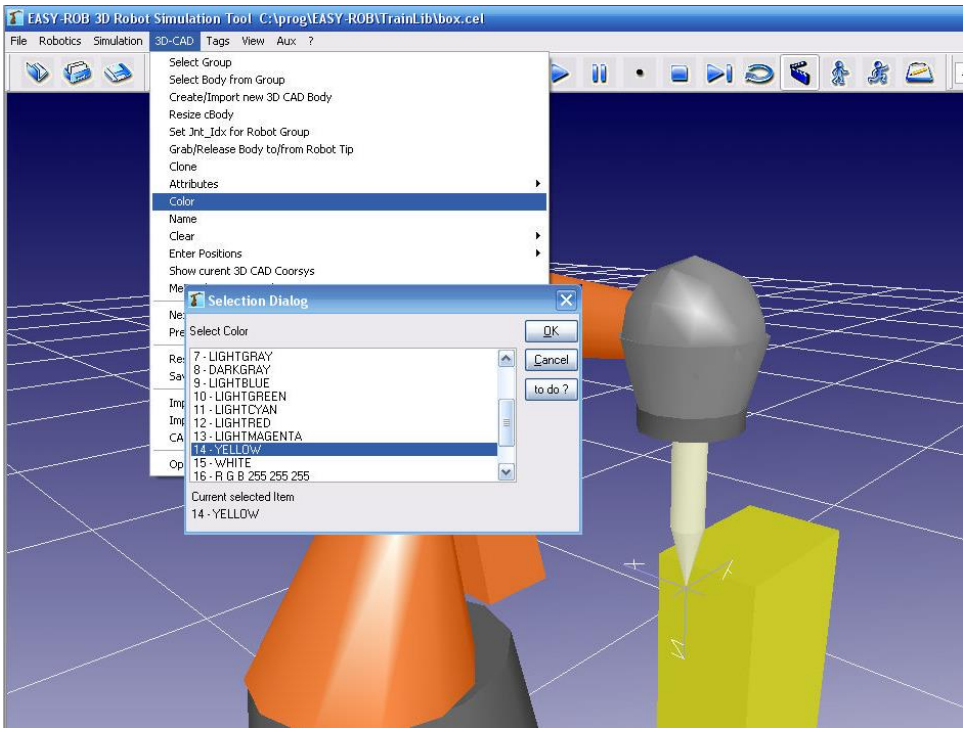
Changing the color of the work piece

To change the bodies color select *3D-CAD / Color*.

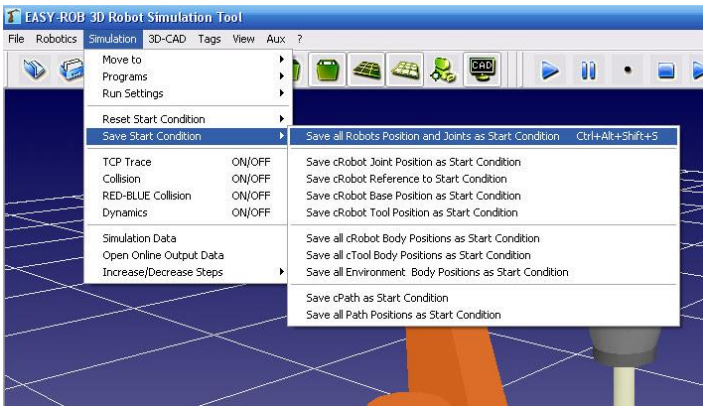


Save the current positions

Save the current position of all robots and bodies in the workcell and define them as start positions. Select *Simulation / Save Start Condition / Save all Robots Positions and Joints as Start Condition* .

You can also save specific positions of single bodies or robots by using the functions in the Menu.

Hint: to reset all positions just use *Simulation/ Reset Start Condition/ Reset all Positions and Joints as Start Condition.*



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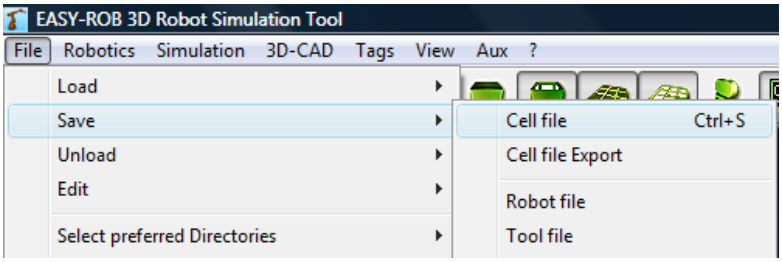
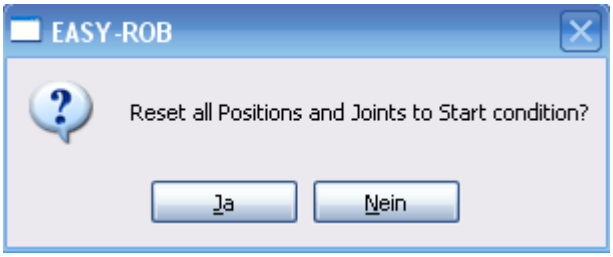
Saving the Workcell

Save the current status of the workcell by using: *File / Save Cellfile* with the file name *box.cell*.



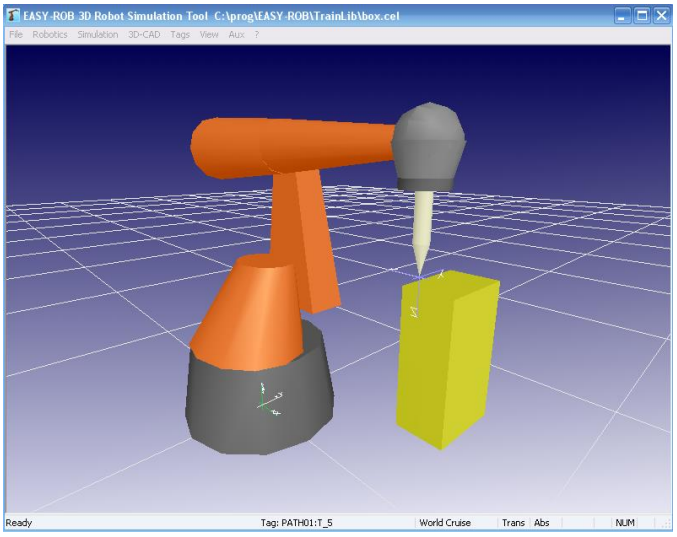
If you confirm the next dialog “Reset all Positions and Joints to Start conditions“ with “Yes” -
everything in the workcell will be reset to the initial positions (that’s the position you stored in the previous step)



Attention:
If you confirm with „Yes“ but you did not store the positions like described above, an unwanted change of positions might occur
Please note that there is **no „Undo“**-button to cancel that.

If you confirm the dialog with „No“ you can save the positions as start values at the end of the workcell saving procedure.

Note: EASY-ROB™-working cells (files with the extension *.cel*) contain all information about the robot, the tool and work piece as well as references to possible robot programs.



Hint: Working cells can also be saved by clicking the Save-Button in the toolbar.

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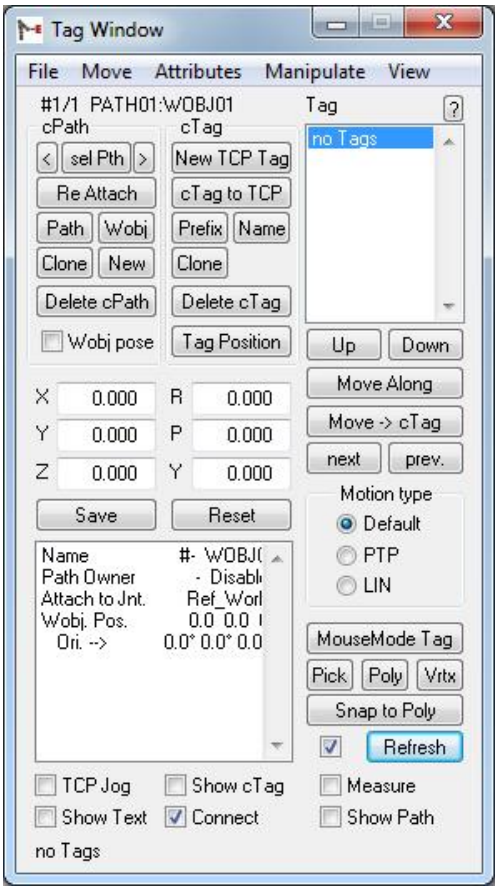
Creating working points (tag points)

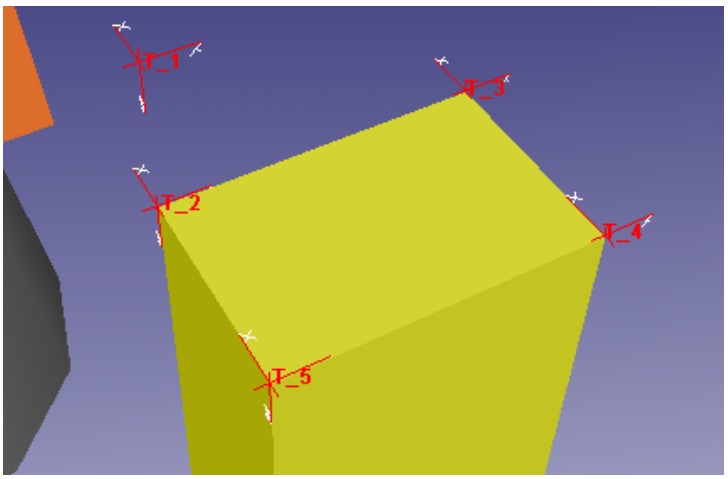
Tag-points (or teach-points) describe the position and orientation of working points that the robot should move to.

Note: The tag-window is shown by a single click on the *SEL TAG* button.



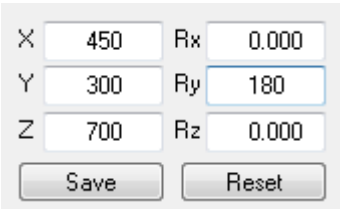
Task:

A tag point should be created on all four upper corners of the cube (nr. 2 to 5). An additional tag point (nr. 1) should be defined as approaching point.



Procedure for creating tag points

Click once on the button *New Tag on TCP*. This will create a tag point at the tool tip (Tool Center Point: TCP). The tag point will show up in the tag point list.



Now set up the position of the tag point *T_1* to X=450 mm, Y=300 mm, Z=700 mm and tit's orientation to Rx=0 degree, Ry=180 degree and Rz=0 degree.

Now activate the checkbox *TCP Jog* at the bottom of the tag window and the robot will move to the first tag point which means that the coordinate systems of the TCP and the tag point will be brought to congruence.

Now click again on *New Tag on TCP* to create the tag point *T_2*. This one lies congruent with *T_1*. Move the tag point *T_2* to a height of Z=550 mm. *T_2* now lies on the first corner of the cube.

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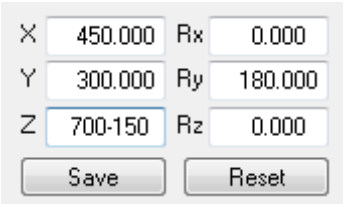
Now create the tag point *T_3* and set up its Y-coordinate to 600 mm.
After that create *T_4* with the X-coordinate set to 650 mm. At last create *T_5* with Y=300 mm.

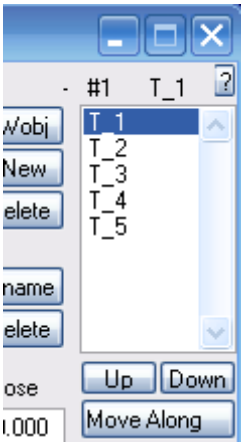
The following table contains the position and orientation of all five tag points for checkup:

Tag	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]
T_1	450	300	700	0	180	0
T_2	450	300	550	0	180	0
T_3	450	600	550	0	180	0
T_4	650	600	550	0	180	0
T_5	650	300	550	0	180	0

Hint: For easier positioning you can use the functionality of EASY-ROB™ formula-parser. If a tag point lying on the height of Z=700 mm should be moved to Z= 550 mm just enter 700-150 to the Z-field.

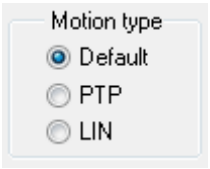


If position and bearing of your tag points fit the values in the table, drive the robot to its home position and save the actual state as working cell in the file *box_tags.cel*.



Note: The EASY-ROB™-cell files also contain the tag points. Furthermore the actual state of the robot is defined as home position.

Hint: To move the robot to the tag points in the same order as they are shown in the list choose the first tag point and select *Move Along*. The type of motion that should be used to move the robot to the tag points can be defined with button *Motion type* in the *TagWindow*.



Hint: The order of the tag points can be changed with the *Up* and *Down* buttons.

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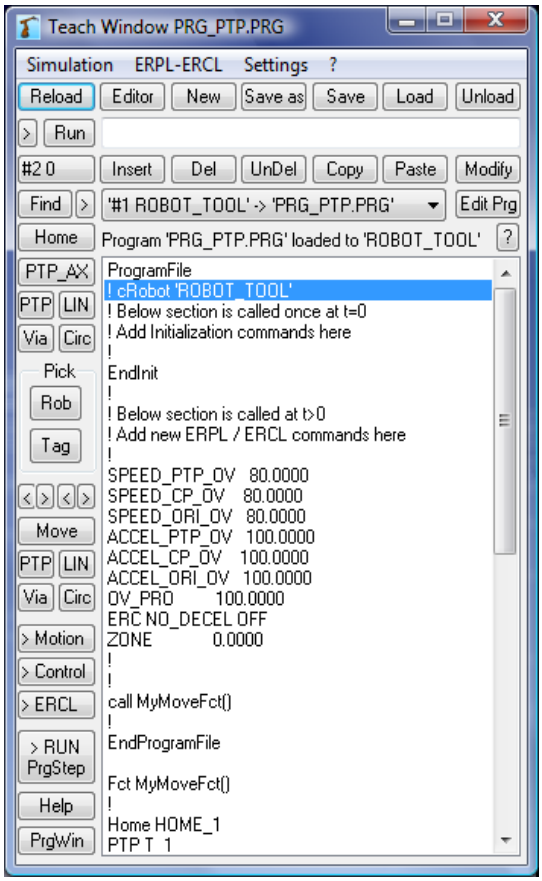
Creating a PTP-robot program in EASY-ROB™

At first open the *TeachWindow* by clicking the corresponding button.

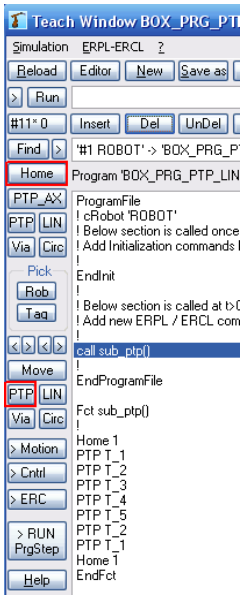
Create a new program by click on *New*. Save the program as *prg_ptp.prg* by a click on the *Save as* button in the *TeachWindow*. Then save the cell in the file *box_prg_ptp.cel*.

Note: The name of the EASY-ROB™-program will be saved in the working cell. The program will be automatically activated the next time you load the cell.



Renaming the sub routine

The values for the PTP-motion (Point-to-Point) should be stored in a function named *sub_ptp*. Get the program line *call my_fct_name()* into the edit line of the *Teach Window* by a double click on it and change it into *call sub_ptp()*. Pressing return will transfer the changed line back into the program. Now change the name of the function by changing the line *fct my_fct_name()* into *fct sub_ptp()*.



Note: Programs can be created very comfortable in EASY-ROB™ by simple mouse clicks. All commands can be divided into the groups *Motion*, *Cntrl* and *ERC*. Make yourself an overview by clicking the corresponding buttons in the *TeachWindow* (*> Motion*, *> Cntrl*, *> ERC*).

Inserting motion commands for PTP

Commands are always inserted before the actual line so select the last program line *endfct*. At first the robot should move to its home-position. Insert the command *Home 1* into the sub routine by clicking the *Home*-button in the *Teach Window*.

Now open the *TagWindow* and select the tag point *T_1*. Press the button *PTP cTag* in the *TeachWindow* (*cTag* is the short form of *current Tag*, which means the currently selected tag point).

Proceed for the tag points *T_2* to *T_5* in the same way. At last insert a motion command for *T_2*, *T_1* and back to the home position.

Save the program by clicking the *Save* button in the *TeachWindow*.

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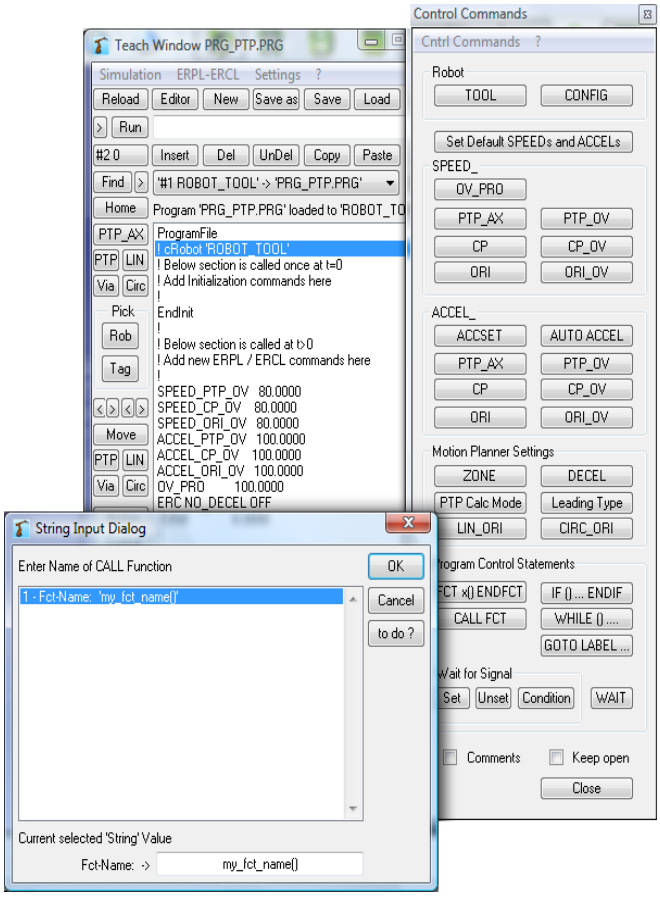
Executing the program

The program can be started by clicking on the *Run*-button. The simulation speed can be changed with the *Decrease Step size*-(Ctrl + Shift + -) and the *Increase Step size*-(Ctrl +) buttons.

Hint: Press the *Repeat*-button if you want to repeat the program infinitely.

Note: By pressing the *Show Robot TCP Trace* button the TCP-Trace will be displayed.

Creating a LIN-robot program in EASY-ROB™



At first save the program as *box_prg_ptp_lin.prg* by pressing *Save as*- in the *TeachWindow*. Then save the cell as *box_prg_ptp_lin.cel*.

Adding a sub routine for LIN

The sub routine with the motion commands for LIN should be executed before the sub routine with the PTP-commands. Therefore select the line with the *call sub_ptp()* command. Now press *>Cntrl* in the *TeachWindow* and choose *CALL FCT* in the dialog. Enter *sub_lin()* as function name. EASY-ROB™ will automatically insert a sub routine when you answer the following question with yes.

Inserting motion commands for LIN

Choose the program line *endfct* which closes the function *sub_lin()*.

Now insert the commands *Home 1* and *PTP T_1* because the robot should first move to the home position before moving to the first point by a PTP-command.

Now select *T_2* to *T_5* in the *TagWindow* one by one and press *LIN cTag* in the *TeachWindow* for each one. Don't forget to insert LIN-commands for *T_2* and *T_1* too. Finally the robot will be moved to the home position by the command line *Home 1*.

Remember to save the program using the *Save*-button in the *TeachWindow*.

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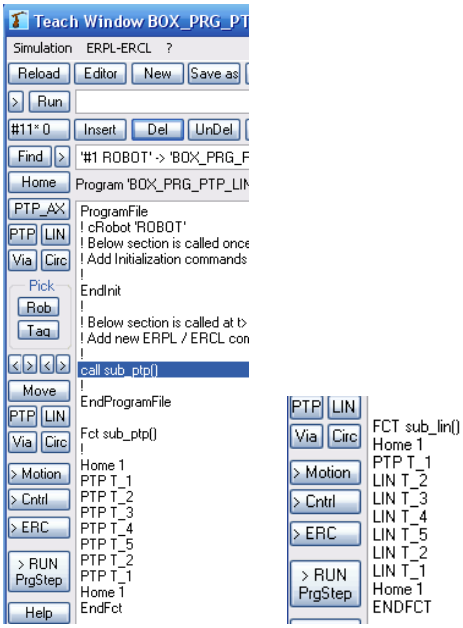

That's how the complete program for LIN- and PTP-motion looks like.

