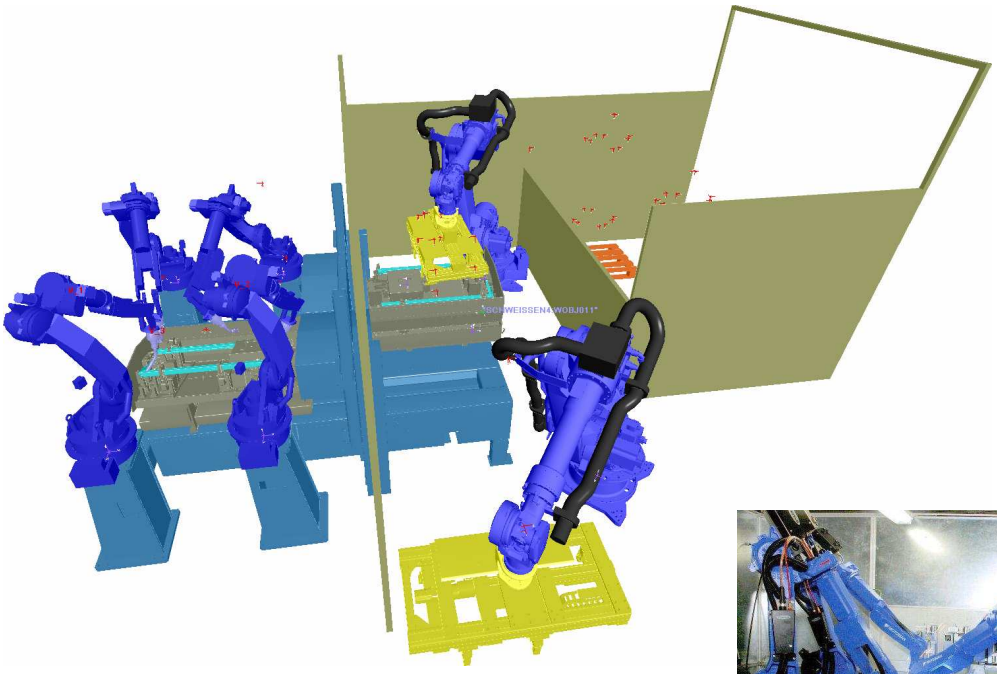
Update

EASY-ROB™ V5.006



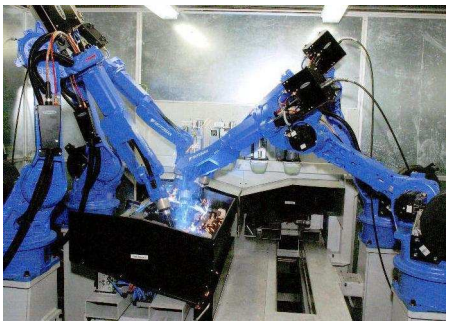


Image: WESOBA GmbH, Schwarzenberg

July 2009

Version 1.02

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EASY-ROB™

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EASY-ROB™ V5.006

Introduction

The new EASY-ROB™ Update Version 5.006 contains a numerous of reforms and improvements. Below document will give you a first overview about most important changes. You will find a more detailed description in the Operation references.

- **EASY-ROB™ Viewer**
  The new free of charge EASY-ROB™ Viewer allows to simulate existing work cells. Program specific functions such as different views, start, stop or creating video files are available. This application is especially developed for marketing staff and to improve presentations.
- **CAD Data-Import more comfortable**
  For the 3D Visualization in EASY-ROB™, the CAD data import for all established formats is an essential part. When importing assemblies, device files are created automatically at the same time. Finally single components can be individual disabled or deleted.
- **Improved: Modeling of kinematics with synchronization**
  Kinematics joints can be arbitrary and independent defined. Thus, individual gripper, punching machines, and so on, can be created much easier. Furthermore, external axes are better embedded into the simulation process. The possibility to synchronize kinematics presents a huge number of new simulation possibilities.
- **External TCP**
  External TCP motions are better supported now, especially while creating and modifying Tag points at the work piece.
- **EASY-ROB™ License Manager as Service**
  The License Manager can be installed as service now, which makes administration easier.
- **More accurate cycle time calculations**
  Based in real conditions, we made cycle time measurements. The results are now part of the motion planner in EASY-ROB™. From now on, cycle times can be estimated more accurate.

Beside additional small changes, new ERCL- and ERPL-Commands, API functions to control EASY-ROB™ from outside have been added. This update is available free of charge for all customers with a valid license key for EASY-ROB™ V5.0. For customers using older versions, it will be possible to purchase an update. We would like to thank you for your suggestions and ideas in advance.

