



Orange Apps

# **RobFit V1.1**

## **Calculation of robot coordinate systems**

User documentation

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The contents of this document have been tested with the described software. Since deviations cannot be excluded, no guarantee for full compliance can be taken.

## History of document versions

Version	Date	Author	Change Reason / Comment
1.0	05/28/2013	Christian Mayer	First release
1.1	07/17/2013	Christian Mayer	Formatting changed, small mistakes corrected
1.2	01/10/2014	Christian Mayer	RobFit version 1.0.10.10 implemented
1.3	01/31/2014	Christian Mayer	RobFit version 1.1. implemented (new license management)
1.4	02/05/2014	Christian Mayer	Document Revision

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# 1 Introduction

## 1.1 Target group

This documentation is intended for users with the following skills:

- Knowledge of robot programming
- Knowledge of coordinate metrology

## 1.2 Representation of information



These notes indicate that death or severe personal injury will be safe or very likely to occur if precautions are not taken.



These notes indicate that death or serious bodily injury could occur if precautions are not taken.



These notes indicate that minor personal injury can result if precautions are not taken.



These notes indicate that damage may occur if precautions are not taken.



This manual contains useful tips or special information for the current topic.

## 1.3 Terminology used

Notion	Description
Dongle	Dongle
Laser Tracker	Optical measuring system
TCP	Tool center point, the tool coordinate system
License point	The number of measurements is stored on the dongle as a "license point"

Table 1-1 terms used

## 2 Patent Notice

The RobFit program uses a method for robot base / tool measurement, which is protected by an international patent. The company Orange Apps GmbH is the exclusive licensee of this patent.

### 3 Product Description

The software tool RobFit is used to calculate robot coordinate systems.

#### Key Features

- Wizard-driven software operation

#### Key Features

- Calculation of the robot coordinate systems by clearing of the robot position data with reference data
- For the position data of the robot the TCP of the measurement tool does not need to be known. The used TCP is calculated by the software!
- Presentation of the quality of the measurement
- Export of the measurement result as a data file for direct use in the robot
- Documentation of measurement results
- Language English and German

## 4 Installing the software

Double-click setup.exe and accept the license terms.

### 4.1 System requirements for running

#### Minimum Hardware Requirements

- PC with min. 1 GHz processor clock
- 512 MB RAM
- at least 1 MB free hard disk space

#### Recommended Equipment

- PC with 2 GHz processor clock
- 1GB of RAM
- 1 MB free hard disk space

#### Software

- Windows XP with Service Pack 2
- Windows Vista 32/64 bit
- Windows 7 32/64 bit
- . NET Framework 3.5

## 5 Licensing

The application of RobFit is subject to licensing. To view a new calculation result a USB dongle with thereon stored purchased license points is required. One licensing point will be deducted each new calculation. Without change of position parameters already computed projects don't consume an additional license point.

Charging the dongle with license points is done by an activation code. Visit our website [www.orangeapps.de](http://www.orangeapps.de) for more information on licensing or see Chapter 9.3.

### Notes

- The user is allowed to install RobFit on any number of computers
- The software can be run completely without dongle
- The software is free of charge via [www.orangeapps.de](http://www.orangeapps.de) available
- Each recalculation of a coordinate system consumes a paid license point
- Already computed projects don't consume a license point



RobFit automatically detects whether a license point has already been used for a project. Therefore, save the currently open project before closing the software. If the program is closed without saving, at reopen of a project a used license point will not be recognized. To view the result, a further license point will then be consumed.

### 5.1 Load points on license dongle

See Chapter 9.3.

## 6 Basic principles of operation

A wizard guides you through the operation of the software.

### General buttons

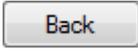
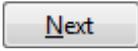
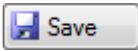
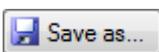
Button	Description
 or 	Moves to the previous page
	Moves to the next page
	Saves the current state using the current file name
	Opens the file selection dialog to save the current state

Table 6-1: Buttons

## 7 Using RobFit

### 7.1 Start Application

#### Method

- start RobFit.exe



After starting the software a wizard guides through the operation.

### 7.2 Quit the application

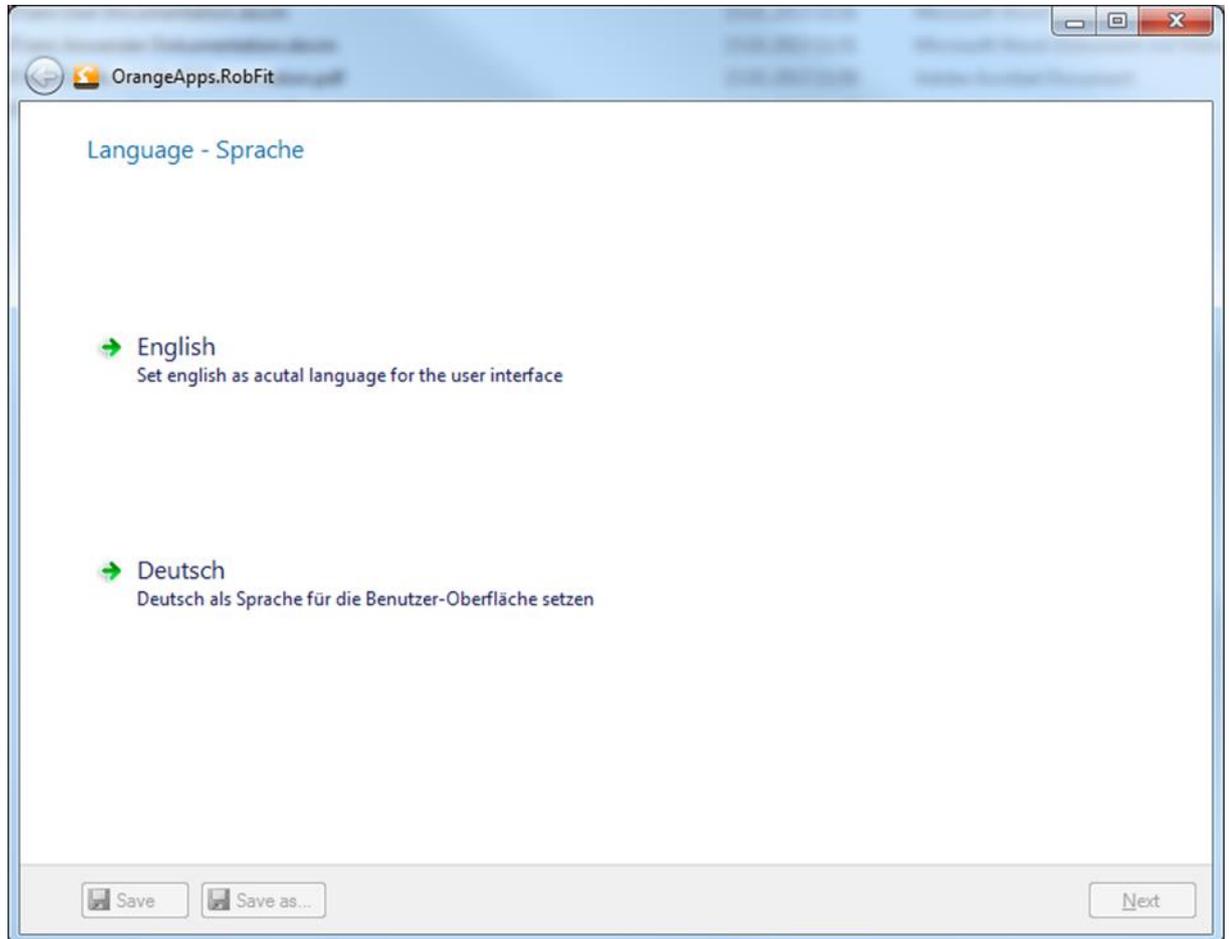
#### Method

- Like a standard Windows window by clicking on "X" top right 

## 8 User interface

### 8.1 Language

This window appears when you first start the software after installation. Select the desired language.

