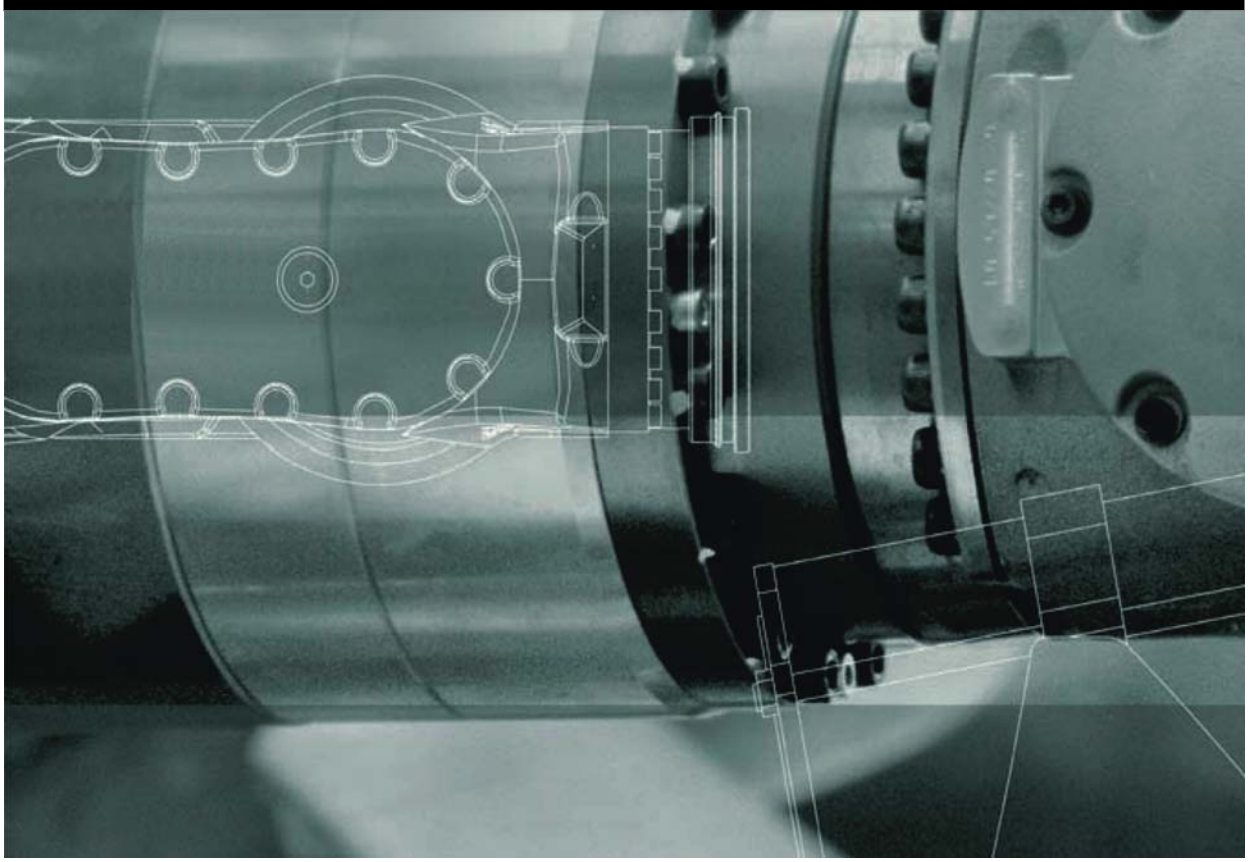
KUKA

Controller

KUKA Roboter GmbH

KR C2 edition2005

Operating Instructions



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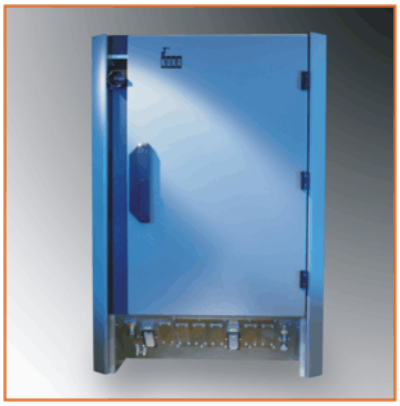

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Contents

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

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

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

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

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

Notes

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

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

1.3 Terms used

Term	Description
AGP PRO	Accelerated Graphic Port
DSE	Digital Servo Electronics
EMC	Electromagnetic compatibility
ESC	Electronic Safety Circuit
KCP	Teach pendant (KUKA Control Panel)
KGD	KUKA Guiding
KRL	KUKA Robot Language
KSK	Force sensor card
KVGA	KUKA Video Graphics Array
LPDN	DeviceNet card
FOC	Fiber-optic cable

Term	Description
Manipulator	The robot arm and the associated electrical installations
MFC3	Multi-function card
RDC	Resolver Digital Converter
RoboTeam	A number of robots whose continuous path motions are synchronized, or both synchronized and geometrically coordinated
SafeRobot	Software and hardware components to replace conventional axis range monitoring systems
USB	Universal Serial Bus. Bus system for connecting additional devices to a computer.
US1	Load voltage (24 V) not switched
US2	Load voltage (24 V) switched. Deactivates actuators, for example, when the drives are deactivated.
KSS	KUKA System Software
VxWorks	Real-time operating system

2 Purpose

2.1 Target group

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

- Advanced knowledge of electrical and electronic systems
- Advanced knowledge of the robot controller
- Advanced knowledge of the Windows operating system

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

The robot controller is intended solely for operating the following components:

- KUKA industrial robots
- KUKA linear units
- KUKA positioners

Impermissible misuse

Any use or application deviating from the intended use is deemed to be impermissible misuse; examples of such misuse include:

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the permissible operating parameters
- Use in potentially explosive environments

3 Product description

3.1 Overview of the industrial robot

The industrial robot consists of the following components:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- Software
- Options, accessories

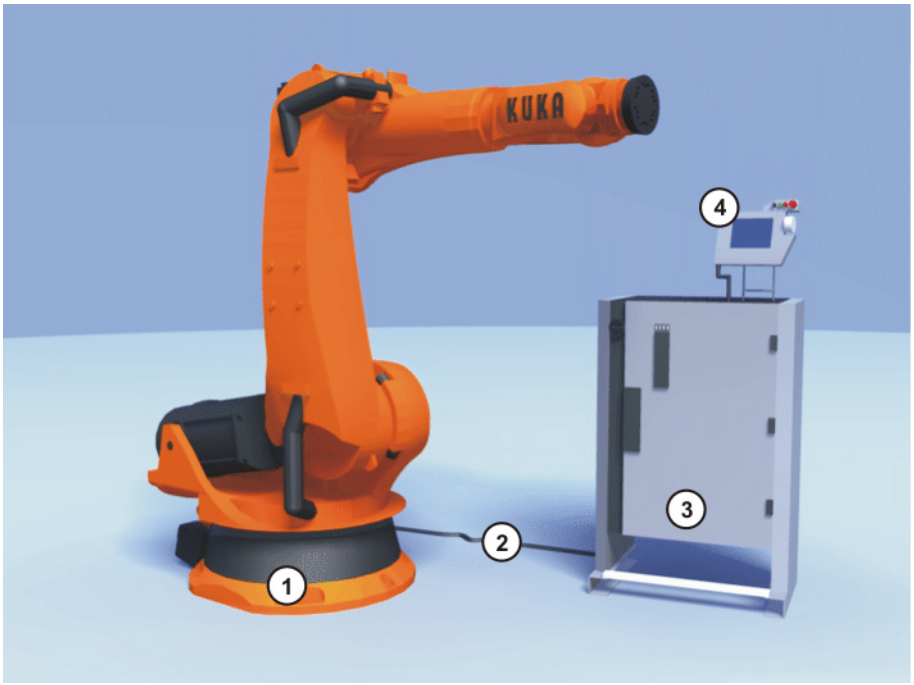

Fig. 3-1: Example of an industrial robot

1	Manipulator	3	Robot controller
2	Connecting cables	4	Teach pendant

3.2 Overview of the robot controller

The robot controller consists of the following components:

- Control PC
- Power unit
- KCP teach pendant
- Safety logic ESC
- KCP coupler (optional)
- Service socket (optional)
- Connection panel

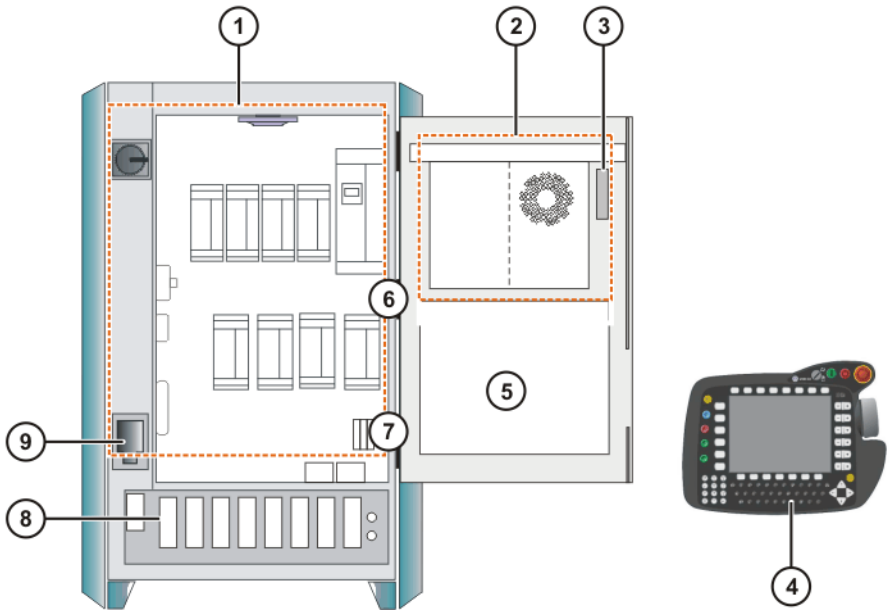

Fig. 3-2: Overview of the robot controller

1	Power unit	6	Safety logic (ESC)
2	Control PC	7	KCP coupler card (optional)
3	KCP coupler control and indicator elements (optional)	8	Connection panel
4	KCP	9	Service socket (optional)
5	Mounting plate for customer components		

3.3 Description of the control PC

Functions

With its fitted components, the PC performs all the functions of the robot controller.

- Windows user interface with visual display and input
- Program creation, correction, archiving, and maintenance
- Sequence control
- Path planning
- Control of the drive circuit
- Monitoring
- Parts of the ESC safety circuit
- Communication with external periphery (other controllers, host computers, PCs, network)

Overview

The control PC includes the following components:

- Motherboard with interfaces
- Processor and main memory
- Hard drive
- MFC3
- KVGA
- DSE-IBS-C33
- RDC
- Batteries
- Optional modules, e.g. field bus cards

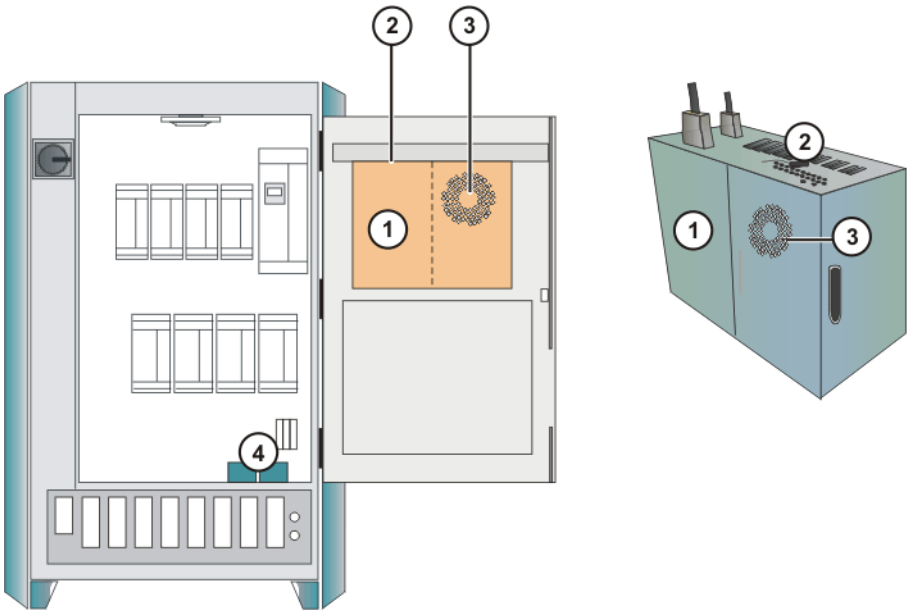

Fig. 3-3: Overview of the control PC

1	PC	3	PC fan
2	PC interfaces	4	Batteries

3.3.1 Control PC interfaces

Overview

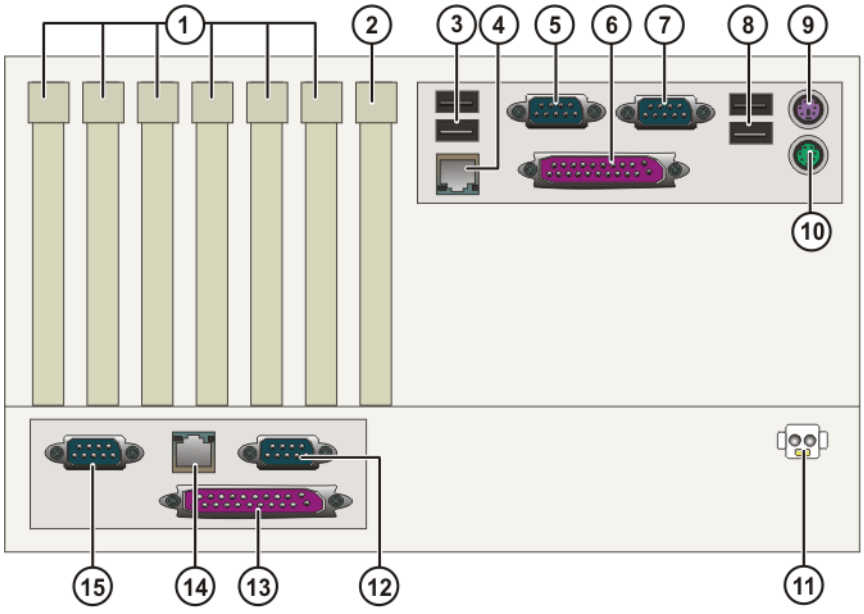

Fig. 3-4: Control PC interfaces

Item	Interface	Item	Interface
1	PCI slots 1 to 6 (>>> 3.3.2 "PCI slot assignment" Page 16)	9	Keyboard connection
2	AGP PRO slot	10	Mouse connection
3	USB (2x)	11	X961 power supply DC 24 V
4	X804 Ethernet	12	ST5 serial real-time interface COM 3

Item	Interface	Item	Interface
5	COM 1 serial interface	13	ST6 ESC/KCP etc.
6	LPT1 parallel interface	14	ST3 drive bus to KPS600
7	COM 2 serial interface	15	ST4 serial RDC interface X21
8	USB (2x)		

3.3.2 PCI slot assignment

Overview

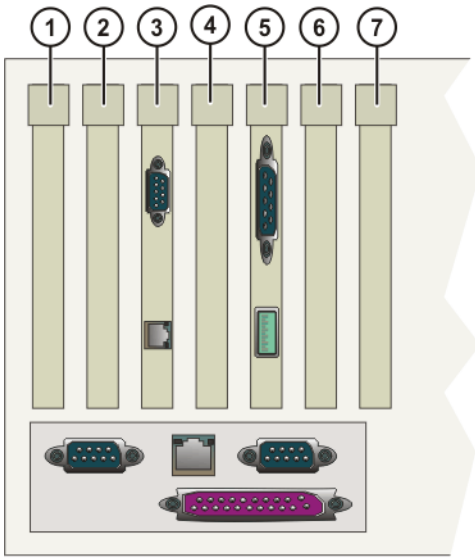

Fig. 3-5: PCI slots

The PC slots can be fitted with the following plug-in cards:

Slot	Plug-in card
1	■ Interbus card (FOC) (optional) ■ Interbus card (copper) (optional) ■ LPDN scanner card (optional) ■ Profibus master/slave card (optional) ■ CN_EthernetIP card (optional)
2	LPDN scanner card (optional)
3	KVGA card
4	DSE-IBS-C33 AUX card (optional)
5	MFC3 card
6	■ Network card (optional) ■ LPDN scanner card (optional) ■ Profibus master/slave card (optional) ■ LIBO-2PCI card (optional) ■ KUKA modem card (optional)
7	free

3.3.3 Motherboard

Configuration

The following components are located on the motherboard:

- Processor

- Main memory (RAM)
- Interfaces to all PC components
- On-board network card
- BIOS

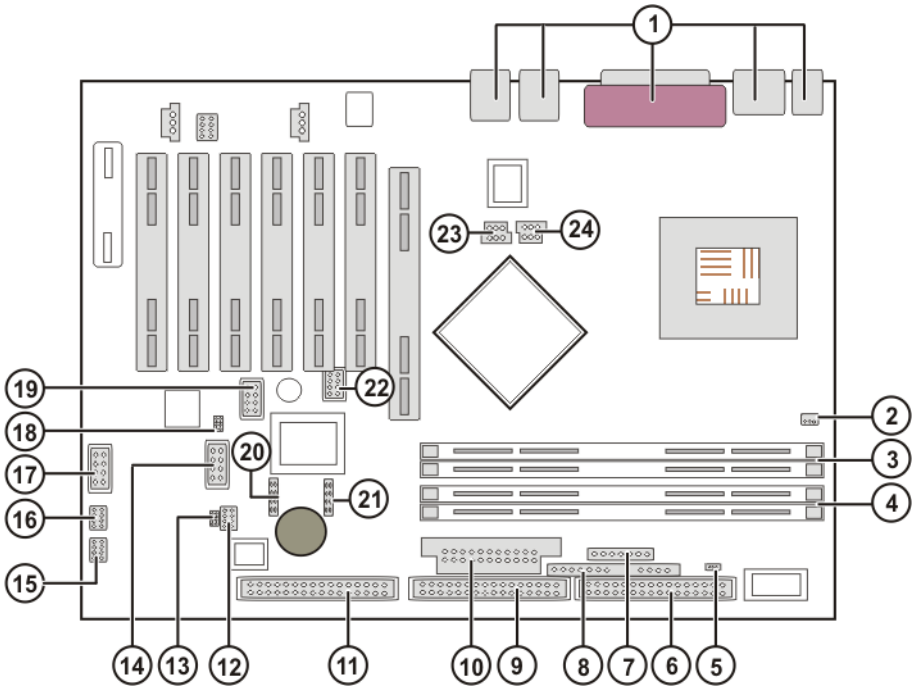

Fig. 3-6: Motherboard

Connections

1	External connections
2	Fan 1
3	RAM slot A
4	RAM slot B
5	Power ON II LED
6	Floppy disk drive
7	Power supply monitoring
8	Control panel
9	IDE drive 3/4
10	Power supply
11	IDE drive 1/2
12	Jumpers
13	External temperature sensor
14	LCD control panel
15	Fan 2
16	Fan 3
17	FireWire (IEEE 1394)
18	Housing monitoring
19	USB G/H
20	Serial AT A1
21	Serial AT A2
22	USB E/F
23	Additional +3 V power supply
24	Additional +12 V power supply

The KUKA Robot Group has assembled, tested and supplied the motherboard with an optimum configuration. No liability will be accepted for modifications to the configuration that have not been carried out by the KUKA Robot Group.

3.3.4 Hard drive

Description

The hard drive is partitioned into 2 “logical” drives. The 1st partition is addressed as C: and the 2nd as D:. The data cable is connected to the motherboard via connector IDE 1/2. The jumper must be connected in the "Master" position.

The following systems are available on the hard drive:

- KSS KUKA System Software
- Windows XP
- Tech packages (optional)

3.3.5 Multi-function card (MFC3)

Description

2 different MFC3 cards are used in the robot controller according to the specific customer requirements:

- MFC3 Standard
- MFC3 Tech

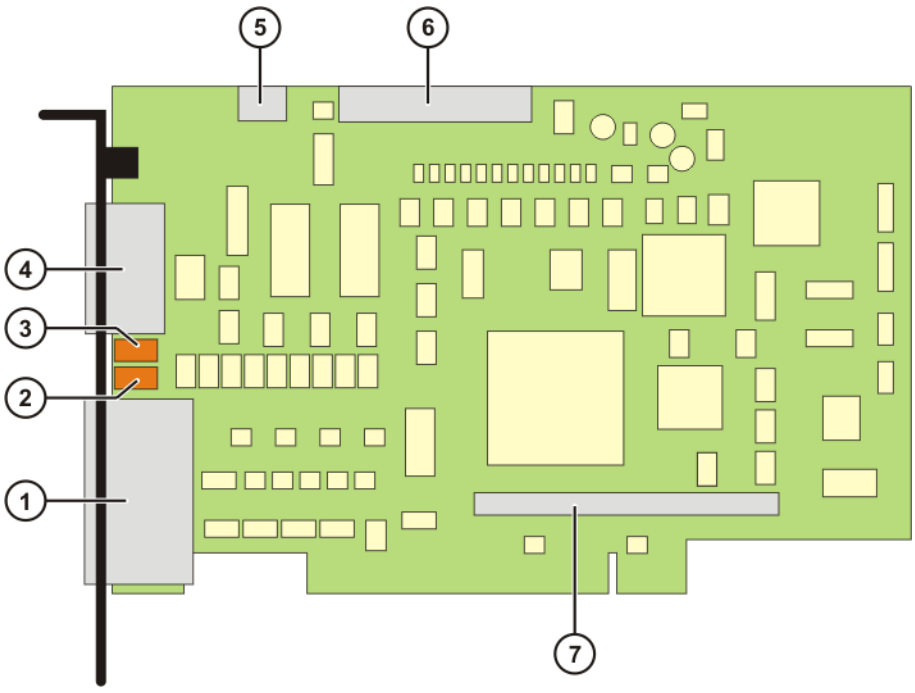

Fig. 3-7: MFC3 card

Connections

Item	Connector	Description
1	X2	Interface to the CI3 board
4	X801	CAN bus connection
5	X3	PC fan monitoring
6	X6	ESC, KCP-CAN, COM, user I/O
7	X8101	DSE connection

LED

Item	LED	Description
2	LED 2	DeviceNet CAN bus (two-color data bit indication)
3	LED 1	DeviceNet CAN bus (two-color data bit indication)

MFC3 Standard

The MFC3 Standard card contains the system I/Os and has the following functions:

- RTAcc chip for VxWinRT (real-time function)
- DeviceNet connection
  - Customer-specific interface.
  - The Multi-Power Tap option is recommended.
  - As master circuit only.
- Interface with the DSE

  The MFC3 Standard card can accommodate a maximum of 2 DSE-IBS-C33 modules.
- Interface to the CI3 safety logic
- Fan monitoring

Further information about the DeviceNet interface can be found in the corresponding KUKA documentation.

MFC3 Tech

The MFC3 Tech card contains the system I/Os and has the following functions:

- All functions of the MFC3 Standard card
- Interface for the CR option (RoboTeam)
- SafeRobot interface

The MFC3 Tech card can only be used together with a CI3 Tech card.

3.3.6 Digital servo-electronics (DSE-IBS-C33)

Description

The DSE-IBS-C33 is plugged into the MFC3 and controls the servo modules. Error and situation information read from the servo modules is also processed.

If more than 8 axes are used in the robot system, the MFC3 must additionally be fitted with a DSE-IBS-C33-AUX board.

Overview

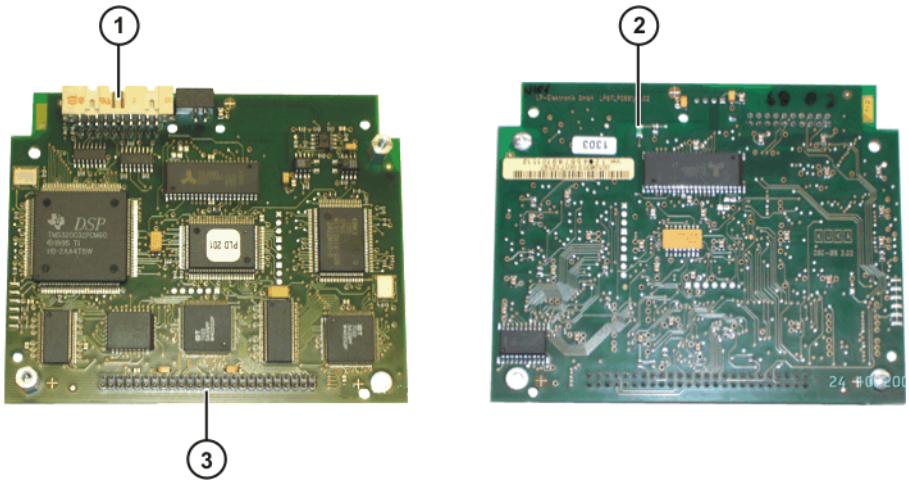

Fig. 3-8

1 X4 connection to the drive servos
2 Green LED
3 X810 connection to the MFC3

LED

A green LED indicates the operating state of the DSE-IBS-C33 (>>> 12.13 "Checking the DSE-IBS-C33" Page 167).

3.3.7 Overview of Resolver Digital Converter (RDC)

2 different RDCs with piggy-back circuit boards are used in the robot controller according to the specific customer requirements:

- RDC
  The following options are available for the RDC:
  - Force sensor card (KSK) for RDC
  - KSK switch box
  - Fast Measurement
- SafeRDC
  - I/O Print card

  The following options are available for the SafeRDC:
  - Force sensor card (KSK) for SafeRDC
  - Fast Measurement

3.3.7.1 Resolver Digital Converter

Description

The RDC has a Digital Signal Processor and converts analog signals to digital signals and is mounted in an RDC box on the base frame of the robot.

Overview

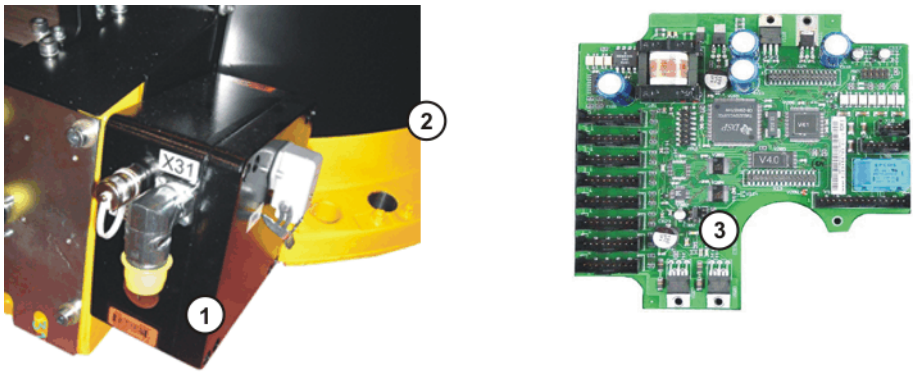

Fig. 3-9: RDC box and RDC board

1	RDC box	3	RDC board
2	Robot base frame		

Functions

- Generation of all required operating voltages
- Resolver power supply for 8 axes
- Isolated power supply to 8 temperature sensors (KTY 84) in the motor windings
- A/D conversion of up to 8 axes
- A/D conversion of 8 temperature sensors
- Automatic offset and symmetry adjustment
- Evaluation of 2 EMT channels
- Detection of 5 Fast Measurement inputs
- Open-circuit monitoring of the resolvers
- Motor temperature monitoring
- Communication with the DSE-IBS3 via an RS422 serial interface
- Saving of the following data:
  - Operating hours meter
  - Absolute position
  - Resolver position
  - Adjustment data (offset, symmetry)

RDC connections

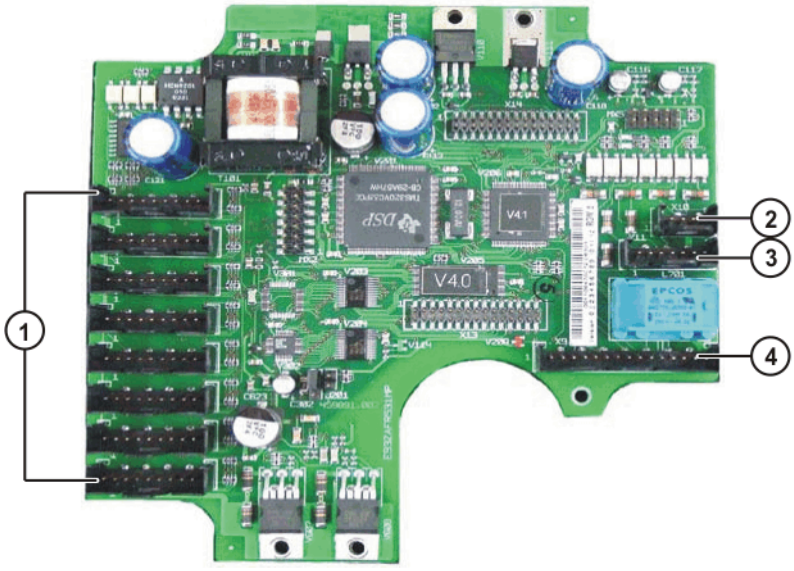

Fig. 3-10: Connections on the RDC board

Item	Designation	Description
1	X1...X8	Connections for resolvers (X1 for resolver of axis 1)
2	X10	EMT connection
3	X11	“Fast Measurement” connection
4	X9	Bus connection to DSE

LEDs

LEDs indicate the operating state of the RDC. (>>> 12.15 "LEDs on the RDC board" Page 170)

RDC box connections

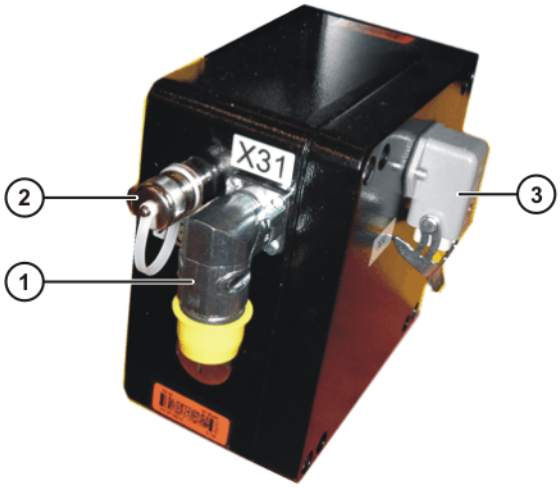

Fig. 3-11: RDC box connections

1 X31 Connection for data cable X21
2 X32 Connection for electronic measuring tool (EMT)
3 X33 “Fast Measurement” connection (optional)

3.3.7.2 Force sensor card (KSK) for RDC (option)

Description

The force sensor card is an expansion card for the RDC, and is located in the RDC box on the robot base frame. The piezoelectric force sensor in the weld gun motor is connected to the force sensor card.

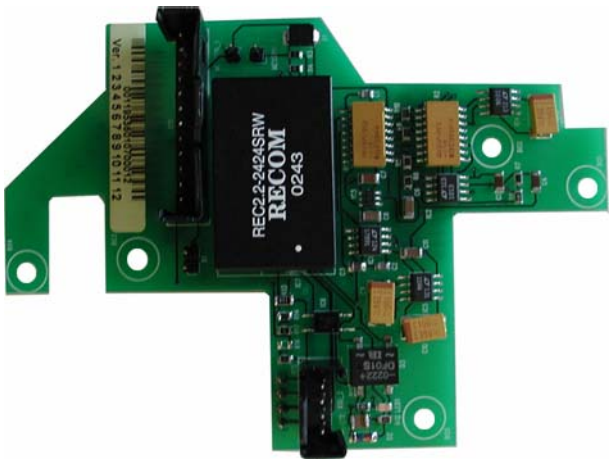

Fig. 3-12: Force sensor card

Functions

- Electrical isolation of the reset signal for the force sensor
- Filtering of the force sensor signal

- Adaptation of the force sensor signal for the RDC
- Power supply for the force sensor

Connections

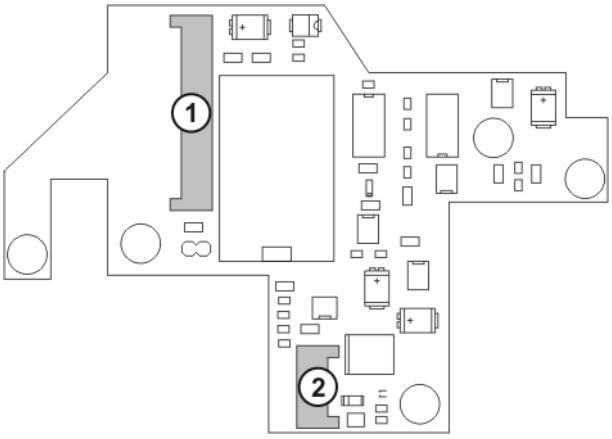

Fig. 3-13: Connections on the force sensor card

1 Connection for force sensor
2 Connection for electronic measuring tool (EMT)

The connections for the RDC board are located on the underside of the force sensor card.

3.3.7.3 KSK switch box (option)

Description

The KSK switch box switches the sensor signals from 2 force-controlled electric motor-driven spot weld guns through to the force sensor card (KSK) via a relay. The resolver signals of axes 7 and 8 are routed through to the RDC board via the switching board in the KSK switch box. The KSK switch box is situated on the base frame of the robot and is mounted on the cover of the RDC box.

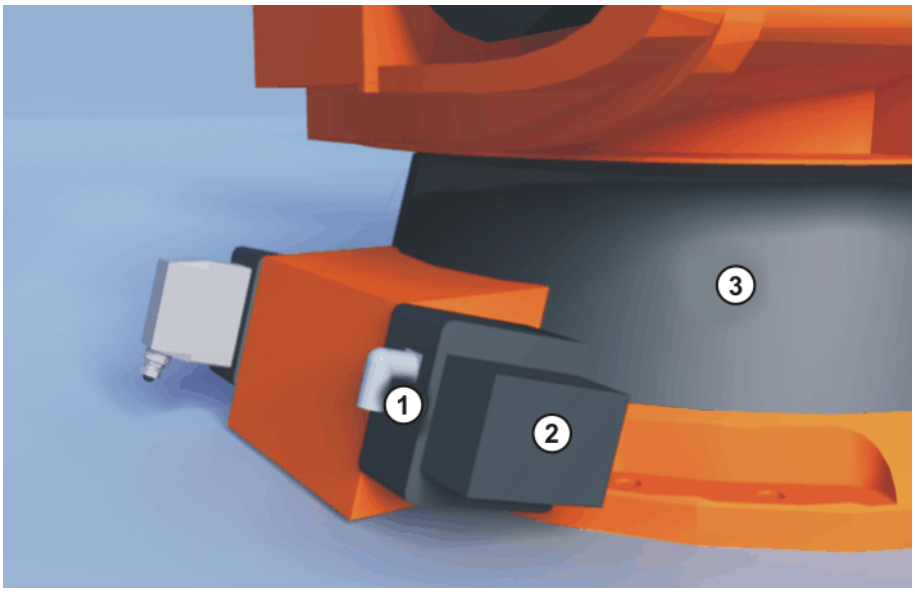

Fig. 3-14: Overview of KSK switch box

1 RDC box
2 KSK switch box
3 Robot base frame

KSK switch box board

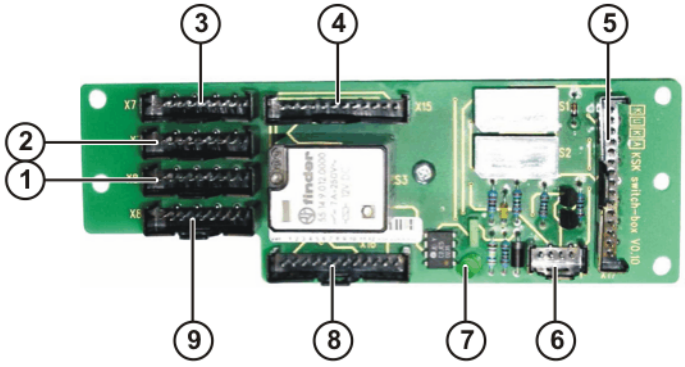

Fig. 3-15: KSK switch box board

Item	Designation	Description
1	X8-1	Resolver connection, axis 8 to RDC
2	X7	Resolver connection, axis 7 to weld gun motor
3	X7-1	Resolver connection, axis 7 to RDC
4	X15	Sensor connection, axis 7
5	X17	Sensor connection to the force sensor card
6	X14	Connection to field bus module / PLC
7	Green LED	Channel switching indicator
8	X16	Sensor connection, axis 8
9	X8	Resolver connection, axis 8 to weld gun motor

Connections

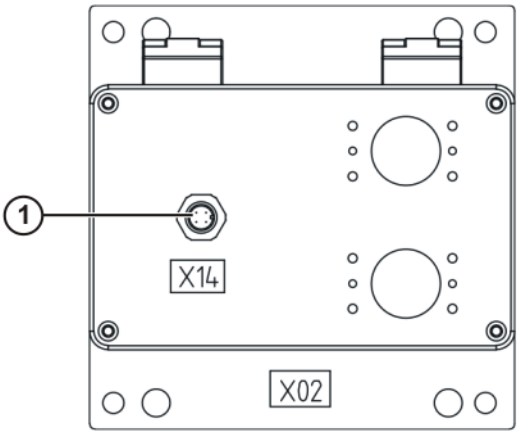

Fig. 3-16: KSK switch box connections

Item	Designation	Description
1	X14	Connection for I/Os from field bus module or PLC

3.3.7.4 Fast measurement with RDC (option)

Description

The Fast Measurement function is a function for recording robot position data via fast measuring inputs and digital sensors to measure components and subsequently correct application programs.

This option can be retrofitted.

Connector pin allocation for X33

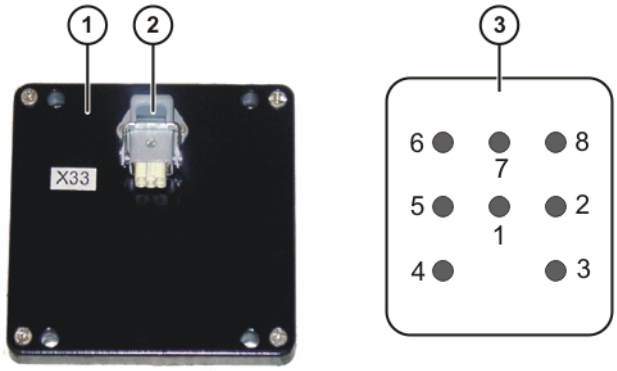

Fig. 3-17: Connector pin allocation for X33

1 Housing cover of RDC box
2 Harting connector X33
3 Contact assignment X33

Pin no.	Designation
1	0 V internal
2	+24 V DC internal
3	Measuring input 1
4	Measuring input 2
5	Measuring input 3
6	Measuring input 4
7	Measuring input 5

Power supply

The Fast Measurement inputs can be supplied with power internally (via the RDC) or externally. (>>> 6.11 "RDC power supply for Fast Measurement (option)" Page 111)

2 RDCs

If more than 8 axes are to be operated in a robot system, a second RDC box must be used. The figure (>>> Fig. 3-18) illustrates the connection of the two RDC boxes.

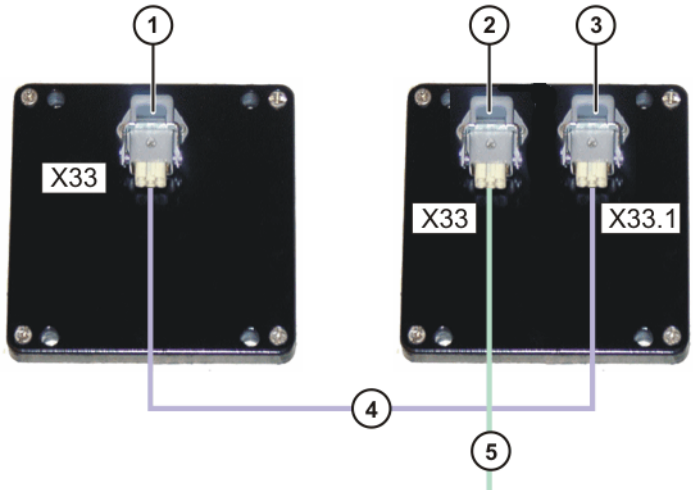

Fig. 3-18: Wiring for 2 RDCs

1 Connector X33 of the first RDC box
2 Connector X33 of the second RDC box
3 Connector X33.1 of the second RDC box
4 Connection of the two RDC boxes
5 Cable to the Fast Measurement sensors

3.3.7.5 SafeRDC

Description

The SafeRDC consists of the following components:

- SafeRDC board
- I/O Print board
- SafeRDC box
- Force sensor card for SafeRDC (optional)

The SafeRDC board redundantly evaluates the resolver signals and monitors the position of the robot axes. The resolver signals are compared with the safety parameters that have been set.

The I/O Print board is plugged onto the SafeRDC board and provides the 24-volt input and output signals.

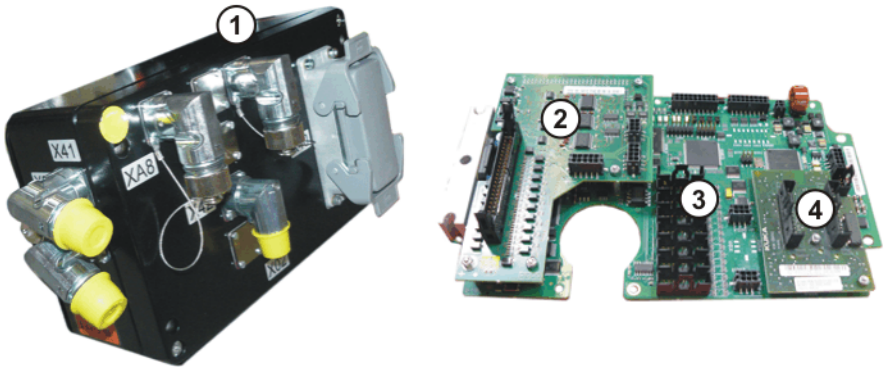

Fig. 3-19: SafeRDC hardware components

1	SafeRDC box	3	SafeRDC board
2	I/O Print board	4	Force sensor card

Functions

- Monitoring of the robot according to the safety parameters that have been set and the signals at the safe inputs
- Monitoring of the safe inputs and outputs for violation of dual-channel operation
- Safe evaluation of the actual position
- Safe disconnection of the drives
- Communication with the robot controller
- Pulsing of the safe inputs and outputs

The inputs for the “Fast Measurement” option are not supported.

Connections

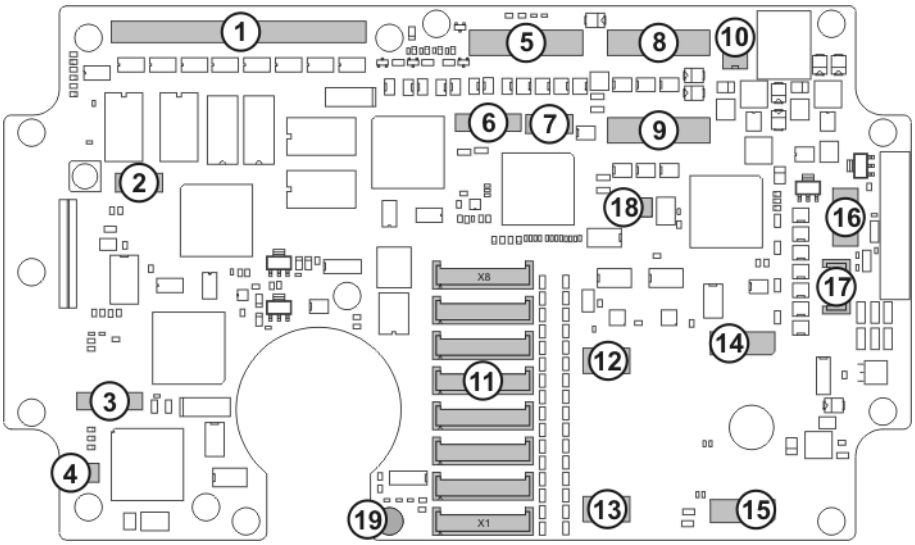

Fig. 3-20: Connections on SafeRDC board

Item	Designation	Description
1	X2000	Connection for I/O Print expansion board
2	X1900	Not used.
3	X1700	Not used.
4	X1500	Not used.
5	X901	Connection of safe inputs and outputs to the ESC circuit
6	X1600	Not used.
7	X1800	Not used.
8	X900	SSI interface A to first DSE
9	X1000	Not used.
10	X9	Connection for RoboTeam lamp
11	X1...X8	Connections for resolvers (X1 for resolver of axis 1)
12	X1200	Force sensor card slot (optional)
13	X1203	Force sensor card slot (optional)
14	X1204	Force sensor card slot (optional)
15	X1208	Force sensor card slot (optional)
16	X1301	Fast measurement connection
17	X10	Connection for electronic measuring tool (EMT)
18	X1400	Not used.
19	- - -	Ground conductor connection The contact to the SafeRDC box is established using a screw.

LEDs

LEDs indicate the operating state of the SafeRDC. (>>> 12.16 "LEDs on the SafeRDC board" Page 170)

Connections on SafeRDC box

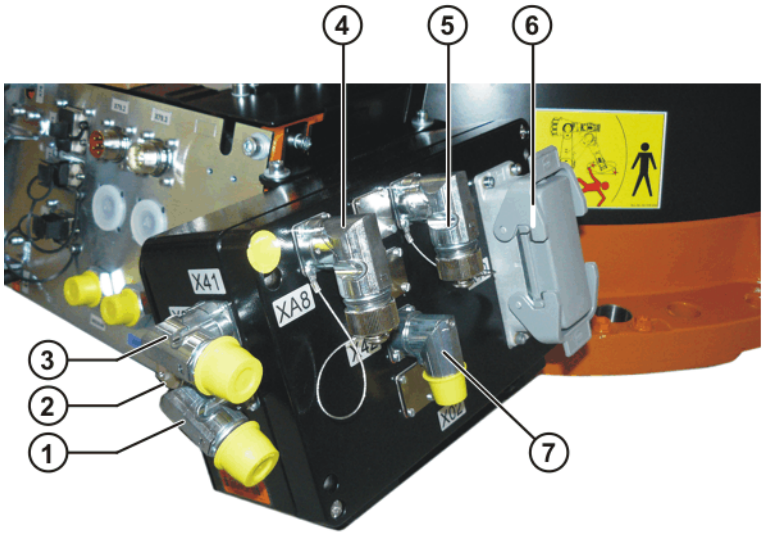

Fig. 3-21: Connections on the SafeRDC box

1 X31 Connection for data cable X21
2 X32 Connection for electronic measuring tool (EMT)
3 X41 Connection for data cable X21.1
4 XA8 Connection for force sensor card, axis 8 (optional)
5 XA7 Connection for force sensor card, axis 7 (optional)
6 X40 Connection for safe inputs and outputs
7 X42 Connection for reference cable XS Ref

3.3.7.6 I/O Print card for SafeRDC

Description

The I/O Print card is plugged onto the SafeRDC board and provides the 24-volt input and output signals.

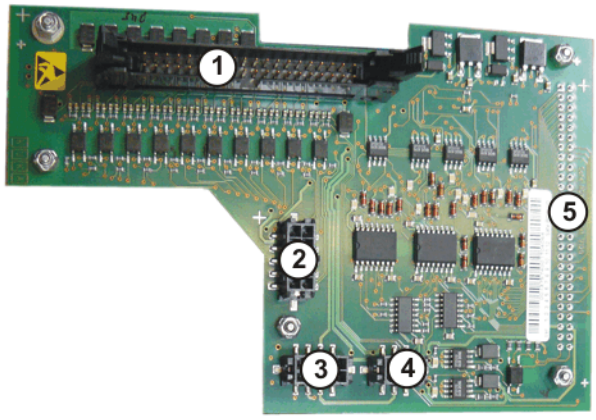

Fig. 3-22: I/O Print board

Item	Designation	Description
1	X902	Connections for safe inputs and outputs
2	X1	Not used
3	X905	Connection for enabling KUKA Guiding Device (KGD)
4	X904	Connection for reference switch input
5	X901	Connection for SafeRDC board

LEDs LEDs indicate the operating state of the I/O Print board. (>>> 12.16.2 "LEDs on the I/O Print board" Page 173)

3.3.7.7 Force sensor card for SafeRDC (option)

Description The force sensor card (KSK) is plugged onto the SafeRDC card. The welding force of a servo gun is measured using the force sensor card. 2 force sensors can be connected.

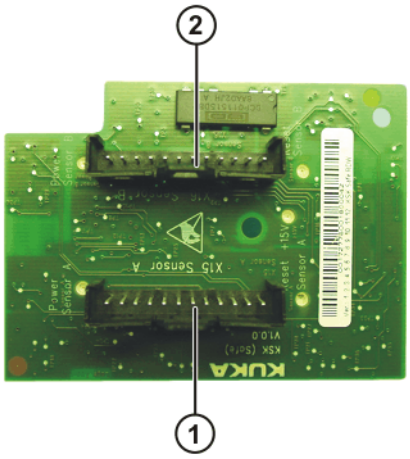

Fig. 3-23: Overview of force sensor card for SafeRDC

Connections

Item	Connector	Description
1	X15	Connection for sensor 1
2	X16	Connection for sensor 2

LEDs LEDs indicate the operating state of the force sensor card for SafeRDC. (>>> 12.16.1 "LEDs on the force sensor card (KSK) for SafeRDC (option)" Page 173)

3.3.7.8 Fast measurement with SafeRDC (option)

Description The Fast Measurement function is a function for recording robot position data via fast measuring inputs and digital sensors to measure components and subsequently correct application programs.

This option can be retrofitted.

Connector pin allocation for X33

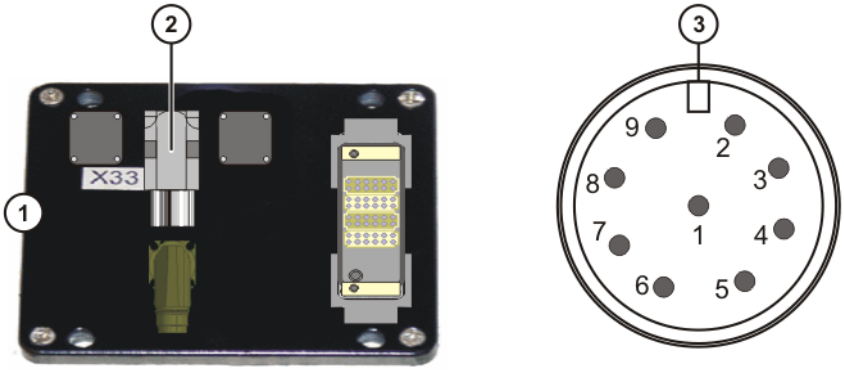

Fig. 3-24: Connector pin allocation for X33

1 Housing cover of SafeRDC box
2 Connector X33
3 Contact assignment X33

Pin no.	Designation
1	Measuring input 1
2	Measuring input 2
3	Measuring input 3
4	Measuring input 4
5	Measuring input 5
6	+24 V DC internal
7	GND input
8	0 V internal

Power supply

The Fast Measurement inputs can be supplied with power internally (via the RDC) or externally. (>>> 6.11 "RDC power supply for Fast Measurement (option)" Page 111)

RDC with SafeRDC

The figure (>>> Fig. 3-25) illustrates the connection of an RDC box and a SafeRDC box.

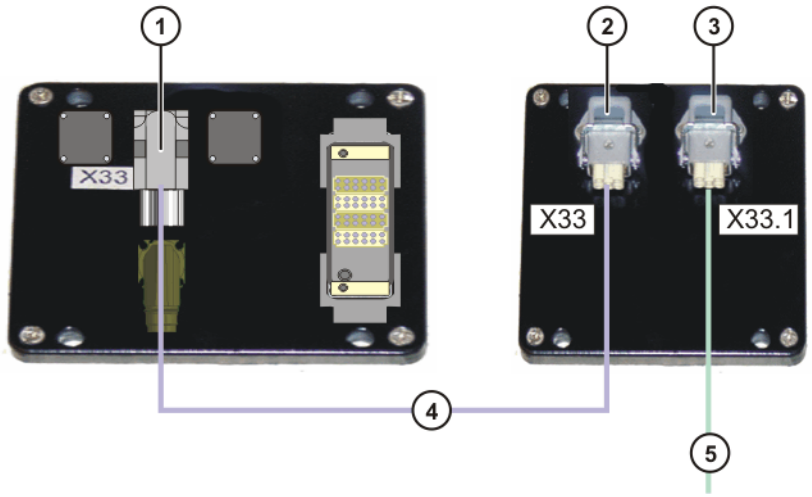

Fig. 3-25: Connection between RDC and SafeRDC

1 Connector X33 of the SafeRDC box
2 Connector X33 of the RDC box
3 Connector X33.1 of the RDC box
4 Connection of the SafeRDC box to the RDC box
5 Cable to the Fast Measurement sensors

3.3.8 KUKA VGA card (KVGA)

Description

The KCP is connected to the KVGA card. The resolution and the number of colors (16 or 256) are set automatically during installation. There are 2 KCP connections on the KVGA card. A normal VGA monitor can also be connected in parallel.