Hint: Single motion commands can be executed by pressing the > *Run Cmd*-button in the *TeachWindow* (single step mode). Simply select the program line you want to be executed and press > *Run Cmd*.

Comparison of PTP-motion and LIN-motion

Compare the robots motion by activating the trace and executing the sub routine with the PTP-commands and afterwards executing the LIN-command-sub routine in single step mode. After executing the PTP-sub routine change the trace color to blue by choosing *View / TCP Trace / Color / Color for desired TCP TRACE*. from the EASY-ROB™ main menu.

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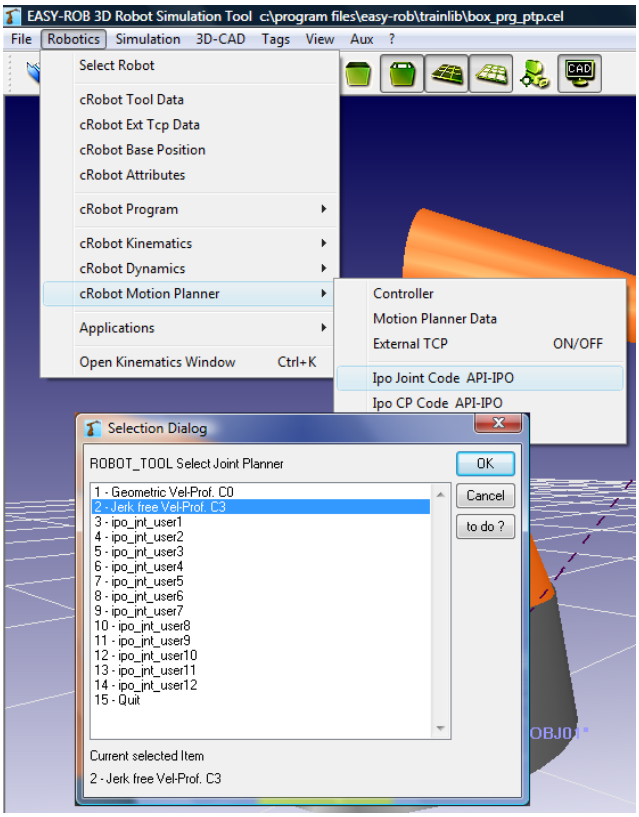
Adjusting the motion speed and acceleration



Make sure that the motion planners for PTP-, CP- and CIRC-method are set to Jerk free Vel-Prof. C3. This setting can be made in the *Robotics / Robot Motion Planner* menu.

Note: Motion planners and speeds are divided into PTP and CP. CP is the short form for *Continuous Path* which means driving a course as with LIN or CIRC.

Save the program as *box_prg_ptp_lin_speed.prg* by pressing the *Save as Button* in the *TeachWindow* and save the new cell as *box_prg_ptp_lin_speed.cel*.

Setting up SPEED and ACCEL

By pressing > *Cntrl*-Knopf in the *TeachWindow* you gain access to the commands for setting up speed and acceleration (*SPEED* and *ACCEL*).

Set up the values for *SPEED* and *ACCEL* by pressing the appropriate buttons according to the following table:

ACCEL_ORI	40	$\frac{deg}{s^2}$
ACCEL_CP	1.500	$\frac{m}{s^2}$
SPEED_ORI	5	$\frac{deg}{s}$
SPEED_CP	0.050	$\frac{m}{s}$
ACCEL_PTP_AX	40 40 40 40 40 40	$\frac{deg}{s^2}$

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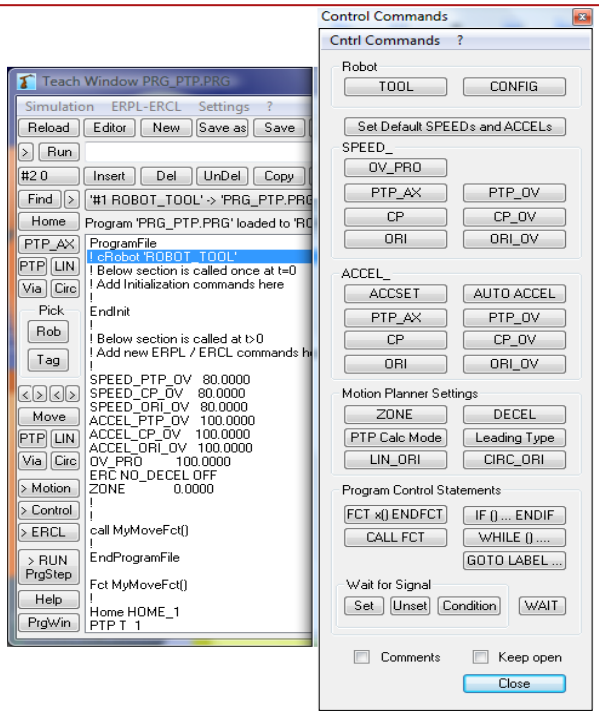
SPEED_PTP_AX 5.0 5.0 5.0
5.0 5.0 5.0

$\frac{deg}{s^2}$



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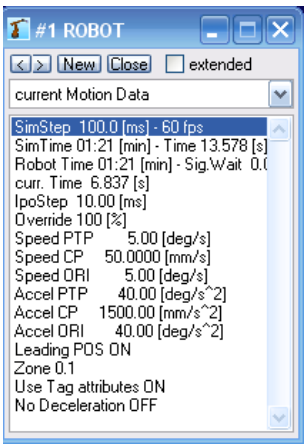


Note: In contrast to the *SPEED*- and *ACCEL*-dialogs length values in EASY-ROB™ robot programs are declared in meters instead of millimeters.

Verifying the result

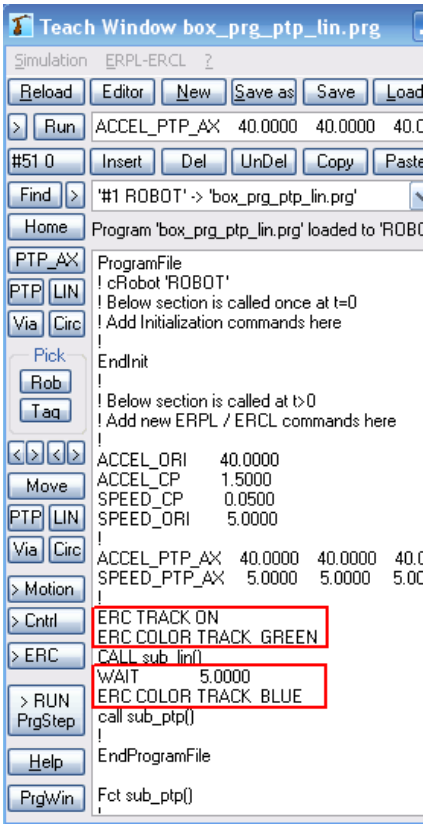
Show up the *Robot IO Output*-dialog using the toolbar and choose the entry *current Motion Data* from the list. Now you will get information about the duration of the simulation, the duration of the robot motion and the duration of the last motion set. Furthermore the actual values of velocity and acceleration are displayed.

Extending the program

Save the program as *prg_ptp_lin_speed_track.prg* and the cell as *box_prg_ptp_lin_speed_track.cel*.

Modifying the track in the robot program

The visualization of the *TCP Trace* can directly be switched on and off in the EASY-ROB™-robot program. Furthermore you can change the color of the track. Just insert the yellow marked lines in your program. To do so press > *ERC* in the *TeachWindow* and choose the option *ERC [] ON*. Afterwards click *TRACK*. To change the color choose the option *ERC COLOR []*. After selection of *COLOR TRACK* you can choose your color.



Inserting a break

Duration bounded breaks can be realized with the *WAIT*-command followed by the duration in seconds. The next command will be executed after that time. The time means simulation time not real time.

Hint: Try the effect by executing the program with and without the *WAIT* command and watch the simulation time.
You can comment out a program line by inserting a leading exclamation mark.

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EASY-ROB™

Operation References

Short Keys and startup options

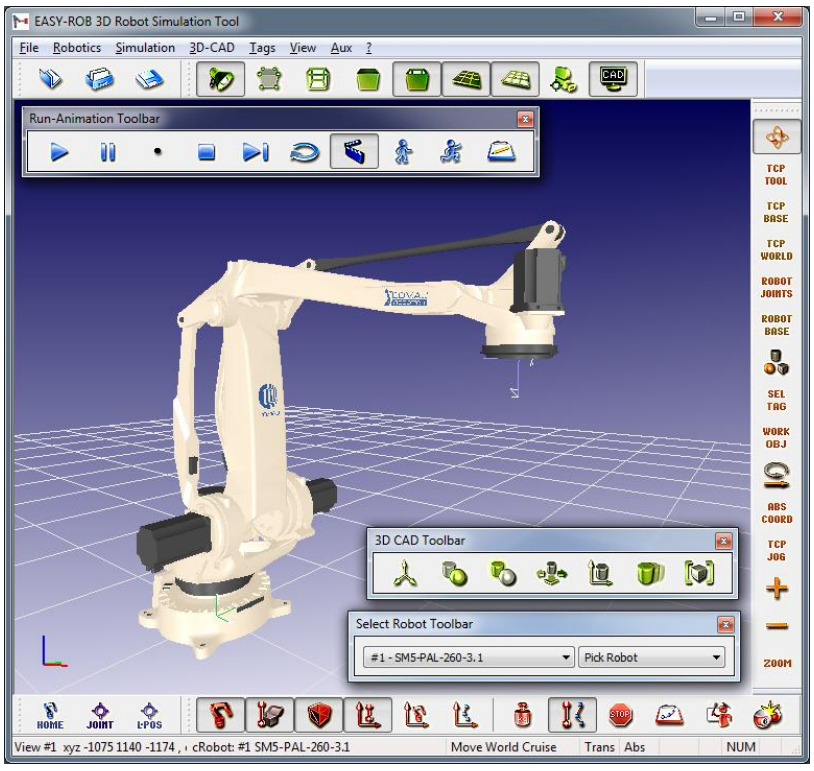
The EASY-ROB™ user interface can be operated by mouse or by keyboard using short keys. The following list gives an overview over the existing short keys.

EASY-ROB™ - Start with option and command list

Examples:

easyrobw.exe .\proj\Zelle.cel -run -io	Loads the cell file "Zelle.cel", launches automatically the program contained in the cell and opens the output window for the joint angles of the robot or NC machine.
easyrobw.exe -remote -info	Opens the remote control dialog and the message window after start-up.
easyrobw.exe -toolbarsoff - statusbaroff	Launches without toolbars and status bar
easyrobw.exe -loadlib	Opens the Load Library dialog
easyrobw.exe -prog -teach	Opens the Program- and Teach Window

EASY-ROB™ user interface



COMAU Industrial robot SM5-PAL-260-3.1

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Button or menu	key combination / option	function
Toggle Light	-light	3D scene displayed without light source
Toggle Point, Vertices	Ctrl + P -point	3D-geometries displayed as vertices
Toggle Wire Frame	Ctrl + W -wire	3D-geometries displayed as wire frame
Toggle BBox	Ctrl + B -bbox	3D-geometries displayed as bounded boxes
Toggle Backface Culling	Ctrl + Shift + B -bface	Back face culling
Toggle Floor	-flooroff	Switch off visibility of the floor
Floor Position	-floorwire	Display the floor as wire frame
Open avi recorder dialog	F6 Open AVI recorder dialog	Starts AVI Recorder Dialog
Toggles: Simulation View or CAD-Preview	Ctrl + Tab	Switch between simulation and preview

Run Program	Ctrl + R -run	Run the actual program
Pause/Continue		Continue / pause program execution
Abort Program		Stop program execution
Stops program execution after each motion command		Automatic stops program execution after each motion command
Repeats program automatically	-runrepeat	Automatic program repeat
3D Animation On/Off		Enables/Disables 3D-Animation while simulation
Decrease Stepsize	Ctrl + '+'	Decrease simulation step size
Increase Stepsize	Ctrl + Shift + '-'	Increase simulation step size

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Display miscellaneous output values	-io -io2 -io3 -io4	Opens the first 4 Output-dialogues (desired Joint Values, desired Cart. Pose, current Motion Data, actual Joint Values)

Button or menu	**key combination / option**	**function**
File → Load → Cell file	Ctrl + O -loadcel	Load a cell file
File → Load → Robot file	-loadrob, -loadrobot	Load a robot file
File → Load → Tool file	-loadtol, -loadtool	Load a tool file
File → Load → Load from Library	Ctrl + Shift + O -loadlib	Load a cell, robot, tool, etc. from the library
File → Load → Start Project Manager	Ctrl + Shift + P	Start the Projectmanager
File → Load → Start ERC Searcher	Ctrl + Shift + S	Start the ERC Searcher
File → Load → Start History Diagram	Ctrl + Shift + H	Start the History Diagram
File → Load → Start CAD2ER Converter	Ctrl + Shift + C	Start the CAD2ER Converter
File → Save → Cell file	Ctrl + S	Save / Save as of the cell file
File → Unload → Cell	Ctrl + U	Unload a workcell
File → Edit → EASY-ROB System Files → Config file	Alt + Shift + C	Edit the file `config.dat`
File → Edit → EASY-ROB System Files → Environment file	Alt + Shift + E	Edit the file `easy-rob.env`
File → Edit → EASY-ROB System Files → License file	Alt + Shift + L	Edit the file `License.dat`
File → Edit → EASY-ROB System Files → Moni_msg file	Alt + Shift + M	Edit the file `moni_msg.txt`
File → Exit	Ctrl + F4, Alt + F4	Close EASY-ROB
? → Online Help	F1	Show online help
? → License Info	-licenseinfo	License information
? → About...	-about	Shows the "about"-dialog
Simulate →Programs → Teach Window Open Prgram Teach Window	-teach	Opens the teach dialog
Simulate →Programs → Progam Output Show Program Window	-prog	Opens the program dialog
(2x) Tags →Tag Window	-tag	Opens the Tag Window

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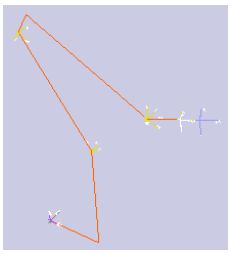
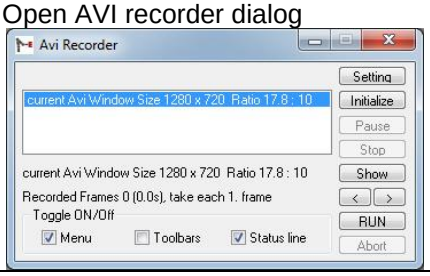
(2x) 3D-CAD → 3D-CAD Window	-3dcad	Opens the 3D-CAD dialog

Button or menu	**key combination / option**	**function**
View → Coorsys → Show Robot Coorsys	-robcoorsys	Show coordinate systems on robot joints 
View → Message Window	Ctrl + M, -message	Open message dialog (information output)
View → Navigator Window	Ctrl + N	Open navigator dialog (Pick & Click, distance measuring, etc.)
View → Status Bar	-statusbaroff	Hide program status bar
View → Coorsys → Show Robot Coorsys	-robcoorsys	Show the coordinate systems in the axis of the Robot
View → EASY-ROB PlugIn Dlls → Avi Recorder	-avi	Open AVI recorder dialog 
View → Show Toolbars → All Toolbars On	Ctrl + T -toolbaron	All tool bars on
View → Show Toolbars → All Toolbars Off	Ctrl + Shift + T -toolbaroff	All toolbars off
View → Show Toolbars → Load/Save	-toolbarloadsaveoff	"Load / Save"-toolbar off
View → Show Toolbars → Render	-toolbarrenderoff	Render Toolbar off
View → Show Toolbars → Run/ Animation	-toolbarrunoff	Run Toolbar off
View → Show Toolbars → On/Off	-toolbaronoffoff	On/Off Toolbar off
View → Show Toolbars → 3DCAD	-toolbar3dcadoff	3D CAD-Toolbar off
View-> Show Toolbars-> Move Robot to	-toolbarmovetooff	Move to Toolbar off

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View → Show Toolbars → Mouse Mode	-toolbarmouseoff	Mouse Move Toolbar off

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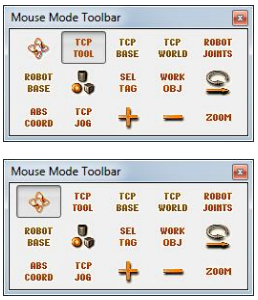
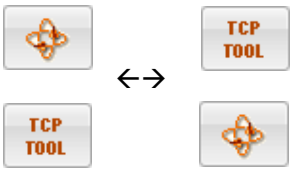
Button or menu	key combination / option	function
View →Show Toolbars → Robot Toolbar	-toolbarselectrobot	Robot Toolbar off
Robotics → Robot Application → Remote Control	F2 -remote	Open remote control dialog
Robotics → Robot Application → External Devices → Sensor Interface	F3 -sensor	Open sensor interface dialog
View → EASY-ROB PlugIn Dlls Vrml97 Export	F7	Start VRML97 Export Dialog
View → Set 3D Views → Goto next Simulation View	Ctrl + Tab	Switch to next Simulation-View
View → Set 3D Views → Goto prev Simulation View	Ctrl + Shift + Tab	Switch to previous Simulations-View

3D CAD → Attributes → Info	Ctrl + I	Geometry information for the actual CAD-object
3D CAD → Cad Preview Settings → Info	Ctrl + Shift +I	Geometry information for the CAD-object in the preview

	Spacebar/ Leertaste 	Toggles between the previous and the actual mouse mode WorldView ←→ Jog Robots TCP Tool Jog Robots TCP Tool ←→ WorldView
Aux → EASY-ROB Client Window	-client	Opens an additional EASY-ROB™ session with the same cell file..
Aux → Mouse Mode → TCP Tool Aux → Mouse Mode → Abs | Rel Aux → Mouse Mode→ Rot | Trans	 MouseMode Shift → Ctrl → 	If the mouse mode "Tcp Tool" is active you can toggle between translatory / rotatory movement by pressing Shift and between absolute / relative movement by pressing the Ctrl-key. Status bar

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Aux → Mouse Mode → TCP World Aux → Mouse Mode → Abs | Rel Aux → Mouse Mode→ Rot | Trans	MouseMode Shift → Ctrl →	If the mouse mode "Tcp World" is active you can toggle between translatory / rotatory movement by pressing Shift and between absolute / relative movement by pressing the Ctrl-key.

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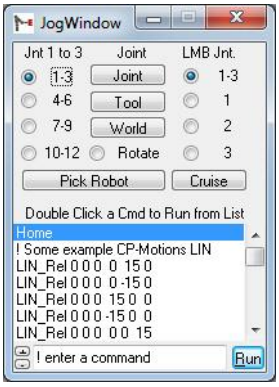
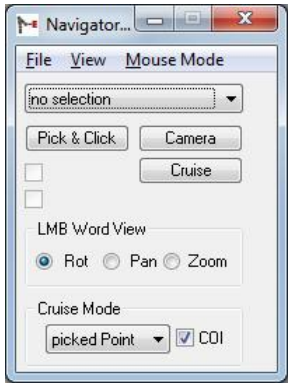
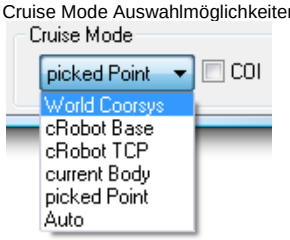
Button or menu	key combination / option	function
Aux → Mouse Mode → Joint  2 ROBOT JOINTS x	MouseMode ROBOT JOINTS ESC Ctrl	ESC resets the joint angles Pressing Ctrl while moving the mouse switches to the axes 4-6. Releasing the key switches back to axes 1-3. Clicking twice on ROBOT JOINTS launches the JogWindow dialog
Aux → Mouse Mode → World View  Cruise Mode Auswahlmöglichkeiten  2 x	MouseMode ESC Ctrl-Key Shift-Key	If the mouse mode "World View" is active you can toggle the camera perspective by pressing TAB. ESC resets the 3D view. Clicking twice on launches the Navigator dialog (Pick & Click, distance measuring, etc.) In the navigator window the cruise mode that the 3D scene will rotate around can be set. When pressing Ctrl the cruise mode is set to Robot TCP. Then the actual rotation center is the TCP of the robot. If a vertex, polygon or tag was previously selected with Pick & Click and this shall be the rotation center, then press the Shift Key. The cruise mode will then be set to „picked Point“ and your selection is the rotation center of the 3D scene.