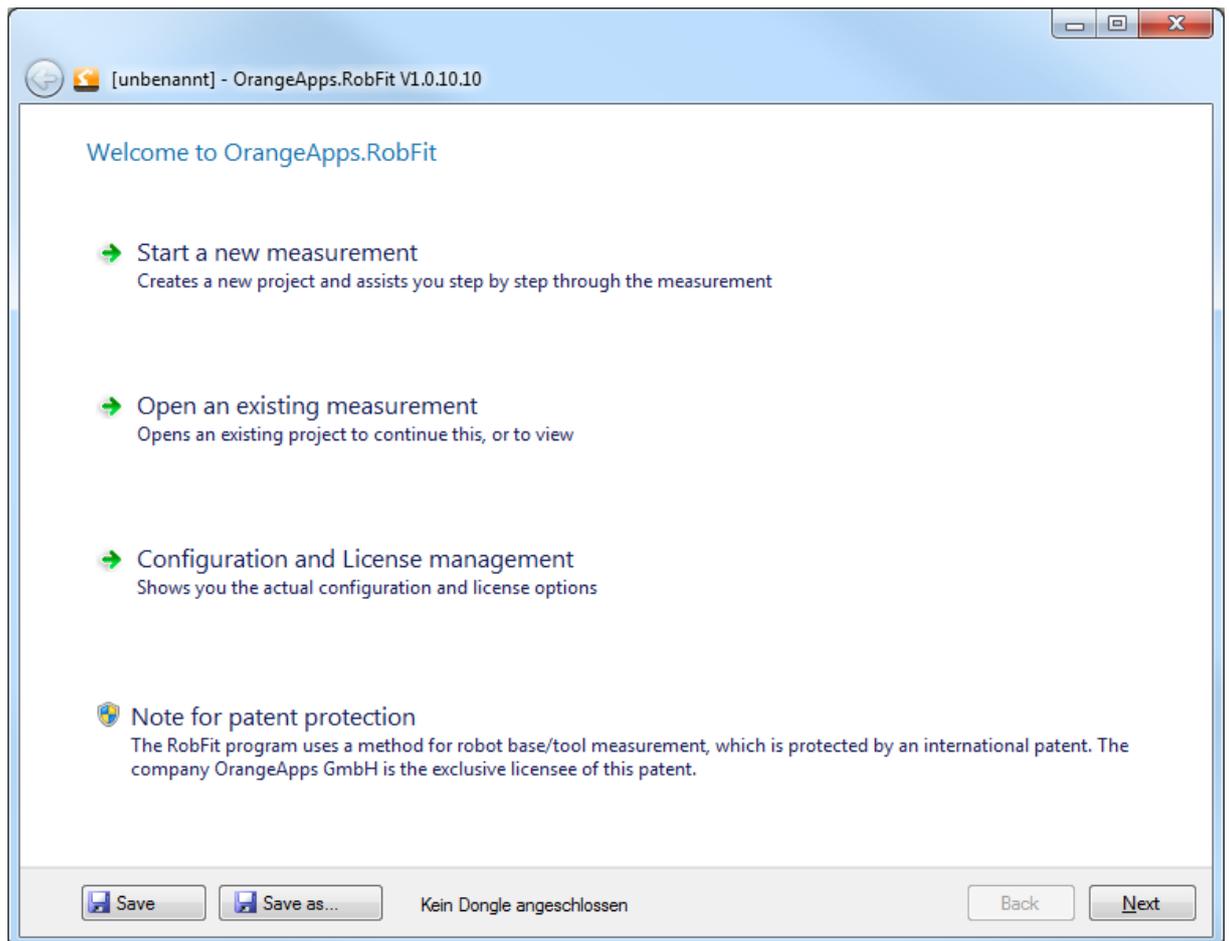


### 8.2 Page "Welcome"

This page is displayed when the software is restarted. You have the possibility to

- Start a new measurement
- To open an existing project
- be changed to the configure and license management page

When the dongle is plugged the number of remaining license points is displayed in the footer.



### Start new measurement

A new measurement is started. You'll be forwarded to the [Project Information](#) Page.

### Open an existing survey

You can open an existing project, the file selection dialog appears.

### Configuration and License Management

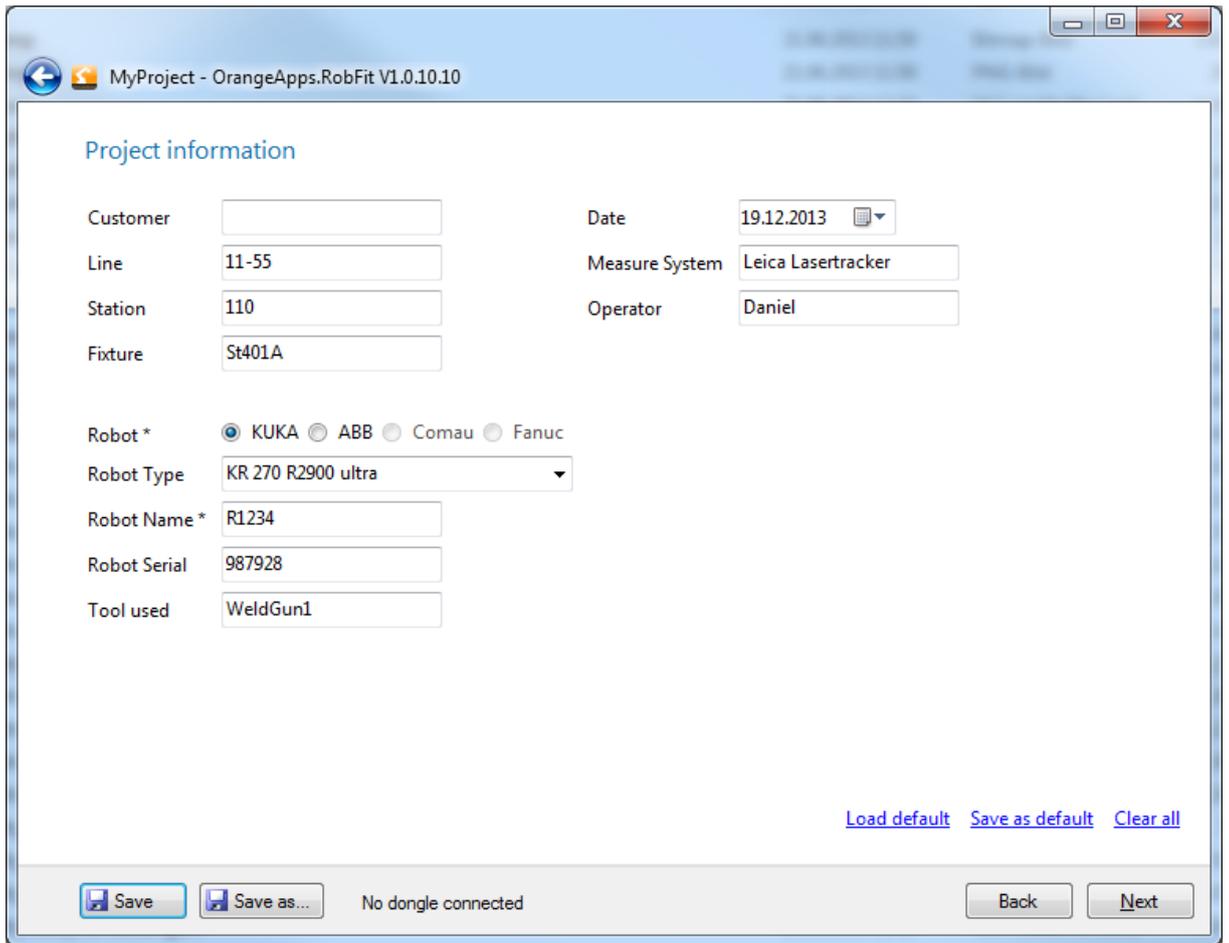
You'll be forwarded to the [Configuration and License Management](#) page.

## 8.3 Page "Project Information"

This page contains information about the current project. These are used among other things for the documentation of each calculation. To go to the next page the following information is mandatory:

- Robot manufacturers
- Designation of the robot (name)

All other fields are optional.



