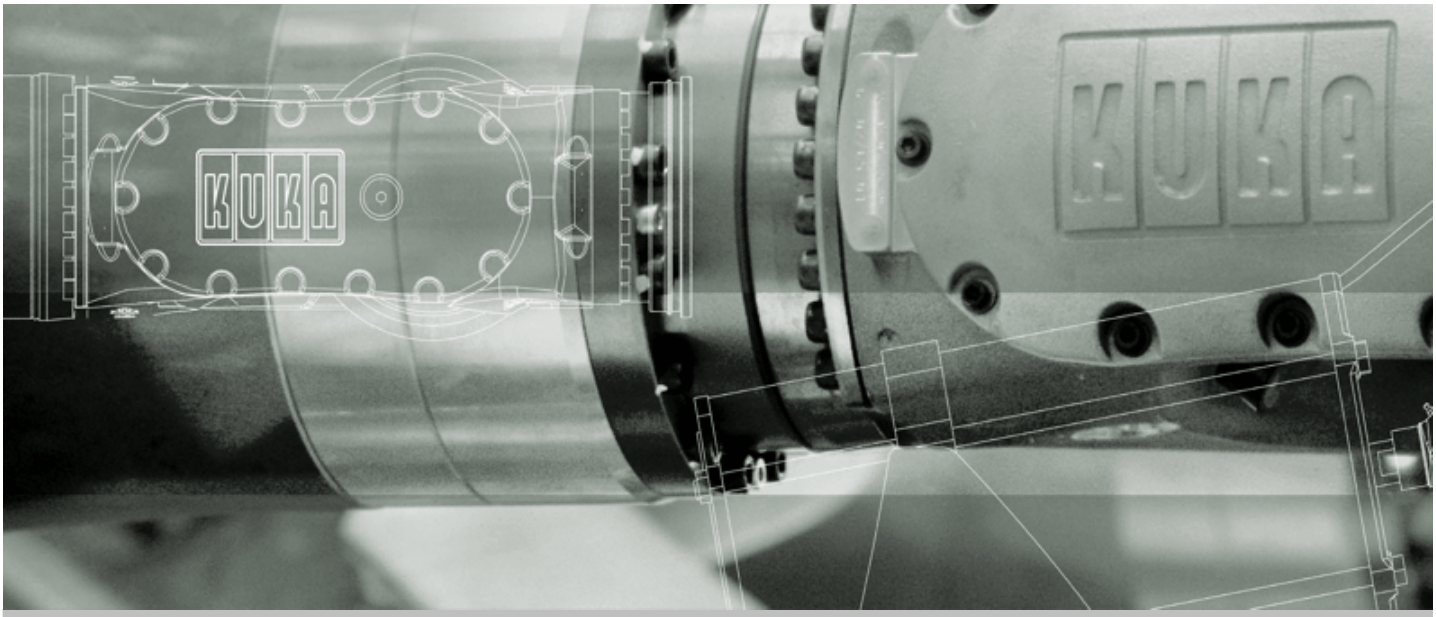

KUKA Robot Group

Software

KUKA.Load 3.1

Operating Instructions

Issued: 15.03.2007 Version: 1.1

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Germany

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Other functions not described in this documentation may be operable in the controller. The user has no claims to these functions, however, in the case of a replacement or service work.

We have checked the content of this documentation for conformity with the hardware and software described. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. The information in this documentation is checked on a regular basis, however, and necessary corrections will be incorporated in the subsequent edition.

Subject to technical alterations without an effect on the function.

KIM-PS4-DOC

Contents

1 Introduction

1.1 Target group

This documentation is aimed at users with the following knowledge and skills:

- Knowledge of robotics
- Advanced knowledge of dynamic and static loading on the robot

For optimal use of our products, we recommend that our customers take part in a course of training at KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

1.2 Representation of warnings and notes

Safety

Warnings marked with this pictogram are relevant to safety and **must** be observed.

Danger!
This warning means that death, severe physical injury or substantial material damage **will** occur, if no precautions are taken.

Warning!
This warning means that death, severe physical injury or substantial material damage **may** occur, if no precautions are taken.

Caution!
This warning means that minor physical injuries or minor material damage **may** occur, if no precautions are taken.

Notes

Notes marked with this pictogram contain tips to make your work easier or references to further information.

Tips to make your work easier or references to further information.

1.3 Trademarks

Windows is a trademark of Microsoft Corporation.

Excel is a trademark of Microsoft Corporation.