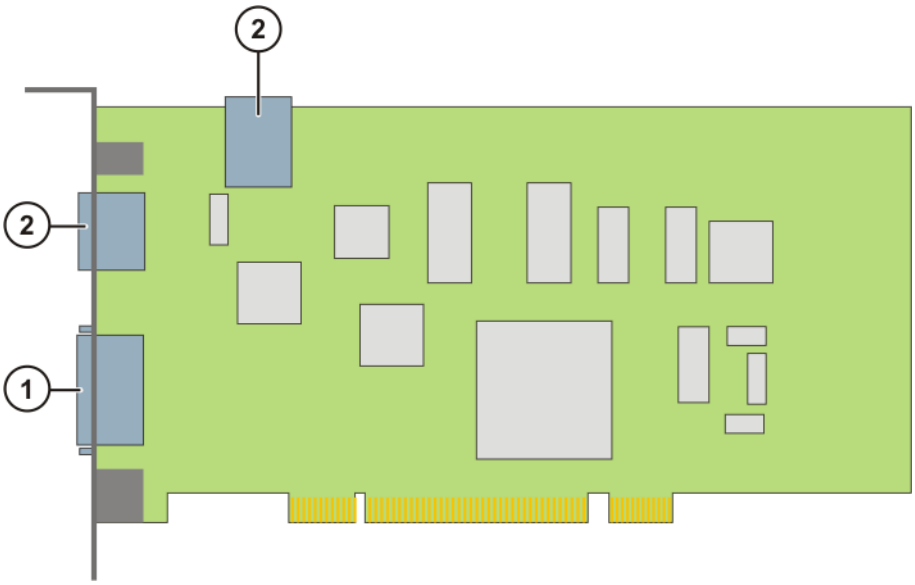

Fig. 3-26: KVGA card

Connections

Item	Connector
1	External monitor connection
2	KCP connection

3.3.9 Batteries

Description

The robot controller is provided with an uninterruptible 24 V power supply by the batteries. The batteries ensure a controlled shutdown of the robot controller in the event of a power failure. They are backed up by the KPS600.

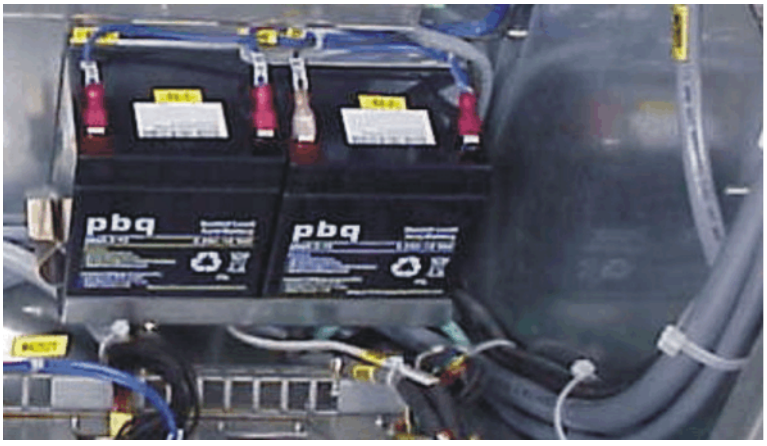

Fig. 3-27: Batteries

3.4 Description of the KUKA Control Panel (KCP)

Function

The KCP (KUKA Control Panel) is the teach pendant for the robot system. The KCP has all the control and display functions required for operating and programming the robot system.

3.4.1 Front view

Overview

Fig. 3-28: Front view of KCP

1	Mode selector switch	10	Numeric keypad
2	Drives ON	11	Softkeys
3	Drives OFF / SSB GUI	12	Start backwards key
4	EMERGENCY STOP button	13	Start key
5	Space Mouse	14	STOP key
6	Right-hand status keys	15	Window selection key
7	Enter key	16	ESC key
8	Arrow keys	17	Left-hand status keys
9	Keypad	18	Menu keys

3.4.2 Rear view

Overview

Fig. 3-29: Rear view of KCP

1	Rating plate	4	Enabling switch
2	Start key	5	Enabling switch
3	Enabling switch		

Description

Element	Description
Rating plate	KCP rating plate
Start key	The Start key is used to start a program.
Enabling switch	The enabling switch has 3 positions: ■ Not pressed ■ Center position ■ Panic position The enabling switch must be held in the **center position** in operating modes T1 and T2 in order to be able to jog the robot. In the operating modes Automatic and Automatic External, the enabling switch has no function.

3.5 KCP coupler (optional)

Description

The KCP coupler allows the KCP to be connected and disconnected with the robot controller running.

Overview

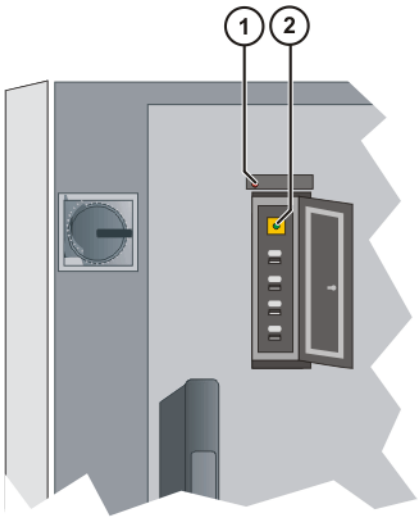

Fig. 3-30: KCP coupler LEDs and request button

1 Fault LED (red), KCP coupler
2 Request button with request LED (green)

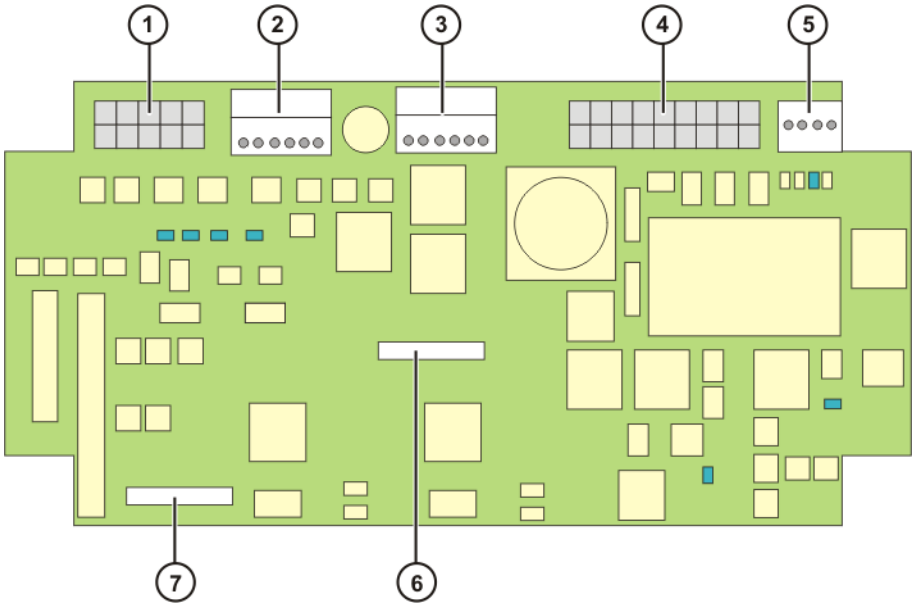

Fig. 3-31: KCP coupler card

Connections

Item	Connect-or	Description
1	X7	Request button LED connection
2	X5	ESC to the KCP
3	X20	SafeRobot to the KCP
4	X2	CI3 connection
5	X21	CAN bus to the KCP
6	X3	Debug connector B
7	X4	Debug connector A

The LEDs on the KCP coupler card indicate the operating status.
(>>> 12.14 "KCP coupler LED display (optional)" Page 167)

3.6 Electronic Safety Circuit (ESC) safety logic

Overview

The ESC (Electronic Safety Circuit) safety logic is a dual-channel computer-aided safety system. It permanently monitors all connected safety-relevant components. In the event of a fault or interruption in the safety circuit, the power supply to the drives is shut off, thus bringing the robot system to a standstill.

The ESC system consists of the following components:

- CI3 board
- KCP (master)
- KPS600
- MFC (passive node)

The ESC system with its node periphery replaces all the interfaces of a conventional safety system.

The ESC safety logic monitors the following inputs:

- Local EMERGENCY STOP
- External EMERGENCY STOP
- Operator safety
- Enabling
- Drives OFF
- Drives ON
- Operating modes
- Qualifying inputs

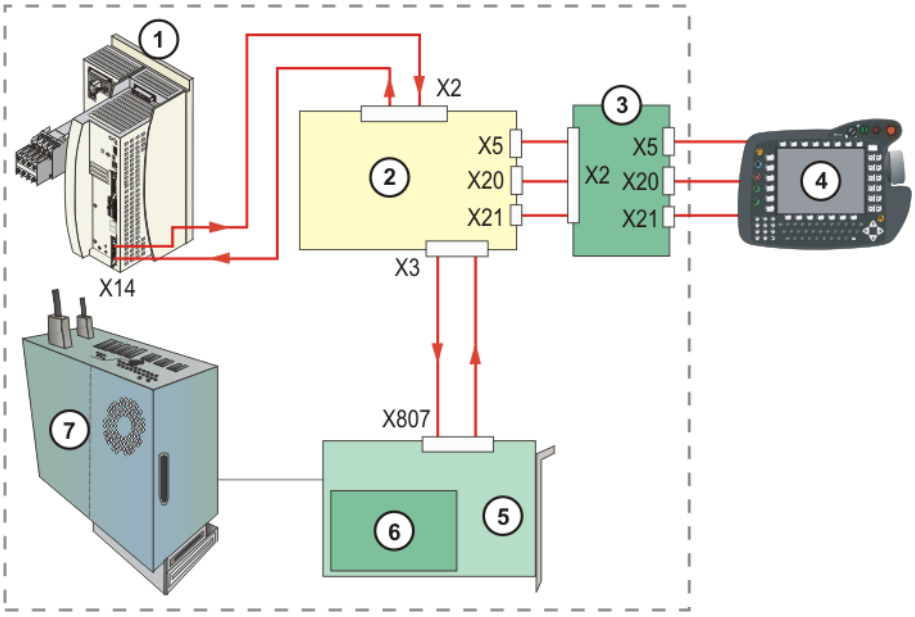

Fig. 3-32: Structure of the ESC circuit

1	KPS600	5	MFC3
2	CI3 board	6	DSE
3	KCP coupler (optional)	7	PC
4	KCP		

Node in the KCP

The node in the KCP is the master and is initialized from here.

The node receives dual-channel signals from:

- EMERGENCY STOP pushbutton
- Enabling switches

The node receives single-channel signals from:

- Drives ON
- AUTO mode, TEST mode

If no KCP coupler is used, the ESC circuit will only function with the KCP connected. If the KCP is unplugged during operation without a KCP coupler, the drives are immediately switched off.

Node in the KPS In the KPS there is an ESC node which switches off the drives contactor in the case of a fault.

Node on the MFC3 On the MFC3 board is a passive ESC node which monitors the information on the ESC circuit and then passes it on to the controller.

3.6.1 ESC nodes

Configuration Each node consists of two ESC chips (A and B), which monitor each other.

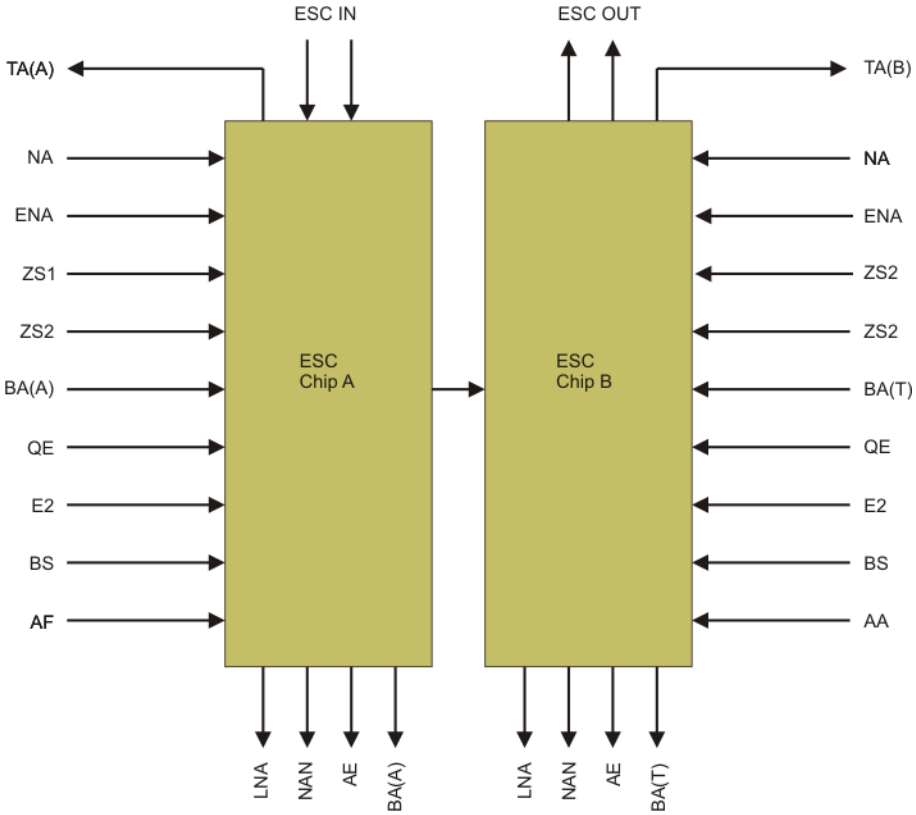

Fig. 3-33: ESC nodes

Signal name	Meaning	Description
TA	Test output	Pulsed voltage for the interface inputs.
NA	Local E-STOP	Input for local E-STOP (dual-channel). If the signal is interrupted, the drives contactor drops out immediately.
ENA	External E-STOP	Input for external E-STOP (dual-channel). If the signal is interrupted, the drives contactor drops out after a delay.

Signal name	Meaning	Description
ZS1	Enabling switches on the KCP	Input for external enabling switch (dual-channel, 1-step). If the signal is interrupted in Test mode, the drives contactor drops out immediately.
ZS2	Enabling switches, panic position	
BA	Operating mode (A=Automatic, T=Test)	Inputs for external mode selector switch (single-channel). If the Automatic and Test modes are activated simultaneously, the drives contactor drops out immediately.
AE	Drives ON output	Output for the drives contactor (dual-channel). The contactor is activated/deactivated by setting the voltage to 24 V/0 V.
AF	Drives enable	Input for external drives enable (single-channel). If the signal is interrupted, the drives contactor drops out immediately.
QE	Qualifying input	0 signal causes a category 0 STOP in all operating modes.
E2	Special key-switch (customer-specific)	-
BS	Operator safety	Input for a safety gate safety switch (single-channel). If the signal is interrupted, the drives contactor drops out after a delay; optionally also immediately.
AA	Drives ON	Input for Drives ON (single-channel). The edge of the signal is evaluated. It is only possible to activate the drives contactor with a positive edge at this input.
LNA	Local E-STOP	Output for local E-STOP (dual-channel). The output is set if a local E-STOP has been triggered. With the relay variant, the contacts are opened in the event of a local E-STOP.
AAUTO/ ATEST BA	Operating mode	Output (single-channel). The corresponding output is set depending on the operating mode. With the relay variant, the contact is closed if the corresponding operating mode has been selected.

Arrows pointing towards the ESC chip represent the input signals, while those pointing away from the ESC chip represent the outputs. The signal TA(A), TA(B) is the pulsed voltage that must be supplied to every input.

3.6.2 Overview of CI3 boards

Description

The CI3 board links the individual nodes of the ESC system with the customer interface being used.

Various different boards are used in the robot controller according to the specific customer requirements:

Board	Own node	Description
CI3 Standard (>>> 3.6.3 "CI3 Standard board" Page 38)	No	Indicates the following states: ■ Local E-STOP
CI3 Extended (>>> 3.6.4 "CI3 Extended board" Page 40)	Yes	Indicates the following states: ■ Operating modes ■ Local E-STOP ■ Drives ON
CI3 Bus (>>> 3.6.5 "CI3 Bus board" Page 41)	No	Connecting board between the ESC circuit and the SafetyBUS p from PILZ
CI3 Tech (>>> 3.6.6 "CI3 Tech board" Page 43)	Yes	This board is required for the following components: ■ KUKA.RoboTeam ■ KUKA.SafeRobot ■ SafetyBUS Gateway ■ Output to the top-mounted cabinet (external axes) ■ Power supply to a 2nd RDC via X19A Indicates the following states: ■ Operating modes ■ Local E-STOP ■ Drives ON

3.6.3 CI3 Standard board

Description

This board is used as standard in the robot controller and has no node of its own. It connects the nodes that are present in the ESC circuit and distributes the signals to the individual interfaces. The “Local E-STOP” state is indicated via a relay. The ESC circuit can be reset using the reset button.

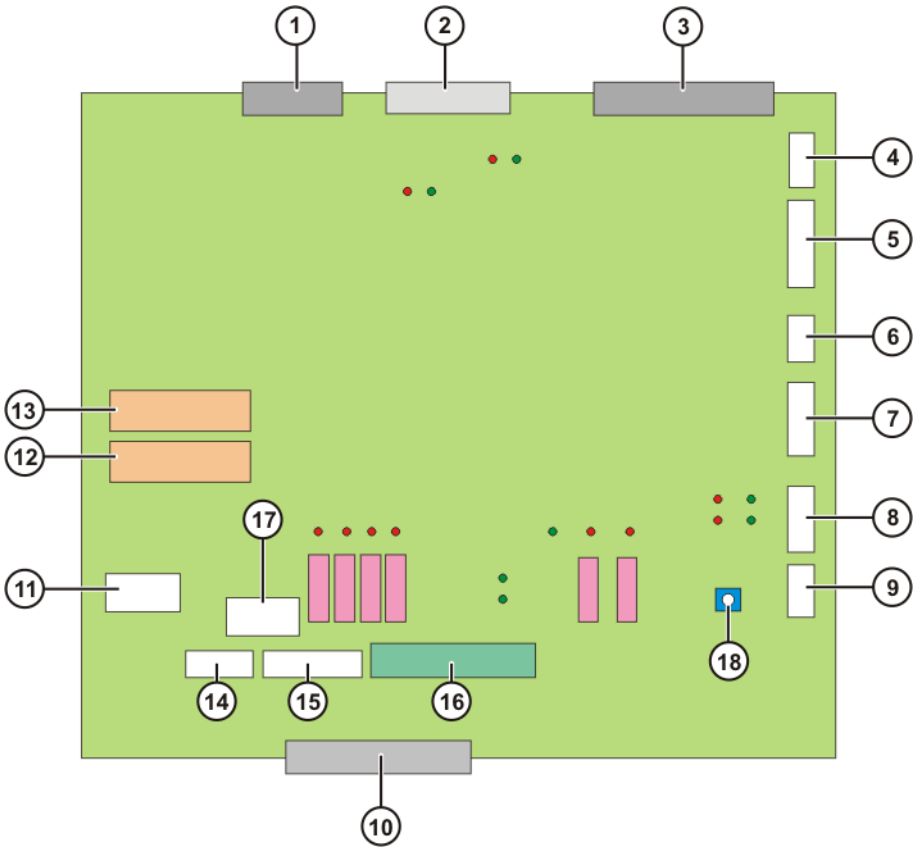

Fig. 3-34: CI3 Standard board connections and relays

Connections

Item	Designation	Description
1	X18	Interface to MFC3 (CR safety signals) (optional)
2	X2	KPS connection
3	X3	MFC connection
4	X19	Interface to the RoboTeam lamp (optional). RDC power supply
5	X4	Connection of external mode selector switches (optional)
6	X7	CAN connection, I/O board
7	X6	Internal/external power supply and ESC circuit
8	X5	KCP connection
9	X21	KCP power supply and KCP CAN
10	X22	Peripheral interface for inputs and outputs
11	X1	Internal 24 V power supply
14	X8	Connection of external controllers, E-STOP button on control cabinet
15	X16	Internal interface
16	X12	Peripheral interface, outputs > 500 mA
17	X31	Connection: robot controller, internal fan

Relays

Item	Designation	Description
12	K4	Message: Local E-STOP
13	K3	Message: Local E-STOP

Reset

Item	Designation	Description
18	KY1	ESC Reset button

3.6.4 CI3 Extended board

Description

This board has its own node and is used to indicate the following states of the ESC circuit:

- Operating modes
- Drives ON
- Local E-STOP

The ESC circuit can be reset using the reset button.

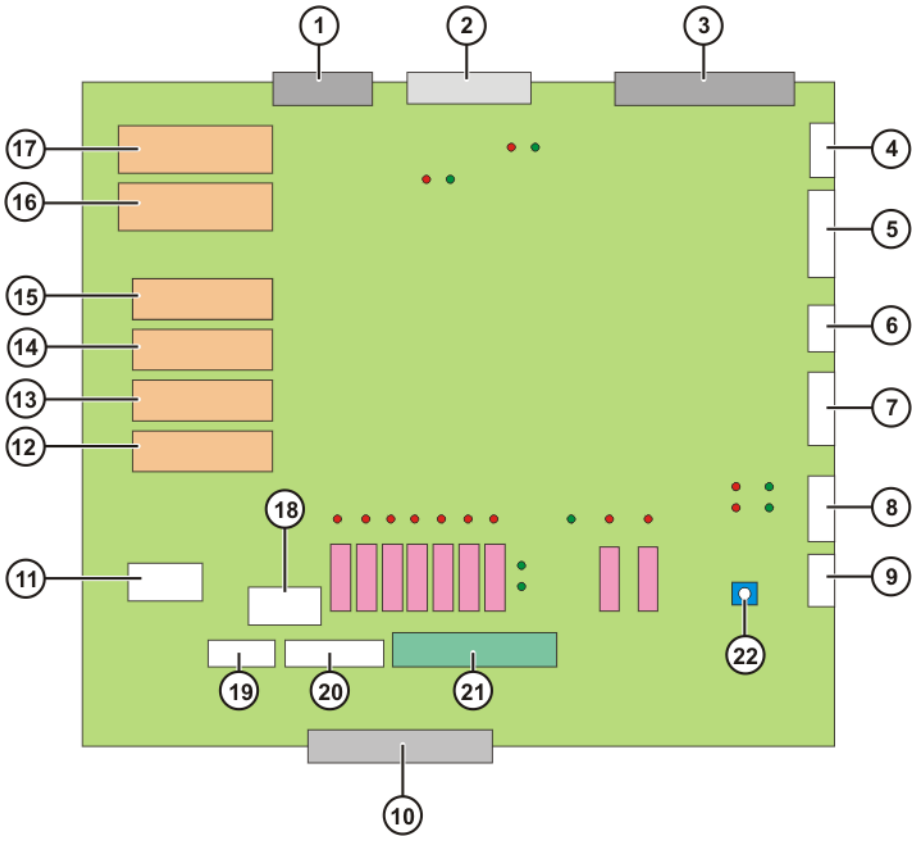

Fig. 3-35: CI3 Extended board connections and relays

Connections

Item	Designation	Description
1	X18	Interface to MFC3 (CR safety signals) (optional)
2	X2	KPS connection
3	X3	MFC connection
4	X19	Interface to the RoboTeam lamp (optional). RDC power supply
5	X4	Connection of external mode selector switches (optional)
6	X7	CAN connection, I/O board
7	X6	Internal/external power supply and ESC circuit
8	X5	KCP connection
9	X21	KCP power supply and KCP CAN

Item	Designation	Description
10	X22	Peripheral interface for inputs and outputs
11	X1	Internal 24 V power supply
18	X31	Connection: robot controller, internal fan
19	X8	Connection of external controllers, E-STOP button on control cabinet
20	X16	Internal interface
21	X12	Peripheral interface, outputs > 500 mA

Relays

Item	Designation	Description
12	K4	Message: Local E-STOP
13	K3	Message: Local E-STOP
14	K8	Message: Auto-Test
15	K7	Message: Auto-Test
16	K1	Message: Drives ON
17	K2	Message: Drives ON

Reset

Item	Designation	Description
22	KY1	ESC Reset button

3.6.5 CI3 Bus board

Description

The SafetyBUS p Gateway board is plugged onto the CI3 bus board and connects the ESC circuit with the SafetyBUS p manufactured by PILZ. The CI3 bus board does not have its own node.

The ESC circuit can be reset using the reset button.

Further information is contained in the "ESC Safety System with SafetyBUS p Gateway" documentation.

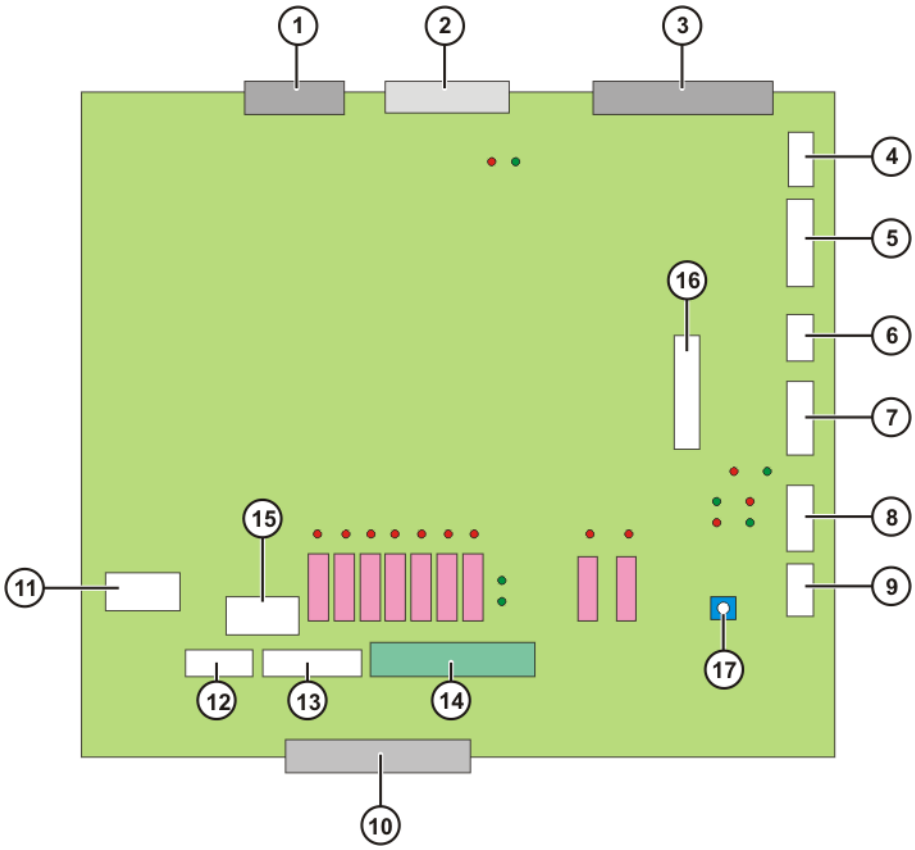

Fig. 3-36: CI3 Bus board connections

Connections

Item	Designation	Description
1	X18	Interface to MFC3 (CR safety signals) (optional)
2	X2	KPS connection
3	X3	MFC connection
4	X19	Interface to the RoboTeam lamp (optional). RDC power supply
5	X4	Connection of external mode selector switches (optional)
6	X7	CAN connection, I/O board
7	X6	Internal/external power supply and ESC circuit
8	X5	KCP connection
9	X21	KCP power supply and KCP CAN
10	X22	Peripheral interface for inputs and outputs
11	X1	Internal 24 V power supply
12	X8	Connection of external controllers, E-STOP button on control cabinet
13	X16	Internal interface
14	X12	Peripheral interface, outputs > 500 mA
15	X31	Connection: robot controller, internal fan
16	X13	SafetyBUS Gateway interface (optional)

Reset

Item	Designation	Description
17	KY1	ESC Reset button

3.6.6 CI3 Tech board

Description

The CI3 Tech board has its own node and is needed for the following components:

- KUKA.RoboTeam (Shared Pendant)
- KUKA.SafeRobot
- SafetyBUS Gateway
- Output to the top-mounted cabinet (external axes)
- Power supply to a 2nd RDC via X19A

The following states of the ESC circuit are indicated:

- Operating modes
- Drives ON
- Local E-STOP

The ESC circuit can be reset using the reset button (26).

The CI3 Tech board can only be used together with the MFC3 Tech card.

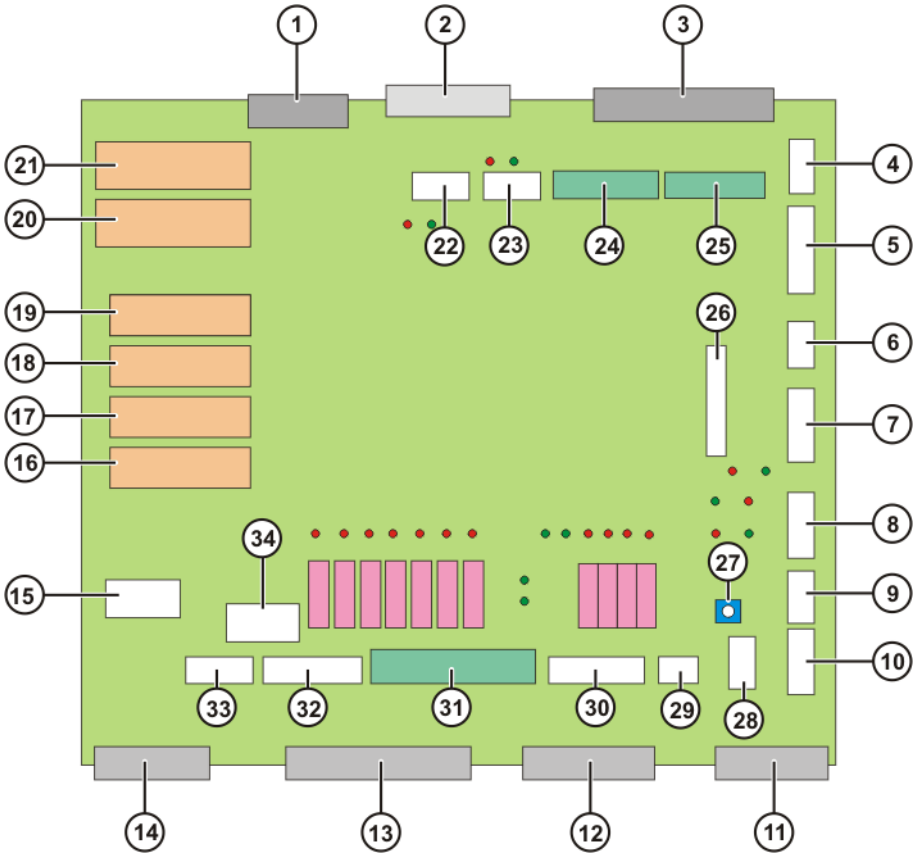

Fig. 3-37: CI3 Tech board connections and relays

Connections

Item	Designation	Description
1	X18	Interface to MFC3 (CR safety signals) (optional)
2	X2	KPS connection
3	X3	MFC connection
4	X19	Interface to the RoboTeam lamp (optional). RDC power supply

Item	Designation	Description
5	X4	Connection of external mode selector switches (optional)
6	X7	CAN connection, I/O board
7	X6	Internal/external power supply and ESC circuit
8	X5	KCP connection
9	X21	KCP power supply and KCP CAN
10	X20	Transfer of operating modes T1 and T2
11	X24	CR OUT interface
12	X25	CR IN interface
13	X22	Peripheral interface for inputs and outputs
14	X23	Safe RDC interface (optional)
15	X1	Internal 24 V power supply
22	X10	QE signals
23	X28	Multi-power tap (OUT1) (optional)
24	X27	Multi-power tap (DeviceNet on MFC) (optional)
25	X29	Multi-power tap (OUT2) (optional)
26	X13	SafetyBUS Gateway interface (optional)
28	X19A	2nd RDC
29	X11	RoboTeam/E7
30	X26	KUKA Guiding Device (KGD) interface (optional)
31	X12	Peripheral interface, outputs > 500 mA
32	X16	Internal interface
33	X8	Connection of external controllers, E-STOP button on control cabinet
34	X31	Connection: robot controller, internal fan

Relays

Item	Designation	Description
16	K4	Message: Local E-STOP
17	K3	Message: Local E-STOP
18	K8	Message: Auto-Test
19	K7	Message: Auto-Test
20	K1	Message: Drives ON
21	K2	Message: Drives ON

Reset

Item	Designation	Description
27	KY1	ESC Reset button

3.7 Description of the power unit

Overview

The power unit includes the following components:

- Power supply units
- Servo drive modules (KSD)
- Fuse elements
- Fans
- Main switch

- Mains filter

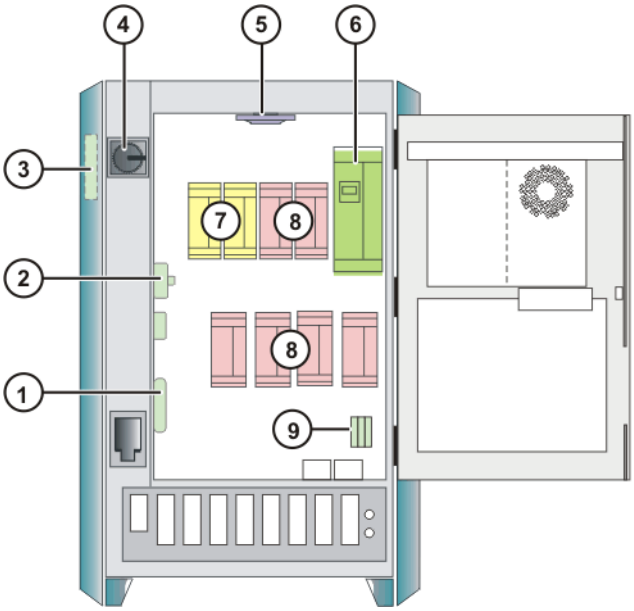

Fig. 3-38: Power unit

1	Low-voltage power supply KPS-27
2	Fuse elements (24 V without battery back-up)
3	Mains filter
4	Main switch (EU version)
5	Fan for inner cooling circuit
6	Power supply unit KPS600
7	KSDs for 2 external axes (option)
8	KSDs for 6 robot axes
9	Fuse elements (24 V with battery back-up)

3.7.1 Fuses

Overview The fuses protect the components of the robot controller.

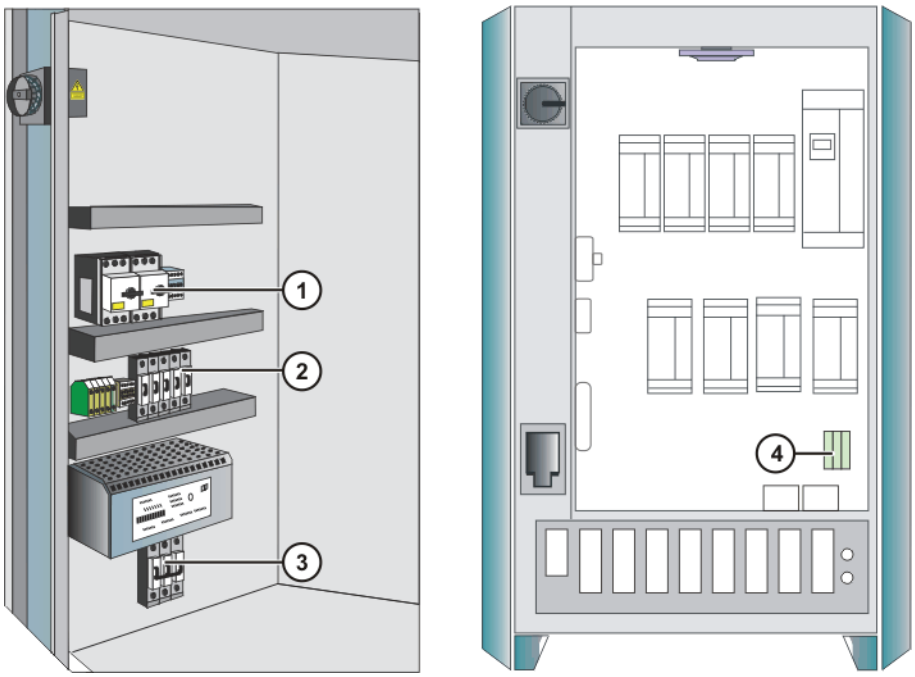

Fig. 3-39: Arrangement of the fuses

1	F1, F3 Motor circuit-breakers	3	F19 miniature circuit-breaker
2	F11-F14 Blowout fuses	4	F15, F16, FG3 Blowout fuses

Values

Item	Fuse	Value	Circuit
1	F1	22 A	KPS600 power supply KPS-27 power supply
	F3	0.63 A	External fan power supply
2	F11	2 A	24 V DC voltage from KPS-27
	F12	20 A	24 V DC voltage from KPS-27
	F13	2 A	Lighting 24 V DC (optional)
	F14	15 A	CI3 power supply
3	F19	2 A	Brakes for axes 1 to 6
4	F15	7.5 A	PC supply
	F16	4 A	24 V DC supply for: ■ KCP ■ CI3 ■ RDC
	FG3	10 A	Battery backup

3.7.2 Power supply unit KPS 600

Overview

The KPS 600 contains:

- Mains contactor
- Power unit with starting circuit
- Ballast circuit, including short-circuit braking relays
- Brake switches (in common for all 6 robot axes and separate for 2 external axes)
- Interface to DSE-IBS and KUKA Servo Drive

- Battery charging circuit, disconnection of the backup voltage, voltage distribution 24 V
- Interbus monitoring
- Fan cutoff (output), fan monitoring (input)
- Interface with the safety logic
- Temperature monitoring of:
  - Heat sink
  - Ballast resistor
  - Control cabinet interior

24 V supply

The following components are connected to the integrated 24 V power supply:

- Motor brakes, additional brakes
- Customer interface
- Control PC
- KUKA Servo Drive
- DC/DC converter

Intermediate circuit

The KPS 600 supplies the energy to the intermediate circuit and includes:

- Rectifier circuit
- Charging circuit
- Ballast circuit
- Discharging circuit
- Main contactor K1

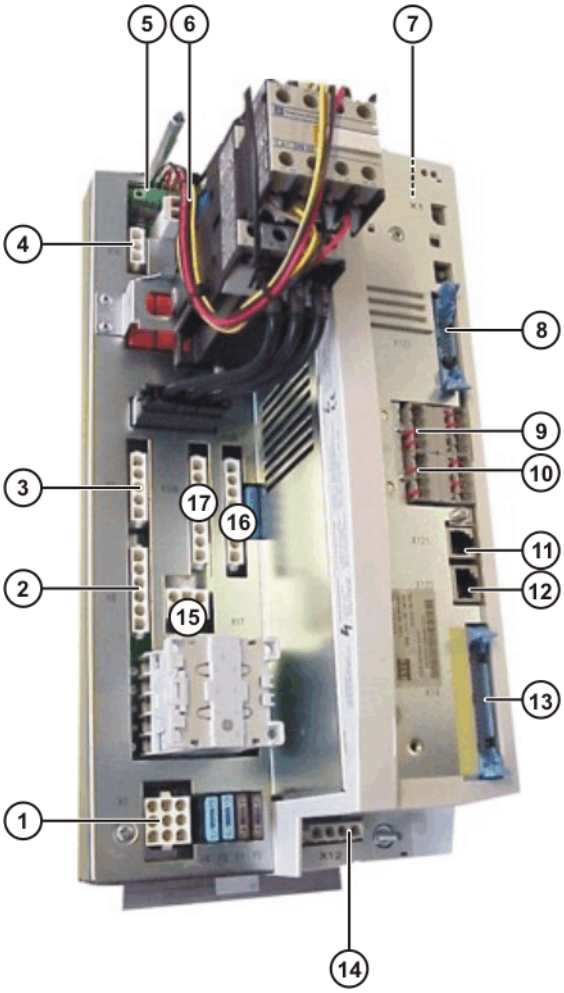

Fig. 3-40: Connections on the KPS 600

Connections

Item	Connector	Description
1	X7	24 V battery, KSD and controller
2	X8	Ballast resistor
3	X9	Not assigned
4	X16	Not assigned
5	X-K1a	Interface to the power board for the K1 auxiliary contacts (internal)
6	X2	Control connections K1
7	X6	24 V from low-voltage power supply
8	X123	User interface
9	X110	Fan/resistor monitoring
10	X114	Additional inputs to the control board
11	X121	Interbus input
12	X122	Interbus output
13	X14	ESC
14	X12	Motor holding brake
15	X17	Intermediate circuit of the external axes
16	X10/B	Intermediate circuit of the robot axes, both connections A/B parallel
17	X10/A	

Fuses

On the KPS 600 there are 5 fuses to protect the 24 V DC and the batteries. (>>> 12.7 "Checking the KPS600" Page 160)

LEDs

On the KPS 600 there are 6 LEDs which indicate the state of the safety logic and the brake control. (>>> 12.7 "Checking the KPS600" Page 160)

3.7.3 Low-voltage power supply KPS-27

Description

The KPS-27 is a 24 V power supply which provides power to the following components:

- Motor brake
- Periphery
- Control PC
- Servo drive module
- Batteries

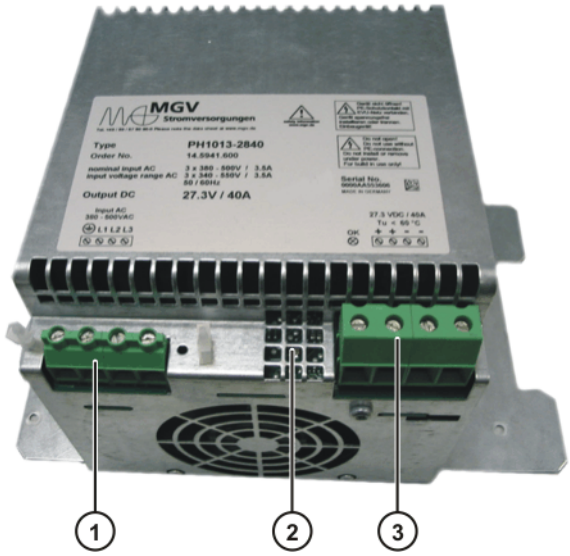

Fig. 3-41: KPS-27 low-voltage power supply

1	Power supply connection (L1/ L2/L3)	3	24 V DC / 40 A output
2	LED		

LED

A green LED indicates the operating state of the KPS-27.
(>>> 12.8 "Checking the KPS-27" Page 163)

3.7.4 KUKA Servo Drive (KSD)

Configuration

The KSD incorporates:

- Power output stage
- Current controller
- Interbus interface for the drive bus
- Monitoring of the motor current and short-circuit protection
- Heat sink temperature monitoring
- Communication monitoring

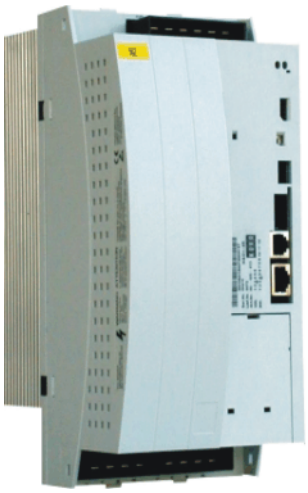

Fig. 3-42: Servo drive module

Sizes

2 sizes are used:

- Size 1 (BG 1) KSD-08/16/32

- Size 2 (BG 2) KSD-48/64

The designations 08 to 64 give the max. current in amps.

Connections

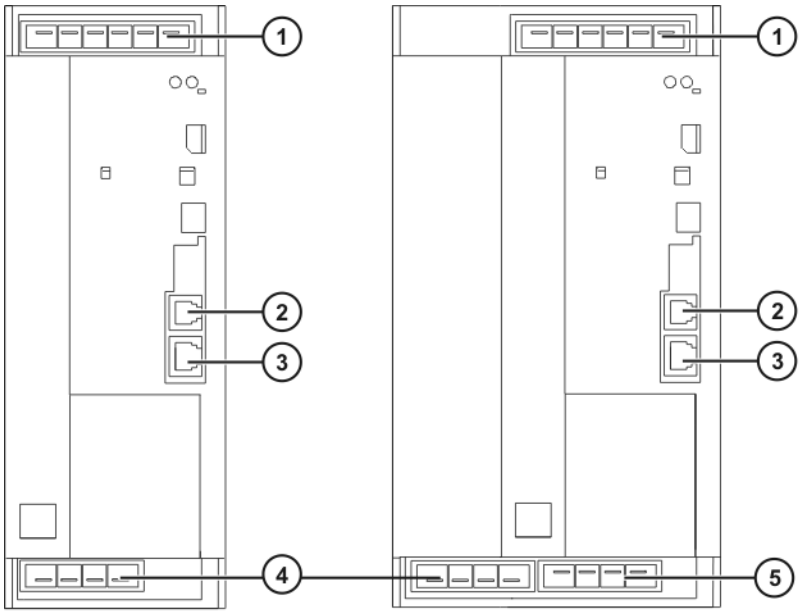

Fig. 3-43: Connections for KUKA Servo Drive, size 1 and size 2

1	X1 Connection	4	X2 Motor connection
2	X13 Interbus IN	5	X3 Additional motor connection
3	X14 Interbus OUT		

LED

The LEDs on the servo drive modules indicate the operating status and any faults that may be present. (>>> 12.9 "Testing the KSD" Page 163)

3.7.5 Mains filter

Description

The task of the mains filter (suppressor filter) consists of:

- allowing 50 Hz / 60 Hz signals to pass through unimpeded
- suppressing conducted interference voltages

In the robot controller, the conducted interference voltages mainly emerge from the KPS600 and would spread throughout the entire power mains without mains filters.

3.8 Cabinet cooling

Description

The control cabinet is divided into two cooling circuits. The inner zone, containing the control electronics, is cooled by a heat exchanger. In the outer zone, the ballast resistor and the heat sinks of the servo modules and the KPS are cooled directly by ambient air.

Caution!
Upstream installation of filter mats causes an excessive rise in temperature and hence a reduction in the service life of the installed devices!

Configuration

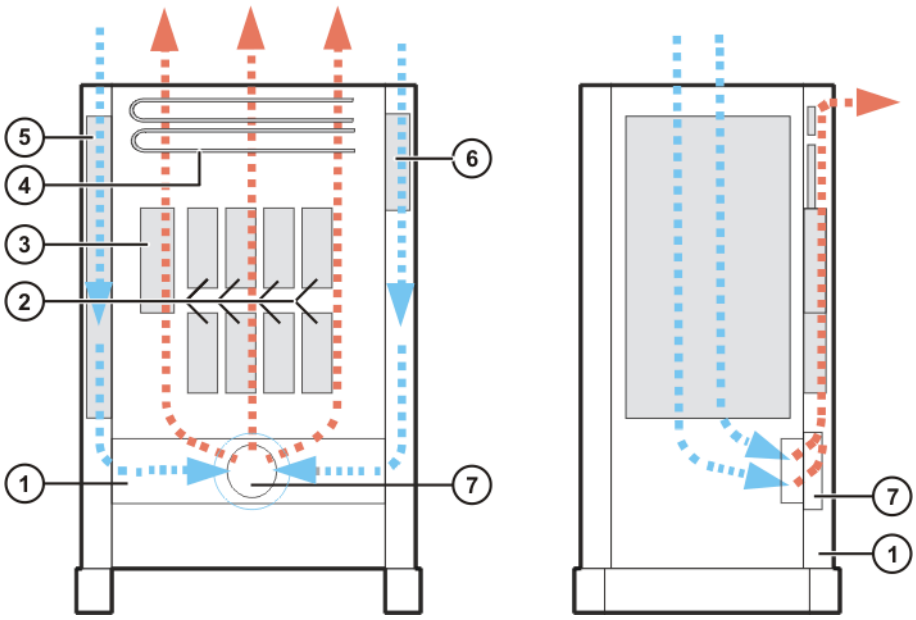

Fig. 3-44: Outer cooling circuit

1	Air duct	5	Outer heat exchanger
2	Heat sink of the KSD	6	Mains filter
3	Heat sink of the KPS	7	Outer fan cooling circuit
4	Ballast resistors		

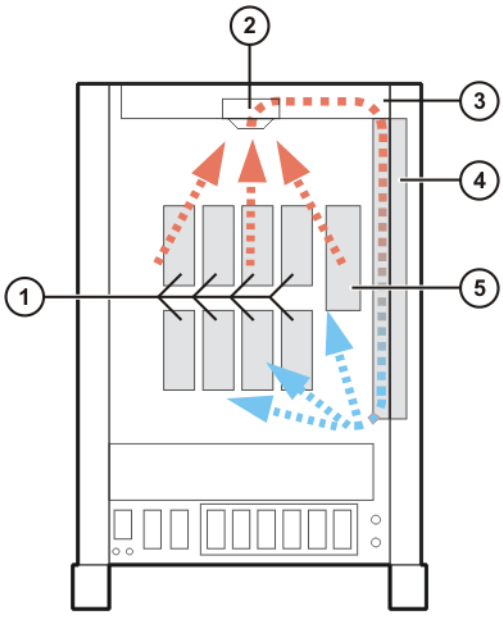

Fig. 3-45: Inner cooling circuit

1	Heat sink of the KSD	4	Inner heat exchanger
2	Fan for inner cooling circuit	5	Heat sink of the KPS
3	Air duct		

Optional cooling The robot controller can optionally be equipped with an additional cooling unit.

3.9 Description of interfaces

Overview The connection panel of the control cabinet consists as standard of connections for the following cables:

- Power cable / infeed
- Motor cables to the robot
- Control cables to the robot
- KCP connection

The configuration of the connection panel varies according to the customer-specific version and the options required.

Connection panel

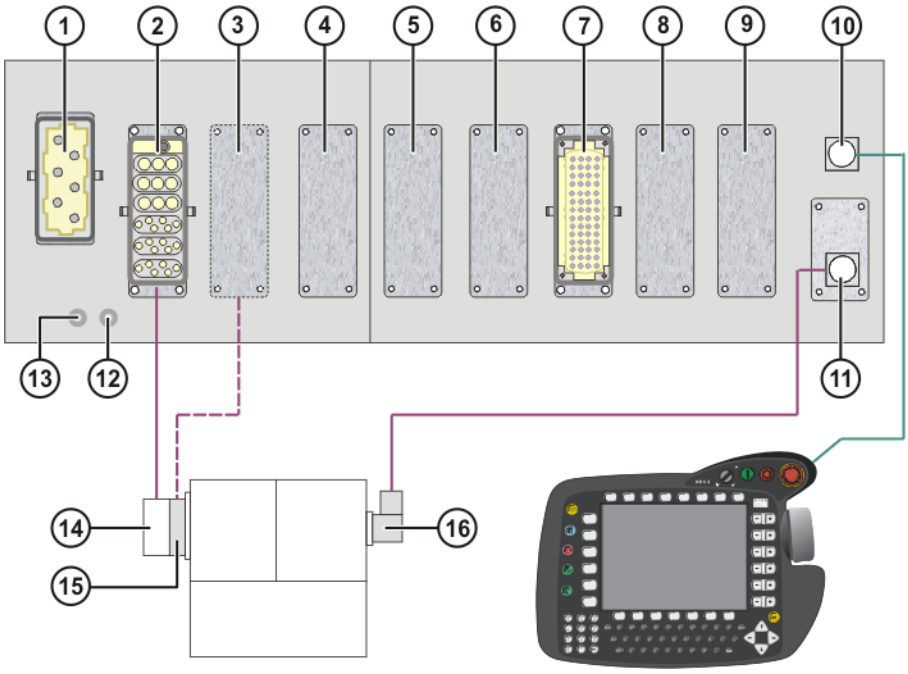

Fig. 3-46: KR C2 edition2005 connection panel

1	X1/XS1 power supply connection	9	Optional
2	X20 motor connection	10	X19 KCP connection
3	X7 motor connection	11	X21 RDC connection
4	Optional	12	PE1 ground conductor to the robot
5	Optional	13	PE2 main infeed ground conductor
6	Optional	14	X30 motor connection on the robot base
7	X11 customer interface	15	X30.2 motor connection on the robot base
8	Optional	16	X31 RDC connection on the robot base

The motor connection X7 is used for:

- Heavy-duty robots
- Robots with high payloads

All contactor, relay and valve coils that are connected to the robot controller by the user must be equipped with suitable suppressor diodes. RC elements and VCR resistors are not suitable.