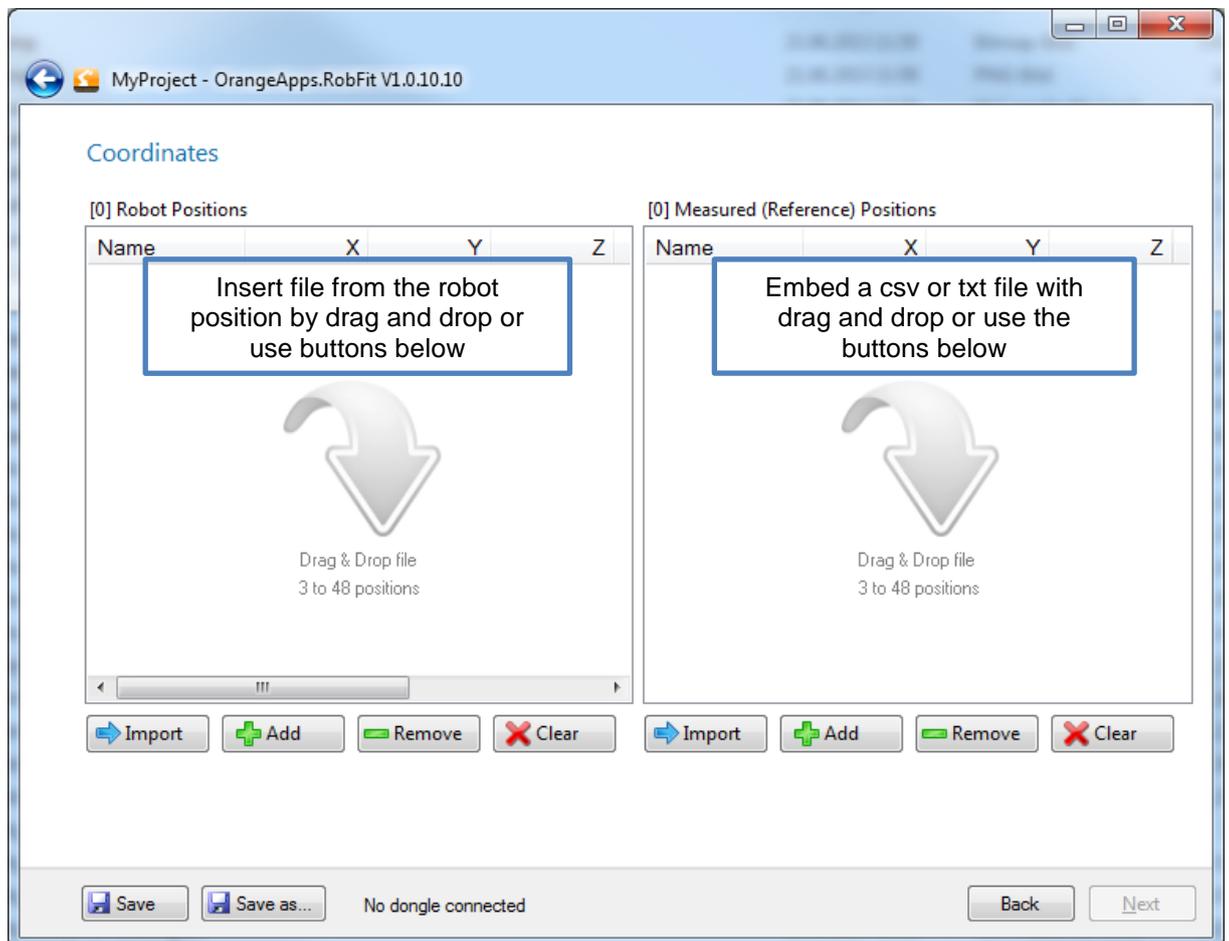
**Links**

Link	Description
<a href="#">Load default</a>	Loads the default project information
<a href="#">Save as default</a>	Saves the current project information as default information
<a href="#">Clear all</a>	Clears all fields

**Table 8-1** Save / Load default values:

## 8.4 Page "coordinate"

Enter the coordinates of the robot positions and reference positions in the respective fields.



### Buttons

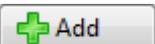
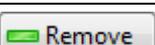
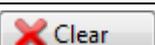
Button	Description
 Import	Opens the file selection dialog for Import of position data
 Add	Adds a position in the position list. The coordinates must be entered manually.
 Remove	Deletes an item from the items list
 Clear	Deletes all items from the items list

Table 8-2: Buttons for page "Coordinates"

### Methods for determining the reference positions

- Using an external measurement system
- Measurement by means of the robot

For further information on the determination of the reference positions see Chapter 10.1

**Acceptable file extension of the file data from the robot**

- \*. dat. (Kuka)
- \*. prg, \*. mod (ABB)

**Acceptable file extension of the file data from the measurement system**

- \*. csv, \*. txt

**Format of the csv data file**

Only csv files in the format of the software company Metromec can be imported



Csv-Files stored in Microsoft Excel get useless and cannot be imported!

**Format:**

```
"F0", "F1 no"; "F2 name", "type F3", "F4 points"; "reference F5", "F6 Mass"; "F7 X",
"Y F8", "F9 Z"; " F10 vx ", " F11 vy ", " F12 vz ", " F13 Mass "; " X F14 ", " F15 Y ", " Z
F16 ", " F17 vx ", " vy F18 ", " F19 vz "; " F20 Wingspan "
"IR1_MP01"; "point / level, Keyed", 1, "XY",, 1530,622, -699 259, 1675,151, 0000,
0000, 1000; ; ; ; ; ; ; 0000
"IR1_MP02"; "point / level, Keyed", 1, "XY",, 2243,581, -528 015, 1770,373, 0000,
0000; -1.000; ; ; ; ; ; 0000
"IR1_MP03"; "point / level, Keyed", 1, "XY",, 2249,518, -1641,038, 1782,211, 0000,
0000; -1.000; ; ; ; ; ; 0000
```

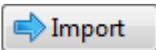
**Format of the txt-data file**

- Parameters separated by semicolons
- Point or comma as decimal separator

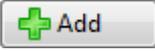
Format: Point name, X, Y, Z

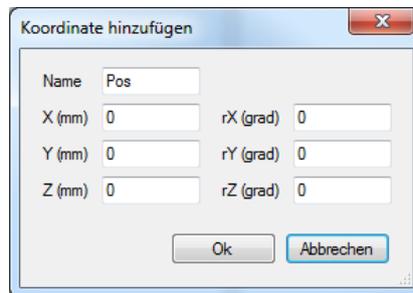
```
IR1_MP01; 4399,617, -132 312, 407 342
```

**Adding a Data File**

- By drag and drop or
- Click the Import button . This opens a file selection window. Depending on the selected project information for the robot brand, the file extension (\*.dat for KUKA, \*.mod,\*.prg for ABB) will be preset.

### Adding individual items

- Click the Add button 
- a window opens for entering position data



### Coordinates window

Coordinate	Description
rX	Rotation around the X-axis in degrees
rY	Rotation around the Y-axis in degrees
rZ	Rotation around the Z-axis in degrees