2 Product description

2.1 Overview of KUKA.Load

Functions

KUKA.Load is a software product with the following functions:

- Verifying a load situation:
  - Verfying a robot for a given load
  - Selecting a robot for a given load
- Calculating the load for several tools mounted simultaneously on the flange
- Generating a message in the event of static overloading
- Generating a message in the event of dynamic overloading
- Creating acceptance reports (Sign Off Sheets)
- Managing projects with a number of robots
- Data transfer to Excel (form is write-protected)

General process forces cannot be taken into consideration by the software.

Description

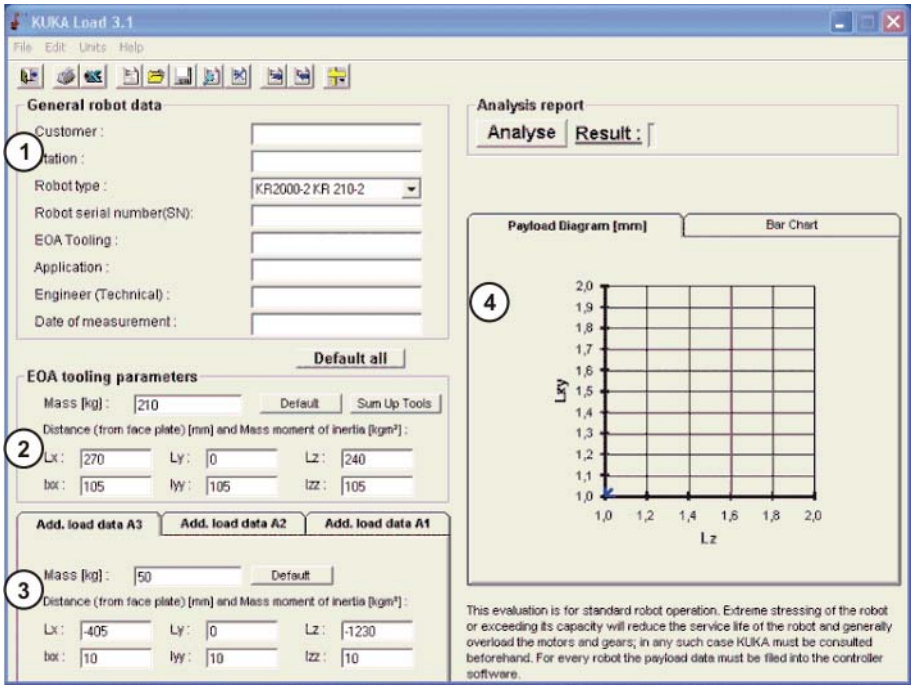


Fig. 2-1: KUKA.Load user interface

1	Data entry fields for customer details and robot type
2	Data entry fields for payloads on the flange
3	Tabs for supplementary loads A1, A2, A3
4	Calculated load data diagram

2.2 Load data

The load data are factored into the calculation of the paths and accelerations and help to optimize the cycle times. The load data must be entered in the robot controller.

Warning!
If a robot is operated with incorrect load data or an unsuitable load, this can result in danger to life and limb and/or substantial material damage to the robot system.

2.2.1 Loads on the robot

Description

Various loads can be mounted on the robot:

- Payload on the flange
- Supplementary load on axis 3
- Supplementary load on axis 2
- Supplementary load on axis 1

All loads added together give the overall load.

There is a payload diagram for every robot. It can be used to check quickly whether the payload could be suitable for the robot. The diagram is not, however, a substitute for checking the payload with KUKA.Load.