Thank you

Stefan Anton

EASY-ROB
3D Robot Simulation Tool

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EASY-ROB™ Viewer

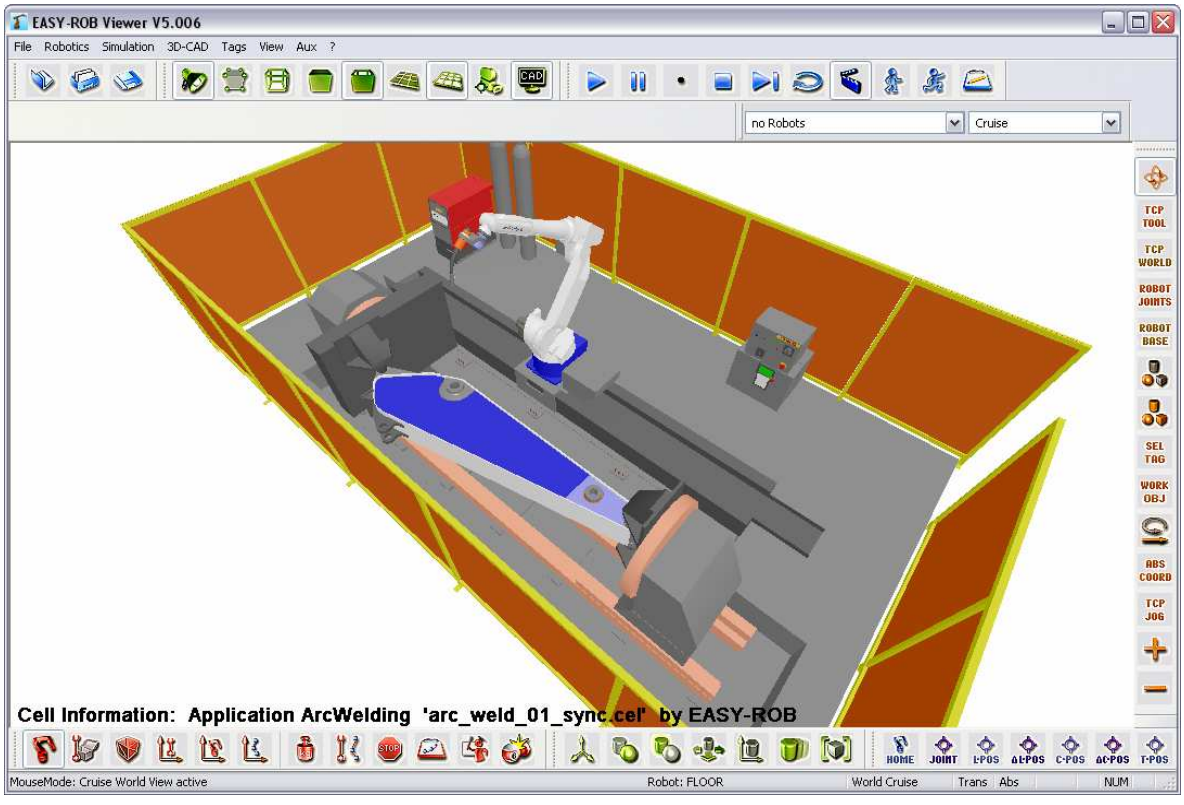
The new free of charge EASY-ROB™ Viewer allows to simulate existing work cells. Program specific functions such as different views, start, stop, pause or creating video files and screenshots are available.

This application is especially developed for marketing staff and to improve presentations. The EASY-ROB™ Viewer belongs to the portable applications. Thus there is no installation necessary. The Viewer can be started directly from USB-Stick or from a CD/DVD. Projects, which are on the same carrier, can be loaded and simulated.

The EASY-ROB™ Viewer can be copied from the current EASY-ROB™ CD in folder ".\Easy_Rob_Viewer\". Alternative the Setup „EASY-ROB Viewer Setup.exe" can be executed for installation.

Assumption for the reasonable usage of the EASY-ROB™ Viewer is the licensed ***RunTime*** option in the EASY-ROB™ Version.

Option ***RunTime*** allows to save protected work cells. These work cells can be loaded into the Viewer.



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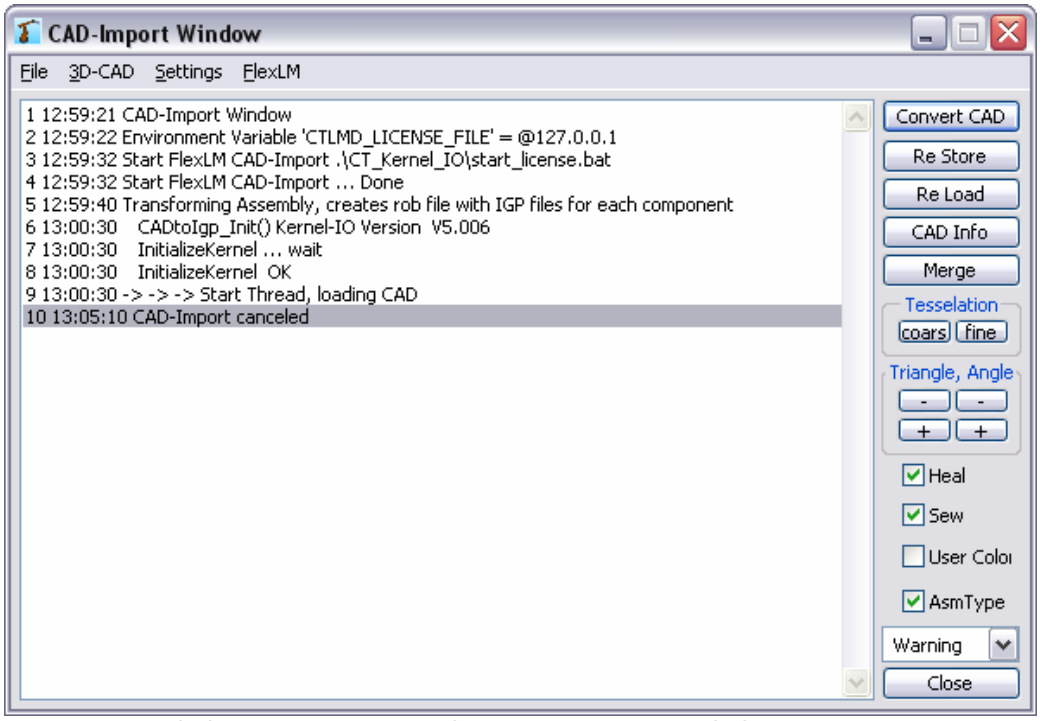
CAD Data-Import

The powerful CAD Data Import (3D_Evolution® API) allows to import all established formats. These imclude among others neutral formats, such as STEP, IGES, VDA, VRML II und JT-Open and also native formats such as CATIA V4 und CATIA V5 R19, Pro/E, UG, SolidWorks, Robface.

Resolve Assemblies.

The previous version was able to convert an assembly into one single geometry (Igp-file) file. Now it is possible to save each component into an Igp-file. When loading the device file, generated at the same time, the user has the possibility to disable and delete components individual. Alternative, he can enter a new position and assign a joint to the component. Building kinematics is much easier now.



CAD-Import Window: Menu „3D-CAD | Open CAD-Import Window“.