3.9.1 Power supply connection X1/XS1

Description

The robot controller can be connected to the mains via the following connections:

- X1 Harting connector on the connection panel
- XS1 CEE connector; the cable is led out of the robot controller (optional)

Caution!
If the robot controller is connected to a power system **without** a grounded neutral, this may cause malfunctions in the robot controller and material damage to the power supply units. Electrical voltage can cause physical injuries. The robot controller may only be operated with grounded-neutral power supply systems.

Overview

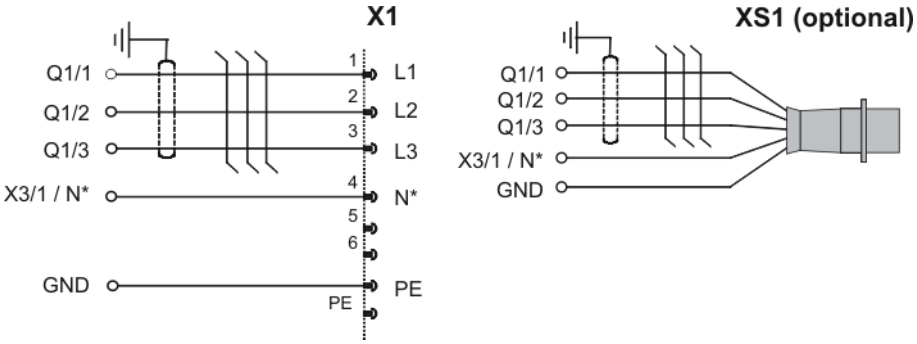

Fig. 3-47: Power supply connection

* The N-conductor is only necessary for the service socket option with a 400 V power supply.

The robot controller must only be connected to a power system with a clockwise rotating field. Only then is the correct direction of rotation of the fan motors ensured.

3.9.2 KCP connector X19

Connector pin allocation

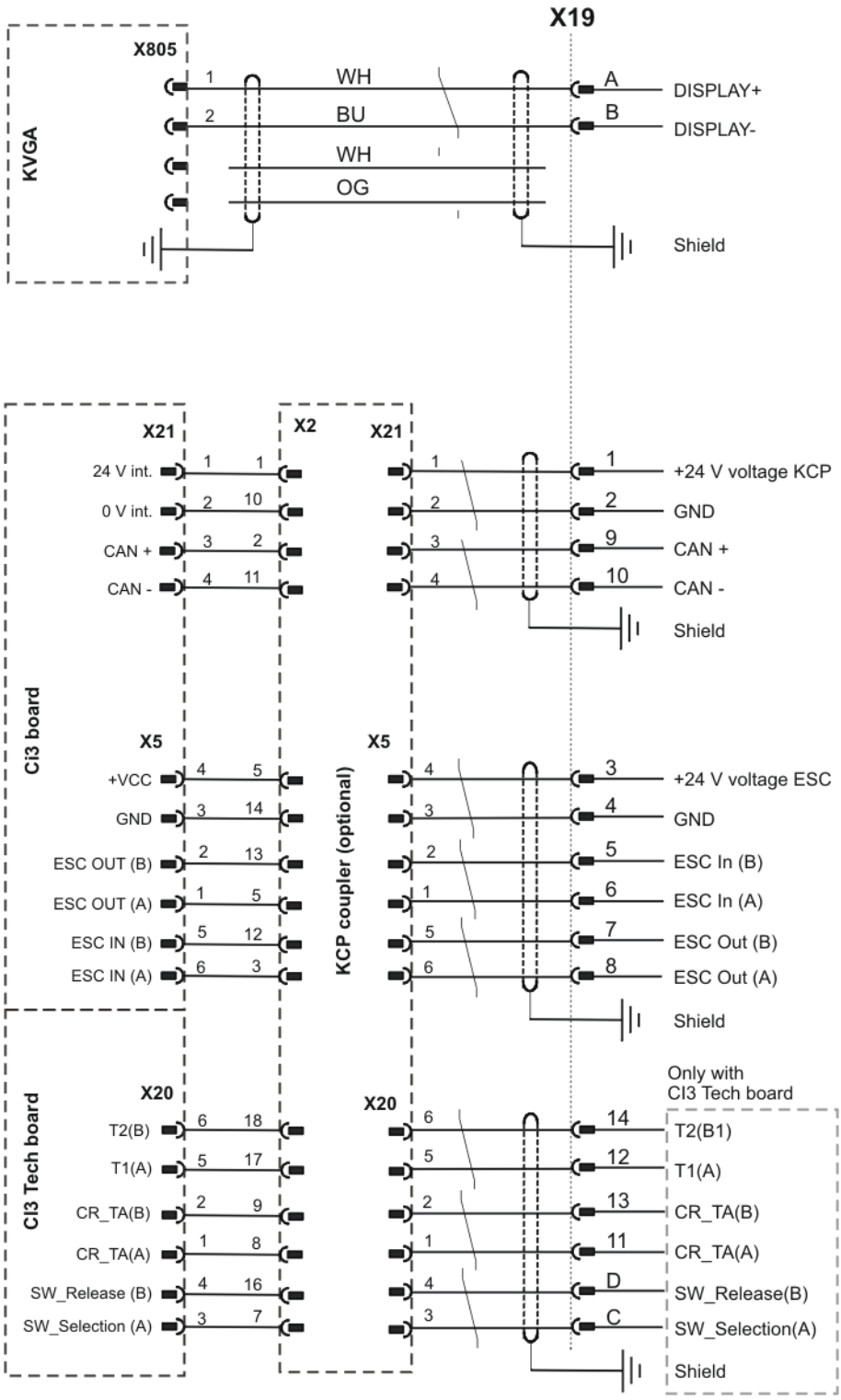

Fig. 3-48

3.9.3 Motor connector X20, axes 1 to 6

Connector pin allocation

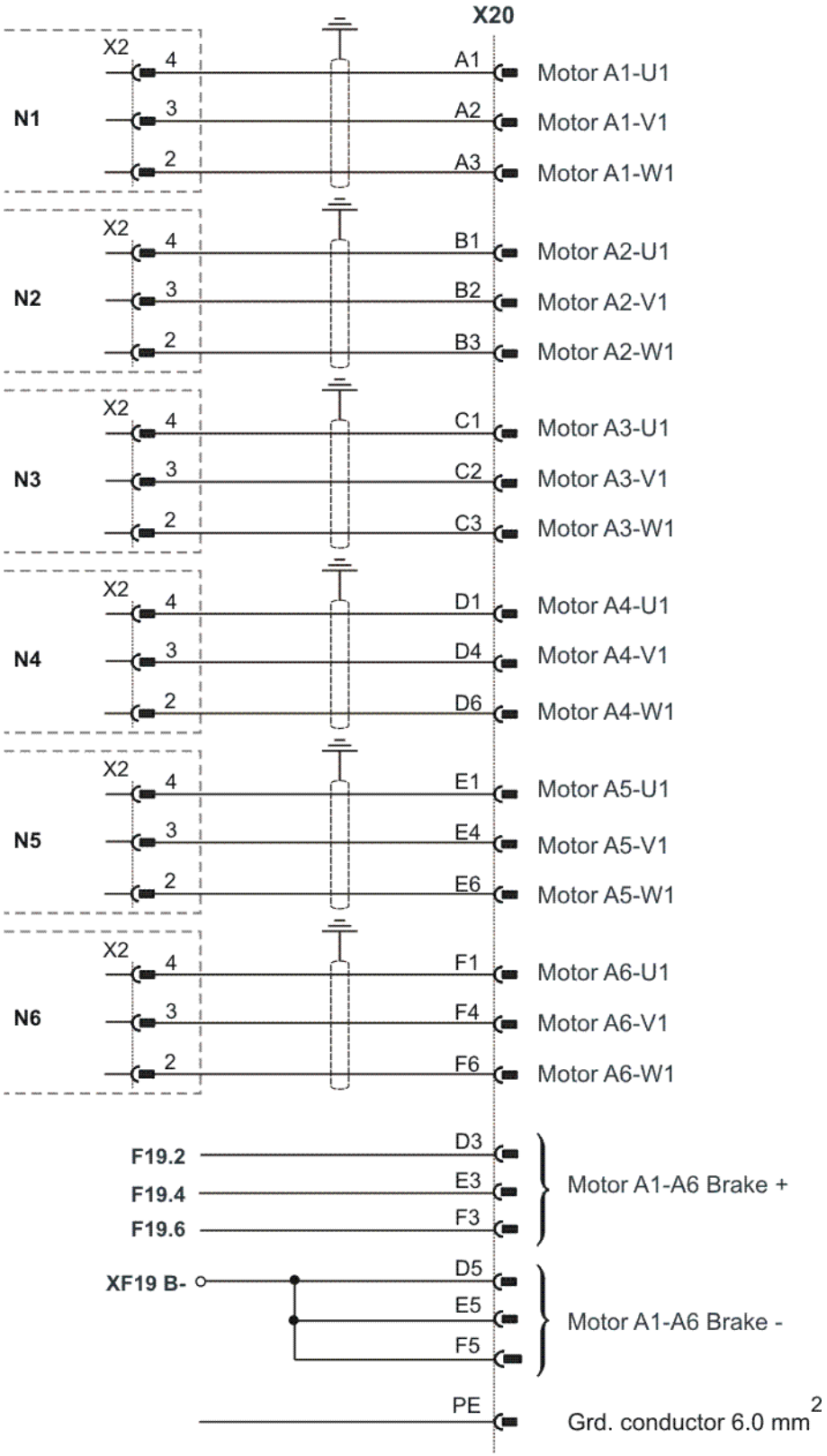

Fig. 3-49: Multiple connector X20: standard brakes

3.9.4 Motor connector X7 (optional)

Connector pin allocation

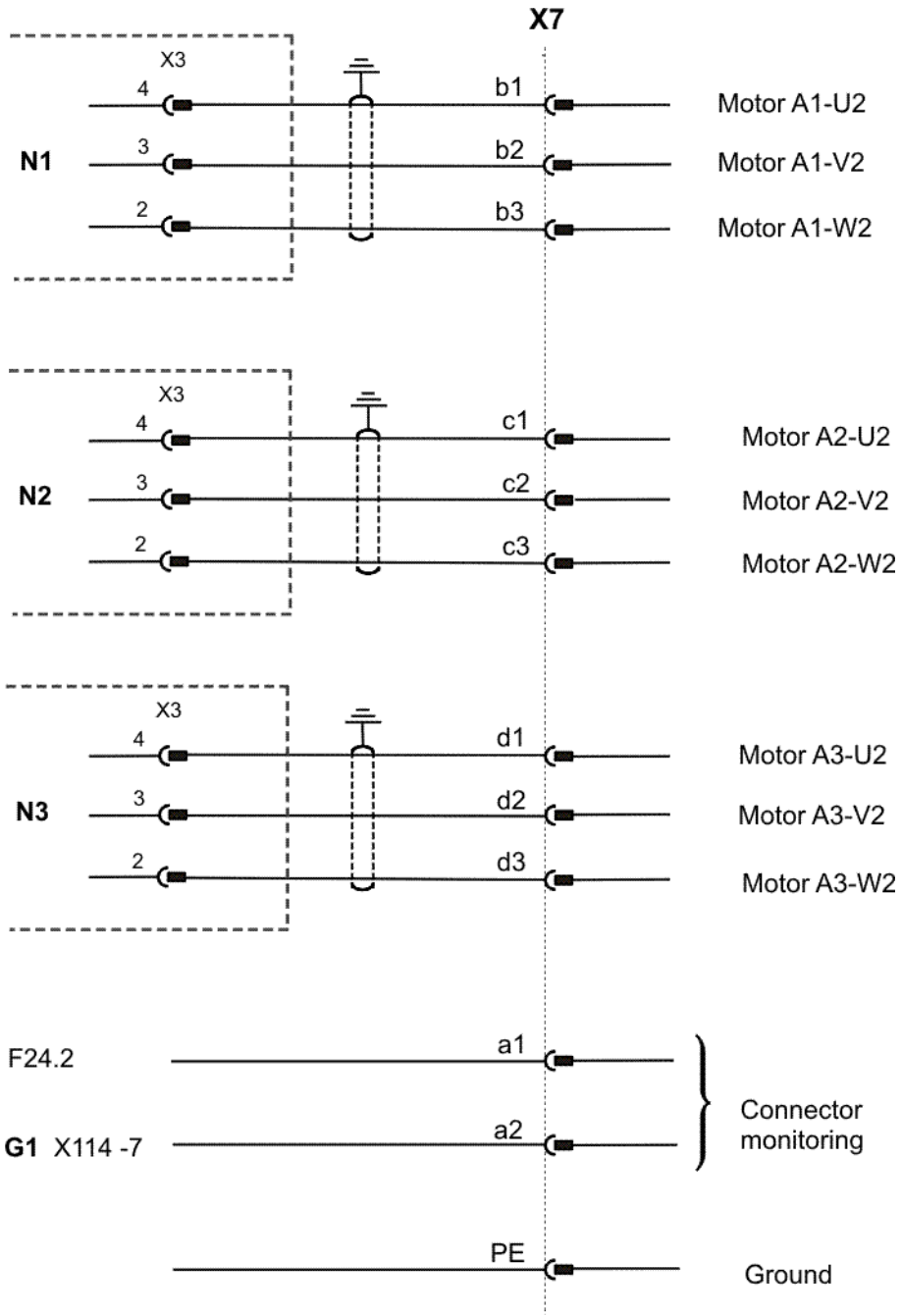

Fig. 3-50

3.9.5 Data cable X21, axes 1 to 8

Connector pin allocation

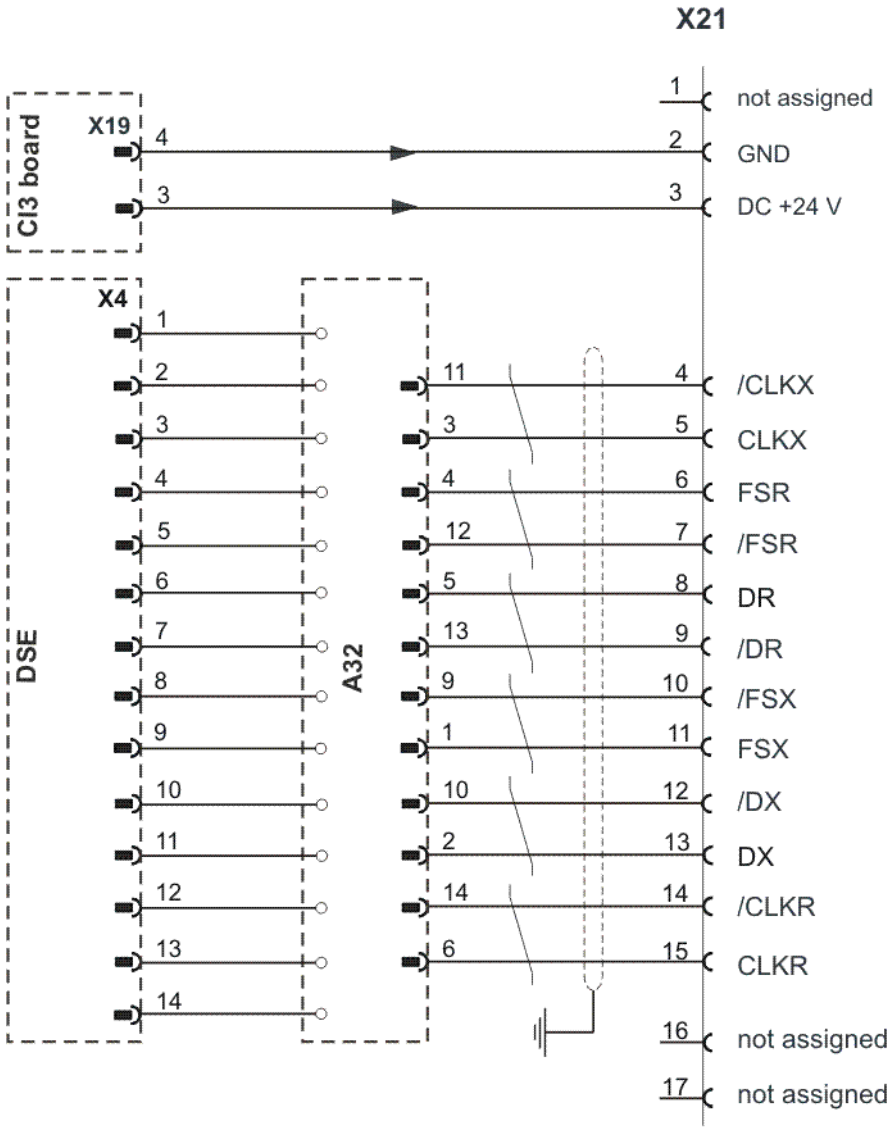

Fig. 3-51: Connector pin allocation for X21

3.9.6 SafeRobot X21.1

Description The SafeRDC signals are routed via connector X21.1.

Connector pin allocation

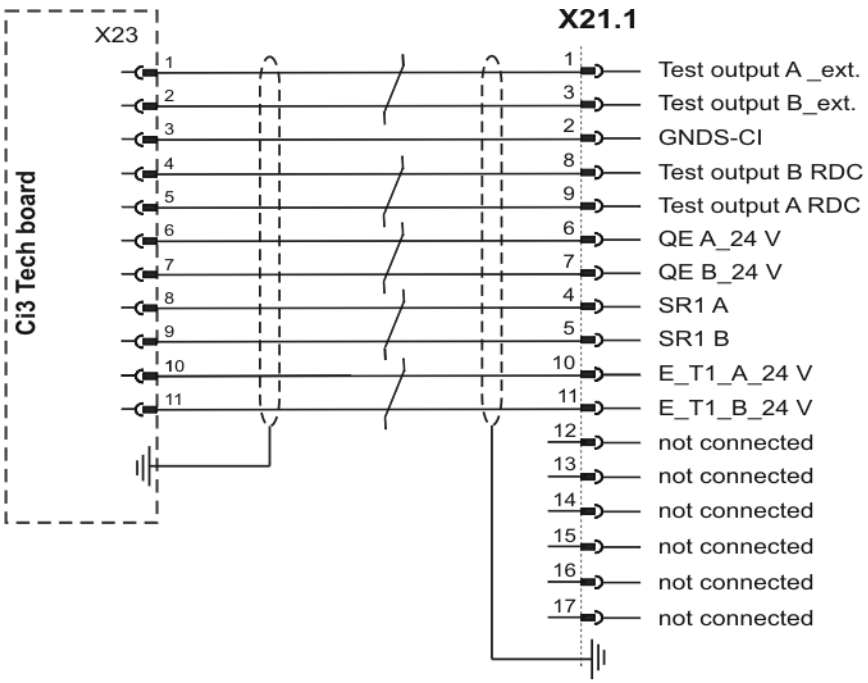

Fig. 3-52

Pin	Signal	Description
1	TA24V(A)_external	Pulsed voltage from ESC circuit if QE_A and BS_A receive power from an external source (24 V level)
2	GNDS-CI	Reference potential for TA24V(A)-ESC and TA24V(B)-ESC
3	TA24V(B)_external	Pulsed voltage from ESC circuit if QE_B and BS_B receive power from an external source (24 V level)
4	SR1(A)	Pulsed voltage channel A for input test (24 V level)
5	SR1(B)	Pulsed voltage channel B for input test (24 V level)
6	QE A_24V	Safe output QE channel A (Cat0) to CI3 Tech board (24 V level)
7	QE B_24V	Safe output QE channel B (Cat0) to CI3 Tech board (24 V level)
8	TA24V(A) RDC	Safe output SR1 channel A (Cat1) to CI3 Tech board (24 V level), ANDed with input ENA
9	TA24V(B) RDC	Safe output SR1 channel B (Cat1) to CI3 Tech board (24 V level), ANDed with input ENA
10	E_T1_A_24V	Safe input, test 1 channel A (24 V level)
11	E_T1_B_24V	Safe input, test 1 channel B (24 V level)
12	-	Not assigned
13	-	Not assigned
14	-	Not assigned
15	-	Not assigned
16	-	Connector coding
17	-	Not assigned

3.9.7 Interface X40

Overview

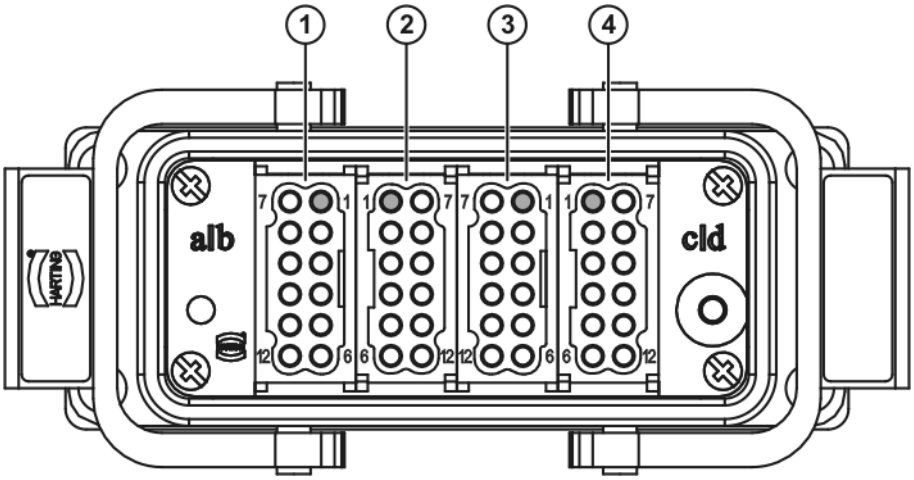

Fig. 3-53: Interface X40

1 Module a (pins)
2 Module b (female contacts)
3 Module c (pins)
4 Module d (female contacts)

Module a Module a contains the safe inputs of the SafeRDC for activating the monitoring ranges.

Channels A **and** B of the safe inputs must have a LOW level signal to activate the monitoring ranges.

Module b Module b contains the connections for the internal and external supply voltages of the safe inputs and outputs.

Module c Module c contains the connections for the standstill monitoring and the reduced axis velocity and acceleration.

Channels A **and** B of the safe inputs must have a LOW level signal to activate the monitoring ranges.

Module d Module d contains the safe outputs of the SafeRDC that can be wired externally and are only used for communication. The voltage supplied via pins b5 and b6 is present at the safe outputs.

The safe outputs have a max. load rating of 100 mA per output.

3.9.8 Safe KSK XA7

Connector pin allocation

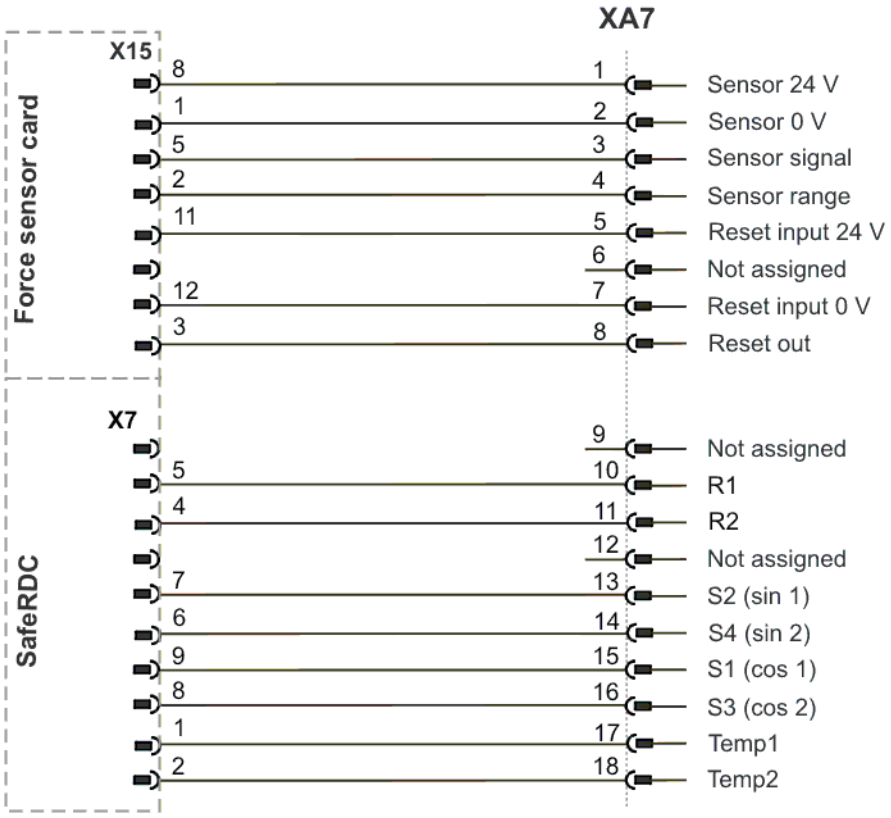

Fig. 3-54: Connector pin allocation XA7

3.9.9 Safe KSK XA8

Connector pin allocation

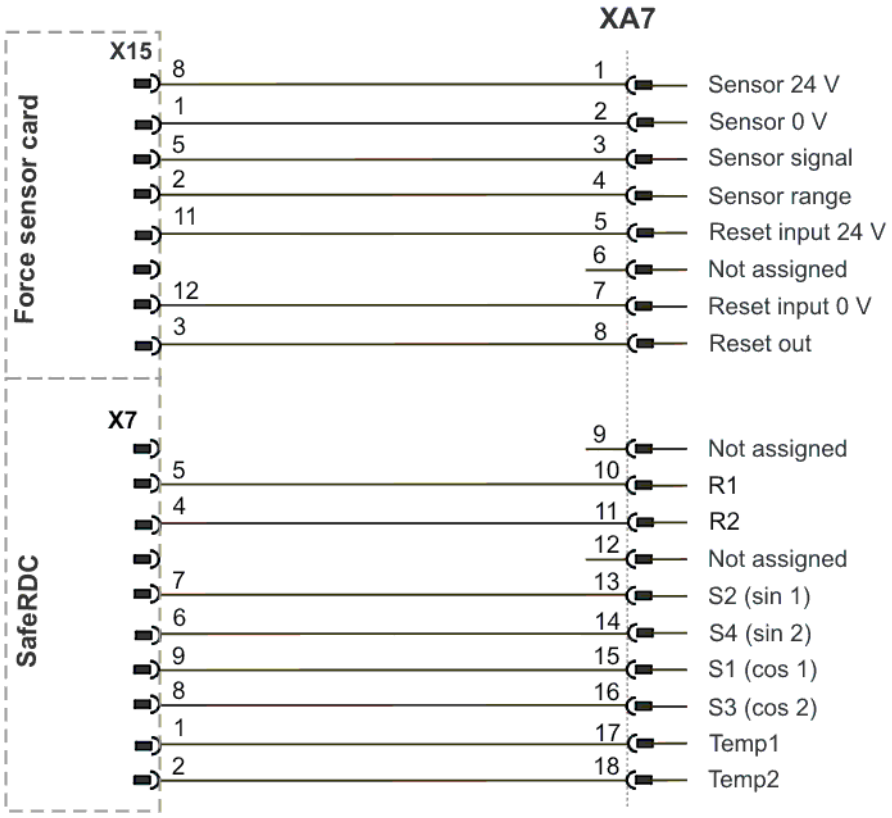

Fig. 3-55: Connector pin allocation XA7

3.10 Description of the mounting plate for customer components (optional)

Overview

The mounting plate for customer components is a mounting plate on the inside of the door which can be fitted as an option for integrating external customer equipment.

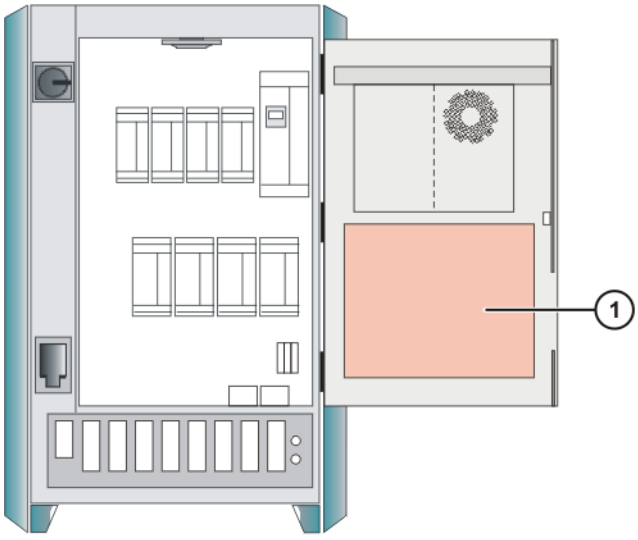

Fig. 3-56: Mounting plate for customer components

1 Mounting plate for customer components

Technical data

Designation	Values
Weight of installed components	max. 5 kg
Power dissipation of installed components	max. 20 W
Depth of installed components	180 mm
Width of mounting plate	400 mm
Height of mounting plate	340 mm

4 Technical data

4.1 Robot controller

Basic data

Control cabinet type	KR C2 edition2005
Color	See delivery note
Number of axes	Max. 8
Weight	See identification plate
Protection classification	IP 54
Sound level according to DIN 45635-1	Average: 67 dB (A)
Installation with other cabinets (with/without cooling unit)	Side-by-side, clearance 50 mm
Load on cabinet roof with even distribution	1000 N

Power supply connection

Rated supply voltage	AC 3x400 V ... AC 3x415 V
Permissible tolerance of rated voltage	400 V -10% ... 415 V +10%
Mains frequency	49 ... 61 Hz
System impedance up to the connection point of the robot controller	≤ 300 mΩ
Rated power input ▪ Standard	7.3 kVA, see rating plate
Rated power input ▪ Heavy-duty robot ▪ Palletizing robot ▪ Press-to-press robot	13.5 kVA, see rating plate
Mains-side fusing	min. 3x25 A slow-blowing, max. 3x32 A slow-blowing, see rating plate
If an RCCB is used: trip current difference	300 mA per robot controller, universal-current sensitive
Equipotential bonding	The common neutral point for the equipotential bonding conductors and all protective ground conductors is the reference bus of the power unit.

Brake control

Output voltage	25-26 V DC
Output current, brake	Max. 6 A
Monitoring	Open circuit and short circuit

Service socket (optional)

Output current	Max. 4 A
Use	The service socket may only be used for test and diagnosis equipment.

Environmental conditions

Ambient temperature during operation without cooling unit	+5 ... 45 °C (278 to 318 K)
Ambient temperature during operation with cooling unit	+5 ... 55 °C (278 to 328 K)
Ambient temperature during storage/transportation with batteries	-25 ... +40 °C (248 to 313 K)
Ambient temperature during storage/transportation without batteries	-25 ... +70 °C (248 to 343 K)
Temperature change	max. 1.1 K/min
Humidity class	3k3 acc. to DIN EN 60721-3-3; 1995
Altitude	■ up to 1000 m above mean sea level with no reduction in power ■ 1000 to 4000 m above mean sea level with a reduction in power of 5%/1000 m

Caution!
To prevent exhaustive discharge and thus destruction of the batteries, the batteries must be recharged at regular intervals according to the storage temperature.
If the storage temperature is +20 °C or lower, the batteries must be recharged every 9 months.
If the storage temperature is between +20 °C and +30 °C, the batteries must be recharged every 6 months.
If the storage temperature is between +30 °C and +40 °C, the batteries must be recharged every 3 months.

Vibration resistance

Type of loading	During transportation	During continuous operation
r.m.s. acceleration (sustained oscillation)	0.37 g	0.1 g
Frequency range (sustained oscillation)	4 - 120 Hz	
Acceleration (shock in X/Y/Z direction)	10 g	2.5 g
Waveform/duration (shock in X/Y/Z direction)	Half-sine/11 ms	

If more severe mechanical stress is expected, the controller must be installed on anti-vibration components.

Control unit

Supply voltage	25.8 to 27.3 V DC

Control PC

Main processor	See shipping version
DIMM memory modules	at least 512 MB
Hard drive	See shipping version

KUKA Control Panel

Supply voltage	25.8 to 27.3 V DC
Dimensions (WxHxD)	Approx. 33x26x8 cm^3
VGA display resolution	640x480 pixels
VGA display size	8"
Protection classification	Top of KCP IP54 Underside of KCP IP23
Weight	1.4 kg

Cable lengths

The designations and standard and optional lengths may be noted from the following table.

Cable	Standard length in m	Optional length in m
Motor cable	7	15 / 25 / 35 / 50
Data cable	7	15 / 25 /35 / 50
Power cable with XS1 (optional)	3	-

Cable	Standard length in m	Extension in m
KCP cable	10	10 / 20 / 30/ 40

When using KCP cable extensions only **one** may be employed at a time, and a total cable length of 60 m must not be exceeded.

4.2 SafeRDC

Ambient temperature during operation	+5 to +50 °C (278 to 323 K)
Ambient temperature during transportation	-25 to +70 °C (248 to 343 K)
Ambient temperature during storage	-25 to +60 °C (248 to 333 K)
Supply voltage	18 to 33 V DC
Relative atmospheric humidity	Class 3K3 to EN 50178 (non-condensing)
Shock sensitivity	■ Duration: 5 ms ■ Strength: 20 g
Vibration resistance	■ Amplitude: 1 mm at ≤ 13.2 Hz ■ Acceleration: 0.7 g at 13.2 Hz to 100 Hz
Electromagnetic compatibility (EMC)	Immunity from interference with mains filter to EN 61800-3
Degree of fouling	Degree of fouling 2 to VDE 0110 part 2

Altitude	1,000 m
Protection classification	IP 65
Permissible cable length for data cable X21 - X31	With internal power supply to the safe inputs and outputs: ■ 7 m ■ 15 m With external power supply to the safe inputs and outputs: ■ 25 m ■ 35 m

4.3 KCP coupler (optional)

Basic data

Power supply	24 V DC
Digital inputs	24 V DC pulsed, resistive load only
Dimensions	147 mm x 73 mm

4.4 Dimensions of robot controller

The dimensions of the robot controller are indicated in the diagram (>>> Fig. 4-1).

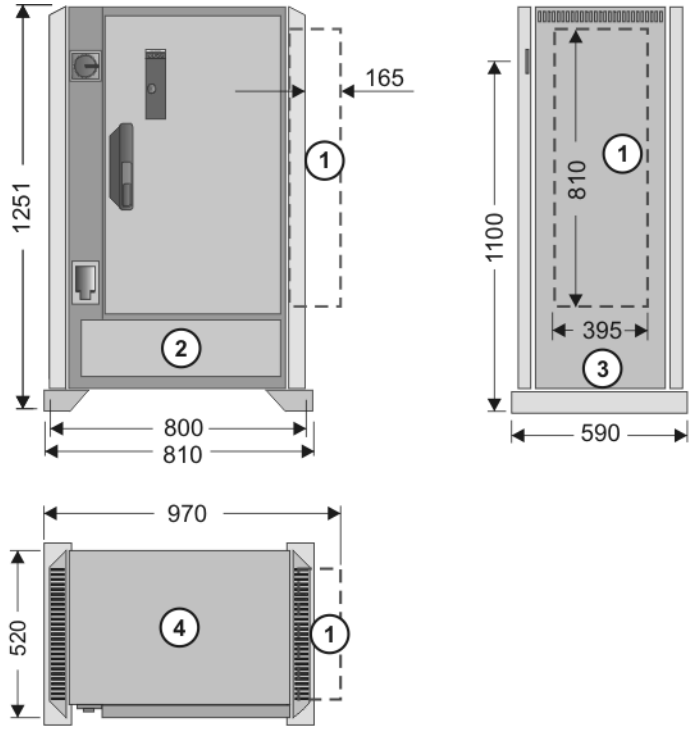

Fig. 4-1: Dimensions (in mm)

1 Cooling unit (optional)
2 Front view
3 Side view
4 Top view

4.5 Minimum clearances, robot controller

The minimum clearances that must be maintained for the robot controller are indicated in the diagram (>>> Fig. 4-2).

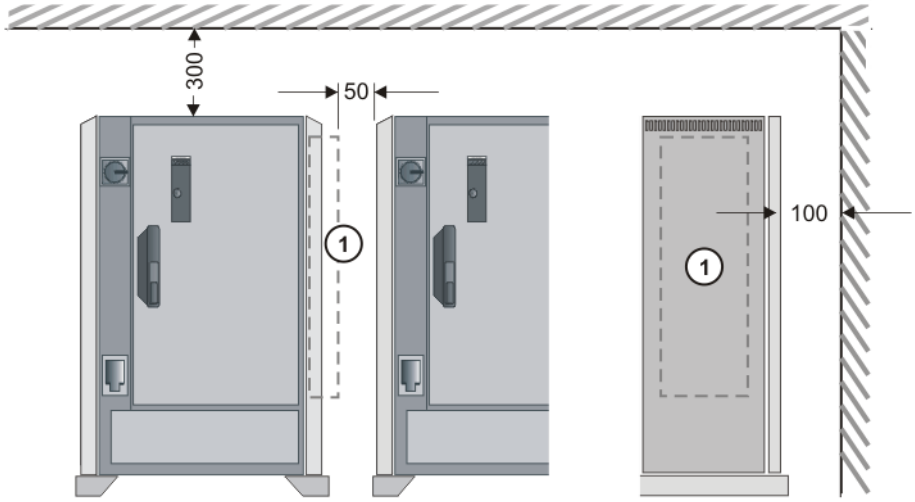

Fig. 4-2: Minimum clearances (dimensions in mm)

1 Cooling unit (optional)

Warning!
If the minimum clearances are not maintained, this can result in damage to the robot controller. The specified minimum clearances must always be observed.

Certain maintenance and repair tasks on the robot controller (>>> 10 "Maintenance" Page 129) (>>> 11 "Repair" Page 131) must be carried out from the side or from the rear. The robot controller must be accessible for this. If the side or rear panels are not accessible, it must be possible to move the robot controller into a position in which the work can be carried out.

4.6 Minimum clearances, top-mounted / technology cabinet

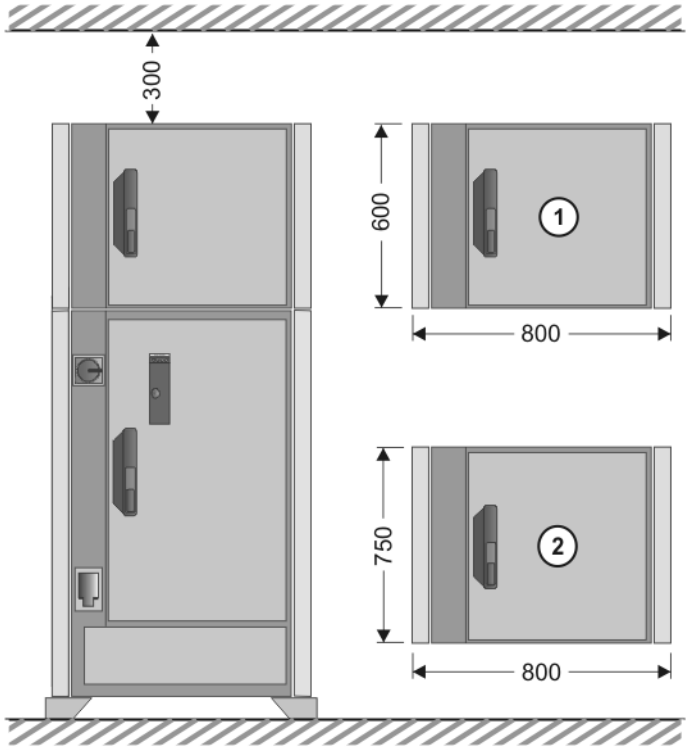

Fig. 4-3: Minimum clearances with top-mounted / technology cabinet

1 Top-mounted cabinet (optional)
2 Technology cabinet (optional)

4.7 Dimensions of boreholes for floor mounting

The dimensions of the boreholes for floor mounting are indicated in the diagram (>>> Fig. 4-4).

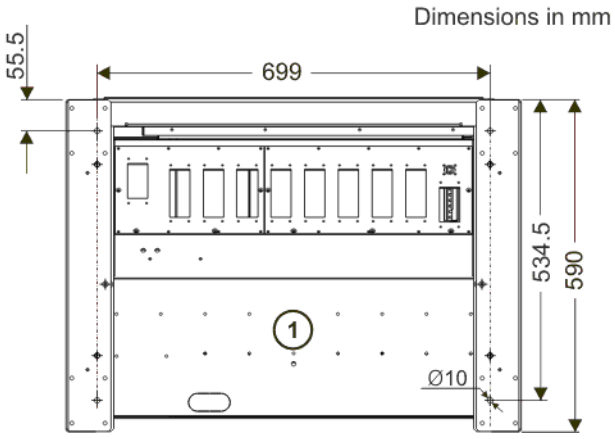

Fig. 4-4: Boreholes for floor mounting

1 View from below

4.8 Swing range for cabinet door

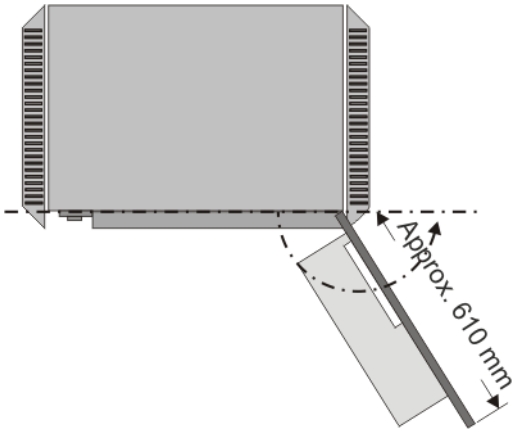

Fig. 4-5: Swing range for cabinet door

Swing range, standalone cabinet:

- Door with computer frame approx. 180°

Swing range, butt-mounted cabinets:

- Door approx. 155°

4.9 Plates and labels

Overview

The following plates and labels are attached to the robot controller. They must not be removed or rendered illegible. Illegible plates and labels must be replaced.

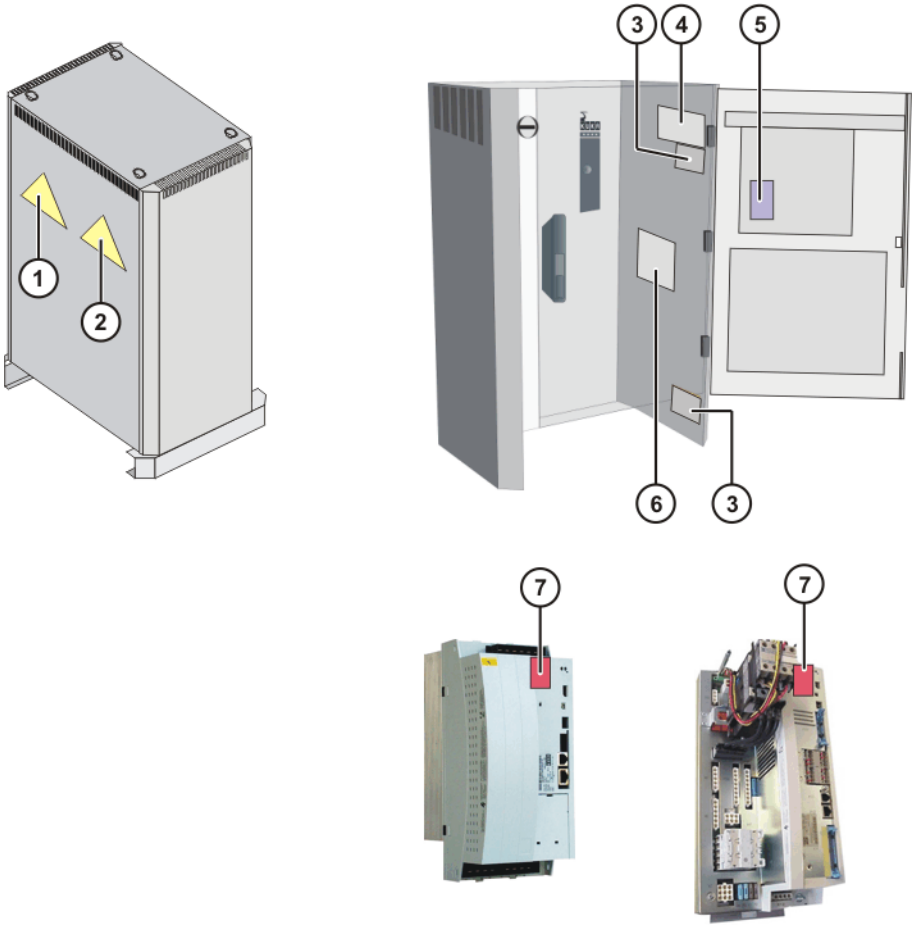

Fig. 4-6: Locations of plates and labels

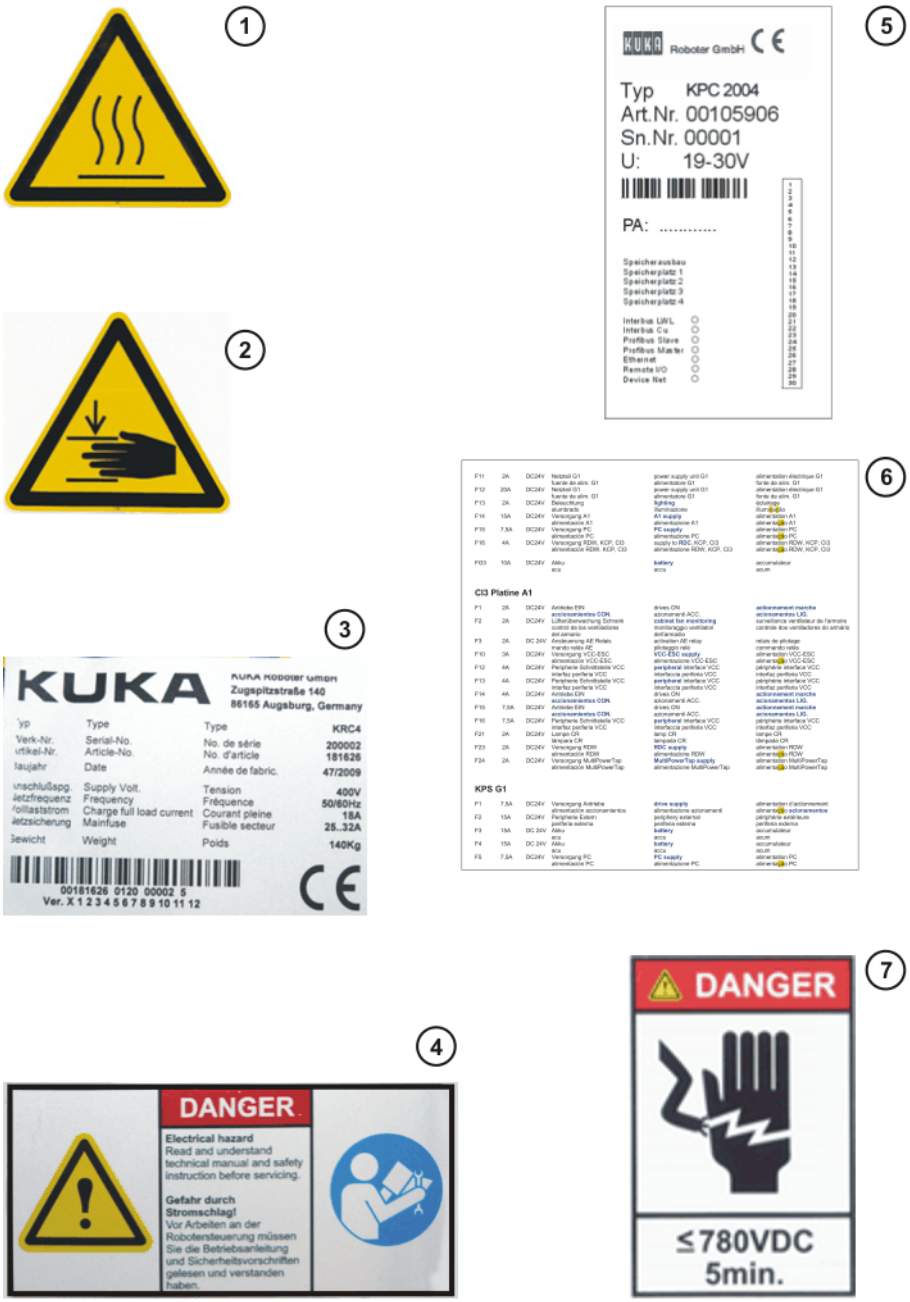

Fig. 4-7: Plates and labels

The plates may vary slightly from the examples illustrated depending on the specific cabinet type or as a result of updates.

Designations

Plate no.	Designation
1	Hot surface warning sign
2	Hand injury warning sign
3	Rating plate on the controller
4	Warning: read manual
5	PC rating plate
6	Fuse ratings
7	Warning: ≤ 780 VDC / wait 5 minutes

5 Safety

5.1 General

5.1.1 Liability

The device described in this document is either an industrial robot or a component thereof.

Components of the industrial robot:

- Manipulator
- Robot controller
- Teach pendant
- Connecting cables
- External axes (optional)
  e.g. linear unit, turn-tilt table, positioner
- Software
- Options, accessories

The industrial robot is built using state-of-the-art technology and in accordance with the recognized safety rules. Nevertheless, misuse of the industrial robot may constitute a risk to life and limb or cause damage to the industrial robot and to other material property.

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons who are fully aware of the risks involved in its operation. Use of the industrial robot is subject to compliance with this document and with the declaration of incorporation supplied together with the industrial robot. Any functional disorders affecting the safety of the industrial robot must be rectified immediately.

Safety information

Safety information cannot be held against KUKA Roboter GmbH. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage.

No modifications may be carried out to the industrial robot without the authorization of KUKA Roboter GmbH. Additional components (tools, software, etc.), not supplied by KUKA Roboter GmbH, may be integrated into the industrial robot. The user is liable for any damage these components may cause to the industrial robot or to other material property.

In addition to the Safety chapter, this document contains further safety instructions. These must also be observed.

5.1.2 Intended use of the industrial robot

The industrial robot is intended exclusively for the use designated in the “Purpose” chapter of the operating instructions or assembly instructions.

Further information is contained in the “Purpose” chapter of the operating instructions or assembly instructions of the component.

Using the industrial robot for any other or additional purpose is considered impermissible misuse. The manufacturer cannot be held liable for any damage resulting from such use. The risk lies entirely with the user.

Operating the industrial robot and its options within the limits of its intended use also involves observance of the operating and assembly instructions for

the individual components, with particular reference to the maintenance specifications.

Misuse

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

- Transportation of persons and animals
- Use as a climbing aid
- Operation outside the permissible operating parameters
- Use in potentially explosive environments
- Operation without additional safeguards
- Outdoor operation

5.1.3 EC declaration of conformity and declaration of incorporation

This industrial robot constitutes partly completed machinery as defined by the EC Machinery Directive. The industrial robot may only be put into operation if the following preconditions are met:

- The industrial robot is integrated into a complete system.

  Or: The industrial robot, together with other machinery, constitutes a complete system.

  Or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot.
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of an assessment of conformity.

Declaration of conformity

The system integrator must issue a declaration of conformity for the complete system in accordance with the Machinery Directive. The declaration of conformity forms the basis for the CE mark for the system. The industrial robot must be operated in accordance with the applicable national laws, regulations and standards.

The robot controller is CE certified under the EMC Directive and the Low Voltage Directive.

Declaration of incorporation

The industrial robot as partly completed machinery is supplied with a declaration of incorporation in accordance with Annex II B of the EC Machinery Directive 2006/42/EC. The assembly instructions and a list of essential requirements complied with in accordance with Annex I are integral parts of this declaration of incorporation.

The declaration of incorporation declares that the start-up of the partly completed machinery remains impermissible until the partly completed machinery has been incorporated into machinery, or has been assembled with other parts to form machinery, and this machinery complies with the terms of the EC Machinery Directive, and the EC declaration of conformity is present in accordance with Annex II A.

The declaration of incorporation, together with its annexes, remains with the system integrator as an integral part of the technical documentation of the complete machinery.