Table 8-3: Meaning of the rotation data in the coordinate window

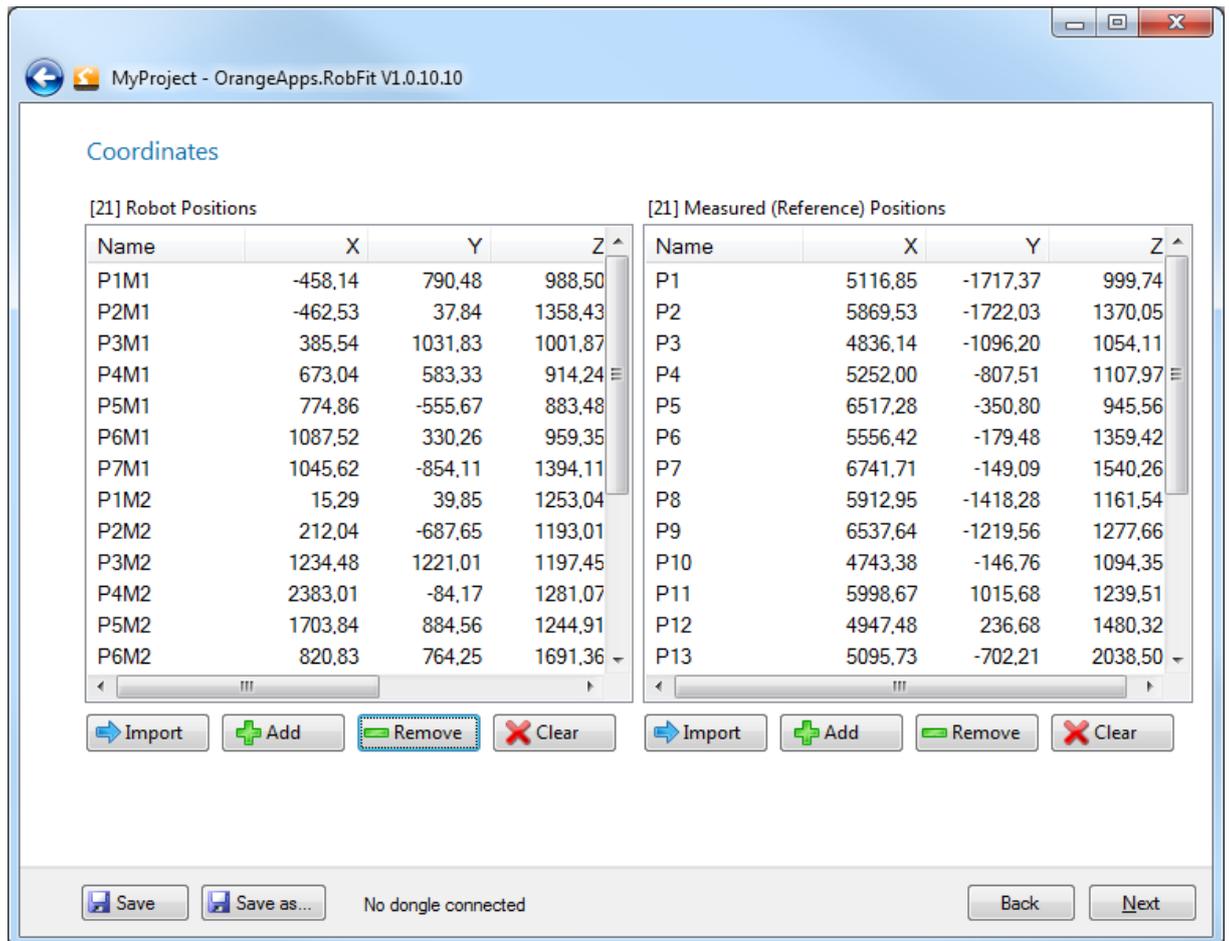
### Delete individual items

- Mark the position and click remove button 

### Clear all locations

- Click the Clear button. 

### Coordinate Window with positions

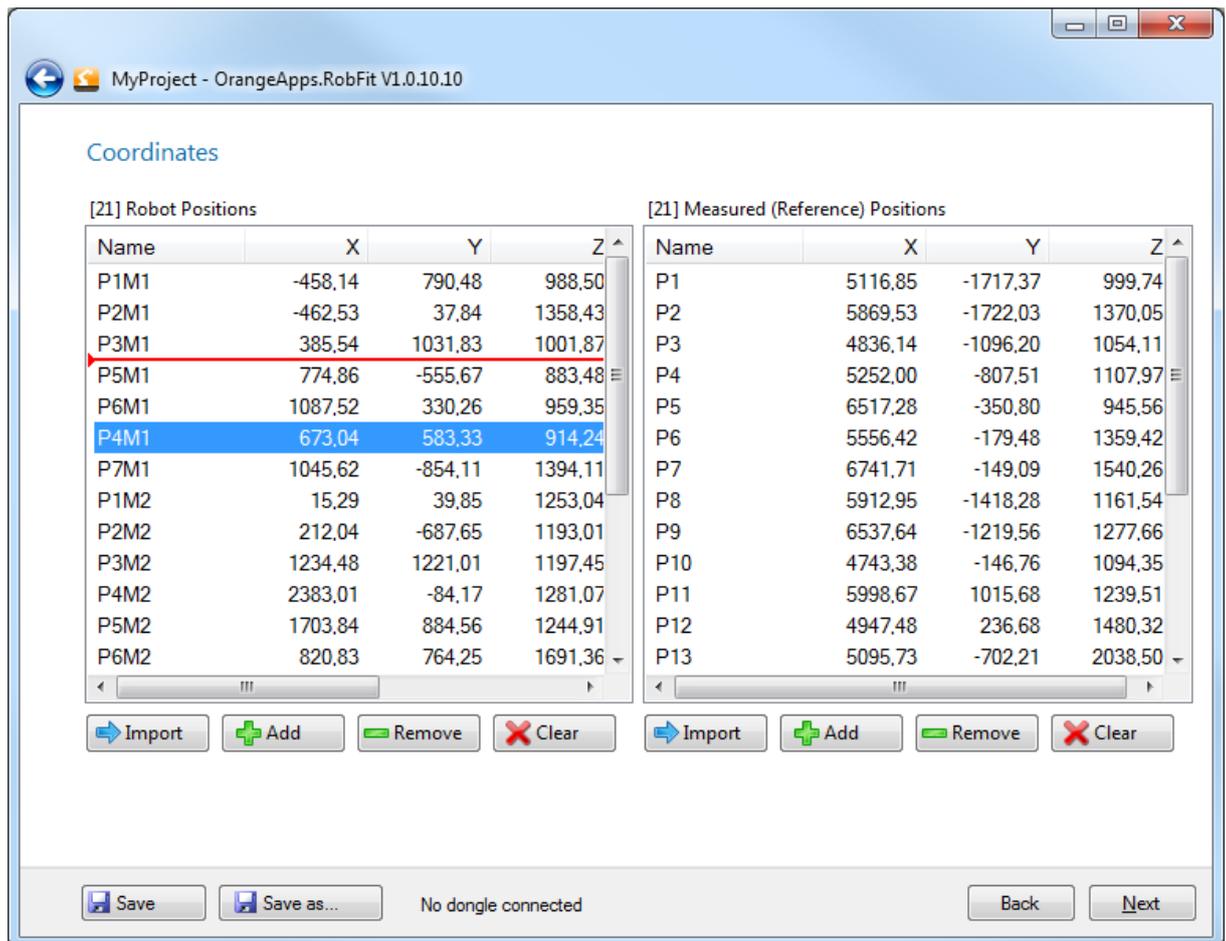


#### Requirements for stepping forward to the page "[Result](#)" by clicking the Next button

- At least three items per list available
- Identical number of positions in both lists

#### Shifting of positions within the list

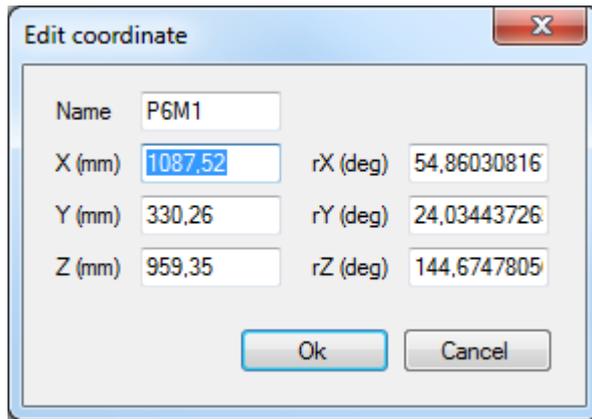
- By simply dragging and dropping individual items can be moved within the lists.



Ensure that the order of the points in both lists is correct (corresponding)  
 Robot Pos 1 belongs to reference Pos 1, Robot Pos 2 belongs to reference Pos 2, and so on...

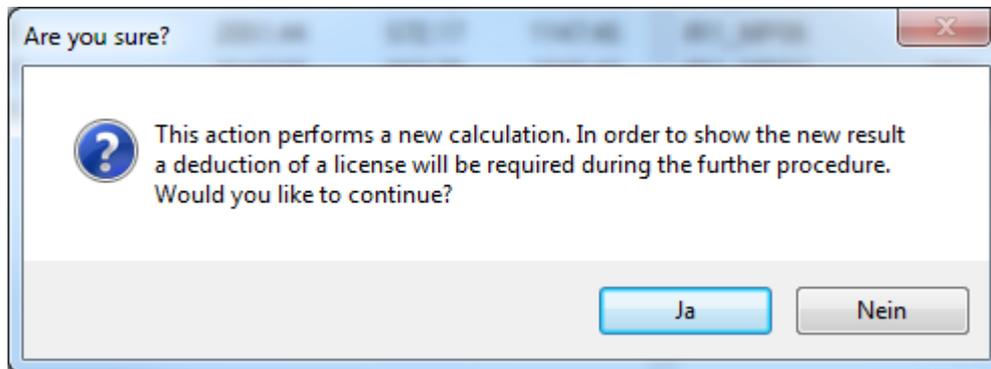
### Editing coordinates

- Double-click on a list entry opens the window for manually entering coordinates. **OK** accepts the values in the list, **Cancel** to reject the entry.