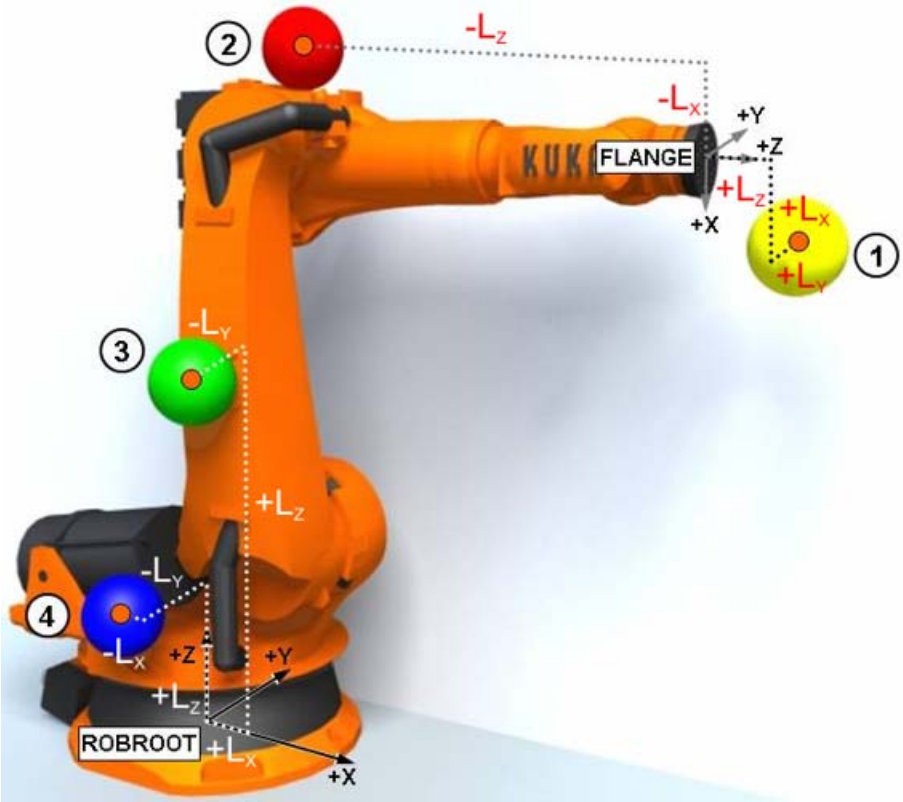


Fig. 2-2: Loads on the robot

1	Payload	3	Supplementary load on axis 2
2	Supplementary load on axis 3	4	Supplementary load on axis 1

Parameters

The load data are defined using the following parameters:

Parameter		Unit
Mass	m	kg lb
Distance to the center of gravity	L_x, L_y, L_z	mm in
Mass moments of inertia at the center of gravity	I_{xx}, I_{yy}, I_{zz}	kg m^2 lb in^2

Reference systems of the X, Y and Z values for each load:

Load	Reference system
Supplementary load A1	ROBROOT coordinate system A2 = -90°
Supplementary load A2	
Supplementary load A3	FLANGE coordinate system A4 = 0°, A5 = 0°, A6 = 0°
Payload	

Sources

Load data can be obtained from the following sources:

- Manufacturer information
- Manual calculation
- Software option KUKA.LoadDetect
- CAD programs

2.2.2 Static overloading of the robot

Description

If the permissible motor braking torques or the motor holding torques under servo control are exceeded while the robot is at a standstill, this is referred to as static overloading of the robot. This overloading can be prevented by means of the following measures:

- Shifting the position of the center of gravity towards the flange center point
- Using a robot with a higher rated payload
- Reducing the mass/weight

The KUKA Robot Group must always be consulted in the case of overloading.

2.2.3 Dynamic overloading of the robot

Description

If the maximum permissible kinetic energy values are exceeded by means of excessive mass moments of inertia, this is referred to as dynamic overloading of the robot. This overloading can be prevented by means of the following measures:

- Reduce the mass moments of inertia by:
  - Using a more geometrically compact load
  - Reducing the mass
  - Using a robot with a higher rated payload

The KUKA Robot Group must always be consulted in the case of overloading.

3 Installation

3.1 System requirements

Hardware

- PC with Pentium processor, min. 166 GHz
- 512 MB RAM
- Graphics card with a resolution of at least 800 x 600 pixels

Software

- Windows 95, WinNT
- Windows 2000 or Windows XP
- Microsoft Excel 97 or higher for:
  - Sign Off Sheet
  - Project creation

3.2 Installing KUKA.Load

Precondition

- Local administrator rights on the PC
- All Windows applications currently running must be closed.
- Any existing versions of KUKA.Load must be uninstalled. Updating without uninstallation is not possible.

Warning!
The software must not be installed on the robot controller.

Procedure

1. Download KUKA.Load free of charge from the KUKA website www.kuka.com.
2. Start the **Setup** program.
3. Press **OK** to continue.
4. If required, change the installation directory with **Change Directory**.
5. Click on  to start the installation.

3.3 Uninstalling KUKA.Load

Precondition

- Local administrator rights on the PC
- All Windows applications currently running must be closed.

Procedure

1. Click on **Control Panel** in the Windows Start menu.
2. Click on **Software**.
3. Select **KUKA.Load** from the list.
4. Click on **Change/Remove** to uninstall the software.

4 Operation

4.1 Starting KUKA.Load

Procedure

- Start the program via the menu sequence **Start** > **Programs** > **KUKA** > **KUKA_Load**.