5.1.4 Terms used

Term	Description
Axis range	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis.
Stopping distance	Stopping distance = reaction distance + braking distance The stopping distance is part of the danger zone.
Workspace	The manipulator is allowed to move within its workspace. The workspace is derived from the individual axis ranges.
Operator (User)	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot.
Danger zone	The danger zone consists of the workspace and the stopping distances.
KCP	The KCP (KUKA Control Panel) teach pendant has all the operator control and display functions required for operating and programming the industrial robot.
Manipulator	The robot arm and the associated electrical installations
Safety zone	The safety zone is situated outside the danger zone.
Stop category 0	The drives are deactivated immediately and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking. **Note:** This stop category is called STOP 0 in this document.
Stop category 1	The manipulator and any external axes (optional) perform path-maintaining braking. The drives are deactivated after 1 s and the brakes are applied. **Note:** This stop category is called STOP 1 in this document.
Stop category 2	The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a normal braking ramp. **Note:** This stop category is called STOP 2 in this document.
System integrator (plant integrator)	System integrators are people who safely integrate the industrial robot into a complete system and commission it.
T1	Test mode, Manual Reduced Velocity (<= 250 mm/s)
T2	Test mode, Manual High Velocity (> 250 mm/s permissible)
External axis	Motion axis which is not part of the manipulator but which is controlled using the robot controller, e.g. KUKA linear unit, turn-tilt table, Posiflex.

5.2 Personnel

The following persons or groups of persons are defined for the industrial robot:

- User
- Personnel

All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

User

The user must observe the labor laws and regulations. This includes e.g.:

- The user must comply with his monitoring obligations.
- The user must carry out instruction at defined intervals.

Personnel

Personnel must be instructed, before any work is commenced, in the type of work involved and what exactly it entails as well as any hazards which may ex-

ist. Instruction must be carried out regularly. Instruction is also required after particular incidents or technical modifications.

Personnel includes:

- System integrator
- Operators, subdivided into:
  - Start-up, maintenance and service personnel
  - Operating personnel
  - Cleaning personnel

Installation, exchange, adjustment, operation, maintenance and repair must be performed only as specified in the operating or assembly instructions for the relevant component of the industrial robot and only by personnel specially trained for this purpose.

System integrator

The industrial robot is safely integrated into a complete system by the system integrator.

The system integrator is responsible for the following tasks:

- Installing the industrial robot
- Connecting the industrial robot
- Performing risk assessment
- Implementing the required safety functions and safeguards
- Issuing the declaration of conformity
- Attaching the CE mark
- Creating the operating instructions for the complete system

Operator

The operator must meet the following preconditions:

- The operator must be trained for the work to be carried out.
- Work on the industrial robot must 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.

Example

The tasks can be distributed as shown in the following table.

Tasks	Operator	Programmer	System integrator
Switch robot controller on/off	x	x	x
Start program	x	x	x
Select program	x	x	x
Select operating mode	x	x	x
Calibration (tool, base)		x	x
Master the manipulator		x	x
Configuration		x	x
Programming		x	x
Start-up			x
Maintenance			x

Tasks	Operator	Programmer	System integrator
Repair			x
Decommissioning			x
Transportation			x

Work on the electrical and mechanical equipment of the industrial robot may only be carried out by specially trained personnel.

5.3 Workspace, safety zone and danger zone

Workspaces are to be restricted to the necessary minimum size. A workspace must be safeguarded using appropriate safeguards.

The safeguards (e.g. safety gate) must be situated inside the safety zone. In the case of a stop, the manipulator and external axes (optional) are braked and come to a stop within the danger zone.

The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional). It must be safeguarded by means of physical safeguards to prevent danger to persons or the risk of material damage.

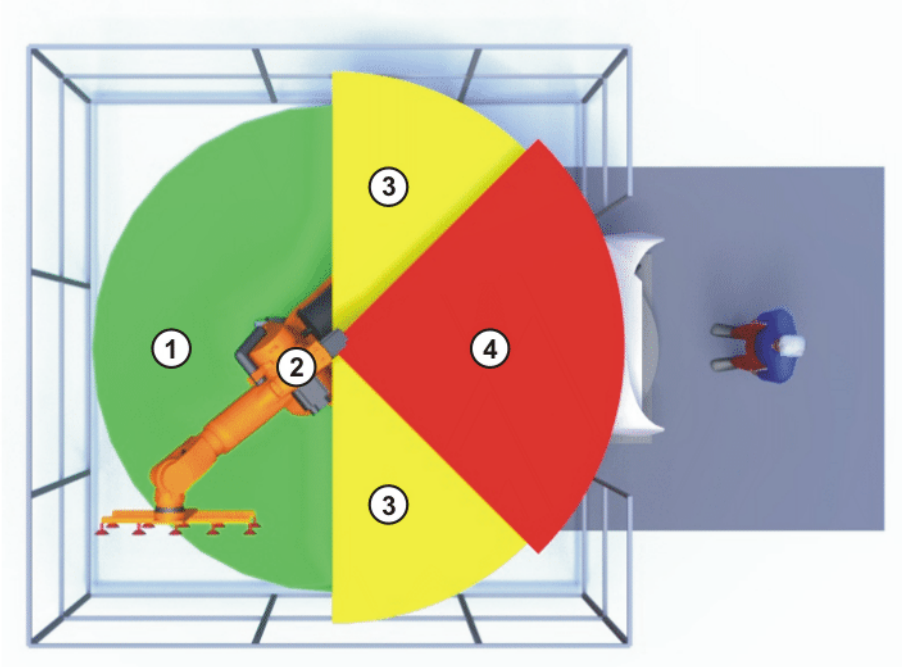

Fig. 5-1: Example of axis range A1

1	Workspace	3	Stopping distance
2	Manipulator	4	Safety zone

5.4 Triggers for stop reactions

Stop reactions of the industrial robot are triggered in response to operator actions or as a reaction to monitoring functions and error messages. The following table shows the different stop reactions according to the operating mode that has been set.

STOP 0, STOP 1 and STOP 2 are the stop definitions according to DIN EN 60204-1:2006.

Trigger	T1, T2	AUT, AUT EXT
Safety gate opened	-	STOP 1
EMERGENCY STOP pressed	STOP 0	STOP 1
Enabling withdrawn	STOP 0	-
Start key released	STOP 2	-
“Drives OFF” key pressed	STOP 0	
STOP key pressed	STOP 2	
Operating mode changed	STOP 0	
Encoder error (DSE-RDC connection broken)	STOP 0	
Motion enable canceled	STOP 2	
Robot controller switched off Power failure	STOP 0	

5.5 Safety functions

5.5.1 Overview of safety functions

Safety functions:

- Mode selection
- Operator safety (= connection for the guard interlock)
- Local EMERGENCY STOP device (= EMERGENCY STOP button on the KCP)
- External EMERGENCY STOP device
- Enabling device
- External enabling device
- Local safety stop via qualifying input
- RoboTeam: disabling of robots that have not been selected

These circuits conform to the requirements of Performance Level d and category 3 according to EN ISO 13849-1. This only applies under the following conditions, however:

- The EMERGENCY STOP is not triggered more than once a day on average.
- The operating mode is not changed more than 10 times a day on average.
- Number of switching cycles of the main contactors: max. 100 per day

Warning!
If these conditions are not met, KUKA Roboter GmbH must be contacted.

Danger!
In the absence of functional safety functions and safeguards, the industrial robot can cause personal injury or material damage. If safety functions or safeguards are dismantled or deactivated, the industrial robot may not be operated.

5.5.2 ESC safety logic

The function and triggering of the electronic safety functions are monitored by the ESC safety logic.

The ESC (Electronic Safety Circuit) safety logic is a dual-channel computer-aided safety system. It permanently monitors all connected safety-relevant components. In the event of a fault or interruption in the safety circuit, the power supply to the drives is shut off, thus bringing the industrial robot to a standstill.

The ESC safety logic triggers different stop reactions, depending on the operating mode of the industrial robot.

The ESC safety logic monitors the following inputs:

- Operator safety
- Local EMERGENCY STOP (= EMERGENCY STOP button on the KCP)
- External EMERGENCY STOP
- Enabling device
- External enabling device
- Drives OFF
- Drives ON
- Operating modes
- Qualifying inputs

The ESC safety logic monitors the following outputs:

- Operating mode
- Drives ON
- Local E-STOP

5.5.3 Mode selector switch

The industrial robot can be operated in the following modes:

- Manual Reduced Velocity (T1)
- Manual High Velocity (T2)
- Automatic (AUT)
- Automatic External (AUT EXT)

The operating mode is selected using the mode selector switch on the KCP. The switch is activated by means of a key which can be removed. If the key is removed, the switch is locked and the operating mode can no longer be changed.

If the operating mode is changed during operation, the drives are immediately switched off. The manipulator and any external axes (optional) are stopped with a STOP 0.

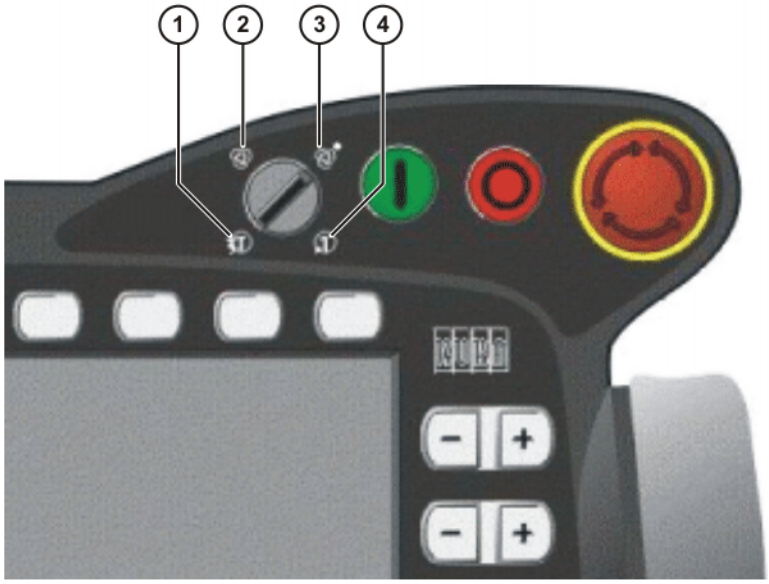

Fig. 5-2: Mode selector switch

1 T2 (Manual High Velocity)
2 AUT (Automatic)
3 AUT EXT (Automatic External)
4 T1 (Manual Reduced Velocity)

Operating mode	Use	Velocities
T1	For test operation, programming and teaching	■ Program verification: Programmed velocity, maximum 250 mm/s ■ Jog mode: Jog velocity, maximum 250 mm/s
T2	For test operation	■ Program verification: Programmed velocity
AUT	For industrial robots without higher-level controllers Only possible with a connected safety circuit	■ Program mode: Programmed velocity ■ Jog mode: Not possible
AUT EXT	For industrial robots with higher-level controllers, e.g. PLC Only possible with a connected safety circuit	■ Program mode: Programmed velocity ■ Jog mode: Not possible

5.5.4 Operator safety

The operator safety input is used for interlocking physical safeguards. Safety equipment, such as safety gates, can be connected to the dual-channel input. If nothing is connected to this input, operation in Automatic mode is not possi-

ble. Operator safety is not active in the test modes T1 (Manual Reduced Velocity) and T2 (Manual High Velocity).

In the event of a loss of signal during Automatic operation (e.g. safety gate is opened), the manipulator and the external axes (optional) stop with a STOP 1. Once the signal is active at the input again, automatic operation can be resumed.

Operator safety can be connected via the peripheral interface on the robot controller.

Warning!
It must be ensured that the operator safety signal is not automatically reset when the safeguard (e.g. safety gate) is closed, but only after an additional manual acknowledgement signal has been given. Only in this way can it be ensured that automatic operation is not resumed inadvertently while there are still persons in the danger zone, e.g. due to the safety gate closing accidentally.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

5.5.5 EMERGENCY STOP device

The EMERGENCY STOP device for the industrial robot is the EMERGENCY STOP button on the KCP. The button must be pressed in the event of a hazardous situation or emergency.

Reactions of the industrial robot if the EMERGENCY STOP button is pressed:

- Manual Reduced Velocity (T1) and Manual High Velocity (T2) modes:
  The drives are switched off immediately. The manipulator and any external axes (optional) are stopped with a STOP 0.
- Automatic modes (AUT and AUT EXT):
  The drives are switched off after 1 second. The manipulator and any external axes (optional) are stopped with a STOP 1.

Before operation can be resumed, the EMERGENCY STOP button must be turned to release it and the stop message must be acknowledged.

Fig. 5-3: EMERGENCY STOP button on the KCP

1 EMERGENCY STOP button

Warning!
Tools and other equipment connected to the manipulator must be integrated into the EMERGENCY STOP circuit on the system side if they could constitute a potential hazard.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

5.5.6 External EMERGENCY STOP device

There must be EMERGENCY STOP devices on every operator panel and anywhere else it may be necessary to trigger an EMERGENCY STOP. The system integrator is responsible for ensuring this. External EMERGENCY STOP devices are connected via the customer interface.

External EMERGENCY STOP devices are not included in the scope of supply of the industrial robot.

5.5.7 Enabling device

The enabling devices of the industrial robot are the enabling switches on the KCP.

There are 3 enabling switches installed on the KCP. The enabling switches have 3 positions:

- Not pressed
- Center position
- Panic position

In the test modes, the manipulator can only be moved if one of the enabling switches is held in the central position. If the enabling switch is released or pressed fully down (panic position), the drives are deactivated immediately and the manipulator stops with a STOP 0.

Warning!
The enabling switches must not be held down by adhesive tape or other means or manipulated in any other way.
Death, serious physical injuries or major damage to property may result.

Fig. 5-4: Enabling switches on the KCP

1 - 3 Enabling switches

5.5.8 External enabling device

External enabling devices are required if it is necessary for more than one person to be in the danger zone of the industrial robot. They can be connected via the peripheral interface on the robot controller.

External enabling devices are not included in the scope of supply of the industrial robot.

5.6 Additional protective equipment

5.6.1 Jog mode

In the operating modes T1 (Manual Reduced Velocity) and T2 (Manual High Velocity), the robot controller can only execute programs in jog mode. This means that it is necessary to hold down an enabling switch and the Start key in order to execute a program.

If the enabling switch is released or pressed fully down (panic position), the drives are deactivated immediately and the manipulator and any external axes (optional) stop with a STOP 0.

Releasing only the Start key causes the industrial robot to be stopped with a STOP 2.

5.6.2 Software limit switches

The axis ranges of all manipulator and positioner axes are limited by means of adjustable software limit switches. These software limit switches only serve as

machine protection and must be adjusted in such a way that the manipulator/ positioner cannot hit the mechanical end stops.

The software limit switches are set during commissioning of an industrial robot.

Further information is contained in the operating and programming instructions.

5.6.3 Mechanical end stops

The axis ranges of main axes A1 to A3 and wrist axis A5 of the manipulator are limited by means of mechanical end stops with buffers.

Additional mechanical end stops can be installed on the external axes.

Warning!
If the manipulator or an external axis hits an obstruction or a buffer on the mechanical end stop or axis range limitation, this can result in material damage to the industrial robot. KUKA Roboter GmbH must be consulted before the industrial robot is put back into operation (>>> 13 "KUKA Service" Page 201). The affected buffer must be replaced with a new one before operation of the industrial robot is resumed. If a manipulator (or external axis) collides with a buffer at more than 250 mm/s, the manipulator (or external axis) must be exchanged or recommissioning must be carried out by KUKA Roboter GmbH.

5.6.4 Mechanical axis range limitation (optional)

Some manipulators can be fitted with mechanical axis range limitation in axes A 1 to A 3. The adjustable axis range limitation systems restrict the working range to the required minimum. This increases personal safety and protection of the system.

In the case of manipulators that are not designed to be fitted with mechanical axis range limitation, the workspace must be laid out in such a way that there is no danger to persons or material property, even in the absence of mechanical axis range limitation.

If this is not possible, the workspace must be limited by means of photoelectric barriers, photoelectric curtains or obstacles on the system side. There must be no shearing or crushing hazards at the loading and transfer areas.

This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.6.5 Axis range monitoring (optional)

Some manipulators can be fitted with dual-channel axis range monitoring systems in main axes A1 to A3. The positioner axes may be fitted with additional axis range monitoring systems. The safety zone for an axis can be adjusted and monitored using an axis range monitoring system. This increases personal safety and protection of the system.

This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.6.6 Release device (optional)

Description

The release device can be used to move the manipulator manually after an accident or malfunction. The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors. It is only for use in exceptional circumstances and emergencies (e.g. for freeing people).

Warning!
The motors reach temperatures during operation which can cause burns to the skin. Contact should be avoided. Appropriate safety precautions must be taken, e.g. protective gloves must be worn.

Procedure

1. Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
2. Remove the protective cap from the motor.
3. Push the release device onto the corresponding motor and move the axis in the desired direction.

   The directions are indicated with arrows on the motors. It is necessary to overcome the resistance of the mechanical motor brake and any other loads acting on the axis.

Warning!
Moving an axis with the release device can damage the motor brake. This can result in personal injury and material damage. After using the release device, the affected motor must be exchanged.

5.6.7 KCP coupler (optional)

The KCP coupler allows the KCP to be connected and disconnected with the robot controller running.

Warning!
The operator must ensure that decoupled KCPs are immediately removed from the system and stored out of sight and reach of personnel working on the industrial robot. This serves to prevent operational and non-operational EMERGENCY STOP facilities from becoming interchanged.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

Further information is contained in the operating instructions or installation instructions for the robot controller.

5.6.8 Labeling on the industrial robot

All plates, labels, symbols and marks constitute safety-relevant parts of the industrial robot. They must not be modified or removed.

Labeling on the industrial robot consists of:

- Rating plates
- Warning labels
- Safety symbols
- Designation labels
- Cable markings
- Identification plates

Further information is contained in the technical data of the operating instructions or assembly instructions of the components of the industrial robot.

5.6.9 External safeguards

Safeguards

The access of persons to the danger zone of the manipulator must be prevented by means of safeguards.

Physical safeguards must meet the following requirements:

- They meet the requirements of EN 953.
- They prevent access of persons to the danger zone and cannot be easily circumvented.
- They are sufficiently fastened and can withstand all forces that are likely to occur in the course of operation, whether from inside or outside the enclosure.
- They do not, themselves, represent a hazard or potential hazard.
- The prescribed minimum clearance from the danger zone is maintained.

Safety gates (maintenance gates) must meet the following requirements:

- They are reduced to an absolute minimum.
- The interlocks (e.g. safety gate switches) are linked to the operator safety input of the robot controller via safety gate switching devices or safety PLC.
- Switching devices, switches and the type of switching conform to the requirements of Performance Level d and category 3 according to EN ISO 13849-1.
- Depending on the risk situation: the safety gate is additionally safeguarded by means of a locking mechanism that only allows the gate to be opened if the manipulator is safely at a standstill.
- The button for acknowledging the safety gate is located outside the space limited by the safeguards.

Further information is contained in the corresponding standards and regulations. These also include EN 953.

Other safety equipment

Other safety equipment must be integrated into the system in accordance with the corresponding standards and regulations.

5.7 Overview of operating modes and safety functions

The following table indicates the operating modes in which the safety functions are active.

Safety functions	T1	T2	AUT	AUT EXT
Operator safety	-	-	active	active
EMERGENCY STOP device	active	active	active	active
Enabling device	active	active	-	-
Reduced velocity during program verification	active	-	-	-
Jog mode	active	active	-	-
Software limit switches	active	active	active	active

5.8 Safety measures

5.8.1 General safety measures

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons. Operator errors can result in personal injury and damage to property.

It is important to be prepared for possible movements of the industrial robot even after the robot controller has been switched off and locked. Incorrect installation (e.g. overload) or mechanical defects (e.g. brake defect) can cause the manipulator or external axes to sag. If work is to be carried out on a switched-off industrial robot, the manipulator and external axes must first be moved into a position in which they are unable to move on their own, whether the payload is mounted or not. If this is not possible, the manipulator and external axes must be secured by appropriate means.

Danger!
In the absence of operational safety functions and safeguards, the industrial robot can cause personal injury or material damage. If safety functions or safeguards are dismantled or deactivated, the industrial robot may not be operated.

Warning!
Standing underneath the robot arm can cause death or serious physical injuries. For this reason, standing underneath the robot arm is prohibited!

Warning!
The motors reach temperatures during operation which can cause burns to the skin. Contact should be avoided. Appropriate safety precautions must be taken, e.g. protective gloves must be worn.

KCP

The user must ensure that the industrial robot is only operated with the KCP by authorized persons.

If more than one KCP is used in the overall system, it must be ensured that each KCP is unambiguously assigned to the corresponding industrial robot. They must not be interchanged.

Warning!
The operator must ensure that decoupled KCPs are immediately removed from the system and stored out of sight and reach of personnel working on the industrial robot. This serves to prevent operational and non-operational EMERGENCY STOP facilities from becoming interchanged.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

External keyboard, external mouse

An external keyboard and/or external mouse may only be used if the following conditions are met:

- Start-up or maintenance work is being carried out.
- The drives are switched off.
- There are no persons in the danger zone.

The KCP must not be used as long as an external keyboard and/or external mouse are connected.

The external keyboard and/or external mouse must be removed as soon as the start-up or maintenance work is completed or the KCP is connected.

Faults

The following tasks must be carried out in the case of faults in the industrial robot:

- Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again.
- Indicate the fault by means of a label with a corresponding warning (tag-out).
- Keep a record of the faults.
- Eliminate the fault and carry out a function test.

Modifications

After modifications to the industrial robot, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).

After modifications to the industrial robot, existing programs must always be tested first in Manual Reduced Velocity mode (T1). This applies to all components of the industrial robot and includes modifications to the software and configuration settings.

5.8.2 Testing safety-related controller components

All safety-related controller components are rated for a service life of 20 years (with the exception of the input/output terminals for safe bus systems). The controller components must nonetheless be tested regularly to ensure that they are still functional.

Check:

- E-STOP pushbutton, mode selector switch

  The E-STOP pushbutton and the mode selector switch must be actuated at least once every 6 months in order to detect any malfunction.
- SafetyBUS Gateway outputs

  If relays are switched on at an output, they must be switched off at least once every 6 months in order to detect any malfunction.

Additional checks are required during start-up and recommissioning.

(>>> 5.8.4 "Start-up and recommissioning" Page 89)

Warning!
If input/output terminals are used in the robot controller for safe bus systems, these must be exchanged after 10 years at the latest. If this is not done, the integrity of the safety functions is not assured. This can result in death, physical injuries and damage to property.

5.8.3 Transportation

Manipulator

The prescribed transport position of the manipulator must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the manipulator.

Robot controller

The robot controller must be transported and installed in an upright position. Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller.

Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot controller.

External axis (optional)

The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, etc.) must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the external axis.

5.8.4 Start-up and recommissioning

Before starting up systems and devices for the first time, a check must be carried out to ensure that the systems and devices are complete and operational, that they can be operated safely and that any damage is detected.

The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

The passwords for logging onto the KUKA System Software as “Expert” and “Administrator” must be changed before start-up and must only be communicated to authorized personnel.

Danger!
The robot controller is preconfigured for the specific industrial robot. If cables are interchanged, the manipulator and the external axes (optional) may receive incorrect data and can thus cause personal injury or material damage. If a system consists of more than one manipulator, always connect the connecting cables to the manipulators and their corresponding robot controllers.

Warning!
If additional components (e.g. cables), that are not part of the scope of supply of KUKA Roboter GmbH, are integrated into the industrial robot, the user is responsible for ensuring that these components do not adversely affect or disable safety functions.

Caution!
If the internal cabinet temperature of the robot controller differs greatly from the ambient temperature, condensation can form, which may cause damage to the electrical components. Do not put the robot controller into operation until the internal temperature of the cabinet has adjusted to the ambient temperature.

Interruptions/ cross-connections

Interruptions or cross-connections affecting safety functions and not detected by the robot controller or SafeRDC must either be precluded (e.g. by the construction) or detected by the customer (e.g. by means of a PLC or by testing the outputs).

Recommendation: design the construction in such a way as to preclude cross-connections. For this, observe the remarks in EN ISO 13849-2, tables D.5, D.6 and D.7.

Overview: possible cross-connections that are not detected by the robot controller or SafeRDC

Cross-connection	Possible in the case of …
Cross-connection to 0 V	■ ESC output Drives ON ■ ESC output E-STOP
Cross-connection to 24 V	■ ESC output Drives ON ■ ESC output E-STOP ■ ESC output Operating Mode ■ SafeRDC inputs
Cross-connection between the contacts of an output	■ ESC output Drives ON ■ ESC output E-STOP ■ ESC output Operating Mode
Cross-connection between the contacts of different outputs	
Cross-connection of an ESC output with an ESC input	
Cross-connection between the channels of different ESC inputs	ESC inputs
Cross-connection between 2 SafeRDC inputs	SafeRDC inputs
Cross-connection of a SafeRDC output with a SafeRDC input	SafeRDC outputs, SafeRDC inputs

Function test

The following tests must be carried out before start-up and recommissioning:

General test:

It must be ensured that:

- The industrial robot is correctly installed and fastened in accordance with the specifications in the documentation.
- There are no foreign bodies or loose parts on the industrial robot.
- All required safety equipment is correctly installed and operational.
- The power supply ratings of the industrial robot correspond to the local supply voltage and mains type.
- The ground conductor and the equipotential bonding cable are sufficiently rated and correctly connected.
- The connecting cables are correctly connected and the connectors are locked.

Test of safety-oriented circuits:

A function test must be carried out for the following safety-oriented circuits to ensure that they are functioning correctly:

- Local EMERGENCY STOP device (= EMERGENCY STOP button on the KCP)
- External EMERGENCY STOP device (input and output)
- Enabling device (in the test modes)
- Operator safety (in the automatic modes)
- Qualifying inputs (if connected)
- All other safety-relevant inputs and outputs used

Test of reduced velocity control:

This test is to be carried out as follows:

1. Program a straight path with the maximum possible velocity.

2. Calculate the length of the path.
3. Execute the path in T1 mode with the override set to 100% and time the motion with a stopwatch.

Warning!
It must be ensured that no persons are present within the danger zone during path execution.

4. Calculate the velocity from the length of the path and the time measured for execution of the motion.

Control of reduced velocity is functioning correctly if the following results are achieved:

- The calculated velocity does not exceed 250 mm/s.
- The robot executes the path as programmed (i.e. in a straight line, without deviations).

Machine data

It must be ensured that the rating plate on the robot controller has the same machine data as those entered in the declaration of incorporation. The machine data on the rating plate of the manipulator and the external axes (optional) must be entered during start-up.

Warning!
The industrial robot must not be moved if incorrect machine data are loaded. Death, severe physical injuries or considerable damage to property may otherwise result. The correct machine data must be loaded.

5.8.5 Virus protection and network security

The user of the industrial robot is responsible for ensuring that the software is always safeguarded with the latest virus protection. If the robot controller is integrated into a network that is connected to the company network or to the Internet, it is advisable to protect this robot network against external risks by means of a firewall.

For optimal use of our products, we recommend that our customers carry out a regular virus scan. Information about security updates can be found at www.kuka.com.

5.8.6 Manual mode

Manual mode is the mode for setup work. Setup work is all the tasks that have to be carried out on the industrial robot to enable automatic operation. Setup work includes:

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

- If the drives are not required, they must be switched off to prevent the manipulator or the external axes (optional) from being moved unintentionally.

  New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).
- The manipulator, tooling or external axes (optional) must never touch or project beyond the safety fence.

- Workpieces, tooling and other objects must not become jammed as a result of the industrial robot motion, nor must they lead to short-circuits or be liable to fall off.
- All setup work must be carried out, where possible, from outside the safeguarded area.

If the setup work has to be carried out inside the safeguarded area, the following must be taken into consideration:

In **Manual Reduced Velocity mode (T1)**:

- If it can be avoided, there must be no other persons inside the safeguarded area.

  If it is necessary for there to be several persons inside the safeguarded area, the following must be observed:
  - Each person must have an enabling device.
  - All persons must have an unimpeded view of the industrial robot.
  - Eye-contact between all persons must be possible at all times.
- The operator must be so positioned that he can see into the danger area and get out of harm's way.

In **Manual High Velocity mode (T2)**:

- This mode may only be used if the application requires a test at a velocity higher than Manual Reduced Velocity.
- Teaching and programming are not permissible in this operating mode.
- Before commencing the test, the operator must ensure that the enabling devices are operational.
- The operator must be positioned outside the danger zone.
- There must be no other persons inside the safeguarded area. It is the responsibility of the operator to ensure this.

5.8.7 Simulation

Simulation programs do not correspond exactly to reality. Robot programs created in simulation programs must be tested in the system in **Manual Reduced Velocity mode (T1)**. It may be necessary to modify the program.

5.8.8 Automatic mode

Automatic mode is only permissible in compliance with the following safety measures:

- All safety equipment and safeguards are present and operational.
- There are no persons in the system.
- The defined working procedures are adhered to.

If the manipulator or an external axis (optional) comes to a standstill for no apparent reason, the danger zone must not be entered until an EMERGENCY STOP has been triggered.

5.8.9 Maintenance and repair

After maintenance and repair work, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety circuits must also be tested.

The purpose of maintenance and repair work is to ensure that the system is kept operational or, in the event of a fault, to return the system to an operation-

al state. Repair work includes troubleshooting in addition to the actual repair itself.

The following safety measures must be carried out when working on the industrial robot:

- Carry out work outside the danger zone. If work inside the danger zone is necessary, the user must define additional safety measures to ensure the safe protection of personnel.
- Switch off the industrial robot and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again. If it is necessary to carry out work with the robot controller switched on, the user must define additional safety measures to ensure the safe protection of personnel.
- If it is necessary to carry out work with the robot controller switched on, this may only be done in operating mode T1.
- Label the system with a sign indicating that work is in progress. This sign must remain in place, even during temporary interruptions to the work.
- The EMERGENCY STOP systems must remain active. If safety functions or safeguards are deactivated during maintenance or repair work, they must be reactivated immediately after the work is completed.

Faulty components must be replaced using new components with the same article numbers or equivalent components approved by KUKA Roboter GmbH for this purpose.

Cleaning and preventive maintenance work is to be carried out in accordance with the operating instructions.

Robot controller

Even when the robot controller is switched off, parts connected to peripheral devices may still carry voltage. The external power sources must therefore be switched off if work is to be carried out on the robot controller.

The ESD regulations must be adhered to when working on components in the robot controller.

Voltages in excess of 50 V (up to 600 V) can be present in various components for several minutes after the robot controller has been switched off! To prevent life-threatening injuries, no work may be carried out on the industrial robot in this time.

Water and dust must be prevented from entering the robot controller.

Counterbalancing system

Some robot variants are equipped with a hydropneumatic, spring or gas cylinder counterbalancing system.

The hydropneumatic and gas cylinder counterbalancing systems are pressure equipment and, as such, are subject to obligatory equipment monitoring. Depending on the robot variant, the counterbalancing systems correspond to category 0, II or III, fluid group 2, of the Pressure Equipment Directive.

The user must comply with the applicable national laws, regulations and standards pertaining to pressure equipment.

Inspection intervals in Germany in accordance with Industrial Safety Order, Sections 14 and 15. Inspection by the user before commissioning at the installation site.

The following safety measures must be carried out when working on the counterbalancing system:

- The manipulator assemblies supported by the counterbalancing systems must be secured.
- Work on the counterbalancing systems must only be carried out by qualified personnel.

Hazardous substances

The following safety measures must be carried out when handling hazardous substances:

- Avoid prolonged and repeated intensive contact with the skin.
- Avoid breathing in oil spray or vapors.
- Clean skin and apply skin cream.

To ensure safe use of our products, we recommend that our customers regularly request up-to-date safety data sheets from the manufacturers of hazardous substances.

5.8.10 Decommissioning, storage and disposal

The industrial robot must be decommissioned, stored and disposed of in accordance with the applicable national laws, regulations and standards.

5.8.11 Safety measures for “single point of control”

Overview

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

Components:

- Submit interpreter
- PLC
- OPC Server
- Remote control tools
- External keyboard/mouse

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

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

Submit interpreter, PLC

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

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

Safety measures:

- Do not modify safety-relevant signals and variables (e.g. operating mode, EMERGENCY STOP, safety gate contact) via the Submit interpreter or PLC.
- If modifications are nonetheless required, all safety-relevant signals and variables must be linked in such a way that they cannot be set to a dangerous state by the Submit interpreter or PLC.

OPC server, remote control tools

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

Safety measures:

- KUKA stipulates that these components are to be used exclusively for diagnosis and visualization.

  Programs, outputs or other parameters of the robot controller must not be modified using these components.

External keyboard/mouse

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

Safety measures:

- Only use one operator console at each robot controller.
- If the KCP is being used for work inside the system, remove any keyboard and mouse from the robot controller beforehand.

5.9 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
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.	2004
97/23/EC	Pressure Equipment Directive: Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment	1997
EN ISO 13850	Safety of machinery: Emergency stop - Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles for design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems - Part 2: Validation	2008
EN ISO 12100-1	Safety of machinery: Basic concepts, general principles for design - Part 1: Basic terminology, methodology	2003
EN ISO 12100-2	Safety of machinery: Basic concepts, general principles for design - Part 2: Technical principles	2003
EN ISO 10218-1	Industrial robots: Safety	2008
EN 614-1	Safety of machinery: Ergonomic design principles - Part 1: Terminology and general principles	2006

Name	Definition	Edition
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments	2005
EN 61000-6-4	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2007
EN 60204-1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2006

6 Planning

6.1 Overview of planning

This is an overview of the most important planning specifications. The precise planning depends on the application, the robot type, the technology packages used and other customer-specific circumstances.

For this reason, the overview does not claim to be comprehensive.

Robot controller

Step	Description	Information
1	Electromagnetic compatibility (EMC)	(>>> 6.2 "Electromagnetic compatibility (EMC)" Page 97)
2	Installation conditions for robot controller	(>>> 6.3 "Installation conditions" Page 98)
3	Connection conditions	(>>> 6.4 "Connection conditions" Page 100)
4	Power supply connection	(>>> 6.5 "Power supply connection" Page 101)
5	E-STOP circuit and safeguard	(>>> 6.6 "EMERGENCY STOP circuit and safeguard" Page 102)
6	Configuration of interface X11	(>>> 6.7 "Interface X11" Page 105)
7	Equipotential bonding	(>>> 6.8 "PE equipotential bonding" Page 109)
8	Load voltage US1 and US2, switched (optional)	(>>> 6.9 "Load voltage US1 and US2 (optional)" Page 111)
9	KCP coupler (optional)	(>>> 6.10 "Visualization of the KCP coupler (option)" Page 111)
10	Fast Measurement power supply (optional)	(>>> 6.11 "RDC power supply for Fast Measurement (option)" Page 111)
11	Performance level	(>>> 6.13 "Performance level" Page 114)

6.2 Electromagnetic compatibility (EMC)

Description

If connecting cables (e.g. field buses, etc.) are routed to the control PC from outside, only shielded cables with an adequate degree of shielding may be used. The cable shield must be connected with maximum surface area to the PE rail in the cabinet using shield terminals (screw-type, no clamps).

The robot controller may only be operated in an **industrial environment**.

6.3 Installation conditions

Dimensions

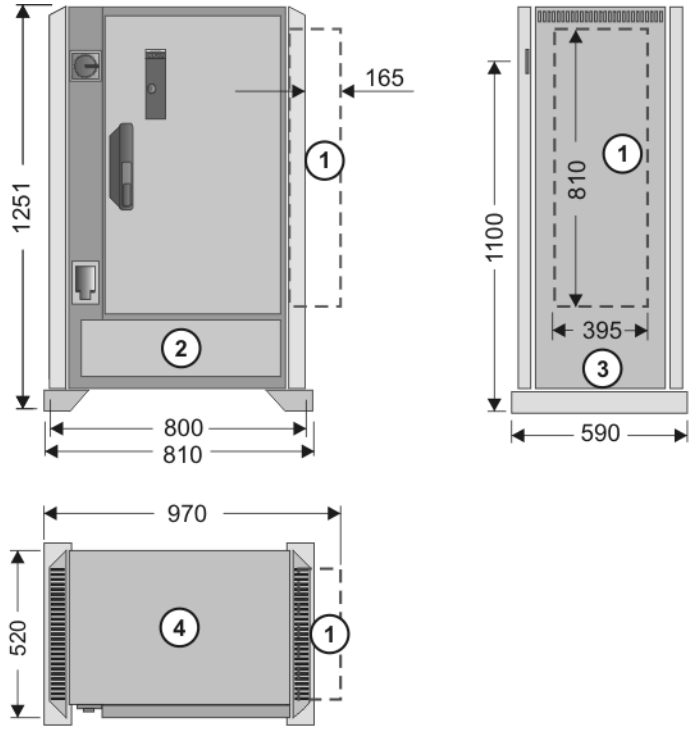

Fig. 6-1: Dimensions (in mm)

1	Cooling unit (optional)	3	Side view
2	Front view	4	Top view

The minimum clearances that must be maintained for the robot controller are indicated in the diagram (>>> Fig. 6-2).

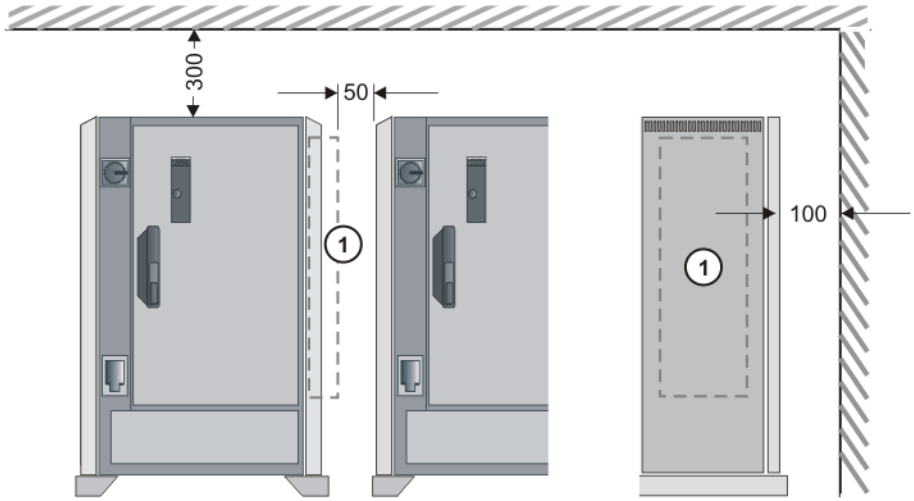

Fig. 6-2: Minimum clearances (dimensions in mm)

1	Cooling unit (optional)

Warning!
If the minimum clearances are not maintained, this can result in damage to the robot controller. The specified minimum clearances must always be observed.

Certain maintenance and repair tasks on the robot controller (>>> 10 "Maintenance" Page 129) (>>> 11 "Repair" Page 131) must be carried out from the side or from the rear. The robot controller must be accessible for this. If the side or rear panels are not accessible, it must be possible to move the robot controller into a position in which the work can be carried out.

Minimum clearances with top-mounted cabinet

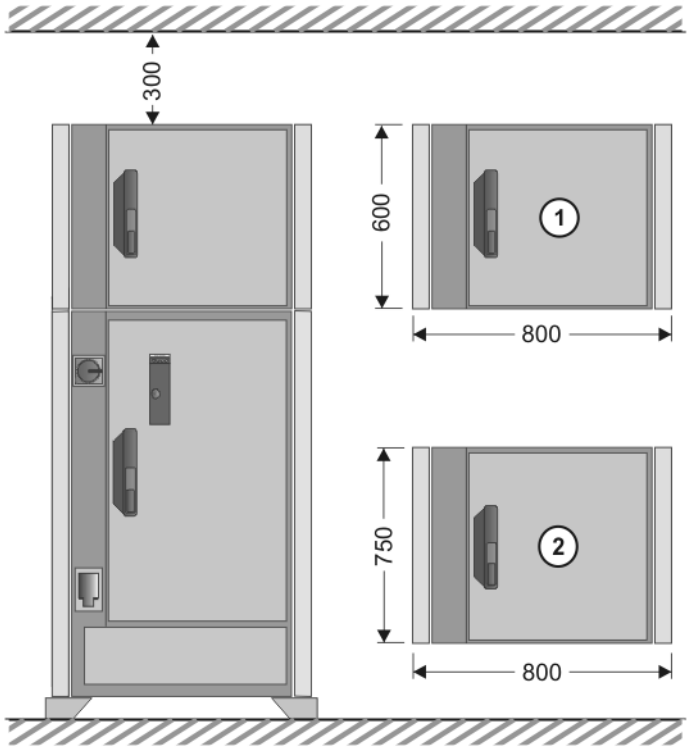

Fig. 6-3: Minimum clearances with top-mounted / technology cabinet

1	Top-mounted cabinet	2	Technology cabinet

Swing range for door

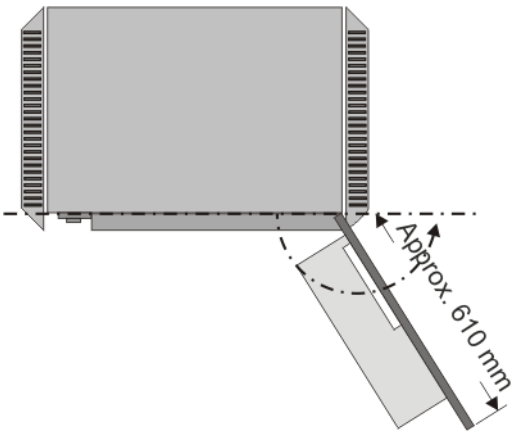

Fig. 6-4: Swing range for cabinet door

Swing range, standalone cabinet:

- Door with computer frame approx. 180°

Swing range, butt-mounted cabinets:

- Door approx. 155°

Boreholes

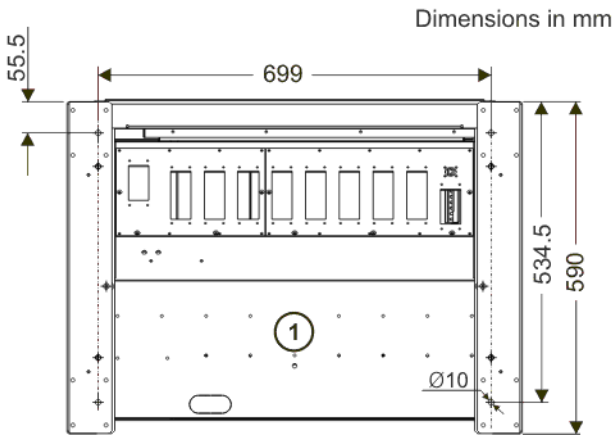

Fig. 6-5: Boreholes for floor mounting

1 Top view
2 View from below

6.4 Connection conditions

Power supply connection

Rated supply voltage	AC 3x400 V ... AC 3x415 V
Permissible tolerance of rated voltage	400 V -10% ... 415 V +10%
Mains frequency	49 ... 61 Hz
System impedance up to the connection point of the robot controller	≤ 300 mΩ
Rated power input ■ Standard	7.3 kVA, see rating plate
Rated power input ■ Heavy-duty robot ■ Palletizing robot ■ Press-to-press robot	13.5 kVA, see rating plate
Mains-side fusing	min. 3x25 A slow-blowing, max. 3x32 A slow-blowing, see rating plate
If an RCCB is used: trip current difference	300 mA per robot controller, universal-current sensitive
Equipotential bonding	The common neutral point for the equipotential bonding conductors and all protective ground conductors is the reference bus of the power unit.

Caution!
If the system impedance of 300 mΩ is exceeded, it is possible that, in unfavorable circumstances, the power fuse of the servo drives cannot be triggered or can only be triggered after a long delay in the event of ground faults. The system impedance up to the connection point of the robot controller must be ≤ 300 mΩ.

Caution!
If the robot controller is operated with a supply voltage other than that specified on the rating plate, this may cause malfunctions in the robot controller and material damage to the power supply units. The robot controller may only be operated with the supply voltage specified on the rating plate.

Caution!
If the robot controller is connected to a power system **without** a grounded neutral, this may cause malfunctions in the robot controller and material damage to the power supply units. Electrical voltage can cause physical injuries. The robot controller may only be operated with grounded-neutral power supply systems.

This device meets the requirements of EN55011 Class A and may be operated in power supply systems with their own low-voltage power supply (transformer station, power plant). The device may be operated in public power supply systems subject to prior approval by the power utility concerned.

Cable lengths

The designations and standard and optional lengths may be noted from the following table.

Cable	Standard length in m	Optional length in m
Motor cable	7	15 / 25 / 35 / 50
Data cable	7	15 / 25 /35 / 50
Power cable with XS1 (optional)	3	-

Cable	Standard length in m	Extension in m
KCP cable	10	10 / 20 / 30/ 40

When using KCP cable extensions only **one** may be employed at a time, and a total cable length of 60 m must not be exceeded.

6.5 Power supply connection

Description

The robot controller can be connected to the mains via the following connections:

- X1 Harting connector on the connection panel
- XS1 CEE connector; the cable is led out of the robot controller (optional)

Overview

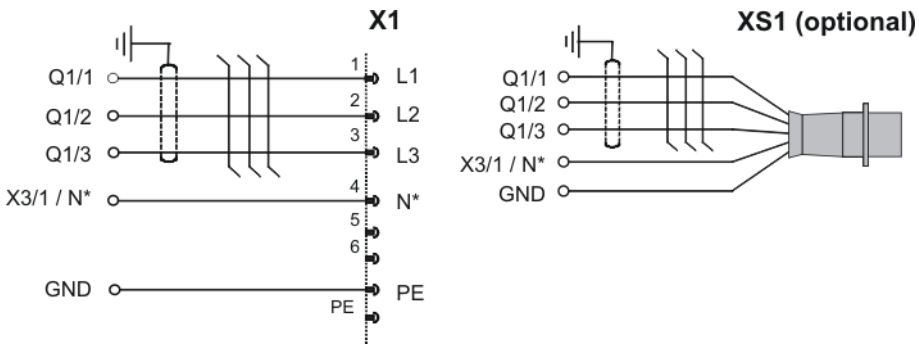

Fig. 6-6: Power supply connection

* The N-conductor is only necessary for the service socket option with a 400 V power supply.

The robot controller must only be connected to a power system with a clockwise rotating field. Only then is the correct direction of rotation of the fan motors ensured.

6.5.1 Power supply connection via X1 Harting connector

Description

A Harting connector bypack is supplied with the robot controller. The customer can connect the robot controller to the power supply via connector X1.

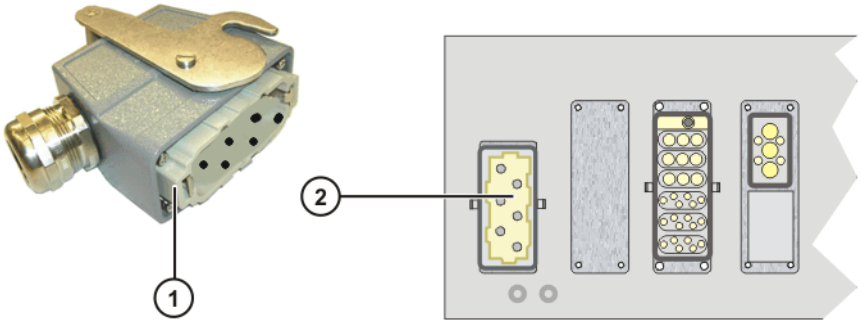

Fig. 6-7: Power supply connection X1

1 Harting connector bypack (optional)
2 Power supply connection X1

6.5.2 Power supply connection via CEE connector XS1

Description

With this option, the robot controller is connected to the power supply via a CEE connector. The cable is approx. 3 m long and is routed to the main switch via a cable gland.

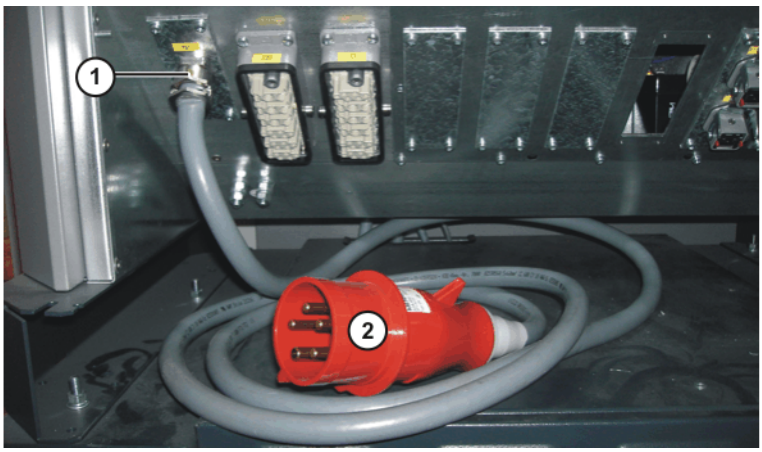

Fig. 6-8: Power supply connection XS1

1 Cable gland
2 CEE connector

6.6 EMERGENCY STOP circuit and safeguard

The following examples show how the EMERGENCY STOP circuit and safeguard of the robot system can be connected to the periphery.