Activate Check-Box 

, to convert each component into one IGP file and to create one Rob file. Pressing „Convert CAD“ prompts the user to choose the CAD file to convert or import.

In case Check-Box „AsmType“ is not activated, one IGP file will be created.

Two examples are on the EASY-ROB™ CD in folder

```
„.\Options\CAD-Import\Iges\AsmType\P-500 Top Machine.IGS“ -> P-500TopMachine.rob
„.\Options\CAD-Import\Step\AsmType\KR500-2_KR360-2.stp “ -> KR500-2_KR360-2.rob
```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Modeling of kinematics with synchronization

We know, EASY-ROB™ is able to simulate the behaviour of industrial robots. Additionally it is also possible to model and simulate different kinematics, such as gripper, positioner, conveyors, turn tables, fixtures and special kinematics.

To fulfil these requirements new possibilities are available to define axes and joints.

Kinematics joints can be arbitrary and independent defined. There are no restrictions the have them into the kinematics 'main' chain.

In addition, it is possible to synchronize kinematics. Here we couple axes of one kinematics with axes of another kinematics. They become quasi slave joints of a master kinematics.

Typical Application
Robot controller control on the one hand the robot with 6 axes and additional the periphery. The external axes, such as tracking axis and a positioner. With the goal to model this circumstance in EASY-ROB™, we add to the six axes robot two additional axes 7 and 8. Synchronizing the tracking axis and the positioner with the robot allows controlling them completely by the robot. This simplifies programming of external axis significant. Now it will be possible to save the external axes data into the Tag points. Moving to a Tag point results in a simultaneous movement of the robot, the tracking axis and the positioner. The motion for all kinematics will start and stop at the same time.

Features
- More then one kinematics can be synchronized with another one.
- Single axes of a kinematics can be synchronized or independent.
- Synchronized kinematics can have an own program

The possibility to synchronize kinematics presents a huge number of new simulation possibilities

Example: „.\ApplicationLib\ArcWelding\arc_weld_01_sync.cel“

In this example the turn positioner „POSITIONER_01“ is synchronized with axis number 8 of the robot „AX-V6L“. Open the Kinematics Window and double click on line „Synchronized with Ref Jnt , AX-V6L' to modify the synchronization settings.

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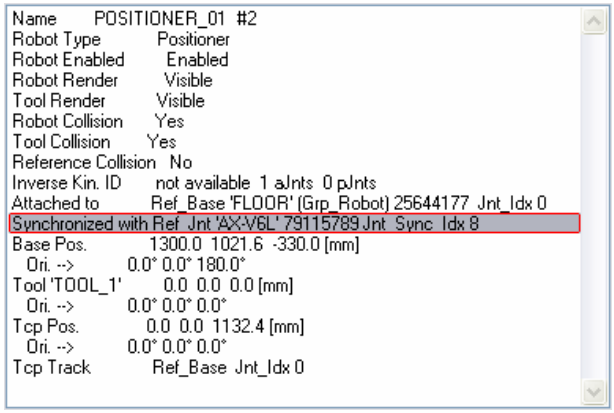
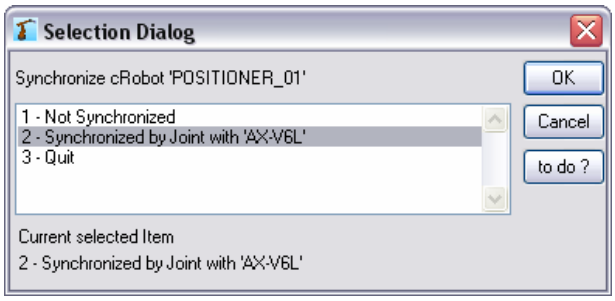
Steps to modify synchronization properties



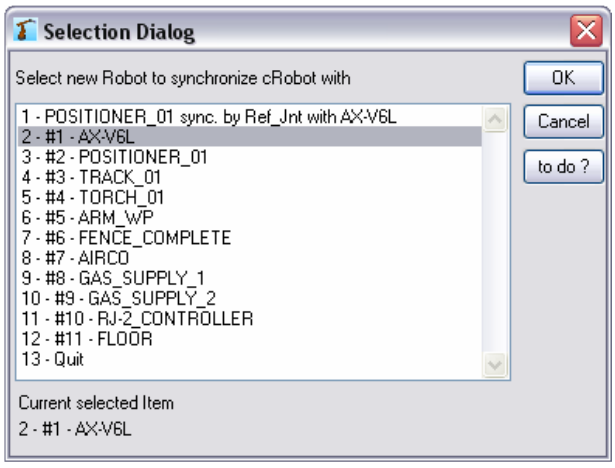
Example: „.\ApplicationLib\ArcWelding\arc_weld_01_sync.cel“

In this example the turn positioner „POSITIONER_01“ is synchronized with axis number 8 of the robot „AX-V6L“. Open the Kinematics Window and double click on line „Synchronized with Ref Jnt , AX-V6L’ to modify the synchronization settings.

1. Double click on „Synchronized with…“to change the properties



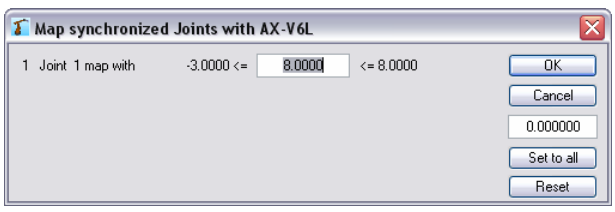
2. Selection:
   - Not Synchronized
   - Synchronized by Joint with ‚AX-V6L’



3. Select device „AX-V6L“ to synchronize current device with.

   More than one device can be synchronized with the „AX-V6L“. However, one device can be synchronized with another one.

   The Positioner can be synchronized only with the robot and not with additional devices at a same time.



4. Selection of axis number of device „AX-V6L“, which is synchronized with the first axis of the positioner.
   Negative values denote synchronization with passive joints. 0 if the axis is not synchronized.