4.2 User interface for KUKA.Load

Description

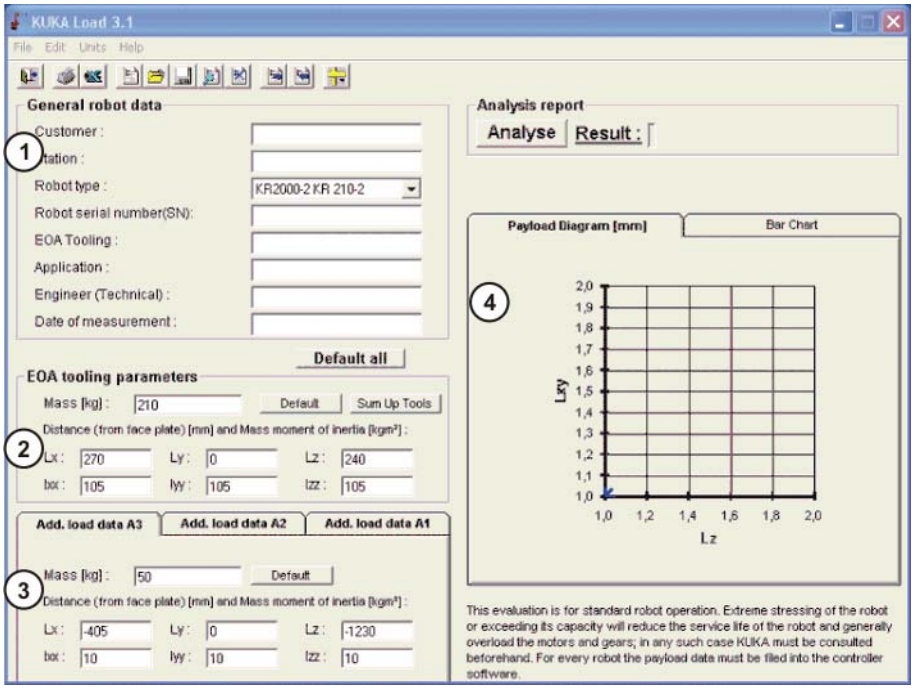


Fig. 4-1: KUKA.Load user interface

1	Data entry fields for customer details and robot type
2	Data entry fields for payloads on the flange
3	Tabs for supplementary loads A1, A2, A3
4	Calculated load data diagram

Description

Fig. 4-2: KUKA.Load toolbar

1	Exit program
2	Print current load data with the default printer
3	Create acceptance report (Sign Off Sheet in Excel)
4	Create new project
5	Open project
6	Save project
7	Display current project (Excel table)
8	Close current project (Excel table)

9	Open robot from current project
10	Add robot to current project
11	Select measurement system

4.3 Creating a new project

Description

A KUKA.Load project can be used to manage and verify the load data for a number of robots. The project is a write-protected Excel file.

Procedure

1. Create a new project using the menu sequence **File** > **New**.
2. Enter the customer details in the **General data** window and select the measurement system.
3. Press **OK** to continue.
   Now the analysis of the load data can be started.

After analysis and project data entry, always save KUKA.Load before closing. New analyses are not automatically saved in an open project.

4.4 Determining the robot for the payload

Precondition

- Load data are known.

Procedure

1. In the **General robot data** area enter the statistical data (customer, serial number, etc.).
2. Select the type of robot in the **General robot data** area under **Robot type**.
3. Click on the button **Default all** to reset all values of the robot type.
4. Enter the values for the payload in the area **EOA tooling parameters**:
   - Mass
   - Distance to the center of gravity (L_X, L_Y, L_Z)
   - Mass moment of inertia at the center of gravity (I_{XX}, I_{YY}, I_{ZZ})

If more than one component is mounted on the flange at the same time, use the **Sum Up Tools** function.

5. Enter the values for the supplementary loads in the tabs **Add. load data A1... A3**:
   - Mass
   - Distance to the center of gravity (L_X, L_Y, L_Z)
   - Mass moment of inertia at the center of gravity (I_{XX}, I_{YY}, I_{ZZ})
6. Click on the **Analyse** button to verify the load data.
   The result is displayed in the **Analysis report** area.

If the load data entered are permissible for the selected robot, the result **Passed** is displayed:

Fig. 4-3: KUKA.Load Analysis report

The robot selected is suitable for the specified load data.

If the selected robot is not suitable for the specified load data, a static overload is shown in the payload diagram and/or a static/dynamic overload is shown in the bar chart.

- Payload diagram:

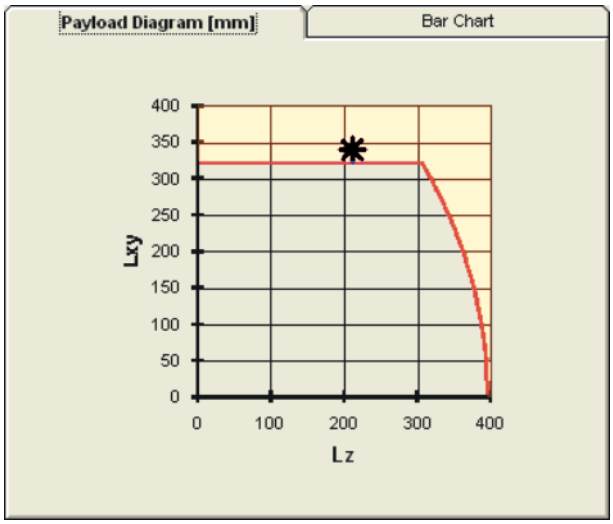


Fig. 4-4: KUKA.Load payload diagram

The calculated point lies outside the limits of the payload diagram. The robot is statically overloaded.