Example

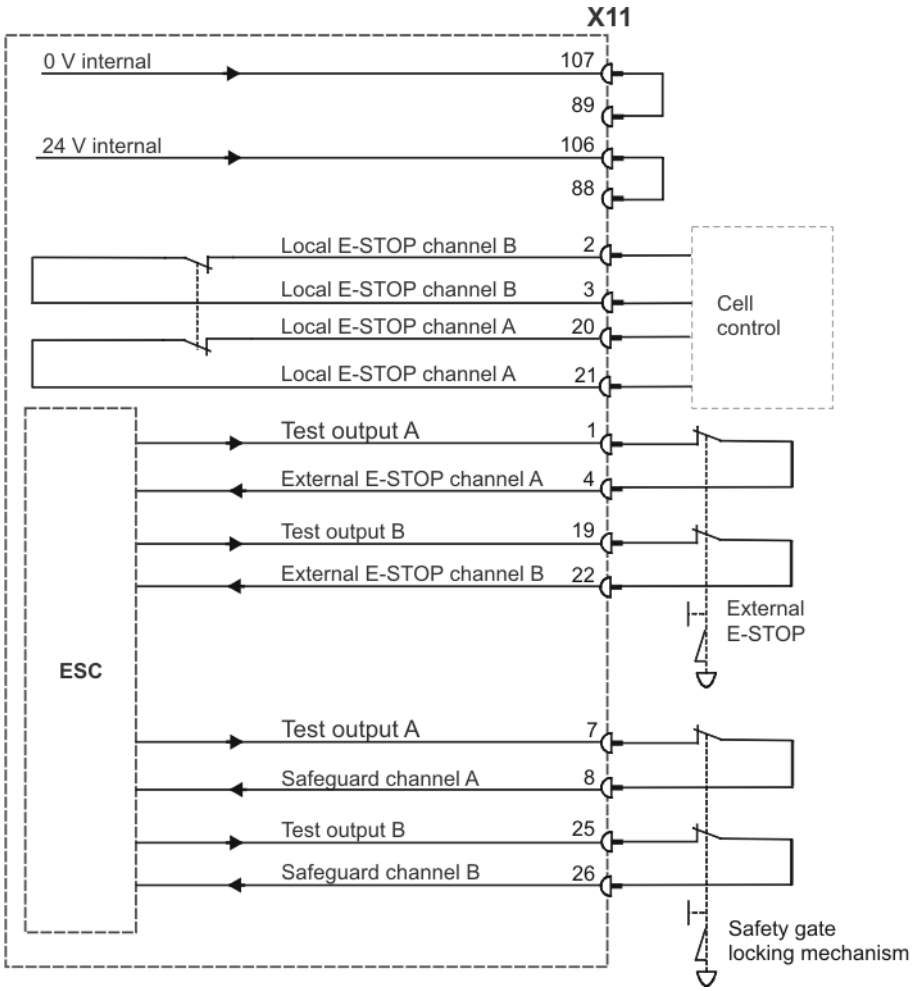

Fig. 6-9: Robot with periphery

Example

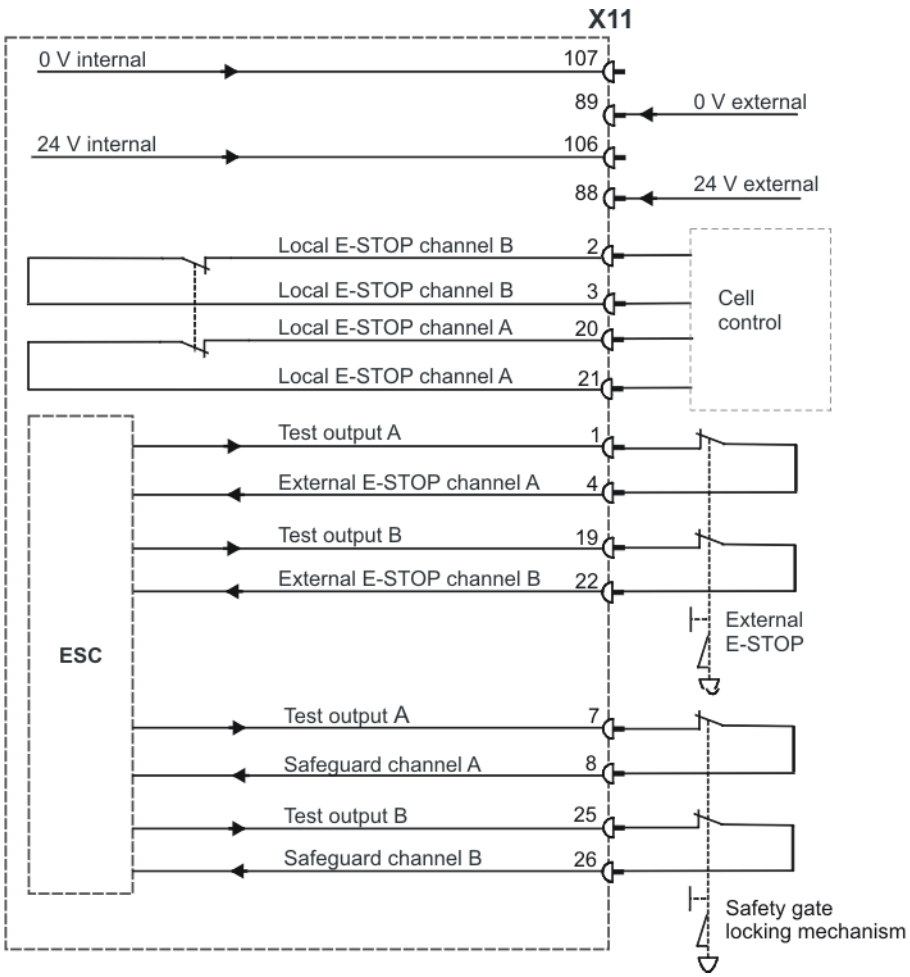

Fig. 6-10: Robot with periphery and external power supply

Example

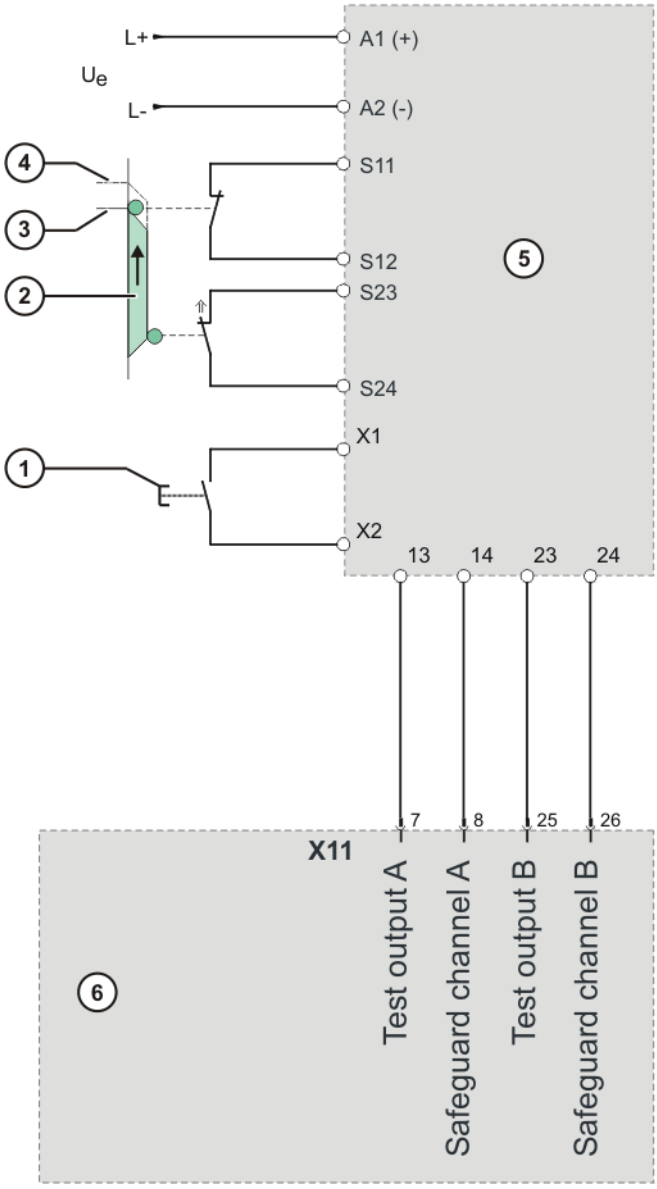

Fig. 6-11: Safety gate monitor

Item	Element	Description
1	Enabling pushbutton with safety gate closed	The pushbutton must be installed outside the safe-guarded zone.
2	Gate position switches	-
3	Gate position switch, safety gate closed	-
4	Gate position switch, safety gate open	-
5	Safety gate monitor	e.g. PST3 manufactured by Pilz
6	Interface X11	-

6.7 Interface X11

Description EMERGENCY STOP devices must be connected via interface X11 or linked together by means of higher-level controllers (e.g. PLC).

Wiring

Take the following points into consideration when wiring interface X11:

- System concept
- Safety concept

Various signals and functions are available, depending on the specific CI3 board. (>>> 3.6.2 "Overview of CI3 boards" Page 37)

Detailed information about integration into higher-level controllers is contained in the Operating and Programming Instructions for System Integrators, in the chapter “Automatic External signal diagrams”.

Connector pin allocation

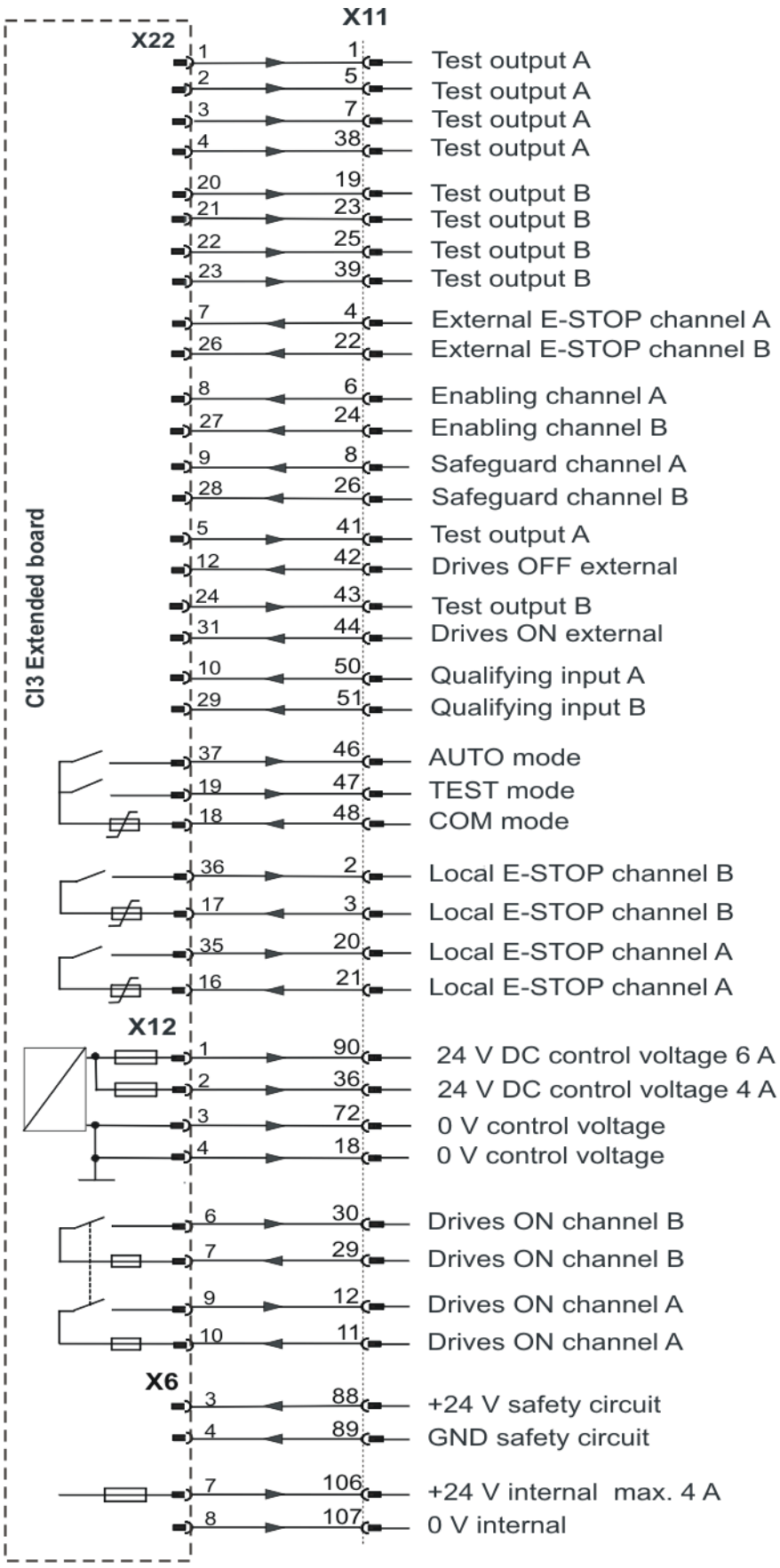

Fig. 6-12

Signal	Pin	Description	Comments
+24 V internal 0 V internal	106 107	ESC power supply max. 2 A	
24 V external 0 V external	88 89	In the absence of an external power supply, 24 V / 0 V must be jumpered internally.	An external power supply is recommended for interlinked systems.
+24 V 0 V	36 18	24 V control voltage for supply to external devices, max. 4 A.	Optional
+24 V 0 V	90 72	24 V control voltage for supply to external devices, max. 6 A.	Optional
Test output A (test signal)	1 5 7 38 41	Makes the pulsed voltage available for the individual interface inputs of channel A.	Connection example: enabling switch is connected under channel A to pin 1 (TA_A) and pin 6.
Test output B (test signal)	19 23 25 39 43	Makes the pulsed voltage available for the individual interface inputs of channel B.	Connection example: safety gate locking mechanism is connected under channel B to pin 19 (TA_B) and pin 26.
Local E-STOP channel A	20 / 21	Output, floating contacts from internal E-STOP, max. 24 V, 600 mA	In the non-activated state, the contacts are closed.
Local E-STOP channel B	2 / 3		
External E-STOP channel A	4	E-STOP, dual-channel input, max. 24 V, 10 mA.	
External E-STOP channel B	22		
Enabling channel A	6	For connection of an external dual-channel enabling switch with floating contacts max. 24 V, 10 mA	If no enabling switch is connected, pins 5 and 6 and pins 23 and 24 must be jumpered. Only effective in TEST mode.
Enabling channel B	24		
Safeguard channel A	8	For dual-channel connection of a safety gate locking mechanism, max. 24 V, 10 mA	Only effective in AUTOMATIC mode.
Safeguard channel B	26		
Drives OFF external, channel A (single-channel)	42	A floating contact (break contact) can be connected to this input. If the contact opens, the drives are switched off, max. 24 V, 10 mA.	If this input is not used, pins 41/42 must be jumpered.
Drives ON external, channel B (single-channel)	44	For connection of a floating contact.	Pulse > 200 ms switches the drives on. Signal must not be permanently active.
Drives ON channel B	29 / 30	Floating contacts (max. 7.5 A) signal “Drives ON”. These contacts are only available if a CI3 Extended or CI3 Tech board is used.	Is closed if the “Drives ON” contactor is energized.

Signal	Pin	Description	Comments
Drives ON channel A	11 / 12	Floating contacts (max. 2 A) signal “Drives ON”. These contacts are only available if a CI3 Extended or CI3 Tech board is used.	Is closed if the “Drives ON” contactor is energized.
Operating mode group Automatic	48 / 46	Floating contacts of the safety circuit signal the operating mode. These contacts are only available if a CI3 Extended or CI3 Tech board is used.	Automatic contact 48 / 46 is closed if Automatic or External is selected on the KCP.
Operating mode group Test	48 / 47		Test contact 48 / 47 is closed if Test 1 or Test 2 is selected on the KCP.
Qualifying input, channel A	50	0 signal causes a category 0 STOP in all operating modes.	If these inputs are not used, pin 50 must be jumpered to test output 38, and pin 51 to test output 39.
Qualifying input, channel B	51		

The counterpart to interface X11 is a 108-contact Harting connector with a male insert, type Han 108DD, housing size 24B.

I/Os

I/Os can be configured using the following components:

- DeviceNet (master) via MFC
- Optional field bus cards
  - Interbus
  - Profibus
  - DeviceNet
- ProfiNet
- Specific customer interfaces

6.8 PE equipotential bonding

Description

The following cables must be connected before start-up:

- A 16 mm^2 cable as equipotential bonding between the robot and the robot controller.
- An additional PE conductor between the central PE rail of the supply cabinet and the PE bolt of the robot controller.

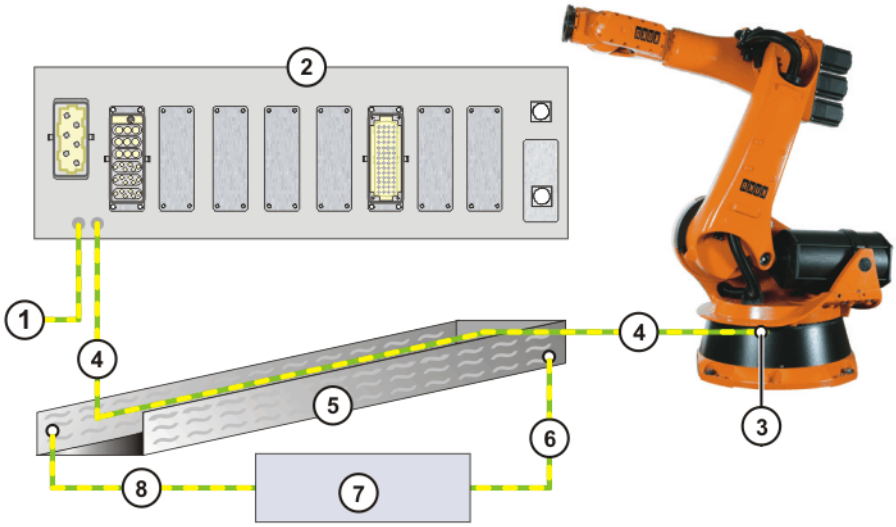

Fig. 6-13: Equipotential bonding, from robot controller to robot, with cable duct

1 PE to central PE rail of the supply cabinet
2 Connection panel on robot controller
3 Equipotential bonding connection on the robot
4 Equipotential bonding from the robot controller to the robot
5 Cable duct
6 Equipotential bonding from the start of the cable duct to the main equipotential bonding
7 Main equipotential bonding
8 Equipotential bonding from the end of the cable duct to the main equipotential bonding

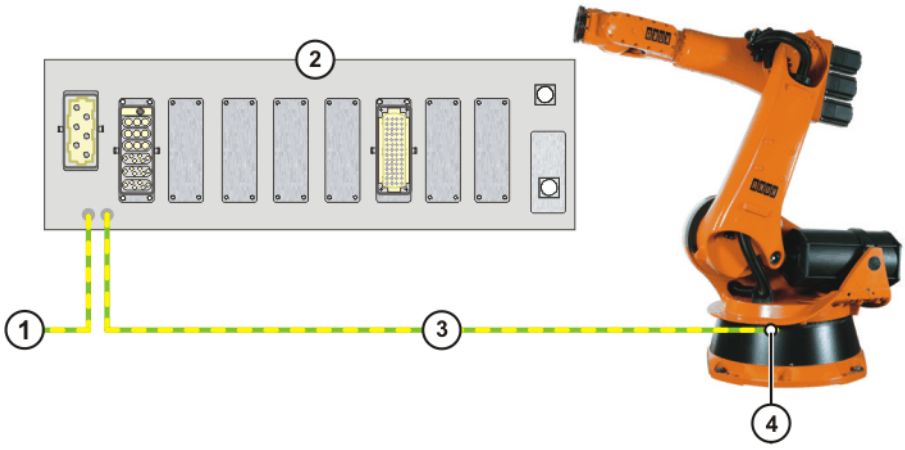

Fig. 6-14: Equipotential bonding, robot controller - robot

1 PE to central PE rail of the supply cabinet
2 Connection panel on robot controller
3 Equipotential bonding from the robot controller to the robot
4 Equipotential bonding connection on the robot

6.9 Load voltage US1 and US2 (optional)

Description

In the case of interfaces with the switchable load voltage option (US1/US2), load voltage US1 is not switched and US2 is wired using failsafe technology so that actuators, for example, are switched off when the drives are deactivated.

If, due to a fault in the system cabling, there is a cross connection between US1 and US2, this will not be noticed during normal operation. The result is that load voltage US2 is no longer switched off which can lead to a dangerous state in the system.

In the cabling for the voltages US1 and US2 in the system, suitable measures must be taken to prevent a cross connection between the voltages (e.g. separate cabling of US1 and US2 or a cable with reinforced insulation between the two voltages).

6.10 Visualization of the KCP coupler (option)

Description

If the robot controller is operated with a detachable KCP, the following system variables must be visualized:

- $T1 (T1 mode)
- $T2 (T2 mode)
- $EXT (External mode)
- $AUT (Automatic mode)
- $ALARM_STOP
- $PRO_ACT (program active)

The display can be configured using I/Os or a PLC. The system variables can be configured in the file: STEU/$MACHINE.DAT.

Warning!
If the KCP is disconnected, the system can no longer be deactivated by means of the EMERGENCY STOP button on the KCP. An external E-STOP must be connected to interface X11 to prevent personal injury and material damage.

6.11 RDC power supply for Fast Measurement (option)

Power supply for one RDC

The figure (>>> Fig. 6-15) illustrates the power supply for one RDC.

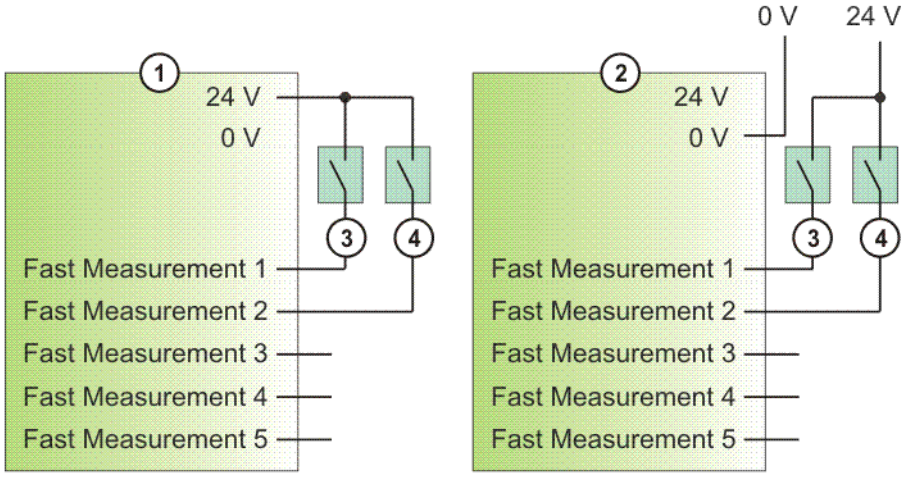

Fig. 6-15: Fast Measurement power supply for one RDC

1	Power supply of RDC	3	Sensor 1
2	External power supply	4	Sensor 2

Power supply for 2 RDCs

The figure (>>> Fig. 6-16) illustrates the power supply for two RDCs.

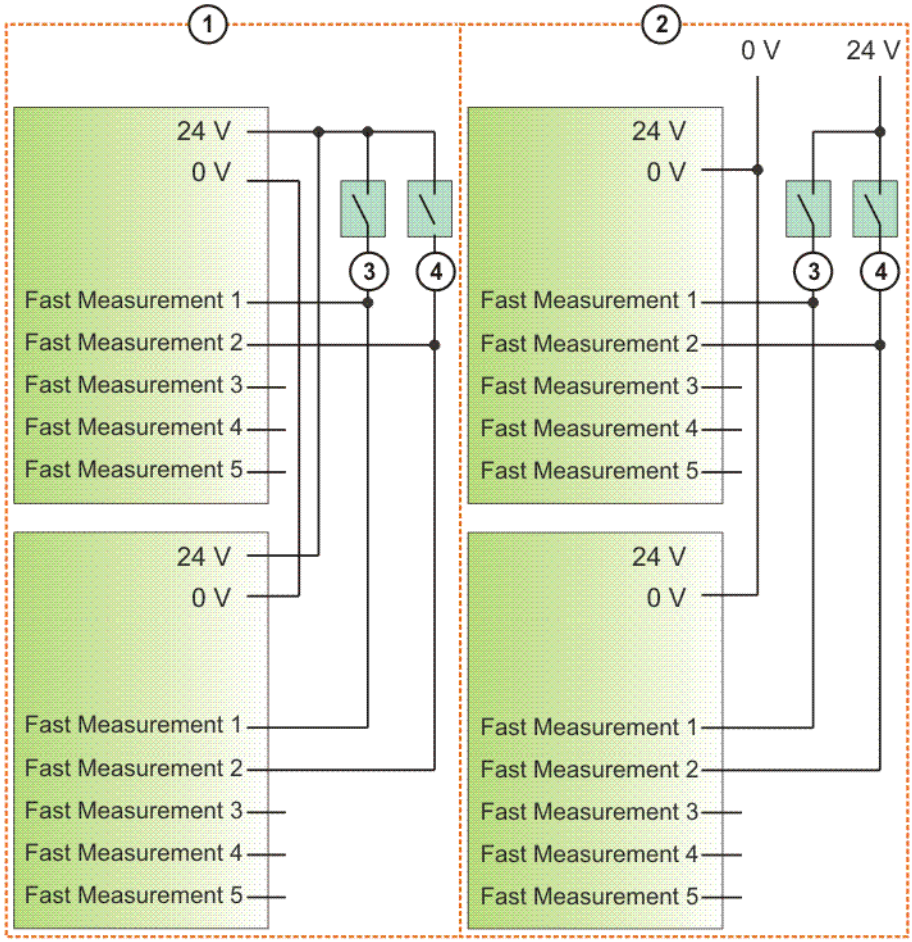

Fig. 6-16: Fast Measurement power supply for 2 RDCs

1	Power supply of RDC	3	Sensor 1
2	External power supply	4	Sensor 2

6.12 SafeRDC power supply for Fast Measurement (option)

Power supply for one SafeRDC

The figure (>>> Fig. 6-17) illustrates the power supply for one SafeRDC.

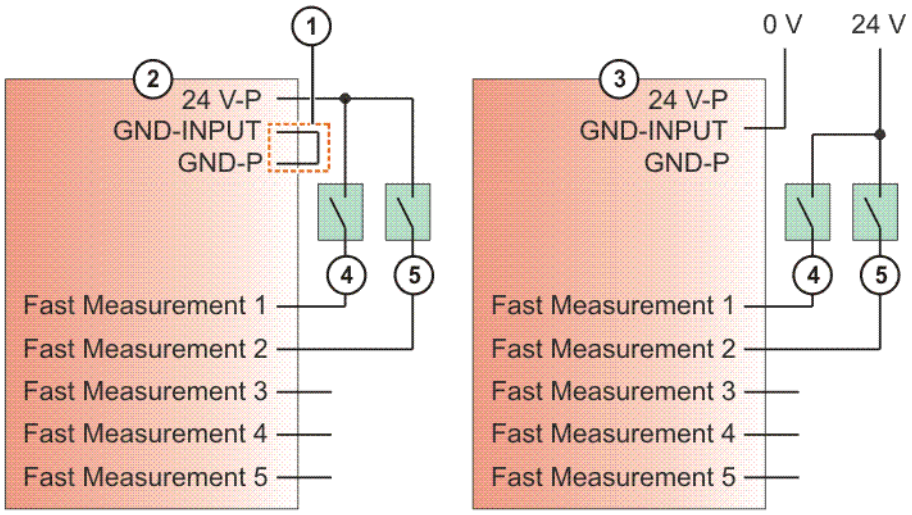

Fig. 6-17: Fast Measurement power supply for one SafeRDC

1	Jumper between GND-INPUT and GND-P in connector X33	4	Sensor 1
2	Power supply via SafeRDC	5	Sensor 2
3	External power supply		

Power supply for RDC and SafeRDC

The figure (>>> Fig. 6-18) illustrates the power supply for one RDC and one SafeRDC.

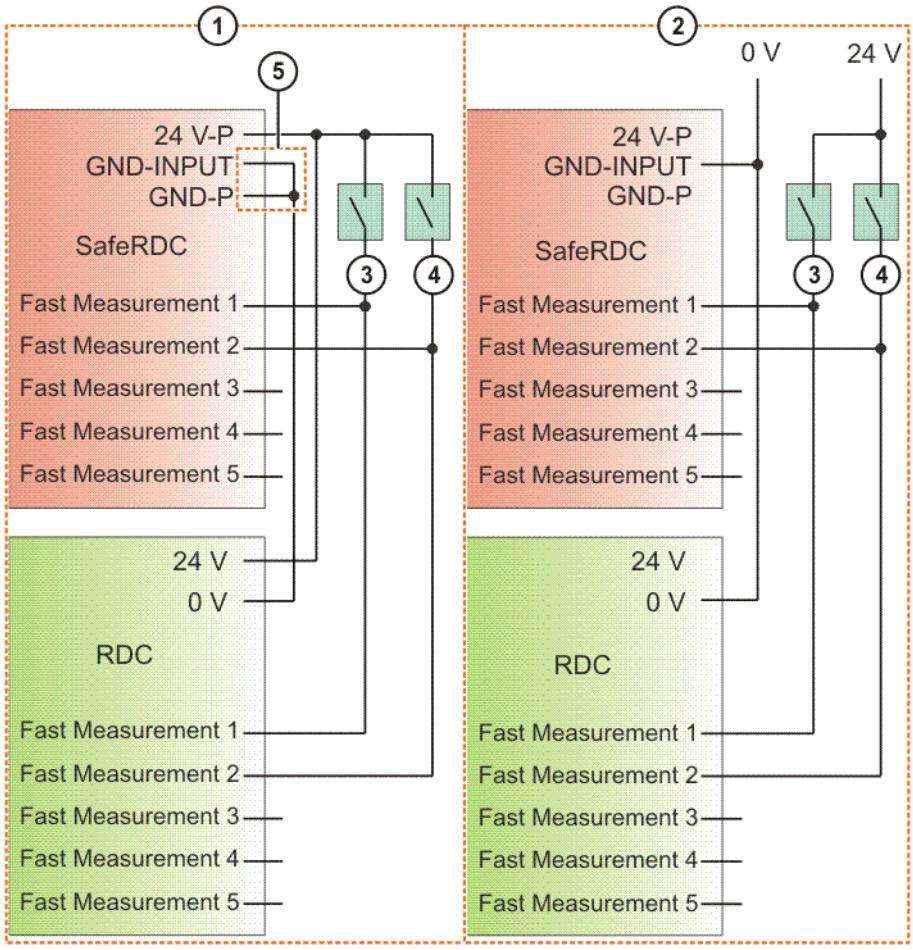

Fig. 6-18: Fast Measurement power supply for RDC and SafeRDC

1	Power supply via SafeRDC/ RDC	4	Sensor 2
2	External power supply	5	Jumper between GND-INPUT and GND-P in connector X33
3	Sensor 1		

6.13 Performance level

The safety functions of the robot controller conform to category 3 and Performance Level d according to EN ISO 13849-1.

6.13.1 PFH values of the safety functions

The safety values are based on a service life of 20 years.

The PFH value classification of the controller is only valid if the test cycles for E-STOP buttons and mode selector switches and the switching frequency of the contactors are observed. E-STOP buttons and mode selector switches must be actuated at least once every 6 months. The switching frequency of the contactors in the disconnection path must be at least twice per year and no more than 100 times per day.

When evaluating system safety functions, it must be remembered that the PFH values for a combination of multiple controllers may have to be taken into consideration more than once. This is the case for RoboTeam systems or higher-level hazard areas. The PFH value determined for the safety function at system level must not exceed the limit for PL d.

The PFH values relate to the specific safety functions of the different controller variants.

Safety function groups:

- Standard safety functions (ESC)
  - EMERGENCY STOP device (KCP, cabinet, customer interface)
  - Operator safety (customer interface)
  - Enabling (KCP, customer interface)
  - Operating mode (KCP, customer interface)
  - Safety stop (customer interface)
- Safety functions of KUKA.SafeOperation (option)
  - Monitoring of axis spaces
  - Monitoring of Cartesian spaces
  - Monitoring of axis velocity
  - Monitoring of Cartesian velocity
  - Monitoring of axis acceleration
  - Standstill monitoring
  - Tool monitoring

Overview of controller variant PFH values:

Robot controller variant	PFH value
(V)KR C2 (edition2005)	1×10^{-7}
(V)KR C2 (edition2005) and 1 top-mounted cabinet	1×10^{-7}
(V)KR C2 (edition2005) with 2 top-mounted cabinets	1×10^{-7}
(V)KR C2 (edition2005) with KCP coupler	1×10^{-7}
(V)KR C2 edition2005 with KUKA.SafeOperation	1×10^{-7}

Robot controller variant	PFH value
(V)KR C2 (edition2005) with 2 top-mounted cabinets and KUKA.SafeOperation	1×10^{-7}
KR C2 edition2005 titan	1×10^{-7}
KR C2 edition2005 titan with top-mounted cabinet	1×10^{-7}
KR C2 edition2005 titan with KCP coupler	1×10^{-7}
KR C2 edition2005 titan with KUKA.SafeOperation	1×10^{-7}
(V)KR C2 (edition2005) RoboTeam (standard) with 5 slaves	3×10^{-7}
(V)KR C2 (edition2005) with SafetyBUS Gateway	3×10^{-7}
(V)KR C2 (edition2005) with SafetyBUS Gateway and KCP coupler	3×10^{-7}
(V)KR C2 (edition2005) with KCP coupler, SafetyBUS Gateway and KUKA.SafeOperation with I/O connection via optocoupler and top-mounted cabinet	3×10^{-7}
(V)KR C2 (edition2005) RoboTeam (with KCP coupler, SafetyBUS Gateway) with 2 slaves, each with 2 top-mounted cabinets and KUKA.SafeOperation	3×10^{-7}
(V)KR C2 (edition2005) RoboTeam (standard) with 5 slaves and KUKA.SafeOperation	3×10^{-7}
KR C2 edition2005 titan with SafetyBUS Gateway	3×10^{-7}
KR C2 edition2005 titan with SafetyBUS Gateway and KCP coupler	3×10^{-7}

For controller variants that are not listed here, please contact KUKA Roboter GmbH.

7 Transportation

7.1 Transportation with the set of rollers (optional)

The robot controller rollers may only be used to roll the cabinet into and out of a row of cabinets – not to transport the cabinet over longer distances.

Fig. 7-1: Transportation on rollers

Warning!
If the robot controller is towed by a vehicle (fork lift truck, electrical vehicle), this can result in damage to the rollers and to the robot controller. The robot controller must not be hitched to a vehicle and transported using its rollers.

7.2 Transportation using lifting tackle

Preconditions

- The robot controller must be switched off.
- No cables may be connected to the robot controller.
- The door of the robot controller must be closed.
- The robot controller must be upright.
- The anti-toppling bracket must be fastened to the robot controller.

Necessary equipment

- Lifting tackle with or without lifting frame

Procedure

1. Attach the lifting tackle with or without a lifting frame to all 4 transport eye-bolts on the robot controller.

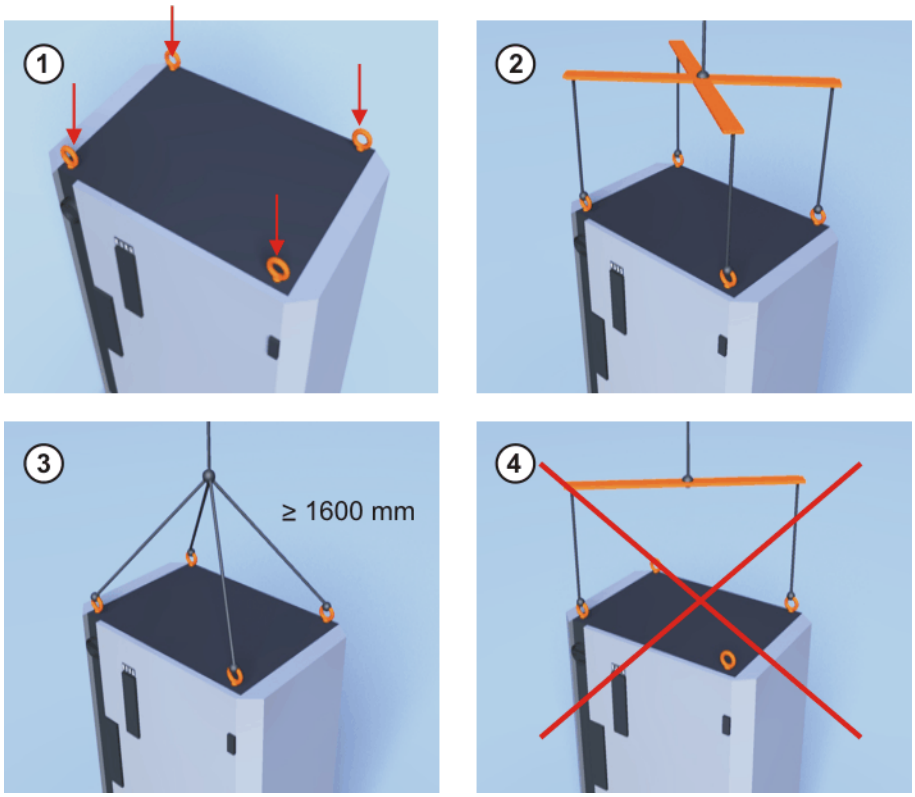

Fig. 7-2: Transportation using lifting tackle

1	Transport eyebolts on the robot controller
2	Correctly attached lifting tackle
3	Correctly attached lifting tackle
4	Incorrectly attached lifting tackle

2. Attach the lifting tackle to the crane.

Danger!
If the suspended robot controller is transported too quickly, it may swing and cause injury or damage. Transport the robot controller slowly.

3. Slowly lift and transport the robot controller.
4. Slowly lower the robot controller at its destination.
5. Unhook lifting tackle on the robot controller.

7.3 Transportation by pallet truck

Preconditions

- The robot controller must be switched off.
- No cables may be connected to the robot controller.
- The door of the robot controller must be closed.
- The robot controller must be upright.
- The anti-toppling bracket must be fastened to the robot controller.

Procedure

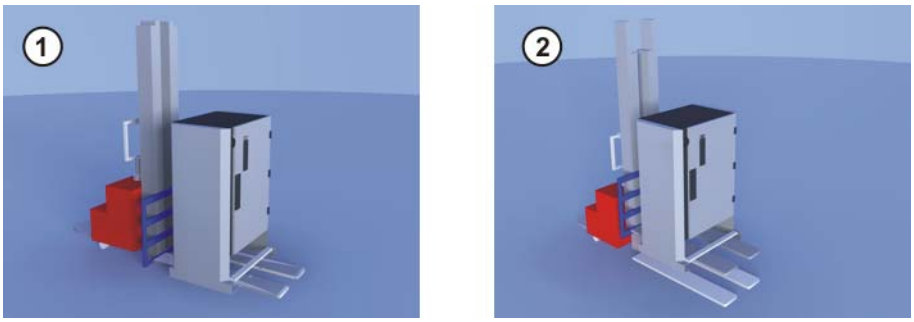

Fig. 7-3: Transportation by pallet truck

1 Control cabinet with anti-toppling bracket
2 Robot controller in raised position

7.4 Transportation by fork lift truck

Preconditions

- The robot controller must be switched off.
- No cables may be connected to the robot controller.
- The door of the robot controller must be closed.
- The robot controller must be upright.
- The anti-toppling bracket must be fastened to the robot controller.

Procedure

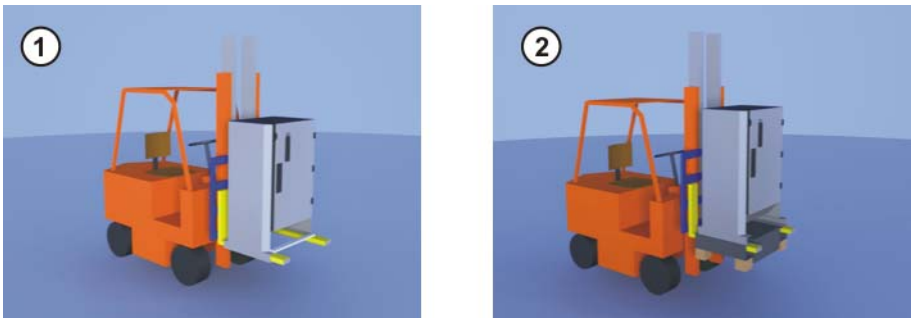

Fig. 7-4: Transportation by fork lift truck

1 Robot controller with fork slots
2 Robot controller with transformer installation kit

8 Start-up and recommissioning

8.1 Start-up overview

This is an overview of the most important steps during start-up. The precise sequence depends on the application, the manipulator type, the technology packages used and other customer-specific circumstances.
For this reason, the overview does not claim to be comprehensive.

This overview refers to the start-up of the industrial robot. The start-up of the overall system is not within the scope of this documentation.

Robot

Step	Description	Information
1	Carry out a visual inspection of the robot.	Detailed information is contained in the operating or assembly instructions for the robot, in the chapter “Start-up and recommissioning”.
2	Install the robot mounting base (mounting base, machine frame mounting or booster frame).	
3	Install the robot.	

Electrical system

Step	Description	Information
4	Carry out a visual inspection of the robot controller.	-
5	Make sure that no condensation has formed in the robot controller.	-
6	Install the robot controller.	(>>> 8.2 "Installing the robot controller" Page 123)
7	Connect the connecting cables.	(>>> 8.3 "Connecting the connecting cables" Page 123)
8	Connect the KCP.	(>>> 8.4 "Connecting the KCP" Page 124)
9	Establish the equipotential bonding between the robot and the robot controller.	(>>> 8.5 "Connecting the PE equipotential bonding" Page 124)
10	Connect the robot controller to the power supply.	(>>> 3.9.1 "Power supply connection X1/XS1" Page 53)
11	Reverse the battery discharge protection measures.	(>>> 8.7 "Reversing the battery discharge protection measures" Page 124)
12	Configure and connect interface X11. **Note:** If interface X11 has not been wired, the robot cannot be jogged.	(>>> 8.9 "Configuring and connecting connector X11" Page 125)
13	Switch on the robot controller.	(>>> 8.10 "Switching on the robot controller" Page 125)
14	Check the direction of rotation of the fans.	(>>> 8.11 "Checking the direction of rotation of the external fan" Page 125)

Step	Description	Information
15	Check the safety equipment.	Detailed information is contained in the operating instructions for the robot controller, in the chapter “Safety”.
16	Configure the inputs/outputs between the robot controller and the periphery.	Detailed information can be found in the field bus documentation.

Software

Step	Description	Information
17	Check the machine data.	Detailed information is contained in the operating and programming instructions.
18	Transfer data from the RDC to the hard drive.	Detailed information is contained in the Operating and Programming Instructions for System Integrators.
19	Master the robot without a load.	Detailed information is contained in the operating and programming instructions.
20	Only for palletizing robots with 6 axes: Activate palletizing mode.	Detailed information is contained in the Operating and Programming Instructions for System Integrators.
21	Mount the tool and master the robot with a load.	Detailed information is contained in the operating and programming instructions.
22	Check the software limit switches and adapt them if required.	
23	Calibrate tool. In the case of a fixed tool: calibrate external TCP.	Detailed information is contained in the operating and programming instructions.
24	Enter load data.	
25	Calibrate base (optional). In the case of a fixed tool: calibrate workpiece (optional).	
26	If the robot is to be controlled from a higher-level controller: configure Automatic External interface.	Detailed information is contained in the Operating and Programming Instructions for System Integrators.

Accessories

Precondition: the robot is ready to move, i.e. the software start-up has been carried out up to and including the item “Master the robot without load”.

Description	Information
Optional: install axis range limitation systems. Adapt software limit switches.	Detailed information can be found in the axis range limitation documentation.
Optional: install and adjust axis range monitoring, taking the programming into consideration.	Detailed information can be found in the axis range monitoring documentation.
Optional: install and adjust external energy supply system, taking the programming into consideration.	Detailed information can be found in the energy supply system documentation.
Positionally accurate robot option: check data.	

8.2 Installing the robot controller

Procedure

1. Install the robot controller. The minimum clearances to walls, other cabinets, etc. must be observed. (>>> 6.3 "Installation conditions" Page 98)
2. Check the robot controller for any damage caused during transportation.
3. Check that fuses, contactors and boards are fitted securely.
4. Secure any modules that have come loose.
5. Check that all screwed and clamped connections are securely fastened.
6. The operator must cover the warning label **Read manual** with a label in the relevant local language. (>>> 4.9 "Plates and labels" Page 69)

8.3 Connecting the connecting cables

Overview

A cable set is supplied with the robot system. In the standard version this consists of:

- Motor cables to the robot
- Control cables to the robot

  The following cables may be provided for additional applications:
- Motor cables for external axes
- Peripheral cables

Danger!
The robot controller is preconfigured for the specific industrial robot. If cables are interchanged, the robot and the external axes (optional) may receive incorrect data and can thus cause personal injury or material damage. If a system consists of more than one robot, always connect the connecting cables to the robots and their corresponding robot controllers.

Preconditions

- Compliance with the connection conditions concerning: (>>> 6.4 "Connection conditions" Page 100)
  - Cable cross-section
  - Fusing
  - Electric potential difference
  - Mains frequency
- Compliance with the safety regulations

Procedure

1. Route the motor cables to the manipulator junction box separately from the control cable. Plug in connector X20.
2. Route the control cables to the manipulator junction box separately from the motor cable. Plug in connector X21.
3. Connect the peripheral cables.

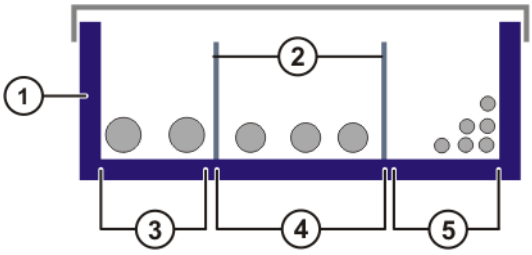

Fig. 8-1: Example: Installing the cables in the cable duct

1 Cable duct
2 Separating webs
3 Welding cables
4 Motor cables
5 Control cables

8.4 Connecting the KCP

Procedure

- Connect the KCP to X19 on the robot controller.

8.5 Connecting the PE equipotential bonding

Procedure

1. Connect an additional PE conductor between the central PE rail of the supply cabinet and the PE bolt of the robot controller.
2. Connect a 16 mm^2 cable as equipotential bonding between the robot and the robot controller.
   (>>> 6.8 "PE equipotential bonding" Page 109)
3. Carry out a ground conductor check for the entire robot system in accordance with DIN EN 60204-1.

8.6 Connecting the robot controller to the power supply

Procedure

- Connect the robot controller to the power supply via X1, XS1 or directly at the main switch. (>>> 6.5.1 "Power supply connection via X1 Harting connector" Page 102) (>>> 6.5.2 "Power supply connection via CEE connector XS1" Page 102)

8.7 Reversing the battery discharge protection measures

Description

To prevent the batteries from discharging before the controller has been started up for the first time, the robot controller is supplied with connector X7 disconnected from the KPS600.

Procedure

- Plug connector X7 (1) into the KPS600.

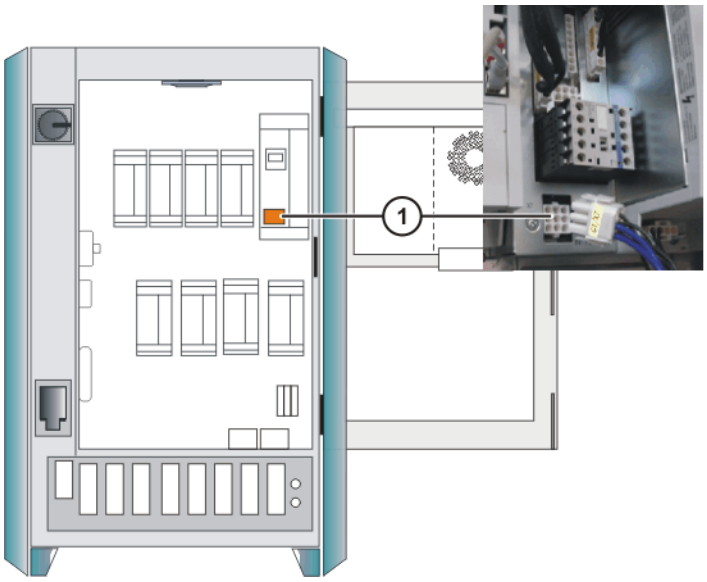

Fig. 8-2: Reversing the battery discharge protection measures

8.8 Connecting the EMERGENCY STOP circuit and safeguard

Procedure

1. Connect the EMERGENCY STOP circuit and safeguard (operator safety) to interface X11. (>>> 6.6 "EMERGENCY STOP circuit and safeguard" Page 102)

8.9 Configuring and connecting connector X11

Procedure

1. Configure connector X11 in accordance with the system and safety concepts. (>>> 6.7 "Interface X11" Page 105)
2. Connect interface connector X11 to the robot controller.

8.10 Switching on the robot controller

Preconditions

- The door of the robot controller is closed.
- All electrical connections are correct and the energy levels are within the specified limits.
- It must be ensured that no persons or objects are present within the danger zone of the robot.
- All safety devices and protective measures are complete and fully functional.
- The internal temperature of the cabinet must have adapted to the ambient temperature.

Procedure

1. Switch on the mains power to the robot controller.
2. Unlock the EMERGENCY STOP button on the KCP.
3. Switch on the main switch. The control PC begins to run up the operating system and the control software.

Information about operator control of the robot using the KCP can be found in the operating and programming instructions for the KUKA System Software (KSS).

8.11 Checking the direction of rotation of the external fan

Procedure

- Check outlet (2) on the rear of the robot controller.

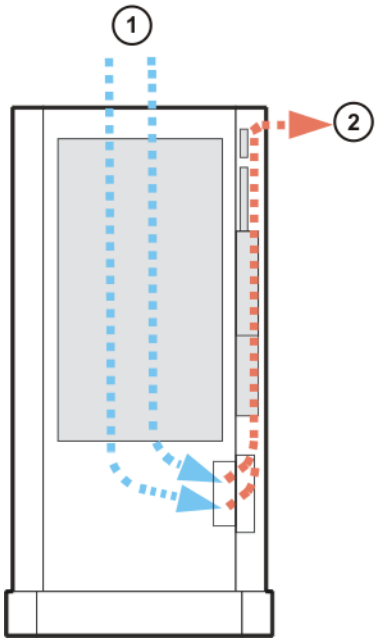

Fig. 8-3: Checking the direction of rotation of the fan

1 Air inlet 2 Air outlet

9 Operation

9.1 Display and operator control elements of the KCP coupler (optional)

Overview

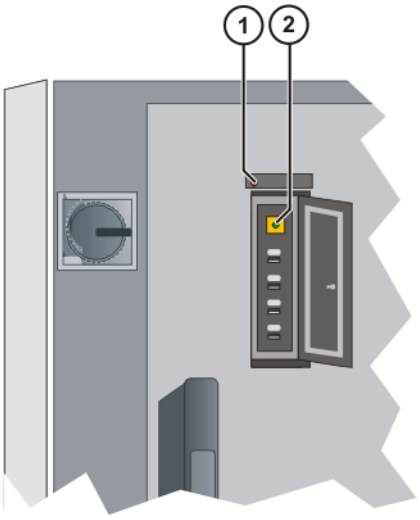

Fig. 9-1: KCP coupler LEDs and request button

1 Fault LED (red), KCP coupler
2 Request button with request LED (green)

9.1.1 Uncoupling the KCP

Procedure

1. Press the request button for at least 1 s.
   The green request LED flashes.
   The KCP is switched off (display goes dark).

Caution!
The KCP must not be disconnected without pressing the request button. If the KCP is disconnected without the request button being pressed, an EMERGENCY STOP is triggered.

2. Disconnect the KCP within 60 s.

Caution!
The KCP with EMERGENCY STOP is deactivated for the request time of 60 s. The EMERGENCY STOP on the KCP is not activated during this time.

3. Remove the KCP from the system.

Warning!
The operator must ensure that decoupled KCPs are immediately removed from the system and stored out of sight and reach of the robot system personnel. This serves to prevent operational and non-operational EMERGENCY STOP facilities from becoming interchanged.
Failure to observe this precaution may result in death, severe physical injuries or considerable damage to property.

9.1.2 Coupling the KCP

Precondition

- The KCP variant to be coupled must be the same as that which was uncoupled.

Procedure

1. Set the operating mode on the KCP to the same operating mode as on the robot controller (the operating mode display is application-specific (>>> 6.10 "Visualization of the KCP coupler (option)" Page 111)).

If the KCP is connected with the wrong operating mode selected, the robot controller switches to the operating mode set on the KCP.

2. Couple the KCP to the robot controller.
   The request LED flashes quickly.
   Once coupling has been completed, the request LED lights up and the KCP display shows the user interface. The robot controller can once again be operated via the KCP.

9.2 Booting the robot controller from a KUKA USB stick

Precondition

- Robot controller is switched off.
- External keyboard
- KCP is connected.

Caution!
If a KCP **and** an external keyboard are connected to the robot controller, the KCP must not be used and must be secured against unauthorized operation. The drives must be switched off and the danger zone must be secured. The external keyboard must be removed as soon as the start-up or maintenance work is completed.
Failure to observe this precaution may result in severe physical injuries or considerable damage to property.

Procedure

1. Connect bootable KUKA USB stick.
2. Switch on the robot controller.
3. Press F10 during the boot procedure.

10 Maintenance

Wartungssymbole

	Ölwechsel
	Schmieren mit Fettpresse
	Schmieren mit Pinsel
	Schraube, Mutter festdrehen
	Bauteil prüfen, Sichtkontrolle
	Bauteil reinigen
	Batterie/Akku tauschen

Description

Maintenance work must be performed at the specified maintenance intervals after commissioning by the customer.

Precondition

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- The power cable is de-energized.
- Observe the ESD guidelines.

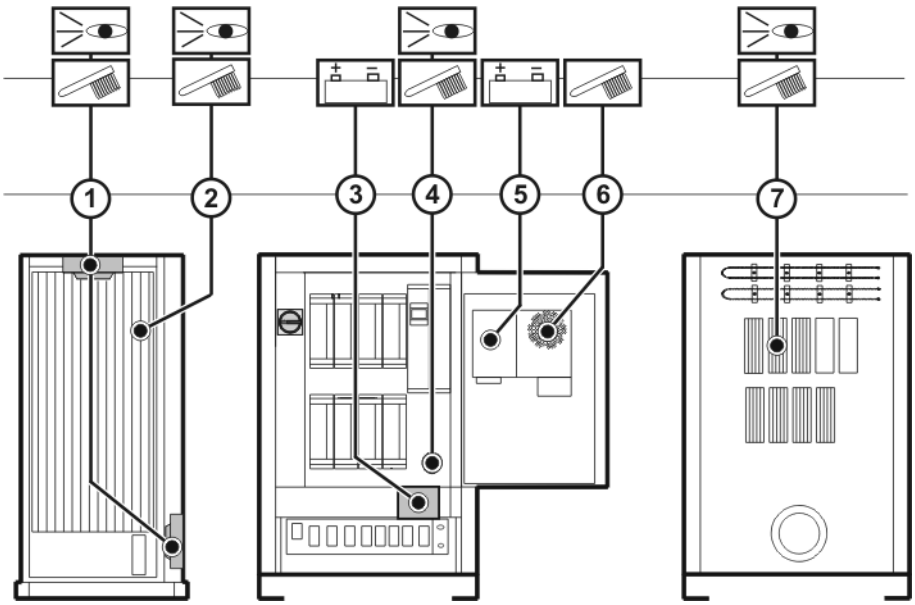

Fig. 10-1: Maintenance points

Interval	Item	Activity
2 years at the latest	1	Depending on installation conditions and degree of fouling, clean the internal and external fans with a brush
	2	Depending on installation conditions and degree of fouling, clean the heat exchanger with a brush
	7	Clean heat sink with brush and check that it is securely fastened
2 years	3	Exchange the batteries (>>> 11.16 "Exchanging the batteries" Page 145)
5 years	5	Exchange the motherboard battery (>>> 11.6 "Exchanging the motherboard battery" Page 135)
5 years (with 3-shift operation)	6	Exchange the control PC fans (>>> 11.5 "Exchanging the PC fans" Page 134)
	1	Exchange the internal and external fans (>>> 11.2 "Exchanging the internal fan" Page 132) (>>> 11.3 "Exchanging the external fan" Page 133)
In the case of discoloration of the pressure relief plug	4	Depends on installation conditions and degree of fouling. Visual inspection of the pressure relief plug: change filter insert if discolored (original color: white) (>>> 11.21 "Exchanging the pressure relief plug" Page 149)

Once an activity from the maintenance list has been carried out, a visual inspection must be made, with special attention to the following points:

- Check that fuses, contactors, plug-in connections and boards are fitted securely.
- Check PE equipotential bonding connection.
- Check cabling for damage.

