

KUKA

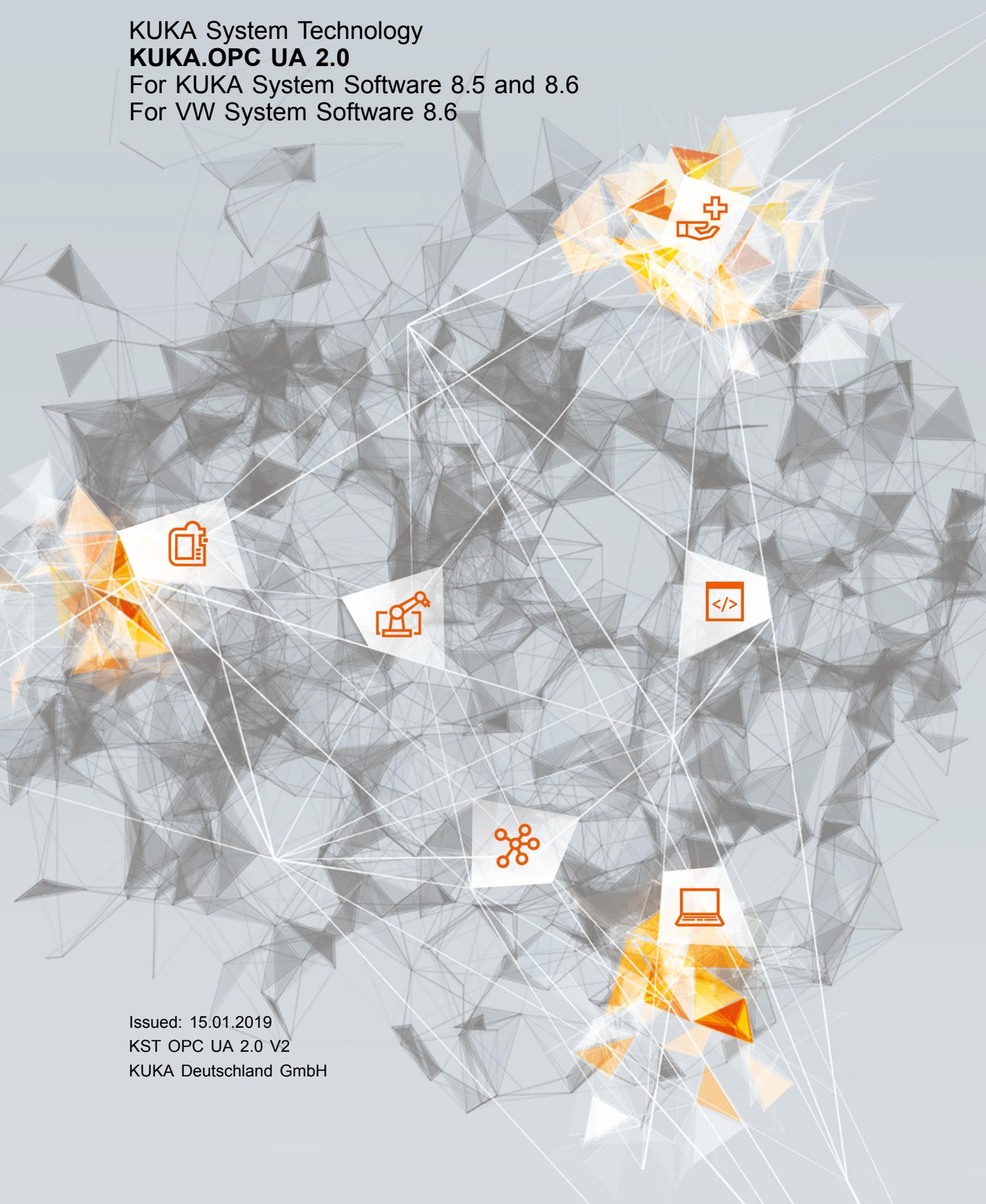


KUKA System Technology

KUKA.OPC UA 2.0

For KUKA System Software 8.5 and 8.6

For VW System Software 8.6



Issued: 15.01.2019

KST OPC UA 2.0 V2

KUKA Deutschland GmbH

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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-PS5-DOC

Translation of the original documentation

Publication: Pub KST OPC UA 2.0 (PDF) en
PB9970

Book structure: KST OPC UA 2.0 V2.1
BS9308

Version: KST OPC UA 2.0 V2

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1 Introduction

1.1 Target group

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

- Advanced knowledge of the robot controller system
- Advanced knowledge of network connections



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 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the robot arm
- Documentation for the robot controller
- Documentation for the smartPAD-2
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Spare parts in KUKA.Xpert

Each of these sets of instructions is a separate document.