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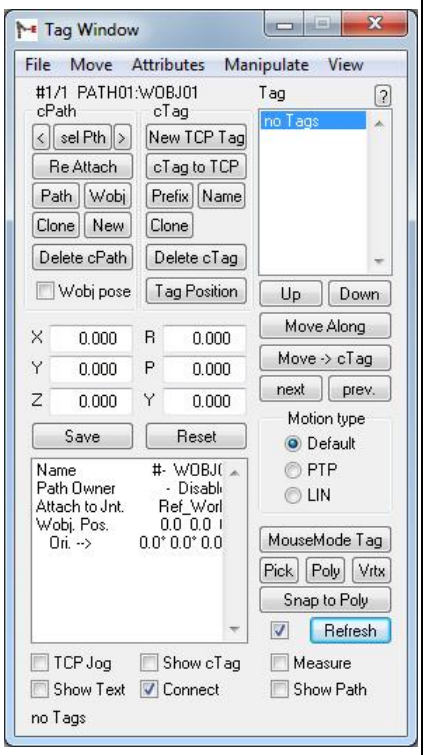
Button or menu	key combination / option	function
Aux → Mouse Mode → Trans/Rot current selected Tag  x 2	MouseMode Shift → Ctrl → Arrow UP Arrow Down Pos 1 (home) Ende (end) ESC	If the mouse mode "Tag" is activated you can toggle between translatory / rotatory movement by pressing Shift and between absolute / relative movement by pressing the Ctrl-key. Absolute: motion in relation to Wobj-frame Relative: motion in the tag frame Pressing Arrow UP and Arrow DOWN selects tag points. The name of the actual tag point is displayed in the status bar. Home (Pos 1) selects the first tag point, end (Ende) selects the last tag point of a path. ESC resets the tag position
EASY-ROB™ status bar 		

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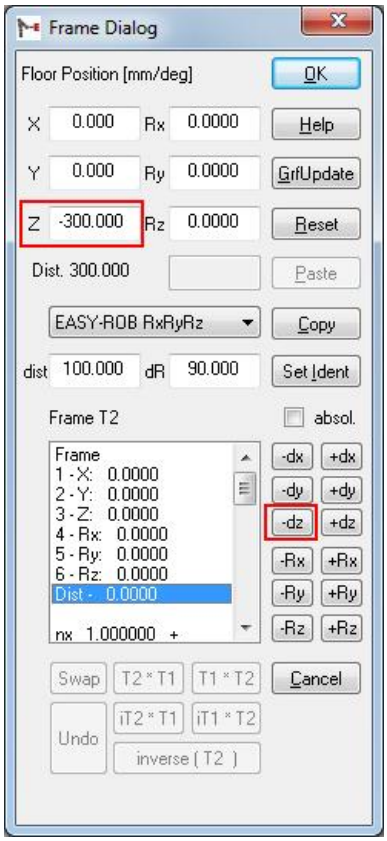
General Functions

Positioning the floor

With this version of EASY-ROB you are able to change position and orientation of the floor in EASY-ROB.

Call the Fame Dialog with the menu „View | Floor | Floor Position“.



Move floor
in x, y oder z- direction

Turn floor
around x, y oder z- direction

See as well the chapter „Frame Dialog“

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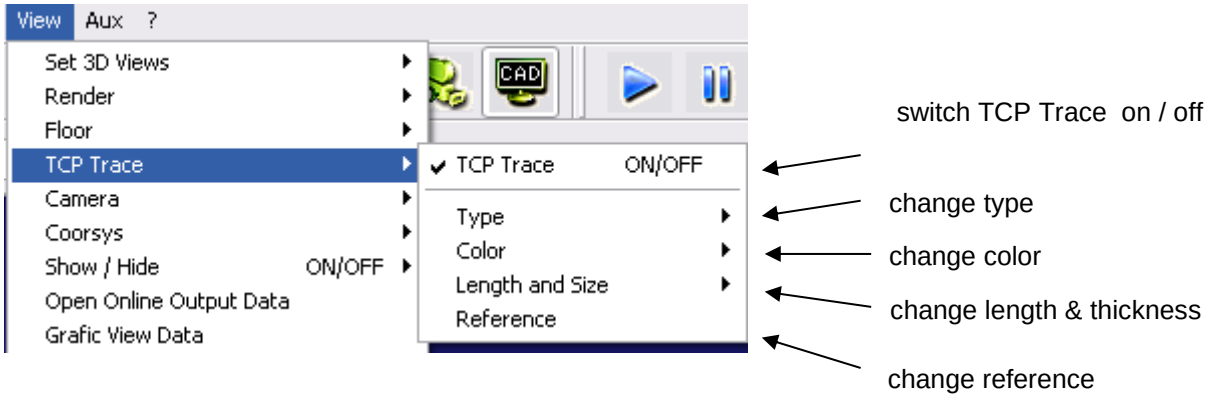
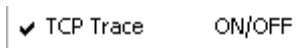
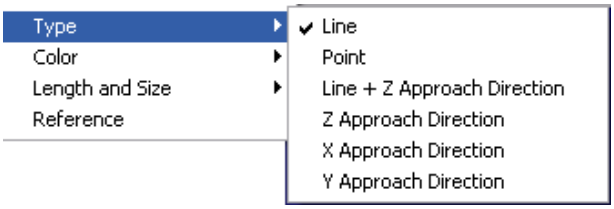
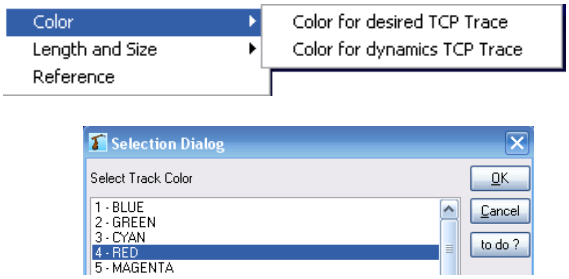
TCP Trace

For the TCP Trace you are able now to change the length, the thickness and the reference.

Use the menu „View | TCP Trace



	Switch TCP Trace ON or OFF
	Settings for the type Line Trace as a line Point Trace as a dotted line Line + Z line with approach-axis in Z Z App. approach-axis in Z X App. approach-axis in X Y App. approach-axis in Y
	Change the color of the TCP Trace

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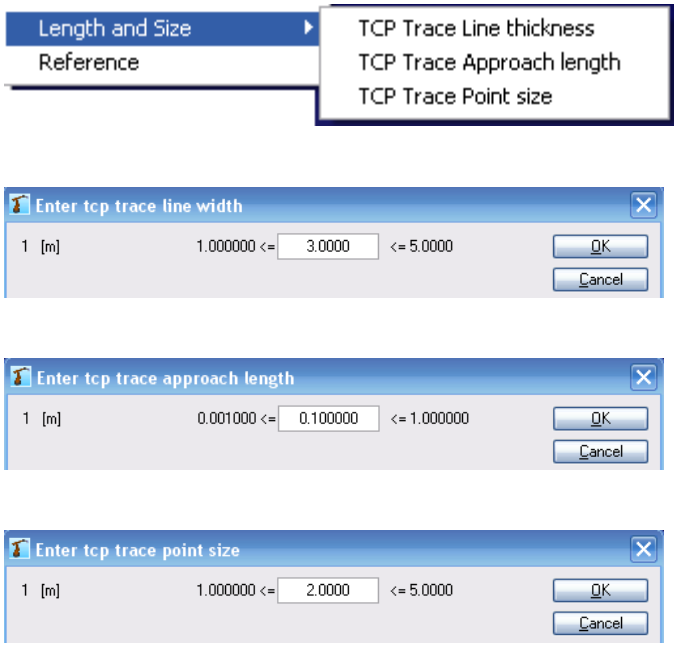
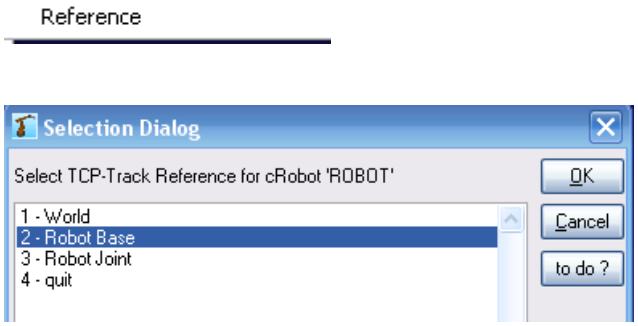


Change

- thickness for the TCP Trace
- approach length for the TCP Trace
- point size for the TCP Trace



Select the reference for the TCP Trace

Options:

- referred to world
- referred to robotbase
- referred to a joint of the robot

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Collision check in EASY-ROB™

The Collision check in EASY-ROB™ enables you to check all objects in the workcell for collision.

You can check object vs. object or group vs. group.
Example: You know for sure that the robot can not reach the fence with axis 1 to 4, because of the axis limits. So you just have to check only axis 5 and 6 vs. the surrounding fence.
The reduction of the number of objects in the collisions queue will reduce the calculation time for the collision check.

The internal mechanism of the collision check works in a hierarchy: first the system will check for bounding box; after that it will for concave or convex.

The system will check for collision while running a program and while manual movement of the robot by moving the TCP or the joints.

In case of collision, the colliding parts will change their color to red and - depending on the settings – the simulation will stop.

On top of the regular collision check, EASY-ROB™ provides a function for a near-miss-collision-check. So you can set a minimum distance (safety area) and every time the robot moves below the value, you will see a warning for collision, although there is no real collision.
(Note: the near-miss-check only works with convex bodies)

All collision related functions can be set manual (by buttons) or automatically by an ERCL command in a program.
(see document „**EASY-ROB_ERPL_ENG.pdf**“, a documentation of all ERCL-commands)

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The mechanism for collisions detection in EASY-ROB™ works on 3 levels:

1. global ON / OFF, to switch collisions detection on or off

2. predefined collision queues
   The following listed collision queues are predefined and can be switched on or off by the user:

BODY_ROBOT	– collision check between Body and Robot
BODY_TOOL	– collision check between Body and Tool
ROBOT_TOOL	– collision check between Robot and Tool
GRABBODY_ROBOT	– collision check between „grabbed“ Body and Robot
GRABBODY_ BODY	– collision check between „grabbed“ and „not-grabbed“ Body
ROBOT_ROBOT	– collision check between all geometries in the same Robot group
BODY_BODY	– collision check between all geometries in the same Body group

3. collision attributes on the object-/geometry level
   Each object does have (beside other attributes) an attribute with the name „Check Collision“
   With this attribute the user can define if and how he wants to check the object for collision.
   The parameters are:

OFF	- no collision detection for the object
BBOX	- check with „bounding boxes“
CONVEX	- check convex
CONCAVE	- check concave

   The default setting is the check for „CONCAVE“

   Note: If one object is set to BBOX or CONVEX and the other object is set to CONCAVE, the collision check will be done CONCAVE.

NOTE:
The correct setting of the switches on all three levels is very important. A few examples:

a)
collsion check “ON”, collision queue Body-Robot „ON“, attribute „Check Collision“ is „OFF
-> even when a collision exist – it won’t be detected or shown, because the attribute for the geometry is set to „OFF“

b)
collsion check “ON”, collision queue Body-Robot is „OFF“, attribute „Check Collision“ is „CONCAVE“
-> even when a collision exist – it won’t be detected or shown, because the collision queue is set to „OFF“

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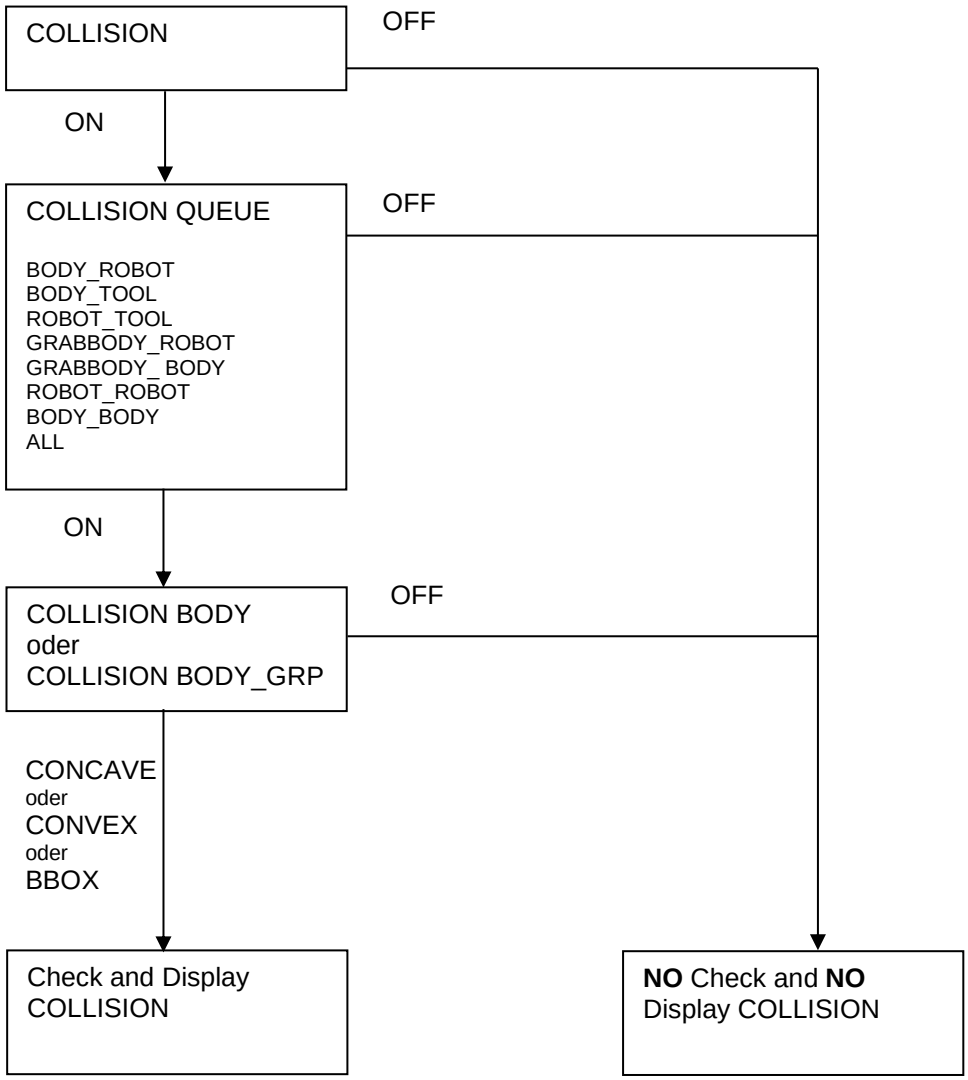
Overview of the dependence of the 3 levels of the collision detection:



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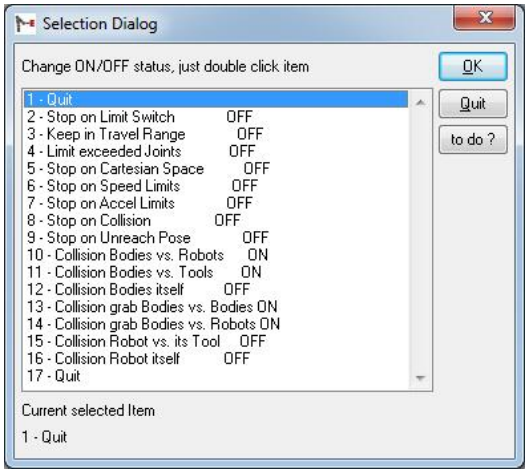
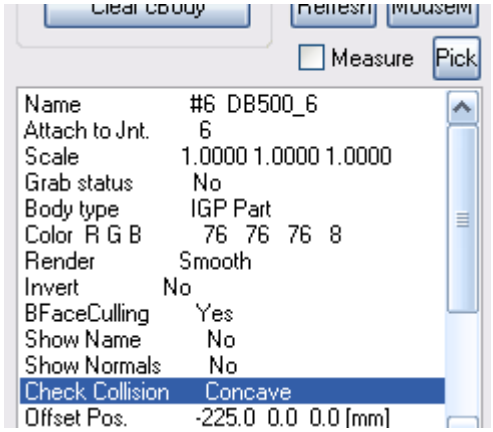
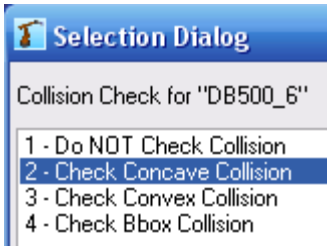
	switch collision detection ON or OFF
	Opens the dialog to switch collision queues ON or OFF
	dialog to switch collision queues ON or OFF double click on the item will toggle between ON and OFF
 	Attribute „Check Collision“ set to „Concave“ double click on the attribute will open a dialog to change the setting

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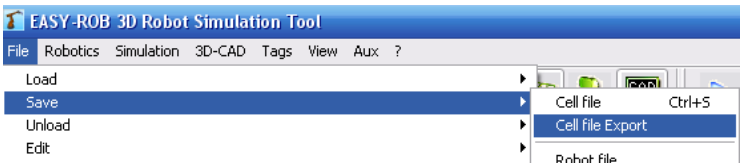
How to export a workcell

Sending an EASY-ROB™ workcell by email for instance to a colleague or a customer (which is not working on the same PC or in the same network) will always bring up the following question:
“Are all required data included into the shipment ?!”

If it is a workcell with many devices consisting of many parts and a program on top, it can be a time-consuming task to collect each single item.

The EASY-ROB™ function “Export Workcell” supports the user to collect all related items of the workcell. It will copy the current workcell and all related files such as IGP-files and programs to a new folder.

2. Load the workcell *Spotweld_Demo.cel* with the button *Load from Library* from the directory: ../EASY-ROB / ApplicationLib / Spotwelding	or shortcut „Ctrl+Shift+O“
2. Start the export by menu File | Save | Cell File Export	

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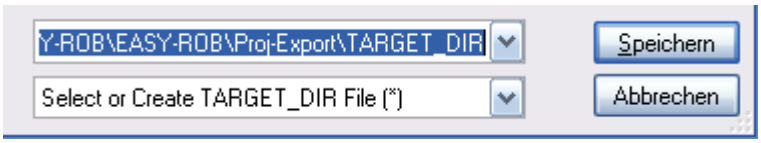
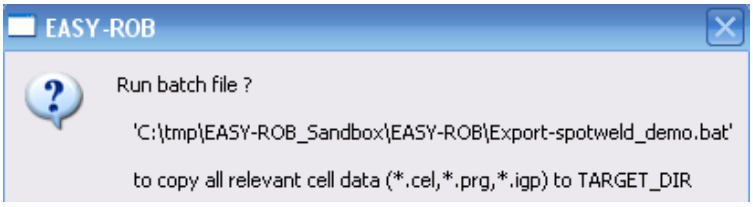
3. Reset the position and overwrite the existing workcell	
4. Now select or create the destination folder (where to store the data) The default path will be the destination folder of the EASY-ROB™ installation: *C:\Program Files\EASY-ROB* in a subdirectory called "\EASY-ROB\Proj-Export\TARGET_DIR" Confirm the default path with "Save"	
5. Confirm the next question with "Yes" to run the batch file and to export the data to the selected directory.	