10.1 Cleaning the robot controller

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Work regulations

- The manufacturer's instructions must be observed when using cleaning agents for cleaning work.
- It must be ensured that no cleaning agents enter electrical components.
- Do not use compressed air during cleaning work.
- Do not spray with water.

Procedure

1. Loosen and vacuum up any dust deposits.
2. Clean robot controller with a cloth soaked with a mild cleaning agent.
3. Clean cables, plastic parts and hoses with a solvent-free cleaning agent.
4. Replace damaged, illegible or missing inscriptions, labels and plates.

11 Repair

11.1 Wiring example X11

Connector X11 is a Harting connector with a male insert, type Han 108DD, housing size 24B.

Connector pin allocation

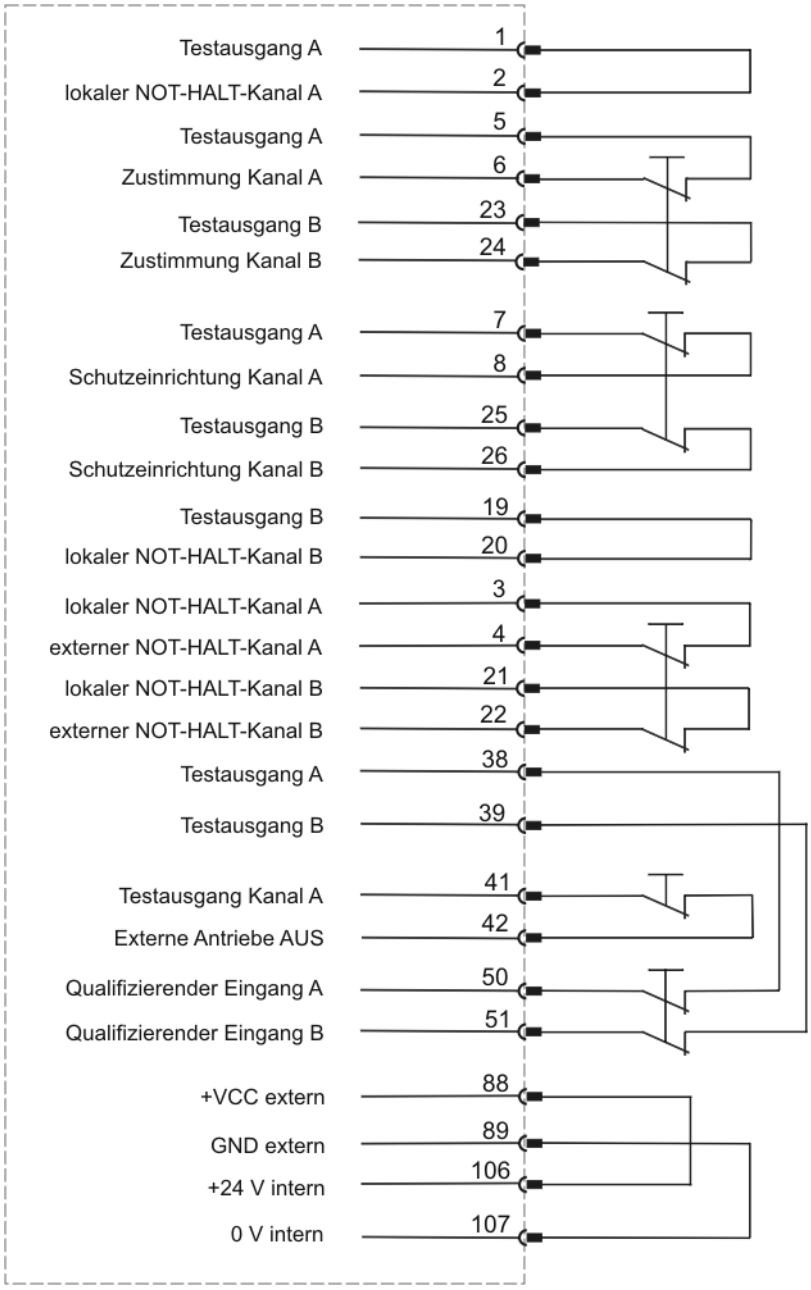

Fig. 11-1: Wiring example X11

Caution!
If wiring example X11 is used for start-up or troubleshooting, the connected safety components of the robot system are disabled.

11.2 Exchanging the internal fan

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Remove the domed cap nuts and the lock nuts underneath them from the fan plate.
3. Tilt the fan plate downwards together with the fan.
4. Unplug the fan connector.

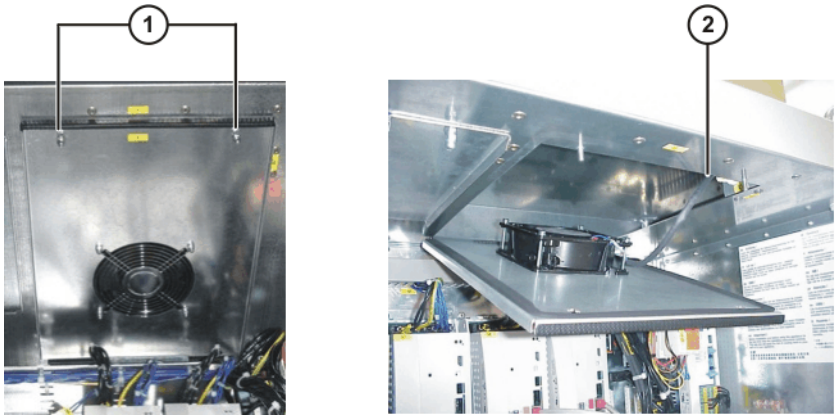

Fig. 11-2: Exchanging the internal fan

1 Domed cap nuts and lock nuts 2 Fan connector

5. Pull the fan plate forwards to remove it.
6. Note the fan installation position (direction of rotation).
7. Unscrew the fan from the mounting.
8. Screw on the new fan. Observe correct installation position (direction of rotation).
9. Insert the tab end of the fan plate into the slot.

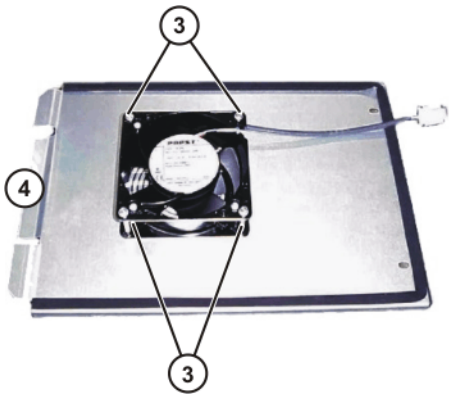

Fig. 11-3

3 Fan fastening screws 4 Tab end

10. Plug in the fan connector.
11. Swing the fan plate up into place and fasten it with new lock nuts.
12. Screw on the domed cap nuts.

11.3 Exchanging the external fan

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Remove the transport safeguard and slacken the fastening screws on the rear panel.
2. Take off the rear panel.
3. Unscrew the screws of the cable inlet.
4. Unplug the fan connector.
5. Remove the screws from the fan holder.
6. Take off the fan with the holder.
7. Install the new fan.
8. Plug in the fan connector and fasten the cable.
9. Mount the rear cabinet panel and fasten.

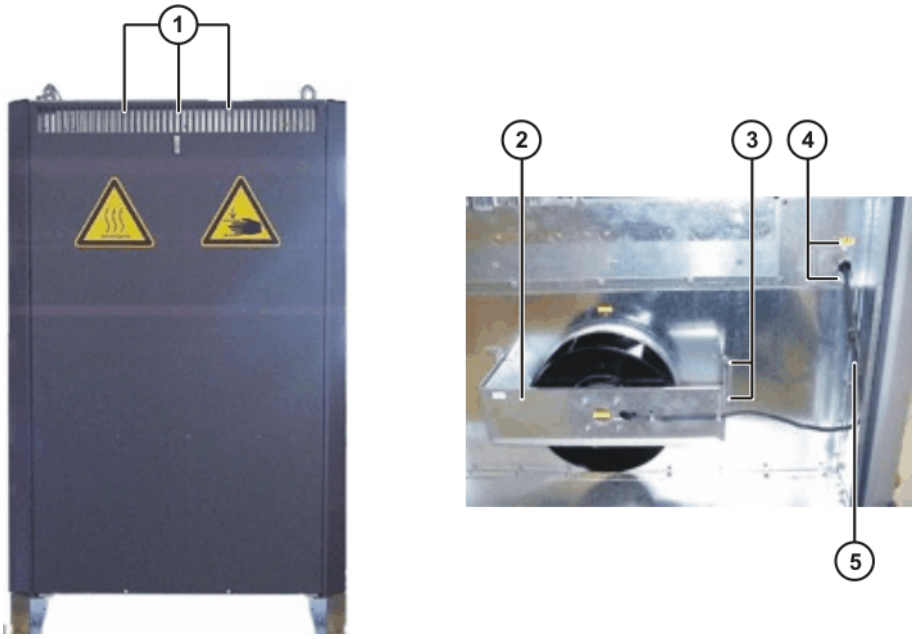

Fig. 11-4: Exchanging the external fan

1	Fastening screws and transport safeguard	4	Cable inlet
2	Holder with fan	5	Cable to fan connector
3	Fan holder fastening		

11.4 Removal, installation of the control PC

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Unplug the power supply and all connections to the control PC interface.
3. Remove the transport safeguard screw.
4. Slacken the knurled nuts.
5. Remove the control PC and lift it out towards the top.
6. Insert the new control PC and fasten.
7. Plug in the connections.

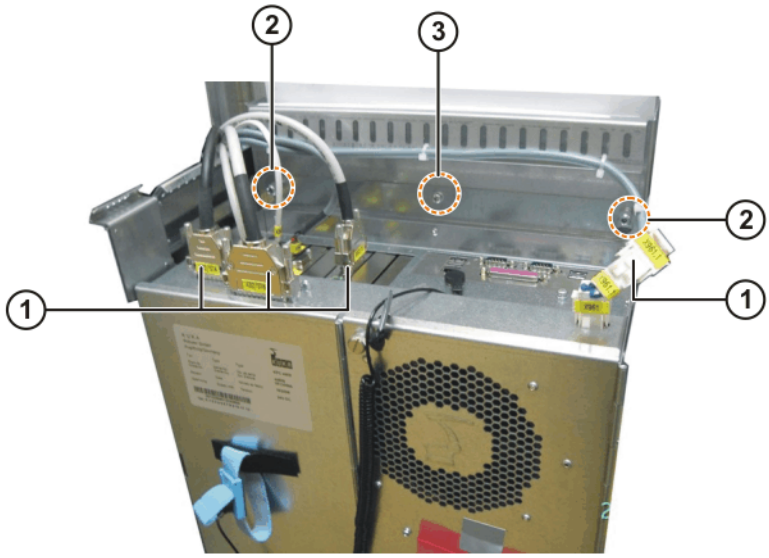

Fig. 11-5: Exchanging the control PC

1	Control PC connections
2	Knurled nut
3	Transport safeguard screw

11.5 Exchanging the PC fans

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Remove the cable strap.
2. Unplug the fan connector.
3. Note the fan installation position (direction of rotation).
4. Remove the fan retaining screws.
5. Take off the fan with the fan grille.
6. Insert the new fan and fasten. Observe correct installation position (direction of rotation).
7. Plug in the fan connector and secure the cables with cable straps.

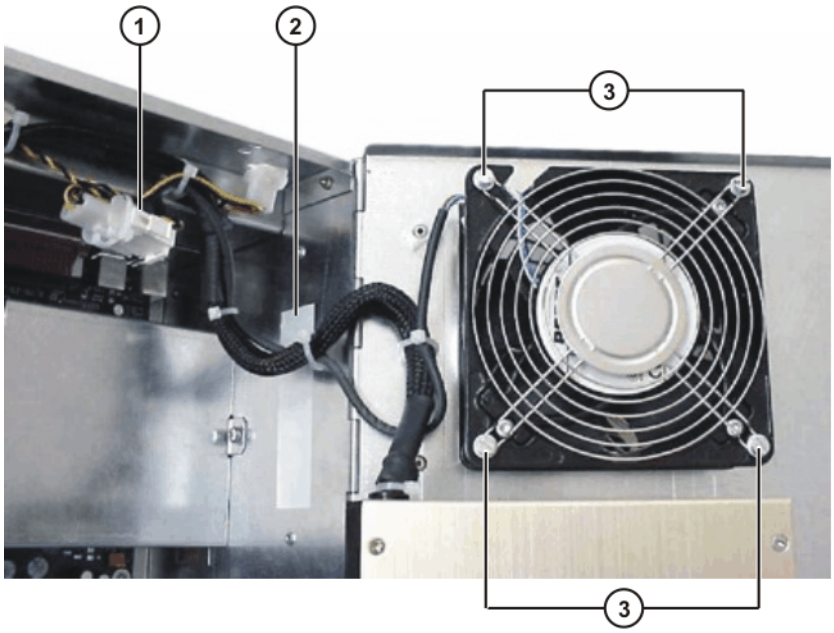

Fig. 11-6: Exchanging the PC fan

1	Fan connector	3	Fan fastening screws
2	Cable strap		

11.6 Exchanging the motherboard battery

The battery on the motherboard of the control PC may only be exchanged by authorized maintenance personnel in consultation with the KUKA customer support service.

11.7 Exchanging the motherboard

A defective motherboard is not exchanged separately, but together with the control PC.

11.8 Exchanging DIMM memory modules

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the PC cover.
2. Using your thumbs, carefully open the side tabs in the direction indicated by the arrows. The DIMM memory module is released and lifted out of its socket.
3. Press the new DIMM memory module into the slot in the DIMM socket until it clicks into position.

There are two asymmetrically positioned recesses on the underside of the DIMM memory modules; these must mate with the coding on the DIMM socket.

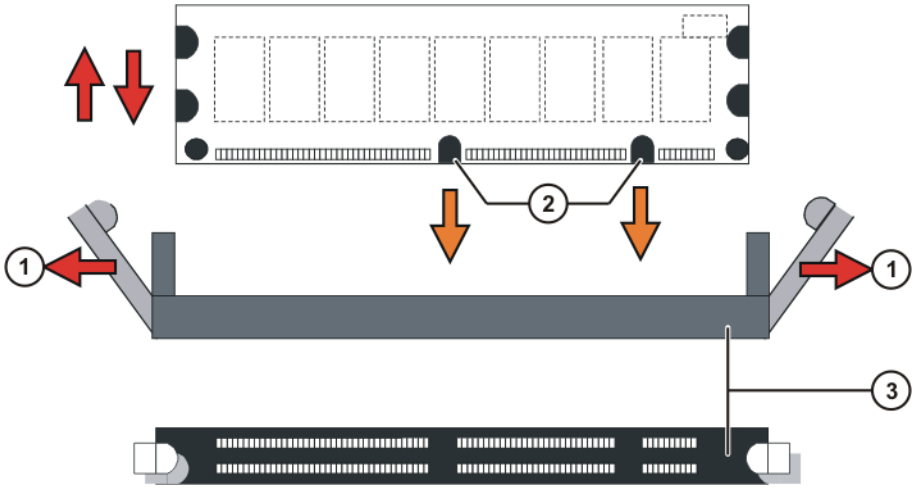

Fig. 11-7: Exchanging DIMM memory modules

1	Side tabs	3	DIMM memory module socket
2	Asymmetrically positioned recesses		

11.9 Exchanging the KVGA card

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Open the PC chassis.
3. Unplug the connections to the KVGA card.
4. Release the fastenings of the card and pull the card out of the slot.

5. Check the new card for mechanical damage, insert it into the slot and tighten the fastening screws.
6. Plug in the connections to the card.

11.9.1 KVGA card settings

Precondition

- User group “Expert”
- Windows interface (CTRL+ESC)

Procedure

1. Select the menu sequence **Control Panel > Display > Properties > System Settings > Extended > Chips**.
2. The following options are offered in the “Display Device” window:
   - CRT (external monitor)
   - LCD (KCP operation)
   - BOTH (both display options)

The graphics card driver file is “Chips XPm.sys”.

11.10 Exchanging the MFC3 card

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Open the PC chassis.
3. Unplug the connections to the MFC3 and DSE-IBS-C33.
4. Release the fastenings of the card and pull the card out of the slot.
5. Unscrew the DSE-IBS-C33 from the MFC3 and unplug it.
6. Inspect the new MFC3 for mechanical damage. Plug on the DSE-IBS-C33 and screw it down.
7. Plug the MFC3 into its slot and tighten the fastening screws.
8. Plug in the connections to the card.

11.11 Exchanging the DSE-IBS-C33 card

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Open the PC chassis.
3. Unplug the connections to the MFC3 and DSE-IBS-C33.
4. Release the fastenings of the MFC3 card and pull the card out of the slot.
5. Unscrew the DSE-IBS-C33 from the MFC3 and unplug it.
6. Plug on the new DSE-IBS-C33 and screw it down.
7. Plug the MFC3 into its slot and tighten the fastening screws.
8. Plug in the connections to the card.
9. Switch on the robot controller and let it run up.
10. After initialization, the LED on the DSE-IBS-C33 should flash.

11.12 Exchanging the hard drive

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Open the PC chassis.
3. Release the retaining clip of the hard drive.
4. Disconnect the interface and power supply cables.
5. Exchange the hard drive for a new one.
6. Connect the interface and power supply cables.
7. Place the hard drive on the holder and fasten it with the retaining clip.
8. Close the PC housing and the control cabinet door.
9. Install the operating system and the KUKA System Software (KSS).

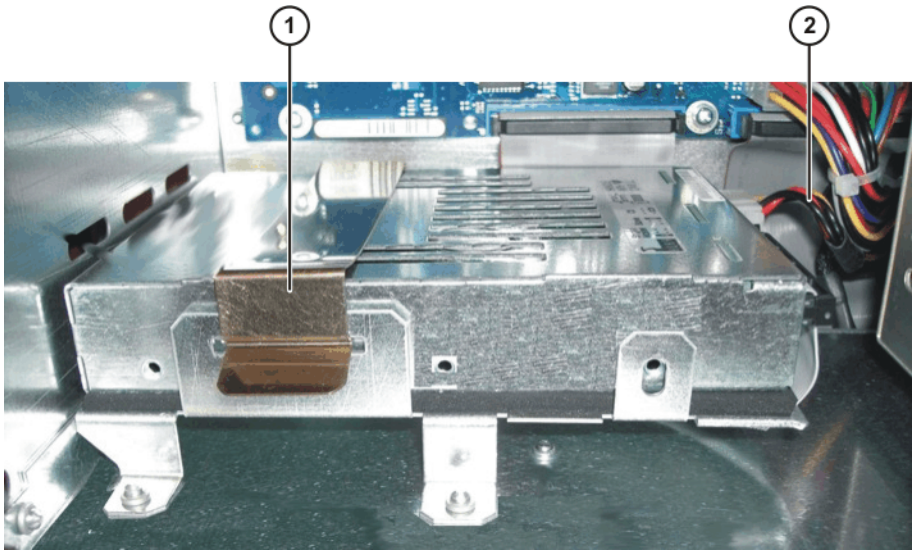

Fig. 11-8: Exchanging the hard drive

1	Retaining clip	2	Interface and power supply cables

11.13 Exchanging the CI3 board

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Disconnect connections to the CI3 board.
3. Remove the screw on the fastening plate and pull the plate out from the tab slots.
4. Check the new card for mechanical damage. Insert the fastening plate with the CI3 board into the tab slots and screw firmly in place.
5. Plug in the connections to the card.

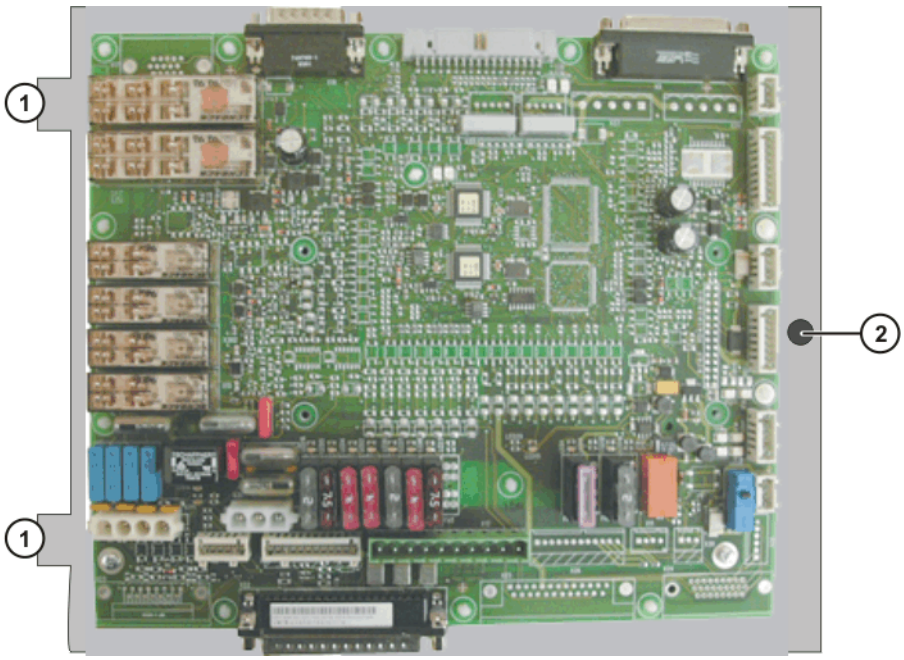

Fig. 11-9: Removal and installation of C13 board

1 Tabs
2 Fastening screw

11.14 Exchanging the RDC board

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Unscrew the screws on the lid of the RDC box.

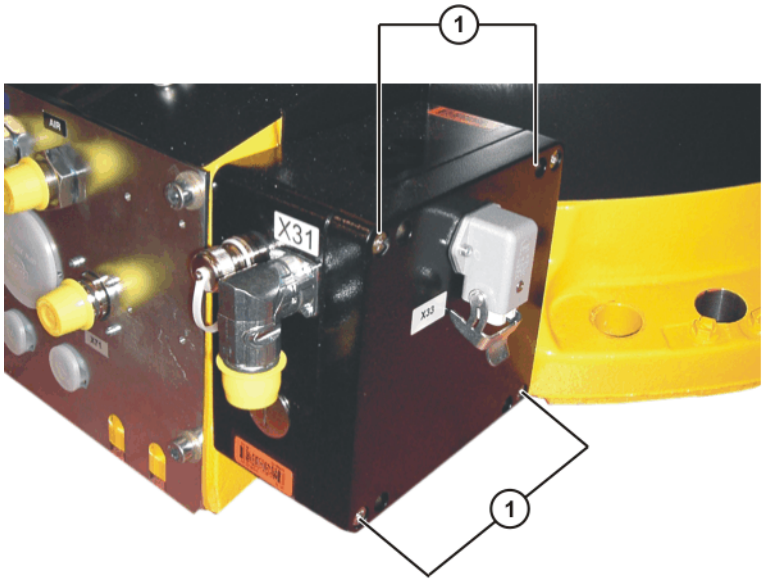

Fig. 11-10: Example: opening the RDC box cover with X33

1 Fastening screws on the lid

2. Carefully open the lid of the RDC box to one side.
3. Carefully disconnect all cables. Pull the cables out of the RDC box, if possible, or bend them out of the way to the sides.
4. Loosen and remove the fastening screws of the RDC board.

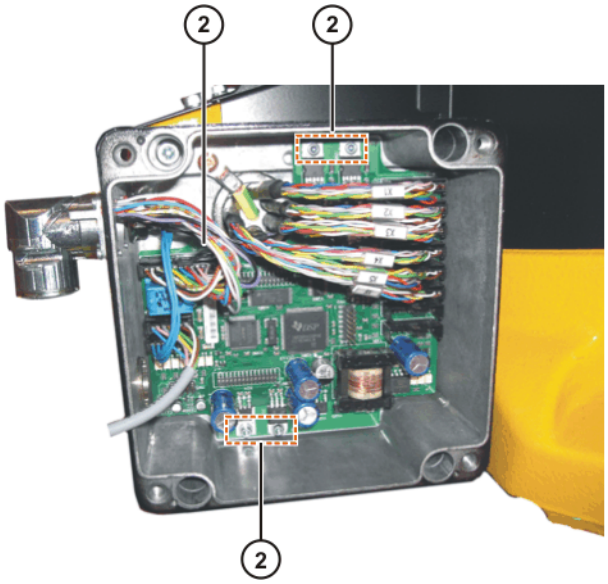

Fig. 11-11: RDC fastening

2 Fastening screws of the RDC board

5. Carefully pull the RDC board out of the RDC box without tilting it.
6. Insert and fasten the new RDC board.
7. Connect all cables.
8. Close cover of RDC box and screw it firmly in place.

11.14.1 Exchanging the force sensor card for RDC

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Remove RDC board. (>>> 11.14 "Exchanging the RDC board" Page 139)
2. Remove the fastening screws of the force sensor card.

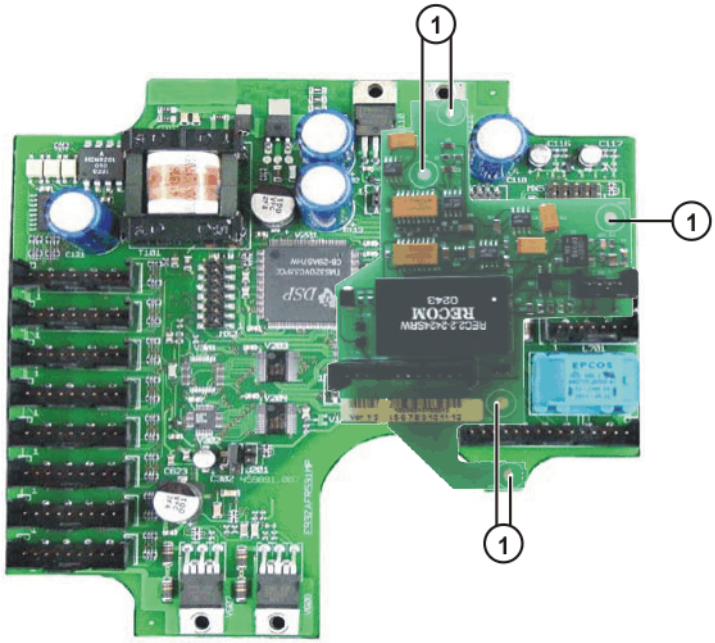

Fig. 11-12: Exchanging the force sensor card

1 Force sensor card fastening

3. Remove the force sensor card from the RDC board.
4. Plug the new force sensor card onto the RDC board and fasten it.
5. Install RDC board.

11.15 Exchanging the SafeRDC board

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Unscrew the 4 screws on the lid of the SafeRDC box. (>>> Fig. 11-13)

2. Carefully open the lid of the SafeRDC box to one side.
3. Carefully disconnect all cables. Pull the cables out of the SafeRDC box, if possible, or bend them out of the way to the sides.
4. Loosen and remove the 6 fastening screws of the SafeRDC board. (>>> Fig. 11-14)
5. Carefully pull the SafeRDC board out of the SafeRDC box without tilting it.
6. Insert and fasten the new SafeRDC board. (>>> Fig. 11-14)

Caution!
If the fastening screws are screwed in too tightly, this can damage the thread, resulting in material damage. Screw in the M4 fastening screws all the way to the stop without exerting major force.

7. Connect all cables.
8. Close the cover of the SafeRDC box and screw it firmly in place. (>>> Fig. 11-13)
9. Switch on the robot controller and let it run up.
10. Accept the safety parameters with the correct robot-specific ID.

Description

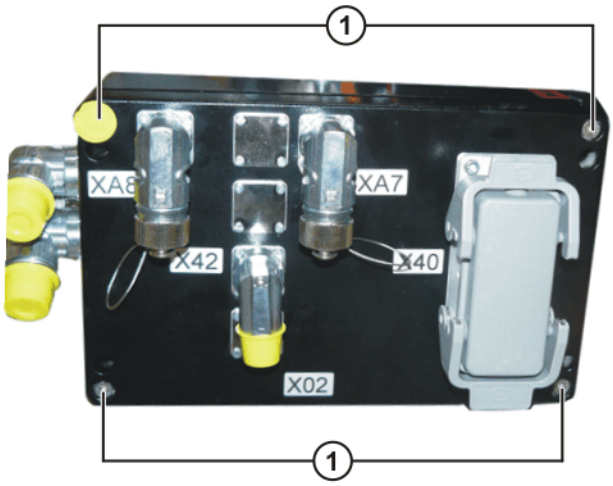

Fig. 11-13: SafeRDC box lid fastening

1 Fastening screws on the lid

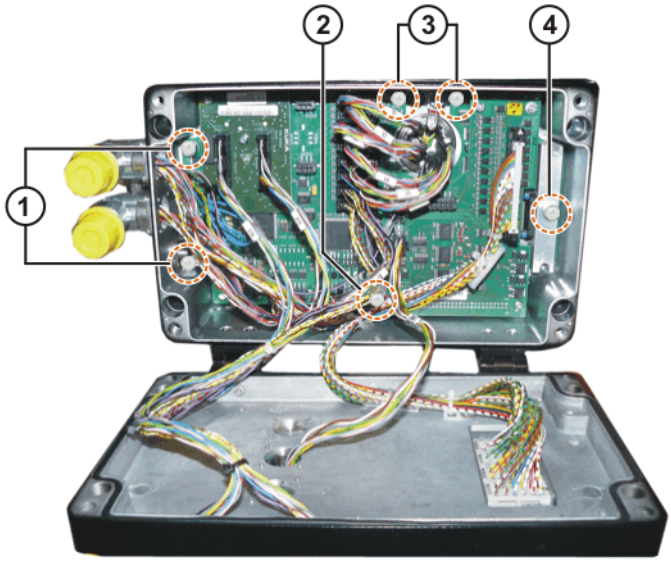

Fig. 11-14: Exchanging the SafeRDC board

1 2 Allen screws M6x10 8.8 with lock washers
Tightening torque M_A = 6.0 Nm

2 Plastic screw M4x6

3 2 Allen screws M4x8 8.8 with lock washers
Tightening torque M_A = 1.5 Nm

4 Allen screw M6x30 8.8 with lock washers
Tightening torque M_A = 6.0 Nm

11.15.1 Exchanging the force sensor card for SafeRDC

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Remove SafeRDC board.
   (>>> 11.15 "Exchanging the SafeRDC board" Page 141)
2. Remove the hexagon screws of the force sensor card. (>>> Fig. 11-15)
3. Remove the force sensor card from the SafeRDC board.
4. Plug the new force sensor card onto the SafeRDC board and fasten it.
5. Install SafeRDC board.
   (>>> 11.15 "Exchanging the SafeRDC board" Page 141)

Description

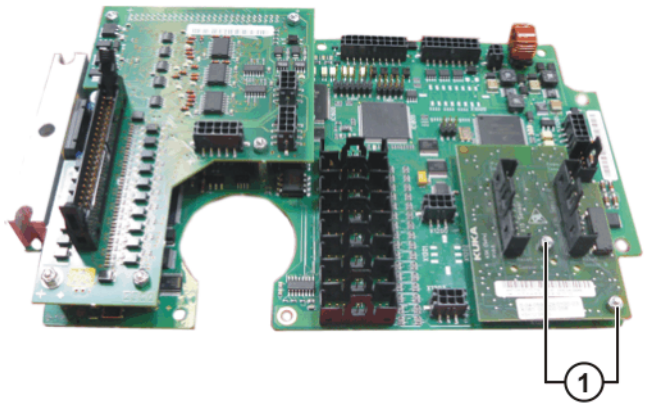

Fig. 11-15: Exchanging the force sensor card

1 Hexagon screws of the force sensor card

11.15.2 Exchanging the I/O Print board for SafeRDC

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Remove SafeRDC board.
   (>>> 11.15 "Exchanging the SafeRDC board" Page 141)
2. Remove hexagon nuts on the I/O Print board. (>>> Fig. 11-16)
3. Remove the I/O Print board from the SafeRDC board.
4. Plug the new I/O Print board onto the SafeRDC board and fasten it with hexagon screws. Tightening torque M_A=0.9 Nm
5. Install SafeRDC board.
   (>>> 11.15 "Exchanging the SafeRDC board" Page 141)

Description

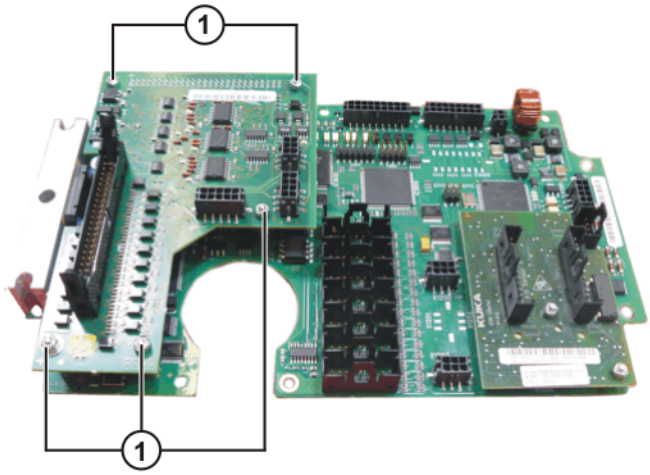

Fig. 11-16: Exchanging the I/O Print board

1 Hexagon nuts on the I/O Print board

11.16 Exchanging the batteries

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- The controller has been shut down.

Procedure

1. Open the cabinet door.
2. Unplug the battery connection cables.
3. Press the spring clamp (1) to the left.
4. Take out both battery blocks.

Always exchange both battery blocks.

5. Insert the new battery blocks and lock them in place with the spring clamp.
6. Plug in the battery connection cables.

Caution!
Observe the battery polarity as shown in (>>> Fig. 11-17). Installing the batteries in the wrong position or with reversed polarity can damage the batteries, the KPS600 and the low-voltage power supply unit.

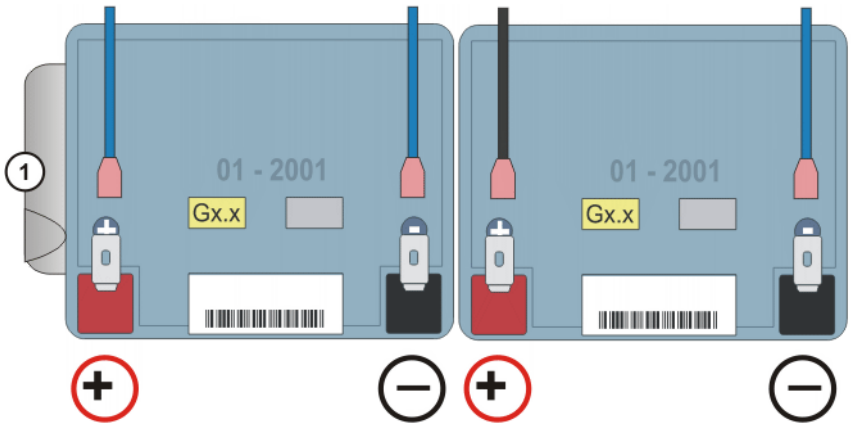

Fig. 11-17: Battery connection example

1 Spring clamp

Caution!
To prevent exhaustive discharge and thus destruction of the batteries, the batteries must be recharged at regular intervals according to the storage temperature.
If the storage temperature is +20 °C or lower, the batteries must be recharged every 9 months.
If the storage temperature is between +20 °C and +30 °C, the batteries must be recharged every 6 months.
If the storage temperature is between +30 °C and +40 °C, the batteries must be recharged every 3 months.

11.17 Exchanging the KPS600

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.
- Wait 5 minutes until the intermediate circuit has discharged.

Warning!
The following components may remain energized (50...600 V) up to 5 minutes after the robot controller has been switched off:

- KPS600
- KSDs
- Intermediate circuit connecting cables

Procedure

1. Open the control cabinet door.
2. Unplug all connections to the KPS600.
3. Slacken the Allen screws.
4. Lift the KPS600 slightly, tip the top forwards and lift the KPS600 out of the holder.
5. Insert the new KPS600 into the lower holder, hook it on at the top and tighten the fastening screws.
6. Plug in all the connections.

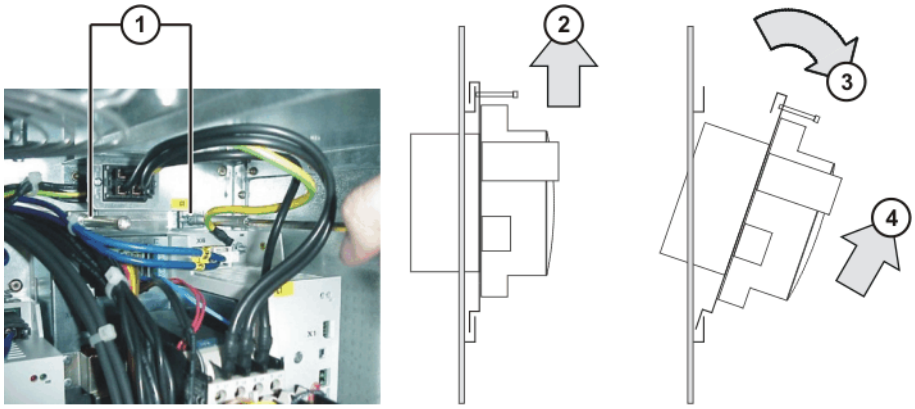

Fig. 11-18: Exchanging the KPS600

1	Allen screws	3	Tip the KPS600 forwards
2	Lift the KPS600	4	Lift the KPS600 out of the holder

11.18 Exchanging the KSD

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.
- Wait 5 minutes until the intermediate circuit has discharged.

Warning!
The following components may remain energized (50...600 V) up to 5 minutes after the robot controller has been switched off:

- KPS600
- KSDs
- Intermediate circuit connecting cables

Procedure

1. Open the control cabinet door.
2. Unplug the KSD connections.
3. Lift the upper retaining clip with a screwdriver until the locking devices are free. Tilt the top of the KSD slightly forwards, so that the retaining clip cannot snap back into the locking device.
4. Lift the lower retaining clip and remove the KSD by pulling it in the direction of the door opening.
5. Insert the new KSD evenly and straight into the opening until the upper and lower retaining clips snap in.
6. Plug in all connectors.

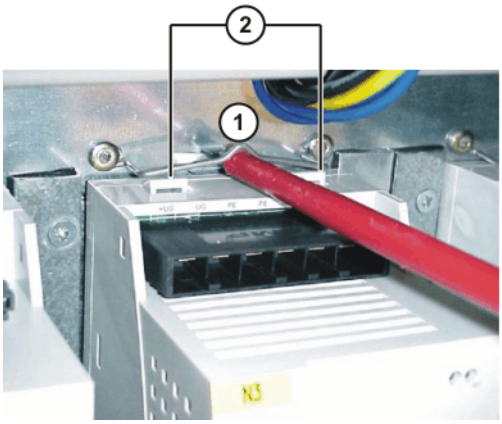

Fig. 11-19: Exchanging the KSD

1	Retaining clip	2	Locking device

11.19 Exchanging the KPS-27

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- The controller has been shut down.

Procedure

1. Disconnect the mains supply and outgoing cables.
2. Remove the knurled screw.
3. Pull the mounting plate with the KPS-27 to the left out of the holders.
4. Remove the fastening screws of the KPS-27 from the rear of the mounting plate.
5. Screw the new KPS-27 onto the mounting plate.
6. Push the right-hand side of the mounting plate into the holders and fasten it with the knurled screw.
7. Connect the mains supply and outgoing cables.

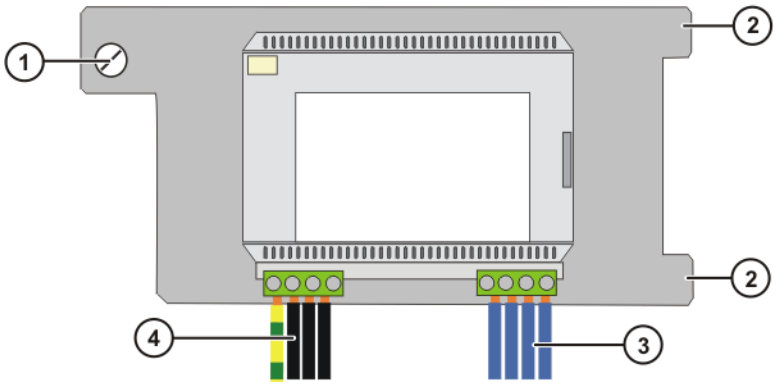

Fig. 11-20: Removal and installation of KPS-27

1	Knurled screw	3	Output terminal
2	Holders	4	Mains terminal

11.20 Exchanging the KCP coupler card

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Unplug all connectors on the KCP coupler card.
3. Remove the fastening screws.

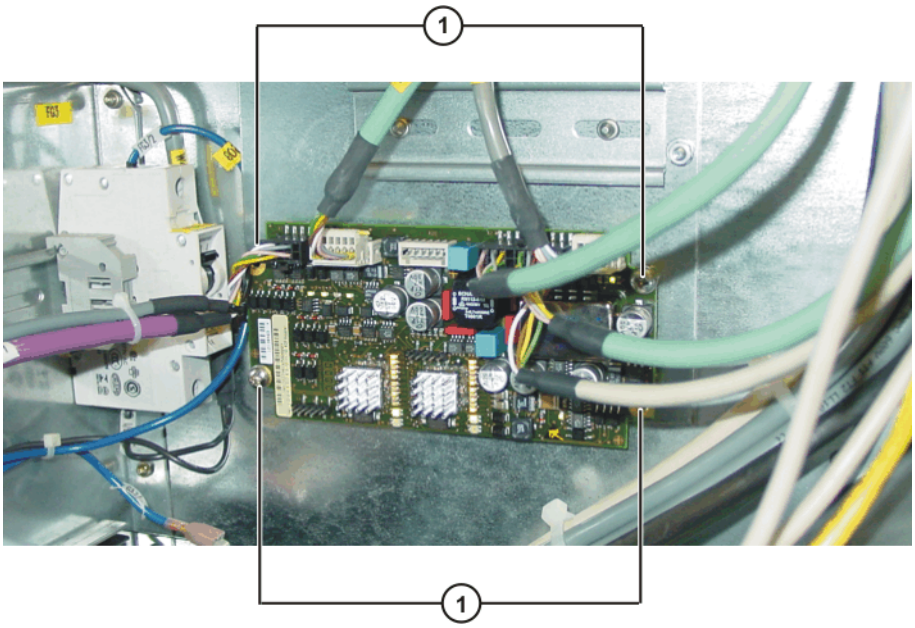

Fig. 11-21: Exchanging the KCP coupler card

1 Fastening screws

4. Install and fasten the new KCP coupler card.
5. Plug in all connectors.

Warning!
When the robot controller is first booted, the KCP variant connected must be the same as the one that was uncoupled and the correct operating mode must be set. If a different KCP variant is connected, this can result in malfunctions of the robot controller.

11.21 Exchanging the pressure relief plug

Description

The pressure relief plug is used to generate an overpressure inside the cabinet. This prevents excessive fouling of the cabinet.

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Remove the foam ring.
3. Exchange the filter insert.
4. Insert the foam ring so that it is flush with the pressure relief plug.

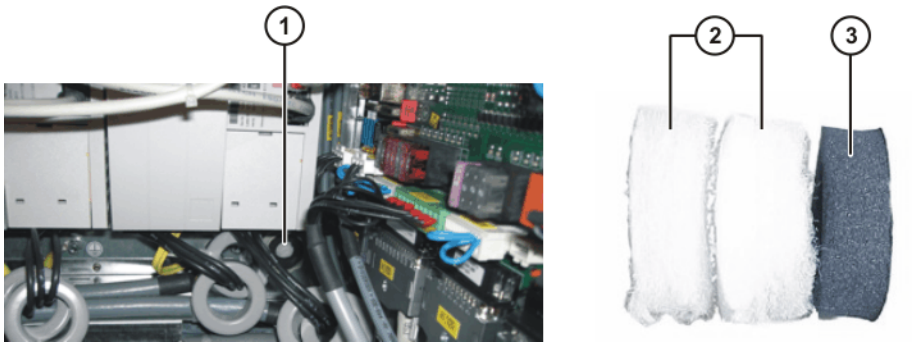

Fig. 11-22: Exchanging the pressure relief plug

1	Pressure relief plug	3	Foam ring
2	Filter insert		

11.22 Installing the KUKA System Software (KSS)

Further information is contained in the operating and programming instructions for the KUKA System Software (KSS).

12 Troubleshooting

12.1 Repair and procurement of spare parts

Repair

Repairs to the robot controller may only be carried out by KUKA customer support personnel or by customers who have taken part in a relevant course of training held by KUKA Roboter GmbH.

Repairs within modules may only be carried out by specially trained KUKA Roboter GmbH personnel.

Procurement of spare parts

The article numbers for spare parts are listed in the spare parts catalog on a CD-ROM that accompanies every robot controller.

KUKA Roboter GmbH supplies the following types of spare parts for repairs to the robot controller:

- New parts

  Once the new part has been installed, the part that has been removed can be disposed of.
- Exchange parts

  Once the exchange part has been installed, the part that has been removed is returned to KUKA Roboter GmbH.

A “Robot Repair Card” is supplied with the exchange parts. The Repair Card must be completed and returned to KUKA Roboter GmbH.

12.2 Control PC errors

Effects	Causes	Remedy
■ Control PC does not boot ■ Display is dark	Power supply defective	Disconnect all devices one by one from the power supply unit (motherboard must remain plugged in). Switch on the control PC and measure output voltages at the power supply unit. Exchange the defective control PC.
	Short circuit on the motherboard	
	Short circuit on a connected device	
■ Control PC does not boot ■ Display is dark	Defective PC card (Interbus, MFC3, KVGA)	Disconnect PC cards (Interbus, Ethernet card) and test system again; replace cards if necessary.
	Memory modules (RAM modules) not correctly snapped into place (contact fault)	Remove memory modules in the switched-off system state and reconnect them.
	Memory modules defective	Exchange memory modules
	Defective motherboard	Exchange the control PC
■ Control PC boots up as normal ■ Display is dark	KVGA defective	Exchange KVGA
	Cable break in KCP connecting cable	Exchanging the KCP connecting cable
■ System crash when booting ■ No keyboard input possible	Defective motherboard	Exchange the control PC

Effects	Causes	Remedy
The system repeatedly resets itself (reboot).	Memory modules defective	Exchange memory modules
	KVGA defective	Exchange KVGA
	KSD defective	Exchange the KSD
BIOS error message “CMOS Checksum Error”	Undervoltage in lithium battery on the motherboard	Exchange lithium battery
	CMOS memory on mother-board defective	Exchange the control PC
BIOS error message “MEM-ORY TEST FAILED”	Memory module defective	Exchange memory module
Cannot boot from hard disk	BIOS fails to detect hard drive	Load KUKA default settings
	IDE cable incorrectly con-nected	Check IDE cable
	Power supply not correctly connected	Check the connector
	Hard drive defective	Exchange the hard drive Install the software
	Defective motherboard	Exchange the control PC
Windows operating system crashes with exceptional error (blue screen on the KCP)	Memory module defective	Exchange memory module
	Defective or lost sectors	Re-install the software
Controller hangs when loading software components	MFC3 board not correctly con-nected	Check that the MFC3 board connector is fitted securely.
	MFC3 board defective	Exchange MFC3 board
	Additional PC card defective (e.g. Interbus)	Remove PC card and run con-troller up again. Exchange PC card
	Motherboard defective	Exchange the PC
KUKA.GUI does not boot, and is aborted with a General Pro-tection fault	Defective files in the software installation	Reinstall control software
	Settings in CMOS setup incor-rect	Check settings in CMOS setup
	Memory module defective	Exchange memory module

12.3 MFC3 errors

Effects	Causes	Remedy
Controller hangs when loading software components	MFC cannot be initialized	Remove PC cards and run the PC up again
	MFC3 incorrectly connected	Check MFC3 slot
	PCI bus on motherboard faulty	Exchange the control PC.
KCP control panel does not work	CAN controller on the MFC defective	Exchange the MFC3
	KCP defective	Replace KCP
Display is dark	Power supply to connector X5 for KCP missing	Check power supply
	KCP cable or connector faulty	Replace KCP
	KVGA card defective	Exchange KVGA card
	Defective motherboard	Exchange the control PC.

Effects	Causes	Remedy
Operating mode switchover on KCP does not react	Operating mode detection on MFC3 defective	Exchange the MFC3
	Mode selector switch on the KCP defective	Replace KCP
When PC is booted, the operating system VxWorks does not run up	MFC3 defective	Exchange the MFC3

12.4 Field bus communication errors

Effects	Causes	Remedy
Communication via diagnostic interface not possible	Data cable, periphery faulty	Check data cable, periphery
	Diagnostic interface on field bus card defective	Exchange field bus card
Error message “xxxxx I/O driver configuration error”	Field bus card incorrectly configured	Check the configuration
	Field bus card cannot be initialized	Exchange field bus card
	Incorrect configuration of the file IOSYS.INI	Check entries in IOSYS.INI
After inserting the field bus card: no display, controller does not boot (Stop 0)	Field bus card defective	Exchange field bus card
The controller “hangs” after initialization of the field bus card	Field bus card defective	Exchange field bus card
No external power supply for slave when controller switched off	External power supply input on IBS card defective	Exchange Interbus card

12.5 Checking the KCP

Procedure

1. Display
   - Use the softkeys on the right edge to adjust the brightness and contrast. If no changes are evident, check that the power cable is fitted securely in the switched-off system state (X19 on the robot controller).
2. ESC bus
   - Press EMERGENCY STOP button.

     A reaction must result in the message window.
   - Turn the keyswitch to all 4 positions.

     The respective position must be displayed in the KCP status window.
   - Press the 3-step enabling switch on the back of the KCP.

     Normal position: Intermediate circuit not charged, or is rapidly discharged via the ballast resistors after release of the first position; switch in normal position, the “I” in the KCP status window has a red background.

     First position: Intermediate circuit is charged, after approx. 4 s the “I” in the KCP status window has a green background.

     Panic position: Intermediate circuit is rapidly discharged, the “I” in the KCP status window has a red background.
   - Press the Drives ON/OFF buttons.
3. CAN bus

- Check the softkeys/menu keys.
- Check the keyboard.
  Switch the numbers to active using the NUM key.
- Check the special keys.
  Arrow keys, ESC key, Enter key, window selection key, etc.

4. Moving the robot
   - Switch to axis-specific jogging and tool coordinate system.
   - Press the enabling switch and move all 6 axes of the robot in the + and - directions.