1.3 Representation of warnings and notes

Safety

These warnings are relevant to safety and **must** be observed.



DANGER

These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.



WARNING

These warnings mean that death or severe injuries **may** occur, if no precautions are taken.



CAUTION

These warnings mean that minor injuries **may** occur, if no precautions are taken.

NOTICE

These warnings mean that damage to property **may** occur, if no precautions are taken.



These warnings contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

This warning draws attention to procedures which serve to prevent or remedy emergencies or malfunctions:

SAFETY INSTRUCTION

The following procedure must be followed exactly!

Procedures marked with this warning **must** be followed exactly.

Notices

These notices serve to make your work easier or contain references to further information.



Tip to make your work easier or reference to further information.

1.4 Terms used

Term	Description
IP	Internet Protocol The Internet Protocol is used to define subnetworks by means of physical MAC addresses.
KLI	KUKA Line Interface Ethernet interface of the robot controller for external communication (not real-time-capable).
OPC	Open Platform Communication Previously also known as OLE for Process Control Specification for data exchange between applications based on Microsoft Windows COM/DCOM technology
OPC UA	OPC Unified Architecture Software framework for data exchange between applications based on platform-independent technologies
TCP/IP	Transmission Control Protocol Protocol of the data exchange between devices of a network. TCP constitutes a virtual channel between 2 sockets in a network connection. Data can be transmitted on this channel in both directions.

1.5 Trademarks

Windows is a trademark of Microsoft Corporation.

UaExpert[®] is a trademark of Unified Automation GmbH.

1.6 Licenses

The KUKA license conditions and the license conditions of the open-source software used can be found in the following folders:

- Under .\LICENSE on the data storage medium with the installation files of the KUKA software
- Under D:\KUKA_OPT*Option package name*\LICENSE after installation on the robot controller

- In the license folder under the name of the option package in the **Options** catalog after installation in WorkVisual



Further information about open-source licenses can be requested from the following address: opensource@kuka.com

2 Product description

2.1 Overview

Description

KUKA.OPC UA 2.0 is an add-on option package that installs an OPC UA interface on the robot controller. The interface provides a predefined set of robot data that can be read and written using an OPC UA client.

Functions

The option package offers the following functions:

- Using the robot controller as OPC UA server
- Connection of multiple OPC UA clients
- Reading and writing robot data
- Access management via user groups

Data

The following data are provided:

- All process data, i.e. all KRL variables
- All customer-specific information, i.e. all user-specific nodes created by the user
- The following basic information about the kinematic system and the robot controller:
 - Robot name
 - Serial number of the robot
 - Robot type
 - Operating system (system software)
 - Robot controller type
 - Serial number of the robot controller (if available)
 - WorkVisual project name
 - WorkVisual project activation time
 - WorkVisual project description
 - IP address of the robot controller (KLI)
 - Installed software options

Restriction

The data provided by the OPC UA server are not automatically updated in the OPC UA client if a value is changed. On the client side, it must be ensured that the data are regularly requested from the server.

OPC UA client

In order to be able to process the data published with KUKA.OPC UA 2.0, an OPC UA client is required. We recommend using the following demo client for test purposes.

- UaExpert v1.4.x and higher

The UaExpert demo client can be downloaded free of charge from the website of Unified Automation GmbH:

www.unified-automation.com

Communication

An OPC UA client must connect to the OPC UA server via the KLI of the robot controller. As standard, the following port is specified for this:

- Port 4840

2.2 Intended use**Use**

The option package KUKA.OPC UA 2.0 installs an OPC UA interface and is used for reading and writing variables. There are absolutely no safety-relevant functions. Safety-relevant data cannot be influenced or overwritten via the interface.

