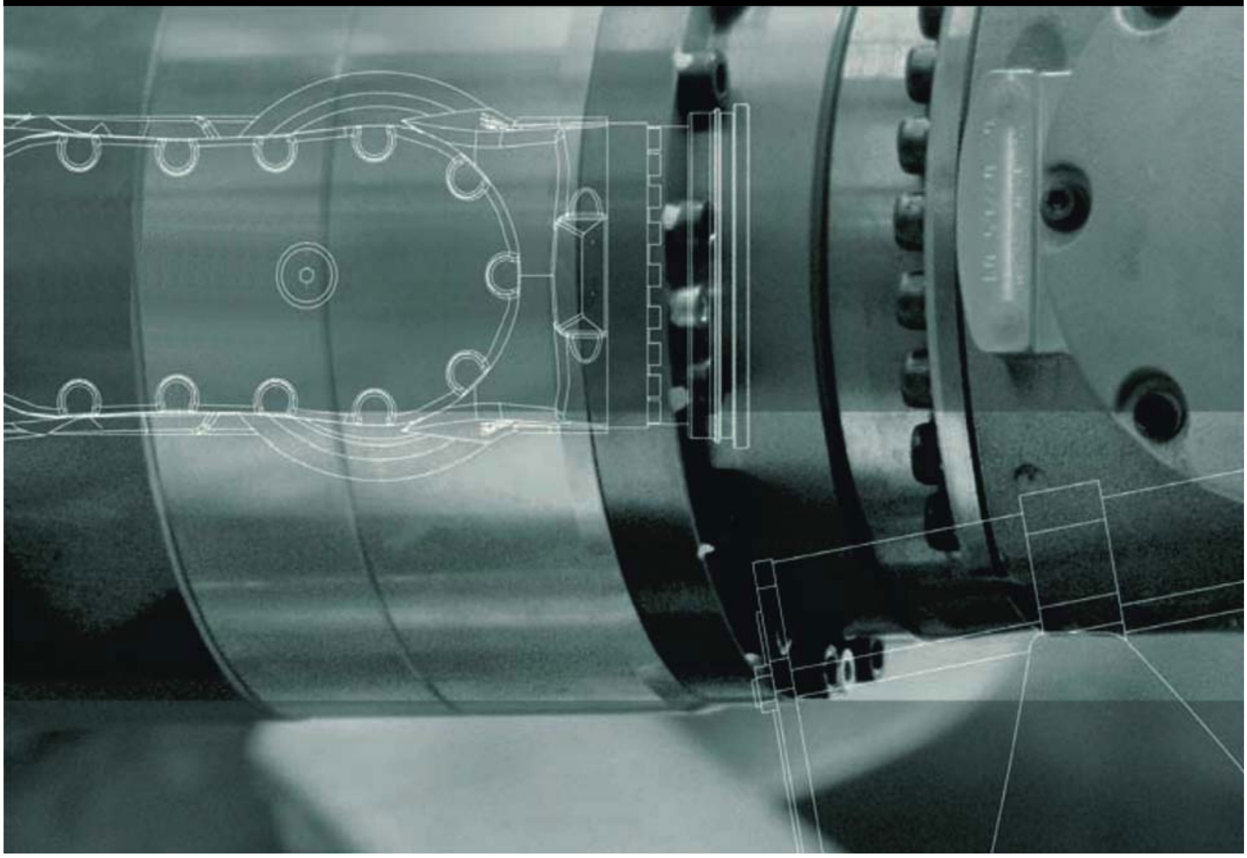
KUKA

KUKA System Technology

KUKA Roboter GmbH

KUKA.VisionTech 2.0

For KUKA System Software 8.2



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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.

Translation of the original documentation

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Contents

1 Introduction

1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the KUKA System Software
- Documentation relating to options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

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

Notes

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

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

1.3 Trademarks

Windows is a trademark of Microsoft Corporation.

VisionPro is a trademark of Cognex Corporation.

1.4 Terms used

Term	Description
KUKA smartHMI	User interface of the KUKA System Software (KUKA smart Human-Machine Interface)
GigE	Gigabit Ethernet
GenICam	Generic Interface for Cameras: generic programming interface for cameras used in industrial image processing.
Reference pose	Robot position for image acquisition
Tool block	Image processing task created using Quickbuild software.
EKI	Ethernet KRL interface
PoE	Power over Ethernet Power supply via network
KONI	KUKA Option Network Interface
KLI	KUKA Line Interface Connection to Ethernet network

2 Purpose

2.1 Target group

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

- Expert knowledge of KRL programming
- Advanced knowledge of the robot controller system
- Advanced knowledge of network connections
- Knowledge of the VisionPro software from Cognex (training)

> 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.

2.2 Intended use

Use

KUKA.VisionTech is used to determine and correct the position of a robot relative to the position of a component with the aid of one or more cameras. Up to 3 cameras may be operated simultaneously with the system. Only hardware components approved by KUKA Roboter GmbH may be used. The hardware components must only be operated under the specified environmental conditions.

Misuse

Any use or application deviating from the intended use is deemed to be impermissible misuse. This includes e.g.:

- Operation outside the permissible operating parameters
- Use in potentially explosive environments
- Use in the vicinity of welding applications
- Networking the camera network with a company network

3 Product description

3.1 Overview of VisionTech

Functions

VisionTech is an add-on technology package and consists of an image processing package and a plug-in for the KUKA smartHMI. The acquisition and processing of images is used to calculate a base correction. The base correction can be used to correct the position of the robot relative to the position of a component.

Areas of application

- Detecting the position of components
- Deracking
- Depalletizing

Communication

The robot controller communicates with one or more GigE cameras via the image processing system. The connection between the kernel system and the image processing system is established via the Ethernet KRL interface.

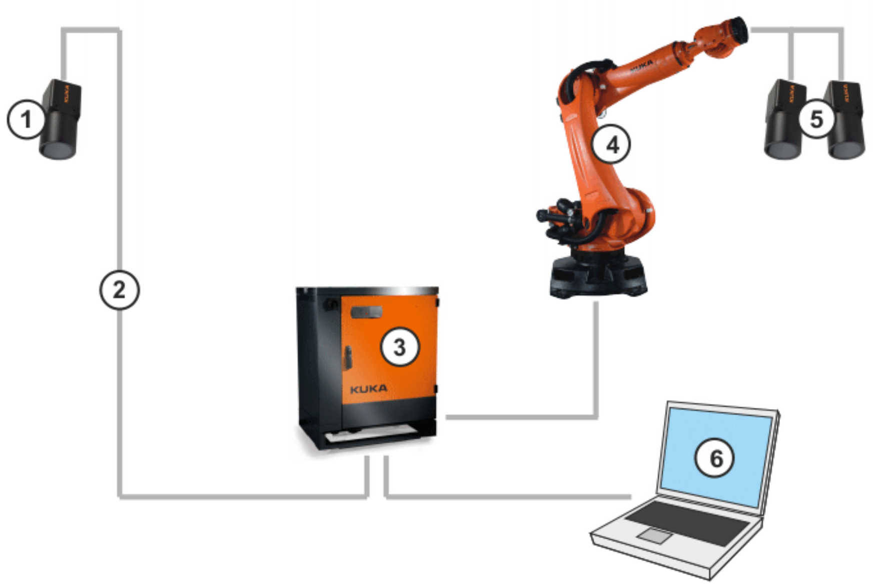


Fig. 3-1: Communication, KR C4

1	Stationary camera	4	Robot
2	Connecting cable	5	Robot-guided cameras
3	KR C4	6	Service laptop

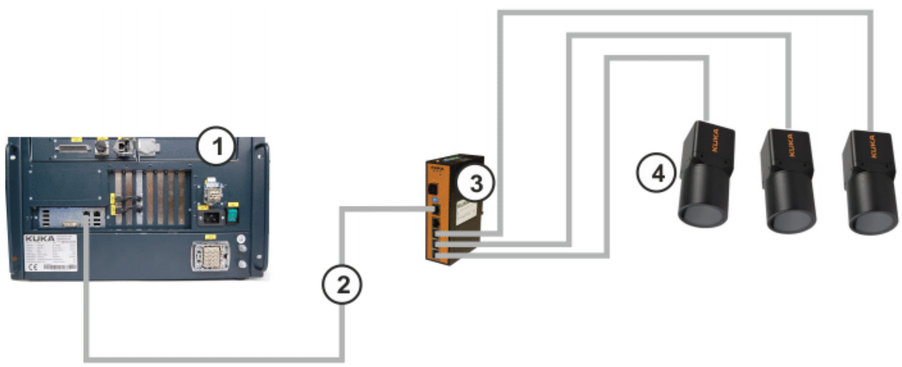


Fig. 3-2: Communication, KR C4 compact

1	KR C4 compact	3	Switch
2	Connecting cable	4	Cameras

Image processing software

An image processing environment is installed on the controller during installation of VisionTech. This software performs the image processing tasks. This software must also be installed on the service laptop.

3.2 Hardware components

The following hardware components are available in the form of a hardware package for KUKA.VisionTech:

- KUKA GigE switch
- KUKA MXG20 cameras
- Calibration plate
- Connecting cables

There are 4 variants of the hardware package. The variants differ with regard to the interface, connecting cables and number of cameras:

- For KR C4:
  - 2D moving: 1-2 cameras mounted on the robot, 1 camera mounted in a fixed position
  - 2D fixed: 1-3 cameras mounted in a fixed position
  - 3D moving: 2 cameras mounted on the robot
- For KR C4 compact:
  - 2D fixed: 1-3 cameras mounted in a fixed position

3.2.1 KUKA GigE switch

Overview

There are 5 RJ45 connections on the KUKA GigE switch. Ports 1 to 4 are PoE-capable. KUKA MXG20 cameras can be connected to ports 1 to 3. Port 5 can be used to connect the KR C4 compact; this port is not PoE-capable. The switch must be integrated into a housing with a protection rating of IP 54 and supplied with a direct voltage of 12-36 V. The switch can be mounted on a TS 35 top-hat rail.

In the KR C4, the switch is installed and connected to the power supply of the KR C4. Up to 3 cameras can be connected to interfaces X64.1 to X64.3. Alternatively, the cameras can be connected directly to the switch in the KR C4 via a cable inlet.

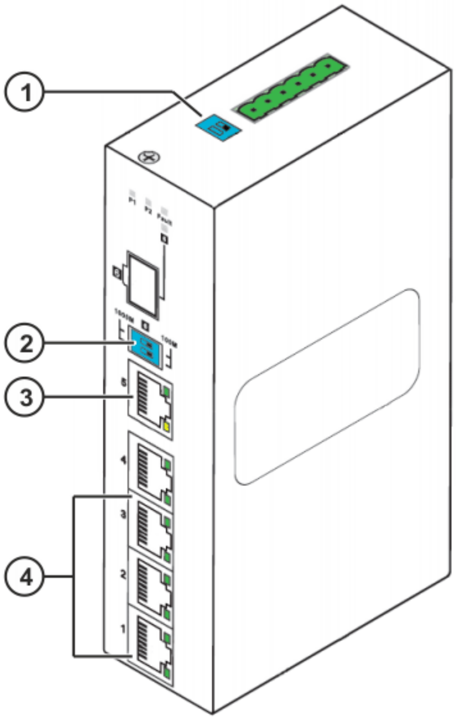


Fig. 3-3: KUKA GigE switch – overview

1 DIP switch for the function “Power Alarm Relay Output”
2 Changeover switch for port 6 (selection of SFP speed)
3 RJ45 PoE connection for the robot controller
4 3 RJ45 PoE connections for cameras

DIP switches

Designation	Description
DIP switch for “Power Alarm Relay Output”	DIP switch 1: P1 error message DIP switch 2: P2 error message On: activated Off: deactivated
Changeover switch for port 6 (selection of SFP speed)	DIP switches 1 and 2. On: 100 Mbps DIP switches 1 and 2. Off: 1000 Mbps

LEDs

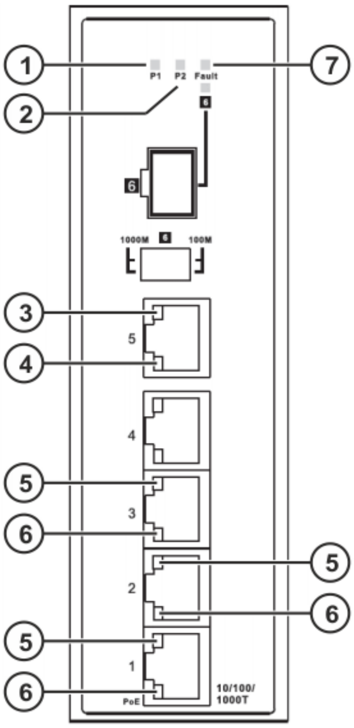


Fig. 3-4: KUKA GigE switch – LEDs

Item	LED	Description
1	P1	Green: Switch is on (if powered via V1)
2	P2	Green: Switch is on (if powered via V2)
3	Gigabit LAN port	Green: GigE port is active, data being transferred to the connected device
4	Gigabit LAN port	Yellow: 100 Mbps
5	Gigabit PoE port	Green: Port is active
6	Gigabit PoE port	Green: PoE is active
7	Fault	Yellow: Fault at P1 or P2

Power supply

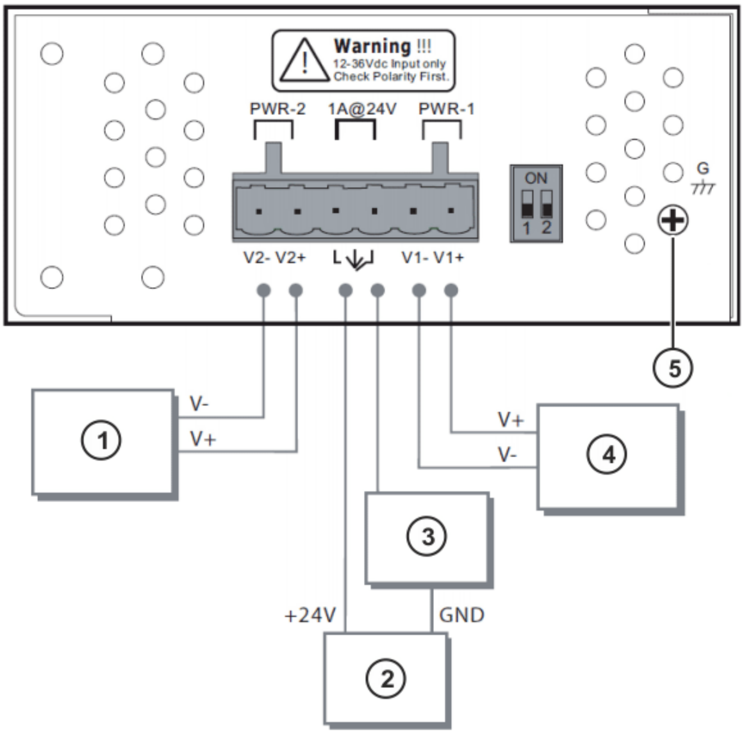


Fig. 3-5: KUKA GigE switch – power supply

1 Power supply connection 12-36 V DC
2 Power supply connection 24 V DC
3 Output, alarm relay
4 Power supply connection 12-36 V DC
5 Housing ground

Interfaces

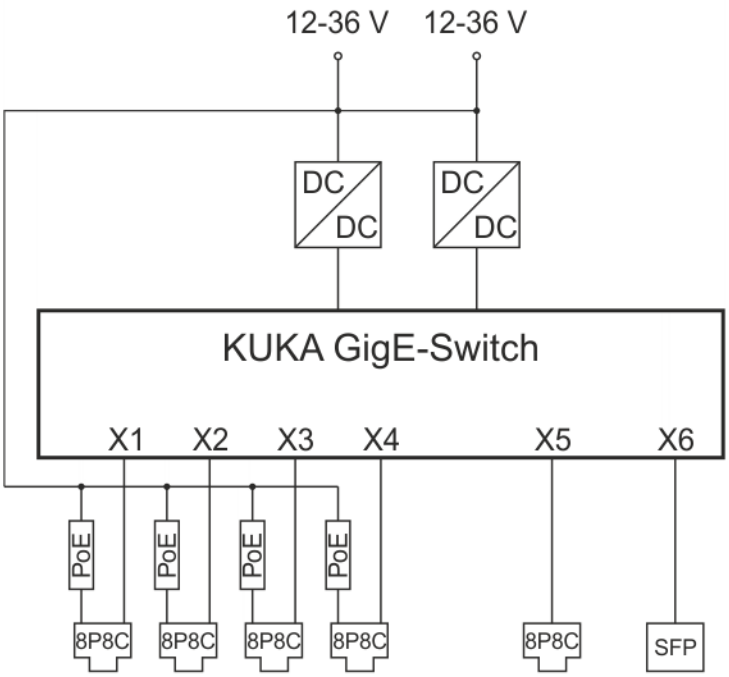


Fig. 3-6: KUKA GigE switch – interfaces

3.2.2 KUKA MXG20 camera

Overview

The KUKA MXG20 camera conforms to the GigE standard and is PoE-capable. The image resolution is 2 megapixels. The camera can be powered via PoE or from an external power supply. A protective lens hood is mounted on the camera. C-Mount lenses can be used (lenses are not included in the scope of supply). When selecting the lens, it must be ensured that it fits into the protective lens hood (depth: 45 mm).