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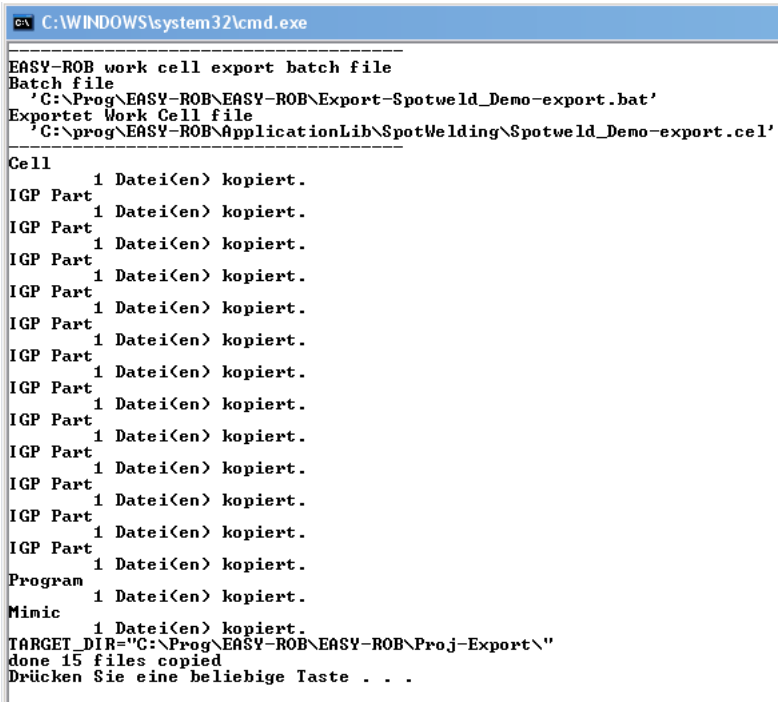
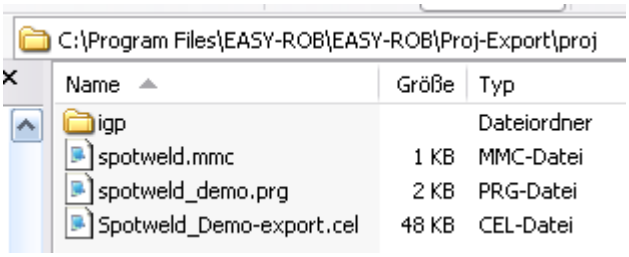
7. After finishing the batch run, press any key to close the command shell.	
8. All workcell related data - workcell-file - program - mimic - parts are now copied to the selected directory. C:\Program Files\EASY-ROB\EASY-ROB\Proj-Export\proj The parts of all devices are placed in the igp folder.	

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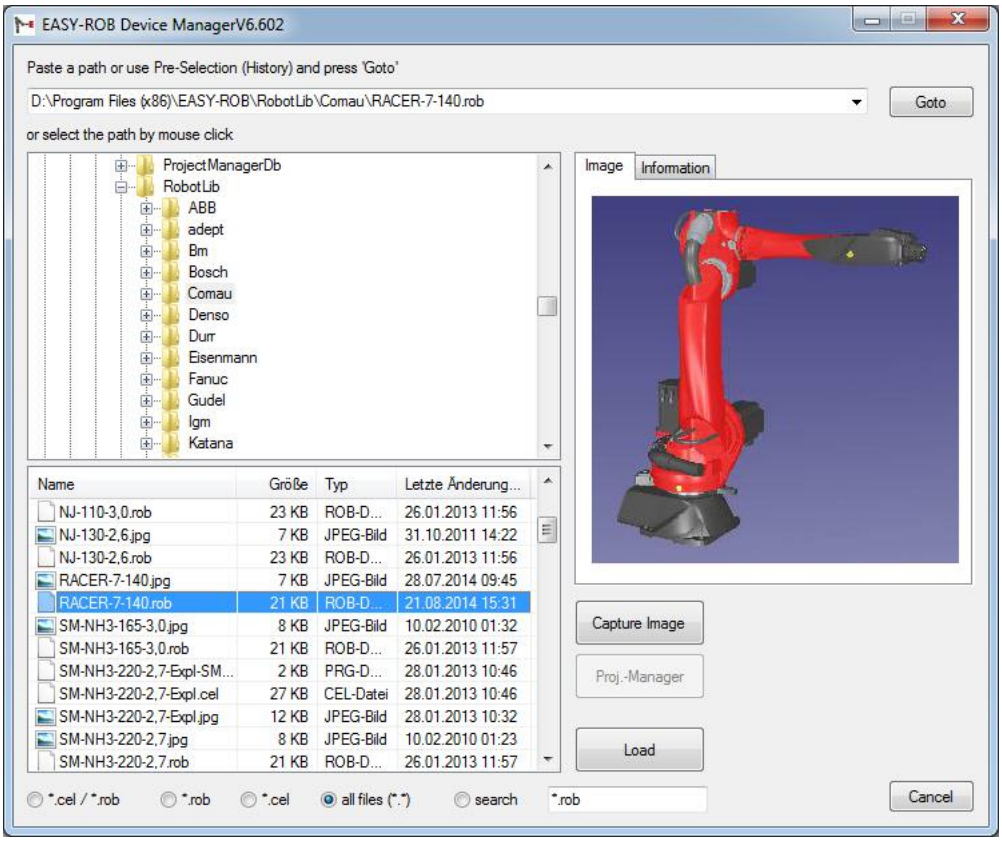
EASY-ROB™
Dialogs & Windows

Device Manager

The Device Manager provides the functionality “to look into a workcell or robot” without loading the file.
Because of the “visible information” through the Device Manager, the user is able to identify immediately if it is the desired workcell or robot.
Beside a screenshot of the workcell or robot additional information as text can be stored.
By using the path history and the list of preferred paths it is possible to navigate through the file tree with just a few mouse clicks.
On top it is possible to send certain data from the Device Manager to the Project Manager. (see chapter „Project Manager“ in this document)

1.
Open the Deveice Manager by the button „Start Device Manager” or Ctrl + Shift + O



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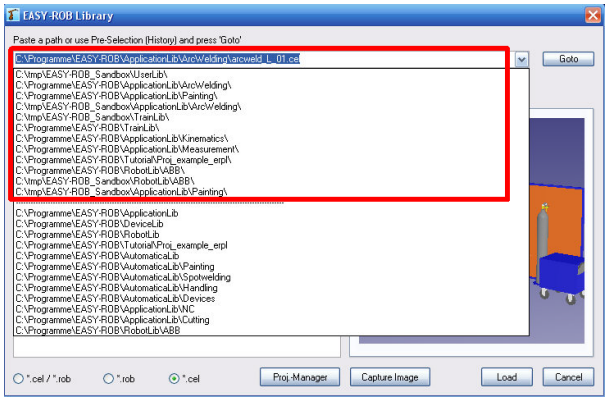
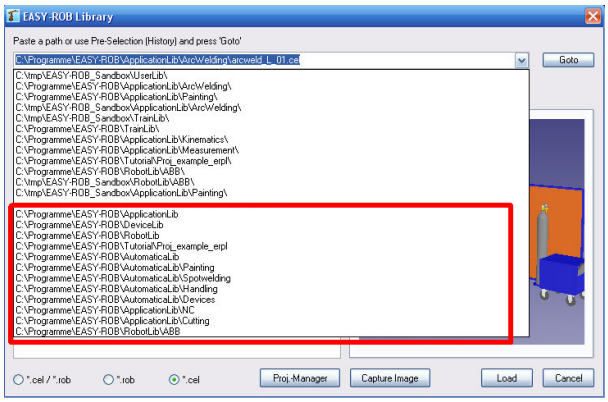
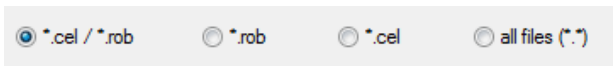
	**Path history:** Every time when loading a workcell or a robot into EASY-ROB™, the system will store the origin path where the data coming from into the path history. The maximum number of listed paths is 12. Identical path names will be listed only one time. The file „*er_LoadFromLibPb.ini*“, which contains the path history, will be administrated automatically. Do not edit is manually.
	**Preferred paths:** Unlike the automatically created path history, won't the list of preferred path change when loading from library. That enables the user to have always a quick access to the 12 most important paths. The list of preferred paths has to be created by the user and will be stored in the file „*er_LoadFromLibPb_prefered.ini*“ in the EASY-ROB™-target directory and be edit through: Menu/File/ Edit/EASY-ROB-SystemFiles.
	Pre-selection of the displayed file type in the list
	Send data of the workcell to the Project Manager
	Function to create a screenshot
	Load the selected file
	Cancel the function

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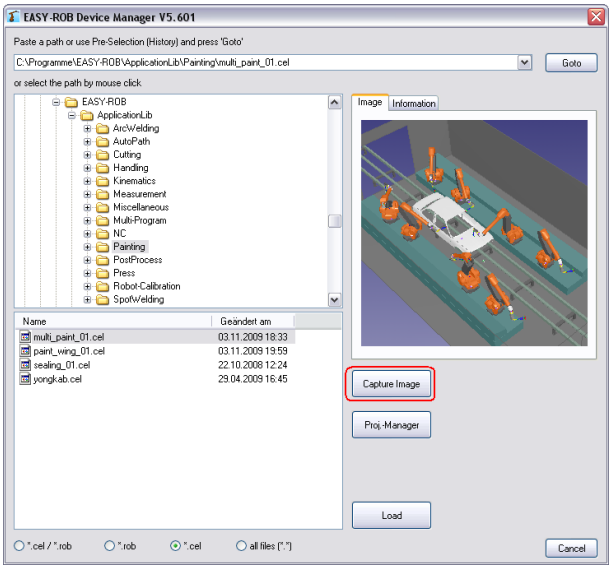
Capture Image

The EASY-ROB™ Capture Image Dialog enables the user to create screenshots in BMP- or JPEG format.

1.
Load at first the robot or the workcell by the Library Dialog into the EASY-ROB™

2.
After loading the cell or the robot call the „Capture Image“ – function from the EASY-ROB™ Library Dialog

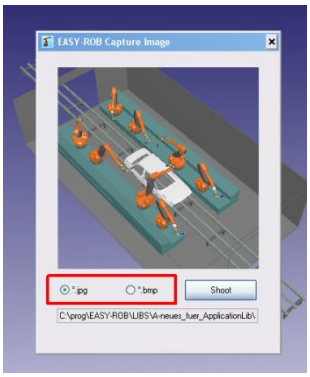
Tip: Select first the file you want to capture (in the example„*multi_paint_01.cel*“), before you activate „Capture Image“. By doing this the system will know the file name and can take it for the picture.



3.
Position the „Capture Image Window“.

Depending on the pre-selected file format the Capture Image will create a BMP- or JPEG file by hitting the „Shoot”-button.

The picture will be stored in the same directory like the workcell or the robot.



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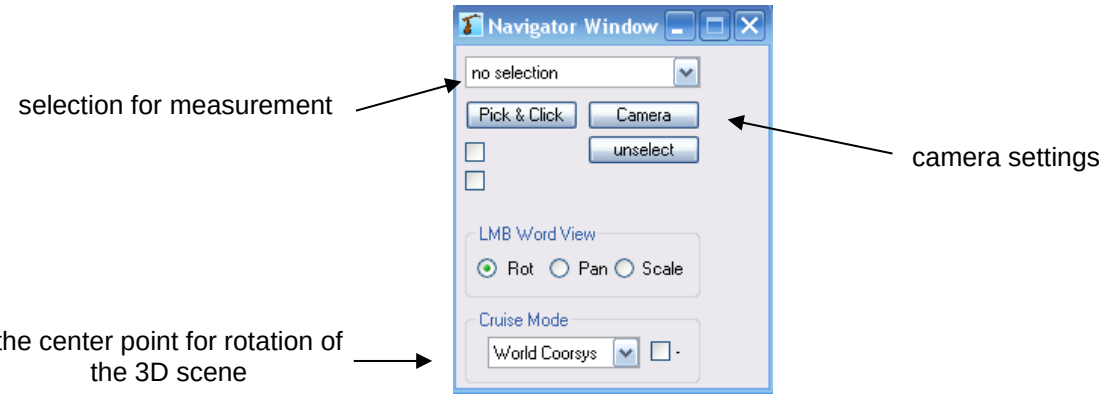
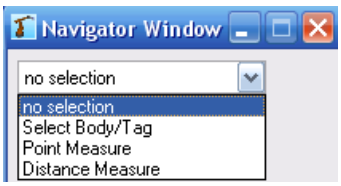
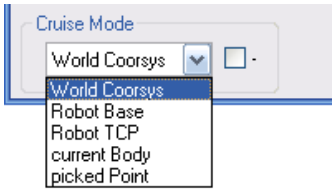
Navigator Window

The Navigator Window is used for selecting geometries and tag points as well as measuring distances in the 3D scene. The *Cruise Mode* defines the point that the 3D scene will rotate around.



Selection for measurement 	*Select Body/Tag* Select a geometry or a tag point by left clicking it. This object is current. *Point Measure* Select a point on a geometry by left clicking it to show its coordinates. *Distance Measure* Used for distance measurement between points, faces and tag points.
Selecting the rotation center point 	By selecting *Modify World View* the 3D scene you can move the scene, zoom in and out or rotate around a point. The following reference systems are available as rotation center. • World Coorsys: (default) The world coordinate system is the rotation center. • Robot Base: The robot base is the rotation centre. • Robot TCP: The robots TCP is the rotation centre. • current Body: The coordinate system of the actual geometry or tag point will be used as rotation center. • picket Point: The selected point on a geometry is the rotation center.

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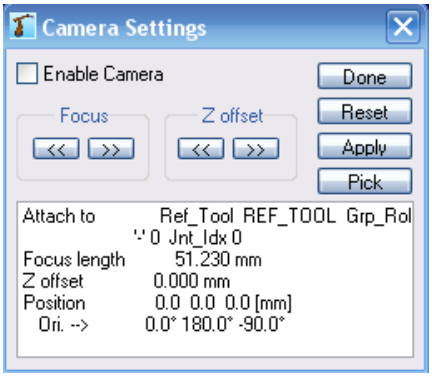
You can switch between the actual *Mouse Mode* and the last recent *Mouse Mode* by pressing *Space*.

Camera settings Camera	You can achieve optimal view points using the camera. For optimal results it's attached to a geometry. If the mouse mode *Modify World View* is active you can switch between camera- and world-view by pressing TAB The line of sight is always in negative Z-direction according to the OpenGL™ definition.

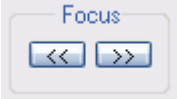
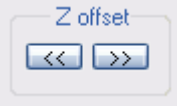
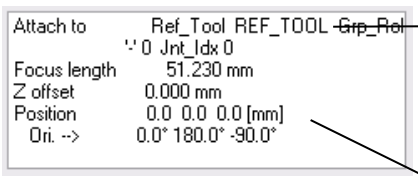
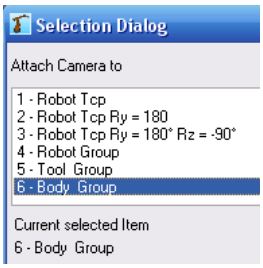
switching camera on and off →

set up focus and offset

property list



← exit dialog
← reset camera settings
← apply changes
← choose geometry

	Changes the focus by 10 mm per click. Double click *Focus length* in the property list to set up an exact focus value.
	The Z offset value moves the lens in Z-direction (line of sight) The Z-offset changes by 10 mm per click. Double click *Z offset* in the property list to set up an exact offset value.
Property list 	Exact values can be entered by double clicking an entry in the property list. Selecting the geometry or the tag point the camera shall be attached to.  Offset adjustment and -rotation with respect to the camera reference system.

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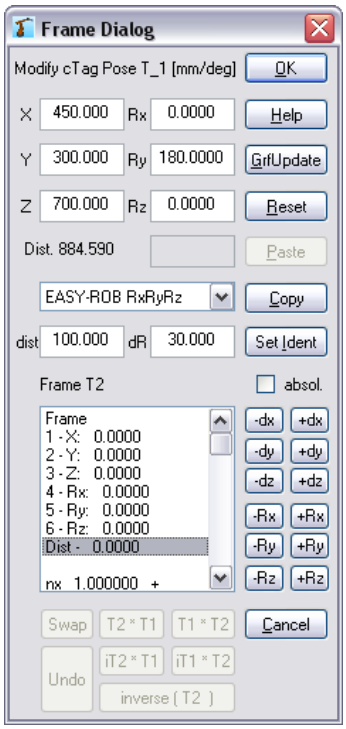
Frame Dialog

The frame dialog is used for entering cartesian coordinates. To redefine the 3D geometries, the base or the TCP of the robot for example, the values for the actual X-, Y- and Z-values with their orientation are shown in the *Frame Dialog* and can be edited. The new coordinates are instantly visualized without closing the dialog which makes fast verification of the values possible. Furthermore the actual positions can be stored for other usage. Even multiplying and inverting homogenous matrices (frames) is possible.

The *Frame Dialog* is one of the central user dialogs in EASY-ROB™ and is used very often when working with the program.



OK	Closes the *Frame Dialog* and accepts the entered coordinates.
Help	Short help for the *Frame Dialog*.
GrfUpdate	Updates the 3D scene according the new coordinates. *"GraficUpdate"* is useful for a fast verification of the coordinates without leaving the dialog.
Reset	Reset to the original coordinates before the *Frame Dialog* was opened.
Copy	Copies the coordinates to the frame list (clipboard).

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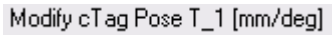
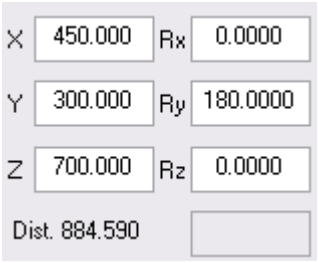
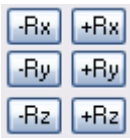
	Copy coordinates from the clipboard.
	Sets coordinates and orientation to null and identity.
	Closes the *Frame Dialog* and discards all changes made.
	The information line shows to which object the coordinates apply to.
	Coordinate fields for position and orientation. Formulas are also allowed for example „200.0+57.3*pi/180“, „0.2*m2mm“, „100*sin(45*RAD)“, „a1=5;8*a1“ or „3*a1“ The formula will be calculated when the cursor leaves the field so simply select another one. *Dist.* calculates the amount of x-, y- and z-value.
	This is a delta value that a coordinate value should be incremented or decremented by.
	The position coordinate x, y, or z will be incremented / decremented by the value of "dist" with the following buttons: - -dx or +dx for x direction - -dy or +dy for y direction - -dz or +dz for z direction This change is absolute or relative. The 3D scene is automatically redrawn for verification.
	The orientation coordinate Rx, Ry, or Rz will be incremented / decremented by the value of "dR" with the following buttons: - -Rx or +Rx for x direction - -Ry or +Ry for y direction - -Rz or +Rz for z direction This change is absolute or relative. The 3D scene is automatically redrawn for verification.
	Changes are absolute in the reference system $T_{new} = dT_{(dist,dR)} * T_{old}$
	Changes are relative $T_{new} = T_{old} * dT_{(dist,dR)}$

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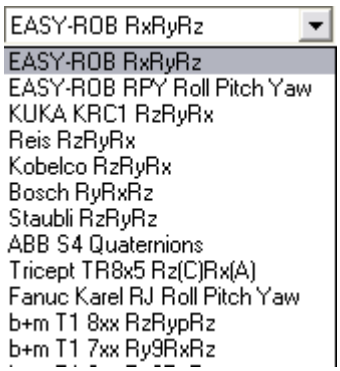
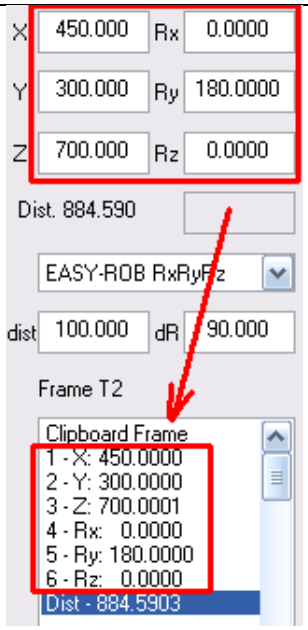
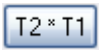
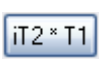
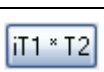
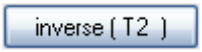
	Setting the orientation rule and conversion of the actual orientation into other wrist configurations. e.g.. • ABB S4 Quaternions • KUKA KRC1 RzRyRx • Stäubli RzRyRz • Fanuc Karel RJ Roll Pitch Yaw • Tricept TR8x5 Rz(C)Rx(A) 
	Frame list for matrix calculations. For calculations with the actual coordinates (named T1) they must be copied into the clipboard first (there named T2). You can now invert the homogenous matrix T2 or make other calculations with another actual coordinate T1. The result in T2 can be copied back to T1 and there be used for further processing. **Hint:** A double click in the frame list for example on „1 - X: 1000.000“ transfers the value into the X-coordinate. The same can be done with the Y- and Z-coordinates and the orientation coordinates.
	Swaps matrix T1 and matrix T2.
	Resets the matrix T2 to its original values.
	Matrix multiplication $T_2 = T_2 * T_1$
	Matrix multiplication $T_2 = T_1 * T_2$
	Matrix multiplication $T_2 = T_2^{-1} * T_1$
	Matrix multiplication $T_2 = T_1^{-1} * T_2$
	Matrix inversion $T_2 = T_2^{-1}$

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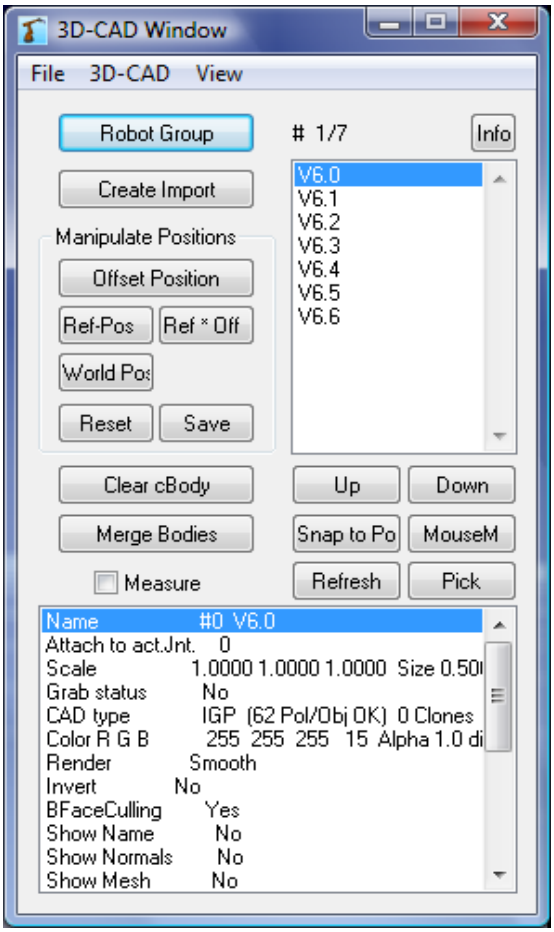
3D CAD Window

The 3D-CAD window is used for importing and positioning 3D geometries and for setting colors and other attributes.