Misuse

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. The manufacturer cannot be held liable for any damage resulting from such use. The risk lies entirely with the user.

3 Safety

This documentation contains safety instructions which refer specifically to the option package described here.

The fundamental safety information for the industrial robot can be found in the “Safety” chapter of the Operating and Programming Instructions for System Integrators or the Operating and Programming Instructions for End Users.



WARNING

The “Safety” chapter in the operating and programming instructions must be observed. It is particularly important to observe those safety measures which are required to ensure complete implementation of the principle of “single point of control” (SPOC). Failure to implement these safety measures may result in death to persons, severe injuries or considerable damage to property.



WARNING

Signal states can be changed by accessing an OPC UA client or by transferring a project from WorkVisual. It must be ensured that potentially hazardous signals (e.g. the opening/closing of a gun) can only be executed if an automatic mode is set and the safety gate is closed. For this, the signals must be mapped accordingly to the variables **bSPOC_UserSafetyActive** and **bSPOC_MotionEnabled**.



KUKA.OPC UA allows up to 100 individual OPC UA connections through which a manipulation of the robot controller is possible. To reduce the risk of unauthorized access to the robot controller, it is recommended to limit the number of OPC UC clients and authorized OPC UA users to a few devices.

3.1 Safety measures for “single point of control”

Overview

If certain components in the industrial robot are operated, safety measures must be taken to ensure complete implementation of the principle of “single point of control” (SPOC).

The relevant components are:

- Submit interpreter
- PLC
- OPC server
- Remote control tools
- Tools for configuration of bus systems with online functionality
- KUKA.RobotSensorInterface



The implementation of additional safety measures may be required. This must be clarified for each specific application; this is the responsibility of the system integrator, programmer or user of the system.

Since only the system integrator knows the safe states of actuators in the periphery of the robot controller, it is his task to set these actuators to a safe state, e.g. in the event of an EMERGENCY STOP.

T1, T2

In modes T1 and T2, the components referred to above may only access the industrial robot if the following signals have the following states:

Signal	State required for SPOC
\$USER_SAF	TRUE
\$SPOC_MOTION_ENABLE	TRUE

Submit interpreter, PLC

If motions, (e.g. drives or grippers) are controlled with the submit interpreter or the PLC via the I/O system, and if they are not safeguarded by other means, then this control will take effect even in T1 and T2 modes or while an EMERGENCY STOP is active.

If variables that affect the robot motion (e.g. override) are modified with the submit interpreter or the PLC, this takes effect even in T1 and T2 modes or while an EMERGENCY STOP is active.

Safety measures:

- In T1 and T2, the system variable \$OV_PRO must not be written to by the submit interpreter or the PLC.
- Do not modify safety-relevant signals and variables (e.g. operating mode, EMERGENCY STOP, safety gate contact) via the submit interpreter or PLC.

If modifications are nonetheless required, all safety-relevant signals and variables must be linked in such a way that they cannot be set to a dangerous state by the submit interpreter or PLC. This is the responsibility of the system integrator.

OPC server, remote control tools

These components can be used with write access to modify programs, outputs or other parameters of the robot controller, without this being noticed by any persons located inside the system.

Safety measure:

If these components are used, outputs that could cause a hazard must be determined in a risk assessment. These outputs must be designed in such a way that they cannot be set without being enabled. This can be done using an external enabling device, for example.

Tools for configuration of bus systems

If these components have an online functionality, they can be used with write access to modify programs, outputs or other parameters of the robot controller, without this being noticed by any persons located inside the system.

- WorkVisual from KUKA
- Tools from other manufacturers

Safety measure:

In the test modes, programs, outputs or other parameters of the robot controller must not be modified using these components.

4 Installation

The option package can be installed on the robot controller via the smartHMI.

4.1 System requirements

Hardware

- Robot controller:
 - KR C4
 - Or VKR C4
- Laptop/PC

Software

Robot controller:

- KUKA System Software 8.5 or 8.6
- Or VW System Software 8.6

Laptop/PC:

- For KUKA System Software 8.5:
 - WorkVisual 5.0.x or higher
- For KUKA and VW System Software 8.6:
 - WorkVisual 6.0

The number of the required release must be taken from the file Release-Notes_[...].TXT. The file is located on the data storage medium with the KUKA.OPC UA 2.0 software.