- Bar chart:

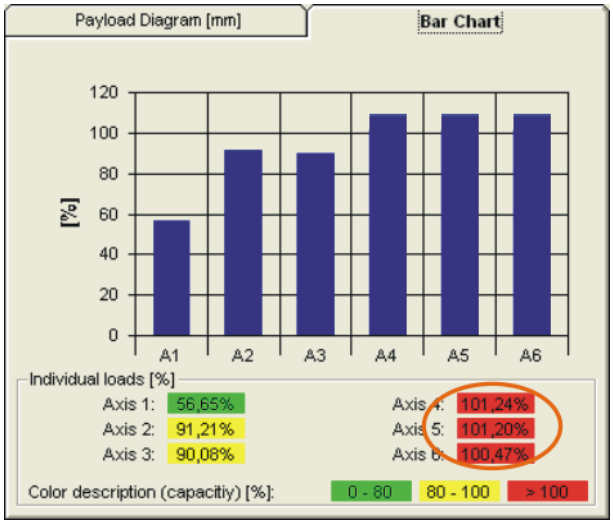


Fig. 4-5: KUKA.Load bar chart

Axes A4 - A6 exceed the 100% limit of the bar chart. The robot is statically and/or dynamically overloaded.

If the selected robot is not suitable:

1. Select a different type of robot in the **General robot data** area under **Robot type**.
2. Click on the **Analyse** button to verify the load data.
3. In the event of repeated negative results, please consult the KUKA Robot Group.

4.5 Verifying the loads on the robot

Precondition

- Load data are known.

Procedure

1. In the **General robot data** area enter the statistical data (customer, serial number, etc.).
2. Select the type of robot in the **General robot data** area under **Robot type**.
3. Click on the button **Default all** to reset all values of the robot type.
4. Enter the values for the payload in the area **EOA tooling parameters**:
   - Mass
   - Distance to the center of gravity (L_X, L_Y, L_Z)
   - Mass moment of inertia at the center of gravity (I_{XX}, I_{YY}, I_{ZZ})

If more than one component is mounted on the flange at the same time, use the **Sum Up Tools** function.

5. Enter the values for the supplementary loads in the tabs **Add. load data A1... A3**:
   - Mass
   - Distance to the center of gravity (L_X, L_Y, L_Z)
   - Mass moment of inertia at the center of gravity (I_{XX}, I_{YY}, I_{ZZ})
6. Click on the **Analyse** button to verify the load data.
   The result is displayed.

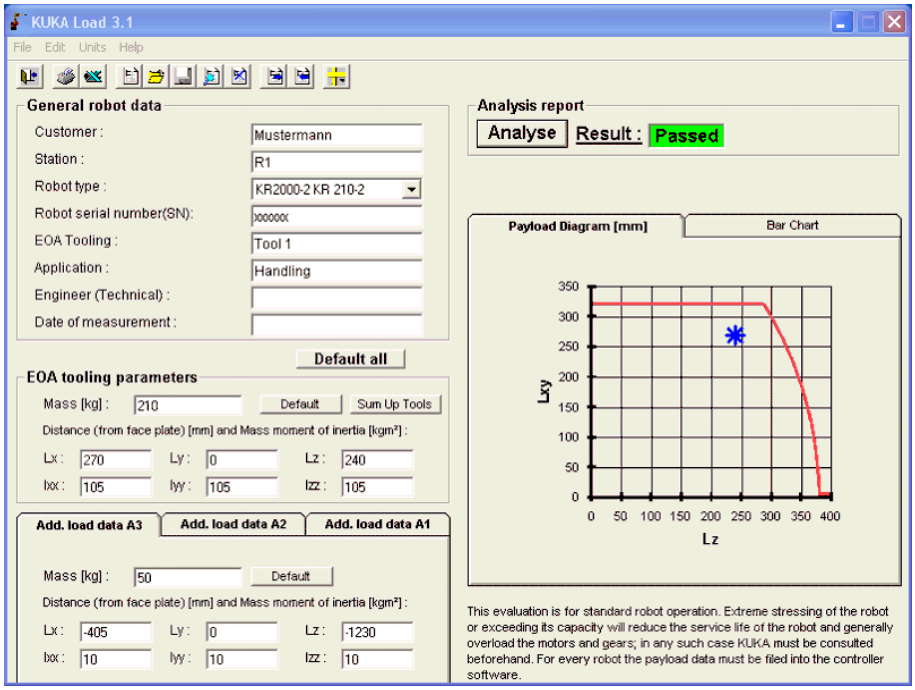


Fig. 4-6: KUKA.Load with payload diagram (result)

4.6 Using the Sum Up Tools function

The **Sum Up Tools** function can be used to calculate the total load from the known values of a number of components mounted simultaneously on the flange (e.g. tool and workpiece). For this, the data for each component are entered separately.