By a single click on the button the 3D-CAD window will show up.



body list	The body list shows all geometries of the actual group by name. Clicking twice on a list element will show up detailed information about the geometry.

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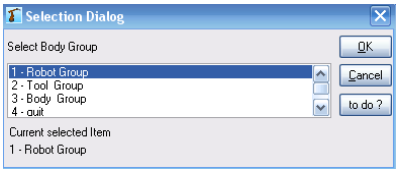
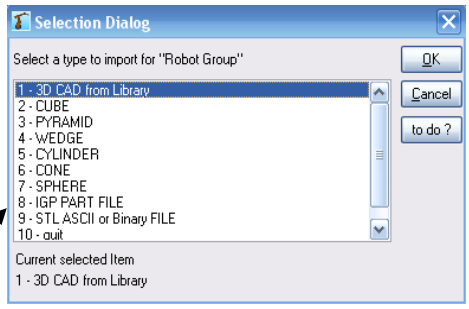
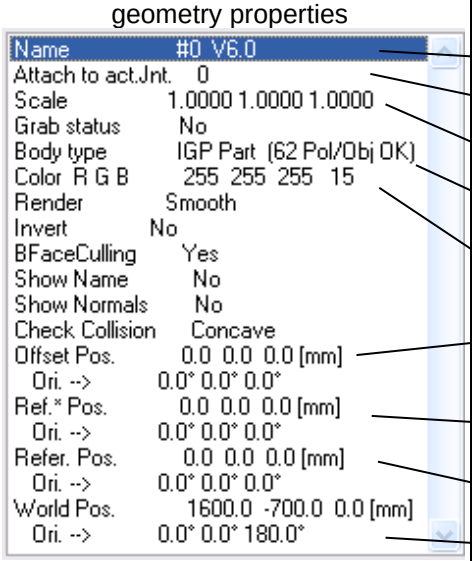
Robot Group group selection	EASY-ROB™ provides three groups for the creation of bodies. They can be separately stored and edited. File → Save → Robotfile Toolfile Bodyfile 
Create Import create / import a body	Bodies can be created or imported. Import from EASY-ROB™ 3D-CAD Library create primitive bodies Import existing 3D-CAD Files. VRML I + II (97) Data have to be in IGP® format 
geometry properties 	The properties of the actual geometry can be changed by a double click. #[number] name [attached to axis] (0 = robot base, 1-12 = active axis 1, otherwise = passive axis) scale value of the geometry type and state GB color value offset position and -orientation product of reference position and offset position reference position and reference orientation world position and -orientation
save / reset changes Reset Save	If the position of the actual geometry has been changed then this can be stored as home position by clicking *Save.* *Reset* discards all changes.

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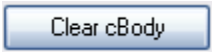
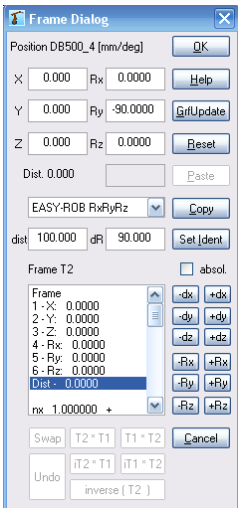
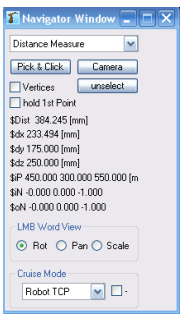
	Delete the actual geometry from the 3D-scene
	Merge the selected body (see chapter „Import of VRML“ in this document)
	Move the part up or down in the listing
position / orientation of the geometry	The position and orientation of the actual geometry can be changed in the frame dialog. Rotates and translates the body in reference to the world coordinate system  Rotates and translates the body in reference to its own coordinate system. After every rotation about x,y or z the coordinate system has a new orientation.
	Offset position T_{off}
	Reference position T_{Ref}
	Product of reference position and offset position $T_{Ref} * T_{off}$
	Set position with respect to the world origin
click the check box „Measure“ to open the Navigator window	Hint: Values measured with the Navigator window can be used for further calculations. For example the value 877.337 is stored in the system variable *$dx* so you don't have to transcribe or remember the value. 

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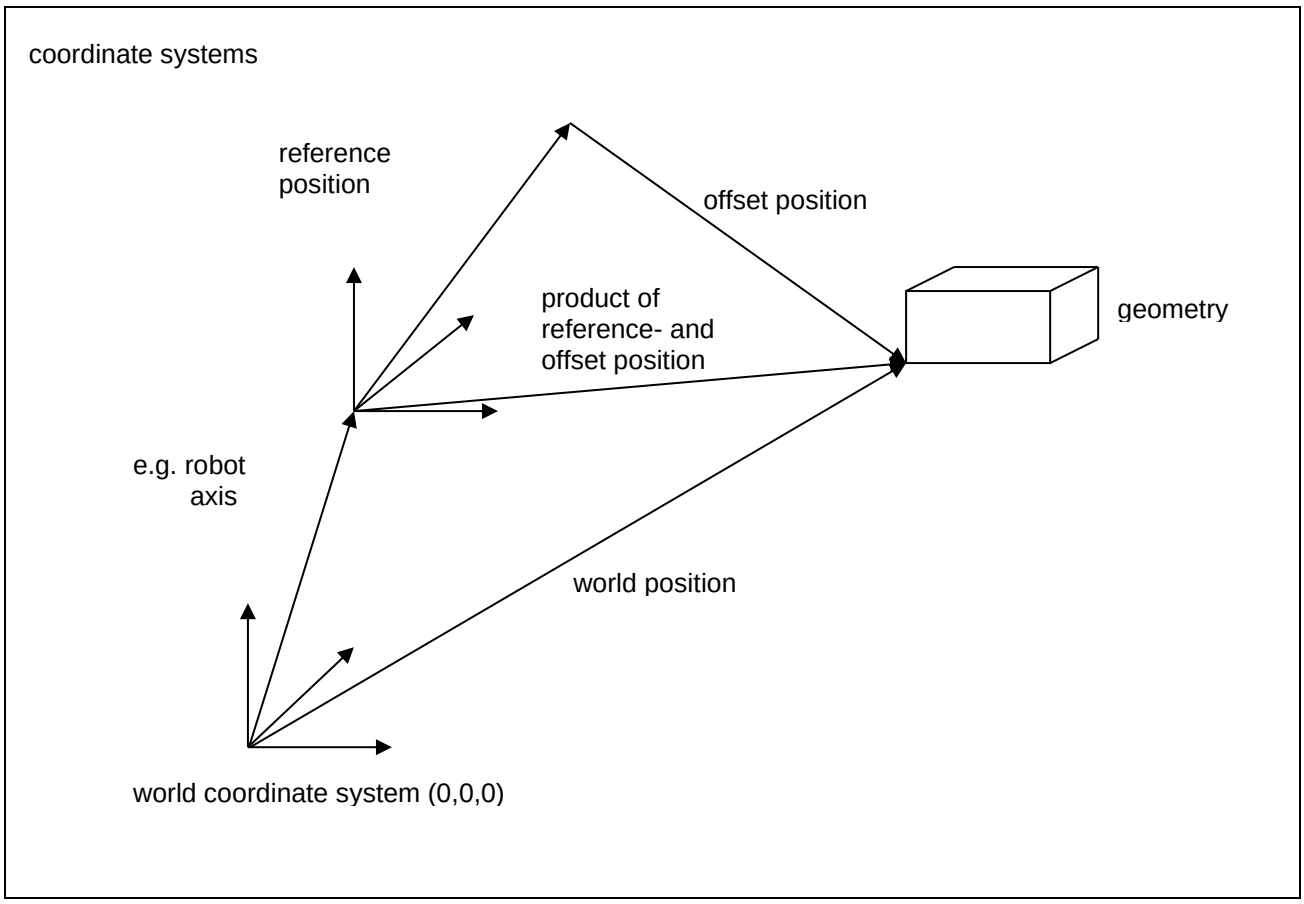

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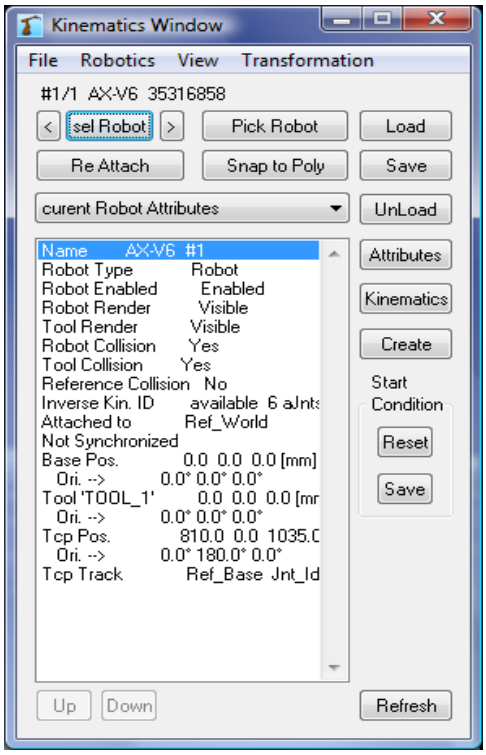
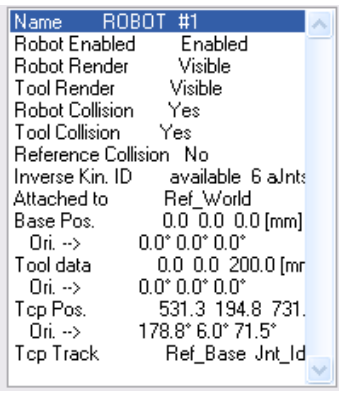
Kinematics Window

The Kinematics Window enables the user to handle robots in the workcell or respectively modify the properties of the robots.

To activate the Kinematics Window just use the menu *Robotics / Kinematics Window* or use the shortcut „Ctrl+K“





The list contains information about the current state of the selected robot e.g.:

- name
- attach to – Status
- position / orientation of the base, the TCP and the tool

Tip:
To change the values just double click onto a value.

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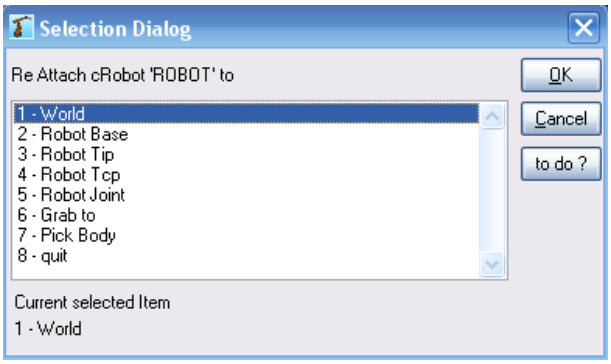
	Select a robot With the buttons < and > you can switch between the robots sel Robot opens the following dialog with a list of all loaded robots:
Re Attach	Re-Attach of a robot Opens the following dialog:  to re-attach the current robot to another „link“
Pick Robot	Select a robot Function to select a robot by mouse click in the workcell
Load	Load new robot
Save	Save current selected robot
Snap to Poly Snap to Vertex	Snap robot to the chosen Polygon or Vertex

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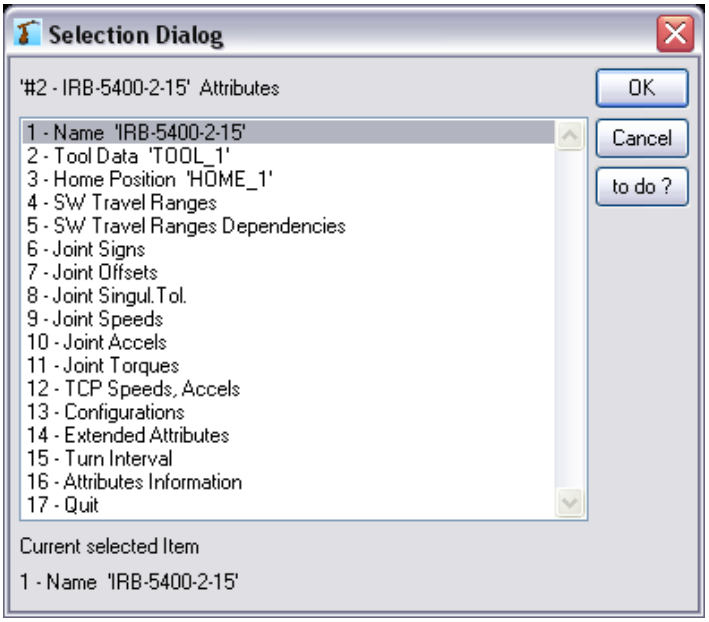
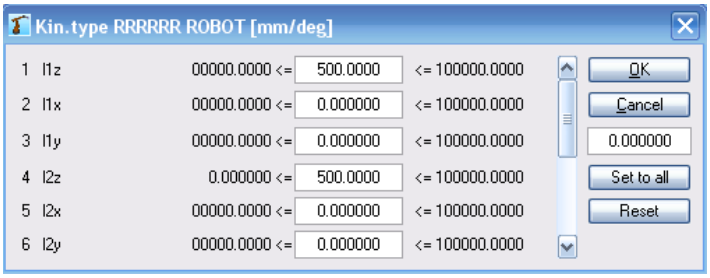
UnLoad	Remove the robot from work cell
Attributes	Attributes of the robot Opens the following dialog to modify the listed properties. 
Kinematics	Kinematics of the robot Opens the following dialog:  to modify kinematics properties .
Create	Creates a new robot

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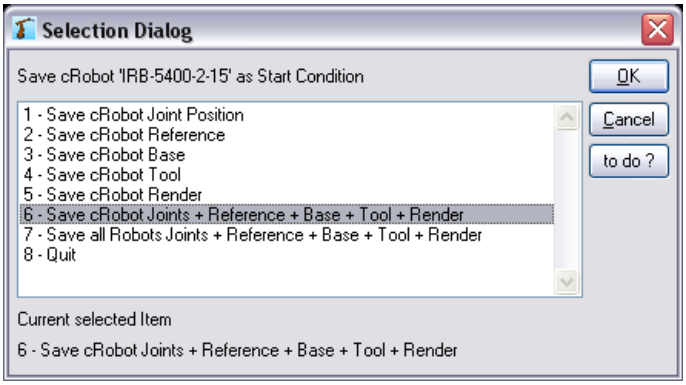
	Save and reset Start Conditions 
	Refreshes of the data in the status list

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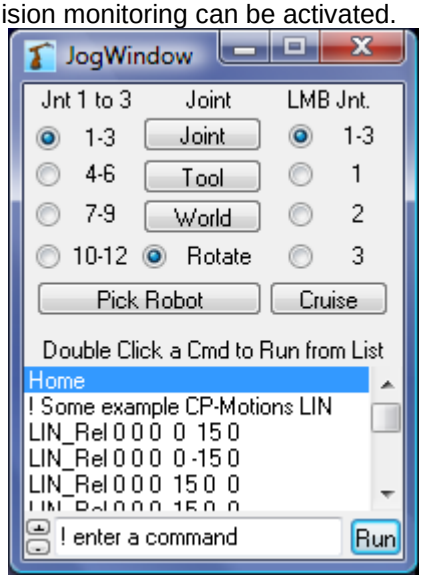
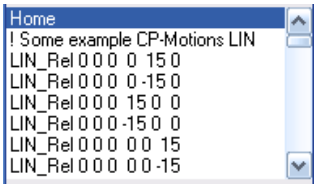
Jog Window

The JogWindow is used to jog or manipulate the robot with a 3 button mouse in individual axes or the TCP in reference to tool- or world coordinates in a fast and comfort way.
In addition the travel ranges and collision monitoring can be activated.





The list contains a few ERPL- and ERCL example commands,

like movement commands LIN, LIN_REL, CIRC ... etc.
ERCL - commands Color, Track, Tag … etc.

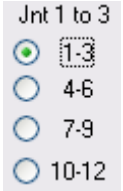
More commands can be added to the list.

By input or double click on a command in the list the command is transferred to the command line.

With + the command is inserted at the marked position.

With - the command is removed from the list.

With Run the command in the command line is executed.



The axes 1-3 are moved with a 3 button mouse by pressing a button and moving the mouse in the 3D-scene..

Left mouse button	axis 1
Middle mouse button	axis 2
Right mouse button	axis 3

With the TAB key the axes 4-6, 7-9 and 10-12 are selected.

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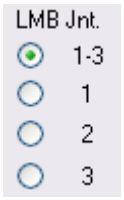
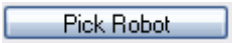
	Assigning the axis to LMB
	Jog the axis
	TCP-movement related to tool coorsys → *TCP Tool* Mouse-Mode. This button is equivalent to the Short-Key
	TCP-movement related to world coorsys → *TCP World* Mouse-Mode. This button is equivalent to the Short-Key
	Switch to rotational TCP-movement
	Selection of the robot
	Switch on the Cruise Mode

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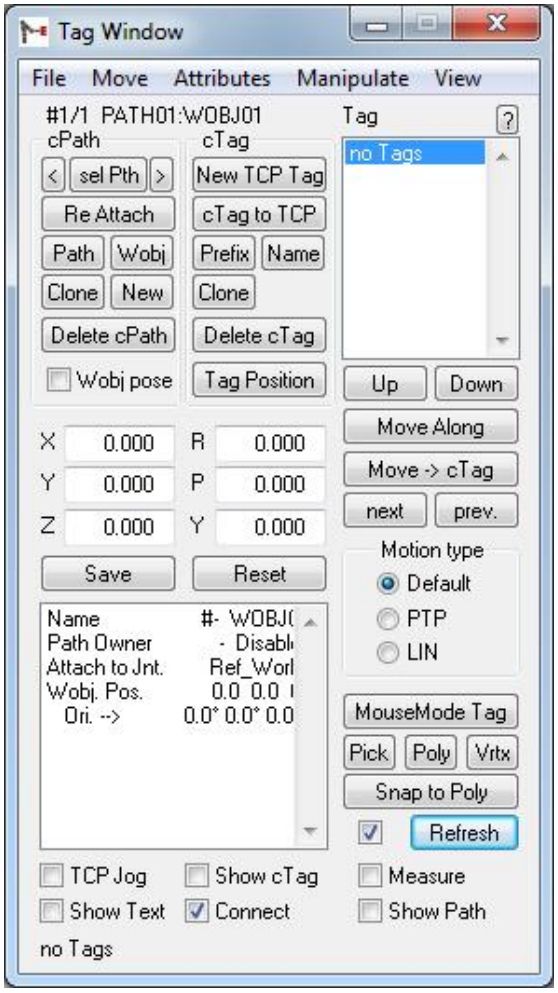
Tag Window

In the tag window paths are being created and edited independent of each other and placed in the space. A path consists of multiple tag points and can be attached to a geometry, a robot base or tip. If the geometry or the robot position changes, the attached path is moved simultaneously. You can select single tag points or a group of tags. As usual you can use the short keys „Ctrl + A“, „Ctrl + C“, und „Ctrl+ V”.