Jogging Joint 8 of the robot, results in a motion of the first axis of the positioner as well.

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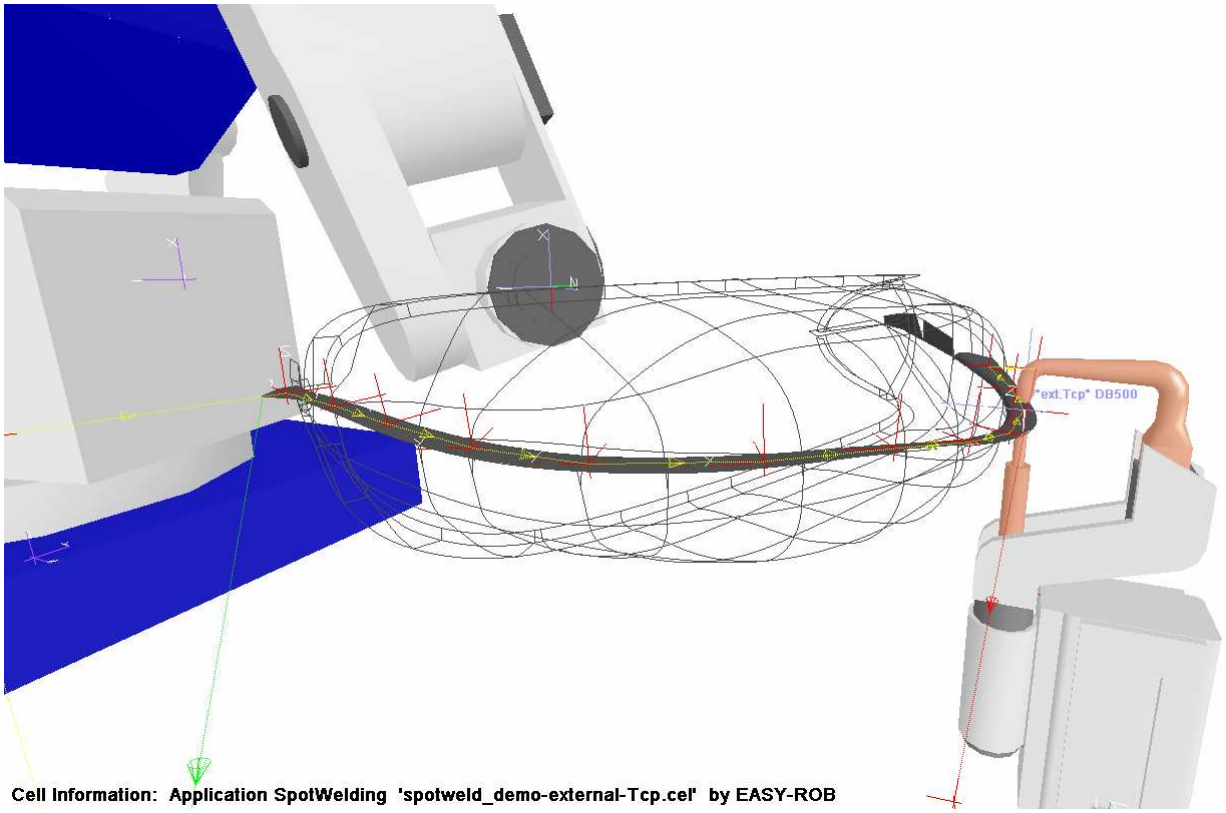
External TCP

External TCP motions are better supported now, especially while creating and modifying Tag points at the work piece.

When using external TCP, the robot carries the work piece and guides it along an external TCP. Here we define Tag points and paths as usual at a work piece and afterwards the position of the external TCP. The Mode „external TCP“ can be activated or deactivated with the ERCL command „**ERC EXT_TCP ON/OFF**“, followed by motion commands such as PTP, LIN, CIRC, MOVE or Along.

The ERPL command ”**EXT_TCP XYZ ABC**“ or “**EXT_TCP tagname**“ defines the position of the external TCP. In Menu: “Robotics > cRobot Ext Tcp Data“ it is possible to change the data manual. The Online Output Data Dialog shows in “current Motion Data“ with ”External TCP ON“ that the external TCP mode is enabled. In the 3D Scene the external TCP is visualized with a light blue coordinate system.

It makes sense to set the tool data to zero when the external TCP mode is activated.



Example: „.\ApplicationLib\SpotWelding\spotweld_demo-external-Tcp.cel“

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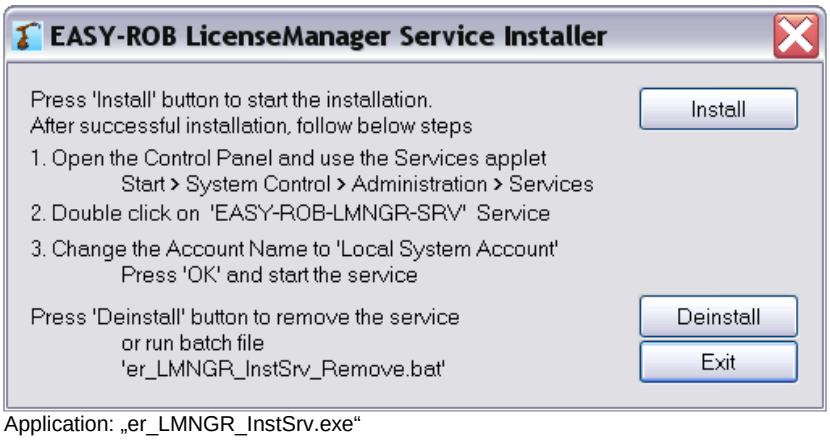
EASY-ROB™ License Manager as Service

The License Manager can be installed as service now, which makes administration easier.

Some user running the EASY-ROB™ License Manager as a service since they use them. In case the License Manager is installed as service, he starts automatically while the computer starts and stops while the computer shuts down. The License Manager keeps activated if no user is logged in.