### Dialog message recalculation

This dialog message appears if in already calculated projects (license point already consumed) coordinates or positions are changed.

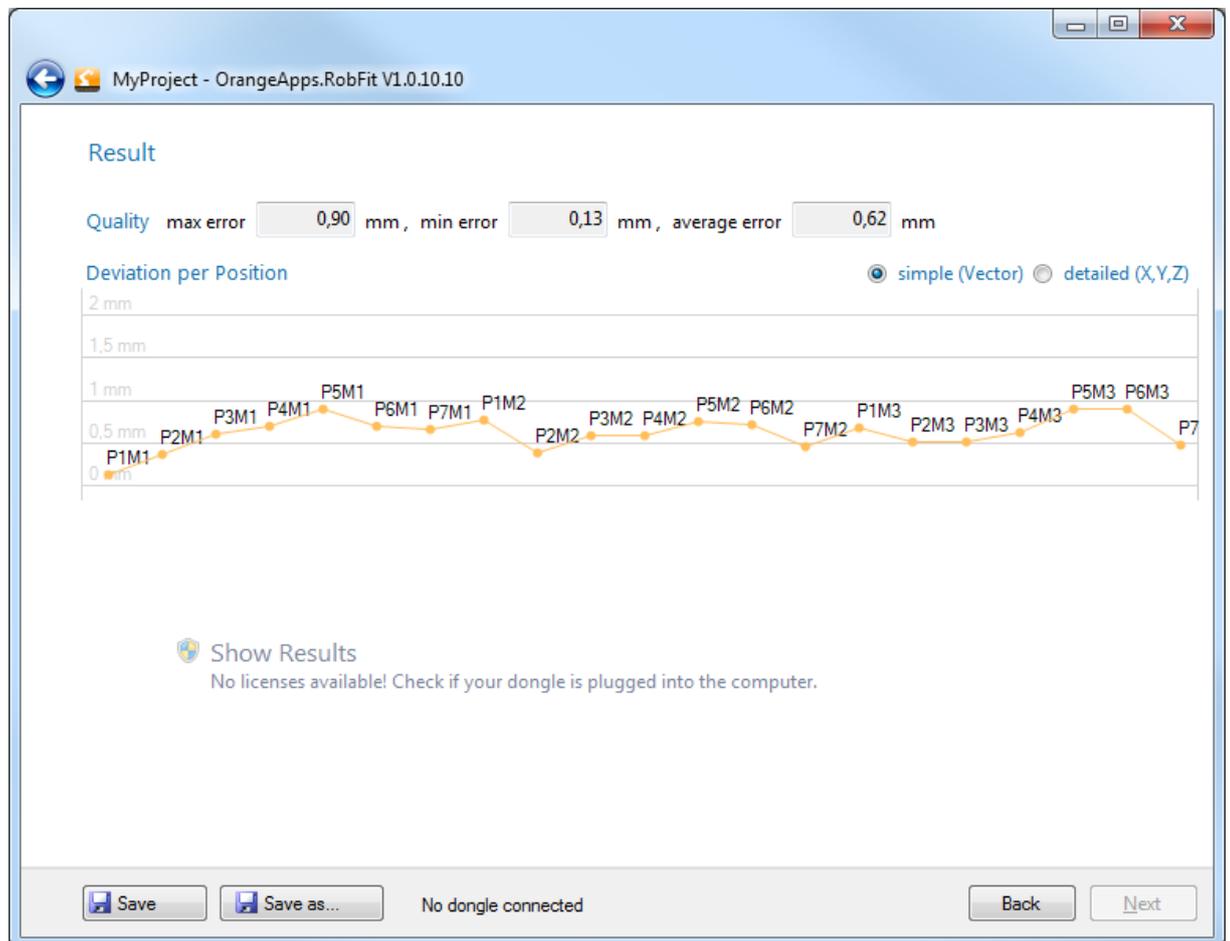


Clicking the **Yes** button leads to a recalculation of the result. To display the new result a licensing point is then required in the further course.

## 8.5 Page "result"

This window displays information about the quality of the measurement and the measurement result itself. To display the result a licensing point is deducted. If a licensing point has already been charged for the calculation a reopening of a project doesn't charge a licensing point again (if the project has been saved properly)

### Window without displayed result



### The quality statement

	Description
Max error	Maximum deviation between the robot position and measurement position
Min error	Minimal deviation between the robot position and measurement position
avg. Error	average deviation between the robot position and measured position

Table 8-4: Representation of the quality

### Diagram

The graph shows for each position the deviation vector between the robot and measuring position. The display can be switched between simple and detailed display.

### Interpretation of the diagram

Example P2M1: If the robot moves to the point P2M1 using the calculated workpiece and tool coordinate system, his maximum physical inaccuracy at this point will be 0.4 mm.

### Causes for errors

A large deviation vector may have the following reasons:

- Positions were not saved correctly in the robot after measuring with the measuring system
- The robot was in a mechanical end position (e.g. extension position A2-A3)
- The position was changed manually.
- The wrong position files were imported to calculate.
- The robot has approached the position with incorrect load data
- The measurement system has been moved during measurement
- The robot is not calibrated correctly
- Mechanical defects of the robot or of the measuring system



To change or improve the calculation result, individual points can be removed from both lists! However, there must remain at least three corresponding positions in each list .



Check all systems and if necessary, repeat the measurement!

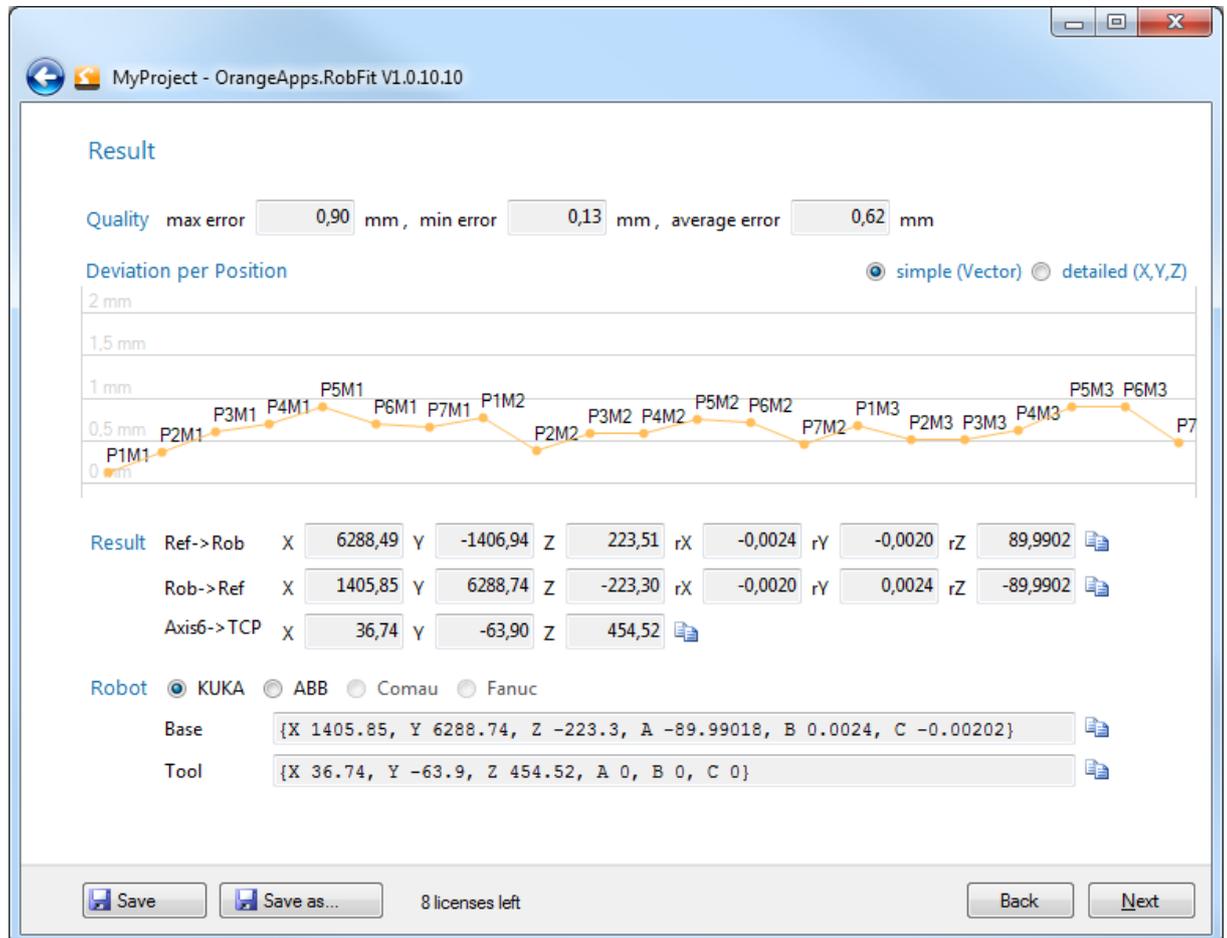
### Robot orientation at the measuring points