A protective cap is mounted on the connection for the process interface / power supply. This may only be removed if a cable is connected to the interface.

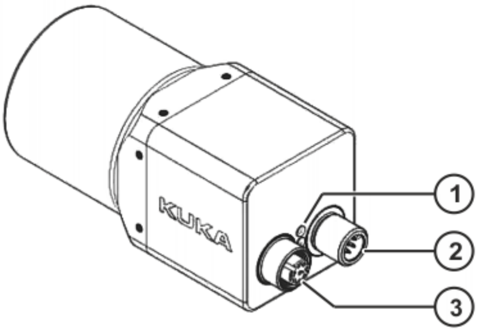


Fig. 3-7: KUKA MXG20 camera – overview

1 LEDs
2 Data/PoE interface
3 Process interface / power supply

NOTICE The camera must not be powered simultaneously via PoE and from an external source, otherwise the camera may be damaged.

Connector pin allocation

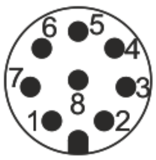


Fig. 3-8: Contact diagram, data/PoE interface (view from contact side)

1 MX3-
2 MX4+
3 MX4-
4 MX1- (neg./pos. V_{port})
5 MX2+ (pos./neg. V_{port})
6 MX1+ (neg./pos. V_{port})
7 MX3+
8 MX2- (pos./neg. V_{port})

Fig. 3-9: Contact diagram, process interface / power supply (view from contact side)

1 OUT 3
2 Power VCC+
5 U_{ext} OUT
6 OUT 1

3	IN1	7	Power GND
4	IO GND	8	OUT 2

LEDs

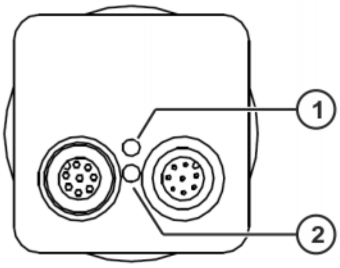


Fig. 3-10: KUKA MXG20 camera – LEDs

Item	LED	Description
1	Status	■ Green: Connection is active. ■ Flashing green: Data are being received ■ Flashing red: Data are being sent
2	Power	Green: Camera is switched on

3.2.3 Connecting cables

Different connecting cables are required for the operation of one or more cameras. The connecting cables used conform to the CAT6 standard for network cables. The network cables have different connectors depending on the interface. The cables are available in various lengths.

3.2.4 Calibration plates

A calibration plate is required for the calibration of a camera. Calibration plates are available in the following sizes:

- 24 x 24 inch, size of one square: 20 mm
- 12 x 12 inch, size of one square: 10 mm
- 11.5 x 8 inch, size of one square: 6.35 mm
- 5.75 x 4 inch, size of one square: 3.175 mm
- 2.875 x 2 inch, size of one square: 1.5875 mm

4 Technical data

4.1 KUKA MXG20 camera

Basic data

Power supply (external)	Control voltage: 12 … 24 V DC ± 10% Rated current: 176 … 252 mA
Power supply (PoE)	Control voltage: 36 … 57 V DC Rated current: 88 mA (with 48 V DC)
Energy consumption	approx. 4.2 W
Digital input	Voltage (min.): 0 … 4.5 V DC Voltage (max.): 11 … 30 V DC Rated current: 6.0 … 10 mA Pulse length: min. 2.0 µs Trigger delay outside of $t_{readout}$: 1 µs Trigger delay during $t_{readout}$: 14 µs
Digital output	Voltage: 5 … 30 V DC Rated current: max. 50 mA
MTBF	335774 h @ 45°C
Protection classification	IP 67
Weight	185 g
Conformity	CE

Ambient conditions

Storage and transportation	-25 °C to +70 °C (248 K to 343 K)
Operation	+5 °C to +50 °C (278 K to 323 K)
Device temperature	max. +50 °C (323 K) at the measurement point
Air humidity	5 … 95% (no condensation)

Connections

Data/PoE interface	Transmission speed: ■ 100 Mbit/s (Fast Ethernet) ■ 1000 Mbit/s (Gigabit Ethernet) Connection: M12 male connector, 8-contact, A standard
Process interface / power supply	Connection: M12 female connector, 8-contact, A standard

Standards and guidelines

Name	Definition
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

Name	Definition
EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards – Immunity for industrial environments
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards – Emission standard for industrial environments

4.2 KUKA GigE switch

Basic data

Housing	Metal
Protection classification	IP 30
Dimensions	41 x 99.9 x 144.3 mm
Weight	580 g
Control voltage	12 … 36 V DC
Energy consumption	approx. 7.5 W
MTBF	> 450000 h @ 45°
Conformity	CE, FCC Part 15, RoHS

Ethernet interface

Interface	1000base-T, 100base-TX, 10base-T
Standard	IEEE 802.3 for 10base-T IEEE 802.3u for 100base-TX and 100base-X IEEE 802.3z for 1000base-X IEEE 802.3ab for 1000base-T IEEE 802.3x for flow control IEEE 802.3at PoE specification (up to 30 watts per port for PoE)
Ports	4x with PoE, 1x SFP, 1x without PoE
Packet size	Up to 9 kB, supports jumbo frames
Auto-functions	Auto-negotiation, auto-crossover
PoE	Conforms to IEEE 802.3at
Protective function	Against overload current
Power infeed	Up to 30 watts per port

Ambient conditions

Storage	-40 °C to +85 °C (233 K to 358 K)
Operation	-40 °C to +60 °C (233 K to 333 K)
Air humidity	5 … 95% (no condensation)

Standards and guidelines

Name	Definition
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
EN 55022	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement

Name	Definition
EN 55024	Information technology equipment – Immunity characteristics – Limits and methods of measurement
EN 61000-3-2	Electromagnetic compatibility (EMC) - Part 3-2: Limits – Limits for harmonic current emissions
EN 61000-3-3	Electromagnetic compatibility (EMC) - Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current

4.3 Connecting cables

4.3.1 Connecting cables, KR C4

Basic data

Type	Suitable for use on robots
Configuration	4x CAT6 elements acc. to DIN EN 50288-5-2
Conductor	Bare copper strand 4x2xAWG26
Outside diameter	8.3 ± 0.2 mm
Operating voltage	≤ 60 V
Transmission characteristics, CAT6 element	in accordance with DIN EN 50288-5-2
Transmission range	50 m (nominal)
Bending radius (one-time)	≥ 3x cable diameter
Bending radius (moving)	≥ 10x cable diameter
Certification	UL AWM Style 20963 80 °C 30 V

Interfaces

Connecting cable	Connector designation	Connections
KR C4 – linear unit	X64.1 – X74.1.1 X64.2 – X74.2.1	PushPull V4 connector at both ends
Linear unit – robot	X74.1.1 – X74.1 X74.2.1 – X74.2	PushPull V4 coupling – PushPull V4 connector
KR C4 – robot	X64.1 – X74.1 X64.2 – X74.2	PushPull V4 connector at both ends
KR C4 – camera	X64.1 – B1 X64.2 – B2 X64.3 – B3	PushPull V4 connector – M12 male connector, 8-contact

Connecting cable	Cable lengths
KR C4 – camera	5 m, 15 m, 25 m, 35 m
KR C4 – linear unit	7 m, 15 m, 25 m
Linear unit – robot	5 m
KR C4 – robot	7 m, 15 m, 25 m

If a cable inlet on the KR C4 is used instead of interface X64, the following connectors are available:

Connecting cable	Connector designation	Connections
Switch – linear unit	A13.1 – X74.1.1 A13.2 – X74.2.1	RJ45 connector – PushPull V4 connector
Linear unit – robot	X74.1.1 – X74.1 X74.2.1 – X74.2	PushPull V4 coupling – PushPull V4 connector
Switch – robot	A13.1 – X74.1 A13.2 – X74.2	RJ45 connector – PushPull V4 connector
Switch – camera	A13.1 – B1 A13.2 – B2 A13.3 – B3	RJ45 connector – M12 male connector, 8-contact

The RJ45 connectors that are connected to interfaces A13.1 to A13.3 have protection rating IP 20.

For detailed specifications of the connecting cables, see (>>> 9.3.6 "Description of the connecting cables" Page 38).

4.3.2 Connecting cables, KR C4 compact

Basic data

Type	Not suitable for use on robots
Configuration	4x CAT6 elements
Conductor	Bare copper AWG 26
Outside diameter	6.2 ± 0.15 mm
Operating voltage	30 V
Bending radius	4x cable diameter
Certification	UL 94 V0

Interfaces

Connecting cable	Connector designation	Connections
KR C4 compact – switch	KONI – No PoE5	RJ45 connectors at both ends
Switch – camera	PoE 1 – B1 PoE 2 – B2 PoE 3 – B3	RJ45 connector – M12 male connector, 8-contact

The RJ45 connectors that are connected to interfaces PoE 1 to PoE 3 have protection rating IP 20.

Connecting cable	Cable lengths
KR C4 compact – switch	1 m, 5 m
Switch – camera	5 m, 15 m, 25 m, 35 m

For detailed specifications of the connecting cables, see (>>> 9.3.6 "Description of the connecting cables" Page 38).

4.4 Dimensions of the camera

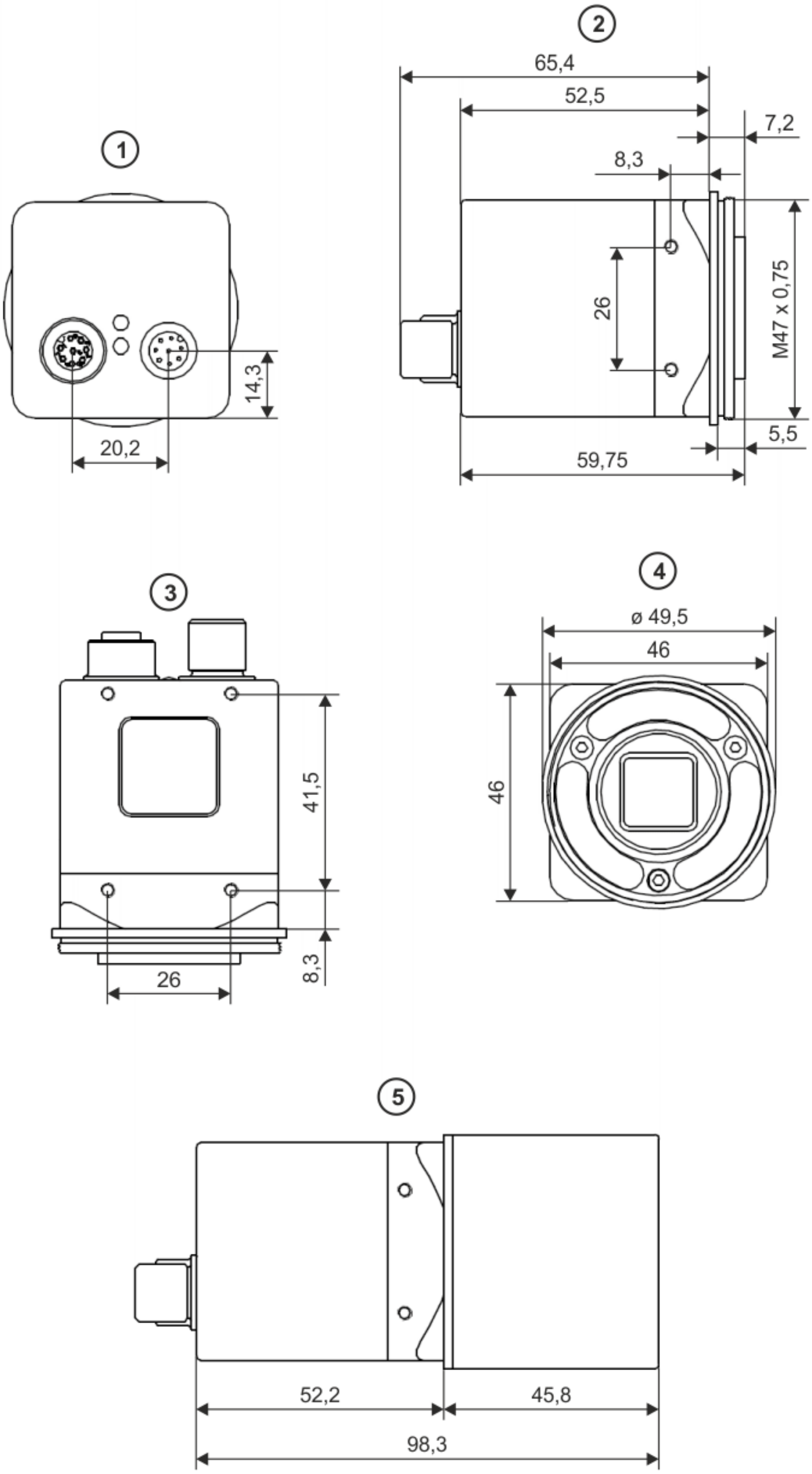


Fig. 4-1: Dimensions (in mm)

1 Rear view
2 Side view
3 View from below
4 Front view
5 Side view with protective lens hood

4.5 Plates and labels

Camera

The identification plate is already mounted on the camera. The camera label must be selected and attached by the user; this depends on the interface to which the camera is connected:

- Interface X64.1 / A13.1 / PoE 1: label **B1**
- Interface X64.2 / A13.2 / PoE 2: label **B2**
- Interface X64.3 / A13.3 / PoE 3: label **B3** (for stationary cameras only)

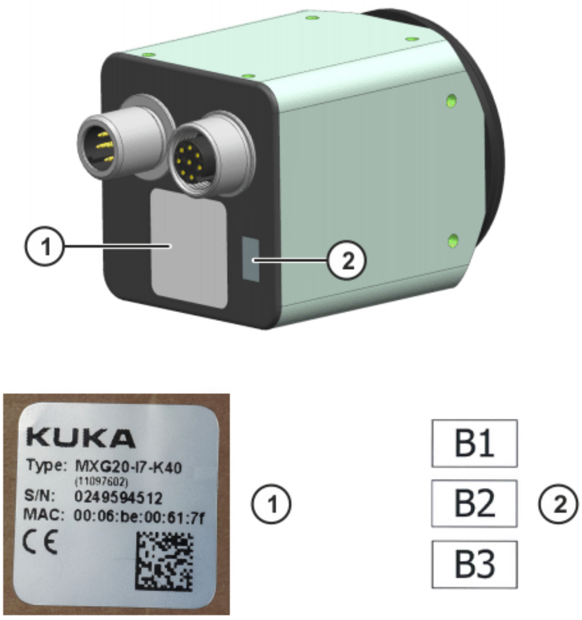


Fig. 4-2: Plates and labels on the camera

Plate no.	Designation
1	Camera identification plate
2	Camera label

Switch

The following plates and labels are attached to the switch.