To install the License Manager as service ,start the application „er_LMNGR_InstSrv.exe“ from the installation folder for the License Manager (for example c:\Programme\EASY-ROB\EASY-ROB LicenseManager). More references are in „EASY-ROB-Lmngr-Install-Service.pdf“ and „Applikationen als Dienste einrichten.pdf“.



Application: „er_LMNGR_InstSrv.exe“

Click on „Install“ to install the License Manager as service.
Two Batch files will be generated („er_LMNGR_InstSrv.bat“ and „er_LMNGR_InstSrv_Remove.bat“), hereby the fist one will be executed immediately.

When executing batch file „er_LMNGR_InstSrv.bat“ the new service with the name „**EASY-ROB-LMNGR-SRV**“ is created.

Administrator rights are required.

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More accurate cycle time calculations

AUTO_ACCEL

Based in real conditions, we made cycle time measurements. The results are now part of the motion planner in EASY-ROB™. From now on, cycle times can be estimated more accurate

Important for the resultant cycle time are the given speeds and accelerations. Using PTP motions, the commands SPEED_PTP_OV %-Value and ACCEL_PTP_OV %-Value define them. The %-Value gives the percentage part of the maximum axes speeds and accelerations of the robot. They are available as robots attributes and can be changes by the user. In most cases it is difficult for the user to find correct and valid acceleration data, because manufactures data are not sufficient.

The new command **AUTO_ACCEL ON** calculates in dependency on the given speeds the accelerations automatically. As basis for calculation we use measurements done with the real robot. The calculations are valid for PTP-, LIN- and CIRC motions, when the robots will halt at the target location.

In example `".\Tutorial\Proj_example_erpl\functions_auto_accel.cel"` four cases are simulated.

Case	Speed_PTP_OV	Accel_PTP_OV	AUTO_ACCEL	Cycle time in s
1	50	100	OFF	1.836
2	50	not used	ON	1.769
3	100	100	OFF	1.630
4	100	not used	ON	1.106

Table 1 „Auto_Accel"

To save axes-, speeds- and acceleration data for every simulation step (10ms) we use the command „ERC STATUS_OUTPUT ON 1 AUTOACCEL_50_100_off.dat -1". The results are saved in file „AUTOACCEL_50_100_off.dat" and visualized afterwards in diagrams using Matlab „taktzeit_auto_accel.m". The robot moves PTP from T_1 to T_2.

Results

Expectedly, AUTO_ACCEL OFF in case 3 with Speed_PTP_OV 100% results in a shorter cycle time with 1.630s compared to case 1 (1.836s) with Speed_ PTP_OV 50%. But this cycle time is only by 11% reduced. This indicates that the given speed was not reached because of to low acceleration or to short distance between the start and the end location.

In case 2 and 4 we set AUTO_ACCEL ON to calculate the accelerations automatically. Comparing case 1 with 2 the cycle times are very close, only 4% difference. Increasing the speed to 100% the cycle time reduces to 1.106s only, which deviates from case 3 by 32%. The distance between start and end location has not changes, thus a higher acceleration must be important for that short cycle time.

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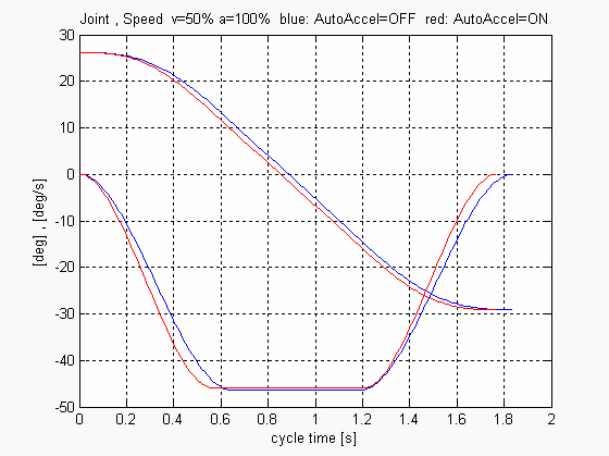
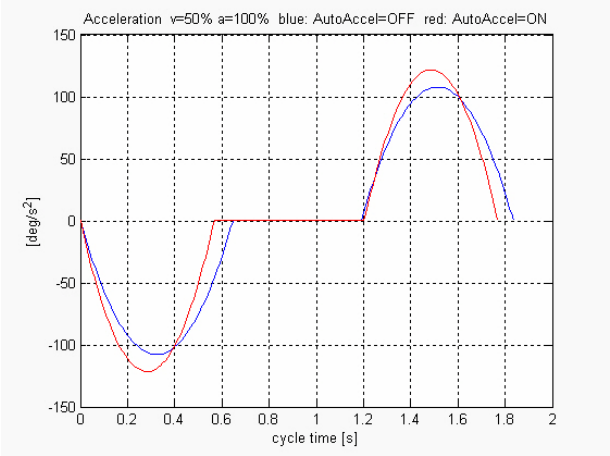
Comparison: Auto_Accel OFF/ON with v=50% and 100%



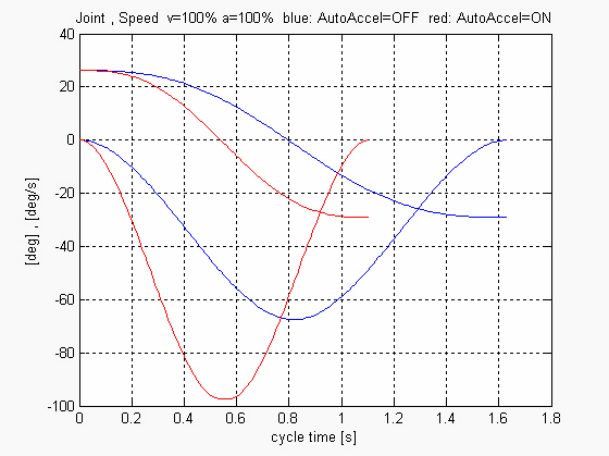
Joint- and Speed diagram Axis 1 „AutoAccel_qv_50_100.jpg“