Procedure

1. Click on the **Sum Up Tools** button.

The Tool Summation dialog appears.

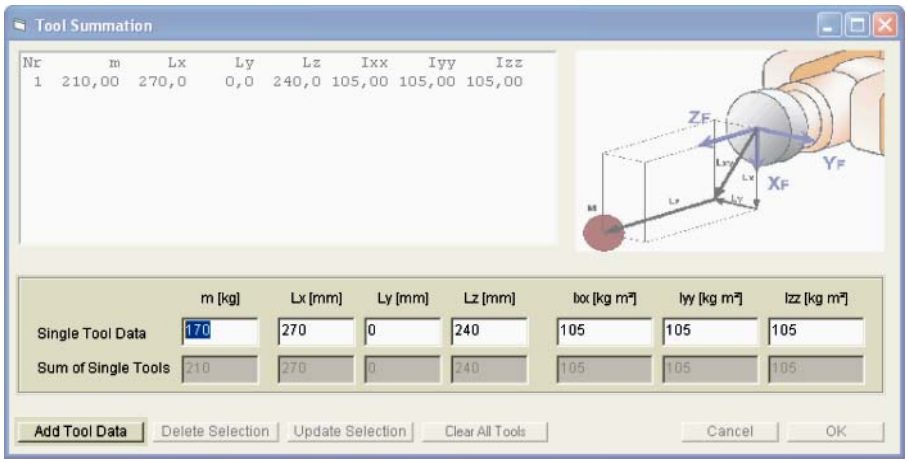


Fig. 4-7: KUKA.Load, Tool Summation dialog

2. Enter the values for the payload in the **Single Tool Data** area:
   - Mass
   - Distance to the center of gravity (L_X, L_Y, L_Z)
   - Mass moment of inertia at the center of gravity (I_{XX}, I_{YY}, I_{ZZ})
3. Add the values to the list using the **Add Tool Data** button.
   The values appear in the window area.
4. Repeat steps 2 and 3 for the next component.
5. When all the values are displayed in the window, start the calculation with **OK**.
   The total load is calculated.

4.7 Saving the robot in the project

Precondition

- Project is created and open.
- The payload has been verified.

Procedure

1. Select the menu sequence **Edit** > **Add Robot** to open the dialog **Save current payload data record**.
2. Enter or accept the serial number of the robot and the customer details.
3. Use the **Save** button to save the data set in the project.

4.8 Opening the robot from the project

Precondition

- The project is open.

Procedure

1. Select the menu sequence **Edit** > **Choose Robot** to open the dialog **Choose robot to analyse**.
2. Select the robot via the serial number and continue with **OK**.

4.9 Creating the Sign Off Sheet

Precondition

- Project is created and open.
- The payload has been verified.