The measurement points may not be all approached with the same constant orientation of the robot. This can lead to an erroneous result. Change repeatedly between the points the orientation.

## Displaying the measurement results

To display the result a dongle with stored license points is required. Connect it to the computer and click **Show Results** to display the calculated workpiece coordinate system and the TCP. A dialog message pops up to give notice about the deduction of a license point. By pressing **ok** one licensing point will be charged once!



## Result

	Description
Ref→Rob	Vector of the workpiece coordinate system towards the robot
Rob→Ref	Vector from the robot towards the workpiece coordinate system
Axis6→TCP	Vector of Axis 6 zero towards TCP of the measuring tool
Base / Work Object	Workpiece coordinate system (this will be entered in the robot)
Tool	TCP of the measuring tool

Table 8-5: Presentation of the Results

## Verification of the calculated workpiece coordinate system (important)

Run in any case a verification of the measurement result.

- Enter the calculated workpiece coordinate system and the TCP in the robot controller. If you want to import this data automatically into the controller, you can generate a robot- specific file on the "[Finally](#)" page.
- The methods to verify the results differ depending on the measurement method. Refer to Chapter 10.1

**If using an external measurement system:**

1. Move the robot to 3-4 different points in the designated work area. To do this, use the calculated coordinate system and tool.
2. Compare at each position the displayed position coordinates in the robot with the position data displayed in the measuring system. The values should match with the required accuracy (e.g. + - 2mm)
3. In case of for severe deviation check the accuracy of all parameters (e.g. robot mastering load data, TCP, coordinate systems, measuring system, etc.) and if necessary, repeat the measurement.

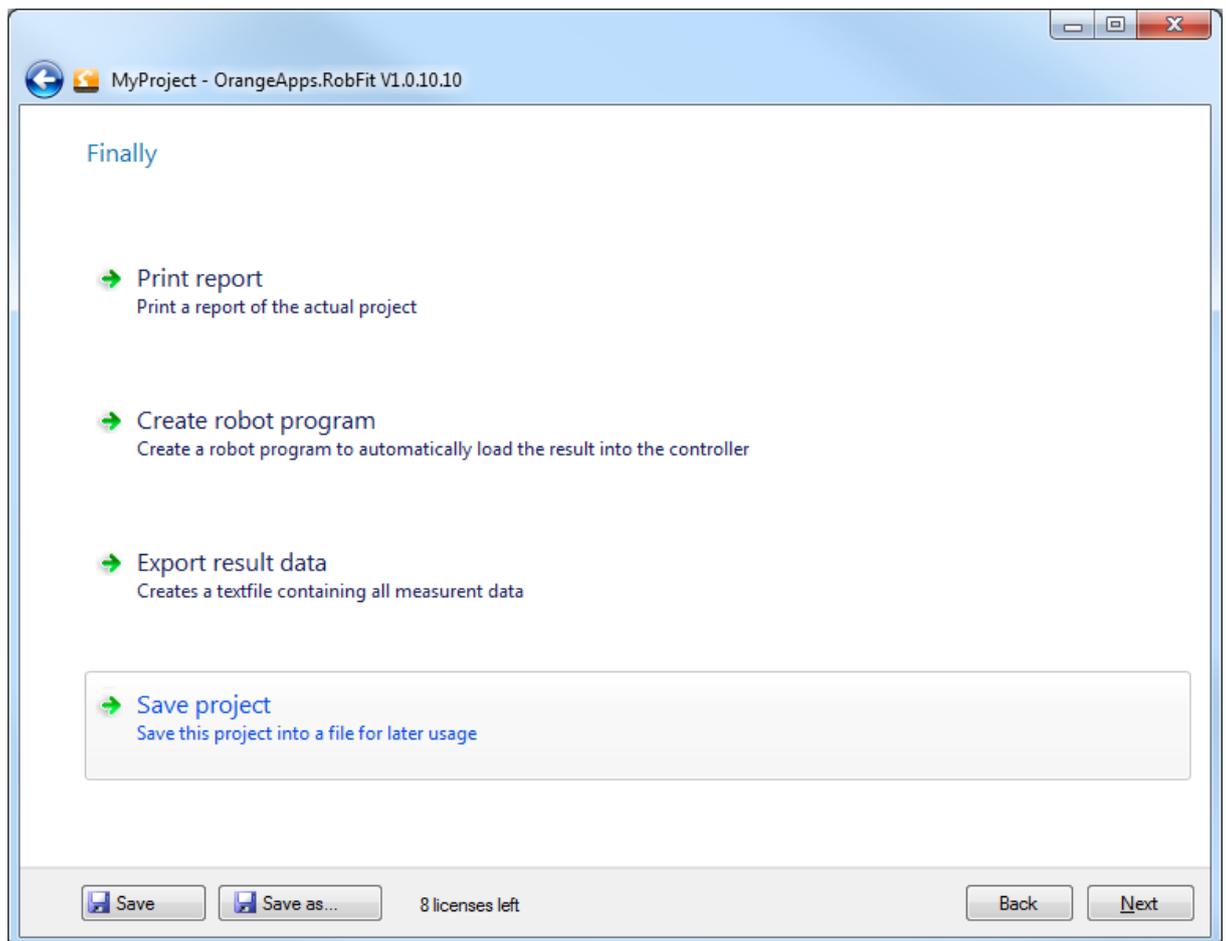
**When using the robot as a measuring system ("peak to peak" method):**

1. Move the robot with the measuring tip to measuring point. Be sure using the calculated coordinate system and calculated TCP for the tip.
2. At each position compare the displayed position coordinates in the robot with the coordinates of the measuring points. The values should match within the required accuracy (e.g. + - 2mm)
3. In case of for severe deviation check the correctness of all parameters (e.g. robot mastering load data, TCP, coordinate systems, measuring system, etc.) and if necessary, repeat the measurement.