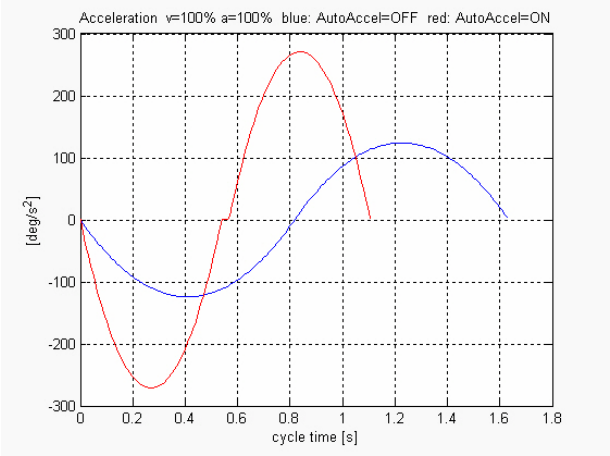
Acceleration diagram Axis 1 „AutoAccel_a_50_100.jpg“

blue:	v=50%	a=100%	Auto_Accel OFF	1.836s
red:	v=50%	a= -	Auto_Accel ON	1.769s

The calculated accelerations are close to the given accelerations.



Axis- and Speed diagram Axis 1 „AutoAccel_qv_100_100.jpg“



Acceleration diagram Axis 1 „AutoAccel_a_100_100.jpg“

blau:	v=100%	a=100%	Auto_Accel OFF	1.630s
rot:	v=100%	a= -	Auto_Accel ON	1.160s

blue: v_max = 67.6°/s
red: v_max = 97.5°/s

blau: a_max = 124.0°/s²
rot: a_max = 271.0°/s²

The calculated accelerations are much higher than the given accelerations. This result in a much reduces cycle time.

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ACCSET

The new command ACCSET allows influencing the acceleration additionally. This command is used when handling fragile and heavy loads to decelerate the acceleration.

ACCSET has 2 arguments

Acc - Acceleration and deceleration as percentage value of normal values
Ramp - Change of acceleration and deceleration as percentage value of normal values

Example "`.\Tutorial\Proj_example_erpl\functions_accset.cel`" varies arguments from 20%, 50%, 80% to 100%.

ACCSET is independent from the command AUTO_ACCEL. Hence, accelerations given with Accel_PTP_OV are decelerated as well.

In example "`.\Tutorial\Proj_example_erpl\functions_accset.cel`" four cases are simulated.

Case	AUTO_ACCEL	ACCSET	Cycle time in s
1	ON	20% 20%	1.815
2	ON	50% 50%	1.380
3	ON	80% 80%	1.180
4	ON	100% 100%	1.106

Table 2 „AccSet"

To save axes-, speeds- and acceleration data for every simulation step (10ms) we use the command „ERC STATUS_OUTPUT ON 1 ACCSET_20_20_on.dat -1". The results are saved in file „ ACCSET_20_20_on.dat " and visualized afterwards in diagrams using Matlab „ taktzeit_accset.m". The robot moves PTP from T_1 to T_2.

Results

Expectedly, the cycle time increases with smaller arguments for Acc and Ramp.

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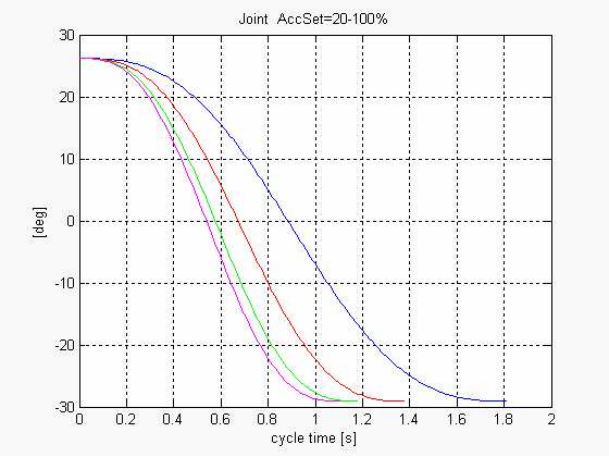
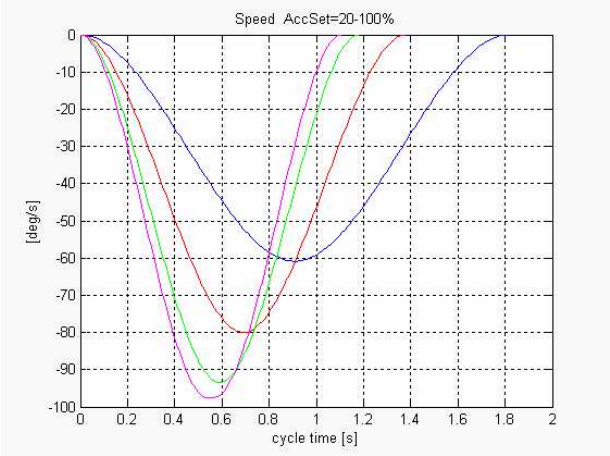
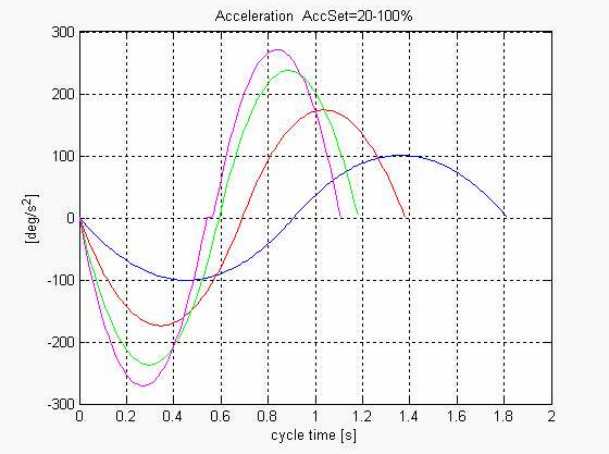
Comparison: ACCSET with 20%, 50%, 80% and 100%