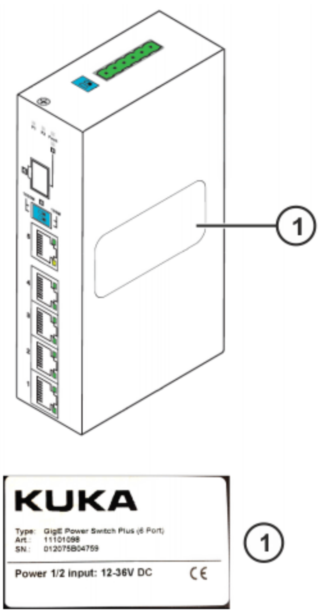


Fig. 4-3: Plates and labels on the switch

Plate no.	Designation
1	Switch identification plate

5 Safety

This documentation contains safety instructions which refer specifically to the software and hardware 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.

> ⚠ The “Safety” chapter in the operating and programming instructions must be observed. Death to persons, severe injuries or considerable damage to property may otherwise result.

5.1 General safety measures

> **NOTICE** If the position of the component is not correctly detected, this may result in a collision. Before operation, check the result of the base correction using the subprograms VT_RESULT_CHECK and VT_CHECKPOSELIMIT.

> **NOTICE** An incorrect camera position or calibration may result in a collision. Before operation, check the permissible offset using the subprogram VT_CHECKPOSELIMIT.

> **NOTICE** The Status and Turn of a target pose may be altered due to the base correction, thereby causing a collision. To avoid this, use the function KUE_WEG2.
> (>>> 11.2 "Calling the function KUE_WEG2" Page 65)

> The user must carry out a risk analysis and is responsible for ensuring correctly adapted lighting.

> When fastening the cameras, the tightening torques must be observed; see (>>> 18.1 "Tightening torque" Page 83).

Personnel

The operator must meet the following preconditions:

- The operator must be trained for the work to be carried out.
- Start-up work may only be carried out by qualified personnel. These are people who, due to their specialist training, knowledge and experience, and their familiarization with the relevant standards, are able to assess the work to be carried out and detect any potential hazards.

5.2 Standards and regulations

Name	Definition	Edition
EN 60204	Safety of machinery: Electrical equipment of machines	2006

6 Planning

6.1 Connecting cables and interfaces

Connecting cables

The connecting cables comprise all the cables for transferring energy and signals between the robot controller, linear unit, robot and cameras. The following connecting cables are available:

- For the KR C4 with interface X64:
  - Connecting cable, KR C4 – linear unit
  - Connecting cable, linear unit – robot
  - Connecting cable, KR C4 – robot
  - Connecting cable, KR C4 – camera
- For the KR C4 with cable inlet to interface A13 on the switch:
  - Connecting cable, switch – linear unit
  - Connecting cable, linear unit – robot
  - Connecting cable, switch – robot
  - Connecting cable, switch – camera
- For the KR C4 compact:
  - Connecting cable, KR C4 compact – switch
  - Connecting cable, switch – camera

All the connecting cables for the KR C4 are suitable for use on robots. The connecting cables for the KR C4 compact are not suitable for use on robots.

Information about the energy supply system for axes 1 to 3 and axes 3 to 6 can be found in separate documentation.

Depending on the specific system configuration, connecting cables are required in different lengths. The following cable lengths are available:

Connecting cable	Cable lengths
KR C4 – camera	5 m, 15 m, 25 m, 35 m
KR C4 – linear unit	7 m, 15 m, 25 m
Linear unit – robot	5 m
KR C4 – robot	7 m, 15 m, 25 m
KR C4 compact – switch	1 m, 5 m
Switch – camera	5 m, 15 m, 25 m, 35 m

The maximum length of the connecting cables must not exceed 45 m with robot-guided cameras and 35 m with stationary cameras. Thus if the robot is operated on a linear unit which has its own energy supply chain these cables must also be taken into account.

The following points must be observed when planning and routing the connecting cables:

- Protect cables against exposure to mechanical stress.
- Route the cables without mechanical stress – no tensile forces on the connectors
- Cables are only to be installed indoors.
- Route cables in such a way that they cannot be damaged by sharp edges, tools or other materials.
- Observe permissible temperature range (fixed installation) of 243 K (-30 °C) to 363 K (+90 °C).

For detailed specifications of the connecting cables, see (>>> 9.3.6 "Description of the connecting cables" Page 38).

Interface X64

Interfaces X64.1 to X64.3 are situated on the connection panel of the KR C4.

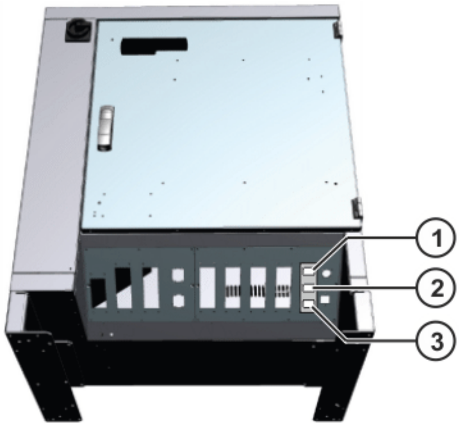


Fig. 6-1: Interfaces X64.1 to X64.3

1 Connection X64.1

2 Connection X64.2

3 Connection X64.3

7 Transportation

7.1 Transportation

Cameras

Before transportation, the cameras must be removed. A protective cap must be mounted on the connection for the process interface / power supply. The cameras must be packaged for transportation in ESD protection foil. Care must be taken to ensure that the cameras do not come into contact with humidity.

Switch

The switch must be packaged for transportation in ESD protection foil. Care must be taken to ensure that the switch does not come into contact with humidity.

8 Installation

8.1 System requirements

Hardware

- KR C4
- Or KR C4 compact
- Motherboard D3076-K

Software

- KUKA System Software 8.2
- KUKA.Ethernet KRL 2.1.2

8.2 Installing or updating VisionTech

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

Preparation

- Copy software from CD to KUKA USB stick.

  The software must be copied onto the stick with the file Setup.exe at the highest level (i.e. not in a folder).

NOTICE Recommendation: Use a KUKA stick. Data may be lost if any other stick is used.

Precondition

- “Expert” user group

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**. The entry **VisionTech** must be displayed in the **Name** column and drive **E:** or **K:** in the **Path** column.

   If not, press **Refresh**.
4. If the specified entries are now displayed, continue with step 5.

   If not, the drive from which the software is being installed must be configured first:

   - Press the **Configuration** button. A new window opens.
   - Select a line in the **Installation paths for options** area.

     Note: If the line already contains a path, this path will be overwritten.
   - Press **Path selection**. The available drives are displayed.
   - Select **E:**. (If stick connected to the robot controller.)

     Or select **K:**. (If stick connected to the smartPAD.)
   - Press **Save**. The window closes again.

   The drive only needs to be configured once and then remains saved for further installations.
5. Mark the entry **VisionTech** and click on **Install**. Answer the request for confirmation with **Yes**.
6. Confirm the reboot prompt with **OK**.
7. Remove the stick.
8. Reboot the robot controller. The robot controller is then automatically restarted once again.

LOG file

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

8.3 Uninstalling VisionTech

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

Precondition

- "Expert" user group

Procedure

1. In the main menu, select **Start-up** > **Additional software**.
2. Mark the entry **VisionTech** and click on **Uninstall**. Reply to the request for confirmation with **Yes**. Uninstallation is prepared.
3. Reboot the robot controller. Uninstallation is resumed and completed.

LOG file

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

9 Start-up and recommissioning

9.1 Start-up overview

Step	Description
1	License VisionTech. (>>> 9.2 "Licensing VisionTech" Page 35)
2	Connect cameras to the robot controller. (>>> 9.3 "Connecting cameras to the robot controller" Page 36)
3	Configure Ethernet KRL interface. (>>> 9.4 "Configuring the KRL interface" Page 41)
4	Configure the network. (>>> 9.5 "Configuring the local GigE network" Page 42)
5	Configure the cameras. (>>> 9.6 "Configuring cameras" Page 42)
6	Align the cameras. (>>> 9.7 "Aligning cameras" Page 43)
7	Calibrate the cameras. (>>> 9.8 "Calibrating cameras (stationary)" Page 44) (>>> 9.9 "Calibrating cameras (robot-guided)" Page 45)
8	Take pictures. (>>> 9.10 "Taking images" Page 46)

9.2 Licensing VisionTech

9.2.1 Activating the license

Procedure

1. In the main menu, select **VisionTech** > **Licensing**.
2. Enter the license key in the **License key** box. The license key is either on a sticker in the robot controller or is enclosed with the software.
3. Press **Create footprint** and select a directory. A file is generated in the selected directory which links the control PC to the license. An encrypted signature for this control PC is saved in the file.
4. Send the generated file to VisionTech@kuka-roboter.de. KUKA Service will use this to create a licensing file and send it to you.
5. Press **...**, select the received licensing file and confirm with **OK**.
6. Reboot the robot controller.

9.2.2 Repairing the license

Description

If hardware components are modified, added or exchanged, this may invalidate the license. A license becomes invalid if the current signature of the control PC differs too greatly from the saved signature. In this case, the license can be repaired.

Procedure

1. In the main menu, select **VisionTech** > **Licensing**.
2. In the list of currently installed licenses, select the license to be repaired.

3. Press **Create repair request** and select a directory. A file is generated in the selected directory.
4. Send the generated file to VisionTech@kuka-roboter.de. KUKA Service will use this to create a new licensing file and send it to you.
5. Press **...**, select the received licensing file and confirm with **OK**.
6. Reboot the robot controller.

9.2.3 Activating an emergency license

Description

It is possible to activate an emergency license. A total of 5 emergency licenses are available. An emergency license is valid for 3 days. On expiry, emergency licenses cannot be reactivated. For this reason, they should only be used in an actual emergency.

Procedure

1. In the main menu, select **VisionTech** > **Licensing**.
2. Select the **Activate emergency license** tab.
3. Press **Activate next emergency license**.
4. Reboot the robot controller.

9.3 Connecting cameras to the robot controller

Description

The cameras are connected via Ethernet; the networking differs depending on the robot controller used and the mounting type of the cameras.

Variant	Description
KR C4 with interface X64, robot-guided	(>>> 9.3.1 "Networking KR C4 with interface X64, robot-guided" Page 36)
KR C4 with cable inlet, robot-guided	(>>> 9.3.2 "Networking KR C4 with cable inlet, robot-guided" Page 37)
KR C4 with interface X64, stationary	(>>> 9.3.3 "Networking KR C4 with interface X64, stationary" Page 37)
KR C4 with cable inlet, stationary	(>>> 9.3.4 "Networking KR C4 with cable inlet, stationary" Page 37)
KR C4 compact, stationary	(>>> 9.3.5 "Networking KR C4 compact, stationary" Page 38)

9.3.1 Networking KR C4 with interface X64, robot-guided

Procedure

- Carry out networking as illustrated below:

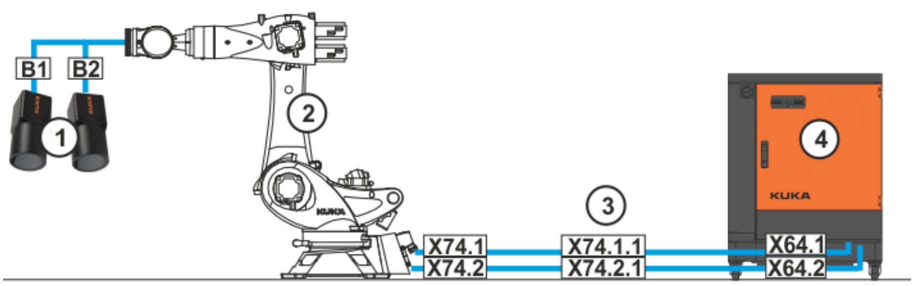


Fig. 9-1: Networking KR C4 with interface X64, robot-guided

1	KUKA MXG20 camera	3	Linear unit (optional)
2	Robot	4	KR C4

9.3.2 Networking KR C4 with cable inlet, robot-guided

Procedure

- Carry out networking as illustrated below:

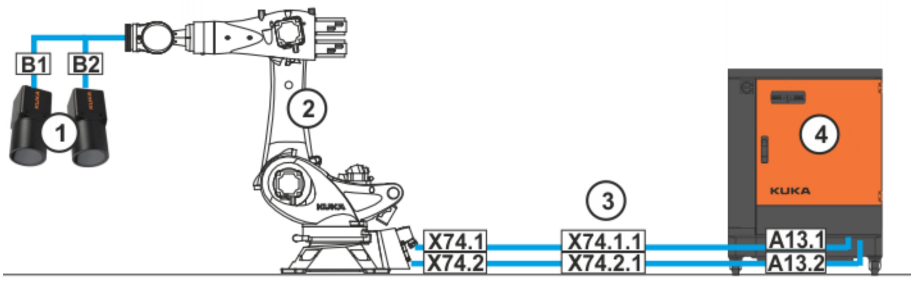


Fig. 9-2: Networking KR C4 with cable inlet, robot-guided

1	KUKA MXG20 camera	3	Linear unit (optional)
2	Robot	4	KR C4

9.3.3 Networking KR C4 with interface X64, stationary

Procedure

- Carry out networking as illustrated below:

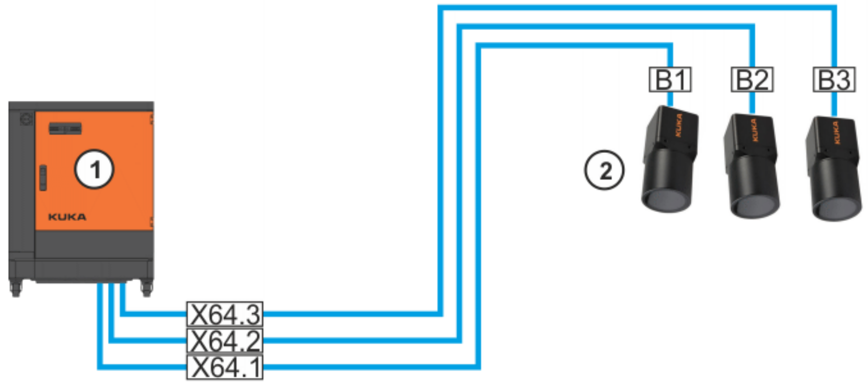


Fig. 9-3: Networking KR C4 with interface X64, stationary (maximum number of cameras)

1	KR C4	2	KUKA MXG20 camera

9.3.4 Networking KR C4 with cable inlet, stationary

Procedure

- Carry out networking as illustrated below:

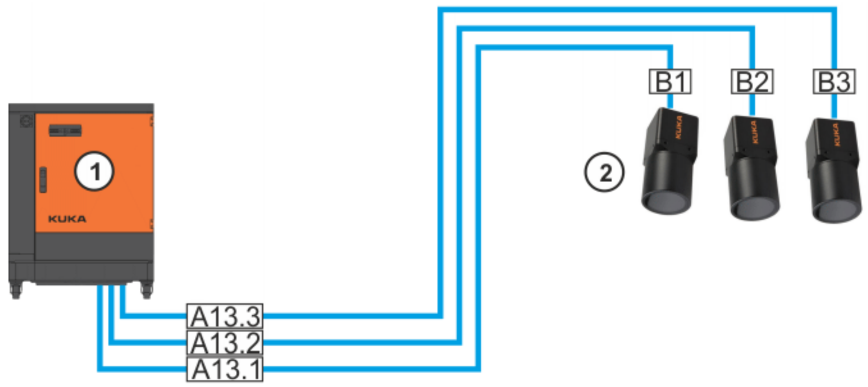


Fig. 9-4: Networking KR C4 with cable inlet, stationary (maximum number of cameras)

1	KR C4	2	KUKA MXG20 camera

9.3.5 Networking KR C4 compact, stationary

Procedure

- Carry out networking as illustrated below:

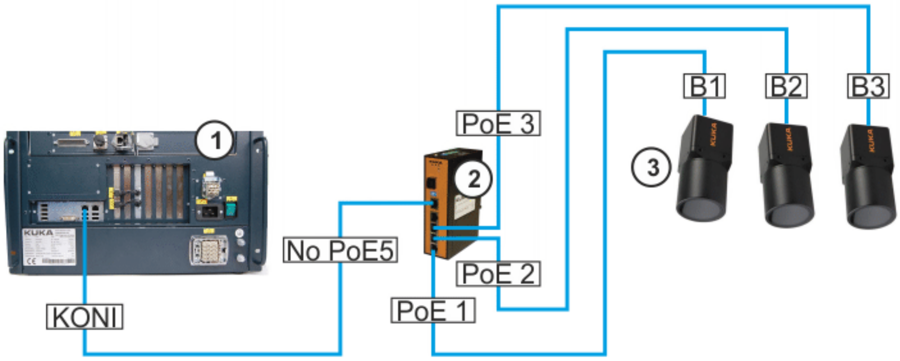


Fig. 9-5: Networking KR C4 compact, stationary (maximum number of cameras)

1	KR C4 compact	3	KUKA MXG20 camera
2	KUKA GigE switch		

9.3.6 Description of the connecting cables

Configuration

The connecting cables are used to transfer power and signals between the robot controller, linear unit, robot and cameras.

The following connecting cables are available:

- For the KR C4 with interface X64:
  - Connecting cable, KR C4 – linear unit
  - Connecting cable, linear unit – robot
  - Connecting cable, KR C4 – robot
  - Connecting cable, KR C4 – camera
- For the KR C4 with cable inlet to interface A13 on the switch:
  - Connecting cable, switch – linear unit
  - Connecting cable, linear unit – robot
  - Connecting cable, switch – robot
  - Connecting cable, switch – camera
- For the KR C4 compact:
  - Connecting cable, KR C4 compact – switch
  - Connecting cable, switch – camera

Interfaces, KR C4

For connection of the connecting cables between the KR C4, linear unit, robot and cameras, the following connectors are available at the interfaces:

Connecting cable	Connector designation	Connections
KR C4 – linear unit	X64.1 – X74.1.1 X64.2 – X74.2.1	PushPull V4 connector at both ends
Linear unit – robot	X74.1.1 – X74.1 X74.2.1 – X74.2	PushPull V4 coupling – PushPull V4 connector

Connecting cable	Connector designation	Connections
KR C4 – robot	X64.1 – X74.1 X64.2 – X74.2	PushPull V4 connector at both ends
KR C4 – camera	X64.1 – B1 X64.2 – B2 X64.3 – B3	PushPull V4 connector – M12 male connector, 8-contact

If a cable inlet on the KR C4 is used instead of interface X64, the following connectors are available:

Connecting cable	Connector designation	Connections
Switch – linear unit	A13.1 – X74.1.1 A13.2 – X74.2.1	RJ45 connector – PushPull V4 connector
Switch – robot	A13.1 – X74.1 A13.2 – X74.2	RJ45 connector – PushPull V4 connector
Switch – camera	A13.1 – B1 A13.2 – B2 A13.3 – B3	RJ45 connector – M12 male connector, 8-contact

Connecting cables, KR C4

The following connecting cables are for a KR C4 with interface X64:

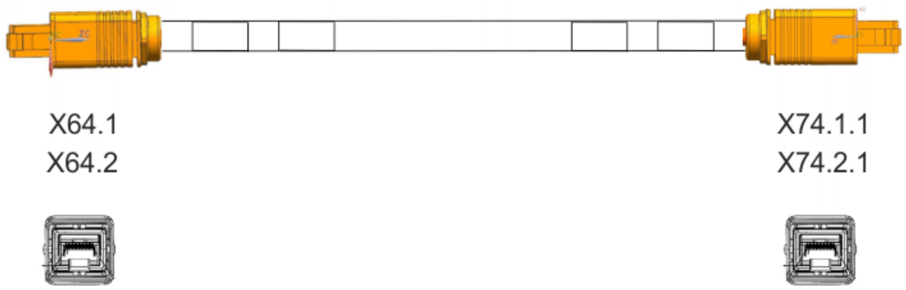


Fig. 9-6: Connecting cable, KR C4 – linear unit

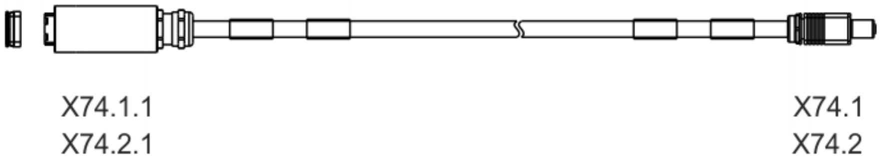


Fig. 9-7: Connecting cable, linear unit – robot

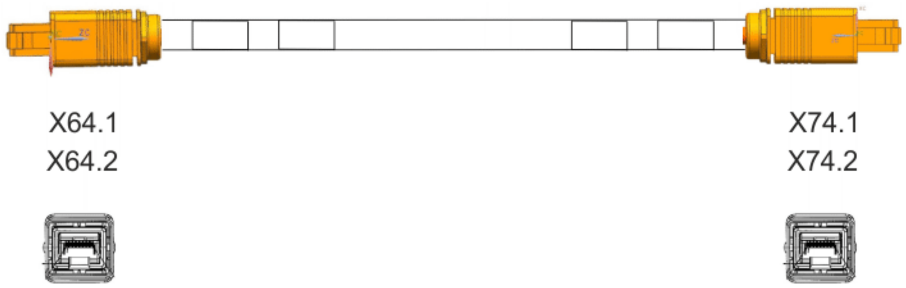


Fig. 9-8: Connecting cable, KR C4 – robot

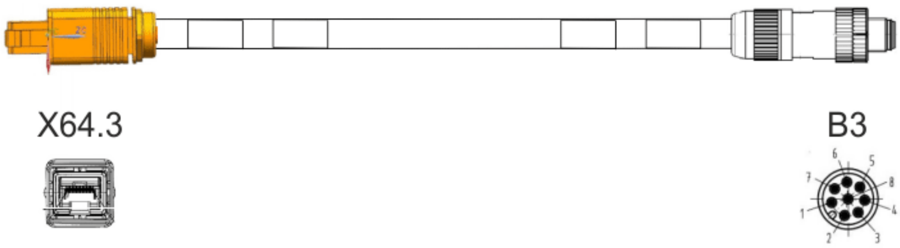


Fig. 9-9: Connecting cable, KR C4 – camera

The following connecting cables are for a KR C4 with a cable inlet:

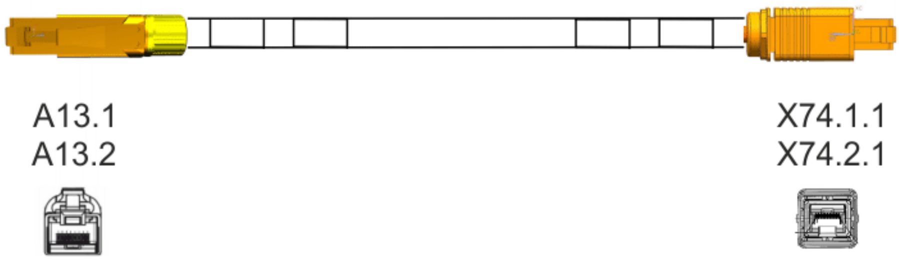


Fig. 9-10: Connecting cable, switch – linear unit

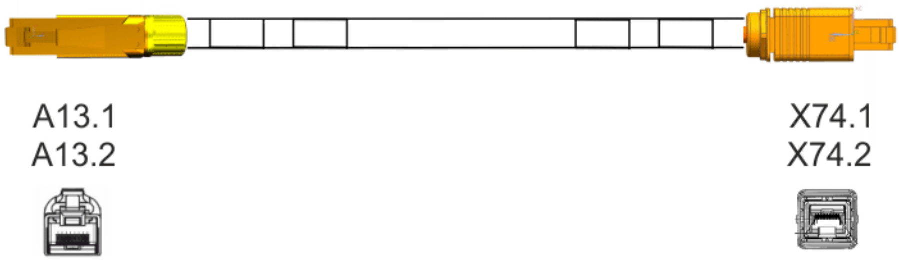


Fig. 9-11: Connecting cable, switch – robot

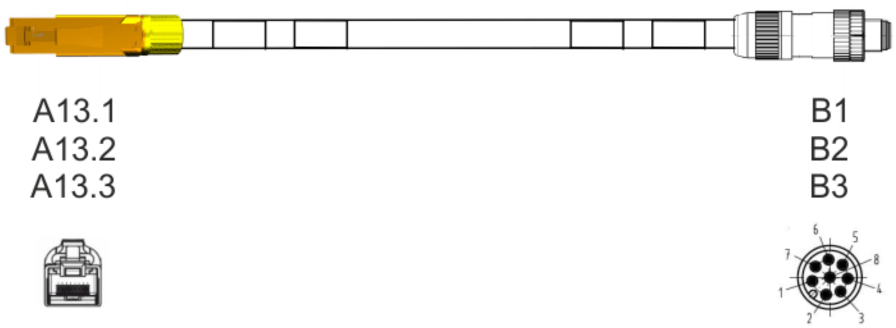


Fig. 9-12: Connecting cable, switch – camera

Interfaces, KR C4 compact

For connection of the connecting cables between the KR C4 compact, switch and cameras, the following connectors are available at the interfaces:

Connecting cable	Connector designation	Connections
KR C4 compact – switch	KONI – No PoE5	RJ45 connectors at both ends
Switch – camera	PoE 1 – B1 PoE 2 – B2 PoE 3 – B3	RJ45 connector – M12 male connector, 8-contact

Connecting cables, KR C4 compact

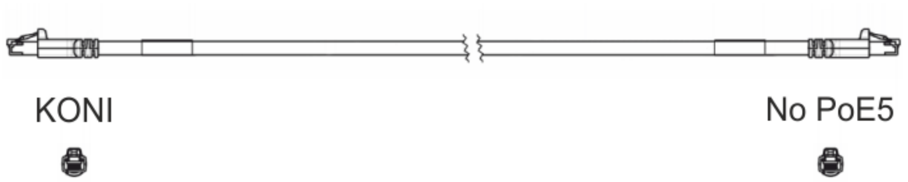


Fig. 9-13: Connecting cable, KR C4 compact – switch

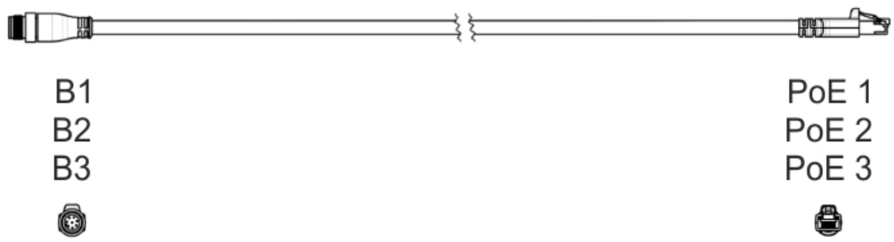


Fig. 9-14: Connecting cable, switch – camera

9.4 Configuring the KRL interface

Description

To establish a connection between the kernel system and the image processing system, the number of the flag that is to trigger execution of the interrupt program must be entered in the configuration file for the Ethernet KRL interface. The interrupt program monitors the result of the image processing.

If the server uses a different port for image processing than port 49152, the port that is set by default, then the port must be changed accordingly (>>> 9.4.1 "Changing the port" Page 41).

Precondition

- User group "Expert".
- Operating mode T1 or T2.

Procedure

1. Open the configuration file VisionTechConfig.xml in the directory C:\KRC\ROBOTER\Config\User\Common\EthernetKRL.
2. In the line:

```
<ELEMENT Tag="TaskResult/EndOfResult" Set_Flag="Choose Flag" />
```

   replace the entry `Choose Flag` with the number of the flag that is to trigger execution of the interrupt program.
3. Save and close the file.
4. In the main menu, select **Configuration** > **Inputs/outputs** > **I/O drivers** and click on **Reconfigure**.

   The I/O driver is reconfigured.

9.4.1 Changing the port

The port on the server for image processing must be a free port.

Precondition

- “Expert” user group

Procedure

1. Open the configuration file VisionTechConfig.xml in the directory C:\KRC\ROBOTER\Config\User\Common\EthernetKRL.
2. In the line:

```
<PORT>49152</PORT>
```

   enter the desired free port instead of 49152.
3. Save and close the file.

4. In the main menu, select **Configuration** > **Inputs/outputs** > **I/O drivers** and click on **Reconfigure**.

   The I/O driver is reconfigured.
5. Open the file VisionTechPlugIn.Kernel.config in the directory C:\KRC\SmartHMI\Config.
6. In the line:

```
<Argument Name="port" Type="System.Int32" Value="49152" />
```

   enter the desired free port instead of 49152.
7. Save and close the file.
8. Reboot the robot controller.

9.5 Configuring the local GigE network

During productive operation, the network configuration must not be changed.

Following installation of VisionTech, the network card is configured as follows:

- IP address: 192.169.2.100
- Subnet mask: 255.255.0.0

Precondition

- The cameras are connected to the GigE switch.
- A free address range is available for the local GigE network.