Resources

Port 4840 must not be assigned in the KLI network configuration.

Compatibility

KUKA.OPC UA 2.0 must not be installed on a robot controller together with the following option package:

- KUKA.OPC Server 5.0

4.2 Installation via smartHMI

4.2.1 Installing or updating an option package



It is advisable to archive all relevant data before updating a software package.

Precondition

- User rights:
 - KSS: Function group **General configuration**
But at least the user group “Expert”
 - VSS: User group “User”

- T1 or T2 mode
- No program is selected.
- USB stick with the option package (KOP file)

NOTICE

We recommend using a KUKA USB stick. Data may be lost if a stick from a different manufacturer is used.

Procedure

1. Connect the USB stick to the robot controller or smartPAD.
2. In the main menu, select **Start-up > Additional software**.
3. Press **New software**: An entry for the option package (name and version) must be displayed in the **Name** column and drive **E:** or **K:** in the **Path** column.
If not, press **Refresh**.
4. If the entry for the option package is now displayed, continue with step 5.
Otherwise, the path from which the software is to be installed must be configured first:
 - a. Press the **Configure** button.
 - b. Select a line in the **Installation paths for options** area.
Note: If the line already contains a path, this path will be overwritten.
 - c. Press **Path selection**. The available drives are displayed.
 - d. If the stick is connected to the robot controller: Select **E:**.
If the stick is connected to the smartPAD: **K:** instead of **E:**
 - e. Press **Save**. The **Installation paths for options** area is displayed again. It now contains the new path.
 - f. Mark the line with the new path and press **Save** again.
5. Activate the check box next to the option package and press **Install**. Confirm the installation query with **OK**.
6. The request for confirmation *Do you want to activate the project [...]?* is displayed. The active project is overwritten during activation. If no relevant project will be overwritten: Answer the query with **Yes**.
7. An overview with the changes and a request for confirmation are displayed. Answer this with **Yes**. The option package is installed and the robot controller carries out a reboot.
8. Remove the stick.

LOG file

A LOG file is created under C:\KRC\ROBOTER\LOG.

4.2.2 Uninstalling an option package

It is advisable to archive all relevant data before uninstalling a software package.

Precondition

- User rights:
 - KSS: Function group **General configuration**
But at least the user group “Expert”

- VSS: User group “User”
- T1 or T2 mode
- No program is selected.

Procedure

1. In the main menu, select **Start-up > Additional software**.
2. Activate the check box next to the option package and press **Uninstall**. Answer the request for confirmation with **Yes**.
3. Answer the request for confirmation *Do you want to activate the project [...]?* with **Yes**.
4. An overview with the changes and a request for confirmation are displayed. Answer this with **Yes**. The option package is uninstalled and the robot controller carries out a reboot.

LOG file

A LOG file is created under C:\KRC\ROBOTER\LOG.

5 Operation



The following descriptions and procedures are based on the UaExpert demo client.

5.1 Adding the server in the client

Description

In order to connect to the OPC UA server on the robot controller, it must be added to the OPC UA client. The connection can be established via the IP address of the robot controller or the controller name.

Precondition

- IP address or name of the robot controller is known.

Procedure

- Enter the following URL when adding the server:
 - `opc.tcp://IP address:4840`
 - Or: `opc.tcp://Controller name:4840`

5.2 Performing file operations

Description

Depending on the user rights (>>> [6.1 "Access management via user groups" Page 25](#)), it is possible to access the file system on the robot controller and perform file operations. The following OPC UA methods are available for this:

- **Open**
Opens a file for further file operations.
The access mode must be specified when opening a file:
 - **1**: File is opened with read access.
 - **2**: File is opened with write access.
 - **3**: File is opened with read and write access.
 The return value is a handle number that is required for all further file operations.
- **SetPosition**
Defines the file position from which a subsequent file operation is to be carried out.
- **GetPosition**
Specifies the current file position. If no other file position is defined, a subsequent file operation will be performed from this position.
- **Read**
Reads the part of a file starting at the current file position. The file position jumps forwards by the number of bytes read.
- **Write**
Writes the part of a file starting at the current file position. The file position jumps forwards by the number of bytes written.
- **Close**
Closes an open file. On closing, the handle number becomes invalid.