Joint diagram Axis 1 „AccSet_q_20_50_80_100.jpg“



Speed diagram Axis 1 „AccSet_v_20_50_80_100.jpg“



Acceleration diagram Axis 1 „AccSet_a_20_50_80_100.jpg“

The maximum speeds and accelerations reducing with smaller Acc- and Ramp values, which results in higher cycle times.

blue:	Acc=20%	Ramp=20%	1.815s
red:	Acc=50%	Ramp=50%	1.380s
green:	Acc=80%	Ramp=80%	1.180s
violet:	Acc=100%	Ramp=100%	1.106s

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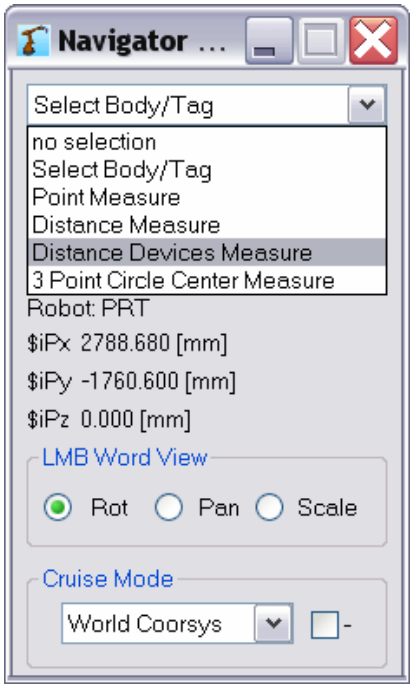
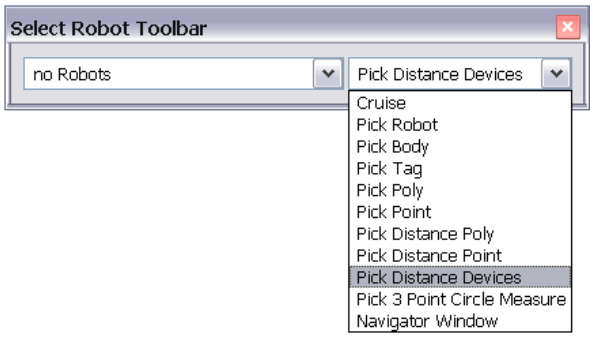
Measuring

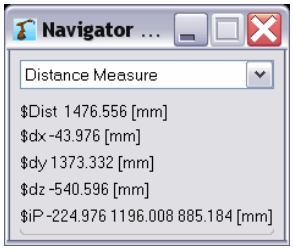
Measure distance between devices

To measure the distance between two devices, open the Navigator Window, choose „Distance Devices Measure“ and „pick“ afterwards the two devices with the left mouse button. Alternative use this function from the Robot Toolbar.



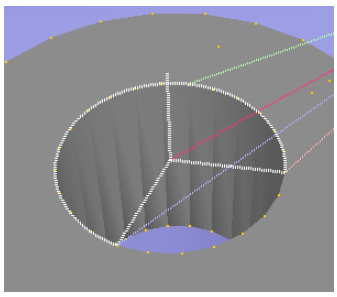


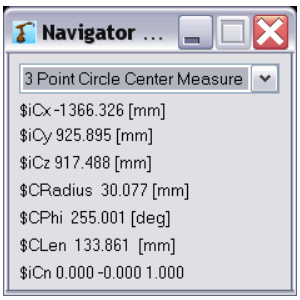
The distance values are in world coordinates (X, Y, Z, Dist) shown in the Navigator Window.



Circle Center Measure

To measure the center of a circle by three points, choose „3 Point Circle Measure“ from the Navigator Window and „pick“ afterwards three points with the left mouse button.





Circle Center Coordinate
$iCx, $iCy, $iCz
Radius
$CRadius = 30.077 mm
Angle
$CPhi = 255°
Segment length
$CLen = 133,86 mm
Normal vector
$iCn = 0 0 1

Create a new Tag point with the middle mouse button. Place this new Tag point to the measured circle center with the Cntrl-Key.

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ERPL-Commands

JUMP_TO *tagname*
JUMP_TO X Y Z A B C [m,deg]

Jump to target location (tagname - name of target Tag, XYZ - Position, ABC - Orientation)

JUMP_TO_AX q1 .. qn [m,deg]

Jump to target joint axis (q1..qn - target Joint/Axis)

EXT_TCP *tagname*
EXT_TCP X Y Z A B C [m,deg]

Position of external TCP
tagname - name of Tag
XYZ - Position, ABC - Orientation in world coordinate system

AUTO_ACCEL ON [OFF, POS, ORI, AX]

Automatic calculation of acceleration dependent on programmed speed.
AX – Calculation for PTP motions
POS – Calculation for motions for Position
ORI – Calculation for motions for Orientation
ON – Calculation for PTP, POS and ORI
OFF – Calculation deactivated

ACCSET Acc Ramp

Lagging of accelerations.
The arguments Acc and Ramp are given in percentage values in the range 20% to 100%.
Acc – Acceleration and Deceleration as percentage value of normal values
Ramp – Change of Acceleration and Deceleration as percentage value of normal values

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ERCL- Commands

ERC EXT_TCP ON/OFF

Enables / Disables external TCP mode

ERC CELL_INFO_SHOW ON/OFF

Enables / Disables the Cell Information line

ERC CELL_INFO text

String for cell Information line

Parser-Funktionen

sim_time()

Return value: global simulation time [s]

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API-Functions

New Header „er_capi_types.h“

In header file „./er_dvlp/er_capi_types.h“ are all constants and type definitions declared. This header is included by „./er_dvlp/er_dvlp.h“. The header files „./er_dvlp/er_dvlp.h“ und „./er_dvlp/er_dvlp_ext.h“ contain only function declarations.