The Tag Window can be accessed by clicking *SEL TAG.*



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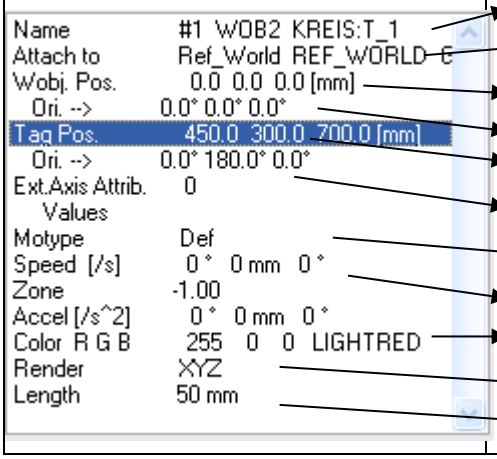
Tag Window

TCP Jog	The robot jumps to the selected tag point.
Show cTag	The tag points are connected with color-marked arrows. • violet: from the reference system to the Wobj-frame • green: from the Wobj-frame to the 1st tag • yellow: from the 1st tag to the following (2nd) Tag etc. • red: from the last but one tag to the last tag
Measure	Opens the Navigator dialog → „Pick a Tag“ mode is active
Tag list	In this list all tags of the actual path are shown. With a double click on a tag the robot will move toward it.
Pick Tag Create tag points attached to geometry.	Tag points attached to geometry can be created. Left mouse button: select position on the geometry Middle mouse button: create new tag point on the TCP Right mouse button: place selected tag point The position on the geometry is shown by a pink arrow.
Up Down	Moves the selected tag point in the list up and down one position.
Move Along	Moves the robot tag to tag along the path. The motion mode is specified by the tag point.
Move -> cTag	Move towards selected tag point, → double click on a tag in the tag list
next prev.	Selection of next or previous tag point.
Motion type Motype PTP LIN Motion type of the robot	Clicking the button Move -> cTag makes the robot move toward the selected tag. The motion mode can be specified as follows. Motype Attributes as described in the tag properties PTP PTP mode (Point to Point, synchro PTP) LIN LIN mode (linear)
Tag point properties	A property can be edited in a new dialog by double clicking on it.



#[tag number] [world object name] [path] : [prefix] _ [tag name]
The Body the path is attached to
Position of the Workobject-frame
Orientation of the Workobject-frame
Position of the tag in respect to the Workobject-frame
Orientation of the tag in respect to the Workobject-frame
Motion mode of the tag
Velocity in tag point „0“ → undefined
Color of the tag
Render type
Size of the shown tag coorsys

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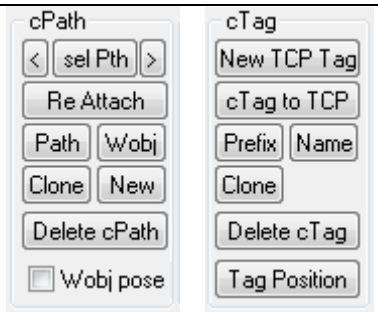
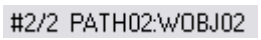
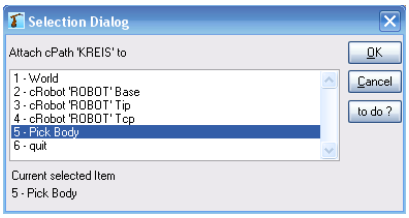
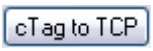
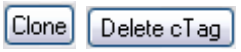
Tag Window

	The position and orientation of the marked tag or of the Workobject-frame can be entered or edited. Corresponds with a double click in the tag point-property list „TagPos.“
	Creating, editing, removing and selecting paths. „ReAttach“ → Attach path to geometry or robot.
	# [path number/path count] [path name] : [Workobject name]
	Select a path
	Attach the path to a geometry or a robot If the geometry is moved the robot moves simultaneously. 
	Change the name of the path or workobject
	Clone Path, new path and delete the current path
	A new tag is created at the current TCP position. Corresponds with a middle mouse button click in the „Pick a Tag“ mode
	Current Tag will be moved to TCP of cRobot
	Change the [prefix] _ [tag name]
	Clone or delete current tag
	Open Frame-Dialog to edit tag- oder workobject-positions

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Tag Window

MouseMode Tag	Activates MouseMode „sel Tag“ The cTag cursor appears
Pick	Pick a Tag in 3D-Scene → cTag
Poly Vrtx	Pick a polygon or a Vertice with LMB Middle mouse button: create new tag point on the TCP Right mouse button: place selected tag point to position
Snap to Poly ←→ Snap to Vertex	cTag will be snapped to Polygon or Vertex
Refresh	Referesh of Tag-Window data

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Procedure for creating a path and attaching it to a geometry

Create a geometry	3D-Cad Window
Select a path	If necessary change the name of the path and the Workobject-frame.
Create a tag on the TCP	New TCP Tag The first tag will be placed at the actual TCP-position.
Re Attach	Re Attach Selection *5 – Pick Body* Click the geometry, it will be framed with a bounding-box. All subsequent created tags of the path are attached to the geometry and simultaneously move with it. The geometry can part of the robot/machine, the tool or the work piece.
Pick a Tag	Pick Tag Additional tag points can be created by clicking on the geometry. Left mouse button: select position on the geometry Middle mouse button: create new tag point on the TCP Right mouse button: place selected tag point With a right mouse click the current selected tag point will be placed on *the* position, which was selected before with the left mouse button (Pick & Click). The middle mouse button is merely needed for adding a further tag point on the path. If the center of a polygon was selected, then its normal vector will be taken over as Z-component of the tag point. The actual TCP-position will be used for calculating the X- and Y-components of the tag point. If a point of the geometry was selected, then the current TCP orientation will be used for the orientation of the tag point. **Hint:** Move the robot to the first tag point and adjust it.

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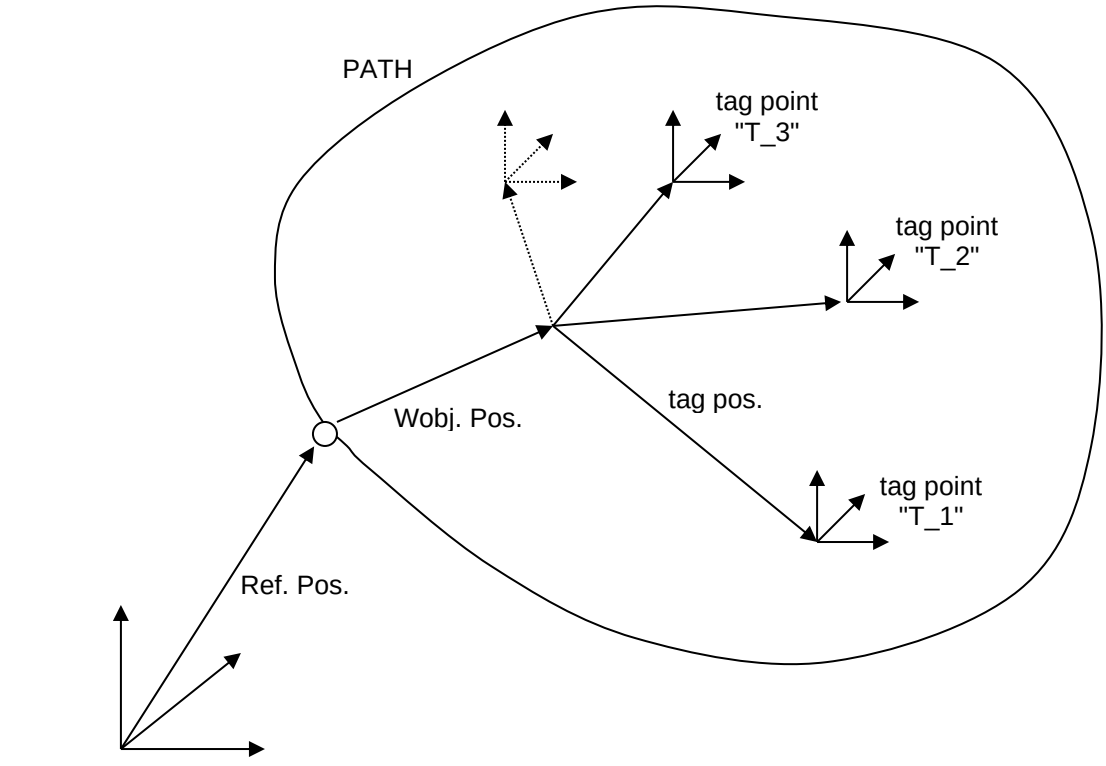
Coordinate- and reference systems of a path

Ref. Pos.	**Reference position** • world coordinate origin • robot base • robot tip (muff) • robot TCP • body The path reference position is always described in world coordinates and depends on which object the path is attached to. The values for the reference position change when for example the geometry or the robot base is moved.
Wobj. Pos.	**Workobject-position** „Wobj.Pos.“ The position of the Workobject is described with respect to the reference position. With *Show cTag* activated the link between the reference position and the Wobj.Pos. will be shown in violet.
Tag Pos.	**Tag positions** All tag positions of a path are described with respect to the position of the Workobject. With *Show cTag* activated the tag points will be connected with yellow arrows. The arrow to the 1st tag is green, the one to the last tag is red.



world coordinate system (0,0,0)

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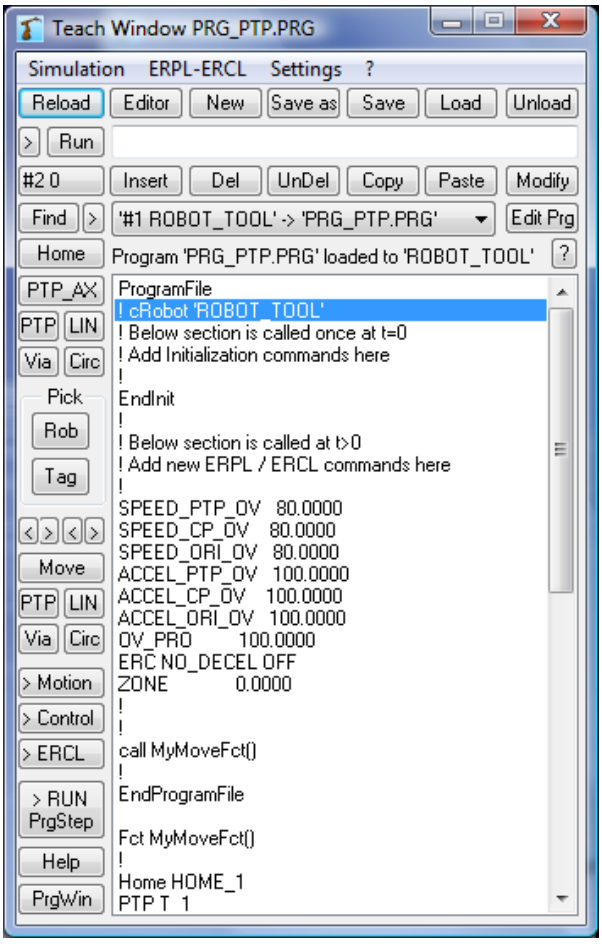
Teach Window

Using the *Teach Window* you can easily create accurate simulation programs in ERPL - the EASY-ROB™ Program Language and ERCL the EASY-ROB™ Command Language. The desired motion- and simulation commands are automatically inserted and can be executed line by line for testing. After storing the program file, the whole program can be simulated.



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Editing the actual program file	
Reload	Discards program changes by simply reloading the file.
Editor	Loads the actual program file in the editor specified in the configuration file „config.dat“.
New	Start with a new, empty program.
Save as	Stores the current content of the window in a program file.
Save	Overwrite the current file with the actual content of the program window.
Load	Load a program file.

Unload	Unload the current program
?	Online help for the Teach Window.
Edit line for command execution	
ERC TRACK ON	Edit line with the ERCL command „ERC TRACK ON“ for switching on the TCP trace.
>	Writes the entered command at the actual position in the source code window. Overwrites an existing code line at the position.
Run	Executes the command in the edit line as single step.
Creating / editing a command line	
#3 0	Shows the actual line number in the source code window. By clicking the button you can enter a new line number.
#3* 0	A star after the actual line number says that its contents where modified.
Insert	Inserts the code in the edit line at the marked position in the source code window. The commands below will be moved down.
Del	Cuts the selected program code. The code below will be moved up.
UnDel	Reinserts the previously cutted code and moves down the rest of the code.
Copy	Copies the currently selected code to the clipboard.
Paste	Inserts the code from the clipboard at the marked line. The code below will be moved down.
Modify	Copies the selected line to the edit line for editing or execution.
Find >	Search for a text the next position of it

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Creating motion commands with respect to the actual TCP position	
Home	Moves the robot to its home position.
PTP_AX	Synchro-PTP motion command axis specific
PTP	Synchro-PTP motion command for the actual TCP position.
LIN	LIN motion command for the actual TCP position.
Via	VIA motion command for the actual TCP position. This means the point needed for the circle interpolation.
Circ	CIRC motion command for the actual TCP position.
Creating motion commands on tag points	
Pick Rob Tag	Select a tag point by clicking it with the left mouse button in the 3D scene. The selected tag is shown with a pink arrow. Name and path of the actual tag are displayed in the main windows status bar.
< > < >	Selection of paths and tags. The first two <> arrows cycle through the paths, the second <> arrows cycle through the tags. Name and path of the actual tag are displayed in the main windows status bar.
Move	Moves the robot to the actual tag using the motion type of that tag (see *Tag Window*).
PTP	Selects motion type synchro-PTP for the actual tag.
LIN	Selects motion type LIN for the actual tag.
Via	The actual tag will be stored as an intermediate point for a CIRC motion.
Circ	Selects motion type CIRC for the actual tag. The robot will move through the VIA-point.
Programming further motion commands	
> Motion	Opens a dialog with further motion commands. e.g. PTP_Rel, LIN_Rel.... etc. Explanations for these commands can be found in the online help in: *Robot Motion Command*

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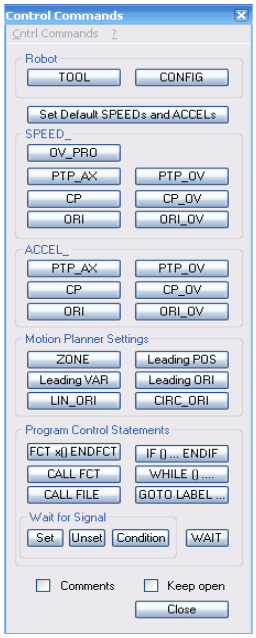
> Control	Opens a dialog with further control commands. e.g. Speed_CP, ACCEL_CP.... etc. Explanations for these commands can be found in the online help in: *Robot Control Command* 
> ERCL	Opens a dialog with further EASY-ROB™ commands. e.g. ERC COLLISION ON, ERC TRACK OFF... etc. Explanations for these commands can be found in the online help in: *ERCL - EASY-ROB™ Command Language*
> RUN PrgStep	Run single program step
Help	Help to Teach Windo
PrgWin	Opens program window

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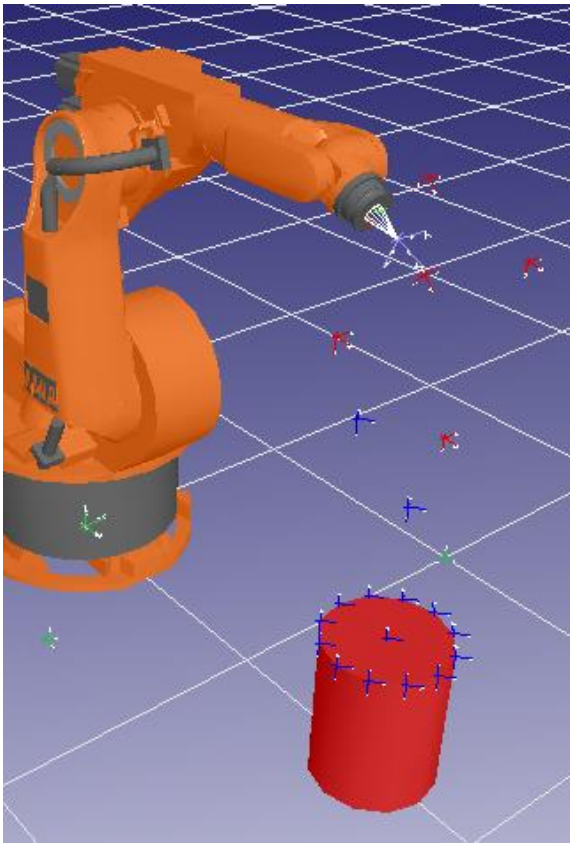
Example: „KR30-2-TAGS.PRG“
in file „..\ EASY-ROB \ Tutorial \ Functional \ KR30-2-Tags.cel“

```
ProgramFile
! cRobot 'KR30-2'
! Below section is called once at t=0
! Add Initialization commands here
EndInit
!
! Below section is called at t>0
! Add new ERPL / ERCL commands here
! Set Default SPEEDs and ACCELs
SPEED_PTP_AX    40.0000  40.0000  40.0000  40.0000  40.0000  40.0000
ACCEL_PTP_AX    40.0000  40.0000  40.0000  40.0000  40.0000  40.0000
SPEED_CP         0.1000 0.0
ACCEL_CP         1.5000
SPEED_ORI       20.0000 0.0
ACCEL_ORI       40.0000
OV_PRO         100.0000
ERC NO_DECEL OFF
ZONE             0.0000
! ---------

ERC TAG_COORSYS OFF
ERC ROBOT_BASE     0 0 0 0 0 0
Home 1

ERC TRACK ON
ERC COLOR TRACK  GREEN
ERC TAG_COORSYS ON
ALONG PATH01
ERC COLOR TRACK  BROWN
ALONG KREIS

ERC TAG_COORSYS OFF
ERC ROBOT_BASE     1 1 0 0 0 -90
ERC COLOR TRACK  BLUE
ALONG PATH01 B_1  B_5
ERC MOVE BODY CYL      0.5000     -0.5  0  -25.0000     0 0
ERC TAG_COORSYS ON
ALONG KREIS 2 14
ERC MOVE BODY CYL      Path03:W_3
ALONG KREIS

Home 1

ERC TAG_COORSYS OFF
ERC MOVE BODY CYL      Path03:W_4
ERC ROBOT_BASE     Path03:W_0

ERC TAG_COORSYS ON
ERC COLOR TRACK  YELLOW
MOVE Kreis:B_1 3 5 7 9 11 13 15  B_16 Path01:B_5 2 B_1 Path03:W_HOME
MOVE Path03:W_2 2  3 6

Home 1
!
EndProgramFile
```



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CAD-Import Window

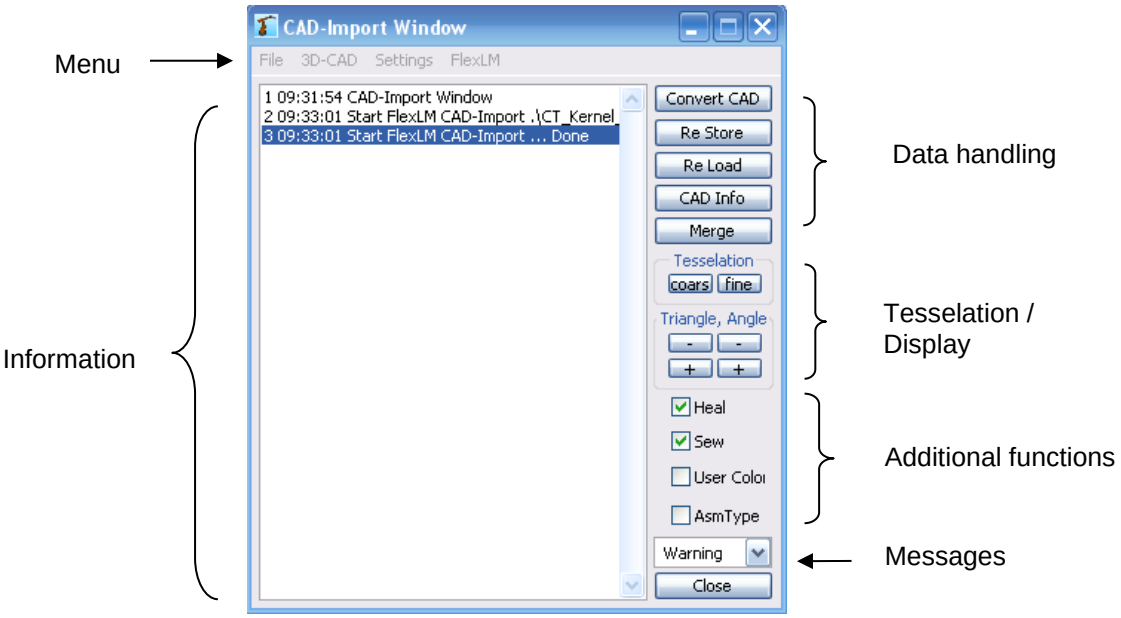
EASY-ROB™ uses the 3D_Evolution® API of CT Core Technology GmbH to import CAD data. The CT Kernel_IO was especially designed for CAD data import and allows importing and optimizing CAD data formats generated by different CAD-Systems.