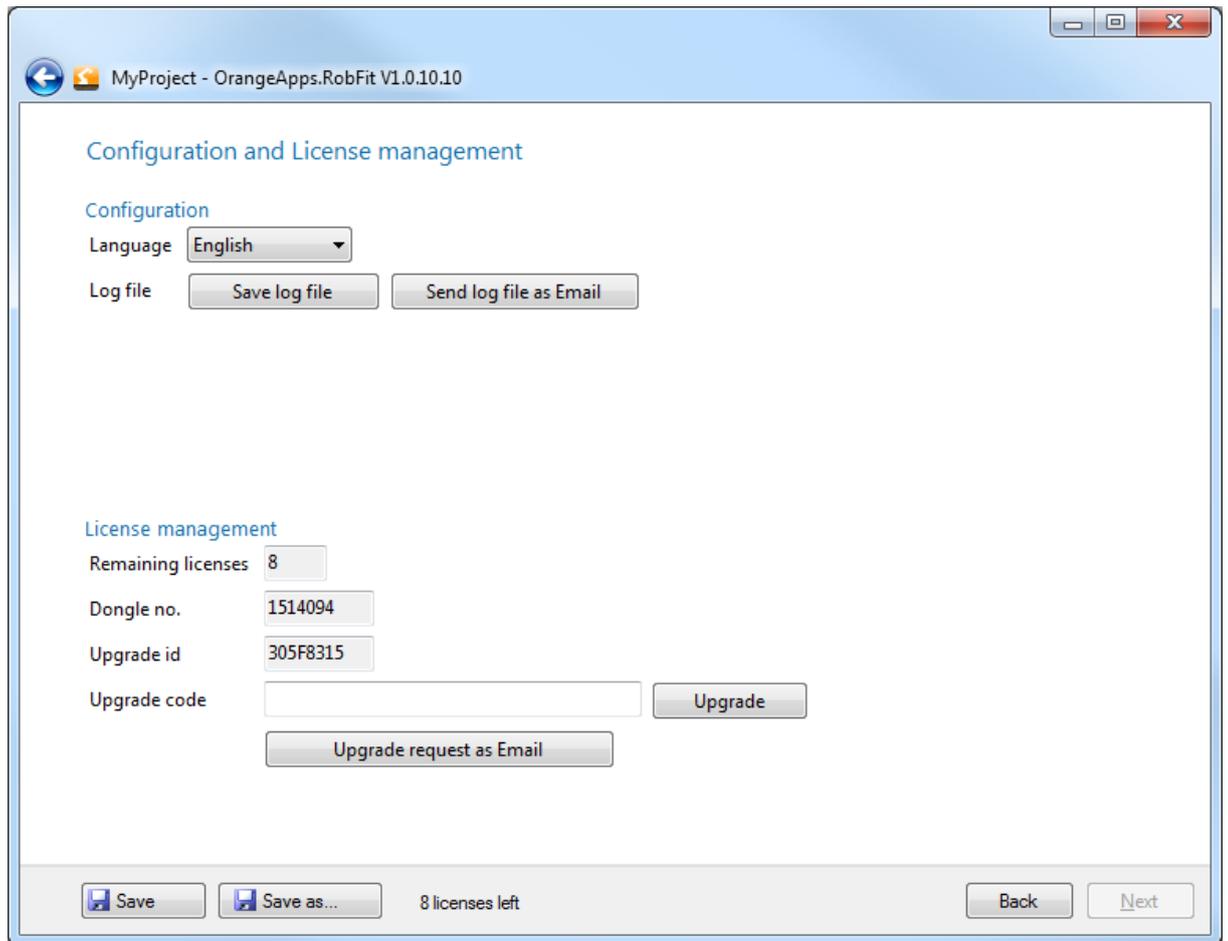
## 8.6 Page "Finally"

This window provides the following functions:

- [Print measurement protocol](#)
- Create a robot specific robot program including the calculated result
- Export all data as a text file
- Save Entire Project



## 9 Configuration and License Management



### 9.1 Configuration

The settings of the used language can be changed.

### 9.2 Log File (used to identify problems with the dongle)

A log file with information on calculations can be saved and sent to us. This file contains only the information we need to identify dongle problems. No personal data is stored!

### 9.3 License Management

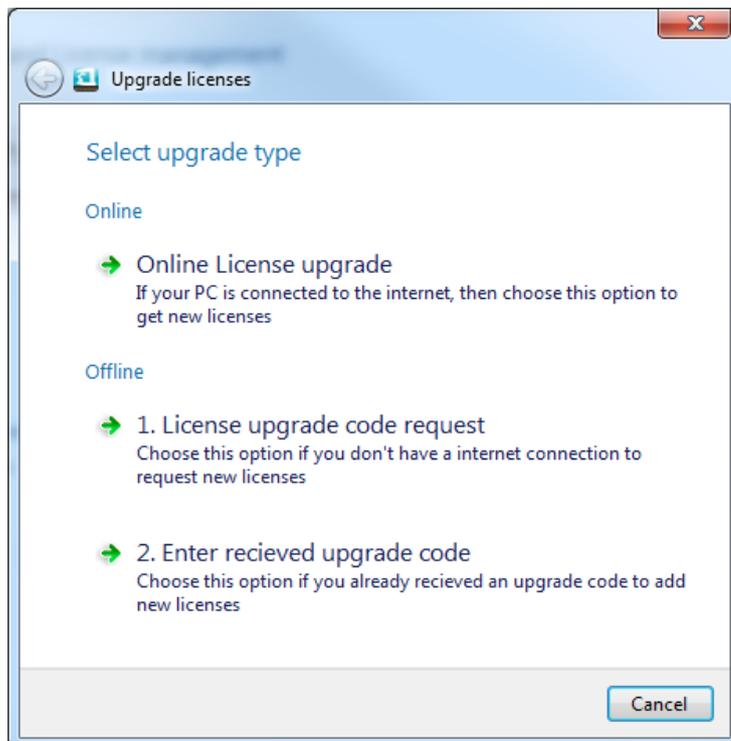
License points are stored only on the dongle, not on the PC. Thus, the software can be used on any number of computers. Purchased license points are stored and managed by OrangeApps in a custom specific license pool. Each customer dongle is associated with this license pool. From this pool of licenses, license points are posted on the dongle when needed. It is therefore not necessary to transfer all purchased license points immediately to a dongle. This reduces potential financial damage in case of loss or theft of the dongle. New license points will be added to those already available on the dongle.

To load license points on the dongle, there are two functions available:

- Online Upgrade (Internet connection required)
- Offline Upgrade

#### Method

1. Connect the dongle to the PC
2. Press **Upgrade Licenses** → this window appears
3. Select the type of upgrade



### 9.3.1 Online license upgrade

This window appears:

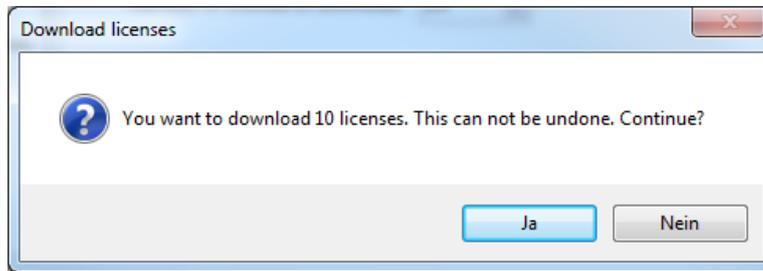
#### Field Description

Field	Description
Name of license pool	Custom specific name of the license pool to which the dongle is associated to
Licenses available in pool	current number of available license points in the pool
Today's limitation for this dongle	The daily available number of license points to download is limited for security reasons by default on 100 points. Each download the number of downloaded license points is subtracted from this and displayed in the field. The default value can be changed (email to <a href="mailto:Info@orangeapps.de">Info@orangeapps.de</a> ).
Number of licenses to download	Number of license points that shall be download onto the dongle

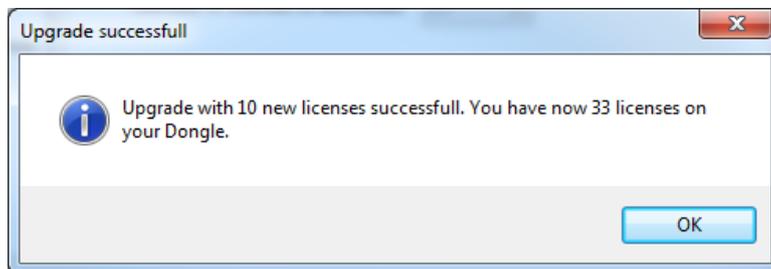
Table 9-1: Field Description Page Online License Upgrade

**Method in order to load license points onto the dongle**

1. Specify the number of licenses to download
2. Press **Finish** → a new window appears



3. Acknowledge the dialog by pressing **Yes**
4. The transfer is initiated. Do not unplug the dongle from the computer. The displayed license points will be added to those already available on the dongle and subtracted from the license pool. After the transfer, the following window is displayed