USER_IO_DIALOG

- **`int _info_line_msg_i (int moni, char *s, int  *vi, int n, int scal)`**

  // Integer-Vector-Output to Message Window
  moni 0- message window, 1- message window and moni_msg.txt
  *s Info-Text
  *vi Vector
  n Dimension von vi
  scal scaling

- **`int _info_line_msg_T_vec (int moni, char *s, frame *T)`**

  // Frame-Output as Vector Pxyz, Rxyz to Message Window
  moni 0- message window, 1- message window and moni_msg.txt
  *s Info-Text
  *T Frame

SIM_ERPL – Simulation ERPL

- **`int *inq_single_cmd_ext_Tcp_idx (void)`**

  // Status External TCP activated=1 or deactivated=0 for single command execution

- **`int *inq_single_cmd_c_device_idx (void)`**

  // Current Device Index for single command execution

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DEVICES

- **int *inq_device_sync_ref_sys_type (void)**

  // Reference type for Synchronization
  // REF_NO_REF = 0 current Device not synchronized
  // REF_JNT = 9 current Device with axis synchronization

  Return Pointer to value

- **char *inq_device_sync_ref_sys_type_name (void)**

  // Name of reference type for synchronization
  // „Ref_no_Ref“ current Device not synchronized
  // „Ref_Jnt“ current Device with axis synchronization

  Return String

- **long *inq_device_sync_ref_sys_grp_uid (void)**

  // Unique ID if reference devices, elseNULL

  Return Pointer to value

- **int *inq_device_sync_ref_sys_jnt_sync_idx (void)**

  // Index of axes of reference device where the current device is synchronized with.
  // Index = 0 axis not synchronized
  // Index < 0 axis synchronized with passive joint of reference device
  // Index > 0 axis synchronized with active joint of reference device

  Return Index-Vector

- **int Device_Sync_by_name (int new_reference_type, char *new_reference_device_name=NULL, int *new_reference_jnt_sync_idx=NULL)**

  // Setting the synchronization properties by name of reference device
  new_reference_type REF_NO_REF = 0, REF_JNT = 9
  new_reference_device_name name of reference device
  new_reference_jnt_sync_idx Sync Index Vector of axes of reference device (REF_JNT)

  Return 0 – OK, 1 – Error

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- **int Device_Sync_by_idx (int new_reference_type, int new_reference_device_idx=0, int *new_reference_jnt_sync_idx=NULL)**

  // Setting the synchronization properties by index of reference device
  new_reference_type REF_NO_REF = 0, REF_JNT = 9
  new_reference_device_idx index of reference device
  new_reference_jnt_sync_idx Sync Index Vector of axes of reference device (REF_JNT)

  Return 0 – OK, 1 – Error

- **int Device_Sync_by_uid (int new_reference_type, long new_reference_device_uid=0, int *new_reference_jnt_sync_idx=NULL)**

  // Setting the synchronization properties by Unique ID of reference device
  new_reference_type REF_NO_REF = 0, REF_JNT = 9
  new_reference_device_uid Unique ID of reference device
  new_reference_jnt_sync_idx Sync Index Vector of axes of reference device (REF_JNT)

  Return 0 – OK, 1 – Error

ROB_KIN – Robot Kinematics

- **char *inq_kin_chain_type_activ (void)**

  // ‘C‘ active axis is in the kinematics chain (standard)
  // ‘-‘ active axis is separated and not in the kinematics chain (new)

- **frame *inq_achs_T0_activ (void)**

  // Transformation to active axis in case the that this active axis is
  // separated and not in the kinematics chain ‘-‘

- **char *inq_robot_fln_name (void)**

  // File name of current robot, else NULL

- **char *inq_kin_chain_type_passiv (void)**

  // replaces **char *inq_kin_chain_type (void) // obsolete**
  // ‘C‘ passive axis is in the kinematics chain
  // ‘_‘ passive axis is not in the kinematics chain
  // ‘-‘ passive axis is separated and not in the kinematics chain

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- **`char *inq_kin_calc_passiv (int passiv_jnt_no)`**

  // replaces **`char *inq_kin_calc (int passiv_jnt_no) // obsolete`**
  passiv_jnt_no Index passive axis, zero based
  Return Formula-String for mathematical dependency

- **`int *inq_kin_attach_dof_passiv (void)`**

  // replaces **`int *inq_kin_attach_dof (void) // obsolete`**
  // Expl. ‚pJ3 RYC2-‘ pass. axis 3, Roty, in the kin. chain, attached to active Joint 2
  // In case the kinematics has 3 passive joints RY_1- , RY_3- , RYC2-
  // the index-Vector is [1, 3, 2]

  Return Index-Vector, Index of active joint where the passive joint is attached to

MOP_PATH – Motion Planner Path

- **`int *inq_ipo_path_no_decel (void)`**

  // 0 – speed in target= 0,
  // 1 – No deceleration, speed in target = given speed (sets zone>0)

  Return Pointer to value

- **`float *inq_ipo_path_zone (void)`**

  // Rounding parameter,
  // „Zone = 0“ allows exact stop in target location
  // „Zone > 0“ Interpolation step skips target location

  Return Pointer to value

- **`float *inq_ipo_path_AccSet (void)`**

  // Lagging of accelerations.
  // The arguments Acc and Ramp are given in percentage values in the range 20% to 100%
  // Acc Acceleration and Deceleration as percentage value of normal values
  // Ramp Change of Acceleration and Deceleration as percentage value of normal values

  Return Pointer to values [Acc , Ramp]

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- **`int *inq_ipo_path_AutoAccel (void)`**

  // Automatic calculation of acceleration dependent on
  // programmed speed
  // ON = 7 – Calculation for PTP, POS and ORI
  // POS = 1 – Calculation for motions for Position
  // ORI = 2 – Calculation for motions for Orientation
  // AX = 4 – Calculation for PTP motions
  // OFF = 0 – Calculation deactivated

  Return Pointer to value

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EASY-ROB Customer area

Online available: Program Updates and Robot libraries

Web: www.easy-rob.com/en/special/customer-area

Access data:

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

Notes

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