12.6 Fuses and LED indicators on the CI3 board

12.6.1 CI3 Standard board

Overview

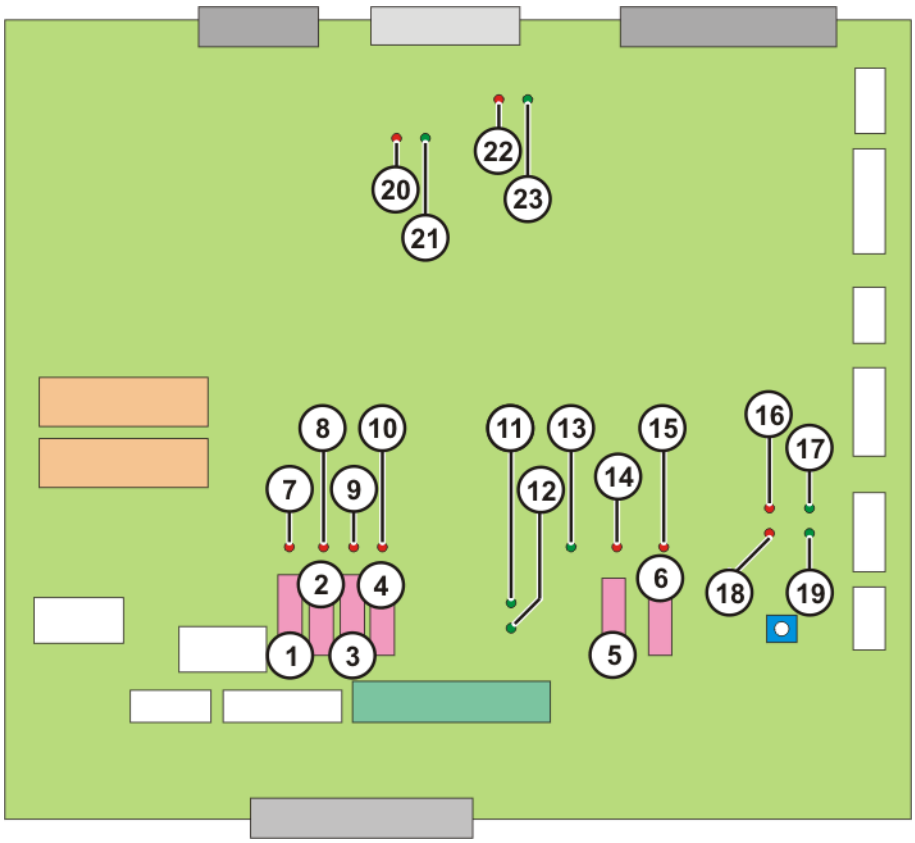

Fig. 12-1: CI3 Standard board fuses and LEDs

Fuses

Item	Designation	Value in A	Description
1	F2	2	24 V DC fan monitoring
2	F16	7.5	24 V DC interface VCC
3	F12	4	24 V DC interface VCC
4	F13	4	24 V DC interface VCC
5	F10	3	24 V DC VCC-ESC
6	F23	2	RDC supply

LEDs

Item	Designation	Description
7	LED16 (red)	Fuse monitoring for F2
8	LED5 (red)	Fuse monitoring for F16

Item	Designation	Description
9	LED4 (red)	Fuse monitoring for F12
10	LED2 (red)	Fuse monitoring for F13
11	LED14 (green)	24 V without battery back-up
12	LED9 (green)	24 V with battery back-up
13	LED15 (green)	5 V ESC nodes
14	LED1 (red)	Fuse monitoring for F10
15	LED12 (red)	Fuse monitoring for F23
16	LED18 (red)	ESC bus output KCP error
17	LED17 (green)	ESC bus output KCP OK
18	LED27 (red)	ESC bus output MFC error
19	LED28 (green)	ESC bus output MFC OK
20	LED22 (red)	ESC bus, local ESC node error
21	LED21 (green)	ESC bus, local ESC node OK
22	LED19 (red)	ESC bus KPS error
23	LED20 (green)	ESC bus KPS OK

12.6.2 CI3 Extended board

Overview

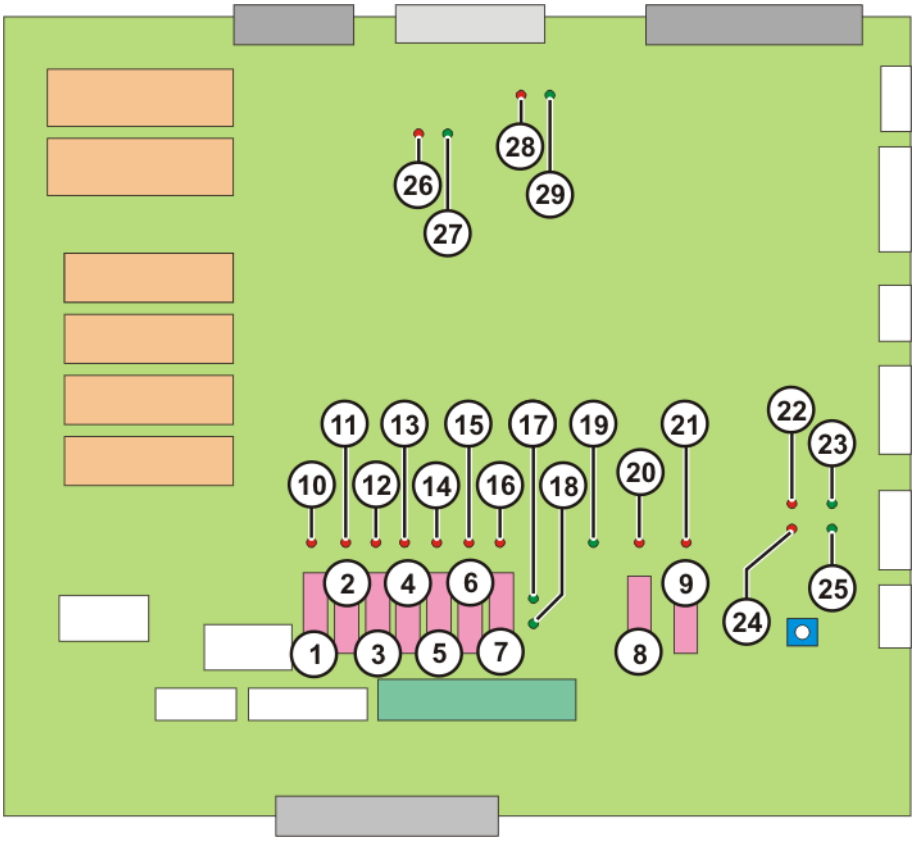

Fig. 12-2: CI3 Extended board fuses and LEDs

Fuses

Item	Designation	Value in A	Description
1	F2	2	24 V DC fan monitoring
2	F16	7.5	24 V DC interface VCC
3	F12	4	24 V DC interface VCC
4	F13	4	24 V DC interface VCC

Item	Designation	Value in A	Description
5	F1	2	24 V DC drives ON
6	F14	4	24 V DC drives ON
7	F15	7.5	24 V DC drives ON
8	F10	3	24 V DC VCC-ESC
9	F23	2	RDC supply

LEDs

Item	Designation	Description
10	LED16 (red)	Fuse monitoring for F2
11	LED5 (red)	Fuse monitoring for F16
12	LED4 (red)	Fuse monitoring for F12
13	LED2 (red)	Fuse monitoring for F13
14	LED6 (red)	Fuse monitoring for F1
15	LED7 (red)	Fuse monitoring for F14
16	LED8 (red)	Fuse monitoring for F15
17	LED14 (green)	24 V without battery back-up
18	LED9 (green)	24 V with battery back-up
19	LED15 (green)	5 V ESC nodes
20	LED1 (red)	Fuse monitoring for F10
21	LED12 (red)	Fuse monitoring for F23
22	LED18 (red)	ESC bus KCP error
23	LED17 (green)	ESC bus KCP OK
24	LED27 (red)	ESC bus MFC error
25	LED28 (green)	ESC bus MFC OK
26	LED22 (red)	ESC bus, local ESC node error
27	LED21 (green)	ESC bus, local ESC node OK
28	LED19 (red)	ESC bus KPS error
29	LED20 (green)	ESC bus KPS OK

12.6.3 CI3 Bus board

Overview

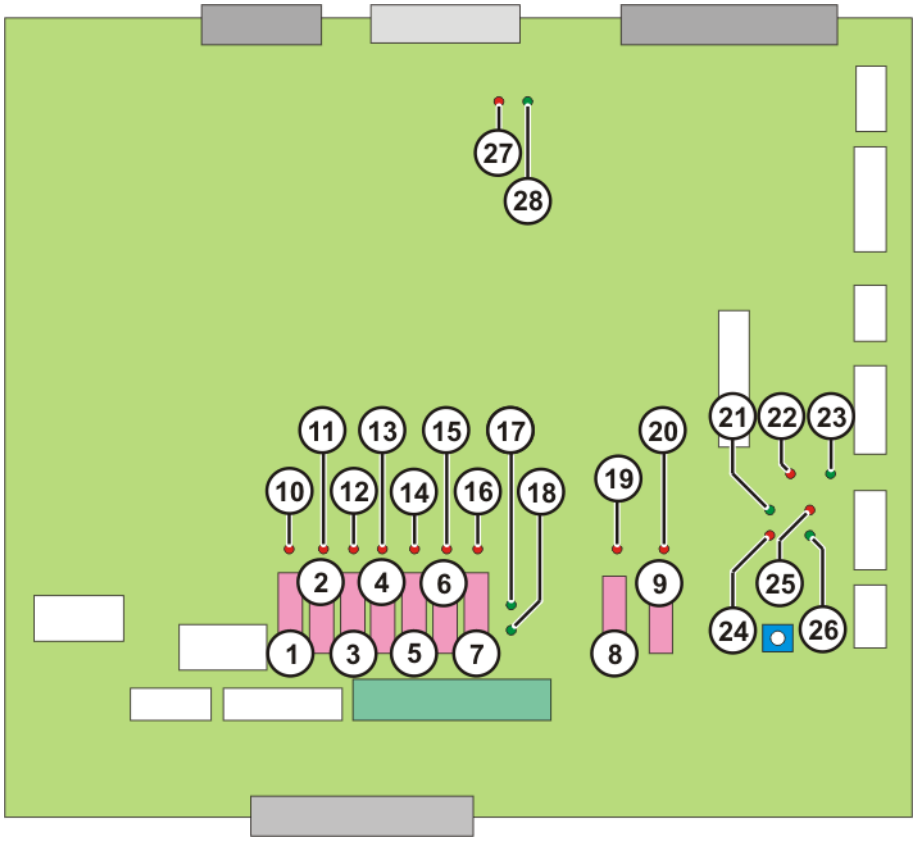

Fig. 12-3: CI3 Bus board fuses and LEDs

Fuses

Item	Designation	Value in A	Description
1	F2	2	24 V DC fan monitoring
2	F16	7.5	24 V DC interface VCC
3	F12	4	24 V DC interface VCC
4	F13	4	24 V DC interface VCC
5	F1	2	24 V DC drives ON
6	F14	4	24 V DC drives ON
7	F15	7.5	24 V DC drives ON
8	F10	3	24 V DC VCC-ESC
9	F23	2	RDC supply

LEDs

Item	Designation	Description
10	LED16 (red)	Fuse monitoring for F2
11	LED5 (red)	Fuse monitoring for F16
12	LED4 (red)	Fuse monitoring for F12
13	LED2 (red)	Fuse monitoring for F13
14	LED6 (red)	Fuse monitoring for F1
15	LED7 (red)	Fuse monitoring for F14
16	LED8 (red)	Fuse monitoring for F15
17	LED14 (green)	24 V without battery back-up
18	LED9 (green)	24 V with battery back-up
19	LED1 (red)	Fuse monitoring for F10
20	LED12 (red)	Fuse monitoring for F23

Item	Designation	Description
21	LED17 (green)	ESC bus KCP OK
22	LED23 (red)	ESC bus SafetyBUS Gateway error
23	LED24 (green)	ESC bus SafetyBUS Gateway OK
24	LED27 (red)	ESC bus MFC error
25	LED18 (red)	ESC bus KCP error
26	LED28 (green)	ESC bus MFC OK
27	LED19 (red)	ESC bus KPS error
28	LED20 (green)	ESC bus KPS OK

12.6.4 CI3 Tech board

Overview

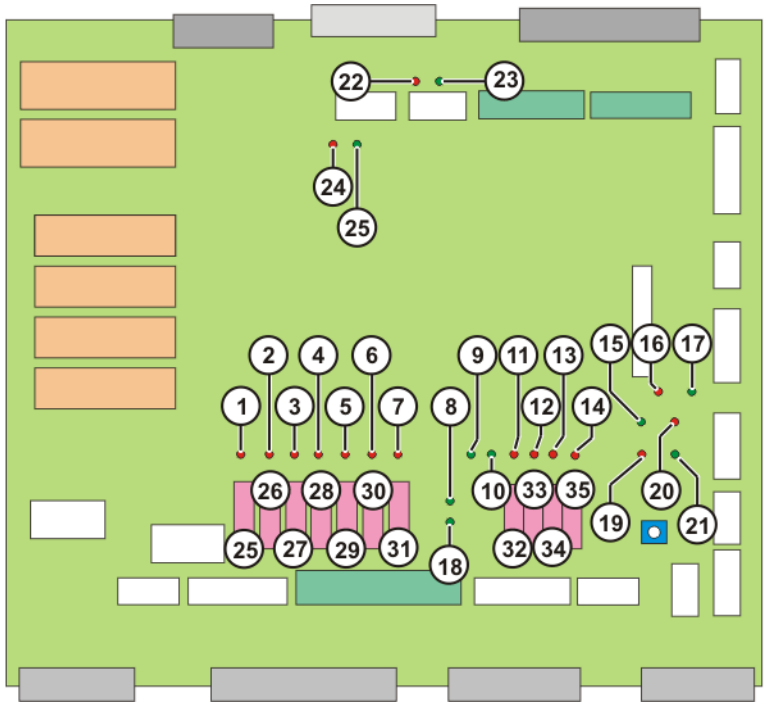

Fig. 12-4: CI3 Tech board fuses and LEDs

Fuses

Item	Designation	Value in A	Description
25	F2	2	24 V DC fan monitoring
26	F16	7.5	24 V DC interface VCC
27	F12	4	24 V DC interface VCC
28	F13	4	24 V DC interface VCC
29	F1	2	24 V DC drives ON
30	F14	4	24 V DC drives ON
31	F15	7.5	24 V DC drives ON
32	F10	3	24 V DC VCC-ESC
33	F21	2	24 V DC lamp CR
34	F23	2	RDC supply
35	F24	2	MPI supply

LEDs

Item	Designation	Description
1	LED16 (red)	Fuse monitoring for F2
2	LED5 (red)	Fuse monitoring for F16
3	LED4 (red)	Fuse monitoring for F12
4	LED2 (red)	Fuse monitoring for F13
5	LED6 (red)	Fuse monitoring for F1
6	LED7 (red)	Fuse monitoring for F14
7	LED8 (red)	Fuse monitoring for F15
8	LED14 (green)	24 V without battery back-up
9	LED29 (green)	Voltage monitoring 3.3 V for CR PLDs
11	LED1 (red)	Fuse monitoring for F10
12	LED11 (red)	Fuse monitoring for F21
13	LED12 (red)	Fuse monitoring for F23
14	LED10 (red)	Fuse monitoring for F24
15	LED17 (green)	ESC bus KCP OK
16	LED23 (red)	ESC bus SafetyBUS Gateway error
17	LED24 (green)	ESC bus SafetyBUS Gateway OK
18	LED9 (green)	24 V with battery back-up
10	LED15 (green)	5 V ESC nodes
19	LED27 (red)	ESC bus MFC error
20	LED18 (red)	ESC bus KCP error
21	LED28 (green)	ESC bus MFC OK
22	LED19 (red)	ESC bus KPS error
23	LED20 (green)	ESC bus KPS OK
24	LED22 (red)	ESC bus, local ESC node error
25	LED21 (green)	ESC bus, local ESC node OK

12.7 Checking the KPS600

Overview

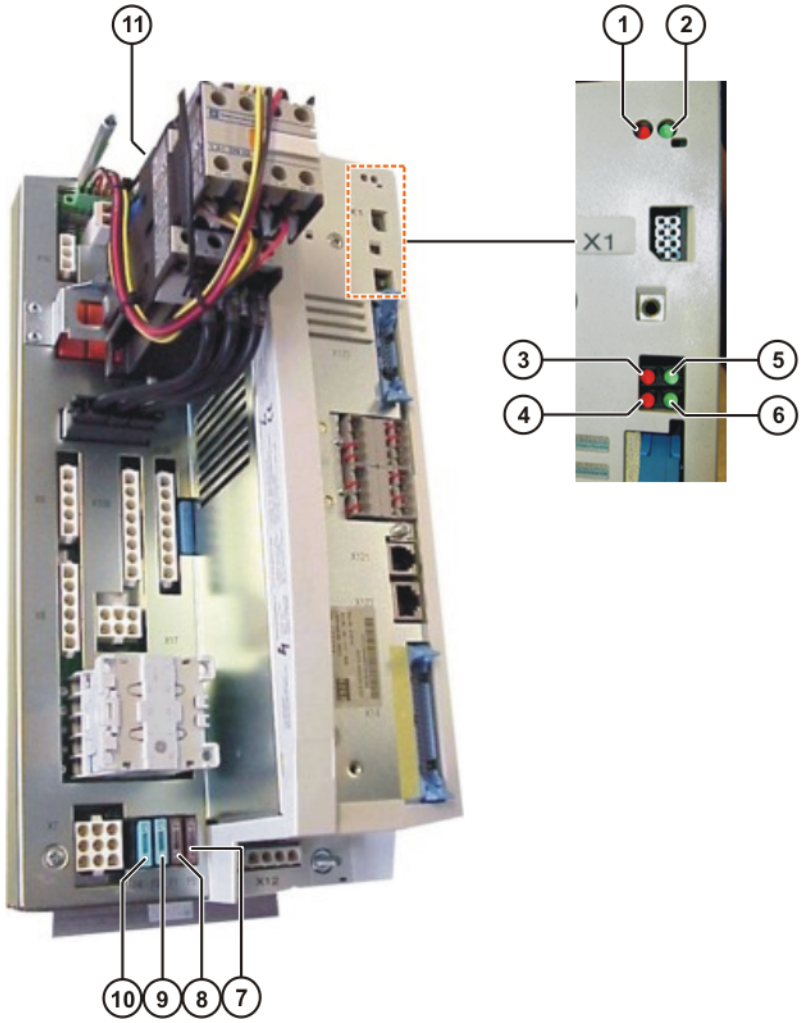

Fig. 12-5: KPS 600 LED display and fuses

1	LED 1 (red)	7	Fuse F5
2	LED 2 (green)	8	Fuse F1
3	LED 3 (red)	9	Fuse F3
4	LED 4 (red)	10	Fuse F4
5	LED 5 (green)	11	Fuse F2
6	LED 6 (green)		

Procedure

1. Check the status of the LEDs

LED 1	LED 2	Priority	Meaning
Off	Off	-	Processor without power supply
Off	Flashes at 1.5 Hz	-	Intermediate circuit voltage below 60 V
Off	On	-	Intermediate circuit voltage above 60 V
Flashes at 6 Hz	-	1	Communication error
Flashes at 3 Hz	-	2	Brake error
On	Off	3	Main contactor K1 stuck

LED 1	LED 2	Priority	Meaning
Flashes 5 times at 1.5 Hz	-	4	Error in BEA signal (signal for flow of current through the ballast resistor)
Flashes 4 times at 1.5 Hz	-	5	Ballast error
Flashes 3 times at 1.5 Hz	-	6	Overvoltage in intermediate circuit
Flashes 2 times at 1.5 Hz	-	7	Overtemperature in interior / heat sink
Flashes once at 1.5 Hz	-	8	Fault in the low voltage supply (24 V not present)

If more than one fault occurs simultaneously, the fault with the highest priority is displayed. (1 = highest priority, 8 = lowest priority)

After 4 s, the red LED again flashes n times.

LED 3	LED 4	Meaning
On	Off	External E-STOP pressed
On	On	Local E-STOP pressed
Off	On	Internal ESC error

LED 5	Meaning
Off	Robot brakes not activated
On	Robot brakes activated

LED 6	Meaning
Off	External axis brakes not activated
On	External axis brakes activated

2. Check the fuses and motor circuit-breakers.

Designation	Rating	Circuit
F1	7.5 A	24 V AC fuse X7, pin 8
F2	15 A	24 V DC periphery, external
F3	15 A	Battery + fuse X7, pin 2
F4	15 A	Battery - fuse X7, pin 3
F5	10 A	PC fuse X7, pin 7

3. Check voltage supply from KPS-27.
4. Visual check on the drive bus devices. Note from the LED display of the devices whether one or more KSDs indicate an error.
5. Press the enabling switch on the KCP, K1 and K2 on the KPS600 must pick up.
6. Observe any error messages appearing in the KCP message window.

The following KPS600 error messages can be displayed in the message window of the KCP:

Display in message window	Meaning / cause	Remedy
Parameter error PMx checksum	Checksum error in parameter set 1	▪ Restart ▪ Exchange KPS
Parameter error PMx control	Checksum error in the control unit device set	▪ Restart ▪ Exchange KPS
Drives error PMx no.: 71	Microcontroller crash	▪ Restart ▪ Exchange KPS
Ballast switch energized for too long PMx during charging	Ixt overload of the brake resistor during charging	▪ Ballast resistor defective ▪ Ballast resistor not connected
Ballast switch energized for too long PMx	Ixt overload of the brake resistor during operation	▪ Ballast resistor defective ▪ Ballast resistor not connected ▪ Deceleration phases in robot program are too long
Heat sink temperature PMx	Overtemperature, heat sink	▪ Cabinet ventilation defective
Cabinet temperature too high PMx	Overtemperature, interior	▪ Cabinet ventilation defective
Drives error PMx no.: 79	Communication error with the EEPROM in the control unit	▪ Restart ▪ Exchange KPS
Watchdog power module PMx	Max. permissible number of communication errors with the servo bus exceeded, causes short-circuit braking	▪ Check field bus drives cable
Overvoltage PMx during charging	Overvoltage in intermediate circuit while charging	▪ Mains voltage too high (transformer may be necessary)
Overvoltage PMx	Overvoltage in intermediate circuit during operation	▪ Mains voltage too high ▪ Ballast switch defective >> Exchange KPS
Undervoltage PMx	Low-voltage supply undervoltage	▪ Check low-voltage supply (rated voltage 27.1 V)
Buffer battery voltage low	Battery undervoltage, U<22 V	▪ Charge battery
Check battery PMx	Battery undervoltage, U<19 V	▪ Charge battery ▪ Exchange battery
Undervoltage PMx during charging	Undervoltage in intermediate circuit while charging, 500 V threshold not reached	▪ Mains voltage too low
Brake error Ax/PMx channel x	Brake error, main axes	▪ Brakes not connected ▪ Short circuit on brake cable
Brake error Ax/PMx channel x	Brake error, external axes	▪ Brakes not connected ▪ Short circuit on brake cable

Display in message window	Meaning / cause	Remedy
Intermediate circuit charging circuit defective PMx	Optocoupler for ballast resistor current detection signals that no current is flowing	▪ Restart ▪ Exchange KPS
K1 contactor welded PMx	Main contactor K1 stuck	▪ Exchange KPS

7. Check that the ground conductor connections are fitted securely.
8. Localize the error further using the DSE-RDW diagnostic tool.

12.8 Checking the KPS-27

Overview

The KPS-27 delivers the voltage to the devices via the KPS600. The KPS600 monitors this voltage. The operating state is indicated by an LED on the front.

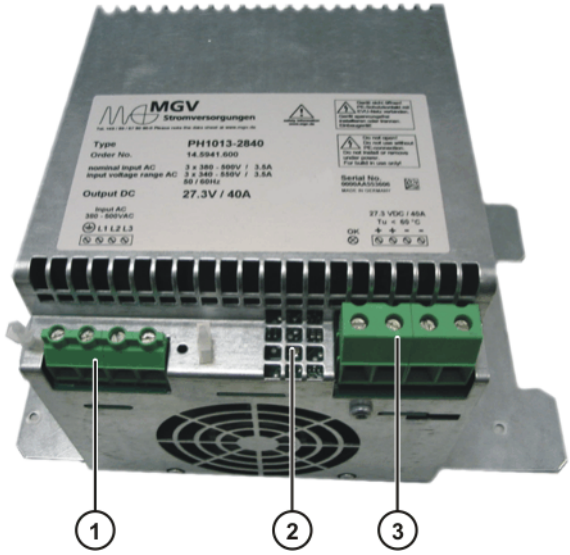

Fig. 12-6: KPS-27 low-voltage power supply

1	Power supply connection (L1/ L2/L3)	3	24 V DC / 40 A output
2	Green LED		

Procedure

1. Check the motor circuit-breaker F2.

Warning!
Work and measurements on the electrical equipment may only be carried out by specially trained personnel. The terminals are under mains voltage. Mains voltage can cause life-threatening injuries.

Measure the input voltage at the terminals G2 (L1/L2/L3).

2. Measure the output voltage at the KPS-27.
3. Check the LED status of the KPS-27.

LED	State	Meaning
Green LED	Lit	Normal operation

12.9 Testing the KSD

Overview

The operating state of the KSD is indicated by two LEDs on the front.

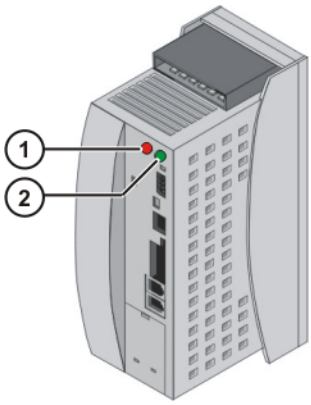

Fig. 12-7: KSD error display

1 LED 1 (red) 2 LED 2 (green)

Procedure

1. Check the LED status of the KSDs.

LED 1	LED 2	Meaning
Off	Off	24 V not available
On	Off	Undefined condition (see further KCP error messages)
Flashes quickly	Flashes quickly	Error present (intermediate circuit voltage too high)
Flashes slowly	Flashes slowly	Error present (undervoltage in intermediate circuit (limit value 250 V))
	Flashes quickly	
Off	Flashes slowly	Intermediate circuit voltage too low
Off	Flashes quickly	Intermediate circuit voltage too high
Off	On	Servo enable, normal operation (intermediate circuit voltage > limit value 250 V)

2. Observe any error messages appearing in the KCP message window.
   The following KSD error messages can be displayed in the message window of the KCP:

Display in message window	Meaning / cause	Remedy
DRIVERS ERROR Ax No.: TRIP	KSD is in a fault state; robot carries out Emergency Stop	▪ see further error message in the display window
OVERCURRENT Ax	▪ Overloading of the axis ▪ Current overload ▪ KSD defective	▪ Reduce load on axis (possible mechanical overloading) ▪ Exchange the KSD
SYNCHRONISATION ERROR DRIVE MODULE Ax	▪ Max. permissible number of communication errors with the servo bus exceeded ▪ Too many consecutive errors cause short-circuit braking	▪ Check Interbus cable between DSE, KPS and KSD and exchange if necessary
HEAT SINK TEMPERATURE Ax	Heat sink overtemperature	▪ Check the fans ▪ Load on axis too large
Parameter error Ax PR1	Checksum error in parameter set 1	▪ Check the KSD ▪ Restart ▪ Exchange the KSD

Display in message window	Meaning / cause	Remedy
Motor cable Ax	▪ Power unit overcurrent (short-circuit or ground fault) ▪ Hardware monitoring tripped ▪ Ground fault, software monitoring	▪ Check motor cable ▪ Check motor
FAILURE OF MOTOR PHASE Ax	Motor phase failure	▪ Check motor cable ▪ Check motor
Drives error Ax no.: xxx	▪ Checksum error in the control unit device set ▪ Microcontroller crash ▪ Communication error with the EEPROM in the control unit ▪ Communication error with the EEPROM in the power unit ▪ Checksum error in the power unit device set	▪ Check the KSD ▪ Restart ▪ Exchange the KSD

3. Turn off the robot controller and take measures to prevent it from being turned on again unintentionally.
4. De-energize the power cable.
5. Wait 5 minutes until the intermediate circuit has discharged.
6. Check that the Interbus cable (connection between the individual KSDs, DSE and KPS600) is fitted securely (X13 = drive bus output on the KSD modules).

12.10 Checking the temperature sensor ballast resistor

Description

The temperature sensor on the ballast resistor R1 has tripped (switches at 180 °C). The temperature monitoring is by means of the KPS600.

Procedure

1. Check the LED status on the KPS600.
2. Check the fan function.
3. Turn off the robot controller and take measures to prevent it from being turned on again unintentionally.
4. De-energize the power cable.
5. Wait 5 minutes until the intermediate circuit has discharged.
6. Check that the connector X110 on the KPS600 is fitted securely and measure the resistance at the following places:

Pin	State	Meaning
5 - 6	Closed/~ 0Ω	Temperature sensor not tripped
	Open/no contact	Temperature sensor tripped

7. Measure ballast resistors at connector X8 (KPS600).

Pin	State	Meaning
1 - 5	R1	22 Ω ± 3 %
2 - 6	R2	22 Ω ± 3 %

12.11 Checking the fans

Procedure

1. Carry out a visual and acoustic check of the air flow from the PC fan, the internal fan and the external fan.
2. Check the KPS600 LED displays to see if a monitoring device of the module has been tripped.
3. Turn off the robot controller and take measures to prevent it from being turned on again unintentionally.
4. De-energize the power cable.
5. Wait 5 minutes until the intermediate circuit has discharged.
6. PC fan
   - Check that connector X4 on the MFC Tech board is fitted securely.
7. Internal fan
   - Check that the cable connection and connectors XE1 (undo the fan fastening screws) and X31 on the CI3 Tech board are fitted securely.
8. External fan
   - Check the motor circuit-breaker F3.
   - Check that connector XE2 is fitted securely.
   - Measure the motor windings of the fan at connector XE2.

Pin	Resistance value
1 - 2	1 KΩ ± 10%
2 - 3	1 KΩ ± 10%
1 - 3	1 KΩ ± 10%

12.12 Checking the motor winding and brake

Preconditions

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

Warning!
White cables remain under mains voltage even with the main switch turned off! This mains voltage can cause life-threatening injuries.

- The controller has been shut down.

Procedure

1. Check the plug-in connections and cables of the motor for the relevant axis for firm connection and for possible damage.
2. Check the resistance of the power connector (6 pins) on the motor.
3. Measure the resistance of the motor winding and the brake on the motor connector.

Pin	Resistance value
1 - 2	0.17...14 Ω
2 - 6	0.17...14 Ω
1 - 6	0.17...14 Ω
4 - 5	24...80 Ω

4. Measure the resistance of the motor cable between the KSD and the motor connector.

12.13 Checking the DSE-IBS-C33

Procedure

1. Carry out a visual check on the green LED on the DSE-IBS-C33 board. The LED flashes when the connection to the MFC3 is established.

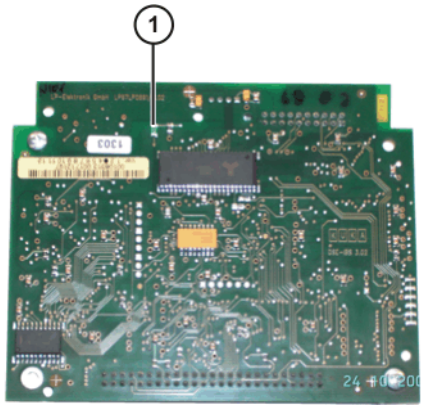

Fig. 12-8: DSE-IBS-C33 board

1 Green LED

2. Localize the error further using the DSE-RDW diagnostic tool. (>>> 12.17 "DSE-RDW diagnosis" Page 174)

12.14 KCP coupler LED display (optional)

The following LEDs are situated in the door interface:

- Fault LED (red), KCP coupler
- Request button with request LED (green)

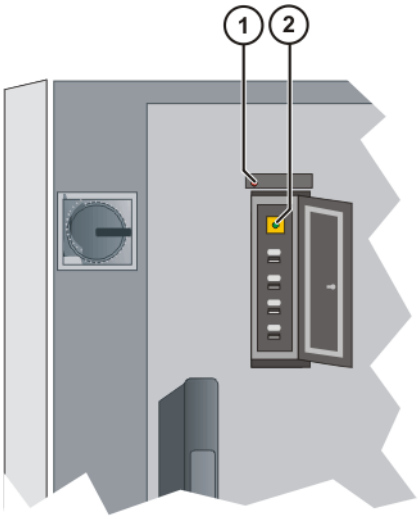

Fig. 12-9: KCP coupler LEDs and request button

LED 1 (red)

Item	State	Meaning	Measures
1	On	Internal error in KCP coupler	Switch robot controller off and then on again. If the error persists, exchange the KCP coupler card.
	Off	No error	-
	Flashes quickly (approx. 10 Hz)	Internal ESC communications error	ESC Reset. Check ESC diagnosis. Check connectors and cables between KCP coupler and KCP.
	Flashes slowly (approx. 1 Hz)	ESC protocol timeout from KCP	ESC Reset. Check ESC diagnosis. Check connectors and cables between KCP coupler and CI board.
	Flashes very slowly (approx. 0.2 Hz)	KCP coupler has received an error log from the ESC circuit.	ESC Reset. Check which ESC node is signaling what fault using the ESC diagnostic tool. If necessary, check the connectors and cables.

LED 2 (green)

Item	State	Meaning
2	On	KCP coupled and KCP coupler operational.
	Off	KCP uncoupled.
	Flashes slowly (approx. 1 Hz)	KCP uncoupling requested. Coupler waits 60 s for disconnection of KCP. The KCP is deactivated for 60 s.
	Flashes quickly (approx. 10 Hz)	KCP coupling requested. Coupling carried out automatically after 10 s.

KCP coupler card

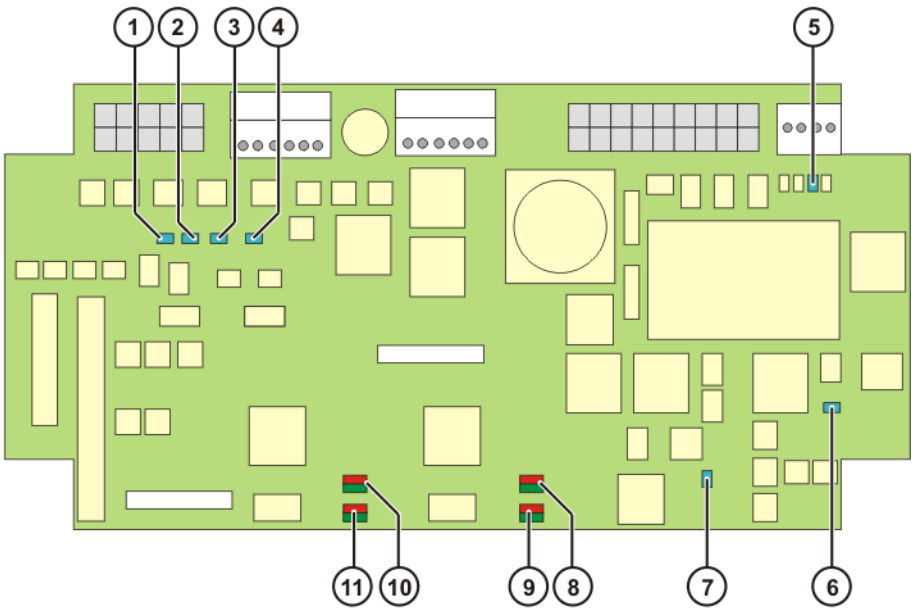

Fig. 12-10: LEDs on the KCP coupler card

Item	LED	State	Meaning
1	H10	On	24 V ESC
2	H9	On	Switched 24 V ESC

Item	LED	State	Meaning
3	H5	On	Test output channel B
4	H6	On	Test output channel A
5	H7	On	Switched 24 V KCP
6	H8	On	24 V KCP
7	H11	On	5 V KCP coupler
8	H14	Off	No error
9	H15	Red on	Request button has been pressed.
		Red on	Request button has not been pressed.
		Green on	KCP is disconnected
		Green off	KCP is connected
10	H13	Off	No error
11	H12	Red on	Request button has been pressed.
		Red on	Request button has not been pressed.
		Green on	KCP is disconnected
		Green off	KCP is connected

12.14.1 KCP coupler troubleshooting

Fault	Remedy
Wrong KCP variant connected.	Switch off the robot controller, connect the correct KCP variant and switch on the robot controller.
KCP disconnected without prior request.	Adhere to correct procedure. (>>> 9.1.1 "Uncoupling the KCP" Page 127) (>>> 9.1.2 "Coupling the KCP" Page 128)
KCP disconnected before the display was dark.	
KCP disconnected too long after request.	
Dual-channel error at request button.	Check wiring, connectors and connections.
Cross-connection at request button.	
ESC communications error in internal cabinet ring.	Check wiring, connectors and connections. Perform ESC reset.
ESC communications error in KCP	Check wiring, connectors and connections to KCP. Exchange defective KCP or KCP cable.
CAN communications error in KCP	

12.15 LEDs on the RDC board

Description

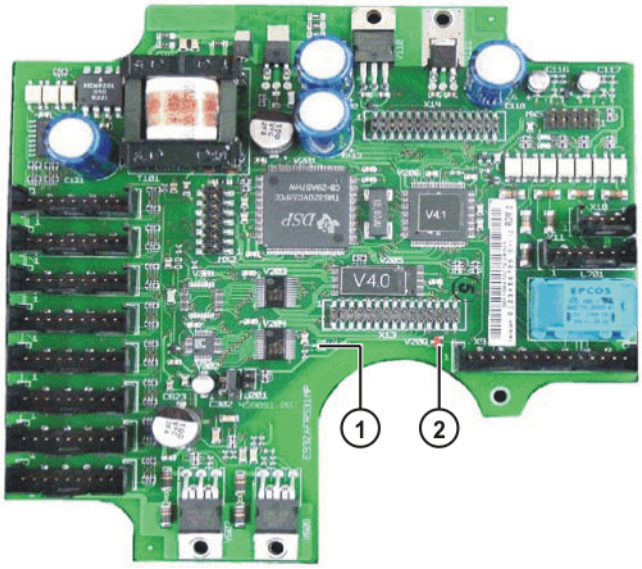

Fig. 12-11: LEDs on the board

Item	Designation	Color	Description
1	V114	Green	3.3 V power supply present
2	V208	Red	■ Flashing = RDC not yet ready ■ On = RDC ready for operation

12.16 LEDs on the SafeRDC board

If the LEDs indicate faulty operation, reboot the robot controller and force a cold start. If the error persists, exchange the SafeRDC board.

Description

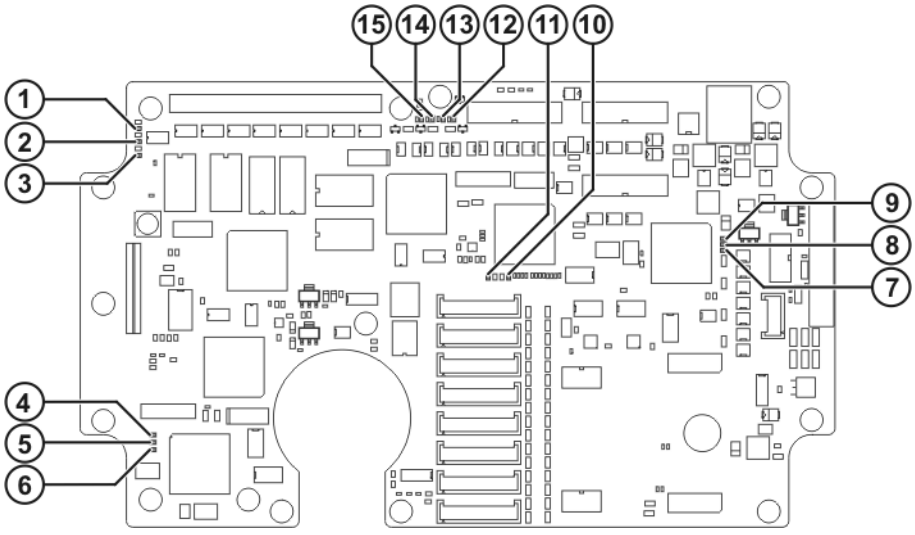

Fig. 12-12: LEDs on the SafeRDC board

Item	Designation	Color	Description
1	H1700	Red	LED for self-test of the SafeRDC, channel B During boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Normal operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation
2	H1701	Green	LED for self-test of the SafeRDC, channel B During boot-up of the SafeRDC board ■ On = Normal operation ■ Off = Faulty operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation
3	H1702	Green	Not used.
4	H1502	Red	Busy LED, channel B
5	H1501	Green	Status LED, channel B During boot-up of the SafeRDC board ■ On = Normal operation ■ Off = Faulty operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Normal operation ■ Flashing = Faulty operation
6	H1500	Green	Operation LED, channel B During boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation (software running) After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation (software running)
7	H1402	Red	Busy LED, channel A

Item	Designation	Color	Description
8	H1401	Green	Status LED, channel A During boot-up of the SafeRDC board ■ On = Normal operation ■ Off = Faulty operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Normal operation ■ Flashing = Faulty operation
9	H1400	Green	Operation LED, channel A During boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation (software running) After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation (software running)
10	H1800	Red	LED for self-test of the SafeRDC, channel A During boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Normal operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation
11	H1801	Green	LED for self-test of the SafeRDC, channel A During boot-up of the SafeRDC board ■ On = Normal operation ■ Off = Faulty operation ■ Flashing = Faulty operation After boot-up of the SafeRDC board ■ On = Faulty operation ■ Off = Faulty operation ■ Flashing = Normal operation
12	H2100	Green	■ On = HIGH level at output QE_A_24V ■ Off = LOW level at output QE_A_24V
13	H2101	Green	■ On = HIGH level at output ENA_A_24V ■ On = LOW level at output ENA_A_24V
14	H2102	Green	■ On = HIGH level at output QE_B_24V ■ Off = LOW level at output QE_B_24V
15	H2103	Green	■ On = HIGH level at output ENA_B_24V ■ Off = LOW level at output ENA_B_24V

12.16.1 LEDs on the force sensor card (KSK) for SafeRDC (option)

Description

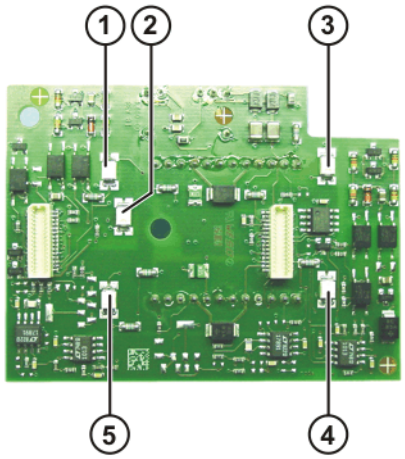

Fig. 12-13: LEDs on force sensor card for SafeRDC

Item	LED	Color	Description
1	LED2	Green	Reset Sensor 2 Lights up in the case of a reset
2	LED6	Green	+15 V Operating voltage
3	LED5	Green	Power Sensor 2
4	LED3	Green	Power Sensor 1
5	LED1	Green	Reset Sensor 1 Lights up in the case of a reset

12.16.2 LEDs on the I/O Print board

Description

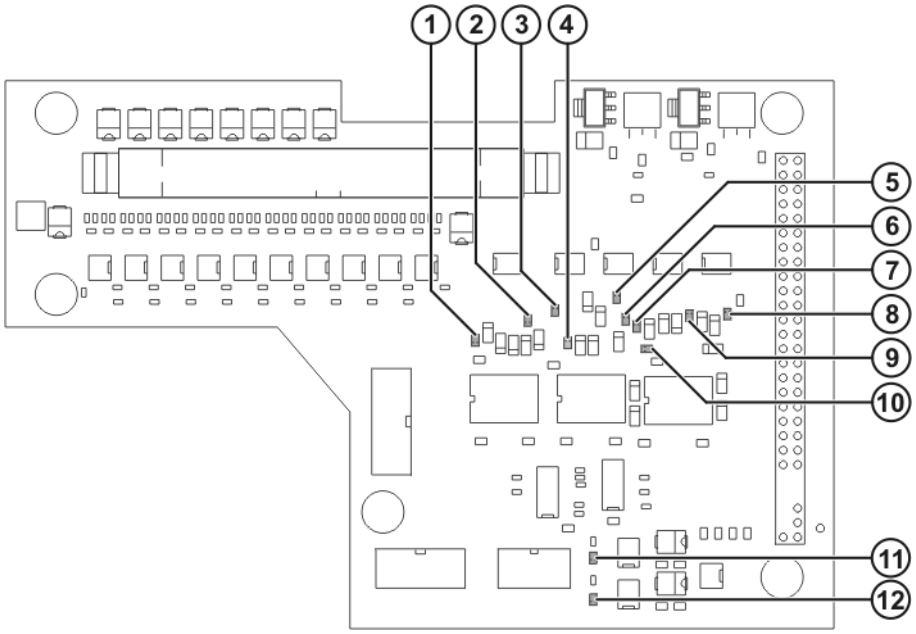

Fig. 12-14: LEDs on the I/O Print board

Item	Designation	Color	Description
1	H800	Green	Not used.
2	H801	Green	Not used.
3	H703	Green	■ On = HIGH level at OUT_STATUS_B ■ Off = LOW level at OUT_STATUS_B
4	H702	Green	■ On = HIGH level at OUT_A2_B ■ Off = LOW level at OUT_A2_B
5	H602	Green	■ On = HIGH level at OUT_A0_B ■ Off = LOW level at OUT_A0_B
6	H603	Green	■ On = HIGH level at OUT_A1_B ■ Off = LOW level at OUT_A1_B
7	H701	Green	■ On = HIGH level at OUT_STATUS_A ■ Off = LOW level at OUT_STATUS_A
8	H600	Green	■ On = HIGH level at OUT_A0_A ■ Off = LOW level at OUT_A0_A
9	H601	Green	■ On = HIGH level at OUT_A1_A ■ Off = LOW level at OUT_A1_A
10	H700	Green	■ On = HIGH level at OUT_A2_A ■ Off = LOW level at OUT_A2_A
11	H1	Green	■ On = Pulsed voltage /TA24V_A present ■ Off = Pulsed voltage /TA24V_A not present
12	H2	Green	■ On = Pulsed voltage /TA24V_B present ■ Off = Pulsed voltage /TA24V_B not present

12.16.3 Checking the SafeRDC

Procedure

1. Check the LEDs on the SafeRDC. (>>> 12.16 "LEDs on the SafeRDC board" Page 170)
2. Check the voltage supply from the KPS 27.
3. Check the ESC circuit.
4. Carry out a cold restart of the system.
5. Localize any errors using the DSE-RDW diagnostic tool.
6. Turn off the robot controller and take measures to prevent it from being turned on again unintentionally.
7. De-energize the power cable.
8. Check that the connections/connectors on the SafeRDC are fitted securely and locked in place.
9. Check that data cable X21 to the SafeRDC is fitted securely.
10. Check that the plug-in connections on the connection panel are fitted securely (connection X20 = motor cable and X21 = connection to SafeRDC).
11. Check that the plug-in connections from the DSE (additional board on the MFC3 Tech board) to adapter board A32 are fitted securely.
12. Check that the plug-in connection from interface A32, connector ST4, to adapter plug X21 is fitted securely.

12.17 DSE-RDW diagnosis

Overview

The DSE-RDW diagnostic tool indicates the current state of communication between the DSE and the RDC, on the one hand, and the DSE and the drive bus, on the other.

12.17.1 Description of the user interface

Procedure

- Select the menu sequence **Setup** > **Service** > **DSE-RDW**.

Description

The arrow keys can be used to navigate in the DSE-RDW diagnostic tool. The Esc key takes you up a level in the menu structure. Pressing the Esc key at the top menu level exits the DSE-RDW diagnostic tool.

The contents of the EEPROM in the RDC unit can be overwritten. These data cannot be restored simply by booting the system.

The following parameters are displayed:

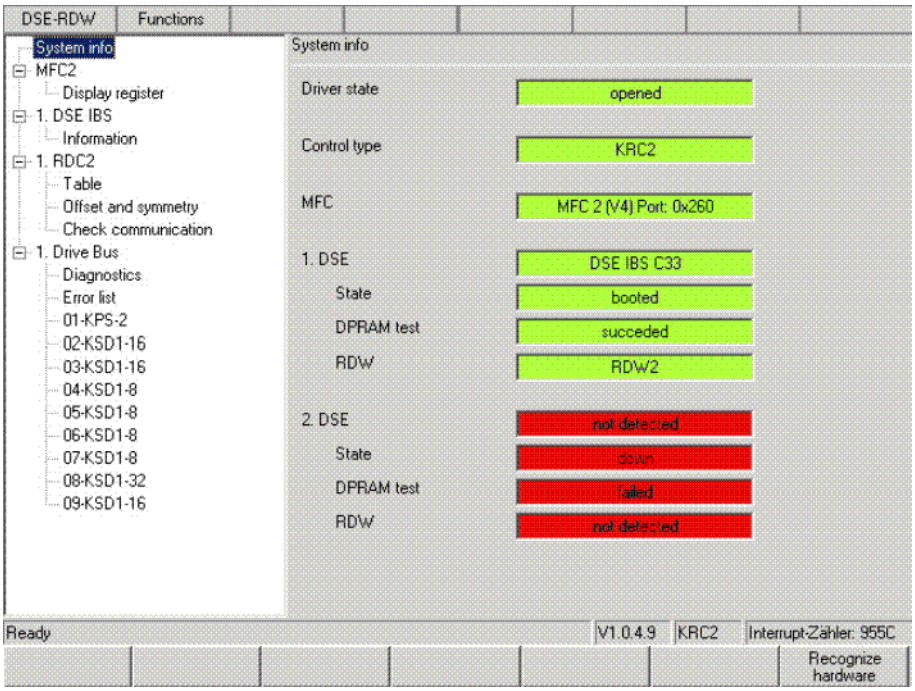

Fig. 12-15: DSE-RDW user interface

Parameter	Description
Driver state:	Driver program is being executed
Control type	Type of controller (KR C2, KR C3)
MFC	Version of the MFC module used

■ 1.DSE
  ■ State
  ■ DPRAM test
  ■ RDC
	■ Type of the first DSE module
	  ■ Operating state of the DSE module
	  ■ Result of the dual-port RAM test
	  ■ Type of RDC module used

Parameter	Description
2. DSE	There is no second DSE present in this case. The 4 display boxes are the same as for the first DSE.
	Status line: ■ Version number of the DSE-RDW diagnostic tool ■ Type of control cabinet ■ Current value of the DSE interrupt counter: incrementation of the counter indicates that the DSE control program is running correctly.

Softkeys

Field name	Description
Recognize hardware	The data in the display boxes are updated

12.17.2 Setting the language

Description Two languages are available:

- German
- English

Procedure

1. Select the menu sequence **DSE-RDW** > **Language**.
2. Select the language and confirm with **OK**.

12.17.3 MFC3 register display

Procedure

- Under "System info", select **MFC3** > **Display register**.

Description The following parameters are displayed:

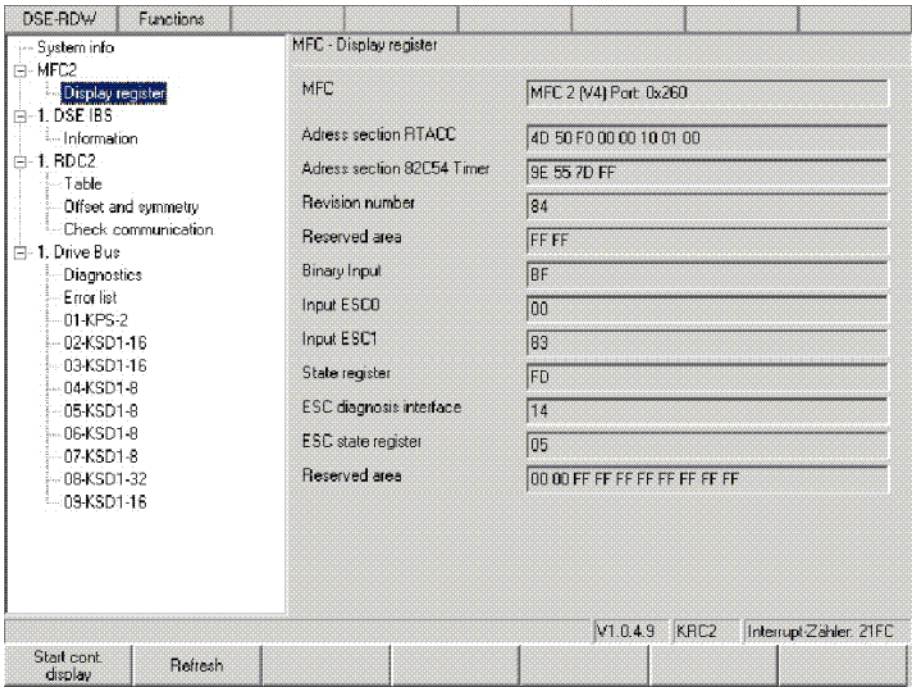

Fig. 12-16: MFC register display

Parameter	Description
MFC	Version of the MFC module used
Address section RTACC	Internal data
Address sesction 82C54 Timer	
Revision number	
Reserved area	
Binary Input	
Input ESC0	
Input ESC1	
State register	
ESC diagnosis interface	
ESC state register	
Reserved area	

Softkeys

Field name	Description
Refresh	The data in the display boxes are updated
Start cont. display	Starts / stops continuous updating of the display

12.17.4 DSE-IBS information

Procedure

- Under "System info", select **1.DSE IBS** > **Information**.