Precondition

- To read files: User group OpcUaObserver
- To write files: User group OpcUaOperator

Procedure

1. Open the file to read or write.
 - a. Right-click on **Open** and call the method with **Call...**
 - b. Transfer the desired access mode to the method and click on **Call**.
The method provides the handle number for further file operations.
 - c. Close the method.
2. If necessary, define the file position from which a subsequent file operation is to be carried out with **SetPosition**.
3. Read and/or write the file with **Read** and/or **Write**.
4. Repeat steps 2 and 3 as often as required.
5. Close the file with **Close**.

5.3 Overview: Information model

If the OPC UA client is connected to the OPC UA server, the current data are retrieved from the robot controller and displayed in the **Address Space** window.

If an element is selected, its properties are displayed in the **Attributes** window.

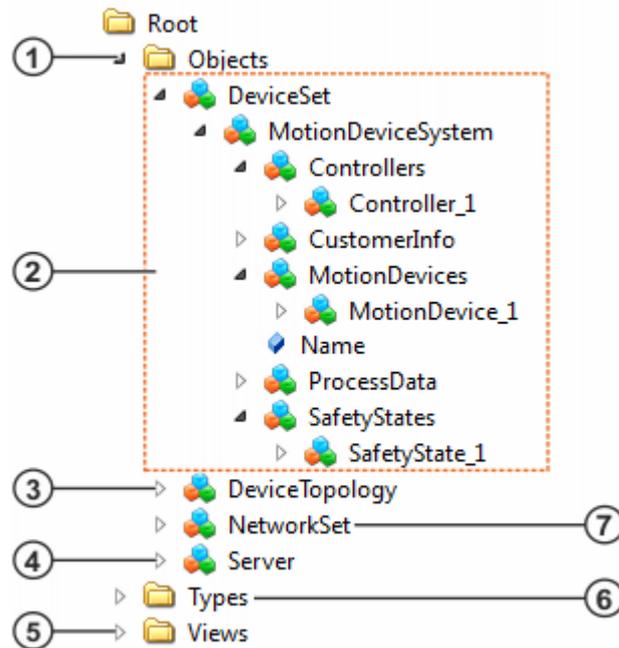


Fig. 5-1: Overview: Information model

Item	Description
1	Objects folder The folder contains the currently retrieved robot data.
2	Information about the robot system <ul style="list-style-type: none"> • Robot controller • Customer information • Kinematic systems • Process data • Safety status
3	Information from the OPC Foundation (not currently used by KUKA)
4	Runtime information about the OPC UA server
5	Views folder No Views are currently defined by KUKA.
6	Types folder The folder contains the definitions for each object type used in the Objects folder.
7	Information from the OPC Foundation (not currently used by KUKA)