5. Pressing **OK** finishes the online upgrade

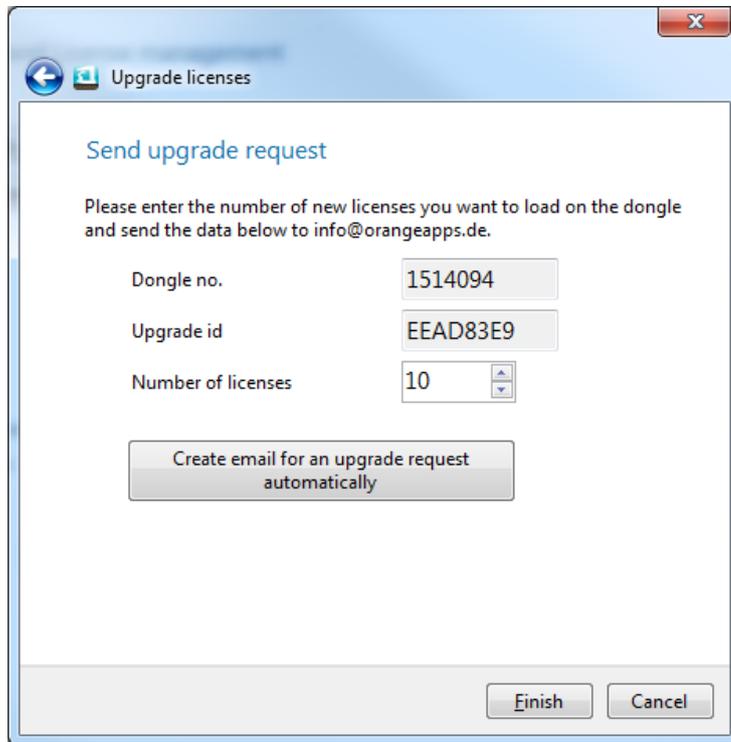


Every download of license points will be logged. There is also the option on each task to receive an email notification. Share us an email address.

## 9.3.2 Offline license upgrade

To manually load licenses on the dongle an upgrade code is necessary. Stating an update ID and the number of license points this code is available from us.

### 9.3.2.1 License upgrade code request



Upgrade licenses

Send upgrade request

Please enter the number of new licenses you want to load on the dongle and send the data below to [info@orangeapps.de](mailto:info@orangeapps.de).

Dongle no. 1514094

Upgrade id EEAD83E9

Number of licenses 10

Create email for an upgrade request automatically

Finish Cancel

#### Method

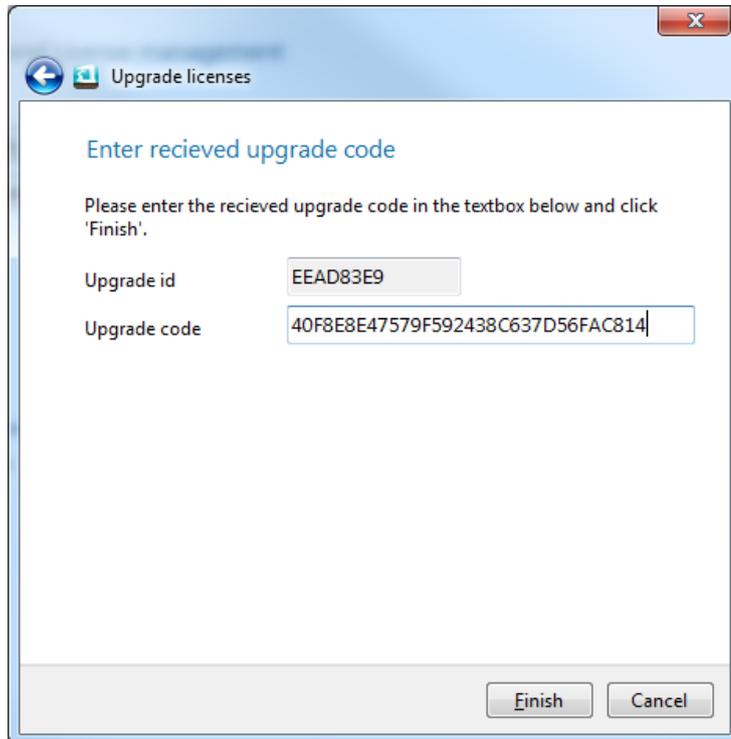
1. Enter the number of license points you want to load on the dongle
2. Press **Create email for an upgrade request automatically**
3. Send the email to [info@orangeapps.de](mailto:info@orangeapps.de)
4. **Finish** closes the window

You will receive an upgrade code immediately by email.

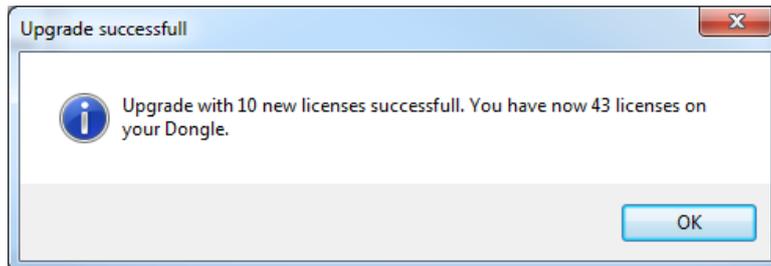
### 9.3.2.2 Enter received upgrade code

#### Method

1. Input the received upgrade code to the text box "Upgrade code"



2. Press **Finish**
  - The purchased license points will be **added** to the existing points on the dongle.
3. The following message appears if everything is ok



4. Press **OK** to close the window

## 10 Appendix

### 10.1 Determining the reference data (measured system data)

The reference data can be determined in various ways. In the following two possible ways are described.

#### Prerequisite for both methods

- Workpiece carrier having at least three measuring points measured with respect to the workpiece coordinate system
- Properly mastered robot



Attached load to the robot must be known and activated in the robot control!

#### 10.1.1 Surveying with external measuring system (e.g., laser tracker from Leica)

- Reference the external measuring system with the workpiece coordinate system
- Attach the measurement helping tool (e.g. reflector bulb) of the measurement system to the robot tool.
- Move the robot to 3-16 points provided in the work area and measure at each point with the external measurement system. Make sure that every point is taught with TCP zero and workpiece coordinate system zero and the correct load.



Use different orientation of the robot at each point. This improves the accuracy of the calculated result.

- Save each measurement point in both the robot and also the measurement system.
- Fill the position coordinates of the robot and the measurement system into RobFit “**Coordinate**” window (e.g. by drag and drop, import or manual entry)
- Check the quality and show the result

#### Verification of the calculated workpiece coordinate system

- Put the calculated TCP and workpiece coordinate system into the robot
- Move the robot to 3-4 points within the designated working area of the robot and measure at each point with the external measurement system. Be sure to use the calculated TCP and workpiece coordinate system
- Compare at each position the displayed robot position coordinates with the position data displayed in the measuring system. The values should match within the required accuracy (e.g. + - 2mm)
- In case of severe deviation check the correctness of all parameters (e.g. robot mastering, load data, TCP, coordinate systems, measuring system, etc.), optionally repeat the measurement
- Remove the help tool from the robot
- The calculated TCP can be deleted in the robot

### 10.1.2 Survey by the robot ("peak to peak" method)

- Attach a tool with a tip to the robot (e.g. a rod with a tip)
- Drive the tip to the measured reference points on the workpiece fixture. **TCP of the tip does not need to be known!** Save each point in the robot program using TCP zero and workpiece coordinate system zero. Ensure to use the correct load data!
- Start RobFit and put the coordinates of the reference points into the "reference points" list in the "**coordinate**" window
- Enter in the "robot positions" list the coordinates of the corresponding robot positions (e.g. drag and drop, import or manual entry)
- Make sure that robot positions and measuring points in the lists correspond with each other (robot point 1 - measuring point 1, robot point 2 - measuring point 2, etc.)
- Start calculation

#### Verification of the workpiece coordinate system calculated

- Approach again each reference position with the tip using now the calculated TCP and calculated workpiece coordinate system
- At each position compare the displayed position coordinates in the robot with the coordinates of the measuring points. The values should match within the required accuracy (e.g. + - 2mm)
- In case of severe deviation check the correctness of all parameters (e.g. robot mastering load data, TCP, coordinate systems, measurement system, etc.)
- Remove the tip from the robot
- The calculated TCP can be deleted in the robot

## 10.2 Generated measurement report



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