Procedure

1. Select the menu sequence **Edit** > **Sign Off Sheet** to open the dialog **Component Sign Off Sheet**.

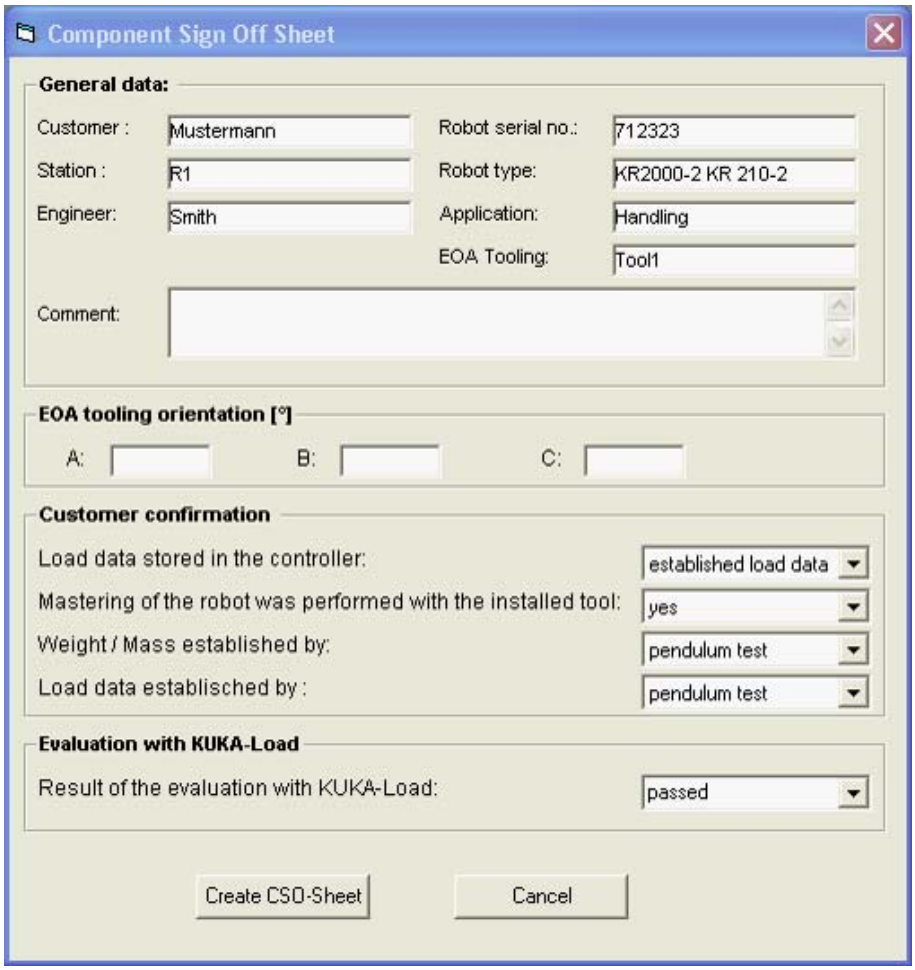
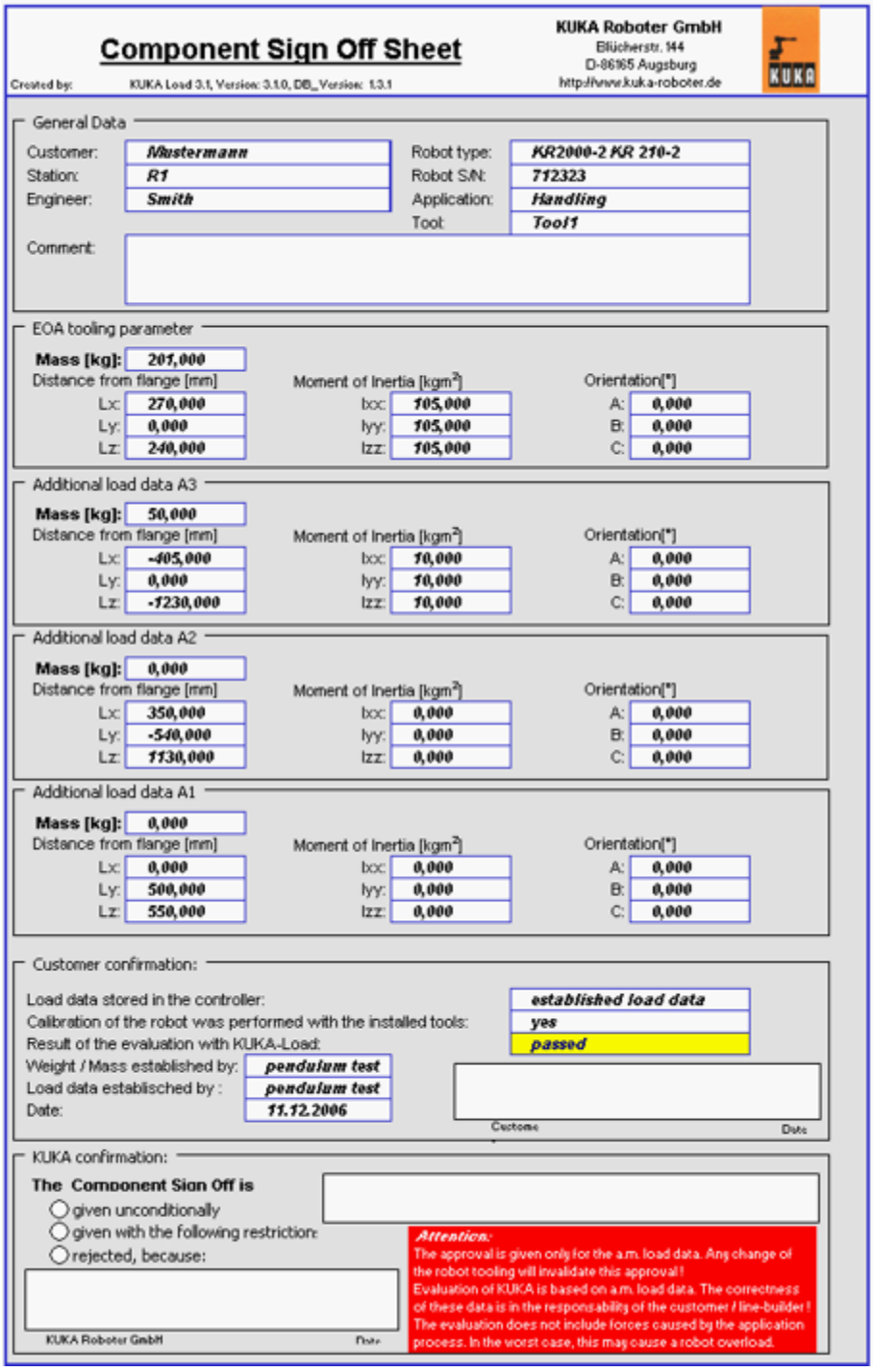