5.3.1 Information about the robot controller

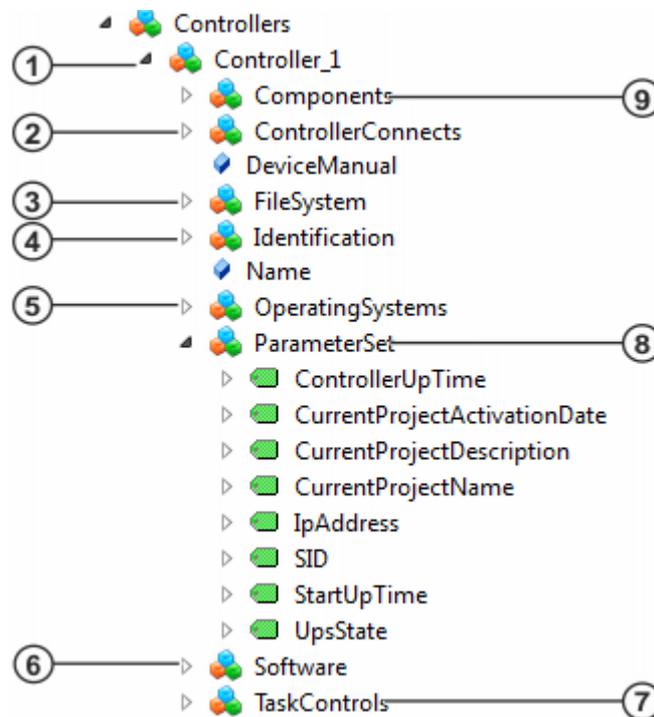


Fig. 5-2: Information about the robot controller

Item	Description
1	Controller_1 object The Controller_1 object provides the system messages of the system software as OPC UA events.
2	KLI network configuration and performance indicators
3	Information about the file system <ul style="list-style-type: none"> • KRCDiag • Configuration files • Programs • Log files
4	Electronic identification plate of the robot controller <ul style="list-style-type: none"> • Article number • Manufacturer • Model • Serial number
5	CPU and memory utilization plus operating system specification
6	Installed KUKA software package
7	Activity of robot interpreter and submit interpreter
8	Operating information <ul style="list-style-type: none"> • Robot controller runtime • Battery status • Activated project
9	Electronic components of the robot controller

5.3.2 Information about the kinematic system

For each kinematic system, a separate motion device object provides the following information:

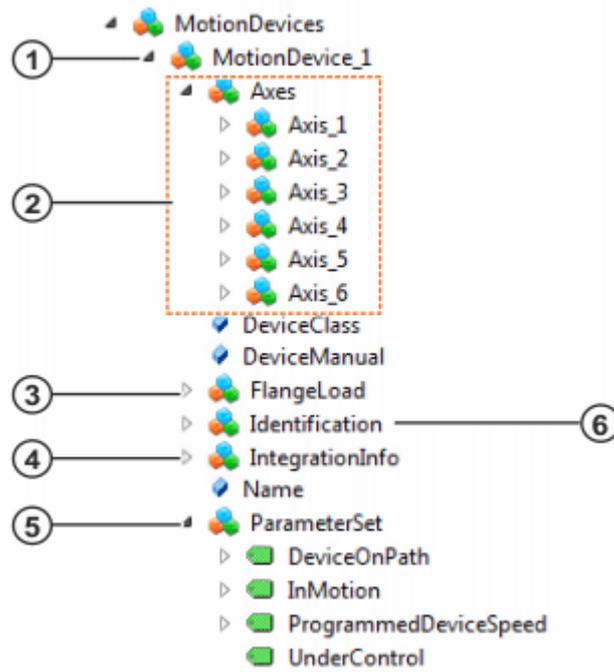


Fig. 5-3: Information about the kinematic system

Item	Description
1	Motion device object
2	List with the axes of the kinematic system
3	Active load on the flange
4	Information about the active TCP and other coordinate systems
5	Information about the motion execution <ul style="list-style-type: none"> • Path-maintaining • Motion status • Programmed Cartesian velocity • Brakes released or applied
6	Electronic identification plate of the kinematic system <ul style="list-style-type: none"> • Article number • Manufacturer • Model • Serial number

For each axis of a kinematic system, the corresponding axis object provides the following information:

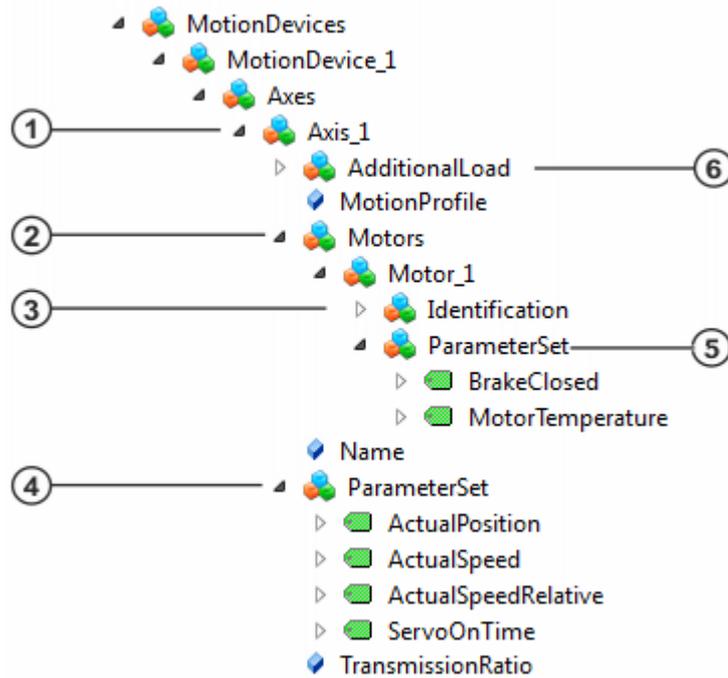


Fig. 5-4: Information about the axis of a kinematic system

Item	Description
1	Axis object
2	List with the motors of the axis
3	Electronic identification plate of the motor <ul style="list-style-type: none"> • Article number • Manufacturer • Model • Serial number
4	Information about the axis (current status) <ul style="list-style-type: none"> • Axis position • Axis velocity • Overall time axis is under servo control (operating hours)
5	Information about the motor (current status) <ul style="list-style-type: none"> • Status of axis brake • Motor temperature
6	Active axis load (if present)

5.3.3 Information about statuses of the safety controller

The safety states object provides information about statuses of the safety controller, e.g.:

- EMERGENCY STOP
- Operator safety
- Enabling device
- Operating mode

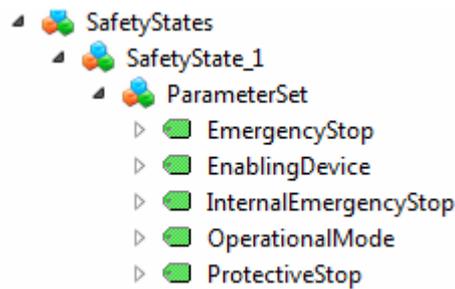


Fig. 5-5: Information about statuses of the safety controller

5.4 Integrating customer-specific information

Description

The OPC UA client can save any amount of static information in the OPC UA server. Using the OPC UA client, the user can create the nodes with the desired information and delete them again as required.

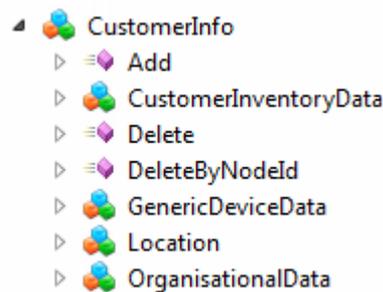


Fig. 5-6: Customer-specific information

Procedure

Creating a node with the Add method:

1. Right-click on **Add** and call the method with **Call...**
2. Transfer the following input parameters to the method:
 - **Path:** Path to variable node
Using the path, any number of levels (separated by the "/" symbol) can be added under the CustomerInfo node.
If no path is specified, the variable node is created directly under the CustomerInfo node.
 - **Name:** Display name of the variable
 - **Value:** Value of the variable
3. Close the method with **Call**.
4. Right-click on the CustomerInfo node and select **Rebrowse**.

Changing the variable value of a node:

1. Select the desired variable under the variable node.
2. Enter the new variable value directly under **Value** in the **Attributes** window.

Deleting a node with the Delete method:

1. Right-click on **Delete** and call the method with **Call...**
2. Transfer the input parameters **Path** and **Name** to the method:

- In order to delete a specific variable node, enter the display name of the variable and the corresponding path to the variable node (separated by the "/" symbol).
 - If the node to be deleted is located directly below the CustomerInfo node, it is not necessary to enter a path.
 - If only a path is entered, and no name, all variables and levels located below the level specified in **Path** are deleted.
3. Close the method with **Call**.
 4. Right-click on the CustomerInfo node and select **Rebrowse**.

Deleting a node with the DeleteByNodeID method (for advanced client users):

1. Right-click on **DeleteByNodeID** and call the method with **Call...**
2. Transfer the **NodeID** of the node that is to be deleted to the method as the input parameter:
 - "NameSpaceIndex"
 - "IdentifierType"
 - "Identifier"
3. Close the method with **Call**.
4. Right-click on the CustomerInfo node and select **Rebrowse**.