Description

The following parameters are displayed:

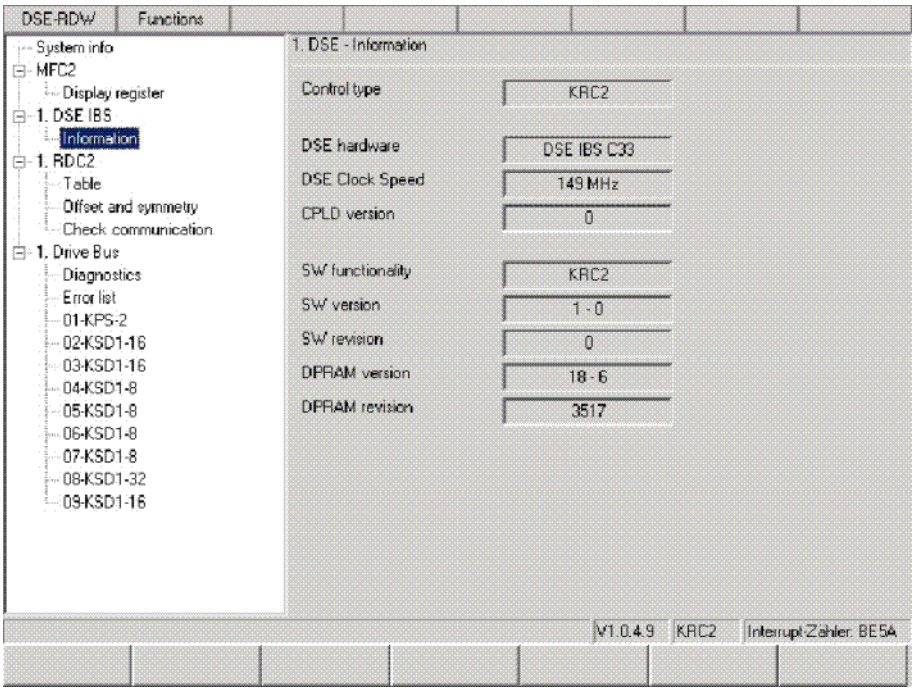

Fig. 12-17: DSE IBS information

Parameter	Description
Control type	Type of controller (KR C2, KR C3)
DSE hardware	Hardware version of the DSE
DSE Clock Speed	Clock frequency of the DSE used

Parameter	Description
CPLD version	Internal version numbers
SW functionality	
Software version	
DPRAM version	
DPRAM revision	

12.17.5 RDC table

Procedure

- Under "System info", select **1.RDC2** > **Table**.

Description

The measurement and configuration data of the RDC are displayed.

Data concerning the hardware configuration of the RDC are listed in the table from line 88 onwards.

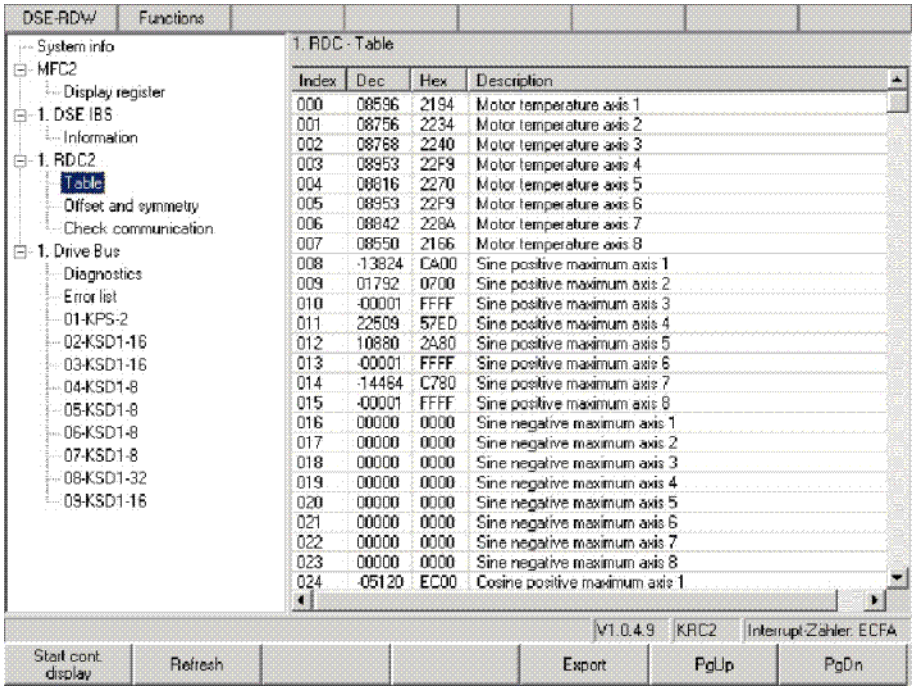

Fig. 12-18: RDC table

Softkeys

Softkey	Description
PgDn	Moves down one line in the table
PgUp	Moves up one line in the table
Export	Saves the current data to the hard drive
Refresh	Starts / stops continuous updating of the display
Start cont. display	Updates the display

12.17.6 RDC offset and symmetry adjustment

Procedure

- Under "System info", select **1.RDC2** > **Offset and symmetry**.

Adjustment

Adjustment of the following values is carried out automatically:

- Sine offset
- Cosine offset

- Sine calibration
- Cosine calibration

In order to be able to determine the sine and cosine values correctly, every axis must be moved through several revolutions of the motor.

Description

The following parameters are displayed:

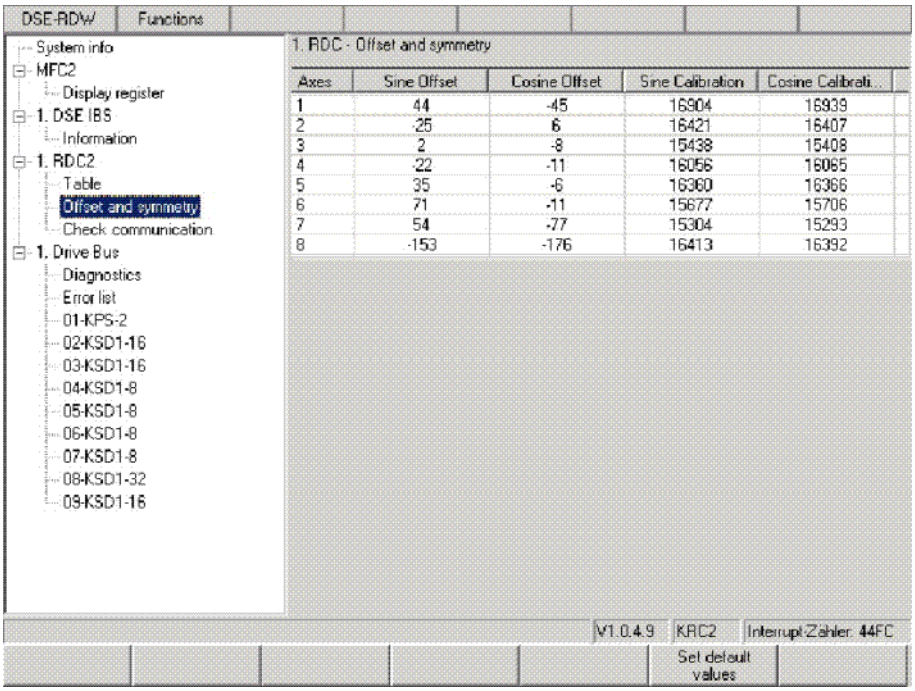

Fig. 12-19: RDC offset and symmetry

Parameter	Description
1.RDC2 offset und symmetry	Displays all adjustment data for the axes

Softkeys

Softkey	Description
Set default values	The default values should be set after: ■ Exchanging motors ■ Exchanging the RDC module ■ Sporadic encoder errors

12.17.7 Check RDC-DSE communication

Procedure

- Under "System info", select **1.RDC2** > **Check communication**.

Description

The following parameters are displayed:

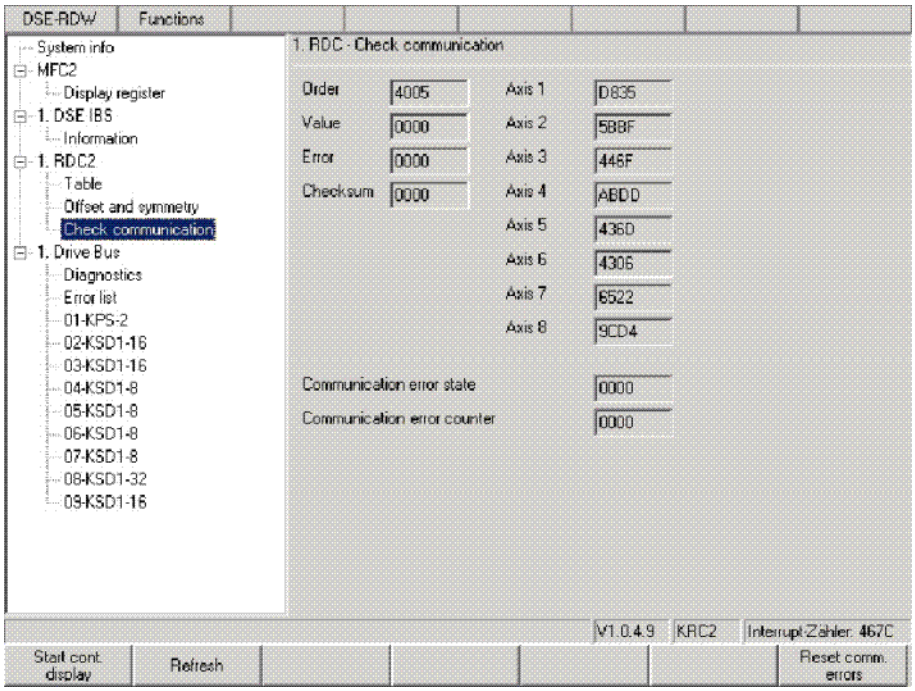

Fig. 12-20: Check communication

Parameter	Description
System info - Check communication	The RDC sends data words to the DSE in a 125 µs cycle. This function is used to check the communication between the DSE and the RDC
Order	The last command the DSE has sent to the RDC
Value	Motor temperatures of axes 1 to 8
Error	Encoded display of the encoder error bits and EMT signals
Checksum	Checksum for all transferred data
Axes 1 to 8	Displays the resolver position of axis nn. The values vary during operation. If a resolver position has the value 0, there is an encoder error
Communication error state	If more than 3 transmissions have failed, the value 0001 is displayed.
Communication error counter	Sum of all incorrect transmissions since the last “Reset comm. errors”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Insignificant for diagnosis						EMT signals		Encoder error bits for the robot axes							
								A8	A7	A6	A5	A4	A3	A2	A1

Fig. 12-21: Encoded display of the encoder error bits and EMT signals

Softkeys

Softkey	Description
Reset comm. errors	Sets errors to 0

Softkey	Description
Refresh	Updates the display
Start cont. display	Starts / stops continuous updating of the display

12.17.8 Drive bus diagnostics

Procedure

- Under "System info", select **1.Drive Bus** > **Diagnostics**.

Description

The following parameters are displayed:

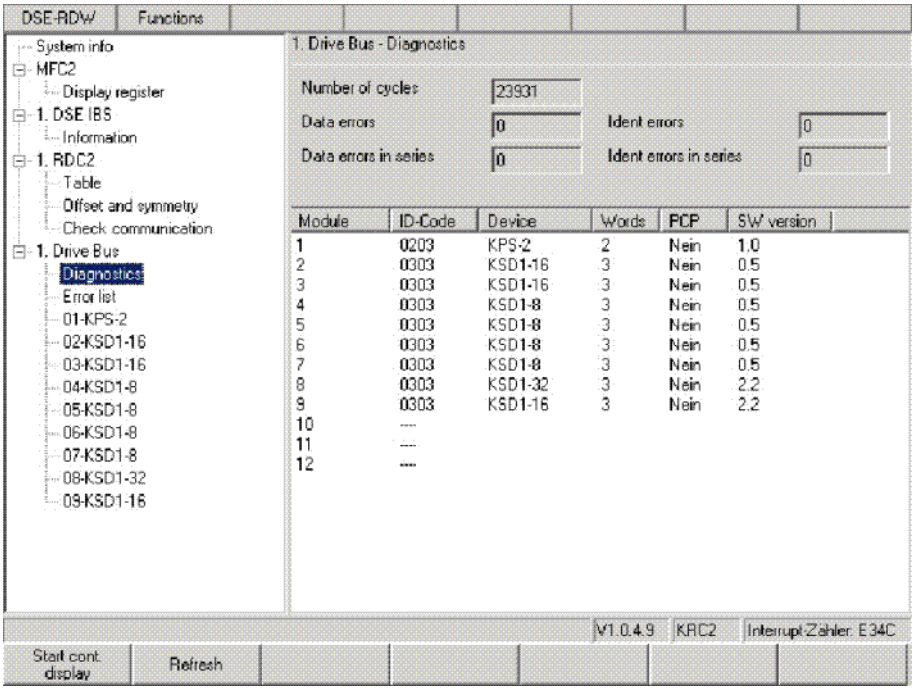

Fig. 12-22: Drive bus diagnostics

Parameter	Description
Number of cycles	Number of data transmissions between DSE and RDC since system switched on / reset
Data errors	Number of data errors in the data transmissions between DSE and RDC (sporadic errors)
Data errors in series	Number of consecutive data errors following the first three
Ident errors	Number of transmission errors
Data errors in series	

Softkeys

Softkey	Description
Start cont. display	Starts / stops continuous updating of the display
Refresh	Updates the display

12.17.9 Drive bus error list

Procedure

- Under "System info", select **1.Drive Bus** > **Error list**.

Description The error statistics are displayed with the drive bus running.

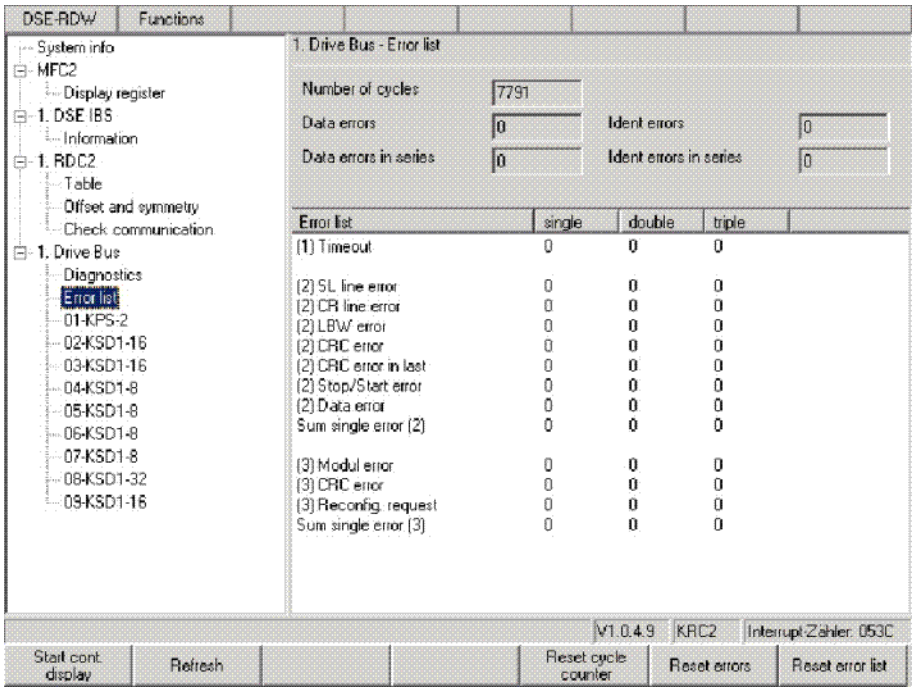

Fig. 12-23: Drive bus error list

Softkeys

Softkey	Description
Start cont. display	Starts / stops continuous updating of the display
Refresh	Updates the display
Reset cycle counter	Reset
Reset errors	Reset
Reset error list	Reset

12.17.10Drive bus - KPS

Procedure

- Under "System info", select **1.Drive Bus** > **01-KPS-2**.

Description

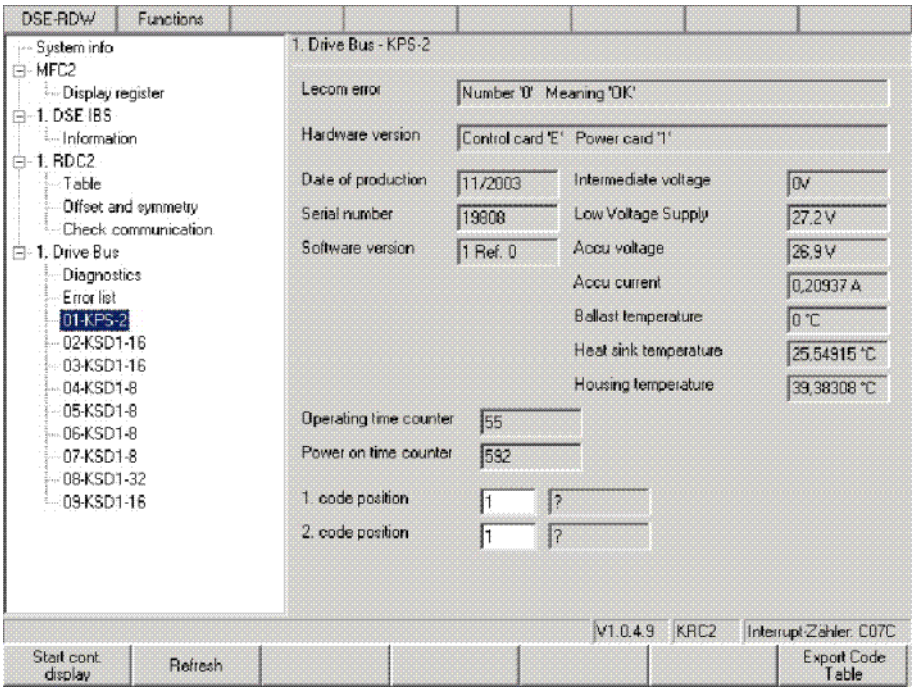

Fig. 12-24: Drive bus - KPS

Parameter	Description
Lecom error	Lenze communication error number
Hardware version	Control and power units
■ Intermediate voltage ■ Low voltage supply ■ Accu voltage ■ Accu current ■ Ballast temperature ■ Heat sink temperature ■ Housing temperature	Voltages, currents and temperatures of the KPS
Operating time counter	Intermediate circuit has been active for xx hours
Power-on time counter	KPS has been active for xx hours
1. and 2. code position	Polling of the current error memory and the last 3 history entries Code position: ■ 161: current error ■ 162: current error -1 ■ 163: current error -2 ■ 164: current error -3

Softkeys

Softkey	Description
Start cont. display	Starts / stops continuous updating of the display
Refresh	Updates the display
Export Code Table	Saves the current code table to the hard drive (example: C:\KRC\Roboter\Log\Drivebus1-4_KSD1-8.log)

12.17.11Drive bus - KSD-16

Procedure

- Under "System info", select **1.Drive Bus** > **02-KSD-16**.

Description

The following parameters are displayed:

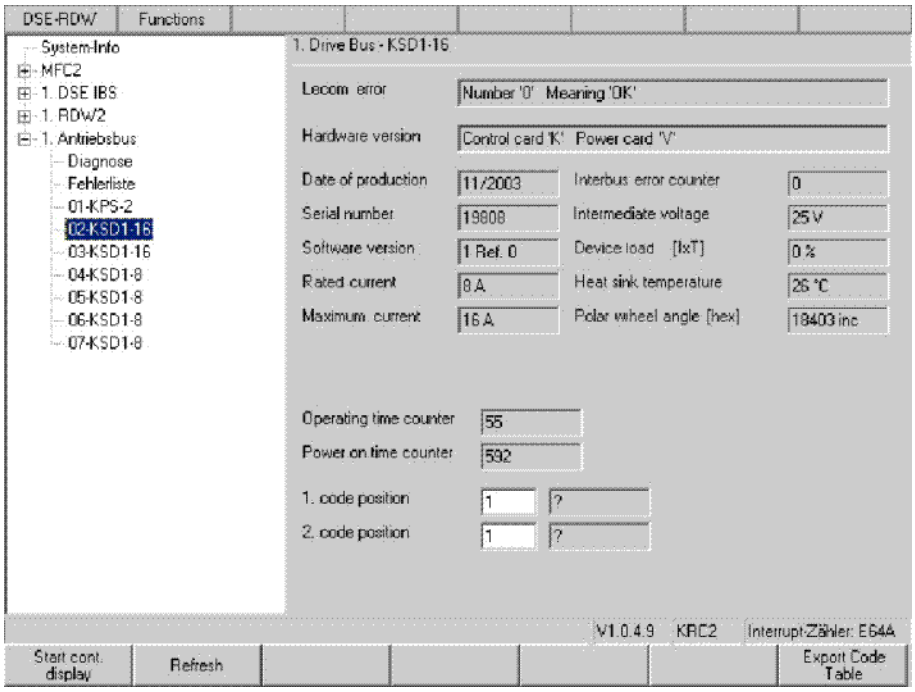

Fig. 12-25: Drive bus - KSD

Parameter	Description
Lecom error	Lenze communication error number
Hardware version	Control and power units
Date of production	Date
Serial number	Number
Software version	Software version
■ Rated current ■ Maximum current ■ Intermediate voltage ■ Device load ■ Heat sink temperature ■ Polar wheel angle	Voltages, currents and temperatures of the KSD
Operating time counter	Intermediate circuit has been active for xx hours
Power-on time counter	KSD has been active for xx hours
1. and 2. code position	Polling of the current error memory and the last 3 history entries Code position: ■ 161: current error ■ 162: current error -1 ■ 163: current error -2 ■ 164: current error -3

Softkeys

Softkey	Description
Start cont. display	Starts / stops continuous updating of the display
Refresh	Updates the display
Export Code Table	Saves the current code table to the hard drive (example: C:\KRC\Roboter\Log\Drivebus1-4_KSD1-8.log)

12.17.12KPS600 error messages

IBS trip no.	Lecom error no.	Display	Description
0	0	"ok"	Device state OK
1	72	"Pr1-Trip"	Checksum error in parameter set 1
3	105	"HO5-Trip"	Checksum error in the control unit device set
5	71	"CCr-Trip"	Microcontroller crash
6	11	"OC1-Trip"	Ixt overload of the brake resistor while charging
8	15	"OC5-Trip"	Ixt overload of the brake resistor during operation
10	50	"CH-Trip"	Overtemperature, heat sink
39	52	"CH2-Trip"	Overtemperature, interior
24	79	"Pr5-Trip"	Communication error with the EEPROM in the control unit
28	65	"CE4-Trip"	Max. permissible number of communication errors with the drive bus exceeded, causes short-circuit braking
35	131	"OV1-Trip"	Overvoltage in intermediate circuit while charging
36	132	"OV2-Trip"	Overvoltage in intermediate circuit during operation
19	32	"LP1-Trip"	Mains phase failure
31	121	"LV1-Trip"	Low voltage supply undervoltage
32	122	"LV2-Trip"	Battery undervoltage, U<22 V
33	123	"LV3-Trip"	Battery undervoltage, U<19 V
34	124	"LV4-Trip"	Undervoltage in intermediate circuit while charging, 500 V threshold not reached
41	141	"BR1-Trip"	Brake error, main axes
30	142	"BR2-Trip"	Brake error, external axes
37	112	"BEA-Trip"	Optocoupler for ballast resistor current detection signals that no current is flowing
40	111	"K1-Trip"	Main contactor K1 stuck

12.17.13 KSD error message

Valid from Firmware V0.3 onwards

IBS trip no.	Lecom error no.	Display	Description
0	0	"ok"	Device state OK
1	72	"Pr1-Trip"	Checksum error in parameter set 1
3	105	"HO5-Trip"	Checksum error in the control unit device set
5	71	"CCr-Trip"	Microcontroller crash
6	11	"OC1-Trip"	Power unit overcurrent (short-circuit or ground fault), hardware monitoring
7	12	"OC2-Trip"	Ground fault, software monitoring
8	15	"OC5-Trip"	I*t overload
10	50	"OH-Trip"	Overtemperature, heat sink
11	91	"EEr-Trip"	External error, short-circuit braking requested by the controller
19	32	"LP1-Trip"	Motor phase failure
24	79	"Pr5-Trip"	Communication error with the EEPROM in the control unit
28	65	"CE4-Trip"	Max. permissible number of communication errors with the drive bus exceeded, or too many toggle bit errors in succession, causes short-circuit braking.
43	80	"PR6-Trip"	Communication error with the EEPROM in the power unit
44	106	"H06-Trip"	Checksum error in the power unit device set

12.18 ESC diagnosis

Overview

The ESC diagnosis indicates the current state of the ESC circuit and the active ESC signals. The current structure of the ESC circuit is determined when the ESC diagnosis is started. The ESC diagnosis loads the suitable configuration based on the structure it finds. A separate configuration can be defined for each structure.

12.18.1 User interface

Procedure

- Open the menu via **Monitor** > **ESC Diagnosis**.

Description

The type and number of nodes available depend on the periphery used. The ESC diagnosis monitors all the robot controllers in a RoboTeam system. The arrow keys can be used to navigate in the ESC diagnosis tool.

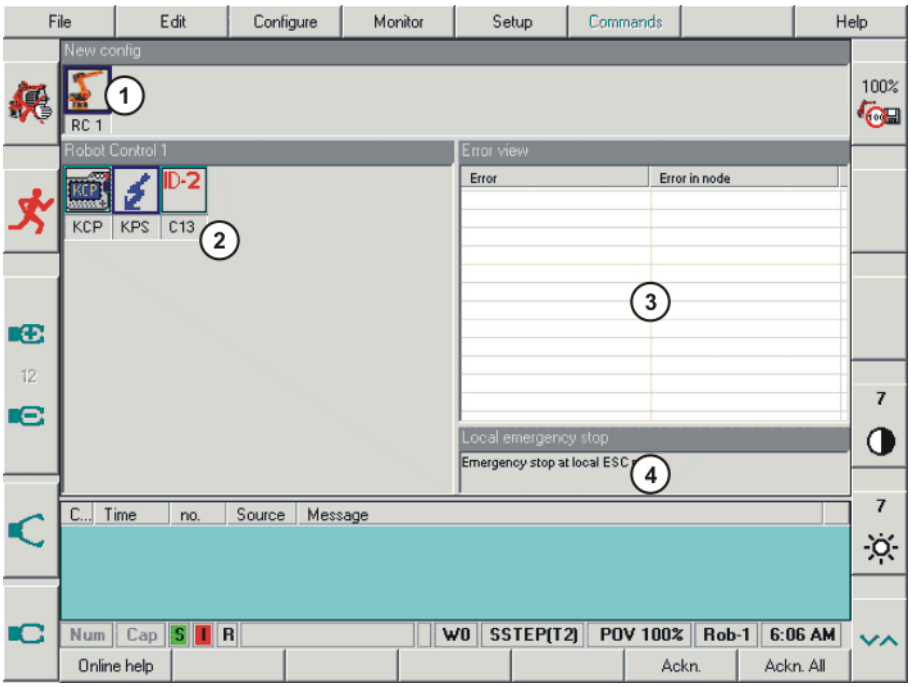

Fig. 12-26: Example: a controller with three ESC nodes

Item	Description
1	Display of all the connected controllers. The controller currently selected is highlighted.
2	Display of all the nodes present in the safety circuit. The activated node is highlighted.
3	Display of the signal statuses or the accumulated errors and the location of the source of the errors.
4	Help text about the status and error display.

The next window is selected by pressing the **Next Window** softkey.

12.18.2 Log file

Procedure

1. Start recording data by pressing the **Log on** softkey. Data recording begins and the softkey label changes to **Log off**.
2. Stop recording data by pressing the **Log off** softkey.

Description

The states of all the ESC nodes can be recorded in the log file **EscDiagnosis.log** and saved in the directory **C:\KRC\Roboter\Log**. The log file is an ASCII file and can be opened using a text editor.

12.18.3 ESC circuit reset

Procedure

- Reset the ESC circuit by pressing the **Reset** softkey.

Description

The ESC circuit can be reset after an error. The "Reset" softkey is only available if CI3 and MFC3 modules are being used.

12.18.4 Terminating ESC diagnosis

Procedure

- Terminate ESC diagnosis by pressing the **Close** softkey.

12.18.5 State display of the ESC nodes

Description

The states of an individual node and its values can be viewed in the state display. The values are updated cyclically. The state of the ESC node is shown in color.

In the event of an error, the display automatically switches to the error display and the relevant node and controller flash.

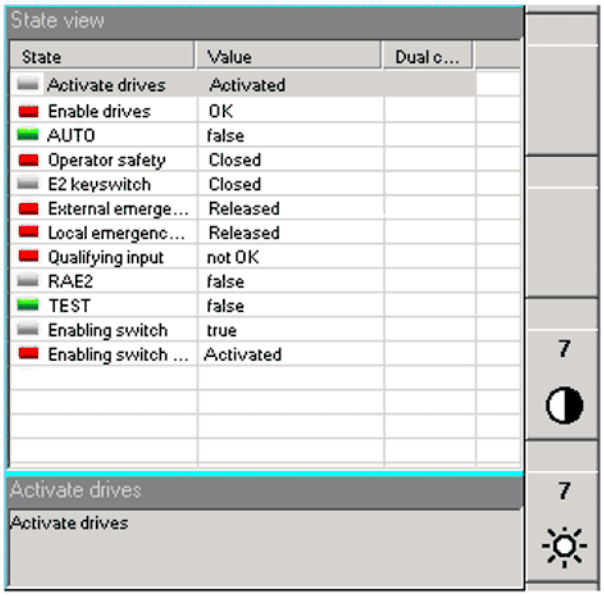

Fig. 12-27: State display (example)

Display

If a dual-channel error occurs, "Error" appears in the "Dual channel" box. The states of the signals are displayed according to the current operating state of the robot system.

Color	State	Element	Help text
Red	Pressed	Local E-STOP	E-STOP at local ESC node
Gray	Released		
Red	Pressed	External E-STOP	E-STOP in periphery
Gray	Released		
Red	Open	Operator safety	Operator safety
Green	Closed		
Gray	False	AUTO	Auto mode
Green	True		
Gray	Not activated	Enabling switch	Position 1
Green	Pressed		
Green	OK	Qualifying input	Qualifying input
Red	Not OK		
Red	Not OK	Drives OFF key	Drives enable
Green	OK		
Red	Panic	Enabling switch	Panic position
Gray	No panic		
Gray	False	AE	AE bit
Green	True		

Color	State	Element	Help text
Gray	False	ANA	E-STOP output
Green	True		
Gray	False	LNA	Local Emergency Stop
Green	True		
Gray	False	AAUTO	AUTO output
Green	True		
Gray	False	ATEST	TEST output
Green	True		
Gray	False	Res1	(Reserved signal)
Green	True		
Green	False	RAE2	Drives contactor auxiliary contact
Gray	True		
Gray	Open	E2 keyswitch	E2 keyswitch
Green	True		
Gray	False	TEST	TEST mode
Green	True		
Gray	Not activated	Drives ON key	Activate drives
Green	Pressed		

12.18.6 Error display of the ESC nodes

Procedure

- Switch to the “Error view” window by pressing the **Show Error** softkey. The error table is displayed. The softkey changes to **Show data**.

Description

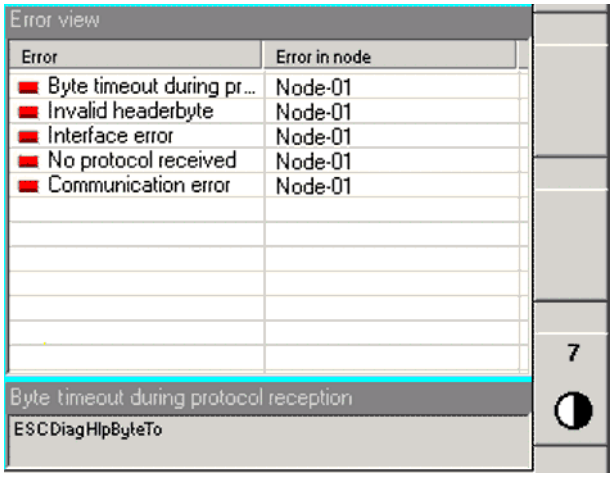

Fig. 12-28: Error display (example)

Error messages and troubleshooting:

Message text	Cause	Corrective action
Byte timeout during receipt of log	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring, check the CI3 board LEDs.
Checksum error in log	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.

Message text	Cause	Corrective action
Invalid header byte	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Interface error	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Operating mode error	Defective KCP, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
No protocol received	Defective KCP, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Initialization error	Two KCPs in the ESC circuit! Only one KCP (master) may be present in the circuit. Wrong configuration on ESC master (KCP).	Disconnect second KCP.
Configuration error	Wrong KCP used.	Exchange KCP.
Hardware fault	General message.	Hardware fault in node xx; observe other error messages.
PICA/PICB	ESC chip from which the message comes.	Relevant in the case of supervisor errors.
Communication error	Defective KCP, KPS or CI3 board, EMC interference, defective connectors or connecting cables.	Exchange the defective module, reduce the interference, carry out a visual inspection of the bus wiring.
Software error	-	Exchange module with software error.
I/O monitoring error	TA24V/A-B or input channels A/B interchanged, drives contactor return not connected.	Check the wiring to the inputs and the external contactor.
RAM error	RAM error.	Exchange module.
Relay error	Two modules are active, the relay on the module is stuck, or two operating modes are selected.	Exchange CI3 board.
Output error	General message.	-
Output error: operating mode	Relay error (operating mode), incorrect KCP variant, defective mode selector switch on cabinet.	Exchange CI3 board.
Output error: drives contactor auxiliary contact	Auxiliary contact or coil not wired, or wired incorrectly, jumper not plugged in, KPS defective.	Check wiring to external contactor (auxiliary contact), check jumper X123 on KPS600, exchange KPS600.
Output error: local E-STOP	Relay error (EMERGENCY STOP).	Check periphery.
Output error: AE coil	Mains contactor fault.	Check wiring to external contactor, exchange KPS600.

Message text	Cause	Corrective action
Crossed connection error on: Local E-STOP	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for local E-Stop (NA).
Crossed connection error on: External E-STOP	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for external E-Stop (ENA).
Crossed connection error on: Operator safety	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for operator safety (BS).
Crossed connection error on: Qualifying input	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for qualifying input (QE).
Crossed connection error on: Enabling switch 1	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for enabling switch 1 (ZS1).
Crossed connection error on: Mode selector switch	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for operating mode (Auto/Test).
Crossed connection error on: E2 keyswitch	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for keyswitch E2.
Crossed connection error on: Enabling switch 2	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for enabling switch 2 panic position (ZS2).
Crossed connection error on: Activate drives or enable drives	Short-circuit TA24(A) / TA24(B). The signals "Activate drives" and "Enable drives" have been interchanged.	Check wiring of the input for Activate drives (AA) and Drives enable (AF).

12.18.7 Displaying all status bits

Procedure

- The states of the status bits of all available controllers in the ESC circuit and of the ESC nodes in the ESC circuit can be displayed by pressing the **Bit-Data** softkey (2).

Description

The node bits are sorted by node number from top to bottom (1). If there are two identical nodes in the ESC circuit (e.g. 2 KPS units), the designation of the nodes should be modified in the configuration. This makes it possible to assign them precisely.

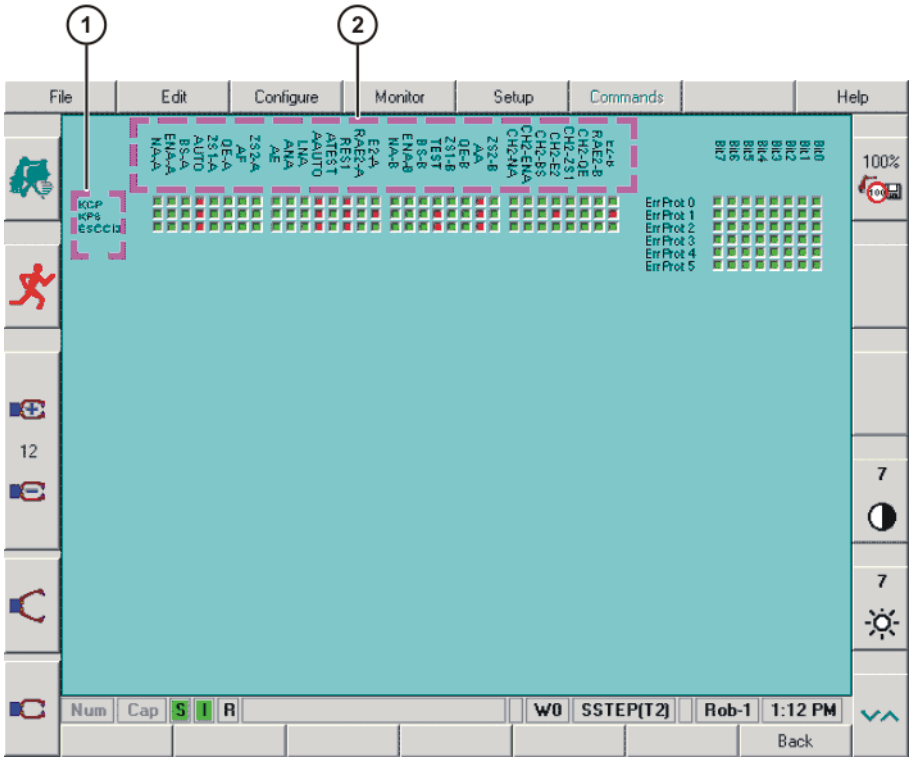

Fig. 12-29: State of the status bits in the ESC circuit

12.18.8 Configuring controllers

Preconditions

- A controller must be highlighted.
- Switch to Expert level.

Procedure

- Open menu by pressing the **Configure** softkey.

Description

All the nodes present in the ESC circuit are determined when the ESC diagnosis is started. The number of nodes and the order of the node types define the structure of the ESC circuit. A separate configuration can be defined for each structure. The ESC diagnosis loads the suitable configuration based on the structure it finds.

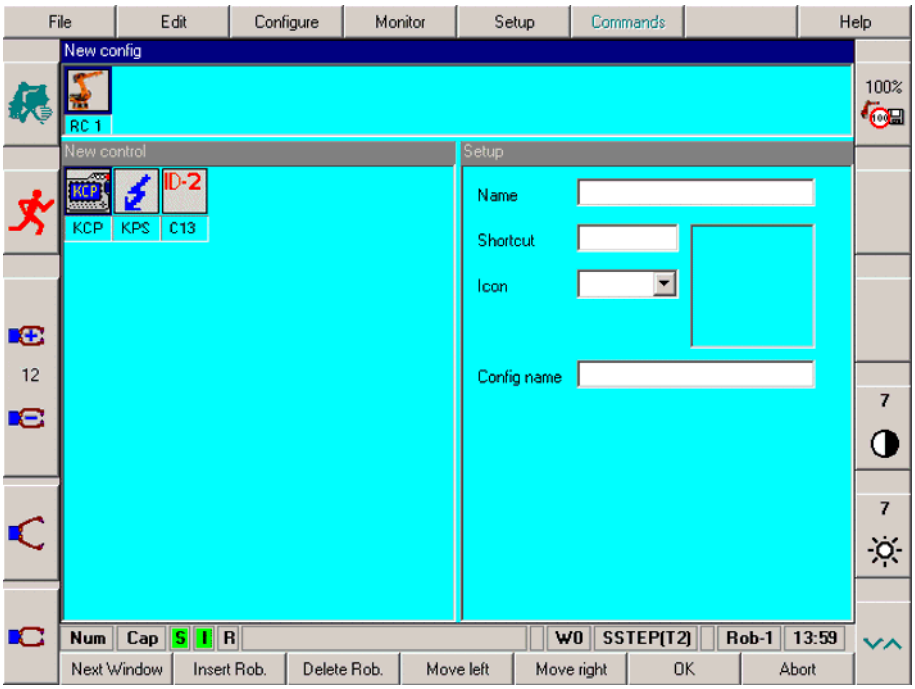

Fig. 12-30: Controller configuration menu

The KUKA default settings are overwritten.

Softkey

Softkey	Description
Next Window	The first node is highlighted.
Insert Rob.	A controller is added.
Delete Rob.	The selected controller is removed.
Move left	The selected controller is moved to the left.
Move right	The selected controller is moved to the right.
OK	Modifications are saved on the hard drive.
Abort	Closes the program without saving the changes.

The default setting envisages just one controller in an ESC circuit. If the ESC circuit passes through more than one controller, these additional controllers must be added manually.

12.18.9 Configuring the controller properties

Description

The four property boxes of the selected controller are displayed in the **Setup** menu. The controller designations are entered and modified in the property boxes.

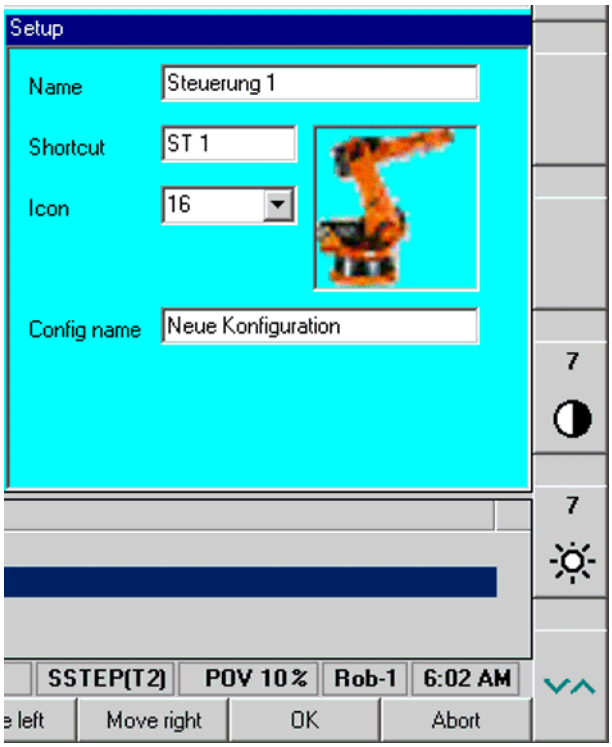

Fig. 12-31: Example: robot property boxes

Parameter	Description
Name	Name of the controller
Shortcut	Short designation of the controller
Icon	Controller icon
Config name	Name of the current configuration set

The contents of the **Config name** box are valid for all controllers. It is only necessary to enter the configuration name once.

12.18.10Configuring ESC nodes

Precondition

- A node must be highlighted.

Description

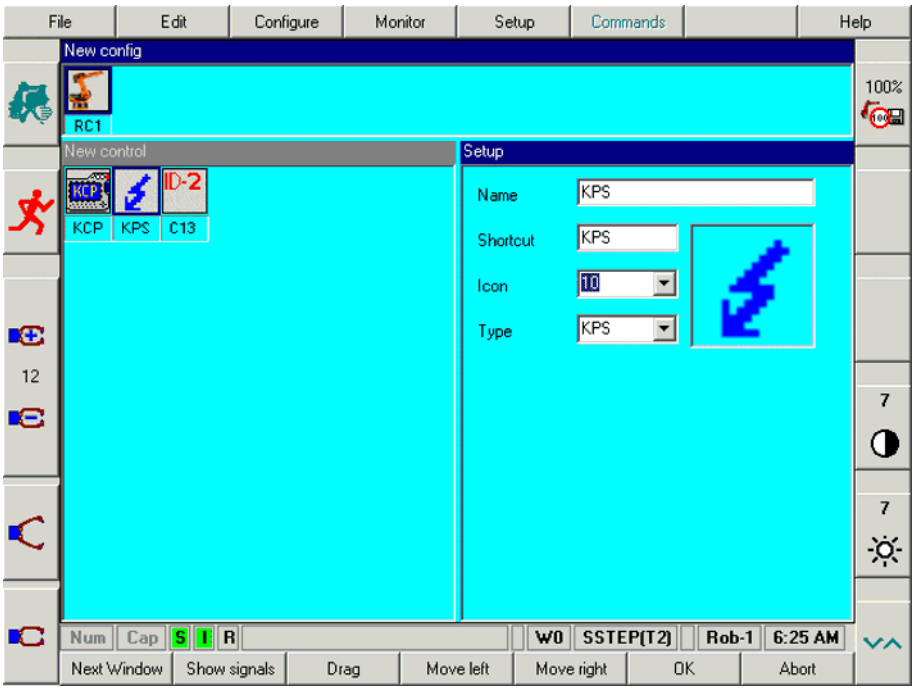

Fig. 12-32: Configuring ESC nodes

Softkey

Softkey	Description
Next Window	The first node is highlighted.
Show signals / Property	Toggles between configuring the properties and configuring the signals.
Drag / Drop	Assigns ESC nodes to a controller.
Move left	The selected ESC node is moved to the left.
Move right	The selected ESC node is moved to the right.
OK	Modifications are saved on the hard drive.
Abort	Closes the program without saving the changes.

12.18.11 Selecting the display for signals

Procedure

1. Select ESC node.
2. Display the signals of the ESC node by pressing the softkey **Show signals**. A list of all ESC signals appears. The softkey changes to **Property**.

Description

The up and down arrow keys can be used to select a signal. The display of the signals can be activated or deactivated for the ESC diagnosis by pressing the space bar.

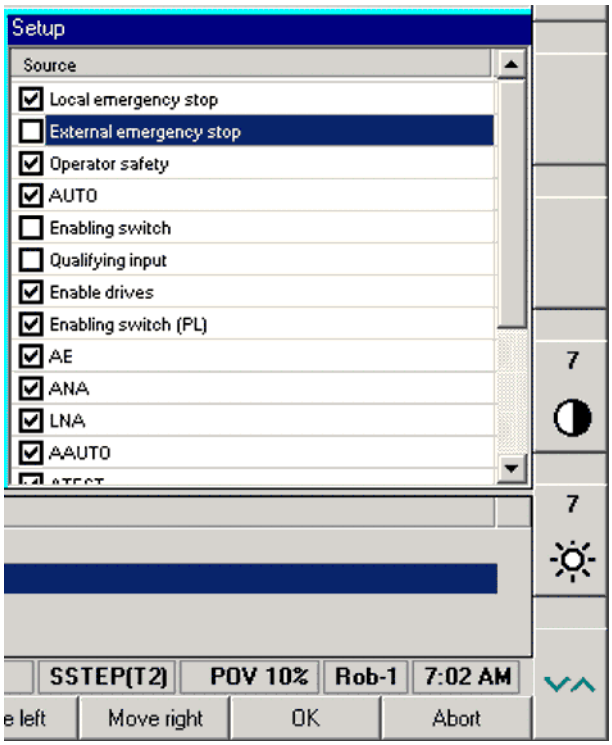

Fig. 12-33: Example: signals of a KCP ESC node

12.18.12Selecting the properties of the ESC node

Procedure

- Display the property boxes for by pressing the **Property** softkey.
  The property boxes of the selected ESC node are displayed and the softkey changes to **Show signals**.

Description

The four property boxes of the selected ESC node appear in the Setup menu. The node properties can be entered and modified in these property boxes.

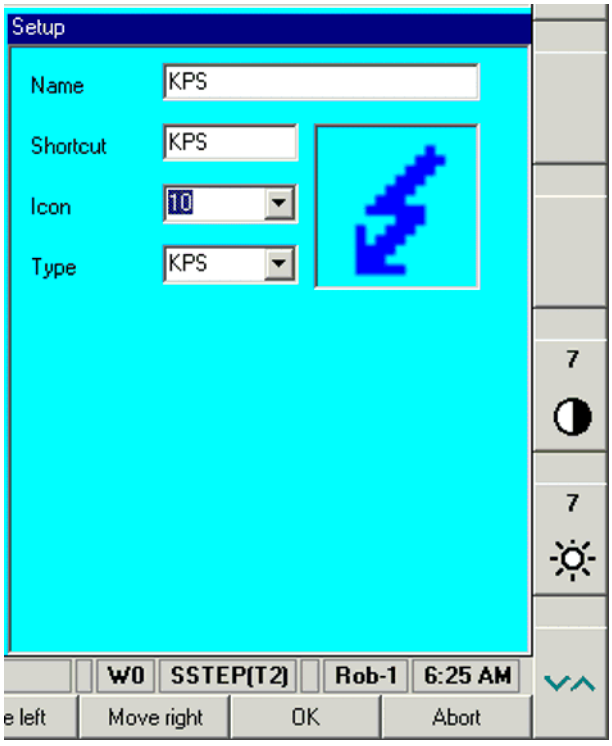

Fig. 12-34: Example: KPS property boxes

Parameter	Description
Name	Name of the node
Shortcut	Short designation of the node
Icon	Node icon
Config name	Name of the current configuration set

12.18.13Assigning ESC nodes to a controller

Description The softkeys can be used to assign an ESC node to a specific controller.

Procedure

1. Select the ESC icon to be moved.
2. Press the **Drag** softkey. The softkey changes to **Drop**.
3. Select the icon of the controller to which the ESC node is to be assigned.
4. Press the **Drop** softkey in the softkey bar. The selected ESC node is removed from the old controller, integrated into the new controller and added to the end of the ESC node list.

12.18.14Error messages and troubleshooting

Message text	Cause	Corrective action
Byte timeout during receipt of log	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring, check the CI3 board LEDs.
Checksum error in log	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Invalid header byte	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Interface error	Defective KCP or KPS, defective CI3 board, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Mode error	Defective KCP, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
No protocol received	Defective KCP, defective connectors or connecting cables, voltage dips.	Exchange the defective module, carry out a visual inspection of the bus wiring.
Initialization error	Two KCPs in the ESC circuit! Only one KCP (master) may be present in the circuit. Wrong configuration on ESC master (KCP).	Disconnect second KCP.
Configuration error	Wrong KCP used.	Exchange KCP.
Hardware fault	General message.	Hardware fault in node xx; observe other error messages.
PICA/PICB	ESC chip from which the message comes.	Relevant in the case of supervisor errors.

Message text	Cause	Corrective action
Communication error	Defective KCP, KPS or CI3 board, EMC interference, defective connectors or connecting cables.	Exchange the defective module, reduce the interference, carry out a visual inspection of the bus wiring.
Software error	-	Exchange module with software error.
I/O monitoring error	TA24V/A-B or input channels A/B interchanged, drives contactor return not connected.	Check the wiring to the inputs and the external contactor.
RAM error	RAM error.	Exchange module.
Relay error	Two modules are active, the relay on the module is stuck, or two operating modes are selected.	Exchange CI3 board.
Output error	General message.	
Output error: operating mode	Relay error (operating mode), incorrect KCP variant, defective mode selector switch on cabinet.	Exchange CI3 board.
Output error: drives contactor auxiliary contact	Auxiliary contact or coil not wired, or wired incorrectly, jumper not plugged in, KPS defective.	Check wiring to external contactor (auxiliary contact), check jumper X123 on KPS600, exchange KPS600.
Output error: local E-STOP	Relay error (EMERGENCY STOP).	Check periphery.
Output error: AE coil	Mains contactor fault.	Check wiring to external contactor, exchange KPS600.
Crossed connection error on: Local E-STOP	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for local E-Stop (NA).
Crossed connection error on: External E-STOP	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for external E-Stop (ENA).
Crossed connection error on: Operator safety	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for operator safety (BS).
Crossed connection error on: Qualifying input	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for qualifying input (QE).
Crossed connection error on: Enabling switch 1	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for enabling switch 1 (ZS1).
Crossed connection error on: Mode selector switch	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for operating mode (Auto/Test).
Crossed connection error on: E2 keyswitch	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for keyswitch E2.

Message text	Cause	Corrective action
Crossed connection error on: Enabling switch 2	Short-circuit TA24(A) / TA24(B). Single-channel wiring. Channels A-B interchanged.	Check wiring of the input for enabling switch 2 panic position (ZS2).
Crossed connection error on: Activate drives or enable drives	Short-circuit TA24(A) / TA24(B). The signals "Activate drives" and "Enable drives" have been interchanged.	Check wiring of the input for Activate drives (AA) and Drives enable (AF).

13 KUKA Service

13.1 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.

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

Information

The following information is required for processing a support request:

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

13.2 KUKA Customer Support

Availability

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

Argentina

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