NOTICE The address range of the GigE network must not be in the address range of the KLI or the Windows network. This can cause severe errors in the robot controller.

Example address range

Device	IP address	Subnet mask
1st GigE camera	192.169.2.101	255.255.0.0
2nd GigE camera	192.169.2.102	255.255.0.0
3rd GigE camera	192.169.2.103	255.255.0.0
GigE network card in the robot controller	192.169.2.100	255.255.0.0

Procedure

1. In the main menu, select **VisionTech** > **Sensor overview**.
2. Select the camera that is to be configured.
3. On the **Network** tab, enter the IP address of the camera and the subnet mask for the address range of the GigE network.
4. Save the settings.
5. If necessary, repeat steps 2 to 4 for further cameras.

9.6 Configuring cameras

VisionTech can be used with both stationary and moving cameras. A stationary camera is fixed in its position, e.g. mounted on a stand or on the ceiling. A moving camera is mounted on the robot flange.

Procedure

1. In the main menu, select **VisionTech** > **Sensor overview**.
2. Select the camera that is to be configured.
3. On the **General** tab, select the mounting type for the camera.
4. Optionally: Enter the name, e.g. “Camera on robot”, in the **Description** box.

5. Press **Save**.
6. Repeat steps 2 and 3 for the other cameras.

Description

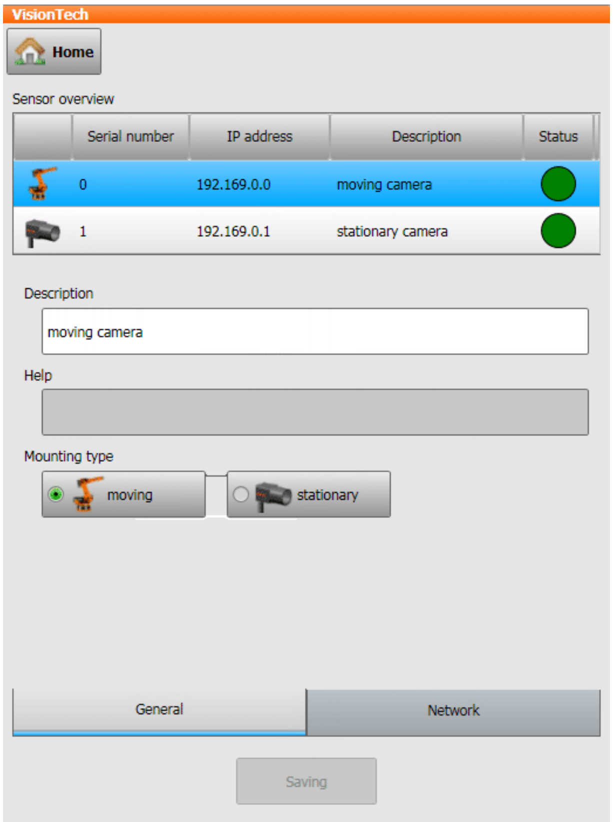


Fig. 9-15: Sensor overview

Box	Description
Serial number	Serial number of the cameras
IP address	IP address of the cameras
Description	Description of the cameras
Status	■ **Green**: The camera is ready for operation. ■ **Red**: The camera is not ready for operation and can thus not be used.

9.7 Aligning cameras

Precondition

- The object to be measured (e.g. component or calibration plate) is mounted.
- The cameras are networked.
- The network has been configured.

Procedure

1. In the main menu, select **VisionTech** > **Live picture**.
2. Press **Start**. A live image is generated for each camera.
3. This step differs depending on the mounting type of the cameras:
   - For moving cameras: Position the robot over the measurement object so that the measurement object is visible in the live image of the cameras.
   - For a stationary camera: Position the camera over the measurement object so that the measurement object is visible in the live image of the camera.

4. Press on the live image of one camera. The live image is displayed in enlarged form.
5. Enter the default exposure time or set it using the plus/minus keys or the slider control.
6. Save the settings by selecting **Set default exposure**.
7. Use the arrow button to switch back to the overview and perform steps 4 to 6 for the other cameras.
8. Tighten and secure the camera fastening screws.
9. Focus the cameras with the aid of the enlarged live image display until the measurement object is clearly visible.
10. Secure the lenses of the cameras with the fastening screws.

9.8 Calibrating cameras (stationary)

> During calibration, the IP address of camera must not be changed.

Precondition

- The camera is mounted in a fixed position and configured as **stationary**.
- The camera is networked.
- The network has been configured.
- The camera is aligned.
- A calibration plate is attached. This is in the workpiece plane and in the field of vision of the camera.

Procedure

1. In the main menu, select **VisionTech** > **Live picture**.
2. Press on the live image of the camera. The live image is displayed in enlarged form.
3. Enter the calibration exposure time or set it using the plus/minus keys or the slider control.
4. Save the settings by selecting **Set calibration exposure**.
5. In the main menu, select **VisionTech** > **Calibration**.

   A freeze-frame image from the camera is displayed on the **fixed sensors** tab. If the camera is calibrated, the freeze-frame image has a green frame. If the camera is not calibrated, the freeze-frame image has a red frame.
6. Select the camera by pressing on the freeze-frame image.
7. Press **Calibration Wizard**.
8. Select the calibration plate used as the calibration body.

   All calibration plates from Cognex are available for selection. Each calibration plate has a different size which is marked on the plate. The calibration plate used can be determined on the basis of size.
9. Press **Take picture**.

   > Recommendation: The camera should be directly above the calibration plate.

   The fiducial mark (cross at the center of the calibration plate) must be visible.
10. Press **Calibrate**.
11. Once the calibration process has been completed, the result is displayed. For an adequate degree of accuracy, the result should be < 1 mm. The result can be saved by pressing **Save**. Pressing **Reject** causes the result to be deleted.

After calibration, the live image is displayed without distortion, i.e. as if the camera were positioned exactly vertically above the calibration plate.

12. When asked whether to proceed with measurement of the robot base, answer with **Yes**.
13. Calibrate the robot base in the calibration coordinate system, e.g. using the 3-point method.

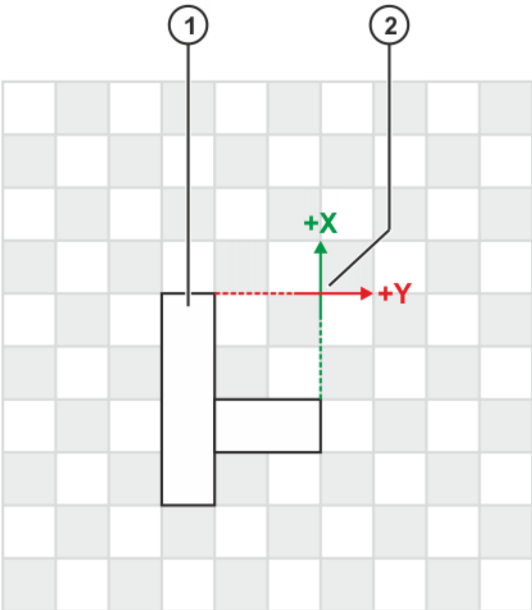


Fig. 9-16: Calibration plate with fiducial mark

1	Fiducial mark	2	Origin

9.9 Calibrating cameras (robot-guided)

> During calibration, the IP addresses of cameras must not be changed.

Precondition

- The cameras are mounted on the robot flange and configured as **moving**.
- The cameras are networked.
- The network has been configured.
- The cameras are aligned.
- A calibration plate is mounted and is located in the field of vision of the cameras.
- The NULLFRAME tool is selected.

Procedure

1. In the main menu, select **VisionTech** > **Calibration**.

   Freeze-frame images from the cameras are displayed on the **moving sensors** tab. The freeze-frame images of the cameras that have already been calibrated have a green frame. In the case of cameras that have not yet been calibrated, the freeze-frame images have a red frame.
2. Select the cameras that are to be calibrated by pressing the freeze-frame images.
3. Press **Calibration Wizard**.
4. Move the robot to the first calibration pose and press **Take picture**.

> **i** Recommendation: For the first pose, the cameras should be directly above the calibration plate. In every pose, the cameras should be at a different angle relative to the calibration plate; for this, the robot must be moved.

The fiducial mark (cross at the center of the calibration plate) must be visible in every pose. It is not possible to record the same pose twice.

5. Repeat step 4 for every pose. Record at least 6 poses. A maximum of 9 poses are possible.
6. Select the calibration plate used as the calibration body.

   All calibration plates from Cognex are available for selection. Each calibration plate has a different size which is marked on the plate. The calibration plate used can be determined on the basis of size.
7. Press **Calibrate**. The calibration process takes approx. 5 to 10 minutes.
8. Once the calibration process has been completed, the result is displayed. For an adequate degree of accuracy, the result should be < 1 mm. The result can be saved by pressing **Save**. Pressing **Reject** causes the result to be deleted.

9.10 Taking images

Precondition

- The cameras are networked.
- The network has been configured.

Procedure

1. In the main menu, select **VisionTech** > **Live picture**.
2. Images can be taken either by all cameras or by 1 camera:
   - All cameras: Press **Save pictures**.
   - 1 camera: Press on the live image of the camera and press **Save picture**.

   The images are saved in the directory C:\KRC\TP\VisionTech\Snapshots*camera serial number*. The Snapshots folder is a shared network resource. A maximum of 20 images can be saved per camera; any further images overwrite the oldest existing image.

10 Configuration

10.1 Overview of measurement task configuration

Step	Description
1	Teach reference position above the component.
2	Set up an image processing task in WorkVisual. (>>> 10.2 "Setting up an image processing task in WorkVisual" Page 47) Or: Set up an image processing task in Quickbuild. **Note:** Information can be found in the documentation of the Quickbuild software.
3	Configure task. (>>> 10.3 "Configuring a 2D task" Page 50) (>>> 10.6 "Configuring a 3D task" Page 56)
4	Generate model. (>>> 10.4 "Generating a 2D model" Page 53) (>>> 10.7 "Generating a 3D model" Page 58)
5	Test task. (>>> 10.5 "Testing a 2D task" Page 55) (>>> 10.8 "Testing a 3D task" Page 59)
6	Create KRL program.

10.2 Setting up an image processing task in WorkVisual

Step	Description
1	Install the image processing environment on the service laptop. (>>> 10.2.1 "Installing the image processing environment" Page 47)
2	Install the **VisionTech** option package in WorkVisual.
3	Save any images that were taken via the controller to a USB stick or make them available via the network.
4	Create a tool block file in WorkVisual. (>>> 10.2.2 " Creating a tool block file in WorkVisual" Page 48)
5	Transfer the tool block file to the controller on a USB stick or via the network.

> Information about installing and managing option packages can be found in the **WorkVisual** documentation.

10.2.1 Installing the image processing environment

Precondition

- The VisionTech software is copied to a USB stick, or is accessible via the network.

Procedure

1. Copy the software to the service laptop.

2. Execute the file WoV_CognexSetup.bat in the directory ...\INTER-NAT\KRCSETUP\Cognex. The image processing environment is installed.
3. Connect the Cognex USB dongle.

10.2.2 Creating a tool block file in WorkVisual

Precondition

- The Cognex USB stick is connected.

Procedure

1. Open the **VisionTech plug-in**:
   - Select the menu sequence **Editors** > **Option packages** > **VisionTech**.
   - Alternatively: Click on the button.
2. Select the menu sequence **Toolblock** > **New** > **2D** or **3D**.
3. Select the menu sequence **Image source** > **File...** or **Directory...** and select the image(s) that were taken using the controller.
4. Click on the button. The image(s) are inserted next to the inputs under *InputImage*.
5. Click on the button. Tools and templates are displayed.

   (>>> 10.2.2.1 "Templates" Page 49)
6. Select the desired template or tool and drag it between the inputs and outputs.
7. Link the inputs and outputs, e.g. *InputImage* under the inputs with *InputImage* in the template. To do so, click on the input or output and drag it onto the other input or output. The link is displayed by an arrow.
8. Double-click on the template and train the desired pattern.
9. Click on the button and choose whether the tool should be saved completely or without images or results.
10. Select a directory and click on **Save**.

Description

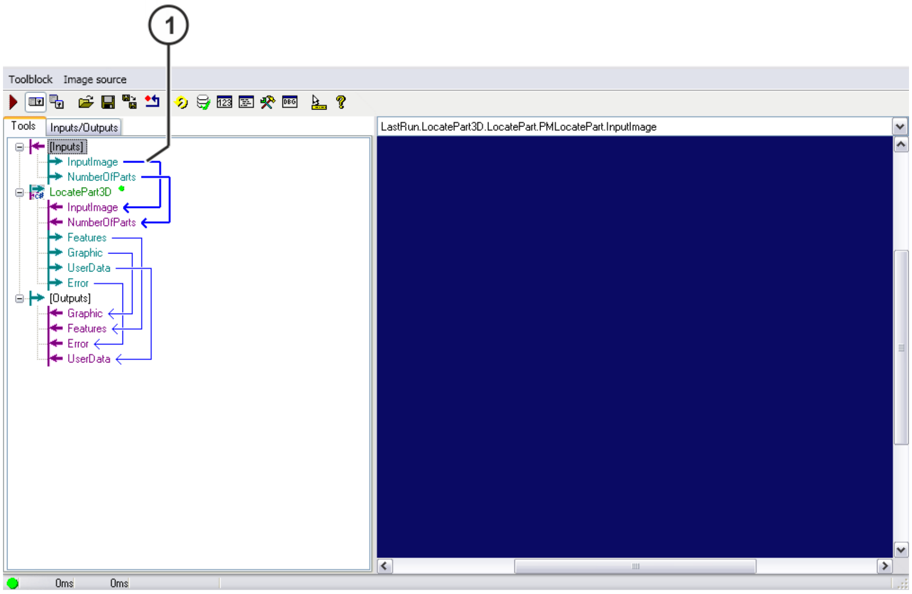


Fig. 10-1: VisionTech plug-in: overview

1 Linking arrow

10.2.2.1 Templates

<table>
<tr><th>Template</th><th>Description</th></tr>
<tr><td>LocatePartsOneStage</td><td>Type: 2D

Suitable for parts which are defined by relatively coarse structures, e.g. complete panels. The search area is the entire image. Further tools can be added; only the result of “PatMax” is transferred, however.</td></tr>
<tr><td>LocatePartTwoStages</td><td>Type: 2D

With this template, the search procedure is subdivided into 2 steps:
Coarse search
In the coarse search, a search is carried out for a preset number of instances of the part that is to be located. Coarse structures are searched for, e.g. complete panels. The search area is the entire image.
Fine search
In the fine search, a part is located on the basis of its finer structures, e.g. a square hole in a panel. A relatively small search area can be selected; this also increases the speed of execution. The fine search is run once for each instance found in the coarse search.</td></tr>
<tr><td>LocatePartsKnown-Position</td><td>Type: 2D

With this template, a number of parts are searched for in the field of view. The rough position of these parts must be known, however. The search area is limited to the known rough position.</td></tr>
<tr><td>LocatePart3D</td><td>Type: 3D

With this template, the search procedure is subdivided into 2 steps (analogous to LocatePartTwoStages):
Coarse search
The position of the parts in the picture is determined.
Fine search
Individual features are located which are required for 3D position determination of the part. The features are identified by a consecutive index. The index is positioned at the start of the name of the feature tool block. The numbering starts at zero and must be consecutive. Numbering is largely automatic, however. The fine search is run once for each instance found in the coarse search.
Templates for features:
PointFeaturePM
Point feature which is located with a PatMax tool.
LineSegFeature
Straight line feature; normally represents points on a straight edge of the part that is to be located. Has a start point and end point, which are defined by the search area of the FindLine tool.
LineFeature
Line feature, without a start and end point.
CircleFeature
Feature which describes a circle in 3D.
Note: The PatMax tool and the FindLine tool must not be renamed.</td></tr>
<tr><td>CrspCollector</td><td>Collects the data from the FeatureCrsp outputs of 3D feature tool blocks and makes these available at the output as a list of Crsps. In addition, the result images of the Crsps are collected and forwarded in the Graphic output.</td></tr>
</table>

Template	Description
StringCollector	Collects the values at its inputs and returns these values as a string, separated by a vertical bar, at the UserData output. The inputs accept the data types INT32, DOUBLE, BOOL and STRING. These inputs must be created as required.
PoseCreator	Can be used if a 2D pose is not to be generated by a PatMax tool. The values from which the pose is to be created are provided by the inputs.
PoseCollector	Collects the individual poses from various tools and generates a list which is returned to the PartResults output. This list is expected at this output by the KUKA interface for 2D tasks.
PMResultCollector	Collects the poses and scores of the results in lists. For each result, a result graphic is generated, collected in a CogGraphicCollection and sent to the Graphic output.