6 Configuration

6.1 Access management via user groups

The access rights are regulated via user groups.

The following user groups are available:

- Anonymous
May browse all OPC UA variables.
- OpcUaObserver
May browse all OPC UA variables and read OPC UA variables.
- OpcUaOperator
May browse all OPC UA variables and read and write OPC UA variables.



Prior to start-up, the passwords for the user groups must be changed by the administrator. The passwords must only be communicated to authorized personnel.

6.2 Changing the password in the Windows user management

Description

The passwords of the user groups are managed in the Windows user management on the robot controller.

When Windows is started, OPC UA users are automatically logged on with the following data:

- User name:
 - **OpcUaObserver**
 - **OpcUaOperator**
- Password: **kuka**

The password can be changed using the procedure described here. There are no restrictions for the password, e.g. in terms of length or complexity.

NOTICE

If the changed password is lost, access to the Windows system is no longer possible – not even via KUKA Deutschland GmbH!

Precondition

- User group: Expert
- Windows interface (**Minimize HMI**)
- Administrator rights in Windows

Procedure

1. Press the Windows key, right-click on **Computer** and select **Manage**.
2. In the tree structure, select **System Tools > Local Users and Groups > Users**.
3. Select the desired user group, right-click on it and select **Set password**.
4. Acknowledge the warning with **Proceed**.
5. Define a new password and click on **OK**.
The password is changed and can now be used.

7 Troubleshooting

7.1 No connection to the OPC UA server

Error

The OPC UA client can no longer establish the connection to the OPC UA server on the robot controller.

Cause

Port 4840 of the KLI, which is used for the OPC UA communication, has been deactivated, e.g. by activating an earlier version of a WorkVisual project on the robot controller following installation of KUKA.OPC UA 2.0.

Solution

In order to be able to use the currently active project for OPC UA communication, the port must be enabled and the project must then be activated on the robot controller again via WorkVisual.

Precondition

- User group "Expert"
- Operating mode T1 or T2.
- No program is selected.

Procedure

1. In the KLI network configuration, check whether port 4840 is present in the NAT list; if not, enable the port:
 - a. In the main menu, select **Start-up > Network configuration**. The **Network configuration** window opens.
 - b. Press **Advanced...**. The window for advanced network configuration opens.
 - c. Select the **NAT** tab. A list of all the enabled ports of the Windows interface is displayed in the **Available ports:** area.
 - d. If the port is to be enabled:
 - i. Press **Add port**. A new port with the number "0" is added to the list.
 - ii. Enter 4840 in the **Port number:** box.
 - iii. Select **tcp** in the **Permitted protocols:** box.
 - iv. Press **Save**.
A maximum total of 40 ports can be enabled.
 - e. Close the **Network configuration** window using the Close icon.
 - f. Only if modifications have been made:
Reboot the robot controller so that the changes take effect. To do so, if PROFINET is used, select **Shutdown** in the main menu and select the option **Reload files**.
2. Load the active project from the robot controller in WorkVisual.
3. Transfer the project back from WorkVisual to the robot controller and activate it.

8 KUKA Service

8.1 Requesting support

Introduction

This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Information

The following information is required for processing a support request:

- Description of the problem, including information about the duration and frequency of the fault
- As comprehensive information as possible about the hardware and software components of the overall system

The following list gives an indication of the information which is relevant in many cases:

- Model and serial number of the kinematic system, e.g. the manipulator
- Model and serial number of the controller
- Model and serial number of the energy supply system
- Designation and version of the system software
- Designations and versions of other software components or modifications
- Diagnostic package KRCDiag
Additionally for KUKA Sunrise: Existing projects including applications
For versions of KUKA System Software older than V8: Archive of the software (KRCDiag is not yet available here.)
- Application used
- External axes used

8.2 KUKA Customer Support

Availability

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

Argentina

Ruben Costantini S.A. (Agency)
Luis Angel Huergo 13 20
Parque Industrial
2400 San Francisco (CBA)
Argentina
Tel. +54 3564 421033
Fax +54 3564 428877
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