Fig. 4-8: KUKA.Load, Sign Off Sheet dialog

2. Enter or accept the serial number of the robot and the customer details.
3. Optionally: Enter the orientation of the principal inertia axes of the center of gravity in the **EOA tooling orientation** area.
4. Select the following options in the **Customer confirmation** area:
   - Load data saved in the controller:
     - Correct load data entered
     - Work with standard settings
   - Robot mastered:
     - Yes
     - No
   - Weight / mass established by:
     - Measured
     - Determined with KUKA.LoadDetect
     - Calculated
   - Load data established by:
     - Measured
     - Determined with KUKA.LoadDetect
     - Calculated
5. Create the Component Sign Off Sheet using the button **Create CSO-Sheet**.



Component Sign Off Sheet

KUKA Roboter GmbH
Blücherstr. 144
D-86165 Augsburg
http://www.kuka-roboter.de

Created by: KUKA Load 3.1, Version: 3.1.0, DB_Version: 1.3.1

General Data

Customer:	Mustermann	Robot type:	KR2000-2 KR 210-2
Station:	R1	Robot S/N:	712323
Engineer:	Smith	Application:	Handling
		Tool:	Tool1
Comment:			

EOA tooling parameter

Mass [kg]: 201,000

Distance from flange [mm]		Moment of Inertia [kgm²]		Orientation[°]	
Lx:	270,000	Ixx:	105,000	A:	0,000
Ly:	0,000	Iyy:	105,000	B:	0,000
Lz:	240,000	Izz:	105,000	C:	0,000

Additional load data A3

Mass [kg]: 50,000

Distance from flange [mm]		Moment of Inertia [kgm²]		Orientation[°]	
Lx:	-405,000	Ixx:	10,000	A:	0,000
Ly:	0,000	Iyy:	10,000	B:	0,000
Lz:	-1230,000	Izz:	10,000	C:	0,000

Additional load data A2

Mass [kg]: 0,000

Distance from flange [mm]		Moment of Inertia [kgm²]		Orientation[°]	
Lx:	350,000	Ixx:	0,000	A:	0,000
Ly:	-540,000	Iyy:	0,000	B:	0,000
Lz:	1130,000	Izz:	0,000	C:	0,000

Additional load data A1

Mass [kg]: 0,000

Distance from flange [mm]		Moment of Inertia [kgm²]		Orientation[°]	
Lx:	0,000	Ixx:	0,000	A:	0,000
Ly:	500,000	Iyy:	0,000	B:	0,000
Lz:	550,000	Izz:	0,000	C:	0,000

Customer confirmation:

Load data stored in the controller:	established load data
Calibration of the robot was performed with the installed tools:	yes
Result of the evaluation with KUKA-Load:	passed
Weight / Mass established by:	pendulum test
Load data established by :	pendulum test
Date:	11.12.2006

Customer Date

KUKA confirmation:

The Component Sign Off is
- ○ given unconditionally
- ○ given with the following restriction:
- ○ rejected, because:

KUKA Roboter GmbH Date

Attention:
The approval is given only for the a.m. load data. Any change of the robot tooling will invalidate this approval!
Evaluation of KUKA is based on a.m. load data. The correctness of these data is in the responsability of the customer / line-builder!
The evaluation does not include forces caused by the application process. In the worst case, this may cause a robot overload.

Fig. 4-9: KUKA.Load Sign Off Sheet

When submitting the Sign Off Sheet for checking by the KUKA Robot Group, please always include the project database (Excel).

5 KUKA Service

5.1 Requesting support

Introduction

The KUKA Robot Group documentation offers information on operation and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Faults leading to production downtime are to be reported to the local KUKA subsidiary within one hour of their occurrence.

Information

The following information is required for processing a support request:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software
- Application used
- Any external axes used
- Description of the problem, duration and frequency of the fault

5.2 KUKA Customer Support

Availability

KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.

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