10.3 Configuring a 2D task

During configuration of a 2D task, a tool block is assigned to the camera. A tool block contains image processing tasks and has the file extension VPP.

For 2D tasks, only 1 camera is needed; the calibration is carried out at the workpiece level. In the case of a robot-guided camera, the robot position must be the same for calibration and for image processing.

Precondition

The following inputs and outputs must be configured in the tool block in order to enable the tool block to be read and used by VisionTech:

Input	Type	Description
InputImage	ICogImage	Input image on which the image processing task is carried out
NumberOf-Parts	INT	Number of components to be detected by means of the image processing

Output	Type	Description
PartResults	List<CogTransform 2DLinear>	Positions of the found components in image coordinates
Scores	List<Double>	Accuracy with which the components were detected
Graphic	CogGraphicCollection	Graphic showing the results of the image processing task

The following outputs can optionally be configured:

Output	Type	Description
Error	Exception	Exceptions or errors that occur during execution of the image processing task
UserData	Object	User-specific data forwarded to KRL by VisionTech. Any type can be used that is derived from Object and overwrites the ToString() method.

> The directory INTERNAT\KRCSETUP\KRC\TP\VisionTech\Template on the VisionTech CD contains sample tool blocks which meet the following requirements:
>
> - Tool block for 2D tasks with a stationary camera
> - Tool block for 2D tasks with a moving camera
> - Tool block for 3D tasks

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Press **New** and select the mounting type **2D fixed** or **2D moving**. A new 2D task is created. The name of the task can be changed.
3. Press the Settings icon and select the number of components to be found.

> If the selected is too low, this may lead to inconsistencies, e.g. if each camera detects different objects. It is advisable to enter the number of components that one expects to find.

4. In the **Configurations** area, activate the camera by activating the check box.

> Only those cameras are displayed which correspond to the selected mounting type.

5. Press **...** in the **Toolblocks** column.
6. Select the tool block file and confirm with **OK**.
7. Press the camera icon in the line for the camera. A window for setting the exposure time is displayed.
8. Optionally: Enter the exposure time or set it using the plus/minus keys or the slider control.
9. Press **Save**. The setting is saved.

   Configuration of the task has been successfully completed when the icon in the **Status** column changes to green.

Description

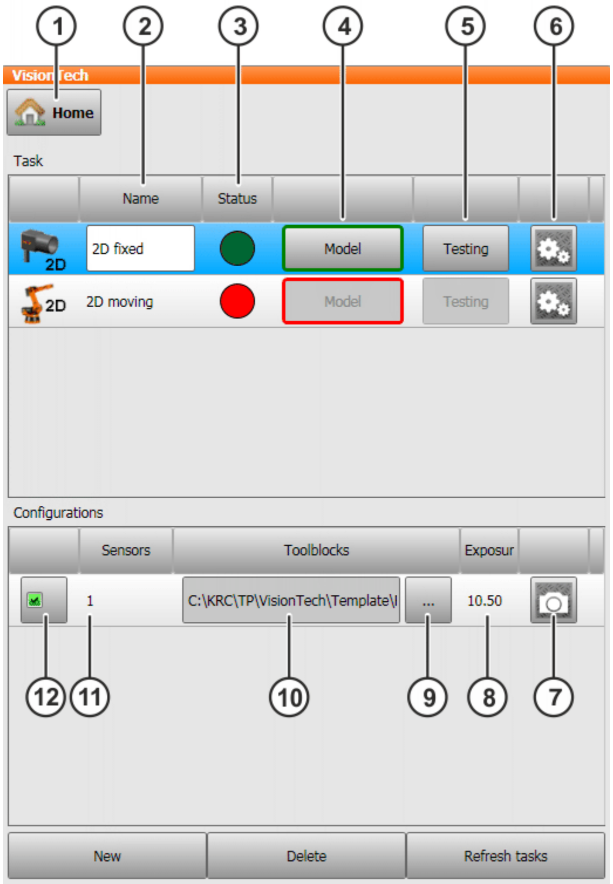


Fig. 10-2: Configuring a 2D task

Item	Description
1	Back to Overview
2	Name of the task The name is freely selectable.
3	State of the task ■ **Green:** Task has been successfully configured. ■ **Red:** Task is not configured.
4	Generate model. ■ **Green frame:** Model has been successfully generated. ■ **Red frame:** No model has yet been generated.
5	Test task ■ **Activated:** The task can be tested. ■ **Deactivated:** The task cannot be tested. No model has yet been generated, or the task is not configured.
6	Settings icon Select the number of components.
7	Camera icon Set the exposure time. ■ **0 … 200 ms**
8	Exposure time that has been set
9	Select directory of tool block file.
10	Directory of tool block file

Item	Description
11	Serial number of the camera
12	■ **Activated:** Camera is used. ■ **Deactivated:** Camera is not used.

The following buttons are available:

Button	Description
New	Creates a new task.
Delete	Deletes the selected task from the list and from the file system.
Refresh tasks	Reloads all tasks and tool blocks in the directory C:\KRC\TP\VisionTech\Tasks.

10.4 Generating a 2D model

10.4.1 2D model with a stationary camera

Precondition

- The robot base is calibrated to the calibration base.

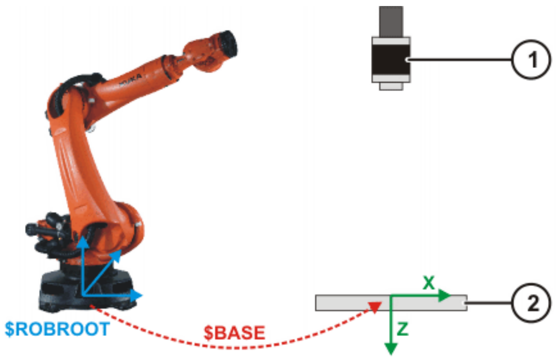


Fig. 10-3: Base for a stationary camera

1	Stationary camera	2	Calibration plate

- The task has been configured.
- The icon in the **Status** column is green.
- There is only 1 component in the field of vision of the cameras.

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. In the **Task** area, press **Model**.

   A model is generated and a result window is displayed.
3. The images in the result window can be enlarged. To do so, press the desired image once.

   Generation of the model has been successfully completed when the **Model** button has a green frame.

   The reference position of the component is now known; all deviations are relative to this position.

Description

Once the model has been generated, a result window with images and a table is displayed. The result is the position of the component in the workpiece base. Areas detected by the cameras are indicated in green in the images. Areas that have not been detected are marked in red.

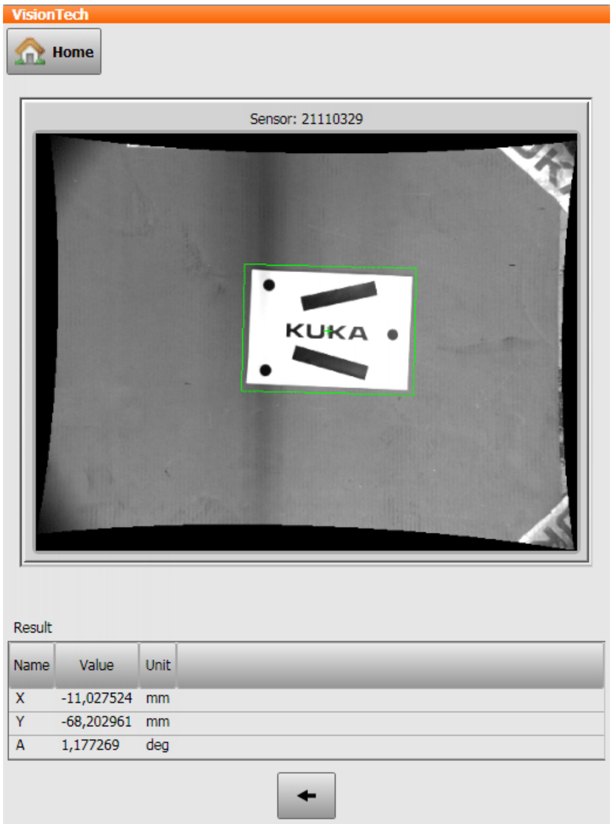


Fig. 10-4: Result of 2D model generation with a stationary camera (example)

10.4.2 2D model with a moving camera

Precondition

- The XY plane of the workpiece base is located on the surface of the component.
- The Z axis of the workpiece base points in the same direction as the calibration coordinate system.
- The task has been configured.
- The icon in the **Status** column is green.
- There is only 1 component in the field of vision of the cameras.
- The NULLFRAME tool is selected.

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Move the robot to the reference pose.
3. In the **Task** area, press **Model**. Confirm the request with **Yes**.

   A model is generated and a result window is displayed.
4. The images in the result window can be enlarged. To do so, press the desired image once.

   Generation of the model has been successfully completed when the **Model** button has a green frame.

   The reference position of the component is now known; all deviations are relative to this position.

Description

Once the model has been generated, a result window with images and a table is displayed. The result is the position of the component in the workpiece base. Areas detected by the cameras are indicated in green in the images. Areas that have not been detected are marked in red.

10.5 Testing a 2D task

Precondition

- The task has been configured.
- The model has been generated.
- The base is the same as was used for model generation.
- Only with use of a robot-guided camera: the NULLFRAME tool is selected.

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Only with use of a robot-guided camera: move the robot to the reference pose.
3. In the **Task** area, press **Test**.

   The test is carried out and a result window is displayed.
4. The images in the result window can be enlarged. To do so, press the desired image once.

   If user data from the tool block have been transferred, they are displayed beneath the enlarged image.

Description

Once the test has been performed, a result window with images and a table is displayed.

Areas detected by the cameras are indicated in green in the images. Areas that have not been detected are marked in red. The differences between the reference position and the calculated position are displayed in the table. If multiple components have been detected, the tables are displayed on tabs.

The value of Score is between 0.0 and 1.0. The better the match between the trained pattern and the pattern in the current search image, the higher the value of Score.

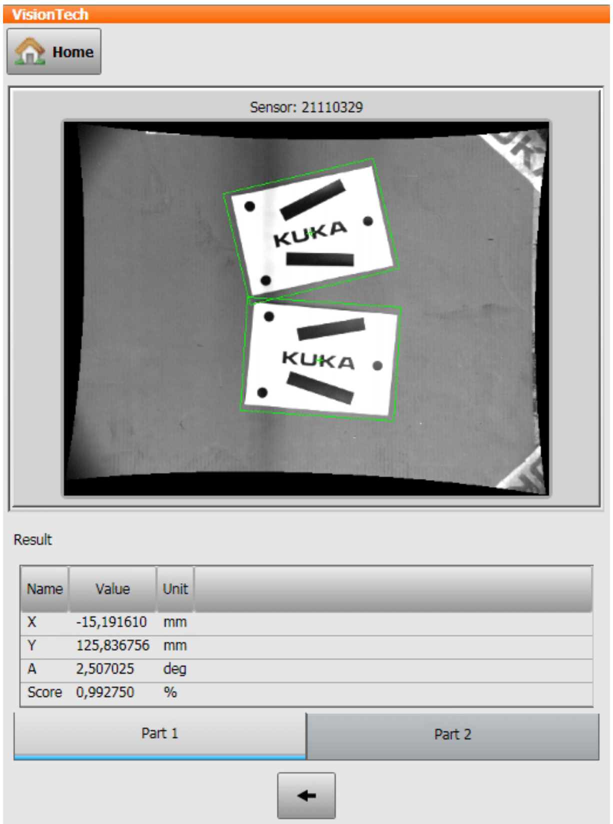


Fig. 10-5: Result of a 2D task test (example)

10.6 Configuring a 3D task

During configuration of a 3D task, a tool block is assigned to the cameras. A tool block contains image processing tasks and has the file extension VPP.

For 3D tasks, at least 2 cameras are required.

Precondition

The following inputs and outputs must be configured in the tool block in order to enable the tool block to be read and used by VisionTech:

Input	Type	Description
InputImage	ICogImage	Input image on which the image processing task is carried out
NumberOf-Parts	INT	Number of components to be detected by means of the image processing

Output	Type	Description
Graphic	CogGraphicCollec-tion	Graphic showing the results of the image processing task
Features	List<Cog3DCrsp2D 3D>	List of features found by means of the image processing

The following outputs can optionally be configured:

Output	Type	Description
Error	Exception	Exceptions or errors that occur during execution of the image processing task
UserData	Object	User-specific data forwarded to KRL by VisionTech. Any type can be used that is derived from Object and overwrites the ToString() method.

The directory INTERNAT\KRCSETUP\KRC\TP\VisionTech\Template on the VisionTech CD contains sample tool blocks which meet the following requirements:

- Tool block for 2D tasks with a stationary camera
- Tool block for 2D tasks with a moving camera
- Tool block for 3D tasks

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Press **New** and select **3D moving**. A new 3D task is created. The name of the task can be changed.
3. Press the Settings icon and select the number of components to be found.

If the selected is too low, this may lead to inconsistencies, e.g. if each camera detects different objects. It is advisable to enter the number of components that one expects to find.

4. In the **Configurations** area, activate the desired cameras by activating the check box. At least 2 cameras must be activated.
5. For the desired cameras, press **...** in the **Toolblocks** column.
6. Select the tool block file and confirm with **OK**.
7. Press the desired camera icon in the line for the desired camera. A window for setting the exposure time is displayed.

8. Optionally: Enter the exposure time or set it using the plus/minus keys or the slider control.
9. Press **Save**. The setting is saved.

   Configuration of the task has been successfully completed when the icon in the **Status** column changes to green.