Please read first the chapter „CAD Import (CT Kernel_IO) into the Installation-Guidelines !

After converting CAD geometry it will be loaded automatically into the CAD Preview. Depending on the requirements the tessellation of the workpiece can be manipulated for e.g.data reduction.
„Restore“ will convert the geometry again and will load it for the examination automatically into the CAD Preview.
For further optimization functions like „merge“, „healing“ and „sewing“ are available.

All required functions are provided in the CAD-Import Window.

Open the CAD-Import Window through the menu „3D-CAD | Open CAD-Import Window“.



File | Load	Load and convert data into the workcell
File | Save	Saving the CAD data and the CAD-Import message
File | Unload	Unload the CAD data

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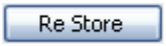
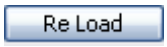
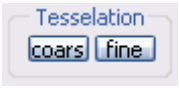
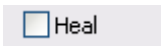
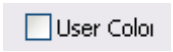
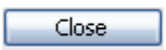
CAD-Import Window

3D-CAD	Functions to scale, to set the position, to show edges, to merge and to show the object information
Settings	Show, change and reset the tessellation
FlexLM	Start, stop the FlexLM for the CAD-Import show the logfile and the license
	Load and convert CAD Data and load it automatically into the CAD Preview
	Convert again a loaded CAD geometry after changing tessellation parameter and load it automatically into the CAD Preview
	Reload the converted IGP file
	Show the object information like file name and path, number of objects, lines, vertices, polygons, scaling and position
	Merge will reduce the number of objects and will increase the number of polygons per object
	Change the Tessellation of the geometry (Solids)
	Change the size of the polygons and the angle between the polygons (Solids)
	„Heal“ the object. Open geometries will be closed.
	“Sew” edges which are within a tolerance
	Original colors will be overwritten and it possible to change them afterwards in EASY-ROB.
	Consideration of the assembly structure (no function yet)
	Warning level; “verbose“, „normal“ and „silent“
	Close the CAD-Import Window

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Mini Tutorial

Creating Tags on 3D geometries

The following text will describe step by step how to create paths and tags on a face or at a vertex of a 3D geometry. Paths and tag points are attached to the geometry even if it changes its position.

The file *CreateTags.cel* will be used as an example.

Note:
Please read as well the operation reference for the *Tag Window* and the *3D-Cad Window* which will be used here.

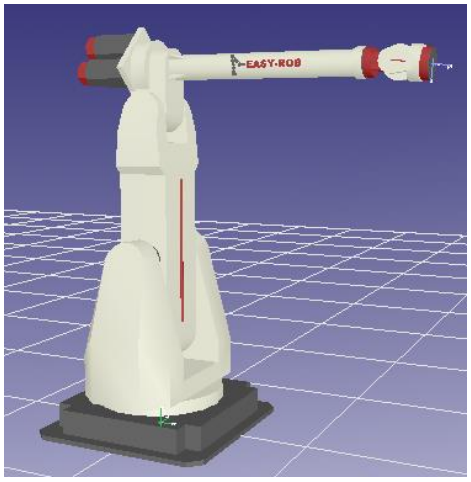
Step 1:

Load the robot from the TrainLib:

File / Load / Robot file

The ER431 will be used for this example.

../ EASY-ROB / TrainLib / ER431.rob



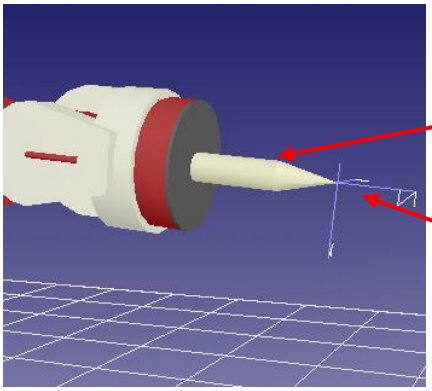
Step 2:

Load the tool from the TrainLib:

File / Load / Tool file

the example is: tool.tol

../ EASY-ROB / TrainLib / tool.rob



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Step 3:

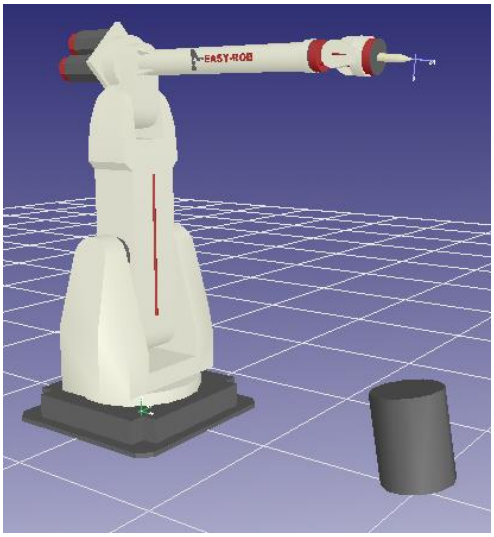
Create a cylinder (3D geometry) and position it.

metrics:

Radius	200 mm
High1	500 mm
Radius Top	200 mm
High2	500 mm

offset position:

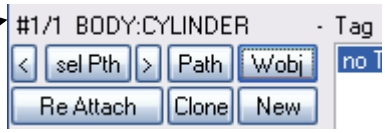
X	2000 mm
Y	0 mm
Z	50 mm
Rx	0°
Ry	-10°
Rz	0°



Step 4:

Name the path and the work object:

e.g. path: BODY
wobj: CYLINDER



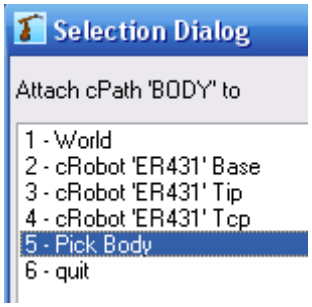
Step 5:

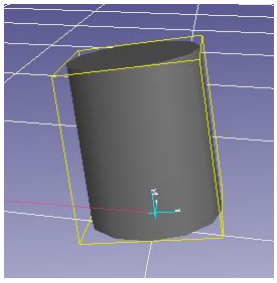
The new path should be assigned (attached) to the cylinder and move with its position.

Choose *ReAttach*
and *5 - Pick Body*
and then click on the cylinder.

The next question for “Keep World Position” answer with “No”.

The path with its tag points is now attached to the cylinder.





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Step 6:

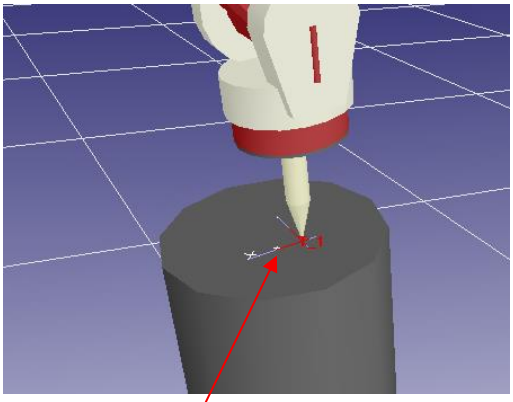
The cylinders coordinate system has another orientation than the coordinate system of the TCP.

To place the first tag point directly on the surface of cylinder cap

- activate *Pick a Tag* and left - click the designated face
- create a new tag on the robots TCP by clicking once with the middle mouse button
- assign the tag on the TCP the correct position on the cylinder by once clicking it with the right mouse button.

Double clicking the currently created tag point in the *Tag Window* causes the robot to move to this position.

left mouse button: select a position on the geometry
middle mouse button: create a new tag point on the TCP
right mouse button: place the tag point at the position of the geometry.



Aligning the tags to surface normal

Step 7:

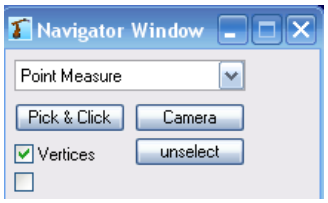
More tag points shall be created.

Open the *Navigator Window* :

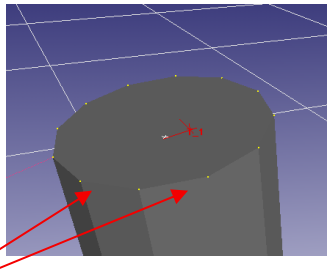
Step 8:

Selecting points on a geometry

Activate *Point Measure* and *Vertices* in the *Navigator Window*.



If *Vertices* is selected then the vertices of all 3D geometries are shown with yellow points and can be selected using the left mouse button.



Cylinder with *Vertices*

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Step 9:

To create more tag points with the same orientation as the first tag point the robot must first be moved to it.

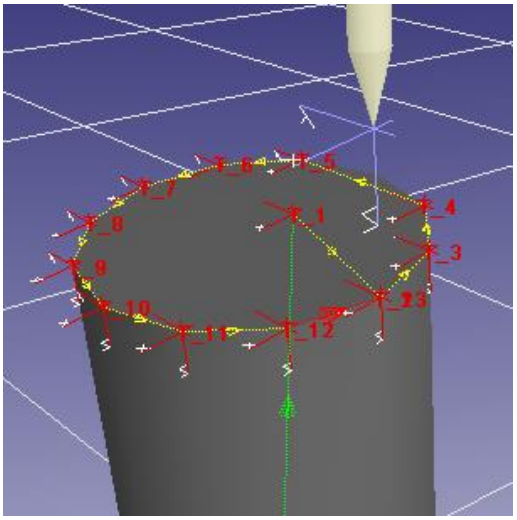
Now select a vertex on the cylinder with the left mouse button.

Create a new tag point on the robots TCP with the middle mouse button.

Assign the position on the cylinder to the new tag on the robots TCP by clicking once with the right mouse button.

The last operation will cause the tag to change its position from the robots TCP to the selected vertex on the cylinder.

left mouse button: select a position on the geometry
middle mouse button: create a new tag point on the TCP
right mouse button: place the tag point at the position of the geometry.



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Multi-KIN

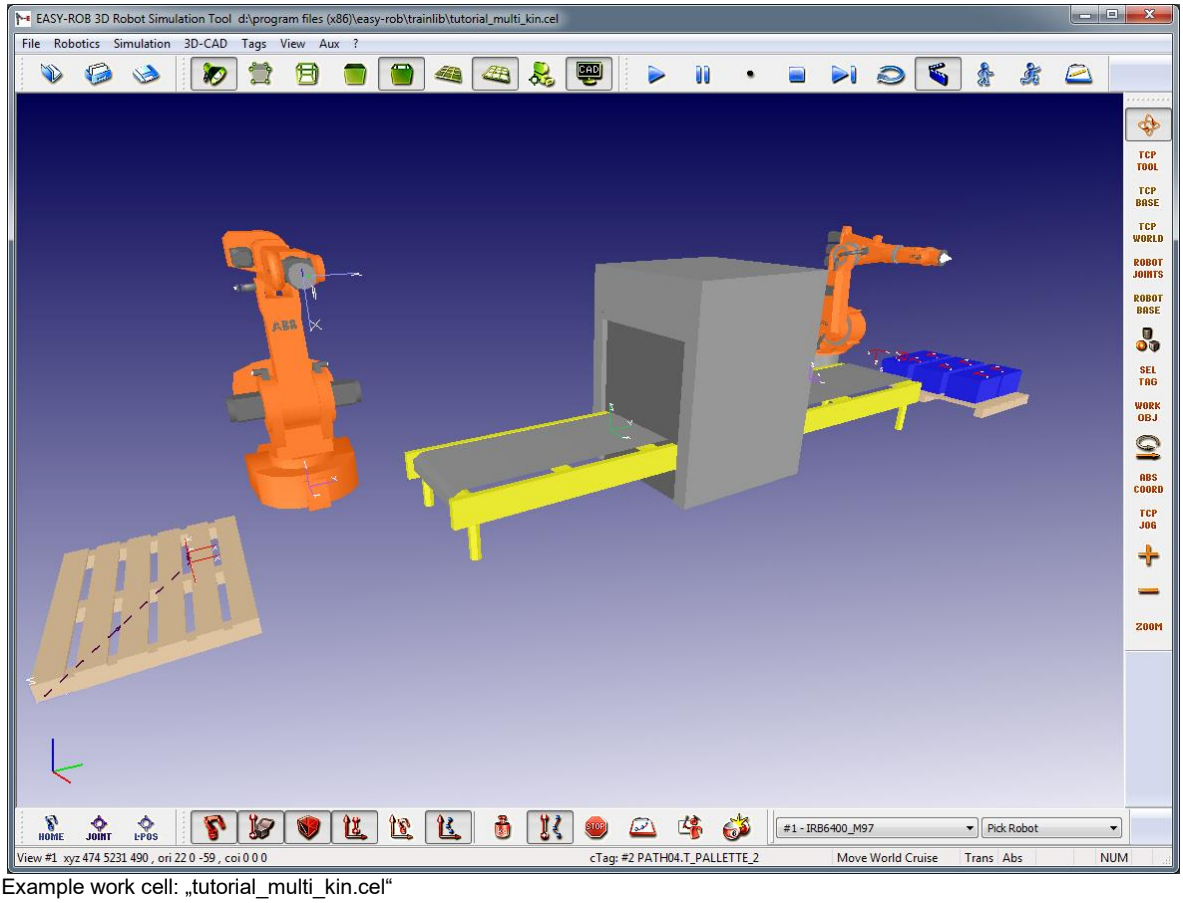
The option “EASY-ROB™ Multi-KIN“ enables you to load and run any number of robots (*.rob-files) with an inverse kinematics solution and more than three axis/joints into the work cell. Robots with up to three axis/joints such as conveyors, positioner or xyz gantries, don’t need Option “Multi-KIN“ and can be loaded as much as required.

With Option “Multi-KIN“, all robots / kinematics in a simulation are able to move to cartesian positions. That means that you can simulate both: processes between robots and processes between robots and e.g. conveyor in one simulation.

There is only one program in the work cell which contains all commands for all robots.

As an example see the work cell „tutorial_multi_kin.cel“ from TrainLib-directory.

Remark: Please also read the part “Teach Window“ in the general Operation Reference.



Example work cell: „tutorial_multi_kin.cel“

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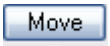
Working with Multi-KIN (Workcell „example_multi_kin.cel“)

	Please load the workcell „tutorial_multi_kin.cel“ from TrainLib
open Kinematics Window	with the menu *Robotics / Kinematics Window* or the keys „Ctrl+K“
select Robot	activate with arrow keys or „sel Robot“ the Robot „KR125-2“
open Teach Window	
new program	
activate line	set active line to 10
set Defaults	Set Default SPEEDs and ACCELs
activate 1. Robot	cRobot / SET / KR125-2
Home Position	
select Tag	select Tag Point T_BOX_1
move to Tag	move to Box
grab Box	GRAB [ ] / Grab „Bodyname“ / BOX_1
move away linear	LIN_Rel in Z by -1000 mm
select Tag	select Tag Point T_CONV_1
move to Tag	 move to T_CONV_1
release Box	Release [ ] / Release „Bodyname“ / BOX_1
move away linear	LIN_Rel in Z by -200 mm
Home Position	
move Box	Move [ ] / Move_Rel „Bodyname“ / BOX_1 in X=5200

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activate 2. Robot		cRobot / SET / IRB6400_M97
select Tag		select Tag Point T_BOX_G_2
move to Tag		move to Tag Point T_BOX_G_2
select Tag		select Tag Point T_BOX_G_1
move to linear		move to Tag Point T_BOX_G_1 linear
grab Box		GRAB [ ] / Grab „Bodyname“ / BOX_1
move away linear		LIN_Rel in Z by -200 mm
select Tag		select Tag Point T_PALLETTE_2
move to Tag		move to Tag Point T_PALLETTE_2
select Tag		select Tag Point T_PALLETTE_1
move to linear		move to Tag Point T_PALLETTE_1 linear
release Box		Release [ ] / Release „Bodyname“ / BOX_1
Home Position		
save Program		

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EASY-ROB™

Operation References

Overview about the program

ProgramFile	**Begin of the Program**
! cRobot 'KR125-2'	
! Below section is called once at t=0	
! Add Initialization commands here	
!	
EndInit	
!	
! Below section is called at t>0	
! Add new ERPL / ERCL commands here	
! Set Default SPEEDs and ACCELs	Def. of speed and accelaration
SPEED_PTP_AX 40.0000 40.0000 40.0000 40.0000 40.0000 40.0000	20 °/s
ACCEL_PTP_AX 40.0000 40.0000 40.0000 40.0000 40.0000 40.0000	40 °/s²
SPEED_CP 0.2500 0.0	250 mm/s
ACCEL_CP 1.5000	1500 mm/s²
SPEED_ORI 20.0000 0.0	20 °/s
ACCEL_ORI 40.0000	40 °/s²
OV_PRO 100.0000	programmed override in percent
ERC NO_DECEL OFF	No decelaration OFF
ZONE 0.0000	Zone value = 0
! ---------	!--------
ERC CURRENT_DEVICE SET KR125-2	activate Robot 1
Home 1	move to Home position
MOVE T_BOX_1	move to the Box
ERC GRAB BODY BOX_1	grab the Box
LIN_REL 0.0000 0.0000 -1.000 0.0000 0.0000 0.0000	move away linear by 1000 mm
MOVE T_CONV_1	move to Conveyer
ERC RELEASE BODY BOX_1	release the Box
LIN_REL 0.0000 0.0000 -0.2000 0.0000 0.0000 0.0000	move away linear by 200 mm
Home 1	move to Home position
ERC MOVE_REL BODY BOX_1 5.2000 0.0000 0.0000 0.0000 0.0000 0.0000	move Box relativ
ERC CURRENT_DEVICE SET IRB6400_M97	
MOVE T_BOX_G_2	activate Robot 2
LIN T_BOX_G_1	move to the Box
ERC GRAB BODY BOX_1	move to in linear mode
LIN_REL 0.0000 0.0000 -0.2000 0.0000 0.0000 0.0000	grab the Box
MOVE T_PALLETTE_2	move away linear by 200 mm
LIN T_PALLETTE_1	move to the Palette
ERC RELEASE BODY BOX_1	move to in linear mode
Home 1	release the Box
	move to Home position
EndProgramFile	**end of Program**

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Trajectory planning and -interpolation

The task of the trajectory planner is to plan the path from start location A to target location B in the cartesian space so that the interpolation produces the desired axis values for the robot at every time step. For the trajectory planner, the motion types Synchro-PTP, SLEW, LIN and CIRC are available. The below pages show the dependency between position interpolation and orientation interpolation and the resulting different time- and motion behavior.