Description

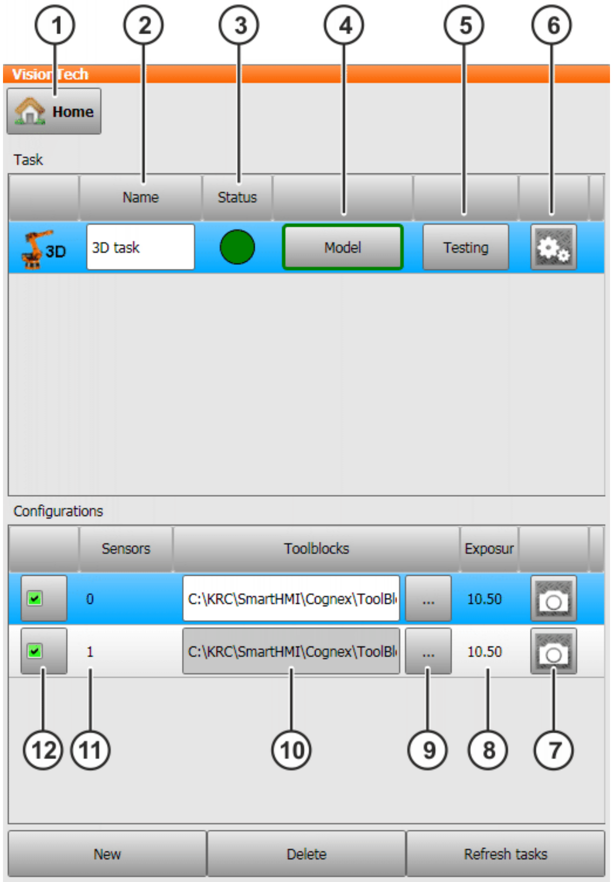


Fig. 10-6: Configuring a 3D task

Item	Description
1	Back to Overview
2	Name of the task The name is freely selectable.
3	State of the task ■ **Green:** Task has been successfully configured. ■ **Red:** Task is not configured.
4	Generate model. ■ **Green frame:** Model has been successfully generated. ■ **Red frame:** No model has yet been generated.
5	Test task ■ **Activated:** The task can be tested. ■ **Deactivated:** The task cannot be tested. No model has yet been generated, or the task is not configured.
6	Settings icon Select the number of components.

Item	Description
7	Camera icon Set the exposure time. ■ **0 … 200 ms**
8	Exposure time that has been set
9	Select directory of tool block file.
10	Directory of tool block file
11	Serial number of the camera
12	■ **Activated:** Camera is used. ■ **Deactivated:** Camera is not used.

The following buttons are available:

Button	Description
New	Creates a new task.
Delete	Deletes the selected task from the list and from the file system.
Refresh tasks	Reloads all tasks and tool blocks in the directory C:\KRC\TP\VisionTech\Tasks.

10.7 Generating a 3D model

Precondition

- The task has been configured.
- The state of the task is green.
- There is only 1 component in the field of vision of the cameras.
- The NULLFRAME tool is selected.

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Move the robot to the reference pose.
3. In the **Task** area, press **Model**. Confirm the request with **Yes**.

   A model is generated and a result window is displayed.
4. The images in the result window can be enlarged. To do so, press the desired image once.

   Generation of the model has been successfully completed when the **Model** button has a green frame.

   The reference position of the component is now known; all deviations are relative to this position.

Description

Once the model has been generated, a result window with images and a table is displayed. Areas detected by the cameras are indicated in green in the images. Areas that have not been detected are marked in red. All configured model points are listed in the table. For each model point, the model type is specified and whether or not it has been found. The maximum and mean error when finding the model point are also specified. For good results, the RMS error should be < 1 mm.

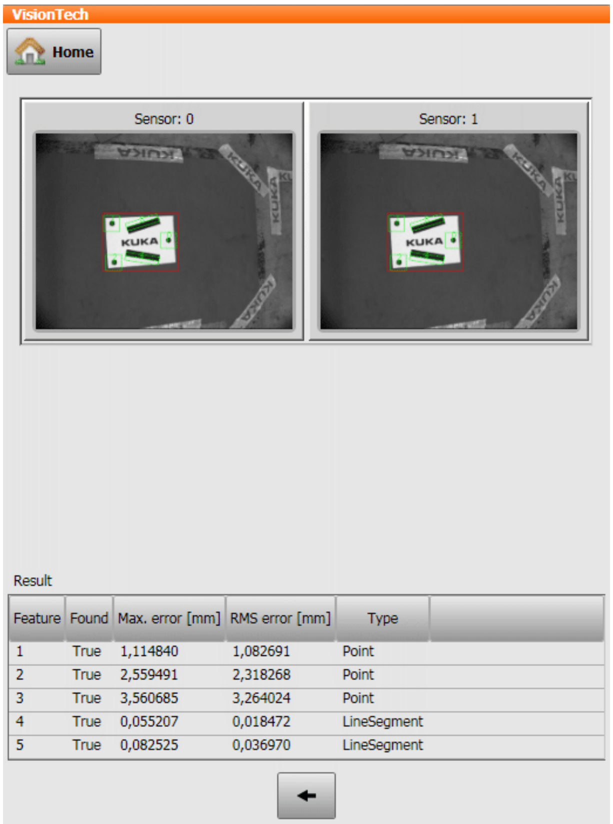


Fig. 10-7: Result of 3D model generation (example)

10.8 Testing a 3D task

Precondition

- The task has been configured.
- The model has been generated.
- The base is the same as was used for model generation.
- The NULLFRAME tool is selected.

Procedure

1. In the main menu, select **VisionTech** > **Task configuration**.
2. Move the robot to the reference pose.
3. In the **Task** area, press **Test**.

   The test is carried out and a result window is displayed.
4. The images in the result window can be enlarged. To do so, press the desired image once.

   If user data from the tool block have been transferred, they are displayed beneath the enlarged image.

Description

Once the test has been performed, a result window with images and a table is displayed.

Areas detected by the cameras are indicated in green in the images. Areas that have not been detected are marked in red. The differences between the reference position and the calculated position are displayed in the table. If multiple components have been detected, the tables are displayed on tabs.

The value of Score is the mean square residual error after calculation of the object position relative to the nominal position. If the position of the object cannot be calculated, Score has the value -1.

Fig. 10-8: Result of a 3D task test (example)

11 Programming

> VisionTech is programmed using not KRL commands, but subprograms.

11.1 Subprograms

> The default configuration file has the name “VisionTechConfig”.

Subprogram	Description
VT_INIT	Type: CHAR (IN) Syntax: VT_INIT(“*Name of the configuration file*”) Initializes the EKI channel. The configuration file is transferred. Executed in the advance run.
VT_OPENCONNECTION	Type: CHAR (IN) Syntax: VT_OPENCONNECTION(“*Name of the configuration file*”) Opens an EKI connection to the server. The configuration file is transferred. Executed in the advance run.
VT_TASKTRIGGER	Type: CHAR (IN), CHAR (IN) Syntax: VT_TASKTRIGGER(“*Name of the configuration file*”,“*Name of the task*”) Requests recording and processing of the images. The configuration file and the name of the task are transferred. Triggers an advance run stop.
GET_VTRESULT	Type: CHAR (IN) Syntax: RESULT = GET_VTRESULT(“*Name of the configuration file*”) The return value of this statement is the result of the previously executed task in the form of a VTRESULT structure. The configuration file is transferred. Executed in the advance run.
VTRESULT_CHECK	Type: VTRESULT (IN) Syntax: VTRESULT_CHECK(RESULT) Checks the result. If the result is faulty, a message is displayed. The result of the task is transferred. Executed in the advance run.
VT_CLOSECONNECTION	Type: CHAR (IN) Syntax: VT_CLOSECONNECTION(“*Name of the configuration file*”) Closes all existing connections to the server. The configuration file is transferred. Executed in the advance run.

Subprogram	Description
VT_CLEAR	Type: CHAR (IN) VT_CLEAR("*Name of the configuration file*") Terminates the EKI channel. The configuration file is transferred. Executed in the advance run. **Note**: Ensure that no data are called by a connection that has already been terminated by VT_CLEAR.
GET_VTCORRECTIONFRAME	Type: VTRESULT (IN) Syntax: GET_VTCORRECTIONFRAME(RESULT) The return value of this statement is of structure type FRAME. The return value of a task is transferred. Executed in the advance run. (>>> 11.1.1 "Structure of VTRESULT" Page 63)
DO_GETVTRESULT	Type: CHAR (IN), VTRESULT (OUT), INT (IN), INT (IN) Syntax: DO_GETVTRESULT("*Name of the configuration file*", "*Flag that is to be set to TRUE once the result has been read*", "*Flag that is to be set to FALSE once the result has been read*") Reads in the result of the image processing and creates a result structure. The result is written to the transfer parameter RESULT. The flags are then set to TRUE and FALSE. Executed in the advance run. The subprogram can also be used as an interrupt program. This is called after the image processing task has been executed. In this case, the subprogram is executed in the main run. **Note**: The flag that is to be set to TRUE is the same flag that is used in the subprogram VT_WAIT. The flag that is to be set to FALSE is defined in the configuration file.
VT_WAIT	Type: INT (IN) Syntax: VT_WAIT("*Flag for which the program is to wait*") Waits until the flag is set to the value TRUE. Program execution is then resumed. Triggers an advance run stop. **Note**: The flag for which the program is to wait is the same flag that is set to TRUE in the subprogram DO_GETVTRESULT.
GET_VTUSERDATA	Type: CHAR (IN), CHAR (OUT) Syntax: GET_VTUSERDATA("*Name of the configuration file*","*Used data from the tool block*") Calls user-specific data from the tool block and makes them available to the KRL. Executed in the advance run.

Subprogram	Description
DO_GETVTRESULTS	Type: CHAR (IN), VTRESULT (OUT), INT (OUT), INT (IN), INT (IN) Syntax: DO_GETVTRESULTS("*Name of the configuration file*", RESULTS[], PARTCOUNTER, "*Flag that is to be set to TRUE once the result has been read*", "*Flag that is to be set to FALSE once the result has been read*") Generates a result structure for all object instances found. This is written to the transfer parameter RESULTS. Once the subprogram has been executed, the parameter PARTCOUNTER contains the number of components that have been found by the image processing system. The flags are then set to TRUE and FALSE. Executed in the advance run. The subprogram can also be used as an interrupt program. This is called after the image processing task has been executed. In this case, the subprogram is executed in the main run.
VT_CHECKPOSELIMIT	Type: FRAME (IN), FRAME (IN), REAL (IN) Syntax: RET = VT_CHECKPOSELIMIT("Robot pose to be checked", "Frame returned by the function GET_VTCORRECTIONFRAME", "Maximum offset between the original robot pose and the robot pose in the new workpiece base in mm") Determines whether the target robot pose lies within the defined limit range. Executed in the advance run. The return value of this statement is of type BOOL: ■ **RET = TRUE**: The target robot pose lies within the defined limit range. ■ **RET = FALSE**: The limit value is exceeded. (>>> 11.1.2 "Subprogram VT_CHECKPOSELIMIT" Page 64) **Note**: This subprogram should be executed in order to avoid collisions.

11.1.1 Structure of VTRESULT

Name	Unit	Data type	Description
X	mm	REAL	Translational deviation in the X direction relative to the nominal position.
Y	mm	REAL	Translational deviation in the Y direction relative to the nominal position.
Z	mm	REAL	Translational deviation in the Z direction relative to the nominal position.
A	degrees	REAL	Rotational deviation about the Z axis relative to the nominal position.
B	degrees	REAL	Rotational deviation about the Y axis relative to the nominal position.
C	degrees	REAL	Rotational deviation about the X axis relative to the nominal position.

Name	Unit	Data type	Description
SCORE		REAL	For a 2D task: Match between the trained pattern and the pattern on the current search image. **Note**: The value is normally between 0.0 and 1.0. If the value is higher, the match is greater.
			For a 3D task: Mean square residual error after calculation of the object position relative to the nominal position. **Note**: If the position of the object cannot be calculated, the value -1 is displayed.
SUCCEEDED		BOOL	■ **TRUE**: The image processing task has been executed successfully. ■ **FALSE**: An error occurred during execution of the image processing task.
ERRORMESSAGE		CHAR[100]	Indicates errors that have occurred during execution of the image processing task.

11.1.2 Subprogram VT_CHECKPOSELIMIT

VT_CHECKPOSELIMIT can be used to determine whether the target robot pose (here: P1') lies within the defined limit range. The defined limit value specifies a range about the original robot pose (here: P1). The range is represented here by a circle. The defined limit value specifies the radius of the circle in which the target robot pose must lie.

If e.g. a limit value of 100 mm is specified, the target robot pose must lie within a radius of 100 mm about the original robot pose.

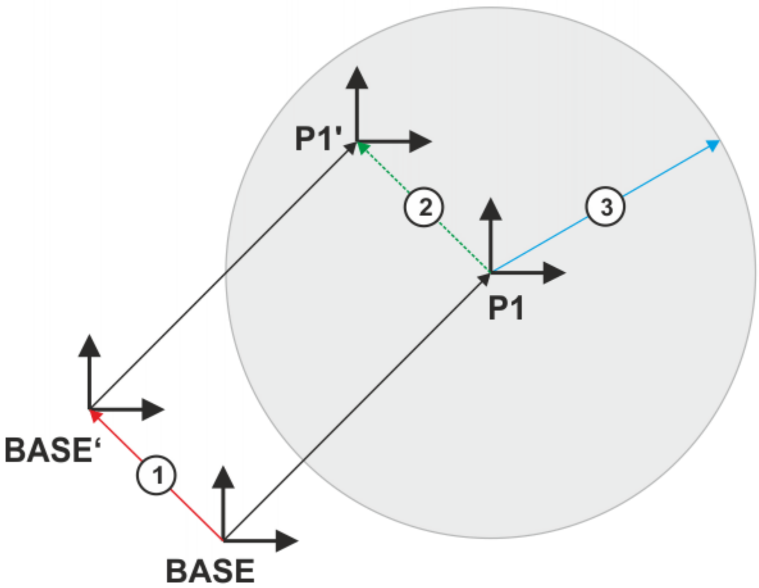


Fig. 11-1: Base correction with VT_CHECKPOSELIMIT

1 Base correction
2 Offset of point P1 due to the base correction
3 Radius (limit value)

11.2 Calling the function KUE_WEG2

Procedure

1. Copy the file KUE_WEG2.SRC from the directory C:\KRC\UTIL\KUEWEG to the directory KRC:\R1\Program.
2. Call the function in the KRL program as follows:
   KUE_WEG2(*start point*, *end point*, *base of the end point*)

Description

The function KUE_WEG2 is used to execute a PTP motion between the start and end point in such a way that axes 4 and 5 are moved as little as possible. In addition, a different base can be used for the end point than for the start point.

KUE_WEG2 can be used to avoid collisions. Notes on using the function:

- $TOOL and $BASE must be valid.
- The Status of the start point must be correctly transferred.
- Only the Status of axis 5 is determined for the end point. For this reason, the Status for the basic/overhead area and for axes 2 and 3 must not change.
- With CP motion, the Status of the end point is ignored.

12 Example programs

12.1 Example program for a 3D task

Program

```
 1  DEF Beispiel(  )
 2  DECL INT PART
 3  DECL FRAME POINT
 4  DECL BOOL VALID
 5  INI
 6  INTERRUPT DECL 89 WHEN $FLAG[998]==TRUE DO
    DO_GETVTRESULTS("VisionTechConfig",RESULTS[],
    PARTCOUNTER,1,998)
 7  INTERRUPT ON 89
 8  PTP HOME Vel=100 % DEFAULT
 9  BASE_DATA[2]=$NULLFRAME
10  LOOP
11  $FLAG[1]=FALSE
12  PARTCOUNTER=0
13  PTP P1 Vel=100 % PDAT1 Tool[0] Base[2]
14  VT_INIT("VisionTechConfig")
15  VT_OPENCONNECTION("VisionTechConfig")
16  VT_TASKTRIGGER("VisionTechConfig","Test")
17  VT_WAIT(1)
18  GET_VTUSERDATA("VisionTechConfig",APPDATA[,])
19  FOR PART=1 TO PARTCOUNTER
20  VTRESULT_CHECK(RESULTS[PART])
21  CORRFRAME=GET_VTCORRECTIONFRAME(RESULTS[PART])
22  POINT={X 1,Y 2,Z 3,A 4,B 5,C 6}
23  VALID=VT_CHECKPOSELIMIT(POINT,CORRFRAME,3)
24  IF(VALID==TRUE) THEN
25  PTP P2 Vel=100 % PDAT3 Tool[0] Base[2]
26  BASE_DATA[3]=BASE_DATA[2]:CORRFRAME
27  KUE_WEG2(XP2,XPUNKTCORR,BASE_DATA[3])
28  PTP PUNKTCORR Vel=100 % PDAT2 Tool[0] Base[3]
29  ENDIF
30  ENDFOR
31  VT_CLOSECONNECTION("VisionTechConfig")
32  VT_CLEAR("VisionTechConfig")
33  ENDLOOP
34  PTP HOME Vel=100 % DEFAULT
35  END
```

Description

Line	Description
6	Defines the interrupt program that is to be executed when the result of the image processing is received. On successful execution, the program sets flag 1 to TRUE. This signals to the main program that execution can be resumed. The number of workpiece instances found is saved in the PartCounter variable.
11	Flag 1 is set to FALSE.
12	The parameter “Partcounter” is pre-initialized with the value 0.
13	Point for image acquisition
14	Initializes the EKI channel with the data from the configuration file.
15	Opens an EKI connection to the server.
16	Requests execution of the task with the name “Test”.
17	Waits for flag 1. This is set by the interrupt program when the result of the image processing is received. Execution of the main program is then resumed.
18	Calls the user data of the executed task and saves them in the 2-dimensional array APPDATA[,]. **Note**: The 2-dimensional array must be defined elsewhere.

Line	Description
20	Checks the results of all components found. If a result is faulty, a message is displayed.
21	Takes the frame data required for the correction from the result.
23	Checks whether the target pose (point) and the pose that is offset by the calculated correction frame is less than the specified limit value of 3.
24-26	Checks the return value and offsets the correction frame with the workpiece base if the limit value has not been exceeded.
25	Auxiliary point, avoids collisions when approaching a number of components
27	Calls the function KUE_WEG2.
28	Point is addressed in the corrected component base.
31	Terminates all existing connections to the server.
32	Terminates the EKI channel.

13 Messages

Message	Cause	Remedy
An error occurred when creating the task {0}: {1}	Insufficient access rights.	Apply for the relevant access rights.
	The directory C:\KRC\TP\VisionTech\Tasks does not exist.	Create the directory.
An error occurred while acquiring an image from sensor {0}: {1}	The connection to the camera has been interrupted.	Check and restore the connection.
	The camera is performing a different process.	Terminate the process and restart the controller.
Failed to save the calibration result	Insufficient access rights.	Apply for the relevant access rights.
	There is already a write-protected calibration result available.	Turn to person who created the existing calibration result.
	The directory C:\KRC\TP\VisionTech\SensorCalibration does not exist.	Create the directory.
Connection to sensor failed	The camera is not connected.	Connect the camera and restart the controller.
	The connecting cable is defective.	Exchange the connecting cable and restart the controller.
Cannot establish a connection to the image processing module. VisionTech is not ready for operation	The image processing module is not yet completely loaded.	Wait until the image processing module is completely loaded.
	The image processing module is not correctly installed.	Contact KUKA Service.
An unknown exception occurred while acquiring a picture from the senor {0}: {1}	The camera is not connected.	Connect the camera and restart the controller.
	The camera is performing a different process.	Terminate the process and restart the controller.
	The connection to the camera has been interrupted.	Check and restore the connection.
The amount of captured pictures is not sufficient for performing a calibration	Too few images were taken for performance of a calibration.	Take at least 6 images.
The following error occurred during calibration: {0}	The fiducial mark is not detected in all the images.	Move to the poses again and ensure that the fiducial mark is visible in every pose.
	The robot poses used are unsuitable for calculating the calibration.	Move to the poses again and ensure that the poses differ to a greater extent.
No sensor selected for the calibration	No camera is selected.	Select a camera and restart calibration.
An error occurred while saving the general sensor settings: {0}	Insufficient access rights to the file system.	Apply for the relevant access rights.
	The existing camera settings are write-protected.	Contact the person who saved the existing camera settings.

Message	Cause	Remedy
Model for task {0} could not be created: {1}	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.
The following error occurred while creating the reference model for task {0}: {1}	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.
The following error occurred while loading the tasks: {0}	The task is not compatible with this version of VisionTech.	Only use compatible tasks.
	The task does not have the TASK file format.	Only use files with the TASK format.
The sensor {0} has no connection.	The camera is not connected to the robot controller.	Establish the connection and restart the controller.
	The camera is performing a different process.	Terminate the process and restart the controller.
The maximal number of captured images has been reached. It is not possible to add further images.	The maximum number of images has already been taken.	Start calibration or terminate the calibration process.
Failed to calculate the position of the object	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.

Message	Cause	Remedy
Failed to calculate the position of the part	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No component could be detected because the component was not in the field of vision of the cameras.	Align the cameras so that the component is in the field of vision.
Not enough features have been detected for calculating the object position.	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.
Not enough features have been detected for calculating the position of the part	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No component could be detected because the component was not in the field of vision of the cameras.	Align the cameras so that the component is in the field of vision.
The execution of a toolblock failed.	The tool block is faulty.	Check the tool block in the image processing environment or test the task in VisionTech.
No toolblocks defined for the specified task	The task has not been configured completely.	Configure the task completely and generate a model.
No toolblocks are set for the specified task.	The task has not been configured completely.	Configure the task completely and generate a model.

Message	Cause	Remedy
An unknown error occurred while testing the task	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.
The following error occurred while saving the task: {0}	Insufficient access rights.	Apply for the relevant access rights.
	There is already a write-protected task available with the same name.	Contact the person who created the existing task.
	The directory C:\KRC\TP\VisionTech\Tasks does not exist.	Create the directory.
The task has no model. It is not possible to execute the task	No model has been generated for this task.	Generate a model.
Failed to match the part instances found in the toolblocks	The features are incorrectly configured in the tool block: the order of the numbering of the features differs for 2 or more cameras.	Check the tool block in the image processing environment. The order of the numbering of the features must be the same for all cameras.
	Different objects can be seen in the camera images.	Align the cameras so that the same objects are in the field of vision of all cameras.
	The calibration contains errors.	Recalibrate the cameras.
Not enough features found for determining the part's position	The tool block is faulty.	Check the tool block in the image processing environment. At least 3 features must be detected.
	The object is not fully in the field of vision of the camera.	Align the cameras so that the same objects are in their field of vision.
	The lighting is too weak.	Increase the lighting setting.
The connection to one of the sensors could not be established	The camera is not connected.	Connect the camera and restart the controller.
	The connecting cable is defective.	Exchange the connecting cable and restart the controller.
Image acquisition with one of the sensors failed	The connection to the camera has been interrupted.	Check and restore the connection.
	The camera is performing a different process.	Terminate the process and restart the controller.
The specified task could not be found	The task has not been loaded.	Load the task with **Refresh tasks**.
	The task does not exist.	Check the spelling.

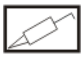
Message	Cause	Remedy
Unknown error during the execution of a task	It was not possible to detect features in the images because the lighting was too strong or too weak.	Set the lighting lower or higher.
	Too few features were detected in the images because each camera detected different features.	Align the cameras so that each camera can detect the same features.
	No object could be detected because the object was not in the field of vision of the cameras.	Align the cameras so that the object is in the field of vision.
Invalid calibration pose	The following causes can be ruled out: ■ TOOL or BASE data differ from those of the previous pose. ■ Identical or similar coordinates to those of the previous pose.	Try a different calibration pose.
Unable to create image buffer in memory: {0}	Invalid image information.	Only use valid image formats.
	Insufficient memory available.	Contact KUKA Service.
No image buffer available: {0}	No image source has been initialized.	Contact KUKA Service.
Unable to write the data to the image buffer: {0}	Insufficient memory reserved for the image source.	Only use valid image formats.
An error occurred when changing the default exposure time	The camera cannot be accessed.	Check the connection to the camera.
An error occurred when changing the calibration exposure time	The camera cannot be accessed.	Establish the connection to the camera.
An error occurred when saving the image from sensor {0}	The camera is performing a different process.	Terminate the process and restart the controller.
	The camera is in an invalid connection state.	Check the connection to the camera.
The entered name {0} contains invalid characters. Please choose another name	The task name contains one or more or the following characters: \ / : * ? " < > |	Delete the invalid characters from the name.
An error occurred while saving the network settings of the sensor: {0}	The network settings are faulty, see error description.	Change the network settings.
The task {0} cannot be deleted: {1}	Another program or user is accessing the task.	Exit the other programs.
	The task no longer exists.	Update the task list.
The calibration type of a sensor is not compatible with the task type	A camera with the wrong calibration type has been assigned to the task, e.g. a stationary 2D camera has been assigned a 3D task.	Assign a different camera to the task.
	An incorrectly calibrated camera has been assigned to a task.	Recalibrate the camera.

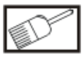
Message	Cause	Remedy
One of the configured sensors is not connected	The camera is not connected.	Connect the camera.
Error in the subroutine DO_GETVTRESULTS. The given array size is too small.	The size of the transferred array is too small.	Declare an array of adequate size (at least the expected number of components).
Unable to create the footprint	The license key entered is not valid.	Enter a valid license key.
	No license key has been entered.	Enter a license key.
Unable to save the request file to the selected path	No write access is enabled for the selected directory.	Request write access for the selected directory or select a different path.
An error occurred while activating the license	The response file is not compatible with the system that is to be licensed.	Check whether the correct response file has been selected.
There is no emergency license available	All the emergency licenses have been used up.	Contact KUKA Service.
The following error occurred while activating the license: {0}	See error description.	Contact KUKA Service.
The following error occurred while opening the selected response file: {0}	The response file is invalid.	Open a valid response file, or contact KUKA Service.
An error occurred while activating an emergency license	The image processing module is not correctly installed.	Contact KUKA Service.
The following error occurred while creating the repair request file: {0}	The image processing module is not correctly installed.	Contact KUKA Service.

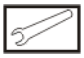
14 Maintenance

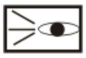
Maintenance symbols

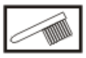
 Oil change

 Lubricate with grease gun

 Lubricate with brush

 Tighten screw/nut

 Check component, visual inspection

 Clean component

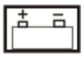
 Exchange battery

Fig. 14-1: Maintenance points

Interval	Item	Activity
Depending on the degree of fouling	1	Depending on the degree of fouling, clean the lens and the protective lens hood with a dry, dust-free microfiber cloth.
1 year at the latest	1	Check the screw fastenings of the camera, the lens and the protective lens hood. Locking varnish can be used to secure the screw fastenings.

15 Repair

15.1 Exchanging the switch

Precondition

- The robot controller is switched off and secured to prevent unauthorized persons from switching it on again.
- The power cable is de-energized.

Procedure

1. Disconnect the switch from the power supply.
2. Unplug the connecting cables.
3. Plug in the connecting cables on the new switch.
4. Connect the new switch to the power supply.

15.2 Exchanging the camera

Precondition

- The robot controller is switched off and secured to prevent unauthorized persons from switching it on again.
- The power cable is de-energized.

Procedure

1. Unplug the connecting cables.
2. Remove the camera.
3. Install the new camera.
4. Plug in the connecting cables on the new camera.
5. Switch on the new camera.
6. Calibrate the new camera.
7. Assign the new camera to the tasks.

15.3 Exchanging the motherboard

> Information about exchanging the motherboard is contained in the robot controller documentation.

16 Troubleshooting

Fault	Remedy
“Power” LED on the camera does not light up	■ Check that the plugged and screwed connections along the connecting cable are fitted securely. ■ Check the connecting cable for damage.
Neither LED “P1” nor LED “P2” lights up	Check whether voltage is present at the power connection (V1 or V2).
LED “P1” or LED “P2” lights up red on the switch	Check that the DIP switches are set correctly. Both switches must be in the “ON” position.
LED “Gigabit PoE Port” does not light up on the switch	The connected device does not support PoE.

17 Decommissioning, storage and disposal

17.1 Decommissioning

Procedure

1. Disconnect the cameras and switch from the power supply.
2. Unplug the connecting cables.
3. Prepare the cameras and switch for storage or transportation.

17.2 Storage

Precondition

If the cameras and switch are to be put into long-term storage, the following points must be observed:

- The place of storage must be as dry and dust-free as possible.
- Avoid temperature fluctuations.
- Avoid condensation.
- Observe and comply with the permissible temperature ranges for storage.
- Select a storage location in which the packaging materials cannot be damaged.
- Only store the cameras and switch indoors.

Procedure

- Cover the cameras and switch with ESD protection foil and seal it against dust.

17.3 Disposal

When the cameras and switch reach the end of their useful life, dispose of them as electrical scrap without disassembling.

18 Appendix

18.1 Tightening torque

Tightening torque The following tightening torques are valid for screws and nuts where no other specifications are given.

	Strength class		
Screw size	8.8	10.9	12.9
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
M2	0.35 Nm	0.48 Nm	0.56 Nm
M2.5	0.68 Nm	0.93 Nm	1.10 Nm
M3	1.2 Nm	1.6 Nm	2.0 Nm
M4	2.8 Nm	3.7 Nm	4.4 Nm
M5	5.6 Nm	7.5 Nm	9.0 Nm
M6	9.5 Nm	12.5 Nm	15.0 Nm
M8	23.0 Nm	31.0 Nm	36.0 Nm
M10	45.0 Nm	60.0 Nm	70.0 Nm
M12	78.0 Nm	104.0 Nm	125.0 Nm
M14	125.0 Nm	165.0 Nm	195.0 Nm
M16	195.0 Nm	250.0 Nm	305.0 Nm
M20	370.0 Nm	500.0 Nm	600.0 Nm
M24	640.0 Nm	860.0 Nm	1030.0 Nm
M30	1330.0 Nm	1700.0 Nm	2000.0 Nm

Tighten M5 domed cap nuts with a torque of 4.2 Nm.

19 KUKA Service

19.1 Requesting support

Introduction

The KUKA Roboter GmbH documentation offers information on operation 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:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- Model and serial number of the energy supply system (if applicable)
- Version of the KUKA System Software
- Optional software or modifications
- Archive of the software

  For KUKA System Software V8: instead of a conventional archive, generate the special data package for fault analysis (via **KrcDiag**).
- Application used
- Any external axes used
- Description of the problem, duration and frequency of the fault

19.2 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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