To plan the path from A to B the following values must be set

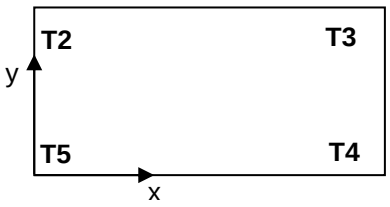
- Start- and target location with orientation
- Path- and orientation speed and accelerations
- Motion type
- Correlation between position- and orientation interpolation

In the following example 4 points are programmed on a rectangle whereas two at a time have the same orientation. The table shows the point- or tag coordinates T2 - T5.

tag	X [mm]	Y [mm]	Z [mm]	Rx [°]	Ry [°]	Rz [°]
T2	250	500	300	0	180	0
T3	1250	500	300	0	180	0
T4	1250	0	300	-45	180	0
T5	250	0	300	45	180	0

To move along the edge of the rectangle the motion type LIN is chosen. The results are different cycle times depending on the selected interpolation method for orientation and position. The next table shows the path distances and the difference between the orientation angles of the tag points.

from - to	distance	angle
T2 - T3	1000 mm	0°
T3 - T4	500 mm	45°
T4 - T5	1000 mm	-90°
T5 - T2	500 mm	45°



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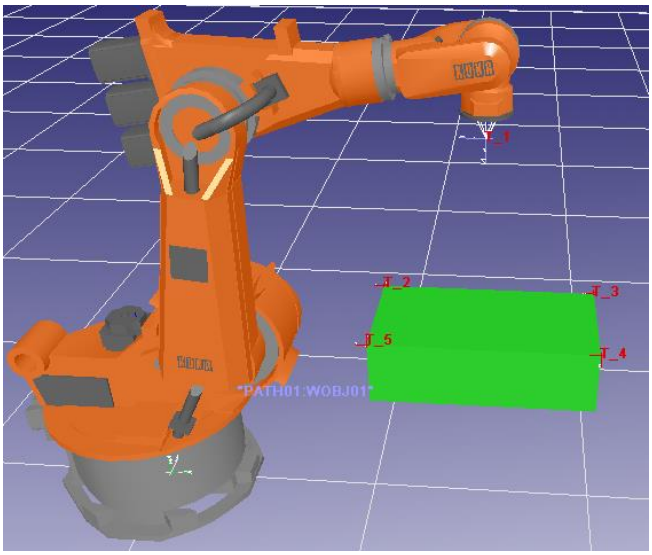
The example
motion_planning_01.cel and the program
motion_planning_01.prg
(from TrainLib) will show the results for a KUKA robot *KR 125-2*



ProgramFile

```
SPEED_PTP_AX  20.0000  20.0000  20.0000  20.0000  20.0000
20.0000
ACCEL_PTP_AX  10.0000  10.0000  10.0000  10.0000  10.0000
10.0000
SPEED_CP      0.2000 0.0
ACCEL_CP      0.1000
SPEED_ORI     10.0000 0.0
ACCEL_ORI     10.0000

ZONE          0.0000

LIN T_2
! ------------------------------------------
ERC STATUS_OUTPUT ON  1  fname.dat 0
! ------------------------------------------
LIN_ORI QUATERNION
LEADING_POSITION ON
!LEADING_ORIENTATION ON
!LEADING_POSITION VAR

call move()

ERC STATUS_OUTPUT OFF
! ------------------------------------------
PTP T_1
EndProgramFile
! ------------------------------------------
fct move()
SPEED_CP      0.2000 0.0
LIN T_3
LIN T_4
SPEED_CP      0.1000 0.0
LIN T_5
LIN T_2
ERC STOP
endfct
```

Beginning of the program
Definition of velocity and acceleration
20 °/s

10 °/s²

200 mm/s
100 mm/s²
10 °/s
10 °/s²

Zone = 0 -> exact move to the target

Move to start position T_2
! --
Write the x-, y- and z-position into the result file *fname.dat*
! --
Interpolation of the orientation by quaternion
1. Try orientation-interpolation-type: position
2. Try orientation-interpolation-type: orientation
3. Try orientation-interpolation-type: variable

Move along the rectangle over T_3, T_4, T_5 and T_2

Close the result file *fname.dat*
! --

End of program
! --
Beginning of the function move()
Move by 200mm/s to T_3 and T_4

Move by 100mm/s to T_5 and T_2

program stop
End of function move()

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The three orientation-interpolation types

Position and orientation are being separately planned when planning a path. This mostly results in different execution times. In practice it's desirable that position and orientation are synchronously interpolated. The type of interpolation for the orientation defines which of the planned execution times shall be dominant.

LEADING_POSITION ON	The execution time is defined by the position. Only if it's 0, the execution time resulting from the orientation is dominant. At small execution times the maximum orientation velocities can be exceeded what normally leads to higher joint velocities and -accelerations.
LEADING_ORIENTATION ON	The execution time is defined by the orientation. Only if it's 0, the execution time resulting from the position is dominant. At small execution times the maximum position velocities can be exceeded what normally leads to higher joint velocities and -accelerations.
LEADING_POSITION VAR	The time behavior is variable and defined by the current longer execution time. Except for singular positions an exceedance of the maximum joint velocities and -accelerations is avoided. Disadvantage: The process velocity is not constant. For this reason this type of orientation interpolation is not practical for applications like glueing, cutting, milling where the robot must move along a contour with constant velocity.

The total execution time „*total Time*“ for all three types of orientation interpolation are displayed in the *Robot IO Output* window „*current Motion Data*“.

The following execution times result along the contour of the rectangle.

LEADING_POSITION ON	28,5 s
LEADING_ORIENTATION ON	28,0 s
LEADING_POSITION VAR	29,5 s

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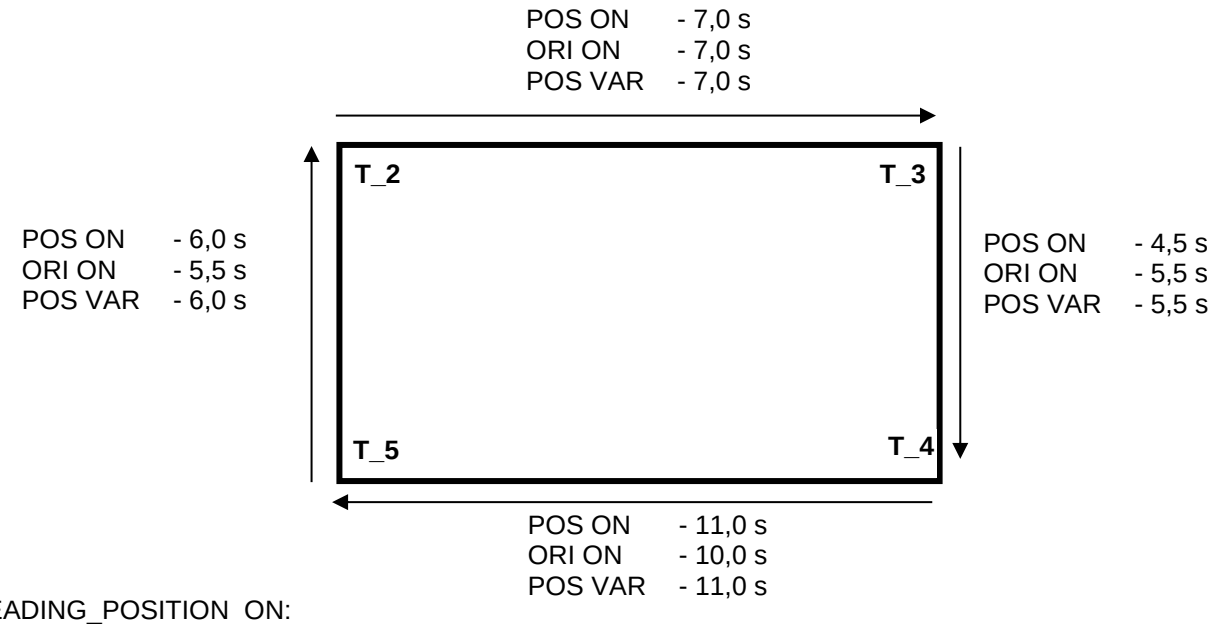

LEADING_POSITION ON:

a) For the path from T_2 to T_3 with s_{pos} = 1000 mm using a programmed velocity of v_{pos} = 200 mm/s and an acceleration of a_{pos} = 100 mm/s² a total time of t_{s_pos} = 7 seconds is needed.

Acceleration time	$t_{r1} = v/a_{pos}$ = 2,0 sec	$s_{r1} = v_{pos}^2/2a_{pos}$ = 200 mm
Deceleration time	$t_{r2} = v/a_{pos}$ = 2,0 sec	$s_{r2} = v_{pos}^2/2a_{pos}$ = 200 mm
Constant moving time	$t_c = (s_{pos} - s_{r1} - s_{r1})/v$ = 3,0 sec	
Total moving time	$t_{s_pos} = t_{r1} + t_c + t_{r2}$ = 7,0 sec	

b) For the path from T_3 to T_4 with s_{pos} = 500mm we get a total time of t_{s_pos} =4,5 seconds when doing the same calculation.
The angle change of □ = 45° results in a total time of t_{s_ori} = 5,5 seconds when using a programmed orientation velocity of v_{ori} = 10 °/s and an orientation acceleration of a_{ori} = 10 °/s²

Acceleration time	$t_{r1} = v_{ori}/a_{ori}$ = 1,0 sec	□ $_{r1} = v_{ori}^2/2a_{ori}$ = 5°
Deceleration time	$t_{r2} = v_{ori}/a_{ori}$ = 1,0 sec	□ $_{r2} = v_{ori}^2/2a_{ori}$ = 5°
Constant moving time	$t_c = (□ - □_{r1} - □_{r1})/v_{ori}$ = 3,5 sec	
Total moving time	$t_{s_ori} = t_{r1} + t_c + t_{r2}$ = 5,5 sec	

Case b) shows that the execution time t_{s_ori} = 5,5s is bigger than t_{s_pos} = 4,5s that result from the position calculation. In this case „LEADING_POSITION ON“ the smaller execution time will be used.

LEADING_ORIENTATION ON:

As a result of the inspection of case b) the execution time of the orientation interpolation will be 5,5 seconds that in this case are dominant and will be used.

LEADING_POSITION VAR:

When using this type of orientation interpolation always the maximum execution time is used. Because of this the total time will also be the maximum time.

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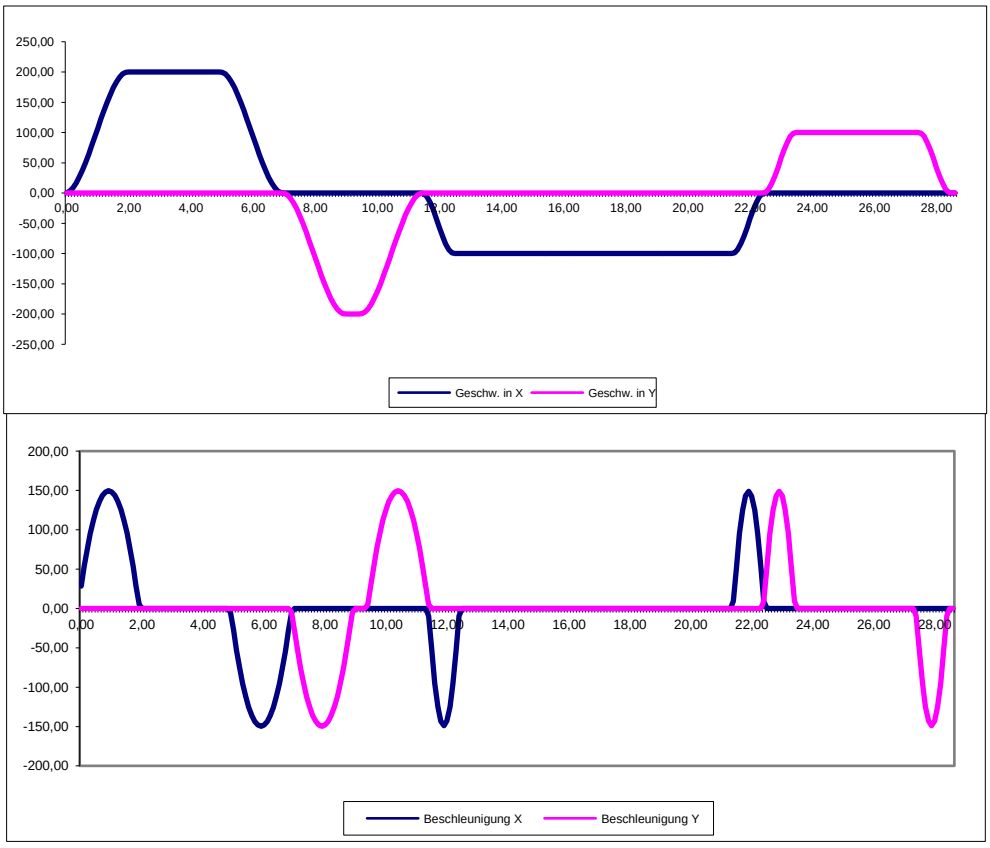
Result file „fname.dat“

The program line „*ERC STATUS_OUTPUT ON 1 fname.dat 0“* creates the result file „*fname.dat*“ in the actual folder. The cartesian positions, joint angles and joint angle velocities are recorded into that file with every simulation step. The program line *ERC STATUS_OUTPUT OFF* stops recording and closes the result file.

Explanation of the columns in the result file:

column	1 :	leading number
column	2 :	time
column	3 :	position X in mm
column	4 :	position Y in mm
column	5 :	position Z in mm
columns	6-11:	Joint angle of the axes 1 to 6 in [°]
columns	12-17:	Joint angle velocities of the axes 1 to 6 in [°/s]

The result file for the motion from T_2 to T_5 using the orientation interpolation type LEADING_POSITION ON has been imported into a spreadsheet to show the cartesian velocities and accelerations for X- and Y-direction in a chart.



The developing shows a continuous velocity- and acceleration profile without any jerk.

Note: The calculated maximum acceleration of 150 °/s² is about 50% higher than the programmed acceleration of 100 °/s².

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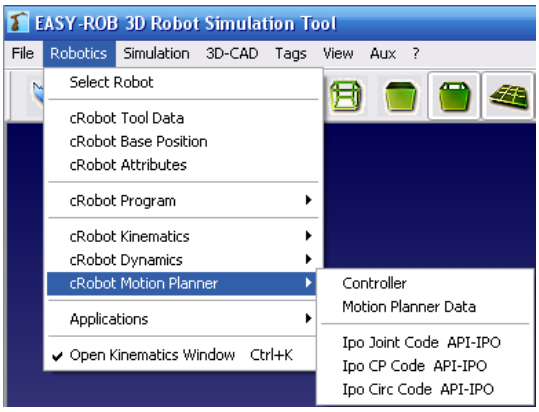
Note:

For calculating jerk-free path motions with EASY-ROB™ the following settings must be done.

Menu -> Robotics -> cRobotMotion Planner

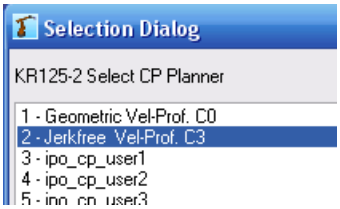
Ipo Joint Code
Ipo CP Code
Ipo Circ Code



Choose setting *"2 - Jerkfree Vel-Prof. C3"* for the *"Ipo CP Code API-IPO"* .

1 - Geometric Vel-Prof. C0 Velocity and jerk are not limited without a velocity profile.

2 - Jerkfree Vel-Prof. C3 Acceleration and jerk are continuous and limited when using a Jerk free velocity profile.



Example files:

motion_planning_01.cel
motion_planning_01.prg
fname.xls

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Usage of digital signals

In a simulation with more than one program in the workcell (Multi-Program) the devices have to communicate. In EASY-ROB™ this will be done by digital signals.
Basically it not very complex to program with digital signals. But this can change very quick if the workcell and the number of the communication devices is growing or if the programmer is ignoring recommended basic rules.

Recommended basic rules:
- always initialize the signals at the beginning the corresponding robot program in area for initialization
- always set the signals while initialization to zero (off)
- always use “meaningful” names for the signals – that helps to keep overview
- always program the communication “step by step” respectively one pair of devices and check straight away for a correct communication

Always work along the following principle:
1. If the signal is not set - then device „A“ will set its signal
2. Device „B“ will wait until the signal of device „A“ is set and
3. Device „B“ will unset (reset) straight away the signal of device „A“

The following extract of programs will show the procedure:
1. the robot places a object onto the conveyor
2. if the signal is not set up to now, the robot will set the signal to „1“ and tell the conveyor on this way that the object arrived
3. the conveyor is waiting for the signal of the robot
4. the conveyor unsets the signal of the robot
5. the conveyor moves the object forward and backward and release is again
6. the conveyor sets the signal to„1“ to tell the robot that its back
7. the robot waits for the signal of the conveyor
8. the robot unsets the signal of the conveyor
9. the robot takes the object and moves away

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Example	
Robot program (extract)	**Conveyor program (extract)**
…..	
1. ERC RELEASE DEVICE BOX_TUTORIAL	
2. WAIT_UNTIL_SIGNAL_UNSET rob01_out	
2. rob01_out=1	**3.** WAIT_UNTIL_SIGNAL_SET rob01_out
	4. rob01_out=0
	5. ERC GRAB DEVICE BOX_TUTORIA
	5. PTP T_CONV_2
	5. PTP T_CONV_1
	5. ERC RELEASE DEVICE BOX_TUTORIAL
	6. WAIT_UNTIL_SIGNAL_UNSET conv_out
7. WAIT_UNTIL_SIGNAL_SET conv_out	**6.** conv_out=1
8. conv_out=0	
9. PTP T_BOX_TOP_1	
9. ERC GRAB DEVICE BOX_TUTORIAL	
…..	

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Internet Links

- EASY-ROB™

  Link: https://easy-rob.com/en/downloads-2/

  Operation References for EASY-ROB™
  operation-references.pdf

  Operation References for EASY-ROB™ Special Functions & PlugIns
  operation-references-functions-plugins.pdf

  ERPL/ERCL - EASY-ROB™ Command Language
  easy-rob-erpl_eng.pdf

- EASY-ROB™ Newsletter

  Link: https://easy-rob.com/en/downloads-2/

  Year 2018
  Topic: Release 7.6 – The new Version update-info-v76-eng.pdf

  Year 2017
  Topic: Release 7.3 – The new Version update-info-v73-eng.pdf

  Year 2016
  Topic: Release 7.0 – The new Version update-info-v70-eng.pdf

  Year 2015
  Topic: Release 6.6 – The new Version update-info-v66-eng.pdf

  Year 2014
  Topic: Release 6.3 – The new Version update-info-v63-eng.pdf

  Year 2012
  Topic: Release 6.0 – The new Version news-04-12-e.pdf

  Year 2011
  Topic: Release 5.6 – The new Version news-04-11-e.pdf

  Year 2010
  Topic: Release 5.3 – The new Version news-02-10-e.pdf

  Year 2009
  Topic: Release 5.006 – Update news-07-09-e.pdf

  3rd/4th Quarter 2008
  Topic: Release 5.0 – The new Version news-10-08-e.pdf

  1./2. Quarter 2008
  Topic: Release 4.606 – Project Manager news-03-08-e.pdf

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4th. Quarter 2007
Topic: Release 4.603 – Multi-Program news-11-07-e.pdf

3rd Quarter 2007
Topic: Release 4.307 – update news-08-07-e.pdf

1st/2nd Quarter 2007
Topic: Release 4.305 – The new Version news-01-07-e.pdf

3rd/4th Quarter 2005
Topic: New functionality for multiple kinematics news-09-05-e.pdf

1st/2nd Quarter 2005
Topic: Release 4.0 with multiple kinematics news-03-05-e.pdf

3rd/4th Quarter 2004
Topic: Customized solutions with the EASY-ROB™ API news-10-04-e.pdf

2nd Quarter 2004
Topic: EASY-ROB™ Robotics Simulation Kernel
integrated into Offline programming system FAMOS® news-06-04-e.pdf

1st Quarter 2004
Topic: Video Mode for Simulations news-03-04-e.pdf

4th Quarter 2003
Topic: Your new Companion – EASY-ROB News news-11-03-e.pdf

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  FH Darmstadt, Summer 2000,
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  Hochschule Magdeburg-Stendal, August 2001,
  Link: http://www.easy-rob.com/service/artikel-publikationen.html
  paper_unitrans.pdf

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  bps-inverse-kinematik-jhaertig.pdf

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  „Inverse Kinematik am Robotersimulationsprogramm EASY-ROB™"
  1. Workshop Robotik, Hochschule Mittweida (FH), Oktober 2004,
  Link: http://www.easy-rob.com/service/artikel-publikationen.html
  EASY-ROB-Inverse-Kinematik.pdf

  Link: http://www.global.hs-mittweida.de/~ifa/archivrobotik.htm

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EASY-ROB customer area

Content: Program updates and robot libraries

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

Log in data:

User name: customer
Password: **********

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Notes

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